# Mobile Coverage and its Impact on Digital Financial Services

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**ABSTRACT**[3]

Digital Financial Services (DFS) is a relatively recent mobile-centric financial inclusion innovation in developing countries. Using ubiquitous mobile phones as the means of service access, DFS provides the unbanked and underserved - many of whom live in rural areas - with access to basic financial services provided by banks and non-banks such as mobile network operators and third party DFS providers (DFSPs).

With mobile phones as the primary access mechanism for services, access to DFS is highly dependent upon the degree and quality of mobile coverage offered by mobile network operators (MNOs).

User interfaces (UIs) for access to DFS are mostly dependent on the type of mobile coverage available which in many cases in the developing world is via slower (narrowband) second generation (2G) GSM technology. Faster broadband third (3G) and fourth generation (4G) mobile coverage is available in most developing world countries, but is mostly limited to urban and peri-urban areas and along national road corridors.

Our study finds that the type of mobile coverage provided has a significant effect on the DFS UI and type of mobile phone that can be used for DFS access. Feature phones and Unstructured Supplementary Service Data (USSD) transactions continue to be the choice for the vast majority of (mobile money) users. Faster mobile broadband technologies are optimal for smartphone use – or hybrid smartphones in feature phone format - which can provide superior and more intuitive graphical user interfaces.

Indeed, the primacy of 2G coverage in developing countries where DFS is prevalent forces DFS customers to use non-intuitive, coverage-sensitive, text-based UIs -- particularly USSD -- and also STK on only 2G-centric basic and feature phones (or its limited, near equivalent on smartphones.) These UIs and resultant user experiences (UX) are sensitive though to the quality of the mobile coverage and signal, and limit the suite of potential services than can be provided to customers to primarily basic transactional 'DFS 1.0' type of services. Inconsistent coverage also forces users to have SIM cards and prepaid accounts for all MNOs they anticipate can provide service at particular locations. Frontline signup and cash handling services are mostly provided by agents who are similarly dependent on availability of mobile coverage of adequate quality.

Use of smartphone-type applications using a graphical menu system can provide a more intuitive UI/UX and well as being more capable of offering a larger suite of services that including easier credit provision and information as well as agent rating and liquidity mapping, but the ability to properly use them is highly dependent on the availability and quality of broadband coverage signals.

We find that the lack of broadband coverage – and fallback dependency on coverage-sensitive 2G-based UIs for DFS provision (primarily via USSD) - handicaps progress to more comprehensive service offerings as well as creating potential competition bottlenecks and system security risks in DFS provision. We define the evolution of DFS offerings as from DFS 1.0 o DFS 4.0, with DFS 1.0 being foundation, basic services such as including simple

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person-to-person (P2P) value transfers. The net result is that rural residents, for the most part, will have to make do with the foundational DFS services because of their reliance on 2G-based coverage and thus UIs. They will not necessarily have access to the same suite of services available to those in urban and peri-urban areas, invariably perpetuating rural-urban financial service access divides.

Growth and security of, and sustained user interest in the DFS ecosystem at a national level then is inexorably linked to the type and quality of mobile coverage available to current and potential DFS customers. Noting this crucial symbiosis between mobile coverage and the provision and evolution of DFS, this study documents the current state, limitations, and bottlenecks and potential strategies and methods for expanding mobile coverage. The role of regulators and other authorities in the coverage expansion process is also examined.

We look at why there is no impetus to national mobile broadband coverage. Findings from our research suggest that provision of mobile coverage in rural areas in developing countries does not provide an adequate return on investment for MNOs and that in many cases because of expansion costs and costs to upgrade from 2G to 3G and higher services, 2G services will be the only technology provided to rural areas by individual MNOs. Indeed, these MNOs may labor under huge debt – and some have shuttered or merged - in attempting to undertake this expansion, one of the primary reasons regulators we canvassed indicated that they have not mandated national mobile broadband provision by individual licensees. We find generally too that national upgrades of 2G infrastructure by a single MNO for provision of broadband speeds for its own customers provides a poor ROI relative to the CAPEX costs required, which must now also include expensive backhaul provision to maintain broadband quality of service levels.

Instead of 'solo' expansion by MNOs from 2G to 3G and higher using their own financial resources, expansion and provision of coverage – be it 2G or higher – in rural areas to achieve near-national mobile broadband provision requires either subsidization of the infrastructure installation and operation; or requires infrastructure sharing between MNOs; or is provided through national wholesale networks; or through provision of turnkey infrastructure by third party tower companies. Further, new 'digital dividend' spectrum resulting from a switchover to digital television and also made available by regulators through auctions and sales may significantly enhance the degree and quality of mobile coverage since fewer mobile base stations would be needed to cover wider surface areas. Evolving innovations such as provision of coverage direct to customers by drones, new low-power mobile base stations, micro-satellites and balloons also hold promise but some are far off from commercial provision. New 'data-lite' smartphones, operating systems and apps that operate relatively efficiently in narrowband environments also hold promise in spurring national DFS 2.0 availability and adoption but are still in early stages of development and maturity.

We find that, besides limiting progression to DFS 2.0 type of services and providing a poor UX, there are also downstream competition and security related effects of not expanding or enhancing beyond the 2G-only coverage. On competition-related concerns, access to DFS via existing 2G-type UIs may be restricted by competing MNOs who control critical USSD or other gateways, with 2G-only coverage likely to be the default coverage for a number of years yet in rural areas in the developing world, competition issues are likely to manifest concurrently and will require regulatory intervention and not as it is often now, forbearance. Security concerns relate to the inherent insecurity of 2G technologies, such as USSD in use for DFS provision, such their use as a primary UI poses risks to the security of the DFS ecosystem as is currently configured. These concerns and current and potential responses from regulators are also discussed.

A stylized graphical matrix of the coverage issues, their implications as well as potential solutions is provided in Exhibit 1. To navigate the study and before beginning the reading of the paper, readers are urged to first view this stylized graphical matrix of the issues which are divided into three parts: A: infrastructure expansion; B: 2G-related issues; and C: Outcomes. We also include specific country-focus annexures on the effect of coverage on DFS in India and Uganda.

**TABLE OF CONTENTS**

1 Introduction 11

1.1 Overview 11
1.2 Problem Statement 14
1.3 Methodology and Approach 16

2 Role of Mobile-Based Services in Financial Inclusion 17

2.1 Comparative Global Overview of Mobile-based Payment Services 17

3 Technologies Used to Access DFS 21

3.1 Overview 21
3.2 Mobile Infrastructure Level 22

3.2.1 Mobile Network Evolution 22

A Narrowband Mobile Data Technologies 23
3.2 GPRS and EDGE 23
B Broadband Mobile Data Technologies 23
3.3 3G Technologies 23
3.4 4G Technologies 23

3.5 5G Technologies 24

3.6 Mobile Phone Types Used in DFS 25
3.7 User Interfaces to DFS Services 26

A Native Phone Interfaces 26
3.7.1 GSM Voice Channel 26
3.7.2 Unstructured Supplementary Service Data 26
3.7.3 Short Message Service 27
3.7.4 SIM Toolkit 27
B. Application Based 28
3.7.5 Java Applications 28
3.7.6 Feature Phone Applications 28
3.7.7 Smartphone Applications 29

4 Law and Regulation 31

4.1 Overview 31
4.2 DFS Related 32
4.3 Mobile-Coverage Related 32

4.3.1 Telecommunications 32
4.3.2 Universal Service Funds 32
4.3.3 Environmental 33
4.3.4 Competition 33
4.3.5 Municipal 33
4.3.6 Military / Intelligence 33
4.3.7 Ministries of ICT 33

5 Mobile Coverage Components 34

5.1 Overview 34
5.2 Mobile Network Infrastructure 34

5.2.1 Components 34

5.2.1.1 Overview 34
5.2.1.2 Backbone 35
5.2.1.3 Backhaul 35
5.2.1.4 Access Network or 'Last Mile' 36
5.2.1.5 Challenges of Expanding Mobile Coverage to Rural Areas 36

5.3 Infrastructure Deployment 37
5.3.1 Overview 37
5.3.2 Standalone Deployment & Shared Networks 37
5.3.2.1 Standalone 37
5.3.2.2 Shared 38
5.4 Financial Considerations for MNOs in Coverage Provision and Upgrades 39
5.4.1 Costs of Building New Base Stations in Rural Areas 39
5.4.2 ROI Considerations in Migrating from 2G to 3G and Higher Coverage 42
5.4.3 Financing Expansion and Upgrades 43
5.5 Mobile Spectrum 45
5.5.1 Overview 45
5.5.2 Spectrum Basics & Mobile Coverage 45
5.5.3 Spectrum Management 46
5.5.3.1 Overview 46
5.5.3.2 International Management 47
5.5.3.3 Regional Management 47
5.5.3.4 National Management 47
5.5.3.4.1 Overview 47
5.5.3.4.2 Allocation 48
5.5.3.4.3 License Types 49
5.5.3.4.4 License Terms 50
5.6 Quality of Service 51
5.6.1 Overview 51
5.6.2 Role of National Telecommunications Authority 51
6 Competition & Quality of Service-Related Implications 53
6.1 Overview 53
6.2 USSD-related Competition Issues 54
6.2.1 Access to the USSD gateway or USSD components 54
6.2.2 Access to USSD Short Codes 55
6.2.3 Length of a USSD Session 55
6.2.4 Quality of Service in USSD Sessions 55
6.3 SIM Toolkit-Related Competition Issues 56
6.3.1 STK Access 56
6.3.2 Access to STK Gateway 56
6.3.3 SIM Menus 56
6.3.4 Access to Short Codes 56
6.3.5 Pricing of STK access 56
6.4 Regulatory Responses 56
7 Expanding and Improving Mobile Coverage 58
7.1 Overview 58
A Policy Driven 58
7.2 Universal Service and Universal Broadband 59
7.2.1 Universal Service Funds 59
7.2.2 Universal Broadband Service 60
7.3 New Spectrum Provision for Use in DFS 61
7.3.1 Overview 61
7.3.2 Digital Dividend Improving Coverage Range 61

7.3.3 Provisioning Policies and Methodologies 62
7.3.3.1 Overview 62
7.3.3.2 Objectives 62
7.3.3.3 Methodologies 63
7.3.3.3.1 Administrative Assignment 64
7.3.3.3.2 Auctions 64
7.4 Infrastructure & Spectrum Sharing 66
7.4.1 The Nature of Infrastructure Sharing 66
7.4.1.1 Passive Sharing 67
7.4.1.2 Active Sharing 68
7.4.2 Legal and Regulatory Aspects of Infrastructure Sharing 69
7.4.3 Spectrum Sharing 69
7.4.4 Network: Open Access Networks 70
7.4.5 Third Party Provision: Tower and Infrastructure Companies 71
7.4.5.1 Overview 71
7.4.5.2 What Tower Companies Provide 72
7.4.5.3 Legal and Corporate Structure 73
B Technology Driven 74
7.5 Innovation in Mobile Coverage & Access Solutions 74
7.5.1 Overview 74
7.5.2 Atmospheric 74
7.5.2.1 Project Loon 74
7.5.2.2 AT&T Flying COW Drones 75
7.5.2.3 Facebook Aquila 75
7.5.2.4 SpaceX 76
7.5.3 Terrestrial 76
7.5.3.1 TIP and OpenCellular: 76
7.5.3.2 Innovation in Antenna Technologies 76
7.5.3.3 Low-power Mesh Base Stations for Rural Areas 77
7.5.4 Mobile Phone Innovations 77
7.5.4.1 Hardware and System on a Chip 77
7.5.4.2 Operating Systems and Software 78
7.5.4.3 Thin SIM Solutions 78
8 Conclusions 79
Annex B: Country Focus: Uganda 85
Annex C: Universal Service Fund Policies and Use 89
Annex D: Wireless Open Access Networks 91
Annex E: Deployment Planning 96
Annex F: Spectrum Assignment Types 98

**TABLE OF EXHIBITS**

**Exhibit 1:** Stylized Mobile Coverage Solutions Matrix 11
**Exhibit 2:** Mobile Broadband: Coverage and Penetration 14
**Exhibit 3:** Characteristics of DFS Phone Types 18
**Exhibit 4:** Crises Responses, DFS and the Role of Mobile Coverage 19
**Exhibit 5:** Location of DFS Agents in Uganda 22
**Exhibit 6:** USSD-Based DFS Transaction Menu 26
**Exhibit 7:** Wave Money Myanmar USSD Menu 27

**Exhibit 8:** Chart of UIs: Comparative Mobile Coverage and Anti-Competitive Sensitivities 28
**Exhibit 9:** Regulators and Authorities: Their Remits Over Mobile Coverage Components 30
**Exhibit 10:** Layers of Mobile Communications Network 34
**Exhibit 11:** Basic Components of a Mobile Base Station 36
**Exhibit 12:** Cost Components for Mobile Base Station Sites for India, UK and China 40
**Exhibit 13:** Costs of Provision of Mobile Technologies 42
**Exhibit 14:** Base Stations Needed Per Radio Spectrum Band 46
**Exhibit 15:** Call Drop QOS Percentages 53
**Exhibit 16:** Steps to Provision USSD & STK Services by Non-MNO DFS Providers 55
**Exhibit 17:** Approaches to Spectrum Valuation 66
**Exhibit 18:** Examples of Failed Spectrum Allocations in DFS-Focused Countries 67
**Exhibit 19:** Types and Impact of Infrastructure Sharing. 69
**Exhibit 20:** Infrastructure Sharing Models 70
**Exhibit 21:** Towerco Growth in Sub-Saharan Africa by Tower Count 75

## ABBREVIATION

| | |
|---|---|
| 1G | First Generation Mobile |
| 2G | Second Generation Mobile |
| 3G | Third Generation Mobile |
| 4G | Fourth Generation Mobile |
| 5G | Fifth Generation Mobile |
| AML | Anti-Money Laundering |
| AMR | Adaptive Multirate |
| AWS | Advanced Wireless Services |
| BOP | Bottom of the Pyramid |
| BTS | Base Transceiver Station |
| CAPEX | Capital Expenditures |
| CBK | Central Bank of Kenya |
| CCK | Communications Commission of Kenya |
| CDMA | Code Division Multiple Access |
| CFT | Countering the Financing of Terrorism |
| CGAP | Consultative Group to Assist the Poor |
| CICO | Cash In / Cash Out |
| COLT | Cell on Light Truck |
| COW | Cell on Wheels |
| CSIR | Council for Scientific and Industrial Research |
| DD | Due Diligence |
| DFI | Digital Financial Inclusion |
| DFS | Digital Financial Services |
| DFSP | Digital Financial Services Provider |
| ECLAC | Economic Commission for Latin America and the Caribbean |
| EDGE | Enhanced Data for Global Evolution |
| ETSI | European Telecommunications Standards Institute |
| FCC | Federal Communication Commission |
| FRAND | Fair, Reasonable and Non-Discriminatory |
| GHz | Gigahertz |
| GPRS | General Packet Radio Services |
| GSM | Global System for Mobile Communications |
| GSMA | GSM Association |
| GUI | Graphical User Interface |
| HSPA | High Speed Packet Access |
| HSDPA | High Speed Downlink Packet Access |
| HSUPA | High Speed Uplink Packet Access |
| Hz | Hertz |
| ICT | Information and Communication Technology |
| ID | Identification |

| | |
|---|---|
| IEEE | Institute of Electrical and Electronics Engineers |
| IFSC | Indian Financial System Code |
| IMEI | International Mobile Equipment Identity |
| IMT | International Mobile Communications |
| IP | Internet Protocol |
| ITR | International Telecom Regulation |
| ITU | International Telecommunications Union |
| IVR | Interactive Voice Response |
| Kbps | Kilo Bits Per Second |
| kHz | Kilohertz |
| Km | Kilometer(s) |
| KYC | Know Your Customer |
| LDC | Least Developed Countries |
| LEO | Low Earth Orbit |
| LONO | Letter of No Objection |
| LTE | Long Term Evolution |
| LTE-A | LTE Advanced |
| m | Meter(s) |
| MB | Megabytes |
| Mbps | Mega Bits Per Second |
| MFS | Mobile Financial Services |
| MHz | Megahertz |
| MNO | MNO |
| MIMO | Multiple Input Multiple Output |
| MO | Mobile Originated |
| MVNO | Mobile Virtual Network Operator |
| NGO | Non-Governmental Organization |
| NI | Network Initiated |
| NLOS | Non Line of Site |
| NTA | National Regulatory Authority |
| NSDT | Near Sound Data Transfer |
| NTFA | National Table for Frequency Allocation |
| WOAN | Open Access Network |
| OECD | Organisation for Economic Co-operation and Development |
| OPEX | Operational Expenditures |
| OTA | Over the Air |
| OTC | Over the Counter |
| OTT | Over the Top |
| PIAAC | Programme for the International Assessment of Adult Competencies |
| P2P | Person to Person |
| POS | Point of Sale |
| PPP | Public Private Partnership |
| QOS | Quality of Service |

| | |
|---|---|
| RAN | Radio Access Network |
| RF | Radio Frequency |
| RFID | Radio Frequency Identification |
| SDR | Software Defined Radio |
| SMS | Short Message Service |
| SOC | System on a Chip |
| SP | Service Provider |
| SS7 | Signaling System 7 |
| STK | SIM Toolkit |
| SWN | Single Wholesale Network |
| Towerco | Tower Companies |
| TIP | Telecom Infra Project |
| TRAI | Telecom Regulatory Authority of India |
| TSP | Technical Service Provider |
| UCC | Uganda Communications Commission |
| UHF | Ultra High Frequency |
| UI | User Interface |
| UMTS | Universal Mobile Telecommunications System |
| UNCDF | United Nations Capital Development Fund |
| UNESCO | United Nations Educational, Scientific and Cultural Organisation |
| US | United States |
| USAF | Universal Service Access Fund |
| USF | Universal Service Fund |
| USSD | Unstructured Supplementary Service Data |
| UX | User Experience |
| VAS | Value Added Services |
| VAT/GST | Value Added Tax / Goods and Services Tax |
| VHF | Very High Frequency |
| VLEO | Very Low Earth Orbit |
| VoLTE | Voice over Long Term Evolution |
| WAP | Wireless Access Protocol |
| WCDMA | Wideband Code Division Multiple Access |
| WIB | Wireless in Browser |
| WOAN | Wholesale Open Access Network |
| WRC | World Radio Congress |

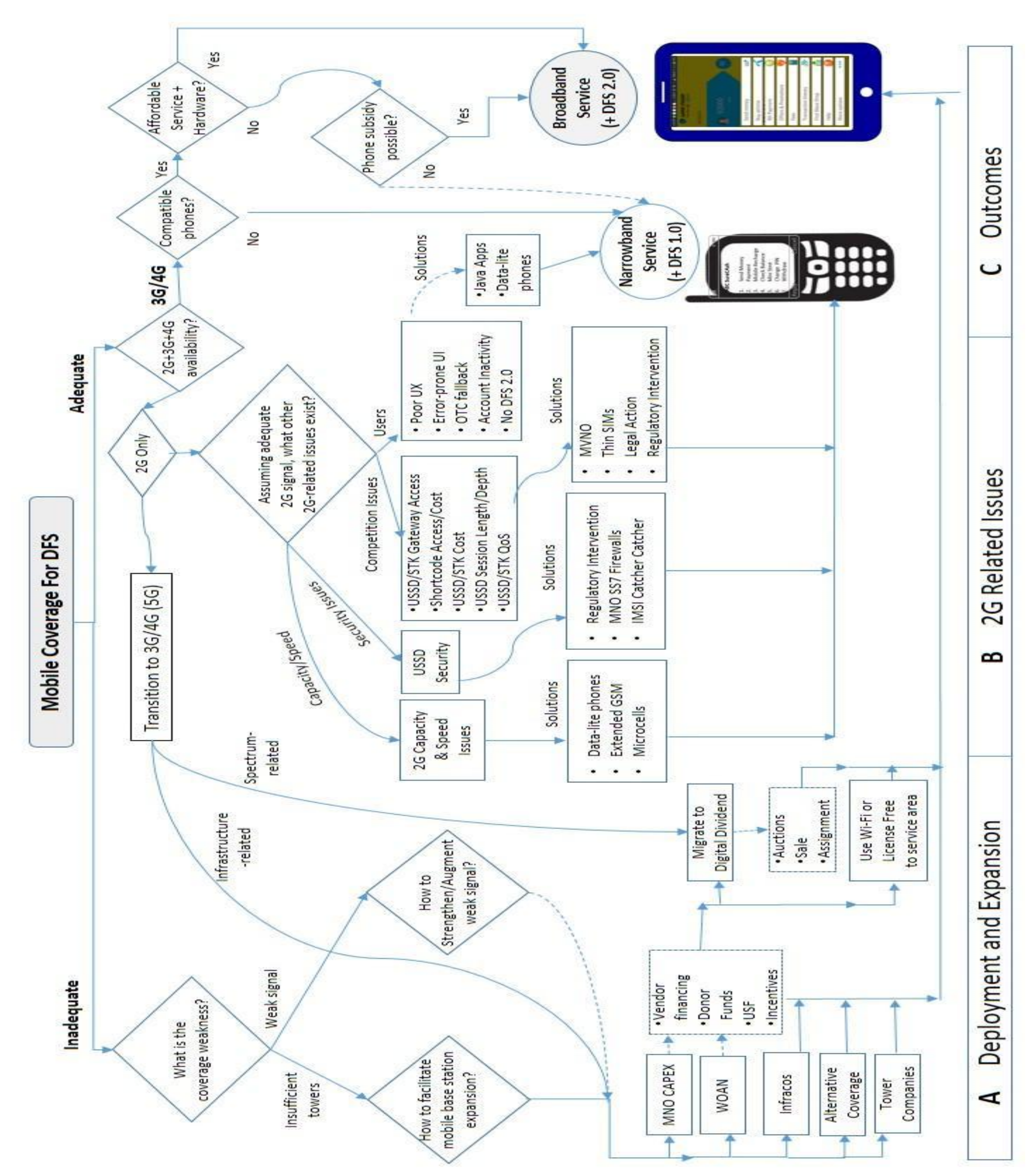


**Exhibit 1:** Stylized Mobile Coverage issues and Solutions Matrix. A stylized matrix summarizing mobile coverage issues, their implications for DFS as well as potential solutions. **Part A** shows methods of infrastructure expansion and improvement, and financing options. **Part B** shows the implications of continuing with 2G (narrowband)-based provision of DFS; and **Part C** shows the outcomes of both narrowband and broadband DFS provision. The dotted lines and boxes represent optional solutions. This assumes there is coverage.

## 1 INTRODUCTION

### 1.1 Overview

Digital Financial Services (DFS) is a relatively new,[4] low-cost means of digital access to transactional financial services.[5] Aimed at those at the Bottom of the Pyramid (BOP) in developing and emerging countries[6] and with an aspirational goal of improving financial inclusion,[7] it shifts provision of financial services from primarily banks to non-banks, [8] with the core access to services using a mobile phone.[9]

With its increasing ubiquity and expansion of basic mobile coverage across emerging and developing countries, new technologies and innovations in vendor platforms have facilitated the use of the mobile phone to evolve from a basic telecommunications utility of calls and messages to that of a new enhanced role as a payment and person-to-person (P2P) transfer instrument. The most proximate means then to facilitate formal financial inclusion and thus access to formal services is through development of a DFS ecosystem that can provide ubiquitous and low cost national access to Digital Financial Service Providers (DFSPs) and banks primarily through the use of low-cost mobile phones operating off mobile networks. Mobile coverage to make DFS available is provided in large measure by licensed MNOs or by third parties contracted to the MNO.

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[4] While DFS is a relatively new term, its scope includes even an early implementation of a mobile phone-centric transactional financial ecosystem was launched in 2001 in the Philippines. It was initially called 'mobile banking,' later 'mobile money,' then 'mobile financial services,' and leading to the contemporaneous term DFS.

[5] See **Exhibit 3** below on sample of conceptions of DFS through the lens of industry observers, regulators and participants

[6] In this paper, the DFSO follows the UNDP classification of developed and developing countries for the most part. It uses the Human Development Index (HDI) to classify countries. HDI is a composite index of three indices that measure longevity, education and income in a country to classify countries. Developed countries are countries in the top quartile of the HDI distribution and developing countries are countries in the bottom three quartiles. The term developing countries is however being used loosely in this paper. In the DFSO's research of developing countries, we also included countries that may not necessarily be in the lower three quartiles of the HDI distribution but have high financial exclusion and can benefit from the use of DFS, for example Brazil and Russia. Nielsen, L (2011) *Classification of Countries Based on their Level of Development*, available at https://bit.ly/2JEg4n7; and UNDP (2018) *Human Development Index*, available at http://hdr.undp.org/en/content/human-development-index-hdi

[7] 'Financial inclusion' is often defined as the provision and use of formal accounts operated by regulated entities that cater to those at the Bottom of the Pyramid. National financial inclusion goals are aimed at lowering account costs, allowing for greater proximity to financial intermediaries, enforcing stronger legal rights, facilitating better management of financial risk to lead to more politically stable environments; and to drive development through access to more capital. See World Bank Group (2018) *The Global Findex Database 2017,* available at https://globalfindex.worldbank.org; and Franklin, A, Demirguc-Kunt, A, Klapper, L, *et al.* (2016) *The Foundations Of Financial Inclusion: Understanding Ownership And Use Of Formal Accounts*, available at https://bit.ly/2LTBLRr. For an overview of national financial inclusion schemes and policies, see World Bank (2015*) Overview: National Financial Inclusion Strategies,* available at https://bit.ly/2LXjB0m The *Global Partnership for Financial Inclusion (*GPFI) describes a generalized path approach to financial inclusion, based on the assumption that there is one path that describes a country's journey toward full financial inclusion which is applicable to all countries. Each country follows the path – usually in its own financial inclusion strategy - but is at a different position on the path. See GPFI (2103) *Financial Inclusion Targets and Goals: Landscape and GPFI View*, available at https://bit.ly/2ABa0co. Many central banks signed what is now known as the 'Maya Declaration,' a statement of common principles regarding the development of financial inclusion policy made by a group of developing nation regulatory institutions during the Alliance for Financial Inclusion's 2011 Global Policy Forum held in Mexico. See AFI (2011) *Maya Declaration,* available at http://www.afi-global.org/gpf/maya-declaration

[8] The GPFI says that an appropriate range of quality financial services helps household's smooth consumption, mitigate and manage risks, build assets, and create the peace of mind needed to make effective decisions about the future. Financial inclusion goals may include. Ibid. There are other international bodies that have developed financial inclusion principles for countries to follow. For example, the UN's Sustainable Development Goals (SDGs) at https://sustainabledevelopment.un.org/sdg16, , and the Better Than Cash Alliance (BTCA).

[9] The moniker 'mobile money' and 'mobile financial services' often refers to some or all of evolving DFS components. Mobile money is the term used by the GSM Association (GSMA) to describe all mobile phone-based financial transactions. See GSMA (2018) *2017 State of the Industry Report on Mobile Money*, available at https://bit.ly/2IvPZ94

DFS often fills a gap left by banks who have been unable or unwilling to service those at the BOP, [10] and features non-banks now providing the financially excluded with an alternative to reliance on cash as a means of payment and transfer. The need for alternative means of access to financial services in many parts of the developing world has its genesis in the needs,[11] challenges[12] and constraints[13] of predominantly cash-based economies using informal means of financial access that do not involve bank accounts.[14] Those without access to financial products are also variously referred to as being 'unbanked,' 'unserved' or 'underserved.'[15]

The success of this transition is evident recent IMF data which shows that DFS use has grown to outgrow bank account us e in many developing and emerging economies..[16] Findings from other surveys however indicate that usage levels are very low.[17] 'Findex' survey data from the World Bank[18] indicates that some 515 million adults opened new accounts in the last three years.[19]

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[10] The term BOP was introduced sometime in 1999 by Prahalad and Hart to describe what they observed were 'Four Consumer Tiers.' At the very top of the world economic pyramid, they said were 75 to 100 million affluent Tier 1 consumers from around the world, comprising a cosmopolitan group of middle- and upper-income people in developed countries and the few rich elites from the developing world. In the middle of the pyramid, in Tiers 2 and 3, are poor customers in developed nations and the rising middle classes in developing countries, the targets of past emerging-market strategies. Tier 4, they indicated, were the 4 billion people at the bottom of the pyramid who had an annual per capita income — based on purchasing power parity in US dollars — is less than USD 1,500, the minimum considered necessary to sustain a decent life. For well over a billion people — roughly one-sixth of humanity — per capita income is less than USD 1 per day. See Prahalad, C & Hart. S (1999) *Strategies for the Bottom of the Pyramid: Creating Sustainable Development*, available at https://bit.ly/2OdTYsV. For an analysis of the BOP concept years later with revised figures, see Kolk, A, Rivera-Santos, M & Rufin, C (2012) *Reviewing a Decade of Research on the 'Base/Bottom of the Pyramid' (BOP) Concept*, available at https://ssrn.com/abstract=2193938

[11] For example, low-cost and proximate access to basic financial services.

[12] For example, lack of an ID for DFS onboarding and usage purposes; affordability of access mechanisms such as even feature phones; slow, unreliable or even non-existent mobile coverage; financial and technical illiteracy; and often significant gender biases that preclude women from having direct access to financial services and even identity documents. For a recent gender perspective on regulatory enablers for DFS, see Bin-Humam, Y; Izaguirre, J-C; & Hernandez, E (2018) *Regulatory Enablers for Digital Finance: A Gender Perspective*, available at https://bit.ly/2PV4SFz; and Perlman, L & Gurung, N (2018) *Focus Note: The Use of eIDs and eKYC for Customer Identity and Verification in Developing Countries: Progress and Challenges*, available at www.dfsobservatory.com

[13] Differences may include often system-wide lack of ID documents and financial history for Customer Identification and Verification (CIV) and Anti-Money Laundering (AML) purposes; use of a feature phones for access to accounts rather than (bank) branches or full web-based interfaces; technological capabilities and financial literacy of users; use of human agents rather than bank branches; and the entry and proliferation of non-bank providers. See also Evans, O (2016) *Determinants of Financial Inclusion in Africa: A Dynamic Panel Data Approach,* available at https://bit.ly/2sEiD0V

[14] Since banks have traditionally been the front-line for the provision of financial services such as savings accounts and for remittances, the financially excluded have also been referred to as being unbanked, unserved and underserved. Sahay, R, Čihák, M, N'Diaye, P, *et al.* (2015) *Rethinking Financial Deepening: Stability and Growth in Emerging Markets*, available at https://bit.ly/1K4Gb3d

[15] For a discussion of these terms, see Lyman, T & Kate Lauer (2015) *What is Digital Financial Inclusion and Why Does it Matter?*, available at https://bit.ly/1GX1xdJ; and Evans, O (2016) *Determinants of Financial Inclusion in Africa: A Dynamic Panel Data Approach,* available at https://bit.ly/2sEiD0V

[16] The IMF's Financial Access Survey results of 2018 showing the encouraging growth of 'mobile money' accounts in low and middle-income countries. Bank accounts reflect deposit accounts with commercial banks while 'mobile money' accounts reflect registered accounts. IMF (2018) *IMF Releases the 2018 Financial Access Survey*, available at https://bit.ly/2AoLKKv. Data is from the Survey and IMF staff calculations and covers 2017 or the most recent 5-year period for reporting countries

[17] See **Section** 3.2.3 on DFS activity levels; and GSMA (2018) *2017 State of the Industry Report on Mobile Money*, available at https://bit.ly/2IvPZ94

[18] World Bank Group (2018) *The Global Findex Database 2017,* available at https://globalfindex.worldbank.org/

[19] As noted by the UNSGSA, the power of the Findex lies in the details—the kind of details policymakers, financial sector providers, and development organizations need to measure progress, understand impact, and plan for the future. See UNSGSA (2018) *Financial Inclusion*, available at https://bit.ly/2qfOcNI

Hence with adults in emerging and developing countries not having a bank account but having a mobile phone,[20] provision of financial services via a mobile phone to the underserved and under-banked is seen as a panacea in improving financial inclusion. But with the mobile phone as the primary access mechanism for DFS, access to DFS is inexorably dependent on the degree and quality of mobile coverage provided by MNOs.

In essence, this may mean that there may be no coverage or poor coverage, or unreliable access to DFS. That is, mobile coverage is not a given, nor is the type and quality thereof often adequate enough to facilitate access to the myriad of potential and evolving DFS transactional facilities. A particular challenge is that mobile coverage in many DFS-focused countries is still largely characterized by low speed 'second generation' (2G) 'narrowband' technologies developed in the 1980s and 1990s. In contrast, newer third generation technologies (3G) and higher fourth generation (4G) 'broadband' coverage in these countries is often limited to urban and peri-urban areas and along national roads. A similar situation will probably arise with the advent of fifth generation (5G) technologies.

This asymmetry in type of coverage means that rural users of DFS – often the most financially excluded - are forced to use non-intuitive text-based and coverage-sensitive 2G-centric text-based user interfaces (UIs) such as Unstructured Supplementary Service Data (USSD)[21] and SIM Application Toolkit (STK).[22] Feature phones and (USSD) transactions continue to be the choice for the vast majority of (mobile money) users.[23] The more intuitive DFS UIs require broadband 3G or 4G or higher speeds, but which may be largely absent in these areas. Hence not only does coverage type and quality have an impact on the type of services that can be provided, but this may also have downstream competition-related causation that requires the intervention of a regulator, or which may lead to legal action to force MNOs to provide access by DFSPs with access to the 2G-based MNO facilities required for DFS access, such as USSD.

An exception – brief, but perhaps a growing one[24] – to the well-understood nexus between feature phone use of text-based UIs such as STK and USSD for DFS access is the growing use of Kaios[25] feature phone operating system is designed as a hybrid between a smartphone and feature phone operating system. [26] This OS has had huge uptake in India where MNO Jio's 'JioPhone' is given away virtually free.[27] It has a feature phone form with the Kaios graphical UI and has even 4G access.

We begin the study by distilling these interrelated issues and possible implications into our problem statement in Section 1.2.

Next, Section 2 provides an overview of mobile-based DFS and will explain how DFS evolved from foundational basic 'DFS 1.0' type of 'mobile money' transactions to more sophisticated 'DFS 2.0' services that require broadband facilities. A brief review is followed by an introduction to the DFS ecosystem, which also serves as platform to help coordination the delivery of aid and a system of order during humanitarian crises.

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[20] The Register (2017) *Developing World Hits 98.7 Per Cent Mobile Phone Adoption*, available at https://bit.ly/2Ic0dyc

[21] Unstructured Supplementary Service Data (USSD) is a novel standard within the GSM and 3G specifications, seen both as a narrowband data transmission mechanism and user interface. See further on USSD, section 5.3.2 on USSD.

[22] SIM Toolkit (STK) is a popular encrypted SMS-based remote access and UI GSM technology used to provide DFS and related services to markets where basic and feature phones are the plurality. See further on STK, Section 5.3.4.

[23] GSMA (2018) *2017 State of the Industry Report on Mobile Money*, available at https://bit.ly/2CKPLqF

[24] Media Nama (2018) India's feature phone shipments doubled in Q1 2018, smartphone market stayed flat, available at https://bit.ly/2CR2bRH

[25] Media Nama (2018) *Facebook app now officially available on the Jio Phone*, available at https://bit.ly/2JuCIP1

[26] KaiOS is a Linux-based operating systems and derivative of the now shuttered Firefox OS. It powers a number of phones and brands, and supports video calls over 4G; mobile payments through NFC and dual-SIM support. It has its own app store and Google has invested in it. See Verge (2018) *Google invests $22 million in the OS powering Nokia feature phones*, available at https://bit.ly/2EWhtHu

[27] [27] Media Nama (2018) *Facebook app now officially available on the Jio Phone*, available at https://bit.ly/2JuCIP1

Section 3 reviews several generations of mobile communications technologies and the hardware and software which deliver DFS. It provides a comprehensive examination of different phones used for accessing DFS, their user interfaces and the differences between basic phones, feature phones and smartphones.

Section 4 provides a comprehensive list of and guide to regulators who may have an active role in regulating mobile coverage and DFS. A concise explanation is provided on how issues are coordinated and handled by and between different regulators.

Section 5 provides a comprehensive examination of mobile network infrastructure and spectrum management that operate in conjunction with mobile technologies to make mobile coverage possible. The components of network infrastructure are identified and explained, followed by a review of how frequency bands of spectrum are managed on international, regional and national levels. This includes a review of how spectrum is allocated, licensed and deployed.

Section 6 (and shown in Part B of Exhibit 1) examines competition and quality of service related issues which directly impact upon the provision of DFS using GSM and USSD. It also explains how regulators typically deal with problems when they arise and how they have attempted to resolve issues in the past in several DFS countries.

Section 7 (and shown in Part A of Exhibit 1) explores the expansion of mobile coverage into rural and remote areas of developing countries, where the majority of the unbanked and underserved reside. Policies for expansion of infrastructure are examined such as universal service funds and national broadband policies. Provisioning and use of spectrum is also examined such as methodologies of assignment, which include auctions, as well as the efficient use of the 'digital dividend' frequency bands. Infrastructure sharing is also examined including network roaming, tower sharing, tower companies and concerted national efforts towards universal broadband coverage such as WOANs. Financing considerations are also outlined. Innovations in mobile coverage and access solutions complete this section and review non-traditional provision of mobile services and a summary of new mobile phone hardware and software tailored to address the needs of the poor.

Section 8 summarizes this study with a series of findings, conclusions and brief recommendations, as well as a graphical matrix of the cumulative issues and potential downstream effects discussed and potential solutions thereto. This graphical matrix of the issues is divided into three parts: A: infrastructure expansion; B: 2G-related issues; and C: Outcomes and appears in Exhibit 1.

While this study explores the evolution of DFS and mobile coverage evolution to next stages, it acknowledges that migration to future solutions will require substantial coordination, patience and the need for regulatory intervention to remedy existing mobile coverage problems which directly impact upon DFS. Concurrent with stabilizing the provision with DFS over USSD is the need to understand the current state and evolution of mobile coverage which, in many countries, is on a path towards universal broadband coverage.

Annexures A and B discuss the effect of coverage on DFS in India and Uganda respectively.

### 1.2 Problem Statement

Digital Financial Services (DFS)[28] is a relatively recent innovation in developing countries in mobile phone-centric provision by banks and non-bank of basic financial services to the 'financially excluded'. Most frontline services, such as customer signup and cash-related services, are performed by DFS 'agents' contracted to the DFS providers and located in urban and rural areas.[29]

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[28] For a comprehensive introduction to DFS, see Perlman, L (2018a) The *Digital Financial Services Primer,* available at www.dfsobservatory.com

[29] Wright, G (2017) *The Clear Blue Water on the Other Side of the Digital Divide*, available at https://bit.ly/2iXaJeo

Large swatches of the excluded live in rural areas and exhibit substantially higher poverty levels and cash use[30] coupled with lower levels of fundamental communications and analytical skills[31] such as literacy[32] and numeracy.[33]

DFS is touted to provide basic financial products and services accessible from basic and feature phones[34] within reach of modest budgets.[35] Since these phones are the primary instruments to access DFS, the quality and range of potential DFS services available to the financially excluded is sensitive to the existence and quality of mobile coverage and where there is coverage, the quality of that coverage. In particular, the lack of national high speed 3G and higher mobile broadband data services means that many users cannot make optimal use of their data-hungry smartphone devices and are limited to basic offerings.

| | 3G Coverage % Pop. | Mobile Penetration | % Penetration Rural | Mobile Broadband % |
|---|---|---|---|---|
| **India** | 79.67 | 84.44 | 66.86 | 19.77 |
| **Uganda** | 45 | 67.59 | 83.56 | 15.86 |
| **Colombia** | 92.45 | 105.06 | 23.29 | 57.57 |
| **Tanzania** | 28.1 | 69.05 | 67.68 | 27.22 |
| **Indonesia** | 60 | 147.55 | 45.53 | 66.56 |

**Exhibit 2**: Mobile Broadband: Coverage and Penetration. Compared to narrowband mobile coverage, broadband coverage in many developing countries is not ubiquitous and is lacking in many rural areas. This has implications for use of smartphones for DFS access.[36]

The state of mobile broadband coverage in some DFS-focused developing countries in outlined in Exhibit 2. This lack of broadband availability limits use of DFS on primarily only narrowband-compatible basic and feature phones. These devices, which facilitate access to (the basic) DFS services through UIs such as provided by USSD,[37] a limited text-based access mechanism inherent to all mobile networks and can be used on any phone.

At a minimum, previous studies have shown that an increase in mobile coverage range and quality may stimulate greater attention and investment in rural areas.[38] Further, a lack of broadband mobile coverage may handicap demand for innovative products and services are only smartphone-based and which may thus be 'data-hungry.'[39]

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30 World Bank (2016) While Poverty in Africa Has Declined, Number of Poor Has Increased, available at https://bit.ly/1XeiBoD

31 UNESCO (2016) *Global Education Monitoring Report 2016*, available at https://bit.ly/2bUGzpA. Illiteracy percentage is likely to be inversely proportional to income levels, with higher income reflecting the ability to afford better education. See examples of Tanzania and India. GSMA (2017) *Accelerating affordable smartphone ownership in emerging markets*, available at https://bit.ly/2qVzgEr

32 Literacy generally refers to the ability to read and write and perform basic language communication skills.

33 Numeracy generally refers to the ability to read and write numbers and perform basic mathematical skills.

34 Perlman, L (2017) *Technology Inequality: Opportunities and Challenges for Mobile Financial Services*, available at https://bit.ly/2r7NZNy ; Shapshak, T (2017*) Feature Phones Still Rule In Africa, As Smartphone Sales Slow*, available at https://bit.ly/2FaPluM

35 In spite of economic challenges, almost 70% of the bottom 20% of the population own some type of mobile phone. Sub-Saharan Africa at 73% overall mobile penetration represents the lowest regional total worldwide. World Bank (2016) *World Development Report 2016: Digital Dividends*, available at https://bit.ly/2aXM2tM

36 GSMA (2018) *GSMA Mobile Connectivity Index 2018*, available at https://bit.ly/2HW2laS

37 See Section 3.3 below on USSD as well as on the other primary UI for DFS, SIM Toolkit.

38 See Section 1.3 below covering the methodology and approach of this study.

39 We note however not always a prerequisite for high-speed mobile coverage to be available to deliver over the mobile channel many of the 'richer' DFS services. For example, M-KESHO is savings product in Kenya that can be accessed using M-PESA's STK menus. Similarly, some providers provide agent searches on some USSD accessed platforms with text-based outputs. M-

This, in turn, could raise basic digital and financial literacy levels[40] and facilitate a rapid shift to 'DFS 2.0' – shown in Exhibit 3 – and provide substantial and essential improvements in service offerings and coverage quality, which could encourage adoption of DFS over cash.

But this necessary expansion and improvement of mobile coverage in rural areas – signal quality and/or at all, or migration from narrowband to broadband - faces many challenges which this study identifies as relating to cost of service provision as well as regulatory inertia.

To distill issues stifling innovation and competition, we assess the essential problems to be:

- The lack of mobile coverage generally and the implications thereof for DFS and financial inclusion.
- Quality of service issues in mobile coverage that may hamper consistent user experiences and which may ultimately lead to inactive DFS accounts and, at worst, financial loss.
- The lack of ubiquitous high-speed (3G and higher) broadband mobile coverage and the implications thereof on the competitive landscape in provision of DFS as well as on the aspirational evolution to DFS 2.0-type services.
- The role of sector regulators in ensuring - or even hindering - proper national and higher speed mobile coverage.

### 1.3 Methodology and Approach

The information contained within this study is based on primate research performed between November 2017 and May 2018, with updates in September to October 2018. We undertook desktop research; an electronic survey of technologies and policies employed sent to telecommunications regulators in a number of countries where DFS is prevalent; interviews and conversations with telecommunications regulators and industry participants; and selected location visits to investigate the nature of problems and solutions. Background studies by other authors that survey the DFS ecosystem are included.

The objective of this study was to obtain a greater understanding of the elements of mobile coverage, methods and trends of expansion methods, and the potential impact upon financial inclusion. Accordingly, we do not endorse nor specifically recommend any particular proposed solution which may be contained herein.

Because of the scope and scale of our study, we have assumed and not undertaken primary research on the following in our writing and conclusions, and so rely largely on external sources to show that:

- Overall, higher mobile data speeds provided by broadband mobile services - 3G and higher - offer a better user experience than narrowband mobile data.[41]
- In the vast majority of DFS implementations worldwide, especially where the service is provided by an MNO, there is zero cost to customers for the use of USSD and STK UIs to DFS. Where a non-MNO

KESHO is a Bank Account enabling send money/funds transfer between the bank account (M-KESHO) and the M-PESA system for deposit and withdrawal). See FSDK (2015) M-KHESO, available at http://fsdkenya.org/retail-innovation/m-kesho/

40 Icon-driven menus can reduce the learning curve of illiterate people, helping them understand how to use mobile devices, especially smartphones. Hudson Matthews, B, Valechha, R & Anand, V*, et. al Digital Wallet Adoption For The Oral Segment In India: Concept Development For Mowo (Mobile Wallet For Oral),* available at https://bit.ly/2vim1B1; My Oral Village (2018) *Digital Wallet for India,* available at http://myoralvillage.org/news/may_9_2017/

41 Chen, G (2016) *The Power of Smartphone Interfaces for Mobile Money*, available at https://bit.ly/2dS7YHD ; and Won, J (2016) *Swiping Right: Ideo.org Prototypes Mobile Money on Smartphones*, available at https://bit.ly/2HG8riT

provides a service, DFS-related access costs as they may be, may be borne by the DFS provider or the customer.[42]

- There is parity in second generation retail mobile data pricing with that of third generation mobile data pricing (but not necessarily with 4G pricing).
- MNOs as rational market actors will seek to provide some broadband coverage for competitive reasons at least, but that the major barriers to MNOs providing national broadband coverage are CAPEX; spectrum costs; return on investment (ROI) exigencies; and access to finance - and not necessarily the lack of technologies and engineering components to accomplish such objectives.[43]
- NTA national broadband are articulated in aspirational 'broadband strategies' but NRAs mostly are not mandating national broadband coverage for mobile licensees because of concerns over burdensome debt that may threaten the viability of licensees.
- Competencies to migrate from 2G to 3G (and higher 4G and 5G mobile technologies) are available internally to MNOs and should not present a barrier to the transition from narrowband to broadband.
- Better coverage, security and quality of service will incentivize customers to actively use a service and DFS account.[44]
- Feature phones are likely to dominate DFS access for the foreseeable future, using USSD, encrypted SMS and Wireless Application Protocol (WAP) as UIs.[45]

As matter of organization, technical granularity and any additional background information is placed within footnotes. We have used the goo.gl and bit.ly web link shorteners throughout this study.

# 2 ROLE OF MOBILE-BASED SERVICES IN FINANCIAL INCLUSION

## 2.1 Comparative Global Overview of Mobile-based Payment Services[46]

The growth of DFS in many parts of Africa, Latin America and Asia[47] has its genesis in the challenges and constraints of predominantly cash-based economies with large numbers of the population who are financially excluded through a lack of access to financial services.[48] Since banks have traditionally been the front-line for the provision of financial services such as savings accounts and for remittances, the financially excluded have also been referred to as being 'unbanked.'

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[42] Mazer, R (2015*) USSD Access: A Gateway and Barrier to Effective Competition*, available at https://bit.ly/2jlWErj; and Perlman, L (2017) *Competition Aspects of Digital Financial Services*, available at https://papers.ssrn.com/sol3/Papers.cfm?abstract_id=2957138

[43] GSMA Intelligence (2012) *Half Of All Mobile Connections Running On 3G/4G Networks By 2017*, available at https://bit.ly/2FzH9o6

[44] Muto, M & Yamano, T (2009) *The Impact Of Mobile Phone Coverage Expansion On Market Participation: Panel Data Evidence From Uganda. World Development*, available at https://bit.ly/2rdzpDo

[45] Perlman, L (2017) *Technology Inequality: Opportunities and Challenges for Mobile Financial Services*, available at https://bit.ly/2r7NZNy

[46] Data in this Section 2 drawn mostly from Perlman, L (2018a) *Digital Financial Services Primer 2018*, available at www.dfsobservatory.com

[47] See GSMA (2018) *2017 State of the Industry Report on Mobile Money*, available at https://bit.ly/2CKPLqF

[48] Substantial portions on the background to DFS in this paper is drawn from Perlman, L (2003) *Mobile Commerce*, Payments Conference, Cape Town; Perlman, L (2010) *Mobile Money*, Mobile Money Conference at Columbia Business School; Perlman, L (2012) LLD *Thesis: Legal and Regulatory Aspects of Mobile Financial Services,* available at https://bit.ly/2KGfC8k; Perlman, L (2017a) *Competition Aspects of Digital Financial Services*, available at https://bit.ly/2rEZAUz ; Perlman, L (2017b) *Technology Inequality: Opportunities And Challenges For Mobile Financial Service*s, available at https://bit.Ly/2r7nzny; Gurung, L & Perlman, L (2018) *Role of DFS in Humanitarian Crises Responses,* available at https://www.dfsobservatory.com; Perlman, L (2018b) *The Role of the Telecommunications Regulator in DFS*, available at www.dfsobservatory.com

Enabled by regulatory innovations, financial services provided by non-banks began to fill these access gaps. The key to their genesis was using the mobile phone as the primary means of access services. Core to this nexus is that while 1.7 billion adults do not have a bank account, more than 1 billion of these unbanked adults have a mobile phone.[49] And while around 230 million unbanked adults work for businesses and get paid in cash, 78% of them people own a mobile phone.[50]

Core to this nexus between mobile phones and access to financial services is that while 1.7 billion adults do not have a (formal) account with a financial institution, more than 1 billion[51] of them have a mobile[52] phone and are within the coverage area – sometimes only low-speed 'second generation' (2G) mobile coverage[53] - of a MNO. Similarly, while around 230 million 'unbanked' adults work for businesses and get paid in cash,[54] 78% of them own a mobile phone.[55]

The first such service to recognize the potential nexus between access to financial services and mobile phones was Smart Money, launched in 2001 in the Philippines by MNO Smart communications which used the network as the communications channel for facilitating mobile payments and remittances using SMS-based SIM Toolkit as the UI.[56] At its most basic iteration, customer accounts would be operated and controlled by Smart, now also acting as a financial service provider in additional to its role as a MNO. Agents contracted to the Smart Money provided cash-handling and account sign-up facilities and covert cash to electronic money ('e-money') which could be used to send to other Smart Money customers and buy a limited range of goods and services.

The number of MNOs and now non-banks providing financial services with the phone at the core has grown globally: As of October 2017, there were some 276 such mobile-centric DFS implementations in 90 countries, with 690 million registered accounts.[57] Services bouquets across the world have grown, in many cases resembling basic

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49 Gallup (2018) *op. cit.*

50 Some 100 million unbanked adults receive government payments in cash, including 67 million who have a mobile phone. Gallup (2018) *op. cit.*

51 Gallup (2018) *Global Findex: Technology Can Bridge Financial Inclusion Gap*, available at https://bit.ly/2IhCoVE

52 The phones primarily use Global System for Mobile Communications (GSM) technology, a phone standard developed in the 1980s by the European Telecommunications Standards Institute to describe the protocols for second-generation (2G) digital cellular networks used by mobile phones. Originally Groupe Spécial Mobile, the first GSM implementation was in Finland in 1991 on a network built by Telenokia and Siemens and operated by Radiolinja. These digital technologies have since evolved to include second generation (2G) mobile technologies such as Unstructured Supplementary Service Data (USSD), Short Message Service (SMS) and various low data speed capabilities. Together, these technologies constitute the enabling infrastructure for DFS. The first SMS message was sent in 1992; while Vodafone UK and Telecom Finland signed the first international GSM roaming agreement. See GSMA (2016) *History*, available at https://bit.ly/1sHjxSC

53 See on mobile coverage and DFS, Perlman, L & Wechsler, M (2018) *The Role of Mobile Coverage on Digital Financial Services*, available at www.dfsobservatory.com

54 This to a degree also refers to those who received remittances or are recipients of government-to-person (G2P) payments.

55 Some 100 million 'unbanked' adults worldwide receive government payments (G2P) in cash, including 67 million who have a mobile phone. Gallup (2018) *Global Findex: Technology Can Bridge Financial Inclusion Gap*, available at https://bit.ly/2IhCoVE

56 GSMA (2009) *Mobile Money in the Philippines – The Market, the Models and Regulation*, available at https://bit.ly/2I9EXG7 G-Cash started commercial operations in the Philippines in October 2004. Globe Telecom (2004) *Annual Report 2004*, available at https://bit.ly/2w9i2cj

57 GSMA (2018) *2017 State of the Industry Report on Mobile Money*, available at https://bit.ly/2CKPLqF

transactional features of a bank account but with primarily non-credit, transactional services at their core.[58] The average DFS customer is moving USD 188 per month.[59]

These basic transactional capabilities – with the mobile-phone-only access variation called 'mobile money' by the GSM Association (GSMA) - are coined 'DFS 1.0' by this study. The current iteration as 'DFS 2.0' is characterized by more sophisticated service offerings. Exhibit 3 shows the evolutionary split between DFS 1.0 and DFS 2.0-based services and the mobile instrument required to access the full range of each type of service. DFS has also been adapted for use in crises situations,[60] as shown in Exhibit 4.

With mobile coverage affecting the UI available, where that UI is poor and error-prone, this often drives users to limit or abandon their DFS usage and rather pursue Over-The-Counter (OTC) DFS services provided by agents. Regular DFS SVA usage has reportedly dropped overall worldwide, with OTC use growing – a concern for regulators worried about traceability of transactions for AML purposes.[61]

Indeed, trend lines on DFS activity show large DFS inactivity levels. Data from the World Bank's 2017 Findex Survey suggest that while DFS accounts have grown from 2014,[62] activity levels have fallen.[63] Whatever the source, and reporting agency - be it from the World Bank Findex study,[64] the IMF,[65] or the GSMA [66] and its annual State of the The Industry Report (soTIR)[67] on 'mobile money.' Analysis from the Center for Financial Inclusion at Accion of Findex data also found that roughly half of the new accounts — nearly 235 million — have not been used in the last year. The number of active account holders only increased by 285 million, much less than the overall growth, they say, in account ownership from 2011–2014. Similar trend lines have been reported by the GSMA, whose SoTIR 2017[68] highlighted that of the 690 million 'mobile money' accounts opened, active account use within a 90 day period was at disappointing 35.8% and active account use within a 30 day period at a worrying 24.3%.

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[58] Unlike the value in most bank accounts, no interest is provided on e-wallet account balances in most DFS implementations. ITU (2016) *Digital Financial Services: Regulating For Financial Inclusion – An ICT Perspective*, available at https://bit.ly/2w8ryfT

[59] USD 57 in P2P transfers; USD 56.4 in cash-in; USD 45.9 cash-out; USD 10.7 in bulk disbursements; USD 9.5 in bill payments; USD 4.3 in merchant payments; and USD 2.8 airtime top-ups. See GSMA (2018) *2017 State of the Industry Report on Mobile Money*, available at https://bit.ly/2CKPLqF

[60] See thereto, Gurung, N & Perlman, L (2018) *The Role of Digital Financial Services in Humanitarian Crises Responses*, available at www.dfsobservatory.com

[61] On these concerns, see in greater detail ITU FGDFS (2017) *Over the counter transactions: A threat to or a facilitator for digital finance ecosystems*?, available at https://bit.ly/2ywZrbA; and on AMl concerns in Bangladesh with OTC, see Dhaka Tribune (2018) *Anonymous transactions raise risk of money laundering*, available at https://bit.ly/2PU1nio

[62] Some 515 million new financial accounts were opened around the world. World Bank Group (2018) *The Global Findex Database 2017,* available at https://globalfindex.worldbank.org/

[63] See Accion-CFI (2018) *Financial Inclusion Hype vs. Reality: Deconstructing the 2017 Findex Results*, available at https://bit.ly/2JAyB3n

[64] See Accion-CFI (2018) *Financial Inclusion Hype vs. Reality: Deconstructing the 2017 Findex Results*, available at https://bit.ly/2JAyB3n

[65] IMF (2018) *IMF Releases the 2018 Financial Access Survey*, available at https://bit.ly/2AoLKKv

[66] The GSM Association. See www.gsma.org

[67] GSMA (2018) *2017 State of the Industry Report on Mobile Money*, available at https://bit.ly/2CKPLqF

[68] *ibid*

| | DFS Activity | Basic | Feature | Smartphone |
|---|---|---|---|---|
| **DFS 1.0** | *Check balances* | Y | Y | Y |
| | *P2P transfer* | Y | Y | Y |
| | *Cash In/Cash Out* | Y | Y | Y |
| | *Pay Bills* | Y | Y | Y |
| **DFS 2.0** | **Secure transactions** | N | Y | **Y** |
| | **e-KYC with camera** | N | Y | **Y** |
| | **Agent location** | N | Y | **Y** |
| | **Interactive assistance** | N | N | **Y** |
| | **Change Profile** | N | N | **Y** |
| | **Easily add beneficiaries** | N | N | **Y** |
| | **Online shopping** | N | N | **Y** |
| | **Spending dashboard** | N | N | **Y** |
| | **Transaction dashboard** | N | N | **Y** |
| | **Universal search facility for Bill Pay Bank codes** | N | N | **Y** |
| | **Add funds via Visa/Mastercard** | N | N | **Y** |
| | **Agent Rating System** | N | Y | **Y** |
| | **One-touch transaction dispute query** | N | N | **Y** |
| | **NFC payment** | N[69] | Y[NS][70] | **Y[NS]** |

**Exhibit 3:** Characteristics of DFS Phone Types. Characteristics of phone types needed for different type of DFS services. The services in italics at the top of the table are the foundational DFS 1.0 activities in DFS markets. The services shaded indicate the next level of DFS – DFS 2.0 - some of which are provided today in a limited number of countries.

For the most part, these new non-bank payment service providers are under the purview of a central bank's payments department, which may issue a license or authorization for the entity to operate. If the provider is an MNO, the telecommunications regulator usually has co-jurisdiction with the central bank over any mobile-centric financial services.[71] Mobile coverage and ancillary matters are usually under the primary purview of the telecommunications regulator.

[69] If not included or non-standard (NS), made possible with NFC 'stickers' placed on the back of non-NFC phones.
[70] *ibid*
[71] The telecommunications regulator usually issues a separate value-added services (VAS) authorization as an annex to the MNOs telecommunications providers' license, or as a separate VAS license/authorization if the entity using the communications channel is not licensed MNO. There may be other regulators with concurrent co-jurisdiction, including those for competition, electronic commerce, consumer protection and anti-money laundering (AML).

Mass migration of refugees across borders in the Middle East, Europe and Africa during recent crises have left these regions to cope with the transition of people in need.[72] Emergency responders require communications for effective assistance efforts whose success may be dependent upon national and international coordination with government and MNOs.[73] Those in need seek to communicate with responders for assistance, to contact family and to receive remittances via mobile money[74] to fund necessities during time of crisis.

Solutions to restore service which can be quickly deployed within hours include Cells on Light Trucks (COLT), Cell on Wheels (COW)[75] and satellite communications.[76] Innovative solutions such Google's Project Loon's air balloons and AT&T's drone system (called the 'COW in the Sky') have assisted with coverage outages in Puerto Rico and the Caribbean and could potentially provide a cost-effective solution to sudden widespread outages such as those caused by natural disasters.[77]

Portable solutions can be costly over long periods of time.[78] To deal with mass migration of refugees who are likely to settle in remote areas for an extended duration, guarantees against loss by nongovernmental organizations (NGOs) can result in MNOs being incentivized to build towers in rural and remote areas.[79]

**Exhibit 4:** Crises Responses, DFS and the Role of Mobile Coverage.[80]

# 3 TECHNOLOGIES USED TO ACCESS DFS

## 3.1 Overview

Several of technologies are available in DFS ecosystems allow users to access their stored value, each with varying degrees of ease of access, ease of use, efficacy, cost, security, and reliability.

Combinations of remote access may be used for technical reasons to confirm of transactions, regulatory requirements, the UX, competition issues or simply for cost reasons. Invariably though, SPs will provide the remote access method(s) that are best suited to the access devices prevalent in the markets in which they operate whilst taking into account the technical literacy levels of their customer base[81] as well as the types of handsets in use. Basic

[72] Nordland, R (2015) *A Mass Migration Crisis, and It May Yet Get Worse*, available at https://nyti.ms/1Muc1m5; Rachman, G (2016) *Mass Migration into Europe Is Unstoppable*, available at https://on.ft.com/2vKb1Pk

[73] Williams, R & Bissessar, S (2017) *Strengthening Cooperation Between Telecommunications Operators And National Disaster Offices In Caribbean Countries*, available at https://bit.ly/2HLRgve

[74] Beneficiaries can receive mobile money funds in multiples ways. Casswell, J & Frydrych, J (2017) *Humanitarian Payment Digitisation: Focus On Uganda's Bidi Bidi Refugee Settlement*, available at https://bit.ly/2qT4BHC

[75] McGrath, F (2014) Mobile Network Restoration & Humanitarian Response The Vodafone Foundation Instant Network Programme, available at https://bit.ly/2Jm4V9J

[76] Both systems require a power supply but can use fuel as needed.

[77] For more information about innovative solutions to coverage deficiencies, see Section 7.5.

[78] At present, building portable solutions such as macro-cells cost USD 120,000 - 140,000 costing about USD 4,000 monthly for infrastructure OPEX. Casswell, J & Frydrych, J (2017) *Humanitarian Payment Digitisation: Focus On Uganda's Bidi Bidi Refugee Settlement*, available at https://bit.ly/2qT4BHC

[79] A guarantee was provided by UNCDF for the Bidi Bidi refugee settlement in Uganda and ultimately a temporary tower was replaced with a permanent solution. Casswell, J & Frydrych, J (2017) *Humanitarian Payment Digitisation: Focus On Uganda's Bidi Bidi Refugee Settlement*, available at https://bit.ly/2qT4BHC

[80] For further insights into the impact of DFS in humanitarian crises responses, see Gurung, L  Perlman, L (2018) *Role of DFS in Humanitarian Crises Responses,* available at https://www.dfsobservatory.com

[81] On the effects of technical literacy on DFS use, see Grameen Foundation (2013) *Use Of Mobile Financial Services India And The Philippines,* available at https://bit.ly/2KuQfGG

and feature phones currently dominate most DFS markets,[82] necessitating text-based UIs such as USSD and the SMS-based STK. In more recent implementations from mid-2012, DFS-oriented apps using Over the Top (OTT) internet connectivity via smartphones are emerging but are not yet in mainstream use in most DFS markets[83] since the high-speed data networks required to sufficiently enable these apps are not always available nationally.

## 3.2 Mobile Infrastructure Level

### 3.2.1 Mobile Network Evolution

Key to the growth of DFS in many emerging markets is the ability to effectively 'bolt-on' services to mobile network access mechanisms and UIs, specifically onto facilities offered by the Global System for Mobile (GSM) mobile specification, developed in the late 1980s by the European Telecommunications Standards Institute. GSM has evolved to become the dominant mobile technology worldwide.[84] The GSM specification has, at its core, the Mobile Application Part (MAP) protocol, that specifies how users can gain seamless access to mobile networks.[85] MAP, in turn, operates over Signalling System 7 (SS7),[86] a communication technology used by most telecommunication network operators around the world to allow their mobile and fixed line networks to interact and for mediating multiple voice calls used on the GSM 'traffic' channel.[87] GSM has evolved from (now) ultra-low speed session-based Circuit Switched data, then to narrowband GPRS and EDGE/EDGE, and then to broadband technologies.

The initial GSM incarnations from the early 1990s to early 2000s were characterized by 'narrowband' or low-speed 2G technologies that used data transport mechanisms (called 'bearers') such as USSD, SMS, General Packet Radio Service (GPRS) and variations of Enhanced Data for Global Evolution (EDGE). USSD and SMS are SS7-only based technologies that use the signaling channel of GSM while GPRS and EDGE provide Internet Protocol (IP) services over SS7.[88] Importantly though, USSD and native SMS data is unencrypted and thus effectively in unencrypted clear text, an innate artifact of its SS7 pedigree.[89] While the GSM specifications implement encryption standards for the wireless transmission of data, these have all been, to some extent, compromised.[90]

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[82] Feature phones include most of the features of basic phones, augmented by features such as Bluetooth, MMS, WAP capabilities, and in some cases 3G capabilities. See further generally, Perlman, L (2012) LLD *Thesis: Legal and Regulatory Aspects of Mobile financial Services,* available at https://bit.ly/2KGfC8k

[83] For example, of the 300,000 DFS clients of Bank South Pacific, only 3,000 use smartphones to access services. Bank South Pacific - Personal Communication with authors.

[84] GSM was the digital successor to first generation – or '1G' - analogue and the largely insecure mobile networks introduced in the 1970s. The first GSM networks were launched in the early 1990's. It is now the dominant world standard in mobile communications, with almost 800 MNOs worldwide. The GSM Association (GSMA) represents member interests. See further GSMA (2018) *History*, available at https://www.gsma.com/aboutus/history

[85] Mobile Application Part is a SS7 protocol that provides an application layer for the various nodes in GSM, GPRS, EDGE, UMTS and HSPA mobile core networks to communicate with each other to provide services to users. USSD messages travel over MAP within the core network of the MNO. See on MAP technical specifications, 3GPP (2007) *Mobile Application Part (MAP) - Operations Signaling Protocols*, available at https://bit.ly/2rdi1iJ; and see further generally, Perlman, L (2012) LLD *Thesis: Legal and Regulatory Aspects of Mobile financial Services,* available at https://bit.ly/2KGfC8k

[86] SS7 was developed in 1975 and standardized in the 1980s in the ITU-T Q.700 series. SS7 itself is not secure however, as it was designed in the 1970s with no real authentication and intrusion-prevention in mind. On the lack security in SS7 and the implications for DFS, see Perlman, L, Traynor, P & Butler, K (2017) *Security Aspects of Digital Financial Services, (DFS),* available at https://bit.ly/2HH6Jtn

[87] This signaling mediation allows multiple calls to efficiently take place on a known frequency without overlap.

[88] IP is the principal communications protocol in the Internet protocol suite for relaying data.

[89] Curiously, no authentication was built in into the original SS7 protocols, nor even when ETSI and the 3GPP added new protocols in the 1990s and 2000s to support mobile phone services through MAP. See generally on security of SS7, Hassan Mourad, H (2015) *The Fall of SS7 How Can the Critical Security Controls Help?*, available at https://bit.ly/2HKr01b vbgyuiuygfdxdfgfdfds; and Butler, K; Perlman, L *et al* (2017) *Security Aspects of Digital Financial Services, (DFS),* available at https://bit.ly/2HH6Jtn

[90] Vijayan, J (2010) *Researchers Use PC To Crack Encryption For Next-Gen GSM Networks*, available at https://bit.ly/2rebrsa

### A Narrowband Mobile Data Technologies

#### 3.2 GPRS and EDGE

GPRS is an IP-based technology used to upgrade GSM networks that use expensive and slow time-based Circuit Switched Data (CSD) to access data.[91] GPRS allows subscribers to stay connected to any online data on the Internet and to be billed per data unit (in megabytes or gigabytes) [92] rather than to be billed in units of time.[29] EDGE[93] is a bolt-on[94] enhancement for 2.5G GSM/GPRS networks that makes it easier for existing GSM networks to upgrade to it.[95] The majority of mobile phones in developing countries use EDGE.[96]

### B Broadband Mobile Data Technologies

#### 3.3 3G Technologies

Higher-speed IP-based 3G technologies developed in the 1990s are based on Wideband Code Division Multiple Access (W-CDMA) technology that manifests itself in variations of Universal Mobile Telecommunications System (UMTS) and its successor, High Speed Packet Access (HSPA). High Speed Packet Access (HSPA) is an amalgamation of two mobile protocols, High Speed Downlink Packet Access (HSDPA) and High Speed Uplink Packet Access (HSUPA) that extends and improves the performance of existing 3G mobile telecommunication networks utilizing the W-CDMA protocols.

A further improved 3rd Generation Partnership Project (3GPP) standard, Evolved High Speed Packet Access (also known as HSPA+), was released late in 2008 with subsequent worldwide adoption beginning in 2010.

#### 3.4 4G Technologies

The current mobile broadband data evolution is at Fourth Generation (4G) technology, manifesting as Long Term Evolution (LTE) and LTE Advanced (LTE-A). Long Term Evolution (LTE) is based in part on UMTS/HSPA network technologies. LTE was developed by the 3GPP and is specified in its Release 8 document series.[97]

The first commercial deployment was in Sweden in 2009. LTE increases the capacity and speed over UMTS/HSPA by using a different radio interface together with core network improvements. LTE Advanced (LTE-A) is a major enhancement of the LTE standard, which includes the Voice over LTE (VoLTE) standard.

As shown in **Exhibit 2**, there are significant gaps in broadband coverage in DFS markets in the developing world.[98] As an example, Ugandan MNO Airtel's published coverage maps shown in modified form in **Exhibit 5** emphasize that when compared to its 2G mobile coverage, broadband coverage is concentrated primarily in urban and/or more densely populated areas.[99] This lack of, or poor 4G coverage, affects uptake of smartphone use since their media-rich applications generally need higher data speeds and which, on the whole, do not operate efficiently with narrowband GPRS and EDGE bearer technologies.

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[91] CSD-based data access is billed per minute compared to always-on systems like GPRS, EDGE and 3G or 4G which charge according to how much data is transferred.

[92] GPRS and the other data facilities are billed in data units like megabytes or gigabytes of use by the MNO.

[93] This is known also as Enhanced GPRS (EGPRS).

[94] 'Bolt-on' means that the MNO system can be upgraded via a software upgrade rather than by installing entirely new hardware to provide the intended result.

[95] EDGE is a superset to GPRS and can function on any network on which GPRS is deployed. It is substantially faster than GPRS, but is much slower than 3G.

[96] Perlman (2012) *op. cit.*

[97] 3GPP (2018) *LTE*, available at http://www.3gpp.org/technologies/keywords-acronyms/98-lte

[98] Ubiquitous 3G/4G coverage in the developed world is, of course, also not a given.

[99] Smartphone coverage is often associated with urban areas, where higher population densities exist with typically higher incomes per capita and greater affordability to make smartphone purchases with appropriate data plans. Beegle, K & Christiaensen, L, Dabalen, A & Gaddis, I (2016) *Poverty in a Rising Africa*, available at http://bit.ly/2Fa3UPx

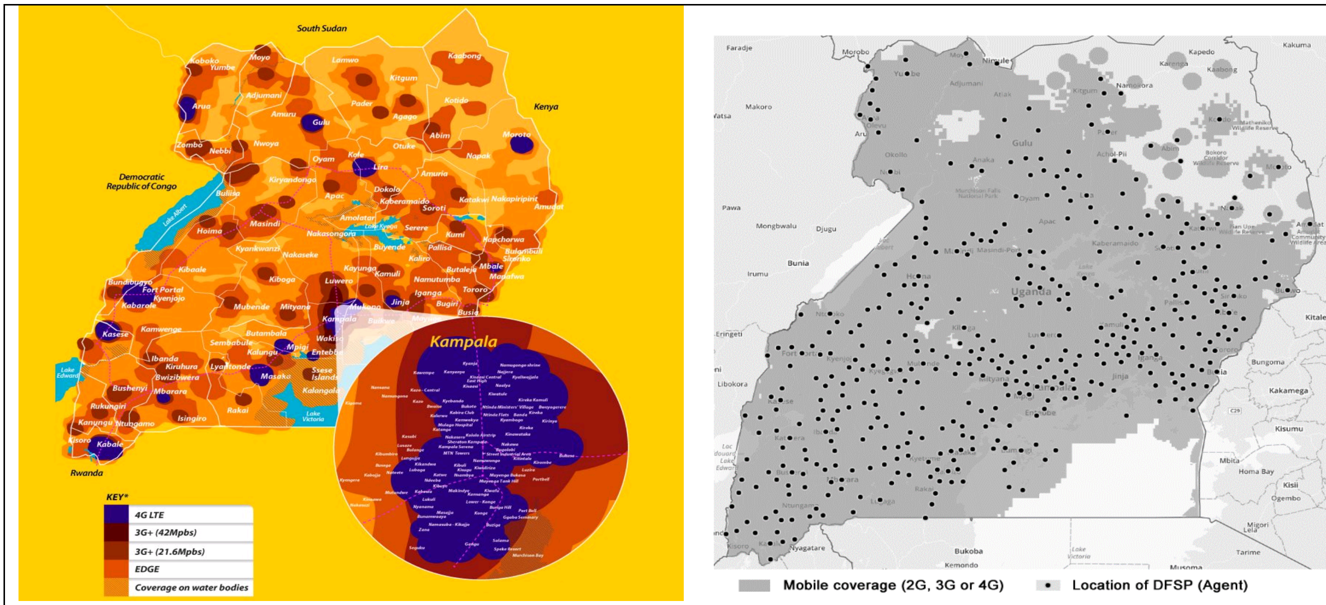


**Exhibit 5:** The map on the left is from MNO MTN Uganda, which has over a 50% market share. Colors from lightest to darkest are from 2G GSM to 4G LTE, the latter of which primarily blankets the country's capital, Kampala, with several other cities including 4G coverage. Broadband coverage does not cover the multitude of areas in between, with only the radius of larger cities indicated a limited radius of 3G or better coverage.[100] The map on the right is agent locations from FSP Maps, which show areas of mobile coverage (2G, 3G or 4G) in darker gray and with DFSP 'agent' locations appearing as dots, many of which fall in appear in the lighter areas which only provide narrowband coverage. Coverage map data is as of July 2018.

### 3.5 5G Technologies

5G mobile data technology is touted a major evolution in mobile data and coverage, promising mobile data speeds of up to 20 gigabits per second and intelligent allocation of bandwidth across multiple devices. The first of several 5G specifications were finalized in December 2017,[101] and there are as yet no handsets or mobile networks providing commercial 5G services.[102] Improvements in antenna technology in 5G-compatible phones and base stations[103] using focused antenna arrays may improve mobile coverage.[104]

[100] Data as of May 2018. Mobile coverage data from MTN Uganda (2018) *Coverage Map*, available at https://bit.ly/2KNIJGN; Airtel (2018) *Airtel Uganda*, available at https://bit.ly/2F9eQNp. Agent data from FSP Maps (2018) *FSP Maps,* available at https://bit.ly/2vES00j

[101] 3GPP (2017) *Release 15*, available at http://www.3gpp.org/release-15, ITU (2017) *ITU towards 'IMT for 2020 and beyond*,' available at https://bit.ly/2qS0fBl

[102] Cheng, R (2018) *What is 5G? Here Are The Basics*, available at https://cnet.co/2nRYuC2

[103] This study uses the term 'mobile base station' to refer to the situs of the access network, which is also commonly called a 'cell site' or 'cell tower. https://bit.ly/2rgrDbH

[104] See Section 7.5.3.2 on innovations in 5G.

**Impact on DFS: Coverage Technologies**

Although growing, broadband coverage is not ubiquitous in many DFS markets, instead being predominant in urban areas and along national roads and their periphery.[105] That is, compared to their narrowband 2G mobile network coverage areas, MNOs in several countries do not necessarily overlay their existing coverage with required 3G and 4G broadband mobile coverage to power new-generation devices. MNOs may satisfy their universal services obligations imposed by regulators to cover rural areas with narrowband coverage, but this does not necessarily equate to universal quality of service. There is a need however for faster network access speeds to power the increased data speed needs of smartphones for optimal and intended usage. This means that many of those with these devices in primarily rural areas may have a degraded smartphone UX.

### 3.6 Mobile Phone Types Used in DFS

The predominant types of mobile handsets in DFS markets that serve those at the bottom of the pyramid (BOP) are what are now known as 'basic' phones and 'feature' phones, with some DFS markets showing increases in smartphone penetration. [106] Mobile phone evolution over the past few years has, to some extent, rendered distinctions between these device categorizations somewhat fuzzy.

The basic phones, also called 'low-end' or 'dumb phone', have limited feature sets, limited or no factory-installed or user-installable value added third party applications, and no or very limited data connectivity. They can, for the most part, access DFS platforms through the use of basic USSD and STK feature sets. Feature phones are the dominant types of phones in DFS.[107] They have more functions than basic phones, but limited functionality and proprietary operating systems (OS).

Not all feature phones support third-party software but, if they do, they are usually run on Java or similar or made for the proprietary OSs of the feature phone (which may require a developer to create different app versions for each feature phones with a unique or non-conforming OS.) These devices have touchscreens and offer a better UI than the USSD and STK UIs used on basic and feature phones, as well as providing increased bouquets of service offerings. **Exhibit 6** through **8** illustrate the differences in the UX between text-based USSD-based menus versus those provided for by the intuitive menus using a graphical user interface (GUI) and available on a DFSP's applications on smartphones.

Market surveys and projections[108] indicate that smartphone penetration is increasing substantially worldwide, although in many DFS-focused markets, non-smartphone phones are in majority use.

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[105] See Exhibits 2 and 5 for comparison and statistical information.

[106] The 'basic'- or 'low-end' - appellation is a throwback to the early days of the emergence of GSM mobile technology, where only basic functionality - such as call functions, SMS, USSD v1 functionality, and a phonebook - were needed (and available) to communicate. Some basic devices could however receive VAS such as ringtones via Over the Air (OTA) installation.

[107] GSMA (2015) *From Feature Phones To Smartphones, The Road Ahead,* available at https://bit.ly/2HKujtl

[108] See for example GSMA (2016a) which projects a majority global smartphone penetration by 2020. For a countervailing view on the rate of smartphone penetration, se Perlman, L (2017) *Technology Inequality: Opportunities and Challenges for Mobile Financial Services*, available at https://bit.ly/2r7NZNy, and Perlman, L & Yoo, P (2017) *Mobile Handset Use In Digital Financial Services*, available at https://bit.ly/2rbHMiG

### 3.7 User Interfaces to DFS Services

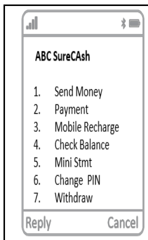
### A Native Phone Interfaces

#### 3.7.1 GSM Voice Channel

The GSM voice channel[109] uses the traffic channel component of GSM, and was the original method of access to basic non-voice transactional services offered by MNOs and other SPs. Users could, for example, access infotainment-type menus and general services by simply dialing special Interactive Voice Response (IVR) numbers linked to infotainment services provided by VAS SPs.[110] The latest use of the voice channel for DFS purposes is for Near Sound Data Transfer (NSDT) which uses the speaker and microphone of a merchant Point of Sale (POS) devices and a user's mobile handset to silently exchange payment information in merchant payments.

#### 3.7.2 Unstructured Supplementary Service Data

Unstructured Supplementary Service Data (USSD) is a novel standard within the GSM and 3G specifications. As with SMS, USSD is an artifact of the original 1980's GSM specification used by MNO engineers to send and receive test messages over GSM networks without interrupting customer calls. It is both a GSM bearer technology and a DFS UI, does not require any additional installations by customers, nor does it require a IP-based data access connection by customers. As a result, USSD has been termed 'The Third Universal App.'[111]




Unlike the store-and-forward functionality with SMS (storing the message when coverage is not available and sending when it is), USSD is session-based and requires sufficient coverage be maintained throughout the entire transaction process before termination of a session. USSD is activated either by users inputting a series of predefined star or hash[112] commands on the mobile handset, or via a session initiated by the MNO or a Service Provider (SP).[113] In both methods, the user is presented with a numbered menu and can use the mobile keypad to respond to and to input in any data required.[114]

**Exhibit 6:** USSD-based DFS Transaction Menu

And as with SMS, USSD uses the mobile signaling channel inherent in SS7 networks. Exhibit 6 shows a sample DFS transaction menu using USSD. Large DFS deployments that rely primarily on USSD include bKash in Bangladesh, WING in Cambodia, EasyPaisa in Pakistan, MTN Money and Airtel Mobile Money in Uganda, ZAAD in Somaliland, M-PESA and Tigo in Tanzania, and EcoCash in Zimbabwe. The security vulnerabilities of the unencrypted, clear text USSD and SMS have been well documented in relation to the impact this has on the integrity

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[109] During a GSM call, speech is converted from analogue sound waves to digital data by the phone itself, and transmitted through the mobile phone network by digital means.

[110] They would input touch-tone codes that would supply the services either through an immediate voice response, or by the service later providing the requested service – such as a ringtone - off-band via SMS to the GSM handset. IVR as a gateway to these basic transactional services has been supplanted by use of USSD and SMS using the GSM signaling channel to access more robust transactional services such as those provided by DFS.

[111] Perrier, T, DeRenzi, B & Anderson, R (2015) *USSD: The Third Universal App*, available at https://bit.ly/2vA3Skc

[112] These relate to combinations of the use of the * [star] and # [hash] keys respectively on the mobile handset. The hash key is also known as the 'pound key'.

[113] USSD is now in version 2. USSD v1 – no longer in primary use, but is still supported by MNOs - has limited features compared to v2, although handsets first issued in the 1990s that use USSD v1 only have long–since been discontinued or reached their useable lifespan, and are unlikely to be used *en masse in* the wild.

[114] While the USSD specification allows a USSD session of up to 600 seconds, typical allowance by MNOs for third party services is up to 180 seconds, with 120 seconds being the typical maximum time allowed for the entire USSD session by MNOs. Response times for the customer to answer challenge questions – such as a need to select 1, 2, 3, or 4 on a USSD-based DFS menu, or type in a recipient's phone number or name in a P2P transaction - may also have their own timeout sequences, either set by the SP, or aggregator or forced by the MNO.

of DFS transactions using this bearer/UI and remains a critical open issue.[115] As USSD is session-based, the quality of the signal that the phone receives and can transmit back to a mobile base station is important. USSD then can only be accessed or be consistently accessible when there is robust communication with MNO base stations and sufficient coverage is maintained without interruption throughout the entire session.[116] Poor mobile signals and substandard antennas in some mobile phones may cause USSD session initiation and sustainability issues. Similarly, competition issues arise when an MNO, competing with a SP on DFS provision, may limit that SP's access to USSD services and access shortcodes or limit the session times and menu trees.[117]

### 3.7.3 Short Message Service

Short Message Service (SMS) – also known as 'text messaging' – was designed in the 1980s to act as a data bearer for mobile network system engineers developing and maintaining the initial version of GSM systems. From these beginnings, text messaging has become a ubiquitous consumer-facing P2P messaging facility. An SMS sent by a user from their mobile handset is known as a Mobile Originating (MO)-SMS, or MO, to signify that the message originated on a mobile handset.

An SMS received by the user on their handset (whether it be from another person or from an automated machine – is known as MT-SMS, or simply MT, for to indicate that an SMS has terminated on a mobile handset. SMS uses GSM signaling channels. The initial SMS protocol allowed users to send and receive messages of up to 160 alpha-numeric characters. Unencrypted 'plaintext' SMS in relation to DFS is primarily used for transaction notifications, 2-factor authentication using one time passwords. Encrypted SMS is used in STK and Java applet-based DFS transactions, outlined below.

### 3.7.4 SIM Toolkit

SIM Toolkit (STK) is a popular encrypted SMS-based remote access and UI GSM technology used to provide DFS and related services to markets where basic and feature phones are the plurality. It is currently one of the most extensively and globally used mobile interfaces in DFS, other than USSD.[118] A specialized SIM to host the STK application and STK-compatible phone is required.[119] As a UI, it is more expensive to provide DFS than if using USSD as the cost (for non-MNO DFSPs) is per text message, with potentially many messages per transaction. A balance enquiry may also be charged (by the host MNO) to the DFSP, although free to the customer.

The STK technology is embedded on the SIM card, allowing special applications for DFS and banking services to be accessed by the subscriber using custom menus stored on the SIM card.[120] The STK usually uses SMS as a bearer for communication with a host,[121] usually encrypting the cleartext SMS to/from the handset and STK server.

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[115] See Butler, K, Perlman, L *et al* (2017) *Security Aspects of Digital Financial Services, (DFS),* available at https://bit.ly/2HH6Jtn

[116] Mobile handsets and base stations must transmit enough power, with sufficient fidelity to maintain a call of acceptable quality or USSD session to completion without transmitting excessive power into the frequency channels and timeslots allocated to others. Receivers must have adequate sensitivity and selectivity to acquire and demodulate a low-level signal. GSM handsets are measured by Class 1-5, with Class 1 being the highest transmitting power. Keysite (2014) *Understanding GSM/EDGE Transmitter and Receiver Measurements for Base Transceiver Stations and their Components*, available at https://bit.ly/2rfkLwe

[117] See Section 6 below on competition issues in DFS.

[118] As with USSD, STK is especially prevalent in developing nations where entry-level phones are mostly used.

[119] These commands are standard for all mobile equipment and defined by ETSI and *3rd Generation Partnership Project* (3GPP) specifications.

[120] On a 'basic' mobile phone, the STK menu may appear as an additional phone menu item when scrolling through basic menus to access the phone's features.

[121] STK as a technology can use USSD as a bearer, but it is very dependent on the STK implementation on the particular handset. Some handset manufacturers have not adequately implemented STK support for USSD however. In practice though, STK will almost always use only SMS as a bearer.

As with USSD, competition issues arise when an MNO, competing with a SP on DFS provision, may limit that SP's access to STK-based services and access shortcodes.[122]

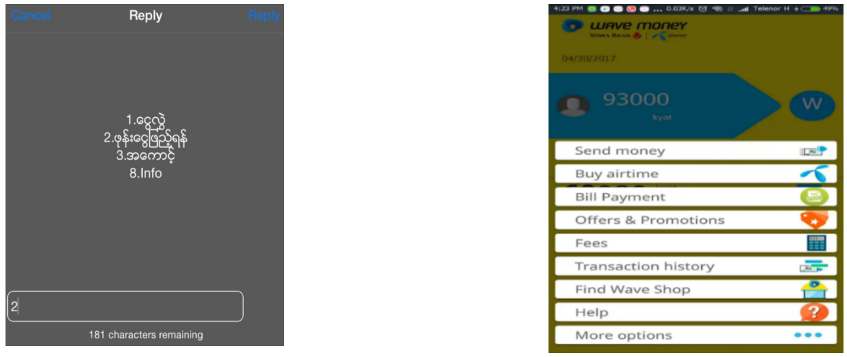


**Exhibit 7:** Wave Money Myanmar USSD Menu. Wave Money Myanmar text-based USSD menu (left) versus the same menu type in its Android application (right).[123] Recognizing the limitation of both a text-based interface and an overwhelming choice of options in graphical interface and to improve customer adoption, Wave worked with CGAP[124] to produce the most intuitive graphics and menu schemes.[125]

## B. Application Based

### 3.7.5 Java Applications

A growing alternative access method for access to DFS using feature phones is to use icon-based Java applications using secure encrypted SMS communications methods installed on feature phones.[126] The menus are relatively easy to use, with an icon-based UI that makes it easier for illiterate/semi- literate users to navigate financial service menus.

Unlike STK-based applets, this access method does not require the MNO to enable the application to operate on its network, and the user can interact and transact with the SP with or without mobile data being available.[127]

### 3.7.6 Feature Phone Applications

Feature phones may operate on proprietary phone operating systems, or mass-market OSs such as those from chip manufactures Mediatek and Spreadtrum. Even so, not all feature phones support third-party software but, if they do, they are usually run on Java or similar platforms, or made for the proprietary OSs of the feature phone.[128] The

[122] See Section 6 below on competition issues in DFS.
[123] Wave Money (2018) *Using *900#*, available at https://bit.ly/2zf1ttY
[124] Consultative Group to Assist the Poor. See www.cgap.org
[125] Chen, G (2016) *The Power of Smartphone Interfaces for Mobile Money*, available at https://bit.ly/2dS7YHD; and Won, J (2016) *Swiping Right: Ideo.org Prototypes Mobile Money on Smartphones*, available at https://bit.ly/2HG8riT
[126] This allows end-to-end security for transactions rather than the cleartext inherent in USSD.
[127] Except if using a WAP link for application download, which requires data.
[128] These are usually standalone applications that do not necessarily integrate with other features of the phone.

most common 'application' platform across feature phones is Java through the J2ME[129] software environment.[130] A similar future influx of 'smarter' feature phones – for example using NFC and 3G, and with factory-installed social media applications – which are sold as part of a larger phone portfolio by some manufactures is anticipated.

### 3.7.7 Smartphone Applications

Smartphone devices provide a rich-media experience by allowing OTT apps to be installed to access DFS and mobile banking applications, for NFC-based payments to merchants and for transit and also have large touch screen displays. At least for some DFS customer segments, the rich media designs may enhance the UX compared to the fixed-menu text-based design of USSD and STK, examined in greater detail in Exhibits 7 and 8.[131]

| DFS UI Type | Primary Handset Type/s Usage | Coverage & QOS Sensitivity | Needs MNO Consent/Cooperation to Provide | Competition-related Sensitivity |
|---|---|---|---|---|
| SMS | Basic; Feature | Low | No | Low |
| Voice/IVR | Basic; Feature, Smart | High | No | Low |
| NSDT[132] | Basic; Feature, Smart | High | No | Low |
| USSD | Basic; Feature | Low | Yes | High |
| STK | Basic; Feature | Medium | Yes | High |
| Phone App | Feature | Medium | No | Low |
| Java App | Feature | Low | No | Low |
| Smartphone App | Smartphone | High | No | Low |

**Exhibit 8**: Chart of UIs: Comparative Mobile Coverage and Anti-Competitive Sensitivities. Comparative Mobile Coverage and Anti-Competitive Sensitivities of various DFS UIs. The competition sensitivity related to whether a (competing) MNO may need to provide a DFS provider with access to that interface via a gateway and/or via provision of use of access shortcodes.[133]

At the same time, however, some caveats relating to the DFS ecosystem are present. For example, not all smartphones being sold in developing markets have 3G and better capabilities, often because the manufacturer wants to save on chipset licensing costs in price-sensitive markets.[134]

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129 J2ME (Java 2 Platform, Micro Edition) is a technology developed by Oracle that allows programmers to use the Java programming language and related tools to develop programs for mobile wireless information devices such as basic and feature phones.

130 However, this is still not ubiquitous, since some phone chipsets are emerging that do not support J2ME, but instead support application development alternatives such as MRE. MRE is implemented by SOC manufacturer Mediatek.

131 It is possible to run a DFS application on a smartphone but send the transaction using a binary SMS to carry it, as is done for Java-based feature phones. This ostensibly gets round the issues of expensive data/data bundles and need for 3G and 4G coverage.

132 An alternative remote access technology that purports to be MNO-independent is acoustic-based access technology – also known as sound-based, or near sound data transfer (NSDT). With this remote access technology, the microphone of any basic phone, feature phone, or smartphone is used for data capture and the standard MNO channel acts as the data transporter. Transaction data is encrypted through the phone's audio channel using a 'cryptosound.' NSDT is the trade name for the acoustic access service offered by Tagpay. See TagPay (2018) *TagPay,* available at www.tagpay.fr, Zhang, B (2013) *PriWhisper: Enabling Keyless Secure Acoustic Communication for Smartphones*, available at https://eprint.iacr.org/2013/581.pdf

133 See Section 6 below on competition issues in DFS.

134 Exhibit 8 displays a chart of different DFS UI types and selected characteristics relating to usage, coverage, competition and consent.

**Impact on DFS: DFS User Interfaces**

Narrowband-centric DFS user interfaces such as USSD and STK have served an important catalytic and foundational role in DFS. As usage behavior becomes evident, services grow and mature however from the foundational DFS 1.0 to the more interactive and more transactional DFS 2.0, reaching the limits of these interfaces. Timeouts on USSD, relatively pricey STK-based access and the non-intuitive nature of these UIs have led in many stop using their DFS wallets – and thus active usage - in favor of the safe harbor of agent-assisted OTC transactions by customers. The World Bank's Findex Survey suggest that while DFS accounts have grown from 2014,[135] account activity levels have fallen.[136] Similar trend lines have been reported by the GSMA, whose State of the Industry Report in Mobile Money 2017[137] highlighted that of the 690 million 'mobile money' accounts opened, active account use within a 90 day period was at disappointing 35.8% and active account use within a 30 day period at a worrying 24.3%.

As noted by CGAP,[138] smartphone UIs not only have the chance to make basic transactions simpler and can potentially address a host of other identified barriers to active use, such as more intuitive icon-driven menus that address the culture the customer, alongside more assuring information such as the ability confirm transactions and easily correct input errors, provide real-time pricing information, as well as transaction logs. Location-relevant maps of the nearest agents with sufficient e-money or cash floats may also provide incentive to use services and save on walking.

Feature phones are likely to dominate DFS access for the foreseeable future using USSD, encrypted SMS and WAP. The need for access to these scarce UI/bearer resources has implications for regulators to continue to develop and maintain policies on access to USSD and STK gateways at fair reasonable and non-discriminatory (FRAND) terms. As noted above, exception – and perhaps a growing one[139] – to the 2G-text-based UI nexus is the growing use of Kaios[140] feature phone operating system is designed as a hybrid between a smartphone and feature phone operating system.[141] This OS has had huge uptake in India where MNO Jio's 'JioPhone' is given away virtually free. It has a feature phone form with the Kaios graphical UI.

[135] Some 515 million new financial accounts were opened around the world. World Bank Group (2018) *The Global Findex Database 2017,* available at https://globalfindex.worldbank.org/
[136] See Accion-CFI (2018) *Financial Inclusion Hype vs. Reality: Deconstructing the 2017 Findex Results*, available at https://bit.ly/2JAyB3n
[137] GSMA (2018) *2017 State of the Industry Report on Mobile Money*, available at https://bit.ly/2CKPLqF
[138] Chen, G (2016) *The Power of Smartphone Interfaces for Mobile Money,* available at https://bit.ly/2rq6Ram
[139] Media Nama (2018) India's feature phone shipments doubled in Q1 2018, smartphone market stayed flat, available at https://bit.ly/2CR2bRH
[140] MediaNama (2018) *Facebook app now officially available on the Jio Phone*, available at https://bit.ly/2JuCIP1
[141] KaiOS is a Linux-based operating systems and derivative of the now shuttered Firefox OS. It powers a number of phones and brands, and supports video calls over 4G; mobile payments through NFC and dual-SIM support. It has its own app store and Google has invested in it. See Verge (2018) *Google invests $22 million in the OS powering Nokia feature phones*, available at https://bit.ly/2EWhtHu

## 4 LAW AND REGULATION

### 4.1 Overview

DFS is an emerging and evolving ecosystem. In developing countries where DFS is primarily found, the extent to which legislative frameworks exist and have been updated to address dynamic changes over time varies greatly. At its most basic transactional enabling of person-to-person transfers, a DFS ecosystem will have as direct regulatory overseers, the central bank, the telecommunications regulator – and if they separately exist – AML, competition and consumer protection regulators. Indirectly and by default, an identity authority, tax authorities and those overseeing commercial entities will also have some degree of oversight or will provide essential enabling frameworks.

| National Regulator/Authority | Scope & Potential Remit | Mobile Coverage-related |
|---|---|---|
| Telecommunications | ICT, telecommunications, information security, bearer channels, competition, telecommunications infrastructure security, data privacy; agents | Yes |
| Central Bank | Banking, payments, capital markets, interoperability, payment security; agents | Sometimes, over USSD/STK access and costs |
| Consumer Protection | Consumer protection, ombudsman, fair competition | Sometimes, if poor QOS results in dropped calls |
| Internal/Home Affairs | Issuance of (biometric) IDs for payment authentication | No |
| Competition | Prevention of anticompetitive behavior | Yes, in relation to access to bearer channels; and access to mobile base stations |
| Financial Intelligence Unit | Customer ID and KYC and prevention of terrorism | No |
| Credit | Provision of consumer credit | No |
| Insurance | Provision of consumer products | No |
| Privacy | Data Protection | No |
| Environmental | Right of way for infrastructure deployment | Right of way for fixed and mobile infrastructure |
| Tax | Import duties, domestic VAT/GST on infrastructure | Tax on imported infrastructure and diesel for generators; and on end-user devices |
| Universal Service Agency | Levies a tax on consumer bills/airtime and/or on licensee spectrum | Yes |
| Finance Ministry | Specifies income the fiscus requires from taxation of licensees; and/or on mobile spectrum sale/auctions | Often |

**Exhibit 9:** Regulators, Agencies and Authorities and their remits over mobile coverage components**.**

But as services move beyond purely person-to-person transfers and become more sophisticated, varied and integrated into the national fabric, other regulators – such as those overseeing credit or insurance provision - may also become involved and need to exercise their remit over participants, technology components and services. The World Bank has referred to mobile money as a 'success story but yet a regulatory minefield.'[142] This section will identify and explain the roles of regulators who are likely to appear in the provision of DFS and mobile communications services.

In the regulatory coordination section which follows, this paper will examine how regulators handle issues which have the potential to be handled by multiple regulators or which may not have applicable enabling legislation.

[142] World Bank Group (2016) *Digital Dividends,* available at https://bit.ly/2aXM2tM

Bilateral or multilateral Memoranda of Understanding (MOU) between these regulators are generally necessary to coordinate oversight and to prevent regulatory arbitrage.[143] See Exhibit 9 on regulators and authorities and their remits over mobile coverage components.

## 4.2 DFS Related

The core DFS 1.0-related regulators will include the central bank, telecommunications regulators and financial intelligence units. The variety of DFS 2.0 regulators will increase as service offerings and competition-based complexities increase. While their regulatory roles are usually similar, their exact names, boundaries of remits, and existence on the list of national regulators will vary between jurisdictions.[144]

## 4.3 Mobile-Coverage Related

### 4.3.1 Telecommunications

The purview of telecommunications regulators generally concerns matters of mobile networks including spectrum management from a national resource side to MNO products, services, infrastructure and third-party providers utilizing the network and spectrum. The regulator may manage spectrum allocation and the national table for frequency allocation NTFA,[145] spectrum assignment, licensing and controlling new entrances into the marketplace. Licensing provisions may be conditioned upon satisfaction of additional requirements, also supervised by the telecom regulator, such as mandatory mobile coverage areas and/or expansion, technology type and the use of infrastructure sharing where deployment may be involved.

Much like a competition regulator and where it has remit, the telecommunications regulator may intervene in relation to level access to technology and services of scarce supply, especially if an entity has significant market power and abuses that power. Action to reduce harm may relate to USSD, STK, SMS short codes, pricing and national tariffs, zero rating and any anti-competitive practices that may arise within the marketplace.[146]

Regulatory activity may include matters of quality of service (QOS), security, privacy and the promotion of fair competition in the marketplace. In developing countries, fewer MNOs may exist, resulting in greater potential for anti-competitive behavior and dealing with state-owned MNOs and a monopoly of providers.[147] Often there will be a competition regulator or authority with which jurisdiction over such matters may be delegated or shared in some fashion.

### 4.3.2 Universal Service Funds

A Universal Service Fund (USF)[148] is a ring-fenced fund which consists of contributions made by MNOs, usually based upon their gross revenues less offset such as interconnection of other operators, to reach national universal service policy goals.[149] The concept of universal service is to assist under/unserved areas by providing access to telecommunications services such as funding the extension of mobile coverage into rural and remote areas and providing universal broadband service. The USF is often run by an autonomous agency or entity or agency administered by a management board and is designed to act independently, although this may not always be the case in practice.[150]

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143 Regulators/Authorities with more proximate remit relating to mobile coverage provision are outlined in Section 4.3

144 Some of these regulatory roles are outlined in **Exhibit 9**.

145 The NTFA, covered in Section 5.5.3.4.2, may sometimes be designated to a specific and specialized authority.

146 See Section 6 on downstream competition-related issues in mobile coverage and DFS

147 MNO's such as Ethiopia's state owned Ethio Telecom maintains a monopoly on wired and wireless telecommunications and Internet services. International Trade Administration (2017*) Ethiopia – Information and Communication Technology*, available at https://bit.ly/2I3i7jx

148 Sometimes called a Universal Access Fund (UAF) or other variation, covered in greater detail in Section 7.2 and 7.2.1.

149 Universal Service is covered above in Section 4.3.2

150 See Section 4.3.2 on USF.

### 4.3.3 Environmental

Infrastructure for mobile networks includes the construction and deployment of mobile base stations. An environmental regulator may handle matters concerning aesthetics of towers appearing in rural or remote areas in nature as well as health and safety concerns that may arise resulting from the transmission of electromagnetic waves from all base stations. Other issues within the regulator's purview includes operations such as the provision of fuel and backhaul to the tower as well as any emissions and refuse that may be generated.

### 4.3.4 Competition

As the CAPEX and OPEX costs of being an MNO are usually exceedingly high, substantial barriers to entry inherently limit the number of MNO marketplace entrants. As a result, some jurisdictions dedicate the management of market power to a competition regulator, sometimes called an 'authority', to promote fair competition within the marketplace and foster progress and innovation. The competition regulator, regarding telecommunications-related issues, may have sole or co-remit (with the telecommunications regulator) over the ecosystem and may intervene to level access to technology and services.[151]

### 4.3.5 Municipal

Municipal regulation is most often encountered concerning deployment of mobile network infrastructure, such as a tower or placement of a small base station. Unless national or regional legislation pre-empts localities from control over base station licensing, construction and operation, these issues may be left to local law and the purview of a municipal official. This includes municipal levies and taxes, zoning laws, licensing, taxes, real estate ordinances and other related matters.

### 4.3.6 Military / Intelligence

Military and government intelligence agencies, as well as organizations such as meteorological and aerospace, may have reserved frequency bands which should appear in a respective country's NTFA. Mobile base stations located near military and government intelligence facilities may be subject to their purview.

### 4.3.7 Ministries of ICT

Ministries of Information and Communications Technology (ICT) are government entities generally responsible for developing and setting national policy regarding information and communications technology, which often includes telecommunications, broadcasting, postal service and print media.[152] They traditionally develop national policy regarding information and communications technology, broadcasting, postal services and print media. This can also extend to mobile broadband policies, universal service policies and spectrum usage.

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[151] See Section 6 on downstream competition-related issues in mobile coverage and DFS

[152] Kenya's Ministry of Information, Communications and Technology (ICT) is a bifurcated organization with two state departments being The State Department of Broadcasting and Telecommunications and The State Department of ICT and Innovation. Ministry of Information, Communications and Technology (2018) *About the Ministry*, available at www.ict.go.ke/about-the-ministry/, The Uganda Ministry of ICT & National Guidance (2018) *Functions,* available at https://www.ict.go.ug/ict/functions; Ministry of Information Communication Technology and Cyber Security (2018) *Overall Functions*, available at http://bit.ly/2JnxZOa

**Impact on DFS: Regulatory Oversight**

The appropriate regulator to handle a specific matter may not always be clear. Sometimes there may be an absence of enabling legislation or unclear boundaries regarding existing legislation, leaving answers as to the appropriate regulator unclear and leading to regulator shopping. But there are methods which are used to maintain peace and order between regulators. Bilateral or multilateral memoranda of understanding (MOU) is another option and is an agreement between regulators on how to handle overlap and who will have authority to handle which matter.[153]

# 5 MOBILE COVERAGE COMPONENTS

## 5.1 Overview

Mobile coverage comprises of three integral components: (i) technology,[154] which defines the manner and protocol which wireless devices communicate with the network such as 2G, 3G and 4G; (ii) network infrastructure, [155] which consists of the physical components of the network which facilitates wireless transmissions; and (iii) spectrum,[156] the natural resource and invisible medium upon which radio waves carrying information travel between distant points. Having covered mobile technology above, this section will complete our review of the latter two components of mobile coverage and begin with mobile network infrastructure, its basic architecture and the deployment of towers and mobile base stations.

## 5.2 Mobile Network Infrastructure

### 5.2.1 Components

#### 5.2.1.1 Overview

At a basic level, mobile network infrastructure can be divided into three primary parts: (i) the backbone; (ii) the backhaul; and (iii) the access or radio network, as illustrated in **Exhibit 10**.

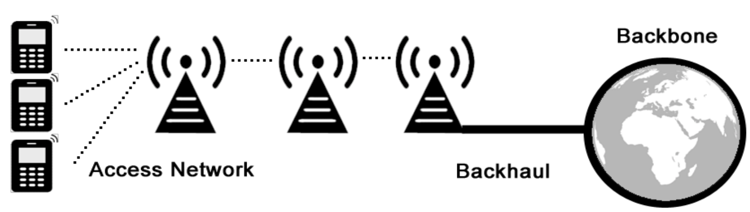


**Exhibit 10:** Layers of Mobile Communications Network

To complete the connection from a fast, high capacity wired connection (such as fiber-optic cables) to wireless connectivity points, towers are built which house equipment for wireless communications[157] to end users and potentially to intermediary towers.

This section will provide a concise review of the composition of mobile network infrastructure, the components of a mobile base station, and the challenges of network expansion into rural areas.

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[153] For an example of a model MOU between a NTA and CB, see Perlman, L (2018) *Model MOU Between a central Bank and National Telecommunications Authority For Digital Financial Services Regulation*, available at www.dfsobservatory.com

[154] Mobile technology is examined in Section 3.

[155] Network infrastructure is examined in Section 5.2.

[156] Spectrum is examined in Section 5.5.

[157] Also known as ‘mobile base stations’ or ‘base stations’.

#### 5.2.1.2 Backbone

The backbone reflects the top level of aggregation in a mobile telecommunications provider network. This layer includes the primary path to which sub-networks connect to share and exchange information. The backbone[158] generally consists of high capacity fiber-optic cable installed through a centralized location, which is the primary transport which interconnects distant areas to each other.[159] A metropolitan network may connect to a national backbone, which is the point of connection to other regions and continents, reaching overseas destinations using undersea submarine cables to establish international connectivity.[160]

#### 5.2.1.3 Backhaul

The backhaul or 'middle mile' segment of the network refers to a transport layer, which connects the backbone to the edge of the network and final aggregation point[161] which serves end users. While high capacity fiber-optic cable is preferred for backhaul, it is not always an option, particularly when installation and necessary rights of way are cost-prohibitive and where local permits and permissions are difficult or impossible to obtain.[162]

Optical[163] and microwave radio networks are often used at lower cost, although line-of-sight is required between microwave transmitters, making use challenging and potentially expensive to manage in demanding areas.[164]

Satellite backhaul is a growing and maturing solution for reaching rural and remote areas, including providing the potential for completing a universal mobile broadband solution.[165] It is often a suitable and effective choice in emergency situations and can overcome the terrestrial challenges faced by fiber and microwave systems. However overall operating costs can be significantly higher in addition to having vulnerability to above ground interference.[166]

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[158] In order to ensure adequate competition and preference to avoid reliance on a single privately-owned network, the South African government built a state-owned backbone network during 2007 to compete with a privately-owned incumbent. See Garcia, J M & Kelly, T (2015) *The Economics and Policy Implications of Infrastructure Sharing and Mutualisation in Africa*, available at https://bit.ly/2qS-HDRM

[159] One example is the National Optic Fibre Backbone (NOFBI) of Kenya, which is completing its 5,900 kilometer fiber optic backbone connecting all 47 counties in Kenya. ICT Authority iCal *National Optic Fibre Backbone (NOFBI)*, available at https://bit.ly/2HSeayM

[160] Sub-Saharan Africa was one of the last major world regions to have direct global connectivity, with Kenya landing its first submarine cable in Mombasa during March 2010. This, in turn, led to a drop in wholesale prices and helped reduce broadband service costs to affordable levels. See Forden, E (2015) *The Undersea Cable Boom in Sub-Saharan Africa*, available at http://bit.ly/2JgAqBZ; *See also* Lancaster, H and Lange, P (2017) *Kenya - Fixed Broadband, Digital Economy and Digital Media - Statistics and Analyses*, available at http://bit.ly/2HphTH1

[161] Flynn, P (2013) *Building a Wireless Infrastructure: The Critical Role of Backhaul*, available at http://bit.ly/2HF6AKa

[162] See Nigerian Communication Week (2014) *'Right of Way' Issues Frustrate Broadband Penetration*, available at http://bit.ly/2HlBojN

[163] ITU (2017) *Telecommunications/ICTs for rural and remote areas*, available at https://bit.ly/2rgrDbH

[164] Microwave networks also require a source of electrical power at each transmission station to operate.

[165] In Uganda for example, the NTA, the UCC will use IntelsatOne Mobile Reach Solar 3G satellite services delivered via the Intelsat 37e satellite and Gilat's SkyEdge II-c multi-application platform to provide broadband connectivity to some communities. For the pilot project, MTN Uganda will integrate the sites into its core network. See Satellite Today (2018) *Uganda to Boost 3G Infrastructure Deployment via Satellite*, available at https://bit.ly/2jQmnsh For examples of innovative satellite and atmospheric mobile infrastructure solutions see Section 7.5.2.

[166] Crouch, A & Davies, S (2013) *A coordinated satellite and terrestrial microwave backhaul for cellular mobile in remote and regional Australia*', available at http://bit.ly/2K6D4LM and see also GSMA (2014) *Wireless Backhaul Spectrum Policy Recommendations & Analysis*, available at http://bit.ly/2HpMVui

### 5.2.1.4 Access Network or 'Last Mile'

The access or radio network,[167] also referred to as 'the last mile', represents the connection from the Base Transceiver Station (BTS)[168] to end users and which may be situated in a mobile base station illustrated in **Exhibit 11**. In urban areas, transmission equipment and antennas may be deployed on rooftops and other high-altitude locations through commercial leasing agreements. In rural areas, real estate may be secured to construct a mobile base station, its supporting infrastructure, and its connection to the backhaul.

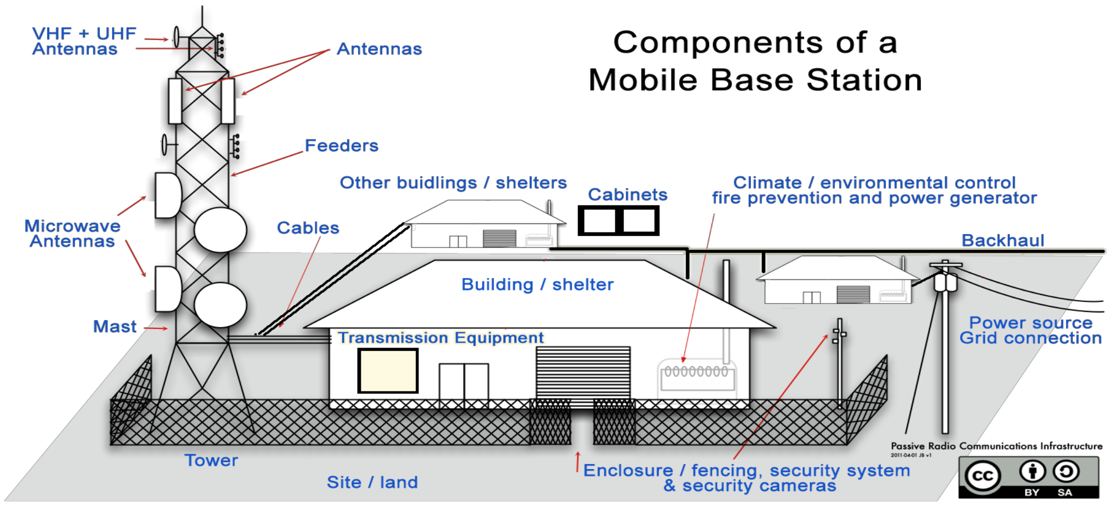


**Exhibit 11:** Basic Components of a Mobile Base Station, showing a stylized diagram of a mobile base station, comprising land and real estate, fencing and security, base stations and transmission equipment, shelters for housing transmission equipment, power supplies and generators, climate control for housing and shelters, fire prevention equipment, a tower and mast, cellular antennas, microwave, (optional) television antennas and the backhaul interface**.** [169] Not to scale.

### 5.2.1.5 Challenges of Expanding Mobile Coverage to Rural Areas

Expanding and maintaining mobile coverage by constructing, deploying and servicing mobile base stations, both its passive and active components,[170] can present high barriers to overcome and sustain. This is especially true when providing coverage to rural and remote areas that are at a distance from public utilities and provide power, fuel, human expertise for installation and maintenance and other required services.

Costs and efforts to provide these necessities are significantly higher in comparison to urban locations. Overall, substantial CAPEX and OPEX costs are to be expected in building, deploying and maintaining mobile base stations.[171]

Rural locations may present environmental and topographical challenges such as difficult weather conditions, terrain and mountains, as well as minimal access roads and supporting infrastructure. There may also not be enough 'high site' locations for (mostly) required direct line-of-site microwave connectivity between base stations.

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[167] The access network is also discussed in Section 7.4.
[168] The BTS is also be referred to as a 'base station' or a 'mobile base station.'
[169] Simmons & Simmons LLP (2014) *Telecoms Infrastructure Sharing: Structures*, available at http://bit.ly/2HnkWeM and see KPMG (2011) *Passive Infrastructure sharing in Telecommunications*, available at http://bit.ly/2HLeGkq and see also Lefèvre, CB (2008) *Sharing Infrastructure*, available at http://bit.ly/2Hp1hLy. Image source: https://creativecommons.org/licenses/by-sa/3.0/nz/
[170] See Section 7.4 on infrastructure sharing.
[171] See Section 5.4.1 regarding the cost of building and deploying a base station.

Alternative inter-base stations methodologies may be required, for example expensive satellite uplinks,[172] or deployment of Non Line Of Sight (NLOS) base stations.[173] A direct connection of the mobile base station to an electrical grid is preferred but not always practical or reliable in rugged areas. Diesel gasoline is often used as an alternative as well as solar power as a supplement, which is an evolving solution. Mobile base station security is also critical since, often unmanned and situated in remote locations accessible periodically and only by helicopter or rugged vehicles, they are frequent targets of vandalism and theft.[174]

Right of way and taxation considerations are also manifest within provision of services in rural areas as are local levies and taxes. For example, in Nigeria, some MNOs have rebelled against what they term 'unapproved taxes' levied by state governments, such as an environmental sanitation levy and generator emission tax.[175] These MNOs are threatening to abandon the mobile base stations sites where these taxes are supposedly applicable. Altogether some 38 different taxes and levies are fastened on MNOs per base station.[176] Similarly, in India, the government is attempting to streamline the regulatory environment to avoid the current situation of multiple agencies having remit over MNOs with each levying some tax or levy on the MNOs.[177]

## 5.3 Infrastructure Deployment

### 5.3.1 Overview

Mobile network infrastructure has been deployed using two general approaches, standalone operator-owned and shared models, which are examined in the following section.

### 5.3.2 Standalone Deployment & Shared Networks

#### 5.3.2.1 Standalone

The manner of deploying telecommunications infrastructure traditionally consisted of carriers, absent sharing mandates or motives, investing in their infrastructure and mobile base stations for their own use and sharing voluntarily if and when motivated and/or incentivized to do so.[178] Mobile network expansion requires a substantial outlay with expectations of long-term cost recovery.[179] A standalone deployment can provide benefits to an MNO of first mover advantage and in staving off new market entrants[180] using technology and coverage area exclusivity as a differentiating factor. When MNOs exhibit a significant degree of market dominance, mobile coverage

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[172] On Uganda's use of satellite backhaul, see Satellite Today (2018) *Uganda to Boost 3G Infrastructure Deployment via Satellite*, available at https://bit.ly/2jQmnsh

[173] See Section 7.5.3.3 on low power mesh networks.

[174] Wireless Estimator, (2017) *Puerto Rico's horrendous cell site outages complicated by generator/Fuel theft concerns*, available at http://bit.ly/2F9RSpo; Theft and 'leakage' of diesel fuel, copper wires and backup batteries presents a substantial problem, especially in remote and unmanned mobile base stations. *See* GSMA (2014) *Tower Power Africa: Energy Challenges and Opportunities for the Mobile Industry in Africa*, available at http://bit.ly/2F9Pn6t ; See also MyBroadband (2015) *How Thieves Are Plundering SA's Telecoms Networks*, available at http://bit.ly/2K9NY3i; *See also* Wireless Estimator, (2017) *Puerto Rico's Horrendous Cell Site Outages Complicated By Generator/Fuel Theft Concerns*, available at http://bit.ly/2F9RSpo

[175] Nigeria Communications Week (2018) *Telcos May Switch Off GSM Services in S/East, Others over Taxes*, available at https://bit.ly/2KRkasM

[176] The MNOs have petitioned the Nigerian president to declare telecommunications infrastructure as critical national infrastructure to address the problem of shuttering of base station sites in the country. The head of Association of Telecommunications Companies of Nigeria has indicated that the association's members do not see any viability in further investing in an environment that appears hostile to them and that until the government seriously addresses the multiple taxation issue, multiple regulation and the harmonization of taxes and removal of exorbitant Right of Way charges applied to its members. Nigeria Communications Week (2018) *Telcos May Switch Off GSM Services in S/East, Others over Taxes*, available at https://bit.ly/2KRkasM

[177] Live Mint (2018) *Trai proposes converged regulation for ICT and broadcast sector,* available at https://bit.ly/2G4VRE4

[178] ITU (2017) *Telecommunications/Icts For Rural And Remote Areas*, available at https://bit.ly/2rgrDbH

[179] The cost of a mobile base station can be substantial. Gadi, HD, Murthy, RV, Shankar, R *et al.* (2014) *Antennae Location Methodology for a Telecom Operator in India*, available at http://bit.ly/2HjvCz4

[180] OECD (2013) *Broadband Networks and Open Access*, available at http://dx.doi.org/10.1787/5k49qgz7crmr-en

exclusivity can result in a pronounced reduction of fair competition in the marketplace and can also lead to issues of reduced QOS.[181]

Standalone deployment can also result in an underutilized cost center for an MNO. Generating greater efficiencies would require an MNO to invest in running, financing, developing and manage colocation and sharing of its facilities.[182]

#### 5.3.2.2 Shared

Infrastructure sharing[183] involves of passive[184] and active network components,[185] in addition to spectrum which can also be shared.[186] There are multiple rationales for sharing, some of which include the desire for economic and technical efficiencies, ensuring the existence of a fair and competitive marketplace and resource planning. With limited physical space for placement and spectrum available for use, unnecessary duplication of resources is a priority[187] although reasons for sharing are often a matter of economics.

Infrastructure-sharing is often voluntarily performed by MNOs. Co-location of MNO-owned facilities exists, although preference related problems can tend to arise and are an obvious concern when equipment and services are hosted in a facility owned by a direct competitor. Government mandates may be issued to level the playing field of access and force infrastructure sharing, such as national roaming, which also fits within coverage and competition goals.[188]

The economic benefits of sharing resources are especially important as they pertain to expansion of mobile coverage into rural areas, with their typically lower population densities, levels of income per capita and commercial activity. Ultimately this leads to lower potential profitability of investment and a reason why expansion is often subsidized.[189] Accordingly, generating the maximum levels of overall efficiency through resource sharing, including cost reduction to lowest levels, is a high and essential priority.

Recently there has been the emergence of third party companies dedicated to providing infrastructure to be shared among tenants known as 'tower companies.'[190] CAPEX and OPEX are borne by third parties who focus upon their core business of expanding and managing infrastructure.[191] Existing standalone mobile base stations may be sold in leaseback arrangements, where MNOs retain an interest in a newly formed company which is majority owned by a

[181] For more information about competition and QOS issues resulting from market dominance of MNOs, see Section 6.
[182] It must also operate as a colocation specialist using time, effort and expert resources to maximize the unused portions of its substantial investment in unused infrastructure.
[183] See Section 7.4 examining infrastructure sharing in greater detail.
[184] See Section 7.4.1.1 for more information about passive infrastructure sharing.
[185] See Section 7.4.1.2 for more information about active infrastructure sharing.
[186] Also known as 'network roaming.'
[187] Osei-Owusu, Alexander (2017) *Network tower sharing and telecom infrastructure diffusion in Ghana - a Structure-Conduct-Performance approach*, available at https://www.econstor.eu/handle/10419/168532; In addition to physics, there is also a limited amount of practical space, such as the desires to limit the number of radiation generating mobile base stations for aesthetic, environmental and health and safety reasons.
[188] ITU (2017) *Policy, Regulatory And Technical Aspects Of The Migration From Existing Networks To Broadband Networks In Developing Countries*, available at https://bit.ly/2HJnBQi
[189] See Section 7.2 on universal service and the funding of expansion of national coverage.
[190] See Section 7.4.5 for more information about tower companies.
[191] See Section 7.4 below on infrastructure sharing. See also Garcia, J M & Kelly, T (2015) *The Economics and Policy Implications of Infrastructure Sharing and Mutualisation in Africa*, available at https://bit.ly/2qSHDRM

tower sharing company specializing in shared infrastructure arrangements.[192] Infrastructure sharing and tower companies are covered in greater detail in **Sections** 7.4 and 7.4.5.

### 5.4 Financial Considerations for MNOs in Coverage Provision and Upgrades

#### 5.4.1 Costs of Building New Base Stations in Rural Areas

MNOs factor in ROI in the decision-making process to deploy specific infrastructure. The investment is a globular figure based on the cost of setting up a base station site and the operational expenses that fasten on that site.[193] ROI would be based primarily on usage of that site, based on the number of active users and how much revenue-generating voice, text and data traffic they undertake.[194]

Standardization of networks technologies, enhanced spectral efficiency and the allocation of additional spectrum are also contributing cost factors.[195] A recurring theme in this study; the CAPEX and OPEX per subscriber are relatively high when the subscriber density is low, with costs decreasing when there are more subscribers sharing the costs.[196]

Using one example, construction costs in 2014 of just four mobile base stations in the Democratic Republic of Congo, providing 1,260 square kilometers of new mobile coverage, cost USD 1.6 million.[197]A sample of the cost of building a mobile base station in India, the UK and China appears in **Exhibit 12**.

To fully appreciate the substantial capital outlay involved in infrastructure expansion, backhaul must also be included in the equation. Using a recent example, the deployment of 8,000 new mobile base stations along with an installation of 4,200 km of fiber optic cable across two Indian states will cost MNO Bharti Airtel approximately USD 332 million.[198]

And as illustrated in Exhibit 12, backhaul costs for fiber optic cabling to uncovered rural areas can add substantial CAPEX to an initial deployment to a new area, with a smaller portion attributable to building a new mobile base station.

**Network Upgradeability:** Migration from older 2G technology to 3G and 4G requires upgrading the mobile network infrastructure to compatible equipment which can include base stations, backhaul and core network

[192] See also ITU (2017) Policy, regulatory and technical aspects of the migration from existing networks to broadband networks in developing countries, available at https://bit.ly/2HJnBQi

[193] OPEX is often higher than CAPEX depreciation, and therefore, it is essential to minimize network OPEX.

[194] This could be based on the cost per subscriber as a function of subscriber density per base station site, or cost of provision per gigabyte as a function of mobile broadband penetration. Subscriber density is the average value over the whole network. See NokiaSiemens Networks (2010) *Mobile Broadband With HSPA And LTE – Capacity And Cost Aspects*, available at http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=4555. Building new base stations in rural areas with mobile broadband capacity often assumes that HSPA and LTE radios are considered with minimum configuration of HSPA 1+1+1 (5 MHz) and maximum configuration of HSPA 4+4+4 @ 900 (5 MHz) and 2100 (15 MHz), and LTE 3+3+3 @ 800 (10 MHz), 1800 (15 MHz) and 2600 (20 MHz). For assessment of the total cost of ownership (TCO) of the backhaul network, see Mahloo, M., Monti, P., Chen, J., & Wosinska, L. (2014). *Cost Modeling Of Backhaul For Mobile Networks. In 2014 IEEE International Conference On Communications Workshops (ICC),* available at https://bit.ly/2qkUrzV

[195] See. Oughton, EJ & Frias, Z (2017) The cost, coverage and rollout implications of 5G infrastructure in Britain, Telecommunications Policy, available at https://doi.org/10.1016/j.telpol.2017.07.009

[196] NokiaSiemens Networks (2010) *infra*

[197] USAID's humanitarian assistance was provided to communities seeking protection from a local rebel group allegedly committing human rights violations. See more below in Section 5.4.3. USAIDD (2014), *Low-Cost Base Transmission Stations Pilot Project*, available at http://bit.ly/2IoCUkJ

[198] The Economic Times (2018) *Airtel to roll out 8000 new mobile sites, 4200 kms of optic fiber in FY 18-19 in Maharashtra, Goa*, available at http://bit.ly/2woV2qd

elements.[199] Different frequency spectrum may also be used and need to be taken into account, such as 900 MHz for 2G, 2100 MHz for 3G and the multiple frequency requirements for 5G.[200]

It is important to note that an upgrade from 2G to a higher generation technology, such as 3G or 4G, may also require modification or (complete) replacement of backhaul technology to ensure that higher capacity throughput can be achieved as well as compatibility.[201] Little of the prior 2G network components may be salvaged and reusable, with backhaul needing to be upgraded to accommodate the much larger throughput of 3G.[202] Accordingly, many factors must be taken into account in order to provide reasonably accurate cost estimate for upgrading mobile network infrastructure[203] as well as a feasibility assessment given the potentially very high cost of upgrading.

The ease in upgrading mobile base station technology is impacted by the presence of versatile components used in manufacture. The presence of a Software-Defined Radio (SDR) in a mobile base station makes migration primarily a software-driven effort as opposed to a process intensive hardware upgrade.[204] It also allows for backward compatibility, such as being able to offer 3G service with 2G fallback.

However, common practice of MNOs is to repurpose aging urban mobile technology for rural usage for the purpose of satisfying the bare minimum thresholds required to operate spectrum licenses. As a result, rural area mobile base station technology may not provide for a simple upgrade from 2G to 3G or 4G, even to 5G and can require the replacement of the components of the base station technology, including the radio and the antenna.[205]

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[199] Paolini, M (2009) *No painless upgrades to 4G*, available at https://bit.ly/2KPZ9ia

[200] As set forth in Section 3.2.1.4, three sets of frequency bands are recommended for use in 5G implementations. See Barret, J (2017) *5G Spectrum Bands*, available at https://gsacom.com/5g-spectrum-bands/; See also GSMA (2016) *5G Spectrum: Public Policy Position*, available at https://bit.ly/2pno8NN

[201] Brydon, A (2010) *3G operators will need to swiftly upgrade backhaul capabilities*, available at https://bit.ly/2wnFT8t

[202] *ibid*

[203] A comprehensive breakdown of upgrading to 5G in the UK, including CAPEX and OPEX costs, can be found in the following cited study. Oughton, E. & Frias, Z. (2017) *Exploring the Cost, Coverage and Rollout Implications of 5G in Britain*, available at http://bit.ly/2HpReWu

[204] Barton, J (2017) *Parallel Wireless folds 2G Capabilities into 3G/4G End-to-End SDR Solution*, available at https://bit.ly/2KNgRmr

[205] McKinsey (2018) *The road to 5G: The inevitable growth of infrastructure cost*, available at http://bit.ly/2CEKely. One calculation for the US puts a 4G to 5G upgrade figure at USD 200 billion. This is because of the high-frequency 5G signals and the need to install smaller cellsites on rooftops and street poles. See Bloomberg (2017) Upgrade to 5G Costs $200 Billion a Year, May Not Be Worth It, available at https://bloom.bg/2Bb8nnK

| INDIA [206] | CAPEX (2014 USD ) | Costs (2014 USD ) |
|---|---|---|
| 40 Meter Ground Based Steel Tower | 14,800 | |
| Battery/Power Plant & Civil Works | 5,920 | |
| Diesel Generator Engine | 4,440 | |
| BTS | 14,8000 | |
| Operating cost, monthly | | 23,147 |
| Rent, monthly | | 2,768 |
| Backhaul - Fiber: add ~USD 2,190 per km[207] | | |
| **Total = USD 65,875** | **39,960** | **25,915** |

| UK | CAPEX (2017 USD ) | Costs (2017 USD ) |
|---|---|---|
| Deploying a multicarrier base station | 28,630 | 2,729 |
| Site lease | | 3,500 |
| Civil works | 12,600 | |
| RAN Sharing (add 10% markup cost) | | |
| Backhaul – Fiber add ~USD 14,00/km | | |
| Core upgrade cost | Add 10% of RAN and backhaul CAPEX | |
| **Total = USD 47,459** | **41,230** | **6,229** |

| CHINA[209] |
|---|
| Cost to build a base station in China during 2017: CNY ¥250-350,000 (USD 39,450-55,230). |

**Exhibit 12 :** Cost Components for Mobile Base Station Sites for India (2014), UK (2017) and China (2017)[210]

[206] Indian Institute of Management Bangalore (2014) *Working Paper No: 454, March 2014*, https://bit.ly/2zhQXCd ; Conversions to USD are based upon the rate of 0.0148 Indian Rupees per US Dollar as of May 14, 2018 using the INRUSD Spot Exchange Rate. Current estimates for the cost of laying optical fiber in India can be found in the BharatNet project which is a part of the Digital India Initiative to expand broadband Internet coverage to a sizeable portion of the population. For more information and specific details concerning costs and coverage, see the following sources. Department of Telecommunications (2017) *Annual Report 2016-2017*, available at http://bit.ly/2Ko2hkd

[207] The estimated cost for installation of fiber optic cable to be used for backhaul is based upon the rollout in the state of Andhra Pradesh in India, quoted at Rs.333 crore to install a 22,500 km broadband network, using the same exchange rate stated in footnote 148. Kalavalapalli, Y (2016) *Cisco to lay 22,500-km long Internet fiber network in Andhra Pradesh*, available at http://bit.ly/2KWIoBL

[208] Oughton, E. & Frias, Z. (2017) *Exploring the Cost, Coverage and Rollout Implications of 5G in Britain*, available at http://bit.ly/2HpReWu, *infra* . Conversions to USD are based upon the rate of 0.7373 Great British Pounds per US Dollar as of May 14, 2018 using the GBPUSD Spot Exchange Rate. See Bloomberg (2018) *GBP to USD Exchange Rate*, available at https://www.bloomberg.com/quote/USD GBP:CUR

[209] TowerXchange (2017) *China tower market FAQs*, available at http://bit.ly/2JmAtvR. Conversions to USD are based upon the rate of 0.1578 China Renminbi per US Dollar as of May 14 2018 using the CNYUSD Spot Exchange Rate.

[210] These numbers were converted to equivalent USD using Bloomberg's list of current global currency exchange rates as of May 14, 2014. See Bloomberg (2018) Currencies, available at https://www.bloomberg.com/markets/currencies. The numbers represented in Exhibit 12 are not additionally adjusted for any other financial factor, such as inflation or present value. Furthermore, please note that the equipment used to build a mobile base station, backhaul, and the factors which may influence costs (such as rights of way) vary dramatically so that comparison between costs should be appreciated as a very general estimation.

### 5.4.2 ROI Considerations in Migrating from 2G to 3G and Higher Coverage

Investment in traditional network deployment can take more than 10 years to recoup, if it is recouped at all.[211] Assuming the infrastructure exists, upgrading a base station from 2G to 3G and higher requires factoring in additional backhaul components in the ROI calculus over Total Cost of Ownership (TCO) factors, as well as what usage is needed to obtain adequate ROI. OPEX is often higher than CAPEX depreciation and, therefore, it is essential to minimize network OPEX.[212]

In one calculation, annual OPEX ranges from EUR8,000 to EUR 80,000 per site, depending on the configuration, including backhaul, site rental, power consumption and radio network software and hardware maintenance. Network capex ranges from EUR40,00 usage requirements per site required in relation to the costs of provision.

Some regulatory artefacts may dampen ROI: for example in Brazil, MNOs cannot simply abandon underperforming infrastructure in many of Brazil's service areas, even being restricted from divesting from abandoned real estate such as tower sites.[213] The regulator Anatel is considering amending these restrictions, potentially freeing cash for MNOs to invest in more profitable mobile broadband infrastructure.[214]

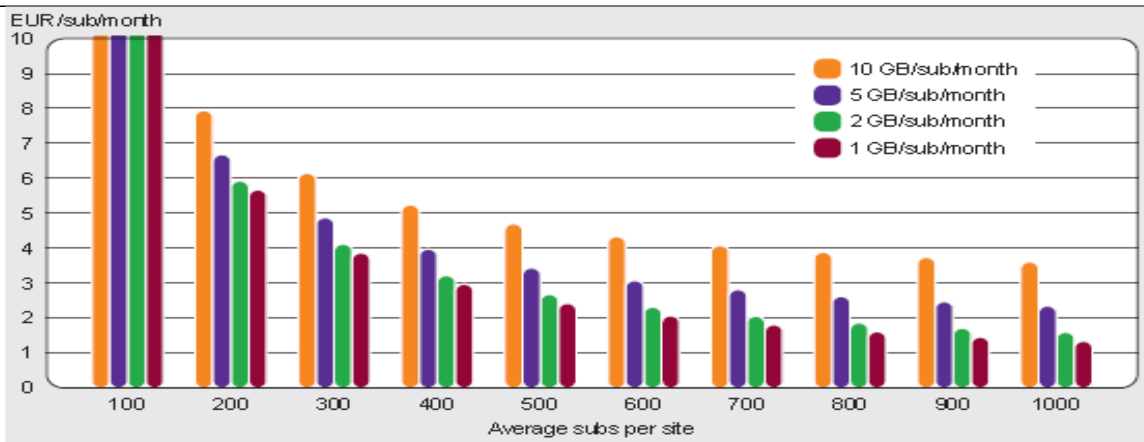


**Exhibit 13:** Costs of Provision of Mobile Technologies for a single MNO (non-sharing). The vertical axis represents the cost of provision and horizontal axis the subscriber number and usage that results in that cost. Rural areas are far left; peri-urban and urban areas on the far right. The data shows that the cost of delivering a gigabyte of data is highly dependent on the network utilization. If total data use is high, either due to a high number of subscribers or to high use per subscriber, the cost per gigabyte decreases.[215] ROI is thus delayed significantly in rural areas (far left). Unlimited (or nearby) mobile data plans may alter this calculus and ROI, especially if backhaul OPEX is high. A high OPEX based on data usage may be mitigated – and ROI accelerated – if tolled voice traffic is 'blended' into the monthly OPEX.

[211] Huawei (2018) *Huawei's RuralStar2.0 Shortens ROI Periods to Less than 5 Years*, available at http://www.huawei.com/en/press-events/news/2017/11/Huawei-RuralStar2
[212] NokiaSiemens Networks (2010) *infra*
[213] MNOs Oi and Vivo are reportedly have significant underused fixed liabilities. They are also obliged to maintain little-used public telephones. See Developing Telecoms (2018) *Brazil considers scrapping liability obligations for mobile operators*, available at https://bit.ly/2I6yXSv
[214] *ibid*
[215] NokiaSiemens Networks (2010) *infra*

### 5.4.3 Financing Expansion and Upgrades

A large barrier to expansion of coverage generally and upgrading coverage from 2G to broadband speeds is that the costs necessary to build and operate a mobile base station are substantial,[216] with rural areas costing significantly more to deploy than urban and likely to yield lower returns.[217]

It is one of several reasons why universal quality of service coverage objectives – that is universal broadband - are generally not mandated on MNOs by NRAs.[218] Indeed, our interactions with NRAs through interviews and surveys indicate that NRAs are concerned that such mandates – and penalties for invariable non-compliance with those national coverage mandates - would burden existing and potential licenses with too much debt, given that spectrum purchases may be involved in addition to the CAPEX costs of upgrading and ongoing additional OPEX costs.

MNOs in Bangladesh,[219] Uganda,[220] Rwanda,[221] and India[222] have recently shut down, are close to doing so, or have merged because of high debt burdens, while others are threatening to shut down if regulatory and market conditions do not improve.[223]

Necessary infrastructure costs of expanding mobile coverage may also require deployment of more backhaul in addition to last mile, especially if 4G and higher service is contemplated. Accordingly, multiple options to finance expansion may be necessary, the most common of which are described below.

**Internal Liquidity:** MNOs and towercos may choose to directly invest their own capital resources into expansion of mobile network infrastructure.

**Shareholder Funding:** Shareholders with sufficiently large capital resources who perceive timely investment opportunities, such as expansion of 4G LTE availability in Bangladesh, may offer to provide financing to an MNO.[224]

**Commercial Lending:** MNOs have traditionally engaged in private debt financing for deployment of mobile infrastructure,[225] including from commercial banks. Other options are available, such as the issuance of payable notes, which provided Mexico Tower Partners with over USD 100 million in financing for tower-based infrastructure expansion in late 2017.[226] MTN Nigeria is raising USD 1.1 billion in debt to finance infrastructure

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[216] Deployment costs for mobile base stations are illustrated in Exhibit 12.

[217] The GSMA estimates that CAPEX in rural and remote areas can range from 5-30% greater than in urban areas with OPEX even more pronounced from 25-100%. Furthermore, revenues in rural and remote areas can generally range from 80-95% below urban counterparts. GSMA (2016) *Connected Society Unlocking Rural Coverage: Enablers for commercially sustainable mobile network expansion*, available at http://bit.ly/2HlXanx

[218] Coverage requirements are sometimes mandated by regulators in a spectrum license. See Section 5.5.3.4.4.

[219] Dhaka Tribune (2017) *Citycell on its way out,* available at https://bit.ly/2rwpCIA

[220] MNO UTL has staved off bankruptcy, and is in the midst of attempts to revive its operations. See Independent (2018) *Govt supports Muhakanizi proposals on UTL revamp*, available at https://wp.me/p7FLkS-lEX

[221] Taarifi (2018) *Airtel Tigo Merger Complete But 49 Top Jobs Scrapped*, available at https://bit.ly/2rznlfE

[222] Forbes India (2018) *Idea Cellular and Vodafone India to merge to create India's largest wireless carrier*, available at https://bit.ly/2jJOhWK; Reuters (2018) *Indian mobile carrier Aircel files for bankruptcy,* available at https://reut.rs/2owCb5U

[223] Airtel India has come close to shutting operations, but is now seeking to merge with a rival. See Standard Kenya (2018) *Telkom Kenya and Airtel seek merger to take on Safaricom,* available at https://bit.ly/2I9EXG7

[224] Islam, M (2017) *Telenor, to invest more, seeks clear terms*, available at http://bit.ly/2wqzZn7

[225] USAID/Caribou Digital and the Digital Impact Alliance (2017) *Closing the Access Gap: Innovation to Accelerate Universal Internet Adoption*, available at http://bit.ly/2K1SGiH

[226] Digital Bridge (2017) *Digital Bridge Completes Securitization Of Mexican Tower Partners Portfolio*, available at http://bit.ly/2rwftwn

expansion, as well as using an IPO to raise funds.[227] In India, Bharti Cellular plans to raise USD 4.6 billion over 3 years, much of it to help expansion, but some to keep some struggling country operations - like in Kenya - afloat.[228]

**Vendor Financing:** Independent financing companies may lend money to a borrower, such as an MNO, for the purpose of purchasing the products and services of a vendor, such as from telecommunications and ICT equipment manufacturers and service providers. The Chinese government has been reported to have played a significant role in financing of privately-owned Huawei[229] and state-owned ZTE,[230] especially in Africa and developing countries.[231] Investigations by governmental authorities found extensions of unusually large lines of credit from state-owned development banks[232] to Chinese companies, questions of subsidies[233] and 'unfair export-credit policies' and generous vendor financing arrangements[234] and transactions involving natural resources.[235] One such example of Chinese dominance includes Ethiopia, whose state-owned telecom monopoly appear to be primarily reliant on vendor-financed telecom equipment contracts linked exclusively with ZTE and Huawei.[236]

**Developmental Lending:** While they have traditionally engaged in private debt financing for CAPEX,[237] with financial inclusion and ICT development goals encouraging expansion, financing may also come from a variety of different sources other than commercial banks. The International Finance Corporation (IFC)[238] for example has often provided loans to developing countries and economies for funding mobile coverage and DFS expansion,[239]

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227 Bloomberg (2018) *MTN Plans to Raise $1.1 Billion in Debt in Nigeria This Year*, available at https://bloom.bg/2K4A01K
228 Bloomberg (2018) *Airtel Plans Paring $4.6 Billion of Debt in Three Years*, available at https://bit.ly/2I9EXG7
229 Huawei Technologies Co Ltd is a wholly-owned subsidiary of Shenzhen Huawei Investment & Holding Co Ltd. It is reportedly owned by Chinese employees, with those abroad not entitled to participate in the company's shareholder ownership plan and with management retaining some significant control over decisions. Sevastopul, D (2014) *Huawei pulls back the curtain on ownership*, available at https://on.ft.com/2KQ0mWq .
230 As early as 2010, Chinese companies Huawei and ZTE were active in 50 African countries with Africa allegedly accounting for over 10% of each company's respective sales in excess of USD 4.5 billion annually. *See* Marshall, A (2011) *China's mighty Telecom footprint in Africa*, available at http://bit.ly/2HZm64K . In May 2018 though, ZTE suspended operations globally.
231 Cheney, C (2017) *China's role in the race to connect the next billion*, available at http://bit.ly/2KN69wg
232 Financial institutions include China Development Bank (CDB) and China Export-Import Bank (CEIB) have been alleged to have provided lines of credit multiple times annual revenues to Chinese telecommunications equipment manufacturers such as Huawei and ZTE (extended a USD 25 billion line of credit on annual revenues of USD 8 billion.) See Dalton, M (2011) EU Finds China Gives Aid to Huawei, ZTE, available at https://on.wsj.com/2K53lsW .
233 *Ibid*. See also McCarthy, M (2012), *Background Material for US-China Economic and Security Review Commission*, available at http://bit.ly/2I7gT6M .
234 US Senate Committee on Homeland Security & Governmental Affairs (2010) *Congressional Leaders Cite Telecommunications Concerns with Firms that have Ties to Chinese Government*, available at http://bit.ly/2IuJc2i
235 Provaggi, A (2013) *China Development Bank's financing mechanisms: focus on foreign investments*, available at https://gpc.stanford.edu/sites/default/files/uc07_0.pdf. *See also* Cisse, D (2012) *Chinese Telcom Companies Foray Into Africa*, available at http://aeaa.journals.ac.za/pub/article/view/94
236 Dalton, M (2014) *Telecom Deal by China's ZTE, Huawei in Ethiopia Faces Criticism*, available at https://on.wsj.com/2ruPB33. Results where competition exists are often superior. For more information about this and the impact of Huawei and ZTE in Africa, see Cheney, C (2017) *China's role in the race to connect the next billion*, available at https://bit.ly/2eHO7fM
237 USAID, Caribou Digital and the Digital Impact Alliance (2017) *Closing the Access Gap: Innovation to Accelerate Universal Internet Adoption*, available at http://bit.ly/2K1SGiH
238 The IFC is an international organization which is also part of the World Bank Group, owned by its member countries, which offers assistance and partnerships with other governments and entities to eliminate poverty and promote financial inclusion. IFC (2018) *Governance*, available at https://bit.ly/2InlwwS and IFC (2018) *Partnerships*, available at https://bit.ly/2rqUHNQ
239 The majority of the IFC's USD 1.4 billion of financing assistance in technology, media and telecommunications since 1995 has been provided to mobile telecommunications and independent tower operators. IFC (2016) *Creating Mobile Telecom Markets in Africa*, available at http://bit.ly/2IuB5To

such in Argentina,[240] Brazil[241] and Afghanistan.[242] The World Bank Group also provides International Development Association (IDA)[243] loans at low to zero interest rates to promote financial inclusion efforts, including those which directly benefit mobile money operators, agents and subscribers.[244]

**Donor Funding:** Funding from donors may finance the cost of expansion of mobile coverage, in whole or in part, such as foreign aid from other governments, industry assistance, NGOs, humanitarian and international organizations, including the World Bank. USAID funded 18% of the construction costs of four mobile base stations deployed in the Democratic Republic of Congo, intended to provide connectivity to up to 4,800 subscribers across 1,260 square kilometers of previously uncovered terrain.[245]

**Contributions from USF:** In many jurisdictions, contributions from MNOs based upon revenues are intended to subsidize efforts to reach national universal service and ICT policy objectives, which often include expanding network infrastructure to reach rural and remote areas where mobile coverage is weak or non-existent. USF is covered in greater detail in Section 7.2.

**Partnerships with Private Entities and Foreign Investment:** Costs to deploy infrastructure may be financed through a combination of government and private entities, such as the creation of a jointly owned entity as can occur with open access networks, discussed in Sections 7.2.1 and 7.4.4.

## 5.5 Mobile Spectrum

### 5.5.1 Overview

Spectrum is the scarce resource which makes mobile communications and DFS possible, with its qualities determinative of the level and quality of coverage provided to end users. As the demand for wireless products and services increases exponentially, the need for optimal spectrum management has become critically important. This section will define the radio frequency spectrum, review its characteristics and document how spectrum is managed, allocated, awarded for use and implementation.

### 5.5.2 Spectrum Basics & Mobile Coverage

Radio frequency (RF) spectrum[246] is the invisible global medium which carries wireless communications information and makes DFS possible using mobile devices. An inverse relationship exists between the range and capacity of radio waves.[247] Relative to high frequency bands, lower frequencies are more capable of traveling greater distances and penetrating dense objects before attenuating[248] but with lower data carrying capacity. As frequency increases, the data carrying capacity increases coupled with a decrease in range and penetrability.[249]

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[240] The Economist (2016) *Argentina's Telecom Personal gets $400m loan from IFC*, available at http://bit.ly/2I4TuCU

[241] IFC (2018) *IFC invests BRL 150 million in Phoenix to help expand coverage of telecommunications services and increase digital inclusion in Brazil*, http://bit.ly/2K6PySD

[242] In 2013, the IFC provided Afghanistan's leading telecommunications provider, Roshan (Telecom Development Company Afghanistan Corp), with USD 65 million in debt financing. IFC (2014) *Roshan*, available at http://bit.ly/2rzmBIz

[243] The IDA is part of the World Bank Group and provides loans, financial advice and assistance to developing countries. See IDA (2018) *What is IDA*, available at https://bit.ly/2gAzY2V

[244] In 2018 the World Bank provided a USD 45 million IDA credit to Madagascar. World Bank (2018) *Madagascar: $45 Million to Promote Financial Inclusion of Individuals and Small Enterprises*, available at http://bit.ly/2rurgub

[245] USAIDD (2014), *Low-Cost Base Transmission Stations Pilot Project*, http://bit.ly/2IoCUkJ

[246] RF spectrum is also commonly referred to as 'radio spectrum' or simply 'spectrum.'

[247] 'In general, signals sent using the higher frequencies have shorter propagation distances but a higher data-carrying capacity.' Dunbar, B (2015) *Characteristics of Electromagnetic Spectrum*, available at https://go.nasa.gov/2vFPU0g

[248] Attenuation is akin to signal degradation. ITU (2015) *Use of the decibel and the neper in Telecommunications*, available at http://bit.ly/2K6DS3r

[249] GSMA (2018) *What is Spectrum? - Find out more*, available at http://bit.ly/2F7PBuN

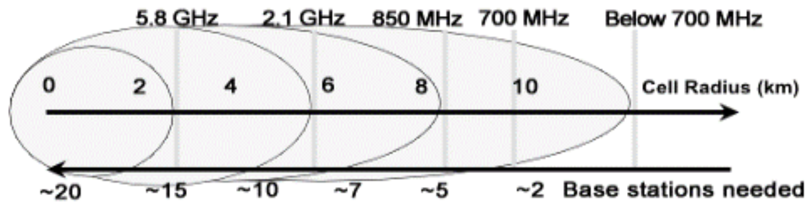


**Exhibit 14:** Base Stations Needed Per Radio Spectrum Band.[250] The sub-700 Mhz range – part of the 'digital dividend' - provides an optimal provision of services per base station site.

These characteristics are especially important for expansion of mobile coverage considerations into the poorer rural areas and provision of DFS. The higher frequency bands with greater capacity and narrower coverage are generally more suitable for densely populated urban areas, where demand for data and income per capita are greater.[251]

More sparsely populated rural areas with relatively lower incomes per capita require greater efforts to deploy infrastructure,[252] presenting a much less attractive investment with profitability concerns. Capitalizing on the wider coverage range of lower frequency bands such as the 'digital dividend'[253] can translate into substantial cost savings, as fewer towers and base stations would be needed to cover the same area as higher frequency bands. This resource efficiency is represented in Exhibit 14,[254] such that spectrum management and use can impact the range, quality, speed and extent of mobile coverage[255] and the UX for DFS users.

### 5.5.3 Spectrum Management

#### 5.5.3.1 Overview

As spectrum is a scarce resource without geographical boundaries, global cooperation is necessary to ensure that it is used with maximum efficiency and minimal interferences from incompatible use by those with differing interests. Uniform agreement can create global synergies capable of translating into quicker adoption of desired standards, greater compatibility of mobile equipment across borders and mitigation of interference from incompatible uses of spectrum. Accordingly, spectrum management and coordination must occur on global, regional and national levels to successfully accomplish spectrum harmonization[256] and clearance.[257]

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[250] Coat, M (2015) *The Digital Dividend & the future of the 700/800 MHz Bands in Region 1*, available at http://bit.ly/2HoQnFu

[251] Beegle, K & Christiaensen, L & Dabalen, A & Gaddis, I (2016) *Poverty in a Rising Africa*, available at http://bit.ly/2Fa3UPx

[252] The costs and factors of deploying of infrastructure are examined in Section 5.4. Infrastructure deployment strategies to offset the relatively unattractive nature of expansion of mobile coverage into rural areas, such as infrastructure sharing, is examined in Section 7.4.

[253] The digital dividend is the quintessential example of operational efficiency, which is the reassignment of valuable lower frequency spectrum to mobile communications which provides wider coverage areas. See Exhibit 14. The digital dividend is covered in greater detail in Section 7.3.2.

[254] This concept of capitalizing on the use of lower frequency radio waves is the essence of the argument to use the 'digital dividend' – a group of refarmed lower frequency bands – and discussed in greater detail in Section 7.3.2.

[255] The range of RF spectrum is illustrated in Exhibit 14 and the 'digital dividend' spectrum is examined in Section 7.3.2.

[256] Spectrum harmonization occurs when countries agree to allocate an identified block of spectrum to a specific use. This practice minimizes cross-border interference and allows for greater mobile telecommunications synergies through international compatibility of devices which operate on the same frequency, reducing the costs of both supplier infrastructure and user equipment. See GSMA (2014) *The spectrum policy dictionary*, available at http://bit.ly/2Jg2CVm

[257] Clearance is the process of clearing existing licensees on a spectrum block to prevent incompatibilities from competing services operating on the same band. Clearance may occur to effectuate a new use of a frequency band, such as the digital

This section will provide a review of a select portion of spectrum management. It will begin with a concise review of international and regional management followed by a comprehensive examination of national management, including allocation and licensing of spectrum.

### 5.5.3.2 International Management

Spectrum management begins with international collaboration and agreement on how spectrum should be used and what services are most appropriate for specific frequency bands. Spectrum is managed and promoted by the International Telecommunications Union (ITU)[258] through its 'Radio Regulations', an international treaty which allocates frequency bands whose characteristics are best suited for specific types of services, such as mobile communications or television broadcasting.[259] The NTFA takes a broader global approach, intended to serve as a model for national regulators in construction of their own conforming NTFA and respective allocations and allotments of spectrum. [260]

### 5.5.3.3 Regional Management

Regional telecommunications organizations[261] represent a collaborative effort among national regulators to develop a set of common and mutually agreeable policies, regulations and long-term objectives. Organizational forums provide a platform for members to exchange and discuss information and to coordinate and harmonize national spectrum policies to ensure that agreed upon initiatives are considered at an upcoming World Radiocommunication Conference (WRC).[262]

### 5.5.3.4 National Management

#### 5.5.3.4.1 Overview

Spectrum is a natural resource that is generally treated as a property of a sovereign state and managed accordingly by government and/or a designated regulator.[263] National objectives are similar to global policy,[264] seeking to maximize spectrum value while taking into account socio-economic concerns, policies and priorities which are of concern to its citizens.[265] This section will examine a select portion of the comprehensive process of spectrum

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television switchover to free the digital dividend, more fully described in Section 7.3.2. See also Ofcom (2018) *Spectrum Management*, available at http://bit.ly/2HjGYDc .

[258] See ITU *Mission statement*, http://bit.ly/2HouLt0. See also Ulaby, F & Lang, D B, *et al.* (2015) *A strategy for active remote sensing amid increased demand for spectrum*, available at http://bit.ly/2Hp05Ie

[259] ITU (2016) *Radio Regulations*, available at http://bit.ly/2qTR8iU

[260] Allocation of a spectrum band is defined by the GSMA as 'services which may operate in a specific frequency band…' which also notes the terms confusion with assignment, defined as 'the decision made by a national regulator to grant a band for use by a specific company…' GSMA (2014) *The Spectrum Policy Dictionary*, available at http://bit.ly/2Jg2CVm . For more information about spectrum allocation, see below Section 5.5.3.4.2. Allotment, as defined by the GSMA, refers to: '[A] decision made at a regional or national level to designate a frequency channel for use by a certain type of service in one or more countries under certain conditions.' GSMA (2017) *Introducing Spectrum Management*, http://bit.ly/2Hll1DL

[261] Regional telecommunications organizations in DFS areas include the Asia-Pacific Telecommunity, the African Telecommunications Union (ATU), and the Caribbean Association of National Telecommunication Organizations, with a complete list available at the ITU website. ITU (2018) *Regional Telecommunication Organizations*. ITU, www.itu.int/en/council/Pages/rto.aspx .

[262] GSMA (2017) *Introducing Spectrum Management*, http://bit.ly/2Hll1DL

[263] RF spectrum is 'managed by the State's government (a responsibility generally assumed by the executive authority and/or telecommunication regulator, although in some countries such as France, Tunisia and Colombia there is a specific regulatory body).' Katz, R (2016) *Assignment And Use Of Radio Spectrum – Policy Guidelines And Economic Aspect*, available at http://bit.ly/2JlS9In. See also Chaduc, J M and Pogore, G (2010) *The Radio Spectrum: Managing a Strategic Resource*, available at http://bit.ly/2HUMWYt

[264] Echoed in Section 5.5.3.1 spectrum policy on a global level strives for maximum value through optimization and harmonization of RF spectrum.

[265] Bakker, H (2016) *ITU Regional Workshop on 'Competition in Telecommunications Market*, available at http://bit.ly/2HIwgpj

management on a national level, including how it is allocated and licensed prior to its valuation, assignment and ultimate deployment by licensees such as MNOs.

Allocation of 3G-centric spectrum began in 1999 with 2100 MHz and AWS spectrum band sales and auctions, while 4G-type spectrum allocations began in 2008, covering the 700 MHz, 800 MHz, AWS-3 and 2600 MHz.[266]

**5.5.3.4.2 Allocation**

Spectrum management at a national level begins with government development of national policy, generally in conformance with the ITU Radio Regulations, tailored to address country specific needs and priorities. Legal framework may delegate a specific administrative agency or authority[267] which is tasked with spectrum planning and the management of frequency allocation.

Spectrum planning begins with collecting information about existing frequency use within national borders including a determination of current and future spectrum needs, demand for new services, identification of wireless services experiencing depleting spectrum availability, and nonconforming uses.[268] Working groups may be formed consisting of experienced members of government and industry. Requests for commentary may be issued and typically include the general public which increases transparency of process.[269]

Guided by and in conformance with the international frequency allocation table in the ITU Radio Regulations, the proceeds of spectrum planning should be the state's NTFA,[270] typically expressed in kilohertz to provide flexibility in subdividing ITU frequency band allocations into smaller frequency bands and maximizing proceeds from spectrum sales.[271] Goals such as financial inclusion, maintaining investments,[272] DFS and universal service are usually factored into this process.[273]

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[266] See GSMA (2017) *Effective Spectrum Pricing: Supporting Better Quality And Affordable Mobile Services*, available at http://bit.ly/2Hm73h2. This also included re-provisioning 4G on existing 900 MHz and 1800 MHz mobile bands that had been used for 2G networks.

Spectrum renewals are generally handled as (i) a presumption of renewal based upon certain conditions

[267] GSMA (2018) *What is Spectrum? - Find out more*, available at http://bit.ly/2F7PBuN. In India, the Wireless Planning and Coordination Wing of the Government of India's Department of Telecommunications (DoT) is responsible for radio frequency spectrum management, including licensing. TRAI, India's telecom regulator, may provide recommendations. The Wireless Planning & Coordination Wing, *Overview: Wireless Planning and Coordination Wing, Government of India*, available at http://bit.ly/2Fbgcaa. In contrast, the Uganda telecom regulator (the UCC) is authorized to perform spectrum management functions. UCC: Uganda Communications Commission (2018) *Spectrum*, available at http://bit.ly/2qSzT2q

[268] Pinnagoda, S (2015) *Overview on Spectrum Planning*, available at http://bit.ly/2HlDgsN

[269] TRAI, India's telecom regulator, may provide recommendations to the DoT. Telecom Regulatory Authority of India (2018) *Recommendation*, available at http://bit.ly/2HMztV2

[270] For example, the NTFA and policy of Zimbabwe, see Ministry of Information and Communications Technology & National Guidance (2016) *National Spectrum Management Policy for Uganda*, available at http://bit.ly/2Fbh2DQ; and for Uganda, see Uganda Communications Commission (2017) *Table of Frequency Allocation 8.3 KHz – 3000 GHz*, available at http://bit.ly/2Kaqlru; and The Postal and Regulatory Authority of Zimbabwe (2014) *Zimbabwe National Frequency Allocation Plan*, available at http://bit.ly/2qWgoF4; and for Samoa, see Office of the Regulator (2017) *National Frequency Allocation Table 2017,* available at http://bit.ly/2Jlk9vk

[271] Government will subdivide these blocks into the smaller kilohertz sized units which are more appropriately sized for provisioning to licensees and service providers. NFTA allocations will list the size of each frequency band, the services which may be operated, technical and operational rules, and future expectations for the band. See thereto, National Academies of Sciences, Engineering, and Medicine (2015) *A Strategy For Active Remote Sensing Amid Increased Demand For Spectrum*, available at http://bit.ly/2Hp05Ie. Valuation of spectrum is examined in greater detail in Section 7.3.4.

[272] Incumbents using a frequency band may oppose an allocation and uses of spectrum which cross borders require international coordination,

[273] On universal service, see Section 7.2.

#### 5.5.3.4.3 License Types

Spectrum management and licensing policies generally aim to maximize economic, technical and social benefits.[274] The type of license being offered represents an optimal blend of these priorities and which presents the best path towards accomplishing national policy objectives. For example, the proceeds[275] of a spectrum license can be used to fund policy goals of universal service[276] and universal broadband service,[277] both of which have been reported to positively impact upon the GDP, especially in developing countries.[278]

License types come in a variety of forms,[279] some of which include: (i) individual licenses for exclusive use of spectrum and granted to the licensee for operation within a geographic area; (ii) unlicensed or 'license exempt' spectrum, which requires no registration but may be subject to rules and regulations and no guarantees against wireless interference by others;[280] and (iii) light licenses which may be considered a hybrid of the prior two opposing approaches where a nominal fee may be imposed and limited protections available (such as from harmful interference of others), with licensees left to work out incompatibilities between themselves.[281]

Mobile coverage is primarily provided through individual spectrum licenses, typically as a frequency assignment, where a licensee acquires an exclusive right of use to a spectrum block over a defined geographic area. Protection of use by law for exclusive usage empowers a licensee service provider with a guarantee against harmful interference. This provides television broadcasters and MNOs with a necessary measure of control to ensure quality of service within a coverage area.[282]

Other NTA approaches favor the 'class license' approach, where there is segmentation in the licensing types, requiring various individual licenses for those engaged in, for example, network infrastructure-only or services-only or content-only. Ostensibly designed to present vertical monopolies where one entity controls everything in the ultimate service provision, it may stifle innovation in requiring consent or general authorizations by requiring operators to apply for, or notify, or register their services with their NTA.[283]

Small portions of the RF spectrum are reserved to allow unlicensed usage, subject to rules, regulations as well as potential registration. While the user may not be required to hold a license, they also will not receive protection from harmful interference from other sources and users. License-free frequency bands are typically associated with

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[274] *See* generally, Katz, R (2016) *Assignment And Use Of Radio Spectrum – Policy Guidelines And Economic Aspect*, available at http://bit.ly/2JlS9In

[275] See Section 7.3.4.5 on spectrum auctions.

[276] The policy of universal service, which endeavors to provide the widest extent of mobile coverage possible, is examined in more detail in Section 7.2.

[277] Mobile broadband technology is explained in Section 3.2.1.2 and universal mobile broadband policy is examined in Section 7.2.2.

[278] See thereto, Minges, M (2015) *Exploring the Relationship Between Broadband and Economic Growth*, available at http://bit.ly/2qS2WCX

[279] ITU (2016) Spectrum and licensing in the mobile telecommunications market, available at http://bit.ly/2HIwgpj. See also Katz, R (2016) *Assignment And Use Of Radio Spectrum – Policy Guidelines And Economic Aspect*, available at http://bit.ly/2JlS9In

[280] A most common example is Wi-Fi. See more below in Section 5.5.3.4. See also Zinno, S and Di Stasi, G and Avallone, and Ventre, G (2018) *On a fair coexistence of LTE and Wi-Fi in the unlicensed spectrum: A Survey, Computer Communications*, available at http://bit.ly/2JjuNmA

[281] There is no standard definition or implementation, which varies between jurisdictions. Light licenses may be issued for a certain class of products mass-produced item appearing in a variety of locations such as x-ray machines, medical equipment, etc. A nominal use fee may exist and a limited number of licenses are offered until capacity is reached. Massaro, M (2017) *Next Generation Of Radio Spectrum Management: Licensed Shared Access For 5G, Telecommunications Policy*, available at http://bit.ly/2HVz0gy

[282] GSMA (2017) *Introducing Radio Spectrum*, available at http://bit.ly/2FaaiGw

[283] In some cases, previously licensed services may be subject to no licensing requirements at all.

limited range, low power devices, such as short-range devices (SRD)[284] using Wi-Fi and Bluetooth technologies,[285] which present a low risk of interference with competing devices.[286] License free bands can be used to drive technological innovation and be used to provide free or low cost mobile coverage to the poor in developing countries such as in Peru, Congo and India.[287] They can also be reserved for special use for industrial, scientific, and medical radio (ISM) purposes.[288]

#### 5.5.3.4.4 License Terms

License terms are specified by regulation within a spectrum license and generally include: (i) the type of service which can be provided using a specified frequency band, e.g. mobile communications; (ii) the technologies which can be used; (iii) the duration of the license; and (iv) coverage obligations.[289]

Having technology specified – and limited – within a license may act to prohibit an MNO from upgrading their network to a new generation of technology over the duration of the license. An upgrade to a new technology may require an additional license. As applicable to DFS, an MNO possessing a license to provide narrowband-based 2G service may not be permitted to operate a mobile network upgraded to 3G technology without an application for a new 3G license.

The duration of spectrum licenses varies depending upon license type but most individual spectrum licenses will consist of 15-20 year terms with potential rights of renewal.[290] Renewal terms vary and must be determined in advance by necessity to avoid risks of interruption of service and postponement of approvals.[291] Limitations on and requirements of spectrum usage may be contained within a spectrum license, such as a levy specifying the percentage of a MNO's gross revenues to be contributed to a fund such as for universal service.[292] Accompanying requirements may include the need to provide a specified level of quality of service, to possess a MNO license or for a specialized type, such as to provide backhaul and backbone services. License renewals offered may also contain similar additional requirements.

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[284] Common examples of short range devices include WiFi routers, remote controls, smart devices, radio frequency identification and wireless consumer products. See ETSI (2012) *Short Range Devices*, available at http://bit.ly/2K9dzJD

[285] The 2.4 GHz band is a well-known example of unlicensed spectrum. Popular use cases include remote controls for household appliances, garage door openers, etc. See GSMA (2017) *Introducing Radio Spectrum*, available at http://bit.ly/2FaaiGw

[286] For examples, in the UK, see Ofcom (2016) *Licence-Exempt radio use*, available at http://bit.ly/2HYaBas . In Canada see Government of Canada (2018) *Low-power Licence-exempt Radiocommunication Devices – Frequently Asked Questions*, available at http://bit.ly/2qTD89H

[287] Community networks in LDC countries using unlicensed spectrum include the Chancay-Huaral Project in Peru, Pajoma Net in the Democratic Republic of Congo and Wireless for Communities (W4C) in India. See thereto, ISOC (2017) *Policy Brief* - Spectrum Approaches for Community Networks, available at http://bit.ly/2Hloouw

[288] The ITU Radio Regulations reserves the ISM frequency bands for scientific, medical and industrial use, excluding applications of telecommunications. ITU (1994) *Recommendation. ITU-R SM.1056*, available at http://bit.ly/2qUmSo5

[289] Massaro, M (2017) *Next Generation Of Radio Spectrum Management: Licensed Shared Access For 5G*, available at http://bit.ly/2HVz0gy

[290] Lengths of this duration are necessary to provide MNOs with the belief that an adequate return on investment will occur versus taking a high risk of not recovering the investment from a shorter duration. In the EU and in many parts of the world, spectrum licenses of a 15 to 20 year duration are common. Recent efforts have been underway to increase licensing duration (such as Sweden, cite GSMA) but a 25 year licensing plan was recently rejected by over a dozen member states, citing that it would stifle innovation. See thereto, Stupp, C (2017) *Member States Reject Commission Plan For 25-Year Spectrum Licences*, available at http://bit.ly/2FaHTQz; Spectrum licenses have often been auctioned for 15-20 years as standard although Sweden has implemented a 25 year license duration with the EU seeking to do the same. GSMA (2017) *Effective Spectrum Pricing: Supporting Better Quality And Affordable Mobile Services*, available at http://bit.ly/2Hm73h2

[291] Spectrum renewals are generally handled as (i) a presumption of renewal based upon certain conditions, e.g. a circumstance or the requirement a different service, annual fee or technology be used.to qualify; (ii) an invitation to bid for another term against competitors; (iii) an inability to renew resulting from reassignment of spectrum to another user by an authorized authority. GSMA (2015) *Best Practice in Spectrum License Renewals*, available at http://bit.ly/2qSnBqJ

[292] The concept of universal service is examined in Section 7.2.

## 5.6 Quality of Service

### 5.6.1 Overview

Customers are sensitive to issues of Quality of Service (QOS) in the telecommunications portion of DFS provision, as non-availability of services and poor service quality can have detrimental effects on access to stored value, and user confidence the ecosystem.

### 5.6.2 Role of National Telecommunications Authority

The National Telecommunications Authority (NTA) mostly have a turnkey remit over mobile provision,[293] and *ex ante, may* include QOS and KPI parameters in licenses, or may add additional parameters *ex post* as customer complaints increase. QOS may relate to availability of mobile coverage; availability of time slots to set up, execute and properly retain/sustain calls, channel/bearer congestion; successful sending and receipt of SMSs, audio quality of calls, the rate of frequency of dropped calls; and data speeds.[294] With the move to packet rather than GSM-based circuit switched-based calls – for example using voLTE – issues of call-muting,[295] jitter, latency, end-to-end delay arise. Automatic fallback to traditional circuit switched - called circuit switch fall back (CSFB) – may also be necessary in QOS standards. Exhibit 15 show call drop percentages analyzed by NRAs in Nigeria and India.

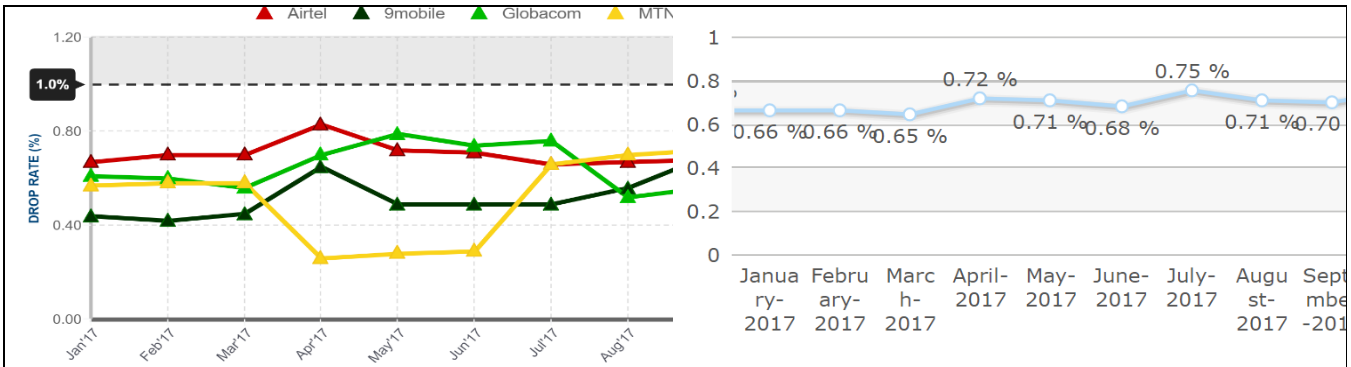


**Exhibit 15:** Call drop QOS percentages up to 3Q17 for Nigeria (left) and India (right) as measured by the respective NRAs. Testing is usually performed in a fixed location, through driving or on trains. If a licensee exceeds a regulated threshold for dropped calls, they are liable to be sanctioned by the NTA. Similar metrics for other QOS components are provided by these NTAs.

[293] Other regulators, departments and agencies may have associated remits over coverage provision, for example on spectrum allocation and policy, and on right of way for mobile tower installation. See Section 4 on Law and Regulation.

[294] QOS parameters include the following, as contemplated by the Nigerian Commission QOS Regulations: Call Completion Rate (CCR): The ratio of successfully completed calls to the total number of attempted calls (ITU-T E600/2.13). That is, the ratio of the number of completed call attempts to the total number of call attempts, at a given point of a network; Answer Seizure Ratio (ASR) is the ratio of the number of successful calls over the total number of outgoing calls from a carrier's network (i.e. On a route or a Destination Point Code (DPC) basis, and during a specified time interval, the ratio of the number of seizures that result in an answer signal to the total number of seizures: ITU-T E600/2.14); Call Setup Success Rate (CSSR) is the number of the unblocked call attempts divided by the total number of call attempts; the Dropped Call Rate (DCR) is the number of dropped calls divided by the total number of call attempts. See NCC (2018) *Quality of Service*, available at https://bit.ly/2rqXiIB

[295] Where poor network quality on packet switched calls and attempts by the MNO to keep the call connected results in audio not being heard by one or either parties for a few seconds. TRAI in India has issued a consultation paper on addressing the issue. See TRAI (2018) *Consultation Paper on Voice Services to LTE users (including VoLTE and CS Fallback),* available at https://bit.ly/2K3DLo7

In many cases, QOS parameters are self-reported every quarter,[296] or may be the result of de novo QOS testing by the NTA using mobile trucks which set up, execute and retain calls.[297] In India for example, TRAI conduct regular drive tests to check the quality of service of MNOs to make sure they are within set benchmarks.[298] TRAI has a free analytics portal for customers where the results of their testing and operator reports can be downloaded.[299] NRAs regularly issue fines to licensees if the QOS falls below minimum standards.[300] A similar portal is offered by the Nigerian Communications Commission (NCC).[301] In some cases, QOS may impact on license renewal.[302]

**Impact on DFS: Effect on Quality of Service Deficiencies**

QOS for DFS is often a co-competency between the central bank and the NTA,[303] especially in relation to USSD sessions – a primary user interface for DFS globally. Often USSD sessions drop, leading to a poor customer experience and maybe even loss of funds. This may dissuade customers from using the DFS service again, instead opting to use an over the counter (OTC) provider to do a transaction for them. The reasons for the dropped USSD session may be poor GSM signal,[304] network congestion, or – as some TSPs and PSPs have alleged – deliberate throttling of their customer's USSD sessions.[305] Such drops may reflect poorly on the TSPs and PSP's service offering. That is, complaints from SPs allege that while MNOs may provide access, the QOS is poor, characterized by a high proportion of dropped USSD sessions that abruptly end before the customer session is completed. As noted above, technical issues relating to GSM networks and coverage may be the issue, although some SPs have alleged that they are being handicapped through implementation of random throttling or prioritizing of access.[306] Whether quality can be selectively degraded by the MNOs, and if they are doing so, is a factual issue that can be further explored by a regulator in markets where these allegations arise.[307] A competition study commissioned by the UCC indicated that TSPs and PSPs reported issues with service quality and that it was not possible for them to negotiate service level guarantees, nor be compensated for poor QOS and dropped

[296] See for example the NCC in Nigeria, which requires QOS reporting from licenses every quarter. Vanguard News Nigeria (2017) NCC creates minimum service quality for telecom industries, available at https://bit.ly/2rsbss3

[297] Analysis is often done using monthly weighted averages based on data collected from MNO Network Operating Centres (NOCs) and during busy hours at the Base Station Controller (BSC). See on these parameters, NCC (2018) *ibid*

[298] TRAI checks the telecom operators network coverage, call quality, call drop rate, call success rate, blocked calls and carrier to interference ratio. These are measured against benchmarks set in QOS regulations. See TRAI (2017*) The Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service (Fifth Amendment) Regulations*, available at https://bit.ly/2rpVOhp. For QOS parameters in Rwanda, see RURA (2013) Regulations for Quality of Service of cellular mobile and fixed networks services, available at https://bit.ly/2rrDtk4

[299] See updated TRAI QOS data at their analytics portal: http://www.analytics.trai.gov.in:8001/trai/qos/index.php

[300] In Kenya, the NTA fined MNOs Safaricom, Airtel and Telkom Sh311 million (USD 3.1 million) for not meeting service standards for the 2015/16 financial year. Safaricom scored 62.5%, while Airtel and Telkom scored 75%, below the 80% required in terms of NTA regulations. See Capacity Media (2018) *The CA Fines Safaricom, Airtel And Telekom Kenya $3 Million For Poor Quality Of Service*, available at https://bit.ly/2wjL8pD

[301] NCC (2018) *Quality of Service*, available at https://bit.ly/2rqXiIB

[302] UCC (2018) Application for renewal of a national telecommunication license by MTN Uganda Limited, available at https://bit.ly/2rou4tS

[303] On specific regulations for DFS access, see for example TRAI (2016) *The Mobile Banking (Quality Of Service) (Second Amendment) Regulations*, available at https://bit.ly/2jIQx0x

[304] Mobile handsets & base stations must transmit enough power to maintain a call of acceptable quality or USSD session to completion without transmitting excessive power into the frequency channels & timeslots allocated to others. See Keysite (2014) *Understanding GSM/EDGE Transmitter and Receiver Measurements for Base Transceiver Stations and their Components*, available at https://goo.gl/n6kqnF

[305] These QOS issues relate primarily to random, dropped USSD sessions affecting DFS SPs and aggregators. As noted by CGAP, selective degradation is technically possible, but is reportedly difficult to do and extremely difficult to prove. And as noted further by CGAP, even if a discrepancy in the quality of USSD is proven, it is not straightforward to identify the cause of the inferior quality. The point of failure could, for example, be with the DFS provider, the USSD gateway operator, or the MNO. See CGAP (2014) *ibid*

[306] See Further Chen (2015) *ibid*); and CGAP (2014) *ibid.*

[307] CGAP (2014) *ibid*

USSD sessions.[308] Minimum QOS standards may also be embedded in MNO-SP contracts.[309] These may provide, in a USSD context, for the provision – if and where available - by an MNO to an SP of NI-USSD, which would be automatically initiated to resume a dropped user-initiated USSD session.

# 6 COMPETITION & QUALITY OF SERVICE-RELATED IMPLICATIONS

## 6.1 Overview

One of the major implications of the lack of universal quality of service – that is, national broadband mobile coverage – is that access to DFS then will require 2G-supporting phones and DFS UIs. That is, basic and feature phones offering USSD and STK-based access.[310]

While DFS implementations have successfully been built on these coverage components and UIs and indeed continue to thrive despite the limited upgrade path to DFS 2.0, they also precipitate competition concerns. Simply, because USSD and STK are scarce server-based resources available only to licensed MNOs. For DFSPs to successfully enter a DFS market using these UIs, cooperation of the MNOs to provide USSD and STK access is necessary, and as further examined in Exhibit 16.

Vertical integration by MNOs with their own DFS provision may however mean they may be reluctant to provide DFSPs constructive and unimpeded access to these bearers at all,[311] or if they do, at Fair, Reasonable and Non-Discriminatory (FRAND) terms.[312] The nature of these restrictions are described below.[313] If the MNO does not cooperate, depending on the jurisdiction, there may only be a few options for a DFSP to sustain its presence profitably and legal action and/or regulatory intervention to force USSD and STK access at FRAND terms may be required. Indeed, a number of competition-related enquiries by telecommunications and competition authorities over access have been launched alongside court cases.

There is anecdotal evidence however that some regulators may have applied regulatory forbearance over universal USSD access and pricing, based on an industry-derived narrative is that OTT and 3G will overtake USSD and other narrowband technologies.

[308] Cartesian (2015) *Mobile Platform Access for USSD-based Applications (MPA-USSD),* available at https://bit.ly/2KHrqY1

[309] See ITU FG DFS (2016) *QOS and QoE Aspects of Digital Financial Services*, available at See https://bit.ly/2lM0YjD ; The report considers the appropriate role for telecommunications regulators in ensuring the provision of high-quality DFS and offers recommendations for telecommunications regulators on how to select Key Performance Indicators (KPIs) for DFS, including technical KPIs for bearer channels used with basic phones, feature phones and smartphones.

[310] See for example Kenya, where users 'plastic roam' with SIMs from multiple MNOs to obtain best coverage. Standard Media (2018) *Analysts Warn Telecom Industry Regulator's Decisions Setting Up Operators For Disputes*, available at https://bit.ly/2rFoHqn

[311] For more information on competition issues in Uganda, see Annex B: Country Focus: Uganda

[312] The corollary has been raised in some markets: MNOs in Bangladesh for example have complained of being forced by regulations to provide USSD access to other DFSPs below the MNO's opportunity cost. See on costing for USSD in Bangladesh, Session-based Daily Sun (2018) *USSD price to raise mobile banking cost,* available at https://goo.gl/yvZiw5

[313] See Section 6.2

Access to USSD is usually via a MNO's USSD gateway.[314] MNOs may provide access to their USSD facilities to third parties who can craft their own USSD menus and session timeouts, usually for VAS and DFS access. In many countries, a USSD gateway is also offered by third party aggregators, who may in turn resell turnkey USSD access to entities – such as banks and micro finance institutions (MFIs) - who may not have the technical ability to properly integrate into the MNO's USSD gateway.

The regulatory, commercial, and technical steps needed by a third party DFS SP to obtain access to a USSD gateway could include:[315]

- Obtain consent to integrate into the USSD or STK gateway of the MNO or aggregator.
- Obtain access to USSD or STK short codes.
- Being able to utilize the full capabilities of these access channels.
- Negotiate FRAND-based pricing for USSD and STK access.
- Obtain QOS assurances from the bearer supplier.

**Exhibit 16:** Steps to Provision USSD and STK Services by Non-MNO DFS Providers. This exhibit explains how access to USSD is provided to VAS providers and the technical and critical steps to provision of USSD and STK services by non-MNO DFS providers[316]

## 6.2 USSD-related Competition Issues

### 6.2.1 Access to the USSD gateway or USSD components

Access to USSD is crucial to the business plans of Service Providers (SP). Loss of this access may irrevocably damage their business.[317] Usually the access given by MNOs to SPs is Mobile Originated USSD (MO-USSD) accessible via short codes. Inability to access the gateway is fatal to a business predicated on USSD access given the scarcity of USSD. SPs denied access by the MNO could, however, approach aggregators, who have access to the MNO gateway, for access, but potentially at a higher price as the aggregator will charge a fee. In some countries, MNOs have given MO-USSD access only to those banks that are in a partnership with the MNO.[318]

Besides MO-USSD, the provision of Network Initiated (NI)-USSD can provide a competitive advantage for SPs. For example, if there is a dropped USSD session and the transaction is not completed, the customer may not want to re-initiate the transaction so as to avoid potential double billing. NI-USSD will allow re-initiation of a dropped USSD-based transaction so that customers can complete their unfinished transaction.[319] However, even if NI-USSD is provisioned on the MNOs USSD gateway, the MNO may decide not to make it available to third parties.[320]

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[314] A gateway is the collection of hardware and software required to interconnect two or more disparate networks, including performing protocol conversion.

[315] The sequence and requirements for getting access to USSD short codes and a USSD gateway as described here are stylized, and will invariably differ in various jurisdictions.

[316] Adapted from Perlman, L (2018a) *The Role of Regulators in Competition-Related Matters in Digital Financial Services*, available at www.dfsobservatory.com; Perlman, L (2018b) *The Role of the Telecommunications Regulator in DFS*, available at www.dfsobservatory.com.

om Perlman, L (2018b) *The Role of the Telecommunications Regulator in DFS*, available at www.dfsobservatory.com; and

[316] Gallup (2018) *op. cit.*

[317] MNOs though may have legitimate reasons for denying a SPs access to their USSD gateway, for example a history of fraudulent use of USSD-based services with other MNOs or bad credit history. See also CGAP (2014) *Mobile Payments Infrastructure Access and Its Regulation: USSD*, available at https://bit.ly/2KtlkKR

[318] CGAP (2014) *ibid.*

[319] TRAI (2016a) *Consultation Paper On The Review Of Regulatory Framework For The Use Of USSD For Mobile Financial Services,* available at https://goo.gl/dSSPLN

[320] TRAI (2016a) *ibid.*

### 6.2.2 Access to USSD Short Codes

The 'short code' access code numbers used to access USSD sessions may be assigned by the MNO at their discretion, although in some markets a regulator may do so.[321]

### 6.2.3 Length of a USSD Session

The length of a USSD session may be restricted by the MNO for third party providers, such that there is not enough time for customers to input long account numbers when prompted. Similarly, MNOs may restrict the time allowed for the input or for the customer to provide input to advance to the next tree on the menu.[322]

In some cases the USSD session is charged to the customer at a fixed rate no matter the length of the session; or the Technical Service Provider (TSP) or PSP is charged at wholesale rates for a transaction, no matter the length, or *pro rata*; or is charged via a percentage of the transaction value. The MNO may also charge the SP a setup fee for access to its USSD gateway, and/or a monthly facilities charge on top of any USSD session charges. While some TSPs and PSPs absorb the USSD charge, others will recoup the USSD cost incurred by directly debiting the customers' wallet with the charge.[323]

### 6.2.4 Quality of Service in USSD Sessions

Often USSD sessions drop, leading to a poor customer experience and maybe even loss of funds. This may dissuade customers from using the DFS service again, instead opting to use an over the counter (OTC) provider to do a transaction for them. The reasons for the dropped USSD session may be poor GSM signal,[324] network congestion, or – as some TSPs and PSPs have alleged – deliberate throttling of their customer's USSD sessions. [325] Such drops may reflect poorly on the TSPs and PSP's service offering.

Complaints from SPs allege that while MNOs may provide access, the QOS is poor, characterized by a high proportion of dropped USSD sessions that abruptly end before the customer session is completed. As noted above, technical issues relating to GSM networks and coverage may be the issue, although some SPs have alleged that they are being handicapped through implementation of random throttling or prioritizing of access.[326] As a recent CGAP report noted, whether quality can be selectively degraded by the MNOs, and if they are doing so, is a factual issue that can be further explored by a regulator in markets where these allegations arise.[327]

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[321] See on USSD policy, TRAI (2016a) *ibid.*

[322] MNOs may cite the so-called 'opportunity cost' inherent in providing USSD to third parties, since they argue that the GSM system design of voice channels needing an open 'signaling channel' which USSD operates on may mean that there is no ability to provide tolled voice calls when USSD sessions are open. This issue has arisen in complaints by Bangladeshi MNOs to their telecommunications regulator. The NTA has proposed a four-fold increase in USSD wholesale pricing against the objections of the central bank. See Perlman (2012) *op. cit;* and Perlman, L (2018a) *The Digital Financial Services Primer*, available at www.dfsobservatory.com

[323] Mazer, P & Rowan, P (2016) *Competition in Mobile Financial Services: Lessons from Kenya & Tanzania*, available at https://goo.gl/osF8Mo

[324] Mobile handsets and base stations must transmit enough power to maintain a call of acceptable quality or USSD session to completion without transmitting excessive power into the frequency channels & timeslots allocated to others. See Keysite (2014) *Understanding GSM/EDGE Transmitter and Receiver Measurements for Base Transceiver Stations and their Components*, available at https://goo.gl/n6kqnF

[325] See Daily Sun (2018) infra on Bangladesh and USSD pricing and access; and on Uganda, Macmillan Keck. Attorneys & Solicitors (2017) *Draft Non-Confidential Summary Of. Final Report. Public Consultation Document. Support to the Uganda Communications Commission on USSD and SMS services, available at.* https://bit.ly/2KbRXg3

[326] Chen (2015) *ibid*; CGAP (2014) *Mobile Payments Infrastructure Access and Its Regulation: USSD*, available at https://bit.ly/2KtlkKR

[327] CGAP (2014) *ibid.*

### 6.3 SIM Toolkit-Related Competition Issues

#### 6.3.1 STK Access

Key to providing STK-based services is that the MNO provides access to its STK gateway; allows the SPs menu to be placed on the MNO SIM; allows Over The Air (OTA) updating of the SIM menus as needed; and that the MNO provides the DFS SP with short codes the SP's customers will use to access the SPs DFS service.[328]

#### 6.3.2 Access to STK Gateway

It is self-evident that for third party SPs to provide STK-based services to their customers, the MNO must provide these third parties access to their STK gateway. If this is refused, the third party may need to use another access bearer such as USSD, Near Sound Data Transfer (NSDT), Java applets, Wireless Application Protocol (WAP)-based access, or Over The Top (OTT) smartphone apps. Some of these alternate access mechanisms, however, may not have the same relative mass-market discovery potential as STK-based access.

#### 6.3.3 SIM Menus

In terms of competition, issuance by a MNO of SIMs with STK and specific menus or icons may give the MNO and its partners a huge advantage over any other third parties that may want to provide similar services, since the discovery of the MNO's STK menu is persistent and does not require a download[329] to the handset by the third party. To deliver SIM menu updates, either the SIM must be returned to a MNO or SP agent, as the case may be, and exchanged for a new one. Or, the application updates must be delivered OTA using specialized, optional SIM features and multiple binary SMSs sent to the mobile handset. Update limitations – and the fact that the MNO controls the STK gateway and pricing thereof - may hinder the number and frequency of STK application deployments and thus the ability to provide new user features. This is especially so for SPs dependent on the STK gateway access from the MNO, and who are sensitive to STK transaction pricing by MNOs.[330] Use of Thin SIMs may bypass competition-related access bottlenecks.[331] Even if access is made available to the necessary STK components, variable and often caustic pricing can make the transaction unprofitable.[332]

#### 6.3.4 Access to Short Codes

The 'short code' access codes numbers used to access STK may be assigned by the MNO at their discretion, although in some markets a regulator may do so.[333]

#### 6.3.5 Pricing of STK access

Pricing of STK access has been an issue in some markets. This may relate to the charges for a transaction, which may be per transaction no matter how many SMS are used, or per SMS. The MNO may also charge for OTA updates to a SPs STK-based SIM menu.

### 6.4 Regulatory Responses

To ensure that DFS markets function fairly and to guarantee an equal playing field for all stakeholders in the ecosystem, competition authorities or their counterparts in sector regulators need to have real powers to prevent anti-competitive behavior as well as to sanction *ex post* abuses. They should have the ability to detect and

[328] Since MNOs own the SIM card and thus control anything on it, this includes controlling the ability of third parties to load and use their own applications and encryption keys for use by their own customers. And as only the MNO can provision the SIM, the ability of a SP to receive or gain access to the required mobile encryption keys independently of the MNO is usually a complicated and expensive negotiation.

[329] Or through some other discovery mechanism.

[330] Daviplata in Colombia was affected by MNO STK pricing, rendering their already-launched G2P services unprofitable. See Perlman, L (2017b) *Competition Aspects of DFS*, available at https://ssrn.com/abstract=2957138

[331] See Section 7.5.4.3 on Thin SIMs

[332] See on thin SIMs, Perlman, L (2017) *Competition Aspects of Digital Financial Services*, available at https://bit.ly/2rEZAUz

[333] See also on USSD policy, TRAI (2016a) *ibid.*

sanction anti-competitive behavior, and where possible, provide remedies to identifiable anti-competitive behaviors.[334]

There are a number of methods[335] - which do not apply to competition authorities, who have very different tools and times to intervene - which sectoral regulators possessing competition-related competencies have employed to date to approach or resolve competition issues. The following methods, described stylistically below, have been used to intervene in competition issues:[336]

- **Regulatory forbearance:** Here the responsible regulator(s) - aware of a competition issue and having the power to intervene - instead allow the market to come to a solution.[337]
- **Use of moral suasion:** The responsible regulator(s) use a light-touch and coordinated approach to persuade the market participants to come to a satisfactory resolution to their competition dispute(s) on their own, and at the risk of the regulators stepping in to mandate a solution if they do not.
- **Intervention:** If the parties are unable to, or will not, resolve their disputes, the responsible regulators may *intervene*.[338] The intervention may, for example, relate to pricing and/or access rights by competitors to a specific service.[339] The regulator may also intervene unilaterally, based on policy precepts without a competition issue necessarily being raised with them.[340]
- **Blunt instrument:** Here the regulator may employ a *blunt instrument* approach, by breaking up an entity - that a study has shown that has been abusing its vertically-integrated market power[341] - into two independent entities, say, for infrastructure and services. The newly-independent infrastructure entity would then have to provide services to all market participants at FRAND terms. Similarly, the newly independent services entity is in the same position as all other market participants, and must now obtain its access from the new infrastructure entity at market-related prices.[342]

Some regulatory responses are shown below:[343]

**Bangladesh:** MNOs require approval from Bangladesh Telecommunications Regulatory Commission (BTRC) to provide USSD connectivity to the banks they partner with. Given the bank-driven regulatory framework, MNOs in

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[334] Perlman, L (2017b) *Competition Aspects of Digital Financial Services*, available at https://bit.ly/2rEZAUz

[335] For an overview of the potential tools available to regulators to deal with competition issues, see Sitbon, E (2015) *Addressing Competition Bottlenecks in Digital Financial Ecosystems*, available at https://ssrn.com/abstract=2673637

[336] The list below and terminology used is stylized and descriptive, and does not necessarily use terms of art usually associated with regulatory powers in competition-related matters.

[337] This has been the approach to date for example in Uganda. However the UCC appears to be set for a more interventionist approach. Macmillan Keck. Attorneys & Solicitors (2017) *Draft Non-Confidential Summary Of. Final Report. Public Consultation Document. Support to the Uganda Communications Commission on USSD and SMS services*. https://bit.ly/2KbRXg3?

[338] This may involve the financial regulators or telecommunications regulator.

[339] The telecommunications regulator and competition regulator have both intervened in the Kenyan market in response to the dominance of MNO Safaricom and its M-PESA DFS service. See Perlman, L (2017) Competition Aspects of DFS, available at https://ssrn.com/abstract=2957138

[340] See India and Zimbabwe as examples of implementation of price controls for telecommunications access in DFS.

[341] A determination of SMP involves competition law principles. It may be that an entity with SMP abuses that SMP to the detriment of competitors. The abuse is what usually triggers regulatory intervention. See Perlman, L (2017) Competition Aspects of DFS, available at https://ssrn.com/abstract=2957138

[342] Kenya's ICT secretary was quoted as saying he supports the breakup of Safaricom. A bill was published for public comment, and a companion market study on SMP was launched. See Nation (2015) *Matiang'i Backs Airtel In Push To Break Up Safaricom*, available at https://goo.gl/Va7QK8; Cabinet Secretary for Information, Communications and Technology (2015) *The Kenya Information And Communications (Fair Competition And Equality Of Treatment) Regulations, 2015,* available at https://goo.gl/MnKnEy

[343] Data drawn from Perlman, L (2017) *Competition Aspects of Digital Financial Services*, available at https://papers.ssrn.com/sol3/Papers.cfm?abstract_id=2957138

Bangladesh indicate that they are not very incentivized to offer cheap USSD access or to enter into partnerships with banks. Access to USSD is provided on revenue sharing basis. That is, the MNOs are compensated at a very nominal rate for only those USSD sessions where the DFS providers earn revenue.

**Colombia:** After negotiations between banks and MNOs failed to resolve bank complaints over USSD pricing and access from MNOs, the Colombian telecommunications regulator, the Comisión de Regulación de Comunicaciones, mandated access to USSD and introduced a case-by-case resolution of complaints about price and quality.[344]

**Uganda:** Uganda has no separate competition law.[345] DFS SP Ezee Money sued MNO MTN Uganda for denying it access to its USSD gateway, and for thus breaching provisions of the Uganda Communications Act of 2013 which prohibits anti-competitive behavior between companies licensed to provide communications services. The Commercial Court awarded Ezee Money Sh 2.3 Billion (USD 662,000) in damages. MTN Uganda has reportedly commenced an appeal. Besides the refusal to allow access, DFS SPs have complained about 'unjustifiably high' or unfair revenue share structures for USSD session fees. These, in the view of the Uganda Communications Commission (UCC), may be designed to foreclose independent DFSPs from the downstream DFS market segment.[346]

**Impact on DFS: Anti-competitive Behavior**

On a competition level, SMS and USSD access channels could be blocked or randomly throttled by those providing native mobile services, either at a technical level and/or at a price point that effectively renders third-parties unable to use these scarce access resources to provide services for provision to their own customers. Third party Service Providers (SPs) may be handicapped through implementation of random throttling or prioritizing of USSD and STK access, or even through curtailing the ability of third party competitors and innovators to provide services generally, or competitive apps on smartphones.

In all, the inability of new market entrants and innovators to use these access channels creates a handicap to financial inclusion. Thin SIM technology being implemented in a number of countries affords a technical solution to any abuse of Significant Market Power (SMP) by circumventing any technical or pricing blockages.

# 7 EXPANDING AND IMPROVING MOBILE COVERAGE

## 7.1 Overview

Previous sections have provided a background to the components of mobile coverage[347] and the preceding section has analyzed how to cope with competition and QOS issues which hamper DFS 1.0.[348] This section will examine methods of expanding and improving mobile coverage and the potential paths leading towards the realization of DFS 2.0 and coverage objectives, including use of universal service funds (USF), policies to enhance the efficiency and harmony of spectrum usage, infrastructure sharing, and tower expansion.

### A Policy Driven

[344] Hanouch, M & Chen, G (2015) *Promoting Competition in Mobile Payments: The Role of USSD*, available at https://goo.gl/kWZcUw
[345] New Vision (2015) *MTN Ordered To Pay Ezeemoney Sh2.3b Over Sabotage*, available at https://goo.gl/y0FxA4
[346] New Vision (2015)) *ibid.*
[347] Section 3.2.1 examines mobile phone technology, Section 5.2 examines network infrastructure and Section 5.5 examines radio frequency spectrum.
[348] See Section 6 for a review of competition and QOS issues which impact on the provision of 'DFS 1.0' using GSM and USSD technology and methods of regulatory response.

## 7.2 Universal Service and Universal Broadband

### 7.2.1 Universal Service Funds

Universal service is a global concept in telecommunications representing aspirational policy objectives of ensuring that the widest number of residents have access to a baseline level of telecommunications at affordable prices so as to reasonably and meaningfully participate in society.[349] It has come to be associated primarily with provision of basic telecommunications services in rural areas.[350]

Because this goal is mostly dependent on the market participants building out infrastructure in these areas, where poor ROI may dissuade them from doing so, the state has stepped in to provide what are often known as universal service funds (USF)[351] as a subsidy[352] of sorts for building out infrastructure by providing capital to fund build out of the local infrastructure and/or critical backhaul services [353]

A USF may be controlled by a telecommunications regulator and/or a specialized agency established to control and disburse funds.[354] Funds are often derived from fees collected from licensees - which can include broadcasters and other organizations – based on a percentage of gross revenues less exclusions[355] or a portion of overall of an annual regulatory fee.[356] Some funds may also be based on specific taxes on mobile prepaid airtime or on post-paid customer bills [357]

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[349] ITU (2013) *Universal Service Fund and Digital Inclusion for All*, available at https://bit.ly/2Ho5uPI; Council of the EU (2002) *Universal Service Directive*, available at https://bit.ly/2qRW20D; Ladcomm Corporation (2013) *Survey of Universal Service Funds: Key Findings*, available at https://bit.ly/2HrsMEs; Ladcomm Corporation (2014) *Sub-Saharan Africa - Universal Service Fund study*, available at https://bit.ly/2F864ip . A popular alliteration used to describe universal service includes terms such as available, accessible, affordable, acceptable and adaptable.

[350] Muente- Kunigami, A & Navas- Sabater, J (2009) *Options to Increase Access to Telecommunications Services in Rural and Low- Income Areas*, available at https://bit.ly/2qR9f9Q; UN- ESCAP (2017) *The Impact of Universal Service Funds on Fixed-Broadband Deployment and Internet Adoption in Asia and the Pacifi*c, available at https://bit.ly/2FIJzlI

[351] The USF name varies by jurisdiction and is also referred to as the Universal Access Fund (UAF), Universal Service and Access Fund (USAF) (such as in South Africa), Universal Service Fund (USF) (U.S. and Jamaica), and Universal Service Obligation Fund (USOF) (India). UN – ESCAP (2017) *The Impact of Universal Service Funds on Fixed-Broadband Deployment and Internet Adoption in Asia and the Pacific*, available at https://bit.ly/2FIJzlI ; USAASA (2018) *USAASA - About USAF*, available at www.usaasa.org.za/usaif/ ; USAC (2018) *Frequently Asked Questions (FAQs)*, available at www.usac.org/about/about/universal-service/faqs.aspx; Jamaica Ministry of Science Energy & Technology (2018) *Universal Service Fund*, available at mset.gov.jm/universal-service-fund; Government of India (2018) *Universal Service Obligation Fund (USOF)*, available at https://bit.ly/2w8fE5J

[352] ITU & UNESCO (2015) *The State of Broadband 2015: Broadband as a Foundation for Sustainable Development*, available at https://bit.ly/1QTuNrB

[353] Sunday, F (2018) *Universal Service Fund To Boost Mobile Service Coverage Hits Sh7.1 Billion*, available at https://bit.ly/2Jm4yMd

[354] In Thailand, the NBTC is an independent government agency directed by eleven Commissioners with expertise in the broadcasting, telecom, financial and consumer protection fields. ITU (2013) *Universal service funds and digital inclusion for all,* available at https://bit.ly/2K62GIy . In Nigeria, the fund is a separate entity – the USPF; the Board of Directors is formed with representatives of both the private and public sectors. In Pakistan, the USF is administered by a separate company - USF Co, the independent Board of Directors is comprised of representatives from both the private and public sector. See *ibid.*

[355] *ibid.*

[356] Other funding sources may include full or partial proceeds from spectrum auctions, direct contributions from government budgets, and contributions from international agencies. See *ibid.*

[357] Often the USF may consist of a levy upon gross revenues offset by taxes paid on handset purchases, interconnect fees, etc. See *ibid*; Muente-Kunigami, A & Navas-Sabater, J (2010) *Options to Increase Access to Telecommunications Services in Rural and Low-Income Areas*, https://bit.ly/2qR9f9Q

The effectiveness of USFs are highly debated, with critics pointing to inefficient administration[358] and undistributed or diverted funds which are used to fulfill other objectives.[359]

Another method of financing is through a public-private partnership (PPP), a method that funded the Rwanda WOAN which provides universal mobile broadband service and covers 95% of the population.[360]

### 7.2.2 Universal Broadband Service

Universal Broadband Service[361] often represents national attempts to provide broadband access across the widest area possible within a country to ensure that all residents receive an adequate level of service.[362]

There is no single universal definition for 'broadband' service.[363] Broadband 'speed' is a constantly evolving baseline measure of service which is set and defined by and within each country. Speed levels are often specified in local laws or regulations, and usually increased over time.[364] Speeds differ per country: in the US for example, mobile broadband speed is set at 25 Mbps,[365] while in India it is 512 kbps.[366]

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358 Penteriani, G (2016) *Are Universal Service Funds an effective way to achieve universal access?*, available at https://bit.ly/2qSDFZH, See Section 7.2.1. In Uganda, 50% of USF-related contributions are destined for a general usage fund. UCC (2017) *RCDF Policy 2017/18-2021/22 (RCDF III)*, available at http://bit.ly/2JnM6D8. In India, only 13% of annual contributions in 2017 were disbursed. See Department of Telecommunications, Government of India (2018) *Universal Service Obligation Fund - Fund Status in Table. USOF*, available at usof.gov.in/usof-cms/usof-fund-status-table.jsp. For more information, see Sections covering USF in Annex C.

359 In Kenya for example, a presidential directive specified that some Sh1 billion (USD 10 million) of the country's USF funds be given to the Directorate of Criminal Investigations to enhance cyber-security in the country. Sunday, F (2018) *Universal Service Fund To Boost Mobile Service Coverage Hits Sh7.1 Billion*, available at https://bit.ly/2Jm4yMd

360 KT Rwanda Networks has announced that it has reached 95% population connectivity in 2018 with all Rwandan districts having 4G mobile coverage. KT Rwanda Networks (2018) *Coverage Maps*, available at https://www.ktrn.rw/coveragemap . See also Tumwebaze, P (2018) *4g Internet Network Coverage Reaches All Districts - KT Rwanda*, available at http://www.newtimes.co.rw/section/read/226815 . For more information about the WOAN in Rwanda, see Annex D.

361 Also referred to as Broadband Universal Service.

362 Also see European Parliament (2016) *Broadband As A Universal Service*, available at http://bit.ly/2qWdNeB.

363 Broadband access is often characterized as being 'always on' or 'always connected', equating to a persistent network connection which requires no additional connection which may incur extra charges, such as via a 'dial-up' telephone call. See National Academies Press (2018) *What is Broadband?*, available at https://www.nap.edu/read/10235/chapter/5 . See also Qualcomm (2018) *5 Ways Snapdragon Powered Always On, Always Connected Pcs Are Driving New Mobile Experiences*, available at https://bit.ly/2BzFv49

364 Baseline levels of service defined as broadband' are often set by government or a regulator, according to the type of service (fixed line, wireless, satellite, etc.), and described in terms of 'upstream' and 'downstream' speeds to and from a telecommunications provider. In the US, no floor is specified but thresholds are required to be periodically set by a regulator or through national broadband programs such as for disbursements pursuant to a Universal Service Fund. Kruger, L G (2017) http://bit.ly/2JlcVrr. See also FCC (2018) *Broadband Speed Guide*, available at http://bit.ly/2HohZe9

365 FCC (2018) *ibid*

366 See TRAI (2017) *Consultation Paper on Data Speed Under Wireless Broadband Plans, Consultation Paper No. 6 /2017*, available at http://bit.ly/2HULB3z; Telecom Regulatory Authority of India (2018) *Consultation Paper on Inputs for Formulation of National Telecom Policy - 2018*, available at http://bit.ly/2vEH2YJ . MNOs such as BSNL have been offering minimum broadband speeds of 2 Mbps. BSL TeleServices (2017) *8Mbps Is BSNL Broadband New Speed As Minimum Bandwidth*, available at http://bit.ly/2HpnXza. There is reluctance to raise the floor due to compliance issues with quality of service requirements and pressure from MNOs to avoid issues which arise in rural areas and edges of the network. See TRAI (2016-2018) Performance Indicator Reports, available at http://bit.ly/2K9bk9b

**Impact on DFS: Universal Mobile Broadband Service**

Efforts at increasing and expanding financial inclusion and DFS can provide substantial socioeconomic benefits, including a boost to the overall economy and GDP increase which is more pronounced in developing countries.[367] Wireless broadband is also the conduit for realizing the substantial benefits of DFS 2.0, providing a superior UI and UX and capable of displaying a greater bouquet of products and services within the DFS ecosystem, as described in greater detail in Section 1.2. It also has the potential to alleviate DFS 1.0 related mobile coverage problems, such as the competition and QOS issues connected with the use of GSM and USSD technologies, as described in greater detail in Section 6.

## 7.3 New Spectrum Provision for Use in DFS

### 7.3.1 Overview

Spectrum is a scarce natural resource whose fixed supply is constantly being depleted by exponential growth in demand for wireless services.[368] As such, making efficient use of spectrum is of paramount importance. This section examines an example of such efficiency in using the 'digital dividend' spectrum and is followed by a review of the provisioning process, how spectrum is valued and assigned.

### 7.3.2 Digital Dividend Improving Coverage Range

As noted above, [369] the financially excluded often reside in sparsely populated rural areas which require substantial efforts and capital outlay to deploy and expand existing mobile network infrastructure. One approach intended on reducing the effort and the costs of covering these sparse areas is through the more efficient use of spectrum. As illustrated in Exhibit 14, lower frequencies are more capable of traveling greater distances and penetrating dense objects before attenuating. This translates into fewer towers and base stations being needed to cover the same area as higher frequency bands.

With much of the lower frequencies occupied by analogue TV stations in the 700-850 MHz frequency range, a treaty to complete an analogue TV to digital TV[370] switchover by June 2015 was signed in 2006 at the ITU Regional Communication Conference.[371] Here 119 countries in 3 global regions[372] agreed to free frequency ranges below 1 GHz[373] and to repurpose (or 're-farm') the 700 MHz range for mobile data service provision.[374] The range provides

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[367] The GSMA has estimated that a 10% substitution of 2G with 3G penetration translates to a growth of GDP per capita by 0.15 points on average. See GSMA (2016) *Connected Society Unlocking Rural Coverage: Enablers for commercially sustainable mobile network expansion*, available at http://bit.ly/2HlXanx

[368] According to the Cisco Networking Index, global IP traffic for mobile data is expected to reach 16.6 PB per month and increasing to 24.2 PB, 34.3 and 48.2 PB in the following three years. Cisco (2017) *Cisco Visual Networking Index: Forecast and Methodology, 2016–2021*, available at https://bit.ly/1OdTJgJ

[369] See Section 5.5.2.

[370] Doeven, J, Walop, P, Zilles, E, *et al*. (2012) *Digital Dividend: Insights For Spectrum Decisions*, available at Https://Bit.Ly/2i48kdu *Dividend: Opportunities And Challenges*, available at https://bit.ly/2HIXJUw; Katz, R (2006) *Assignment And Use Of Radio Spectrum – Policy Guidelines And Economic Aspect*, available at https://bit.ly/2HItfoP

[371] A target date of June 17 2015 was set to complete the migration to digital broadcasting in Europe, Africa, Middle East and the Islamic Republic of Iran in an effort to bridge the gap of the digital divide. ITU (2015) *ITU International Symposium on the Digital Switchover*, available at https://bit.ly/1Fkfr8k; Many countries planned and did complete the switchover well prior to the 2015 deadline date. Kholod, A & Lewis, J (2010) *The Digital Dividend: Opportunities And Challenges,* available at https://bit.ly/2HIXJUw

[372] The VHF bands (174-230 MHz) are also a part of the dividend but to a much lesser degree. ITU (2010) The digital dividend: Opportunities and challenges, available at https://goo.gl/Le5CAa

[373] Released frequencies were the VHF (174-230 MHz) and UHF (470-862 MHz) bands. *infra*

[374] Digital compression technology allows from 4-12 channels of digital TV to occupy the same amount of RF spectrum as a single analog channel. Since significantly less spectrum is needed to broadcast the same source material by transitioning analog TV to HDTV, the sizeable remainder is left available for reallocation. ITU (2015) *ITU-R FAQ on the Digital Dividend and the*

an optimal balance of range and capacity, making it a valuable resource[375] for mobile broadband coverage initiatives, a benefit now known as the 'digital dividend'.[376] It presents a more economically viable opportunity to expand mobile coverage into rural areas and to improve the quality and availability of DFS in developing countries.[377] Policy objectives to complete the digital switchover[378] have led to continued re-farming efforts, some of which are still in progress,[379] with clearance and harmonization.[380] Regulators usually allocate the spectrum via sales or auctions, all of varying success. [381]

### 7.3.3 Provisioning Policies and Methodologies

#### 7.3.3.1 Overview

The objectives which national governments plan to achieve in management, use and assignment of spectrum is usually contained within a national spectrum policy. This section will examine common considerations of spectrum objectives, methodologies used in the valuation of spectrum and the process of assignment, such as through the auctions.

#### 7.3.3.2 Objectives

Spectrum management objectives consider the question of what is sought to be accomplished in exchange for granting a license to use the scarce resource. The general answer can be concisely summarized as the intersection of where 'economic efficiency, technical efficiency and social benefit' are maximized.[382] But the equilibrium point is elusive since these goals are impacted by conflicting priorities and objectives, national spectrum policy, as well as the motives of and choices made by decision makers.[383]

A regulator or authorized body must decide upon initiatives of priority and make compromises between them, such as raising money for the fiscus, encouraging investment and innovation, ensuring competition in the marketplace and the promotion of financial inclusion. The determination of objectives will impact upon the choices made as to

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*Digital Switchover*, available at https://bit.ly/2qipWuq; Daglish, T, Saglam, Y & Phuong, H (2017) *Auctioning The Digital Dividend: A Model For Spectrum Auctions,* available at https://bit.ly/2waHe2k

375 Several spectrum auctions of the 700 MHz band have yielded significantly higher than average winning bids. 'The 2008 US spectrum auctions of the 700 MHz band, provided also a good indication of the value of (a part of) the digital dividend. These auctions raised USD 19.1 billion for 56 MHz of spectrum, implying an average value of USD 340 million per megahertz' Doeven, J, Walop, P, Zilles, E, et. al (2012) *Digital Dividend: Insights For Spectrum Decisions*, available at https://bit.ly/2JHInjDf

376 GSMA (2013) *The Digital Dividend in Latin America*, available at www.gsma.com/latinamerica/the-digital-dividend-in-latin-america; Katz, R (2006) *Assignment And Use Of Radio Spectrum – Policy Guidelines And Economic Aspect*, available at https://bit.ly/2HItfoP

377 The size and frequency range of the spectrum recovery is country specific. Frequency bands for analog TV broadcasting vary including the specific details of each digital television switchover, technology used, effective penetration of services, country topology and geography among other variables. Some refer to the digital dividend spectrum as being located between 200 MHz and 1 GHz. Kholod, A & Lewis, J (2010) *The Digital Dividend: Opportunities And Challenges*, available at https://bit.ly/2HIXJUw; Coat, M (2015) *The Digital Dividend & The Future Of The 700/800 Mhz Bands In Region 1*, available at https://bit.ly/20xSZ70

378 Policy related to the digital dividend can be found in Section 7.3.2.

379 Challenges to expansion of mobile coverage in DFS countries include delays from slower than average migration from analog to digital television. Few MNOs have launched services using the digital dividend in Latin America due to substantial migration and clearance delays. GSMA (2016) *Unlocking Rural Coverage: Enablers for commercially sustainable mobile network expansion*, available at https://bit.ly/2Jisikf

380 For more information about spectrum harmonization, see Section 5.5.

381 See Section 7.3.3 on types of allocation.

382 Katz, R (2006) *Assignment And Use Of Radio Spectrum – Policy Guidelines And Economic Aspect*, available at https://Bit.Ly/2hitfop

383 See Exhibit 18 on failed or incomplete spectrum auctions, and for more information about the India's spectrum auctions, see Annex A.

which assignment type[384] will be used, the licensing terms being granted, and valuation method to be used to determine pricing of the license.

#### 7.3.3.3 Methodologies

Different factors must be considered when choosing an assignment type to license spectrum. The manner in which 'frequency assignment'[385] occurs varies in addition to any attached rules and regulations. And the process involved with a specific assignment type can substantially impact upon the availability of spectrum being assigned, which is especially important regarding mobile coverage initiatives.

Spectrum value can be understood as the intersection point where the 'economic efficiency, technical efficiency and social benefit' are maximized.[386] Factors which may be determinative of the value of spectrum are intrinsic and extrinsic and dependent directly upon the frequency bands being assigned and where and how they can be used.[387] A collection of these factors include but are not restricted to: any regulatory restrictions on use;[388] the precise spectrum band location and its propagation characteristics;[389] the density, size and wealth of the marketplace within the geographic coverage range;[390] the spectrum band and block size;[391] marketplace characteristics and timing;[392] and license duration and renewal options.

Approaches and theories on how to most accurately derive spectrum value are numerous. Common approaches include: (i) the marketplace approach, which uses recent comparable sales or spectrum auctions (sometimes called 'benchmarking'); and (b) a bottom-up approach, building business models through an understanding of the business and applying discounted cash flow and cost reduction value.[393] Ultimately, regardless of the valuation method used, the realization of spectrum value is dependent upon the assignment objective[394] preferred and the type[395] selected. Regulators may impose a variety of upfront fees and annual charges on MNOs for licenses to access mobile spectrum. Final pricing is usually determined by an upfront reserve price, annual fees that may be discounted cost over the license term. If the allocation is via auction, the final cost will be the additional cost based on the competitive premium.[396]

**Exhibit 17:** Approaches to Spectrum Valuation

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384 An 'assignment type' describes the method in which licenses will be provisioned, e.g. pursuant to an administrative process, an auction, etc. and as covered in greater detail in Section 7.3.4.3.

385 The GSMA defines 'assignment' as: '[T]he process of awarding spectrum to a particular user (e.g. a mobile operator). It is usual for the national regulator acting on behalf of the government to be responsible for the process of spectrum assignment. They use a number of techniques to allocate spectrum to particular users: auctions and beauty contests are the most common. Often the term is confused with 'Allocation'.' See GSMA (2014) *The Spectrum Policy Dictionary*, available at https://bit.ly/2HBirJV

386 Katz, R (2006) *Assignment And Use Of Radio Spectrum – Policy Guidelines And Economic Aspect*, available at https://Bit.Ly/2hitfop

387 ITU (2012) *Exploring The Value And Economic Valuation Of Spectrum,* available at https://bit.ly/2IbelaS

388 Regulations may limit the usage of particular spectrum such as being usable only for a specific purpose.

389 Spectrum characteristics are explained in Section 5.5.2. Lower frequencies have greater propagation and penetrability characteristics at the expense of lower capacity. Lower frequencies usually then present higher values. See Randolph, K (2011) *Tuning into Spectrum Valuation*, available at https://bit.ly/2HUrTVD

390 The potential ROI for wireless communications services in a geographic location can be impacted by several factors such as population density, the ability to afford services and commercial activity. Urban areas which feature a higher population density, and typically greater affordability and commercial activity, provide much greater potential returns on investment and which are used in justifying the costs of deploying infrastructure.

391 The amount of spectrum being offered is important, especially for MNOs who need to maintain QOS and reach for two way transmissions.

392 A marketplace which has high barriers to entry and significant competitive advantages by participants with significant market power can prevent new entrants in the marketplace and limit the number of potential buyers.

393 Plum Consulting (2011) *Methodologies for Valuing Spectrum: Review of the Experts' Report – A Report for Vodaphone,* available at https://bit.ly/2vCmsZ0, Randolph, K (2011) *Tuning into Spectrum Valuation*, available at https://bit.ly/2HUrTVD

394 Spectrum assignment objectives are discussed in Section 7.3.4.2.

395 Spectrum assignment types are discussed in Section 7.3.4.3.

396 GSMA (2017) *Effective Spectrum Pricing: Supporting Better Quality And More Affordable Mobile Services*, available at https://bit.ly/2vV75sK

For example, auctions are a comparatively long process and require comprehensive steps for planning, preparation, and execution, including valuation of spectrum (as further examined in Exhibit 17, all of which could result in an auction failure if there are no qualified bidders.[397]

#### 7.3.3.3.1 Administrative Assignment

Administrative assignment involves the government, a regulator or an authorized entity directly assigning spectrum to a party of their choosing. Historically, radio spectrum was under government ownership and control and assigned spectrum as it deemed appropriate.[398] Decisions concerning awards and use were and still may be made primarily through arbitrary and opaque administrative processes such as 'beauty contests' or 'comparative tenders.'[399] Subsequently lotteries and first-come first-served were introduced.[400]

#### 7.3.3.3.2 Auctions

In theory, using the appropriate auction method is designed to: (a) ensure that the maximum value[401] of the spectrum is realized; and (b) that the winning bidder is incentivized to use the auction proceeds in the most efficient and effective manner. Ensuring that bidders are qualified and capable of being able to afford bids placed and execute upon plans after payment are both of paramount importance.[402] The most common auction types include English (ascending bid), Dutch (descending bid), simultaneous multi-round ascending, combinatorial clock, first price sealed-bid, and second price sealed-bid (Vickrey) auctions.[403] Use of pre-auction qualification and reserve pricing aims to guarantee that bidders have the ability to afford the cost of a winning bid and are also incentivized to make the best use of the award as envisioned by the State.

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[397] Exhibit 17 reviews approaches to spectrum evaluation, and Exhibit 18 illustrates some failed and incomplete attempts at spectrum allocation. Annex F provides a comprehensive list examining several popular assignment types such as sales, administrative assignments and Dutch and Vickrey auctions.

[398] Noam, E (2012) *The Economists' Contribution To Radio Spectrum Access: The Past, The Present, And The Future*, available at http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6179295

[399] This was the earliest used format for spectrum allocation whereby a government would assign a committee of members would evaluate spectrum usage proposals and make awards using various predetermined criteria which was to maximize the benefits of an award. This method was used most often in Canada and the EU. Jilani, S (2015) *Spectrum Allocation Methods: Studying Allocation through Auctions*, available at http://www.joebm.com/papers/278-M10007.pdf . The same method was also used often in the US. Noam, E (2012) *The Economists' Contribution To Radio Spectrum Access: The Past, The Present, And The Future*, available at https://bit.ly/2I54O5g; Pratt, A & Valletti, T (2000) *Spectrum Auctions Versus Beauty Contests: Costs and Benefits*, available at https://bit.ly/2qTPwpn

[400] Decisions concerning administrative assignment are of paramount importance both with regard to maximizing value and the prevention of failure, as illustrated by the examples of allocation failures highlighted in Exhibit 18.

[401] For more information about spectrum valuation, see Exhibit 17.

[402] A 4G-centric 900 MHz spectrum auction in Thailand failed due to non-payment by the bid winner, a relatively smaller MNO, forcing a re-auction. Fernquest, J (2016) *4G: Newcomer JAS Fails to Make Payment*, available at https://bit.ly/2HS1D0C

[403] Oaca, N (2013) *Planning a Spectrum Auction,* available at http://bit.ly/2K6LOBs

**India**: During the course of spectrum auctions in 2012-2016, 60% of spectrum in the sub-1 GHz was left unsold owing to exceptionally high reserve prices.[404] There were no bidders for the 700 MHz 'digital dividend' bands. In the third quarter of 2018, with regard to the auction of multiple frequency bands (including 5G),[405] TRAI updated its prior recommendations and dropped base prices substantially, including over 40% on the 700 MHz spectrum.[406] While the Indian government and been planning on an auction in 2019,[407] India's Department of Telecommunications (DoT) may request a further price reduction and consideration that an auction not take place until late 2019, at earliest, due to the ailing financial health of the country's telecom industry.[408]

**Jordan:** During auctions of packages of spectrum across the 800, 1800, 2100, 2300, and 2600 MHz bands, it set very high upfront fees for each band and demanded a 10% revenue share. Only some spectrum has been sold.[409]

**Mozambique:** 800 MHz auctions were scheduled for June 2013, but high pricing, reserves and allocation mechanisms have mean that as of May 2017, not no spectrum has been allocated as of June 2018.[410]

**Ghana:** A high reserve price set by the regulator meant that there was only one bidder (and eventual winner) for lots of 800 MHz. spectrum. MNOs have lobbied for a reduction in the price of the 4G license, but this was rejected by the government, who recommended consolidation instead. A June 2018 auction is planned for a second license.[411]

**Senegal:** A high reserve price meant that there was only one bidder – Sonatel - for lots of 800 MHz spectrum, caused by a boycott of the auction by MNOs. This has given rise to concerns about potential monopoly in the 4G spectrum range.[412]

**Exhibit 18:** Examples of Failed Spectrum Allocations in DFS-Focused Countries.[413] Pricing for spectrum is usually measured in cost per MHz per Point of Presence (POP).[414]

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404 Iyengar, R (2016) *Why India's 4G License Auction Was A Flop*, available at https://cnnmon.ie/2KbUYwO; GSMA (2016) *There Are Lessons To Be Learnt From India's 700 MHz Auction*, available at http://bit.ly/2JlBMeJ; Mobile World Live (2018) *India Plans Largest Ever Spectrum Sale*, available at http://bit.ly/2K8O0bC

405 TRAI (2018) *Recommendations on Auction of Spectrum in 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300-3400 MHz, 3400-3600 MHz Bands*, available at https://bit.ly/2zfpD7N; See also Kundo, R (2018) *Panel asks govt to announce 5G spectrum policy by Dec-end*, available at https://bit.ly/2yJt7A1

406 Sarkar, S (2018) Why Next Spectrum Auction May Fail Despite Cheaper Spectrum, available at https://bit.ly/2zfsspi; Business Today (2018) *TRAI proposes steep price cuts for next spectrum auction, proposes new 5G ban*d, available at https://bit.ly/2AFc6bt; TRAI (2018) *ibid.*

407 Economic Times (2018) *Government Plans Largest Ever Spectrum Auction Of 3,000 Mhz*, available at https://bit.ly/2JE4Z4I; Sarkar, S (2018) *ibid.*

408 Agarwal, S (2018) *TRAI proposes steep price cuts for next spectrum auction, proposes new 5G band*, available at https://bit.ly/2AFc6b t

409 GSMA (2017) *Effective Spectrum Pricing: Supporting Better Quality And More Affordable Mobile Services*, available at https://bit.ly/2vV75sK; Many Possibilities (2017) *The Failure of Spectrum Auctions in Af*rica, available at https://bit.ly/2r8H9qc

410 *ibid*

411 ITWeb Africa (2018*) Ghana To Issue Second 4G Spectrum License In June*, available at https://bit.ly/2raGaq8

412 GSMA (2017) *Effective Spectrum Pricing: Supporting Better Quality And More Affordable Mobile Services*, available at https://bit.ly/2vV75sK; Many Possibilities (2017) *The Failure of Spectrum Auctions in Africa, available at https://bit.ly/2r8H9qc*

413 See Nigeria's failed 2.6 GHz auction. This Day Newspapers Ltd. (2016) *The Untold Story of NCC's 2.6 GHz Spectrum Auction*, available at http://bit.ly/2HoKY1o; Adamarola, Z (2016) *2.6ghz Spectrum Auction: Not Good Omen For Nigeria's Telecoms Sector*, available at http://bit.ly/2qXi69l

414 GSMA (2017) *Effective Spectrum Pricing: Supporting Better Quality And More Affordable Mobile Services*, available at https://bit.ly/2vV75sK

## 7.4 Infrastructure & Spectrum Sharing

### 7.4.1 The Nature of Infrastructure Sharing

The continued improvement of existing and expansion of mobile network infrastructure is made possible by more efficient use of resources, such as through infrastructure sharing. The global trend though is for mobile coverage to be provided through state or independently-owned tower companies, known as towercos.[415]

| Sharing Style | Examples | Regulatory Impact | Coverage Impact | QOS Impact | User Impact |
|---|---|---|---|---|---|
| Spectrum | Roaming | Need regulatory approvals | Higher coverage | May impact overall QOS | Zero sum |
| Infrastructure active | Base stations; Switches; Spectrum; Antennas; Transmission equipment[416] | Usually requires regulatory approval | Higher coverage | May impact overall QOS | Zero sun |
| Infrastructure passive | Land and real estate; Fencing & security; Tower; BTS Shelters[417]; Cabinets; Power supply, generators; Utilities; fiber[418] | May need easily obtained regulatory approval | Higher coverage | May impact overall QOS | Zero sum |
| Open Access Networks | Rwanda, Mexico | Need government and regulatory support | Higher Coverage | May impact overall QOS | May result in higher costs[419] |
| Tower companies | Passive sharing, active sharing. Includes network roaming. Global implementation varies by company and jurisdiction. | Regulatory approval more stringent for active sharing. Other corporate and legal approvals necessary for operation. | Higher coverage | May impact overall QOS | No direct impact. But potential to reduce capex by MNO passed on user costs |

**Exhibit 19:** Types and Impact of Infrastructure Sharing. Infrastructure sharing occurs through cooperative agreements to utilize active and passive assets.[420] The types of sharing models that may lead to improved coverage and QOS are shown here, including impact.

As of December 2017, 2.8 million of the world's estimated 4.3 million mobile towers were owned by non-MNO third party 'towercos,' the remainder the exclusive domain of individual MNOs or shared between MNOs.[421] Exhibit 19 lists several examples of different types of infrastructure sharing.[422]

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415 See Exhibit 11 on the Basic Components of a mobile base station. Towercos offer some if not all of these components on a lease basis to MNOs.

416 Simmons & Simmons LLP (2014) *Telecoms Infrastructure Sharing: Structures*, available at http://bit.ly/2HnkWeM and see KPMG (2011) *Passive Infrastructure sharing in Telecommunications*, available at http://bit.ly/2HLeGkq and see also Lefèvre, CB (2008) *Sharing Infrastructure*, available at http://bit.ly/2Hp1hLy

417 A BTS is a base transceiver station for transmission between the network and end user equipment.

418 Simmons & Simmons LLP (2014) *Telecoms Infrastructure Sharing: Structures*, available at http://bit.ly/2HnkWeM and see KPMG (2011) *Passive Infrastructure sharing in Telecommunications*, available at http://bit.ly/2HLeGkq and see also Lefèvre, CB (2008) *Sharing Infrastructure*, available at http://bit.ly/2Hp1hLy

419 Access to OAN-based 4G services in Rwanda is more expensive than 3G for customers.

420 GSMA (2012) *Mobile Infrastructure Sharing*, available at https://bit.ly/2Ho6TWu

421 TowerXchange (2018) *Towerxchange's Analysis Of The Independent Tower Market In Asia,* available at https://bit.ly/2rbsBXF

422 Its benefits are covered in greater detail in Section 5.3, Infrastructure Deployment.

The components of a mobile base station can generally be divided into two parts: passive and active. Passive elements are the physical, non-electrical components such as land, structures, power supplies, climate control and the physical mast and antenna extended from the structure.[423] Active elements include the electronic components which transmit information from the site through the backhaul and to the core of the mobile network.[424]

#### 7.4.1.1 Passive Sharing

Passive network infrastructure generally consists of the physical components of a mobile base station which don't require the active involvement of another MNO or radio network participant. Sharing agreements consist of leases to use all or part of the land, shelters, tower, mast, power and utilities, climate control, ducts and trenches, dark fiber (unused) and rights of way.[425] Some jurisdictions require regulatory approval for passive infrastructure sharing.[426] Exhibits 11 and 20 identifies components comprising of the passive infrastructure (and sharing) of a mobile base station.[427]

There are two predominant types of passive infrastructure sharing. Mast sharing, involves the sharing of the mast space for multiple antennas to be installed and independent network infrastructure

e, such as separate cabinets for base stations and other equipment being connected to the same antenna.[428].
Site sharing features two independent structures making use of the same land, supplied utilities and resources, such as compound security. Individual towers and shelters are constructed and operate separately.[429] Passive sharing agreements can consist of sharing any or all of the passive infrastructure and the extent depends upon the specific nature of the circumstances and the relationship of the parties. Examples of passive sharing include those provided by third-party independent tower companies (known as towercos).[430]

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[423] Meddour, D E, Rasheed, T & Gourhant, Y (2011) *On the Role of Infrastructure sharing for Mobile Network Operators in Emerging Markets*, available at https://arxiv.org/ftp/arxiv/papers/1211/1211.7113.pdf and covered in Section 7.4
[424] Meddour, D E, Rasheed, T & Gourhant, Y (2011) *ibid.* See Section 7.4.
[425] The most common types of passive sharing are site and mast sharing. See *ibid.*
[426] *ibid.*
[427] See Exhibit 11 on mobile base station infrastructure.
[428] These types of arrangements may feature taller and stronger masts than industry average in order to better and appropriately accommodate more antennas on one mast than would typically be expected in a site sharing situation.
[429] KPMG (2011) *Passive Infrastructure Sharing in Communications*, available at https://bit.ly/2vMQJ7R
[430] See Section 7.4.5.2 on the business models of towercos

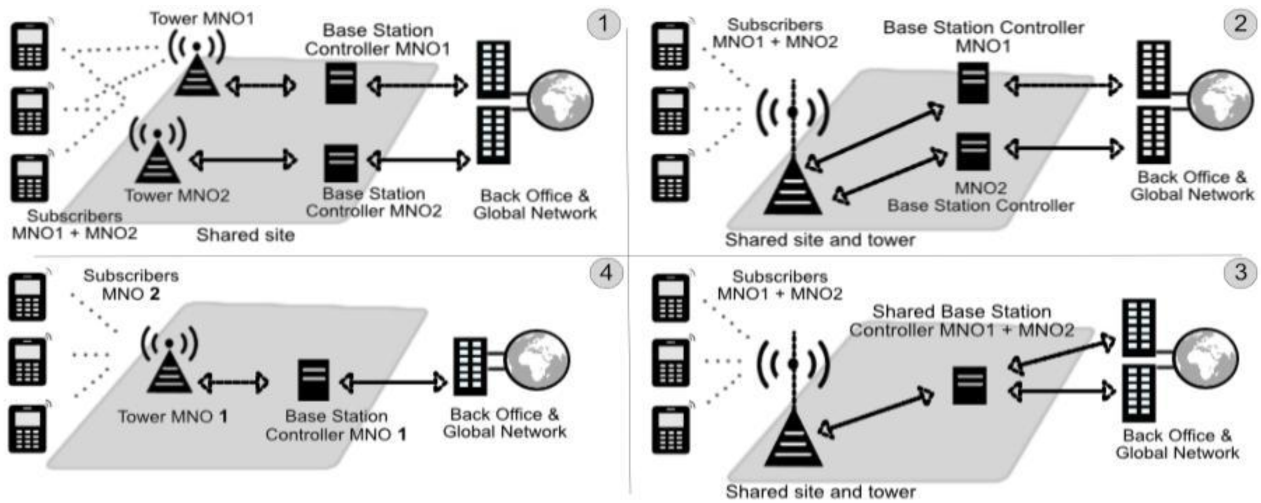


**Exhibit 20:** Infrastructure Sharing Models. (1) Passive Infrastructure Sharing[431] (2) Passive Infrastructure Sharing (3) Active (RAN) Infrastructure Sharing[432] (4) Spectrum Sharing/Network Roaming[433]

#### 7.4.1.2 Active Sharing

Active sharing involves separation of the operational portion of the infrastructure involved in broadcast transmission and reception such as the radio, base station control and functionality, core network and potentially the antenna.[434]

Venerable 2G networks, which were not planned with infrastructure sharing in mind, may more often engage in passive sharing while 3G and 4G networks are better suited for the inclusion of active components such as the Radio Access Network (RAN) and core network sharing.[435] Sharing can include a billing platform as well as equipment and back office functionality such as an equipment identity register.[436] Active sharing is much more likely to require regulatory approval.[437]

Exhibit 20 (3) illustrates RAN sharing operation, which consists of radio equipment, masts, the land and shelters and backhaul equipment. All the equipment on the mobile base station is shared until the network connection reaches the core network where, at that interconnection point, sharing ceases and transmissions run to each respective entity's own core networking ring.[438] The implementation of RAN sharing varies greatly and may differ from the accompanying illustration.

[431] GSMA (2012) *Mobile Infrastructure Sharing*, available at https://bit.ly/2Ho6TWu
[432] *ibid.*
[433] *ibid.*
[434] Meddour, D E, Rasheed, T & Gourhant, Y (2011) *On The Role Of Infrastructure Sharing For Mobile Network Operators In Emerging Markets,* available at https://bit.ly/2qm4rZz; This is also covered in Section 7.4.
[435] RAN sharing is a complex form of active infrastructure sharing. The passive and active network are shared and split at the point where the backhaul connects with the core. GSMA (2012) *Mobile Infrastructure Sharing*, available at https://bit.ly/2Ho6TWu
[436] *ibid.*
[437] *ibid.*
[438] *ibid.*

### 7.4.2 Legal and Regulatory Aspects of Infrastructure Sharing

Government and regulators generally have a favorable view towards passive infrastructure sharing.[439] It promotes competition between MNOs in the marketplace and makes access to towers more affordable to newer and smaller service providers. It also has the potential to reduce the number of towers needed to be deployed[440] and limits friction and burdens of having facilities run by direct competitors.[441]

The primary driver of mobile network infrastructure sharing is commercial incentive, especially for passive efforts, which is sometimes mandated and most often encouraged by regulators. Passive sharing, as opposed to active sharing with many potentially complex variations, typically has the easiest path to approval.[442]

It is paramount important for government and regulators in developing countries to update laws and regulations to reflect changes and innovation in the infrastructure landscape, for example on how to treat the emergence of tower companies and entities who provide merely passive infrastructure. While some jurisdictions like Brazil and Nigeria[443] have existing licensing in place for tower companies, others may be lagging behind or have outdated regulations which treat passive infrastructure companies as if they were providers of active infrastructure or MNOs.[444] As such, antiquated laws, regulations and orders can delay deployment of infrastructure to expand mobile coverage.

Efficient infrastructure sharing is critically important in rural areas in developing countries, where base stations are often powered by diesel burning generators since electrical power is difficult to access in remote areas and often unreliable.[445] The costs savings, environmental and economic benefits of lower fuel consumption and fewer necessary towers makes expansion into rural areas more feasible where revenues are lower, operating costs are higher and demand for services and capacity are growing and necessary.

### 7.4.3 Spectrum Sharing

Spectrum sharing - also known as network roaming - doesn't require any of the active or passive elements to actively be shared. It only requires an agreement to terms and interoperability to extend service, at a cost, to the competing network's customers. It allows MNOs to cooperate with each other in better utilization of an assigned spectrum and move underutilized spectrum blocks, although MNOs sharing spectrum may have pay an additional taxes on revenue earned through sharing.[446]

A user with a mobile phone who does not have coverage but does have compatibility with a tower in range operated by a participating MNO experiences a seamless switch or handoff to the competitor MNO's tower as if it was on its own home system.

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439 *ibid.*

440 Whereas MNO built towers could result in multiple towers being built in the same location, an independently run tower company could potentially serve all providers with one tower, making more efficient use of resources and being run at lower cost.

441 Inter-operator bilateral sharing agreements do exist although these may be more successful with larger incumbents of similar size and strength as opposed to newer and small market entrants. Kaziboni, L & Robb, G (2015) *Infrastructure Sharing In Telecoms: Consolidation In South Africa*, available at https://bit.ly/2HJa5PO

442 GSMA (2012) *Mobile Infrastructure Sharing*, available at https://bit.ly/2Ho6TWu

443 Norton Rose Fulbright (2016) *Sharing Of Telecoms Infrastructure – Opportunities In 2016*, available at Https://Bit.Ly/2qtclkw

444 Press Trust of India (2017) *Telecom Regulator TRAI Forms Joint Panel To Identify Outdated Regulations*, available at https://bit.ly/2qU8Wvh

445 Norton Rose Fulbright (2016) *Sharing Of Telecoms Infrastructure – Opportunities In 2016*, available at https://bit.ly/2qTclKw

446 Economic Times (2015) *Guidelines For Sharing Spectrum Need To Go Hand In Hand With Trading And Leasing,* available at https://bit.ly/2Kgql8x

Network roaming may be mandated or encouraged by law, especially when necessary to ensure fair marketplace competition.[447] The most common instance is 'national roaming' which consists of an agreement between MNOs located within the same country. A more complicated system involves international roaming which requires cross border agreements, invites multi-jurisdictional limitations and regulations along with compatibility questions stemming from vastly different systems that may exist in different world regions.[448] A third type, core network roaming, involves networks using different technologies (such as 2G, 3G and 4G) and adds additional complexity to the equation.

In addition, it will reduce capacity bottlenecks in urban areas, as well as provide a better quality of experience, especially in mobile broadband. Operators engaged in sharing spectrum are liable to pay an additional 0.5% of revenue earned across the relevant LSA as spectrum usage charges.

#### 7.4.4 Network: Open Access Networks

Wholesale open access networks (WOAN)[449] – also known as single wholesale networks (SWN)[450] - represent an effort to capitalize on the efficiencies provided by centralized deployment of infrastructure, selling equal access on the wholesale level while maintaining a competitive marketplace at retail.[451] While many variations exist, the infrastructure layer is often developed and managed by a single entity[452] - often through the vehicle of a PPP[453] - who has the spectrum and service license to sell to MNOs at wholesale prices on FRAND terms.

A primary objective of national WOANs, such as those in Rwanda and Mexico,[454] is the expansion of mobile coverage near or at universal coverage and broadband policy levels.[455] Using a single standard and dedicating the maximum available spectrum to an individual network, the WOAN optimizes efficiency utilizing uniform protocols and requirements, theoretically resulting in increased access, faster speed, lower cost and superior distribution and other benefits passed down to consumers.[456]

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[447] GSMA (2012) *Mobile Infrastructure Sharing*, available at https://bit.ly/2Ho6TWu

[448] In India, see TRAI (2015), *Recommendations on Guidelines on Spectrum Sharing*, available at http://bit.ly/2rIETpI

[449] According to Gilwald: 'Although there is no standard definition of open access (OA) in its regulatory application, it has two common principles: (1) non-discrimination and (2) price transparency. These are generally enforced to ensure equal access to networks and wholesale services and prevent incumbents from favoring their own up-/downstream operations over that of competitors: 'vertical foreclosure'.' See Gillwald, A (2016) *Open Access Wireless Networks Threaten Competition And Investment*, available at https://bit.ly/2nCqXKN

[450] Naming conventions will vary, and also include Open Access Wholesale Networks.

[451] Cramton, P & Doyle, L (2016) *An Open Access Wireless Market - Supporting Competition, Public Safety, and Universal Service*, available at https://bit.ly/2HmBcg7

[452] In three layered WOANs the infrastructure is owned by one party, management and maintenance is handled by a second party and retail service providers consist are the parties at the top layer.

[453] While a PPP can be privately owned, they often include financing and expertise brought by the private investors and government contributing real estate, special access rights and right of way, and may include a grant, capital investment or other contribution and own a stake in the venture. See GSMA (2016) *Best Practice In Mobile Spectrum Licensing*, available at https://bit.ly/2vD8KVY

[454] See Annex D on WOANs.

[455] Rwanda's WOAN and the *Red Compartida* in Mexico are mandated to expand coverage into rural areas and reaching 92.2% and 95.5% of the population, respectively. See Annex D for WOANs in Rwanda and Mexico. See also Cooper, D (2018) *A State-Run Wireless Network Isn't A Crazy Idea, Just Ask Mexico*, available at https://engt.co/2FaGuJG

[456] OECD (2013) *Broadband Networks and Open Access*, available at http://dx.doi.org/10.1787/5k49qgz7crmr-en

The distribution mechanism of a WOAN resembles public utilities, where a wholesale monopoly exists[457] and retailers pay the same access fees on equal terms to purchase unbundled broadband capacity.[458] The parties providing the infrastructure and services on the wholesale level are not permitted to compete at the retail level and create vertical conflicts of interest.[459] MNOs and other retail service providers (such as MVNOs) compete against each other based on mobile services and not infrastructure, differentiated in the marketplace by characteristics such as added value services and competitive rates. The intended result is easier access for new innovative entrants, which will ideally boost economic gains, promote competition and social development.

Proponents of WOANs perceive spectrum auctions with caution, questioning government motives which focus upon 'treasury windfalls' rather than on providing socioeconomic benefits.[460] Auction results can create oligopolies with the same handful of incumbents who possess a massive war chest of funds winning bids for all available spectrum lots.[461] Few are also able to afford the immense costs and possess the expertise necessary to deploy wireless networks at a competitive level.[462] Opponents of WOANs claim that they threaten competition and investment,[463] such as MNOs who generally champion alternative solutions.[464] The wholesale roots of the system lack competitive motivating forces which ultimately lead to the operation losing the drive and incentive to innovate, more closely resembling the slow and unmotivated telecommunication monopolies which it replaced.[465]

### 7.4.5 Third Party Provision: Tower and Infrastructure Companies

#### 7.4.5.1 Overview

The original model of mobile network infrastructure expansion consisted of MNOs incurring substantial expenditures to deploy their own mobile base stations. They served as primary tenants with benefits of coverage advantages over competitors and smaller players,[466] co-sharing with others voluntarily when motivated to do so or as mandated by law.[467]

Subsequently, privately owned tower companies – now known as 'towercos' emerged,[468] presenting an ostensibly more efficient and profit-driven business model specializing in resource management and servicing multiple

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457 In some cases, such as is being proposed in South Africa, a WOAN can also consist of a portion of spectrum allocated to a WOAN with the remainder provided to MNOs who are allowed to compete with the WOAN at predefined levels which, in the case of South Africa, requires 30% of the WOAN capacity being purchased. See Annex D and Roelf, W (2017) *S.Africa Allows Telecoms Operators To Keep Broadband Spectrum Until 2028*, available at https://bit.ly/2Iame0i; Tredger, C (2017) *ITWebAfrica*, available at https://bit.ly/2FAYiOc

458 Tower Xchange (2017) *Tower Xchange*, available at https://bit.ly/2K9oeV0

459 The infrastructure provider is normally not allowed to participate in the retail market. See Garcia, J & Kelly, T (2016) *The Economics and Policy Implications of Infrastructure Sharing and Mutualisation in Africa*, available at https://bit.ly/2qSHDRM, World Bank (2016) *World Development Report 2016 Digital Dividends*, available at https://bit.ly/2qSHDRM

460 Song, S (2018) *Africa Telecoms Infrastructure in 2017*, available at https://bit.ly/2HTlDh3

461 Noam, E (1998) *Spectrum Auctions: Yesterday's Heresy, Today's Orthodoxy, Tomorrow's Anachronism. Taking the Next Step to Open Spectrum Access*, available at https://bit.ly/2JKQJHk; Cramton, P & Doyle, L (2016) *An Open Access Wireless Market - Supporting Competition, Public Safety, and Universal Service*, available at https://bit.ly/2HmBcg7

462 OECD (2013) *Broadband Networks and Open Access*, available at https://bit.ly/2qUuoAb

463 Gillwald, A (2016) *Open Access Wireless Networks Threaten Competition And Investment,* available at https://bit.ly/2nCqXKN

464 Alternatives include voluntary infrastructure sharing, lower priced spectrum in the digital dividend, reduction or elimination of sector taxes.

465 A survey by the Economist showed that the fastest fixed and mobile broadband speeds are in countries which feature highest levels of competition. The Economist (2018) *A National 5G Wireless Network Is Not Such A Stupid Idea*, available at https://econ.st/2qVDHPo, Cooper, D (2018) *A State-Run Wireless Network Isn't A Crazy Idea, Just Ask Mexico*, available at https://engt.co/2FBjHXS /

466 Telecommunications infrastructure comprises of a tremendous portion of a telecommunications operator costs

467 ITU (2017) *Telecommunications/ICTs For Rural And Remote Areas*, available at https://bit.ly/2rgrDbH

468 Private ownership and operation of telecommunications towers and infrastructure companies in the US began to appear. Osmotherly, K (2017) *All Towercos*, available at https://bit.ly/2K9oeV0

MNOs.[469] Often where the state is involved as sole or part shareholder in such omnibus provision of (shared) infrastructure, these are known as 'infracos'[470]

Removing substantial capital and operational costs and moving to lease obligations frees resources for the MNO to invest in its core business.[471] By removing an internal cost center, MNOs can focus on developing its networks, its technologies and subscriber base, improving coverage to meet greater service demands in rural areas. Ideally, these benefits should be reinvested and enhance mobile coverage and DFS.

### 7.4.5.2 What Tower Companies Provide

While the business models differ regionally and because of regulation, tower companies[472] generally provide passive infrastructure sharing consisting of the land and tower at a minimum.[473] In some models, the antennas, shelters, power, climate control and active network components owned and managed by MNOs, or by the towerco.[474]

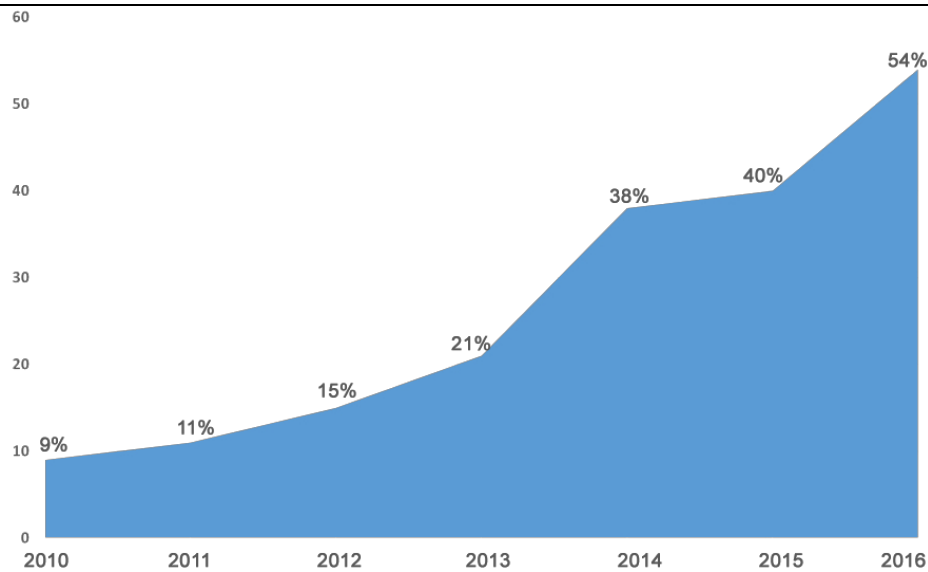


**Exhibit 21**: Towerco Growth in Sub Saharan Africa by tower count.[475] The vast majority are owned by four companies.[476] In Asia, 78% are owned by independent towercos.[477]

[469] Osmotherly, K (2017) *The Rise Of The Operator-Led Towerco*, available at https://bit.ly/2K9oeV0

[470] These may also provide fibre-optic infrastructure and associated transmission equipment on an open access, non-discriminatory and price-regulated basis. See for example, Broadband Infraco, a state-owned enterprise in South Africa, at Broadband Infraco (2018) *Broadband Infraco,* available at http://www.infraco.co.za

[471] Garcia, J & Kelly, T (2016) *The Economics and Policy Implications of Infrastructure Sharing and Mutualisation in Africa*, available at https://bit.ly/2qSHDRM

[472] Tower companies are examined in greater detail in Section 7.4.5.

[473] Passive infrastructure is commonly referred to as the 'green and steel' of network operations.

[474] American Tower Company (2014) *Introduction to the Tower Industry and American Tower,* available at https://bit.ly/2Fa6Xax

[475] TowerXchange (2016) *Towerxchange's Analysis Of The Independent Tower Market In Africa And The Middle East*, available at https://bit.ly/2w2MsNm

[476] TowerXchange (2018) *Towerxchange's Analysis Of The Independent Tower Market In Africa*, available at https://bit.ly/2rhoF6K

[477] TowerXchange (2018) *Towerxchange's Analysis Of The Independent Tower Market In Asia,* available at https://bit.ly/2rbsBXF

Active infrastructure sharing with other MNOs, when provided by MNO tenants, is managed by the MNOs who own, operate and manage their equipment and telecommunications networks collocated on the premises.[478]

The towerco model has grown exponentially,[479] led by organic growth but more through existing MNOs base station sites which have been acquired by tower companies. These are usually leaseback arrangements where the MNO becomes the primary anchor tenant and engages in passive infrastructure sharing.[480] For the MNO, it is the provision of power to rural and remote areas that is the motivating factor for the leaseback arrangement with towercos.[481] An example of the substantial growth of towercos is illustrated in Exhibit 21.

#### 7.4.5.3 Legal and Corporate Structure

The majority of the world's tower companies consist of hybrid 'operator-led' ownership models which, in African countries, often includes a significant MNO interest.[482] Towers are typically sold[483] by an MNO to a locally incorporated joint venture with an MNO leaseback,[484] providing the new entity with a tier-1 long-term anchor tenant.[485]

The MNO receives cash proceeds from the sale to reinvest in its business along with equity in the jointly owned tower company, which it can further benefit from the appreciation in value of the new profit driven, independently financed entity. The level of investment that an MNO retains within the resulting tower company[486] can have negative effects as it can potentially blur the line of indirect investment and influence over operations,[487] raising issues of independence versus influence.

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478 Tower companies may charge an additional rental fee in exchange for potentially losing a co-tenant. Norton Rose Fulbright (2016) *Sharing of Telecoms Infrastructure – Opportunities in 2016*, available at https://bit.ly/2qTclKw

479 See Exhibit 21 on the global and regional growth of towercos.; and TowerXchange (2017) *New Site Topologies and Business Models for 5G*, available at https://bit.ly/2K9oeV0

480 See Section 7.4.5 for more information about Tower and Infrastructure Companies.

481 Difficulties in providing electrical cables to tower locations and reliability often results in the use of diesel fuel generators. Limiting the amount of towers and associated gas powered generators is consistent with national infrastructure sharing goals and reduction of emissions, also covered in the following paragraph. Osmotherly, K (2017) *All Towercos*, available at https://www.towerxchange.com/wp-content/uploads/2017/02/TowerXchange-Issue_18.pdf

482 The four largest tower companies in Africa are IHS Towers, American Tower, Helios Towers Africa and Eaton Towers. TowerXchange (2017) *Towerxchange's Analysis Of The Independent Tower Market In Africa And The Middle East*, available at https://bit.ly/2K873TB

483 TowerXchange estimates the average cost per tower in Africa as USD 115,028 and in India as USD 77,804. Osmotherly, K (2017) *All Towercos*, available at https://bit.ly/2K9oeV0

484 ITU (2017) *Policy, Regulatory And Technical Aspects Of The Migration From Existing Networks To Broadband Networks In Developing Countries,* available at https://bit.ly/2HJnBQi, Norton Rose Fulbright (2016) *Sharing of Telecoms Infrastructure – Opportunities in 2016*, available at https://bit.ly/2qTclKw

485 Critically important is having a long-term tenant capable of defraying capital expenditures involved in tower operations.

486 Osmotherly, K (2017) *All Towercos*, available at https://bit.ly/2K9oeV0, Norton Rose Fulbright (2016) *ibid.*

487 Assessments of some jurisdictions such as Ghana have concluded that the lack of true independence of MNOs as anchor tenants results in significant market misconduct. See Osei-Owusu, A & Henten, A (2017) *Network Tower Sharing And Telecom Infrastructure Diffusion In Ghana - A Structure-Conduct-Performance Approach*, available at http://hdl.handle.net/10419/168532

**Impact on DFS: Infrastructure Sharing**

Infrastructure sharing can provide a significant benefit to mobile coverage through more efficient use of resources, which also frees capital for MNOs to reinvest in its core business and financial inclusion initiatives. Combining these benefits with spectrum efficiencies described earlier, mobile coverage can be expanded with a significantly wider radius and lower cost, reducing the efforts previously needed to expand into rural areas. WOANs are an exciting new solution for providing universal broadband service although its duration of operation is too short to form any substantive conclusions. The emergence of tower companies have the potential to improve the quality of service of mobile coverage, being a dedicated operation which may prove more effective in controlling theft of fuel and uptime of mobile base station operations. Ultimately these improvements in rural areas can impact positively on the DFS experience being provided both by narrowband or broadband technologies.

The type of legal entity and ownership of an infrastructure company may also be dictated by jurisdictional requirements, such as local corporations or natural persons being resident and required to own or avail itself of a telecommunications license. This may also include a license for operating passive infrastructure for deployment of telecommunications services, as well as local ownership of the land.

Foreign direct investment (FDI) is also often set by law and can range from 0% (no FDI) to majority foreign ownership, with regulatory approval potentially being required to engage in business as a tower company.[488]

## B Technology Driven

### 7.5 Innovation in Mobile Coverage & Access Solutions

#### 7.5.1 Overview

This section details emerging or non-traditional examples of expanding coverage in developing countries by using methods other than traditional mobile base stations. While these iterations may be smaller in scale than mainstream solutions, some may be suitable for addressing the needs of specific situations which call for DFS[489] while others may ultimately be capable of significantly improving existing mobile coverage in rural and remote areas.

#### 7.5.2 Atmospheric

#### 7.5.2.1 Project Loon

Project Loon is an effort by X Development LLC[490] to provide mobile communications access to rural and remote areas using a network of high altitude air balloons acting as floating mobile base stations in the sky.[491] A balloon connected to a local partner MNO base station[492] propagates the signal to other balloons in the network, usually positioned a few hundred kilometers apart, which can be automatically positioned to provide coverage in needed

[488] Some countries require a towerco to hold a license, but allow foreign investment in licensees. For example, India which has proposed an FDI limit of 74%. Indonesia imposes more stringent requirements of 100% local ownership. See thereto, Allen & Overy LLP (2012) *Passive Infrastructure Sharing*, available at https://bit.ly/2vCr3uv

[489] DFS has been an essential solution helping refugees receive funds and make payments, as explained in greater detail in Exhibit 4. It also has been used for similar purposes in aiding large groups of people impacted by the effects of natural disasters, as covered in greater detail in this section and specifically in Section 7.5.2.1.

[490] Development began in the Google X incubator in 2011 and officially launched after a trial run in New Zealand in 2013. See Google (2018) *Where Loon Is Going*, available at https://www.google.com/intl/en-US/loon/where/

[491] Project Loon (2018) *What is Project Loon,* available at https://x.company/loon/#video:MiEZfRh-h-s

[492] Project Loon partners with local MNOs to extend the MNOs service coverage area using its balloon network.

areas.[493] The balloons are equipped with a pair of solar powered transceivers[494] including a 4G LTE base station, to interact with terrestrial microcells[495] which provide service to standard mobile phones.[496]

Areas in developing countries featuring live service and testing include Brazil, Sri Lanka, Peru[497] and Puerto Rico[498] and Kenya.[499] Project Loon has been used to provide mobile coverage during humanitarian crises and regions impacted by natural disasters. During October 2017, Alphabet Inc. was granted an experimental license by the Federal Communication Commission (FCC) to deploy Project Loon to provide emergency mobile communications in Puerto Rico.[500] The mobile communications networks of Puerto Rico and the Virgin Islands were devastated[501] several weeks earlier by Hurricane Maria, a category 4 hurricane.[502] An estimated 200,000 Puerto Rican residents experienced some level of service restored through the project.[503]

#### 7.5.2.2 AT&T Flying COW Drones

AT&T's 'Flying COW' drones are capable of hovering 200-400 feet above the ground and provide mobile coverage over approximately 40 square miles.[504] AT&T reported that it assisted Project Loon in 2017[505] to restore a substantial amount of coverage to residents of Puerto Rico and the U.S. Virgin Islands from damage to existing mobile infrastructure resulting from Hurricane Maria.[506]

#### 7.5.2.3 Facebook Aquila

Facebook's Project Aquila uses solar powered drones, which communicate with dispersed ground stations, to propagate signal to terrestrial phones. The drones fly much lower than Loon balloons and designed to remain in the

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493 Balloons can automatically cluster together to cover areas needing connectivity, with each balloon providing some 20 km of mobile coverage. Brodkin, J (2013) *Google Files Internet Balloons In Stratosphere For A 'Network In The Sky',* available at https://bit.ly/2HJVtQ9

494 The second transceiver encodes lasers with data and used for beaming information between balloons. *ibid*

495 Microcells are essentially antennas mounted to a terrestrial structure near the user where there is a clear line of sight to the sky. Greenemeier, L (2017) *Puerto Rico Looks to Alphabet's X Project Loon Balloons to Restore Cell Service,* available at https://bit.ly/2i7NKjS

496 Lawler, R (2017) *Now T-Mobile is working with Project Loon in Puerto Rico*, available at https://engt.co/2ySlWql

497 Kaufman, M (2017) *Why It's Challenging To Deploy Google's Internet-Beaming Balloons In Puerto Rico*, available at https://on.mash.to/2HkUlmG; Lee, T (2017) *Balloon Navigation Breakthrough Helps Extend Cell Service In Puerto Rico,* available at https://bit.ly/2Hp56jS

498 Lant, K (2017) *Google's Internet-Beaming Balloons will Soon Be Floating Over Puerto Rico,* available at https://bit.ly/2xrTO8A; Greenemeier, L (2017) *Puerto Rico Looks to Alphabet's X Project Loon Balloons to Restore Cell Service,* available at https://bit.ly/2i7NKjS

499 Google launched ten balloons in Kenya during August 2017. Marvin, N (2017) *Google's Balloon-Powered High Speed Internet Now in Kenya*, available at https://bit.ly/2FaDfC5 .

500 FCC (2017) *FCC Grants Experimental License for Project Loon to Operate in Puerto Rico*, available at https://bit.ly/2HJRj7J; Hruska, J (2017) *Project Loon Gets Green Light To Deploy Over Puerto Rico*, available at https://bit.ly/2qUBC6h

501 Puerto Rico and the Virgin Islands reported hurricane-related outages of mobile base stations of 95.2% and 76.6%, respectively. FCC (2017) *Communications Status Report for Areas Impacted by Hurricane Maria September 21, 2017*, available at https://bit.ly/2DeNFUM

502 USGS (2017) *USGS Continues Response to Four Hurricanes,* available at https://on.doi.gov/2K9Pd2s

503 Mattise, N (2018) *Project Loon Team Gave Puerto Rico Connectivity- And Assembled A Helicopter*, available at https://bit.ly/2GqSTu2

504 LeFebvre, R (2017) *AT&T's 'Flying COW' Drone Provides Cell Service To Puerto Rico*, available https://engt.co/2h6PTbM

505 In November 2017, MNO AT&T's effort to provide relief coverage in Puerto Rico using drones was approved by the FCC. Wamsley, L (2017) *FAA Approves Drone As 'Cell Phone Tower In The Sky' For Puerto Rico*, available at https://n.pr/2zKZrUz

506 AT&T (2018) *Hurricane Maria: Response & Live Updates,* available at https://soc.att.com/2y3JM2e

air for up to 90 days[507] and using millimeter-wave technology for mobile connectivity.[508] While Facebook has estimated deployment is 2020 – 2022, details have been scant since its second successful short flight on May 22, 2017.[509] Challenges faced by Aquila include connectivity issues, the weight of batteries and day/night patterns which are dependent upon sun/stored power.[510]

#### 7.5.2.4 SpaceX

The plans for SpaceX satellite constellation 'Starlink', as recently approved by the FCC,[511] anticipates the launch of approximately 12,000 low and very low earth orbit (LEO and VLEO) satellites in a mesh network to provide universal broadband service and a near global infrastructure.[512] At present, SpaceX has been launching satellites for Iridium's global mobile voice and data satellite communications network.[513]

### 7.5.3 Terrestrial

#### 7.5.3.1 TIP and OpenCellular:

The Telecom Infra Project (TIP) is a collaborative telecom industry effort - financed primarily by Facebook, aiming - aiming to foster a more ambitious effort at innovation to address the demands of exponential growth of wireless use.[514] Founded early in 2016, the volunteer community is now a consortium of over 300 members comprising of many of the most globally prominent MNOs and leading technology providers.[515] Eleven working groups are divided into three primary sections of focus: (i) access, (ii) backhaul, and (iii) core and management.[516]

One group specifically impacting upon DFS and the underserved is OpenCellular, an open source wireless access platform and technology configurable base station designed for small budgets with minimal resources and rural deployment.[517] The equipment comes in three versions, 2G, LTE and software-defined radio (SDR). Some early proceeds of the group's efforts at solving rural infrastructure challenges include the release of a micro-LTE base station and an open source solar charge controller for power requirements.[518]

In 2018, TIP decided to distribute the initial production run of OpenCellular equipment via a grant program exclusively to non-profit organizations. Eleven organizations were selected during the first round, after which TIP opened a second round.

#### 7.5.3.2 Innovation in Antenna Technologies

The 'beam forming' technology of 5G is touted to improve mobile coverage by directing 5G signals in specific direction or to just one user and getting around obstructions such as walls or trees.[519] Similarly, MIMO (multiple

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507 Etherington, E (2017) *Facebook's Aquila Drone Completes Its Second Test Flight*, lands well this time, available at https://tcrn.ch/2F91ela

508 Tiwari, A (2016) *Facebook Demonstrates Record-Breaking Data Rate Using Millimeter-Wave Technology*, available at http://bit.ly/2vD6D4z

509 Etherington, E (2017) *Facebook's Aquila Drone Completes Its Second Test Flight, Lands Well This Time*, available at https://tcrn.ch/2F91ela .

510 Zuckerberg, M (2016) *The Technology Behind Aquila*, available at http://bit.ly/2HSPA3h

511 FCC (2018) *Memorandum Opinion, Order and Authorization,* available at https://bit.ly/2Gkpx4T

512 Hicks, M (2018) *Spacex's 'Starlink' Proposal Will Launch 12,000 Satellites For Total Worldwide Broadband Coverage,* available at https://bit.ly/2vDotnT

513 SpaceX (2018) *Iridium-5 NEXT Mission*, available at https://bit.ly/2JirGLy

514 Telecom infra Project (2018) *How We Work,* available at telecominfraproject.com/how-we-work/

515 Telecom Infra Project (2018) *Members*, available at telecominfraproject.com/members/

516 Telecom Infra Project (2018) *TIP project groups*, available at telecominfraproject.com/project-groups-2/

517 The platform is designed to address a range of mobile communications technology options, such as being able to be configured to use 2G, 3G and LTE. Ali, K (2016) *Introducing Opencellular: An Open Source Wireless Access Platform*, available at https://bit.ly/2FaDVr7

518 Ali, K (2017) *An Update from the OpenCellular Project Group – Telecom Infra Project,* available at https://bit.ly/2vJSv9o

519 Cheng, R (2018) *What is 5G? Here Are The Basics*, available at https://cnet.co/2nRYuC2

input, multiple output) technology of 5G contemplates placing more antennas in 5G phones and on mobile base stations to facilitate delivering higher speeds.[520]

#### 7.5.3.3 Low-power Mesh Base Stations for Rural Areas

A novel coverage solution is the Huawei's RuralStar 2.0 solution,[521] which extends mobile coverage to rural areas using low-power base station technology placed on wooden poles instead of metal towers. The base station is powered by just three solar panels.

Based on low-band non-line-of-site (NLOS) wireless backhaul technology,[522] it can provide coverage over a 2km radius. It also has a lower CAPEX as deployment needs minimal site preparation and only requires 12m poles instead of 40m towers, reducing infrastructure construction cost by 70%.[523]

By replacing microwave and satellite backhaul technology, each site is capable of running on less than 20W of power and provides over 70 Mbps of throughput.[524] It also uses both lithium and lead-acid battery which extends battery life from 2 years to 5 years.[525] Not requiring diesel generators, such as on traditional tower sites, can generate OPEX savings of up to USD 12k per site annually.[526]

### 7.5.4 Mobile Phone Innovations

#### 7.5.4.1 Hardware and System on a Chip

The emergence of system-on-a-chip (SOC)[527] technology for mobile handsets has substantially reduced the cost of smartphones to sub USD 100, often around USD 50 for entry-level smartphones. At this price point, feature phone users may find an acceptable value proposition and migrate to these low-end smartphones. Quality issues with low-cost smartphones sold in developing countries still remain however, primarily poor battery chemistry and poor-quality displays.[528]

Subsidies are also expected to partially defray the cost of smartphone purchases, such as those made available for refugees[529] and made possible by efforts of national government,[530] MNOs, NGOs, private enterprise and through microfinance products. Expansion and improvement of mobile coverage could stimulate additional demand in low-cost smartphones and attract investment in fostering hardware innovation and content creation.

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[520] For example, '4x4 MIMO' technology places four antennas in one phone.
[521] Huawei (2018) *Roads to New Growth,* available at https://bit.ly/2I8vMWp; Huawei (2018) *MTN Nigeria and Huawei Jointly Complete the Commercial Deployment of RuralStar 2.0,* available at https://bit.ly/2jKlHo7
[522] With NLOS, backhaul signals arrive at the receiver through different paths as they reflect and diffract off obstacles between the transmitter and receiver. New technologies using sub-frequencies the basis for NLOS, will effectively 'stich' these multiple signal components together, preventing the phenomenon known as Multipath fading. See further Wireless design mag (2018) *How Non-Line-of-Sight Backhaul Really Works,* available at https://bit.ly/2ry8emS
[523] Huawei (2018) *Roads to New Growth,* available at https://bit.ly/2I8vMWp
[524] *ibid*
[525] *ibid*
[526] *ibid*
[527] Perlman, L (2017) *Technology Inequality: Opportunities and Challenges for Mobile Financial Serv*ices, available at https://bit.ly/2r7NZNy
[528] *ibid.*
[529] Examples include funding from NGO NetHope to subsidize 20,000 feature phones and 1,050 smartphones for Bidi Bidi refugees, with a resulting cost of less than USD 3 per refugee. Casswell, J & Frydrych, J (2017) *Humanitarian Payment Digitisation: Focus On Uganda's Bidi Bidi Refugee Settlement*, available at https://bit.ly/2qT4BHC
[530] Argentina, Colombia, Malaysia and Pakistan have made substantial commitments towards the subsidization of smartphones for low-income persons. This includes Argentina's financing for 8 million smartphones to select persons to upgrade their 2G phones to 4G, and Pakistan's commitment to provide 30,000 smartphones to low-income women using the country's USF. See GSMA (2017) *Accelerating Affordable Smartphone Ownership In Emerging Markets*, available at https://bit.ly/2qVzgEr

#### 7.5.4.2 Operating Systems and Software

To ameliorate the challenges of using data-heavy smartphone apps, Google launched Android Go, a data-lite version of its Android OS. Go apps are optimized for performance on inexpensive 3G and higher smartphones which do not have access to 3G or higher mobile coverage and which are forced to use narrowband data speeds. [531] Go's lightweight apps and special file management tools are touted to reduce data consumption by 40% to enhance the UX on smartphones. Google announced Go compatible phones from eight leading hardware manufacturers in February 2018 at prices ranging from USD 50–130.[532] Google is currently releasing Go apps in 26 sub-Saharan countries.[533]

#### 7.5.4.3 Thin SIM Solutions

One method of compensation for restricted or unfavorable access to STK and USSD is to use what is known as 'Thin SIMs,' also known as 'Sticky SIMs.' Technically a SIM overlay technology, a Thin SIM is a paper-thin plastic sheet embedded with a number of contact points and a chip on top of a standard SIM card.[534]

Despite its form factor, it is a full-featured SIM:[535] once placed over a larger SIM, the Thin SIM essentially converts any handset into a dual-SIM phone.[536] The solution is device agnostic so it works with feature or smart phones. [537] It is also MNO-agnostic, so works with any MNO operator independent of the underlying SIM card. Switching between the networks is done either manually via the accompanying STK menu, or inputting a specific short code to do the selection.[538]

This technology is now in use in a number of countries for DFS purposes, but are as not yet in widespread use.[539] Kenyan MVNO Equitel – the telecommunications arm of Equity Bank – uses its Thin SIM to bypass market

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531 Bloomberg (2018) *Google's New App Speeds Up the Internet in Places Where It's the Slowest,* available at https://for.tn/2HBFIL ; Mobile World Live (2018) *Lightweight Google App Hits Sub-Saharan Africa,* available at https://bit.ly/2qUKEjK ; Kamdar, S (2017) *Introducing Android Oreo (Go Edition) With The Release Of Android 8.1*, available at https://bit.ly/2Iz9iO9 . Go is a successor to Google's Android One, a project which provides manufacturers with a bare version of Android which would perform well on modest, low-cost hardware. Launched in 2014, it is aimed at devices in developing markets. Milian, M (2014) *Google's Mobile Project in India Aims to Solve the China Problem*, available at https://bloom.bg/2HqTCfX , NDTV Gadgets360.com (2014) *Android One Was Conceived With India in Mind, Says Google's Sundar Pichai*, available at https://bit.ly/1wm43Wj

532 Rosenberg, J (2018) *In Case You Missed It: Android Announcements At Mobile World Congress*, available at https://bit.ly/2qqNBIV . For information about other Android Go phones, see Kastrenakes, J (2018) *Android Go Is Here To Fix Super Cheap Phones*, available at https://bit.ly/2HIwpJd ; ET Telecom (2018) *Airtel And Google Partner To Bring Android Go To Low-Cost 4G Smartphones*, available at https://bit.ly/2FaN0jM

533 Prinsloo, L and Thembisile, D (2018) *Google Releases New Africa App to Beat Slow Internet Speeds*, available at https://bloom.bg/2HIYblE .

534 The technology was developed in china by Shanghai-based tech company f-road in 2005, primarily as a mobile phone solution to support multi-operator access, designed to avoid roaming fees. Digitech and Taisys have in recent years developed their own technology. Taisys recently prevailed in a patent suit over the technology. See thereto, Perlman, L (2017) *Technology Inequality: Opportunities And Challenges For Mobile Financial Service*s, available at https://bit.Ly/2r7nzny

535 The Thin SIM supports GSMA/3GPP/ETSI standards, making it compatible with all standard devices from older feature phones to the latest smart phones. See thereto, *ibid.*

536 Users can then access services on both networks and having two SIM cards in one slot of the device means the user does not have to physically remove and exchange the SIM card when the user travels, eliminating the possibility of losing and misplacing the cards.

537 It also has a patented secure, encrypted SMS technology.

538 Invariably, the Thin SIM will listen out for a specific short code and if the short code belongs to a network supported by the Thin SIM, the traffic will be directed to the alternate network. On thin SIMs, see Perlman, L (2017) *Technology Inequality: Opportunities and Challenges for Mobile Financial Services*, available at https://bit.ly/2r7NZNy

539 A CGAP report identified only a few instances where Thin SIMs were being used because of competition-based issues with access to USSD and STK bearer channels. See Hanouch, M & Chen, G (2015) *Promoting Competition in Mobile Payments: The Role of USSD*, available at http://bit.ly/2ICyU09

behemoth Safaricom, using instead cheaper bearer services from Safaricom competitor Airtel.[540] In India, Yes Bank, India's fifth largest private sector bank, has also launched its own Thin SIM payments solution for feature phones.[541] The sticker installs a STK-based app linked to a prepaid wallet.

| **Impact on DFS: Innovation** |
|---|
| Innovation in mobile coverage which can be impacting upon the delivery of DFS will only include solutions which are directly compatible with existing consumer phones. Satellite-based services are likely to have little if any direct impact on DFS although they might improve mobile coverage as a backhaul provider. Balloon and drone-based efforts are being utilized in small experimental stages and far from mainstream, although they have shown to be useful in providing much needed DFS to those impacted by natural disasters and humanitarian crises.<br><br>SOC has reaped benefits for DFS by driving feature phone and smartphone prices down to levels which make subsidization a viable option as part of financial inclusion efforts. Google's Android Go, perhaps the first concerted effort by phone manufacturers towards bringing affordable smartphones to the poor and generate a better understanding and appreciation of what may be needed to migrate existing basic and feature phone users to smartphone technologies and DFS 2.0. |

## 8 CONCLUSIONS

Mobile coverage is the DNA of the mobile-centric DFS ecosystem. Any deficiencies in this coverage, be that the quality, range, degree, type and security thereof – will affect its viability and growth.

The ecosystem was founded and has shown sustained global growth in the developing world through the provision of a limited array of transactional 'DFS 1.0' services suited for use on basic and feature phones operating on slow, narrowband second generation mobile (2G) networks.[542]

However these 2G networks – predominant in rural areas in many part of the developing world - only allow non-intuitive, text-based DFS user interfaces, a handicap which often leads to transaction errors and failures, account inactivity, and account closure.[543]

Newer DFS 2.0-type services are available, but are best used on (data-hungry) smartphone applications that require 3G and higher speeds to provide a reasonable user experience.[544] Provision of 3G to catalyze the move to smartphone-centric DFS 2.0 is however characterized by both MNO and regulator inertia, the former through concerns over ROI, the latter through concerns on financially handicapping MNOs by peremptory broadband coverage mandates.

The overall result is that large parts of the developing world lack national broadband coverage and leave the DFS ecosystem not only in a state of evolutionary flux, but also buffeted by competition, security and quality of service challenges.

Of noticeable concern as the DFS ecosystem grows and new participants enter, is that access to the user interfaces/bearers available to 2G users – USSD and STK – are controlled by MNOs who may compete with these

[540] In the case of Equitel in Kenya, use of the shortcode *247# will divert the session to use the Airtel network.. See Equitel (2016) *Get Activated*, available at http://www.equitel.com/my-phone/get-activated
[541] Etcio (2016) *Yes Bank To Launch Sim Sleeve Payments Solution For Feature Phones*, available at https://Bit.Ly/23acqer
[542] See Section 1.2 Problem Statement
[543] See Section 3 Technologies Used to Access DFS
[544] *ibid*

new entrants in DFS provision, and who may attempt to stifle competition by denying access to these interfaces or controlling their quality of service. Where this has occurred, it has led to interventions by regulators and courts.[545]

USSD itself has innate security vulnerabilities, leading to concerns about the integrity of DFS transactions and safety and soundness of the DFS ecosystem.

For DFS purposes then, and at the very least based on predominant 2G coverage powering DFS transactions, each of the constituent components of mobile coverage should be improved to ensure adequate coverage range and quality of service to sustain a DFS user session, choice of service, at affordable cost, and ensuring the security of transaction.

While improvements in the range of mobile coverage and in the type/speed of that coverage requires significant opex and capex by MNOs, we assess that these improvements could be achieved through a number of means, such as:

- More efficient use of state-derived universal service funds for building out additional base stations and high-speed backhaul infrastructure to support this growth[546]
- Through regulatory mandates for universal broadband coverage when MNO licenses are renewed[547]
- Through technical and economic efficiencies presented by infrastructure or spectrum sharing between MNOs.[548]
- Through approval by regulators of the involvement of independent towercos to provide turnkey mobile infrastructure solutions.[549]
- Through regulators making available additional sub-800 MHz 'digital dividend' spectrum that facilitates extended range per base station and thus extended and additional rural coverage.[550]
- Through, when available beyond prototype stage and where approved by regulators, balloon-style and low earth orbit-based direct to consumer mobile coverage.[551]
- Through improving the approval process for base station infrastructure provision at national, regional and local levels.[552]
- Through tax holidays/breaks for provision of infrastructure in rural areas, particularly in the lowering or removal of *ad valorem*, VAT/GST or import duties on the import of network infrastructure for these areas, as well as on diesel fuel and solar panels to power the infrastructure.[553]

We assess though that forced use by regulators for licensees to use wholesale access networks – often run in part by state enterprises, and controversial in of themselves – may introduce significant market distortions by concentrating crucial provision of services in one provider.

We recognize that a shift to broadband at best, and improved – in quality and range of coverage – of 2G coverage is likely to be glacial, and highlight interim issues and potential solutions. Firstly, that the use of 2G - and the basic/feature phones that can only use 2G - means that USSD and STK are likely to persist as the primary UI for the majority of DFS users at least past 2020. This situation as noted above, raises significant concerns on the

[545] See Section 6 Competition & Quality of Service-related Implications
[546] See Section 7.2.1 Universal Service Funds
[547] See Section 7.2.2 Universal Broadband Service
[548] See Section 7.3 New Spectrum Provision For Use in DFS, and Section 7.4 on Infrastructure Sharing
[549] See Section 7.4.5 Third Party Provision: Tower and Infrastructure Companies
[550] See Section 7.3.2 Digital Dividend Improving Coverage Range
[551] See Section 7.5 Innovation in Mobile Coverage & Access Solutions
[552] See Section 7.4 Infrastructure Sharing
[553] See Section 7.4 Infrastructure Sharing

potential for anticompetitive behavior by incumbents who control these UI/bearers to the detriment of DFSPs who need them and their customers who would use them.[554]

Regulators with remit over DFS and these bearer channels then not only need to be more conscious of potential abuses, but need to practice less forbearance by:

- Acting against these abuses
- Prohibiting identifiable abuses in regulations and if needed,
- Adding competition related competencies to their remits to enforce such prohibitions on abuse.

There are also other, softer and market-generated solutions to these coverage type and quality conundrums. For example, the introduction of data-lite smartphones and DFS apps that are for use in narrowband 2G environments. Similarly, thin SIM technology provides an alternative access mechanism for DFSPs who are unable to use the bearers of MNOs with significant market power.[555]

The universe of issues and potential solutions related to mobile coverage and the implications for DFS provision is described in Exhibit 1.

[554] See Section 6 Competition & Quality of Service-related Implications
[555] See Section 7.5.4.3 on Thin SIMs

**Annex A: Country Focus: India**

**Telecom Policy.** The Department of Telecommunications (DoT) is a department within the India Ministry of Communications, which is the communications part of the executive branch in the Government of India.[556] The DoT develops and promotes policy, standards and investment concerning telecommunications services as well as handling spectrum management.[557]

**Telecom Regulator.** The Telecom Regulatory Authority of India (TRAI) was established under the Telecom Regulatory Authority of India Act, 1997[558] as the independent regulator of telecommunications services and also reviews and sets telecommunications tariffs. It is set to be renamed the 'Digital Communications Regulatory Authority of India.' Its main objectives include managing the marketplace environment to ensure promotion of fair competition, which it accomplishes through periodic regulations, orders and directives. TRAI also handles issues concerning interconnects and quality of service, with adjudication of disputes involving MNOs and consumers through the Telecommunications Dispute Settlement and Appellate Tribunal (TDSAT).[559] TRAI's assistance with complaints to be addressed first by a toll free Call Centre listed at every MNO.[560]

**Central Bank.** The Reserve Bank of India (RBI) is India's central bank and governs the DFS sector in addition to performing its expected roles. The RBI Guidelines makes DFS possible through the licensing of 'payment banks' in 2014,[561] which are limited purpose financial institutions able to provide deposits, withdrawals, domestic remittances and debit card operations but excludes the provision of debt or credit products and services.[562]

**Mobile Network Operators.** A dozen competing MNOs just a few years ago has been reduced to four,[563] possibly completing a trend of mass industry consolidation. Reasons for the MNO shakeout include fierce competition and massive debt from spectrum purchases.[564] The consolidation will likely lead to less discounts for consumers and potentially impact upon towercos who would likely see lower tenancy rates from fewer MNOs, reduced revenues and fewer needed mobile base stations given a likely service overlap resulting from the consolidation.[565]

**Competition Issues.** India faced a prolonged period of fierce and unusual consumer price wars. Notable was the offer of six months of free voice and data followed by a highly aggressive pricing plan from Reliance Jio Infocomm Ltd., a new MNO entry backed by an India's wealthiest man.[566]

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[556] Government of India (2018) *Functions of DoT,* available at www.dot.gov.in/objectives
[557] *ibid*
[558] Government of India (2018) *Telecom Regulatory Authority of India (TRAI) Act, 1997*, available at www.dot.gov.in/actrules/telecom-regulatory-authority-indiatrai-act-1997
[559] TRAI (2018) *History*, available at www.trai.gov.in/about-us/history
[560] As per the Telecom Consumers Protection and Redressal of Grievances Regulations, 2007. TRAI (2018) *Complaint*, available at www.trai.gov.in/faqcategory/complaint
[561] RBI (2014) *Guidelines for Licensing of 'Payments Banks'*, available at https://bit.ly/2FOAoPG
[562] Summary of the RBI Guidelines is contained in the RBI's press release. RBI (2014) *RBI releases Guidelines for Licensing of Payments Banks*, available at https://bit.ly/11xnTDR, GSMA (2016) *The business case for payments banks in India*, available at https://bit.ly/2ro0p3J, The Economic Times (2018) *Definition of Payments Banks*, available at economictimes.indiatimes.com/definition/Payments-banks
[563] The four remaining operators are anticipated to be Airtel, Reliance Jio, the Vodafone-Idea merger and the state-owned Bharat Sanchar Nigam Limited (BSNL) and MTNL merger. Jayaram, A (2018) *With Aircel filing for bankruptcy, consolidation in the Indian telecom sector is almost over*, available at https://bit.ly/2rosCaSl, *The Hindu Business Line (2017) Consolidation: good for telecom industry, better service for customers*, available at https://bit.ly/2HV5wTw
[564] GSMA (2016) *The Mobile Economy – India 2016*, available at https://bit.ly/2hCdGQY
[565] The Hindu Business Line (2017) *Consolidation: good for telecom industry, better service for customers*, available at https://bit.ly/2HV5wTw
[566] Stacey, K (2017) *Financial Times India's Reliance to start charging for data services*, available at www.ft.com/content/e9f37a44-f814-11e6-9516-2d969e0d3b65, *Reuters* (2017) *Indian regulator says Reliance Jio telecom*

**CIV and Compliance.** India has implemented Aadhaar, a national biometric electronic ID and eKYC[567] identification system managed by the Unique Identification Authority of India (UIDAI), which up until a court ruling in September 2018 that significantly curtailed its use,[568] could be used as proof of identity for DFS, bank account and SIM registration and use.[569] It can now only be used for identification for government-facing services. An estimated 94% of the population has been enrolled and the program and the world's largest and most comprehensive to date.[570] It is part of the 'JAM Trinity'[571] representing the government's goal to link every citizen's bank account number, mobile number with Aadhar number for better financial inclusion policy.[572]

**Mobile Penetration.** India passed the US in October 2017 to become the world's second largest smartphone market[573] and became the world's second largest market of unique users subscribed to mobile services.[574] The country's mobile phone subscriber base exceeded 1 billion users in 2017, with over 300 million owning smartphones.[575] TRAI's latest press release puts total wireless subscribers at 1.2 billion with 499 million residing in rural areas and 345 million mobile broadband subscribers in total.[576]

**Spectrum Management.** The DoT develops, promotes and allocates spectrum policy and TRAI provides expertise and may make recommendations, such as pricing and analysis. While India raised almost $10 billion from its previous spectrum auction in 2016, 60% of the frequencies were left unsold, especially the 700 MHz and 900 MHz bands, which had no bidders. Speculation about the failure included excessively high pricing as recommended by TRAI as a result of a misinterpretation of the market. MNOs were highly leveraged from previous spectrum purchases as well as being under substantial strain from aggressive price wars which intensified with the presence of Reliance Jio and its free and low-priced plans.[577] TRAI released a consultation paper on the auction of available

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*offers not anti-Competitive*, available at https://reut.rs/2KIj7Lx 'To achieve this, Mr Ambani has spent an incredible $25bn on Jio, without making a rupee of profit, terrifying competitors and many investors.' The Economist (2017) *Mukesh Ambani has made the business world's most aggressive bet*, available at www.economist.com/news/business/21718495-jios-100m-new-customers-cost-cool-25bn-acquire-mukesh-ambani-has-made-business-worlds

567 For an overview of eKYC implementations worldwide, see Perlman, L & Gurung, N (2018) *Focus Note: The Use of eIDs and eKYC for Customer Identity and Verification in Developing Countries: Progress and Challenges*, available at www.dfsobservatory.com

568 The September 2018 ruling by the Supreme Court confirmed the constitutional validity of Aadhaar and emphasized that it does not violate the right to privacy of individuals. But while the Court allowed some government-facing uses such as tax filing, it prohibited the mandatory use of Aadhaar for bank CIV and registration for SIM cards. Financial and telecommunications providers have now reverted to use of the physical Aadhaar card for basic, visual-only identification of the holder, since they now do not have the ability to undertake any additional electronic verification. For Supreme Court of India judgment, see https://bit.ly/2OM50Gx; Livemint (2018) *Supreme Court Verdict on Aadhaar: Constitutionally valid, doesn't violate privacy,* available at https://bit.ly/2CKBDlT

569 Wilson, M (2017) *GSMA's case study on Aadhaar: a digital identity programme that is inclusive by design*, available at https://bit.ly/2Ij6isD

570 Wilson, M (2017) *GSMA's case study on Aadhaar: a digital identity programme that is inclusive by design*, available at https://bit.ly/2Ij6isD

571 'JAM' represents the first letters of words Jan-Dhan Yojana, Aadhaar and Mobile Telephony, as described above. GSMA (2017) *Aadhaar: Inclusive by Design*, available at https://bit.ly/2ADEDya

572 TRAI (2016) *Consultation Paper on the review of regulatory framework for the use of USSD for mobile financial services*, available at https://bit.ly/2Sx65od

573 Russell, J (2017) *India overtakes the US to become the world's second largest smartphone market*, available at https://tcrn.ch/2SBOiMq

574 GSMA (2016) *The Mobile Economy – India 2016*, available at https://bit.ly/2hCdGQY

575 ETtech (2017) *India to lead as global mobile penetration set to hit 70% by 2022: Report - ETtech*, available at https://bit.ly/2Rtff3M

576 TRAI (2018) *Press Release No.23/2018*, available at https://bit.ly/2FOnt4f

577 Iyengar, R (2016) *Why India's 4G license auction was a flop*, available at https://cnnmon.ie/2PuLTER; Mukul, P (2016) *700Mhz Auction: The other side of the spectrum*, available at https://bit.ly/2CUsPcn, GSMA (2016) *There are lessons to be*

spectrum in 2017.[578] Government plans are to conduct an auction of 3,000 MHz in 2018 and are awaiting further comment from TRAI.[579] Some industry groups and members have suggested the delay of spectrum auctions until the MNO consolidation is complete and the industry settles.[580]

**The Digital Dividend and DTT.** TRAI recommends a multiphase plan for the analog to digital switchover to be completed by 2023.[581]

**National Broadband Strategy.** Year-end 2016, 92% of India's 236 million broadband subscribers received services through wireless access. Under the Broadband Policy of 2004, broadband was initially defined as 256 kbps download speed.[582] The country is seeking to update its four major policies imminently as TRAI seeks input for its National Telecom Policy of 2018.[583]

**Universal Service.** India's Universal Service Obligations Fund (USOF) was established pursuant to the Indian Telegraph (Amendment) Act, 2003[584] to '[p]rovide widespread and non-discriminatory access to quality ICT services at affordable prices to all people in rural and remote areas.[585] The TRAI's 'Universal Service Levy' recommendation of 5% of adjusted gross revenue earned by telecom service providers, which is treated as part of an operator's license fee,[586] currently remains in effect. Addressing telecom market difficulties in 2017, TRAI has recommended a reduction in the levy to 3%.[587] The USOF balance has grown exponentially since it was funded in 2002,[588] disbursing 13% of the fund's 2017 balance.[589]

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*learnt from India's 700 MHz auction*, available at https://bit.ly/2EV3i5x; Aulakh, G (2016) *Overpriced 700 MHz saw government miss auction target*, available at ehttps://bit.ly/2SAMUK0; Mobile World Live (2018) *India plans largest ever spectrum sale*, available at https://bit.ly/2zf3VAG

[578] TRAI (2017) Consultation Paper on Auction of Spectrum in 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300-3400 MHz and 3400-3600 MHz bands, TRAI, available at https://www.trai.gov.in/sites/default/files/Spectrum_CP_28082017.pdf

[579] Bushell-Embling, D (2018) *India aims to auction over 3,000MHz of spectrum*, available at https://bit.ly/2HUBIWR, Mobile World Live (2018) *India plans largest ever spectrum sale*, available at https://bit.ly/2FU8VvM /

[580] Sen, S (2017) *Telecom sector not ready for spectrum auction till 2019: COAI*, available at https://bit.ly/2JYOArM, Parbat, K (2018) *Telcos want government to postpone 5G spectrum auctions till FY20*, available at https://bit.ly/2K0w0iQ

[581] TRAI (2017) *Recommendations On Issues related to Digital Terrestrial Broadcasting in India*, available at https://bit.ly/2PAzmiU

[582] Under the Broadband Policy of 2004, the full definition of broadband is '[a]n 'always-on' data connection that is able to support interactive services including Internet access and has the capability of the minimum download speed of 256 kilobits per second (kbps) to an individual subscriber from the Point of Presence (POP) of the service
Provider intending to provide broadband service where multiple such individual broadband connections are aggregated and the subscriber is able to access these interactive services including the Internet through this POP.'

[583] TRAI (2018) Inputs for Formulation of National Telecom Policy - 2018, available at https://www.trai.gov.in/sites/default/files/Recommendation_NTP_2018_02022018.pdf

[584] Section 9A in Ministry of Law and Justice (2004) *The Indian Telegraph (Amendment) Act, 2003,* available at https://bit.ly/2qmocAr

[585] Government of India (2018) *Welcome to USOF*, available at usof.gov.in/usof-cms/home.jsp

[586] TRAI (2002) *Recommendations of the TRAI on Universal Service Obligations*, available at http://www.trai.gov.in/sites/default/files/15m.pdf

[587] Aulakh, G (2017) *Trai recommends cut in USOF, SUC and 5% GST for telcos - ET Telecom*, available at telecom.economictimes.indiatimes.com/news/trai-recommends-cut-in-usof-suc-and-5-gst-for-telcos/59384909

[588] USOF balance at end of 2003 was 1353.61 Indian Rupees, currently at 48396.80 in 2018. Government of India (2018) *Universal Service Obligation Fund - Fund Status in Table*, available at usof.gov.in/usof-cms/usof-fund-status-table.jsp

[589] In 2017, 13% of the annual USOF balance (7227.03 of 55556.25 Indian Rupees) was spent. *ibid*

## ANNEX B: COUNTRY FOCUS: UGANDA

**Telecom Policy.** Uganda Ministry of Information and Communications Technology (ICT) is responsible to promote, coordinate, 'support and advocacy matters of policy, laws and regulations and strategy for the ICT sector.'[590] It is mandated to develop and promote ICT policies, manage, coordinate and implement ICT infrastructure in Uganda, and regulate and perform quality assurance of ICT information.[591]

**Telecom Regulator.** The Uganda Communications Commission (UCC),[592] the country's independent telecom regulator, is established pursuant to the Uganda Communications Act of 1997,[593] 2000[594] and 2013.[595] Its primary mandate is to regulate telecommunications, broadcasting, radio communication, postal communications, data communications and infrastructure. The UCC also administrates the Rural Communications Development Fund (the country's universal service fund), the Uganda Institute of Communications & Technology (the country's ICT training center),[596] and manages consumer affairs[597] including dispute resolution.[598] Under Sec. 5 of the Communications Act 2013 the UCC manages spectrum resources including planning, allocation and assignment.[599]

Note also the Telecommunications Regulations of 2005[600] and the Regulation of Interception of Communication Act of 2010[601] as well as the basic establishment of Ugandan government.

**Central Bank.** The Bank of Uganda (BoU) is 'responsible for monetary policy and maintaining price stability'[602] and are responsible for issuing the Mobile Money Guidelines.[603]

**Mobile Network Operators and DFS.** The Uganda mobile communications and mobile money market consists of a duopoly.[604] Market incumbents, MTN and Airtel, service over 90% of the mobile subscribers in a market of seven MNOs,[605] of which two have sought bankruptcy protection in the past year. Price wars of the past several years

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590 Ministry of ICT & National Guidance, Government of Uganda (2018), *Policy*, available at https://www.ict.go.ug/policy; Ministry of ICT & National Guidance, Government of Uganda (2018), *Background*, available at https://www.ict.go.ug/ict/background

591 Ministry of ICT & National Guidance, Government of Uganda (2018), *Ministry of Information and Communications Technology*, available at https://bit.ly/2OiNqJs

592 UCC (2018) *UCC: Uganda Communications Commission*, available at https://www.ucc.co.ug/.

593 UCC (2018) *The Uganda Communications Act, 1997*, available at http://www.itu.int/ITU-D/ict/webs/ucc/uca1997.pdf

594 Uganda Legal Information Institute (2018) *Uganda Communications Act 2000, Chapter 106*, available at ulii.org/ug/legislation/consolidated-act/106 .

595 UCC (2018), *The Uganda Communications Act, 2013*, available at https://bit.ly/2SDSRpR

596 UCC (2018) *About UCC*, available at http://www.ucc.co.ug/about-ucc

597 Pursuant to the UCC Act, Section 5 (i) and (m), the UCC manages consumer affairs matters. UCC (2018) *Consumer Affairs*, available at https://www.ucc.co.ug/consumer-affairs /

598 UCC (2018) *Consumer Rights*, available at https://www.ucc.co.ug/consumer-rights/

599 UCC (2018) *Spectrum*, available at https:// www.ucc.co.ug/spectrum/

600 Uganda Legal Information Institute (2005) *Communications (Telecommunications and Radio Communications Equipment Type Approval) Regulations, 2005*, available at https://ulii.org/ug/legislation/statutory-instrument/2005/200522

601 Uganda Legal Information Institute (2010) *Regulation of Interception of Communication Act, 2010*, available at https://ulii.org/ug/legislation/act/2015/18-2

602 Bank of Uganda (2018) *About the Bank*, available at https://www.bou.or.ug/bou/about/who_we_are.html

603 Bank of Uganda (2018) *Mobile Money Guidelines 2013*, available at https://bit.ly/2CXaonx

604 UCC (2017) *Public Consultation Document – Support to the Uganda Communications Commission on USSD and SMS Services*, available at https://bit.ly/2KbRXg3

605 At present, the seven MNOs in Uganda are: MTN Uganda, Bharti Airtel Uganda, Uganda Telecom, Africell, Vodafone, Smart Telecom (Sure Telecom), Smile Telecom and one MVNO, K2 Telecom. Khisa, I (2018) *Uganda's telecom market too small for seven players?*, available at https://bit.ly/2PBHwHW

have taken their toll on the industry with further consolidation predicted by some to be likely.[606] The market incumbents also account for the overwhelming majority of mobile money agents, with MTN accounting for 57% and Airtel 42% as of the third quarter of 2016.[607] 40% of the adult population have active mobile money accounts.[608]

**Competition Issues.** Uganda does not have an independent competition regulator[609] apart from the UCC and the BoU.[610] However, the Uganda Communications Act and other sectoral laws does contain competition clauses which promote fair practices and foster innovation and has the authority to regulate anti-competitive behavior in the marketplace.

In 2017, a study was commission by the Uganda Communications Commission which reported that the marketplace suffered from anti-competitive problems with a 'history of excessive pricing and exclusionary behavior' by incumbent MNOs. A duopoly exists in Uganda,[611] with each of MTN and Airtel having at least 40% market share for both telecommunications and mobile money services.[612] Some observations contained within the study include:

- The cost of Uganda's USSD short code allocation fees are substantial higher as compared to other countries within the region, USSD charges are higher and for shorter time billing intervals and prevention of zero-rating by DFS and value added service providers for USSD and SMS..
- MTN Uganda denied services / refused to supply or activate USSD services to DFS providers on the basis of being direct competitors.[613]
- USSD may take an excessive time to activate by MNOs.
- MNOs MTN and Airtel control virtually the entire network of mobile money agents.[614]
- MNO unilateral renegotiation of contract terms at any time and within its favor.

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606 TowerXchange (2017) *Towerxchange's Analysis Of The Independent Market In Africa And The Middle East*, available at https://goo.gl/aZ7KsH. See also Muhumuza, M K and Semakula, O (2015) *Price wars: Telecoms are likely to bleed*, available at http://bit.ly/2HWpeLn . MTN reported In 2017 that it has 55% market share. Kamukama, E (2017) *Telecoms scramble for subscribers*, available at http://bit.ly/2HJOUND

607 Uganda Business News (2016) *Airtel's share of mobile money agents grows, but still behind MTN*, available at http://bit.ly/2HnCzPP

608 GSMA (2017) *The Mobile Economy – Sub-Saharan Africa*, available at http://bit.ly/2vGFXzQ

609 The competition regulator is often referred to as a 'competition authority.' For more information about mobile coverage and DFS regulators, see Section 4.

610 Adengo, J (2016) Why Uganda needs a competition law, available at http://bit.ly/2Hsf2t4 . See also UCC (2017) *Public Consultation Document – Support to the Uganda Communications Commission on USSD and SMS Services*, available at https://bit.ly/2KbRXg3 .

611 UCC (2017) *Public Consultation Document – Support to the Uganda Communications Commission on USSD and SMS Services*, available at https://bit.ly/2KbRXg3 .

612 MTN has reportedly 55% market share. Kamukama, E (2017) *Telecoms scramble for subscribers*, available at http://bit.ly/2Fh0Z7O . *See also Public Consultation Document – Support to the Uganda Communications Commission on USSD and SMS Services*, available at https://bit.ly/2KbRXg3 .

613 Ezee Money Uganda, a competing mobile money provider, sued MTN Uganda for unfair restriction of competition under the Uganda Communications Act after the MNO required a third-party aggregator and agency service provider to deny service. Ezee Money was awarded substantial and punitive damages for malicious conduct. The East African (2015) *Ugandan Court Penalises MTN for Malicious Business Conduct*, available at http://bit.ly/2JnS4Uj. Okwii, D (2015) *What Ezee Money Vs. MTN Uganda Court Case Teaches Us about Competition in Uganda*, available at http://bit.ly/2vI6OLF

614 Uganda Business (2016) *Airtel's Share of Mobile Money Agents Grows, but Still behind MTN*, available at http://bit.ly/2HnCzPP

**KYC and Compliance.** In March 2007 and pursuant to an effort to fight crime and enforce AML/CFT requirements,[615] the UCC issued a mandatory order for MNOs to terminate services for unregistered, unverified or partially verified SIM cards.[616] Almost 3.7milllion SIM cards were not registered by the deadline.[617]

**Mobile Penetration.** Mobile penetration and active mobile broadband subscriptions are also among the lowest in Africa.[618] Unique subscribers total 17 million with 41% penetration[619] contrasting with 47% subscriber penetration in 2016 with 21% smartphone adoption. [620]

**Spectrum Management.** The Ministry of ICT develops the National Broadband Strategy and overall spectrum policy with the UCC providing spectrum management.[621] Frequency bands in use in Uganda include the following:[622]

- 2G: 900 (E-GSM), 1800 (DCS)
- 3G: B1 (2100)
- 4G LTE: B20 (800 DD), B7 (2600), B38 (TD 2600)

The Digital Dividend and DTT. After missing the ITU digital television transition (DTT) switchover deadline on June 17 2015,[623] Uganda completed its migration in November 2015.[624]

**Spectrum.** As per the National Broadband Strategy, the spectrum released from the migration of UHF television (The digital dividend) is intended to be used for mobile broadband services.[625]

**National Broadband Strategy.** Uganda's definition of 'broadband' as defined under its national broadband strategy whose goals are to be reached by 2020 constitutes 'a robust connectivity that is affordable, always on and delivers a minimum of 3Mbps to the user for applications, content and services.'[626] No specific distinction is made between fixed line and mobile broadband.

**Universal Service.** Pursuant to the Uganda Communications Act, 1997, the Rural Communications Development Fund (RCDF) was established in 2002, began operation in 2003[627] and administered by the Uganda

[615] Mpagi, C M (2017) *Uganda to switch off two million Sim cards*, available at http://bit.ly/2HpPMU7
[616] Muhumuza, M K (2015) *Uganda: MTN Uganda Disconnects Unregistered SIM Cards to Avoid Hefty Fine*, available at http://allafrica.com/stories/201511190931.html.
[617] Mpagi, C M (2017) *Uganda to switch off two million Sim cards*, available at https://prn.to/2HpL5hd
[618] The Uganda Ministry of ICT & National Guidance estimates only 18% of inhabitants have an active mobile broadband subscription. The Republic of Uganda, Ministry of ICT & National Guidance, (2017) *Overview of the Digital Uganda Vision*'. 20 July 2017, available at https://bit.ly/2P3WtD4; The GSMA reports 45% 3G Coverage (percentage of population), 68% connections (percentage of penetration) 16% mobile broadband connections (percent penetration). *See* GSMA (2018) *GSMA Mobile Connectivity Index 2018*, available at https://bit.ly/2HW2laS
[619] GSMA (2017) *The Mobile Economy – Sub-Saharan Africa*, available at http://bit.ly/2vGFXzQ
[620] *ibid*
[621] UCC (2017) *National Spectrum Management Policy Uganda (Draft), Ministry of Information Communications Technology & National Guidance, Section 1.1*, available at http://bit.ly/2JnUMJy
[622] Source GSM Arena and FrequencyCheck. See 'Network coverage in Uganda'. GSMArena, available at https://www.gsmarena.com/network-bands.php3?sCountry=Uganda . See also 'Uganda Wireless Frequency Bands and Carriers'. FrequencyCheck, available at https://www.frequencycheck.com/countries/uganda.
[623] Khisa, I (2015) *Blackout as Kampala switches to digital TV*, available at http://bit.ly/2KdQrKk
[624] Musisi, F (2015) *Uganda set to fully implement digital migration, says UCC*, available at http://bit.ly/2FeN5mj
[625] Ministry of Information and Communications Technology (2015) *The National Broadband Strategy for Uganda (2016 – 2020)* , available at http://bit.ly/2HL9OMo
[626] Ministry of Information and Communications Technology (2015) *The National Broadband Strategy for Uganda (2016 – 2020)*, available at http://bit.ly/2HL9OMo
[627] GSMA (2014) *Sub-Saharan Africa - Universal Service Fund study*, available at http://bit.ly/2HoxzdF

Communications Commission (UCC).[628] The broadly defined objectives of the fund (and its administration by the UCC) were expanded in the Uganda Communications Act, 2013 to include ICT, and which are generally 'establishing and administering a fund for the development of rural communications and information and communications technology in the country.'[629]

The UCC originally imposed a levy of 1% upon MNOs representing RCDF contributions which was later raised to 2% in 2013.[630] [631]

But the levy has been subject of a lawsuit[632] to prevent government from diverting half of the RCDF contribution away from the telecom regulator and into a 'consolidated fund' for general usage.[633] 50% of the amount levied from the USF is currently designated and ring fenced for accomplishing rural communications development.[634]

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628 'RCDF Operational Guidelines 2017/18–2021/22 (RCDF III)'. Uganda Communications Commission, available at, http://www.ucc.co.ug/rcdf/

629 For the establishment of the RCDF, its administration by the UCC and power vested in it to set a levy for RCDF contributions, see the following Sections, respectively: Sections 3(g), 5(aa) and 6(e) of the Uganda Communications Act, 1997 (UCC (1997) *The Uganda Communications Act, 1997*, available at http://www.itu.int/ITU-D/ict/webs/ucc/uca1997.pdf ) and Sections 3 (g), 5(s) and 68 of the Uganda Communications Act, 2013. See UCC (2013) *The Uganda Communications Act, 2013*, available at http://bit.ly/2L1iZac

630 The UCC levy of 1% for RCDF contributions was raised to 2% by the Uganda Communications Commission pursuant to the powers vested in it originally under Section 6(e) of The Uganda Communications Act, 2013 Section 68. *See* UCC (2017) *The Uganda Communications Act, 2013 – New License Framework, Fees and Fines*, available at http://bit.ly/2GgFHay

631 MTN paid 2% in 2014 and contributed UGX. 16 Billion to the Uganda Communications Commission Rural Communications Development Fund (RCDF). See MTN (2014), *About MTN*, available at http://bit.ly/2Jn2wvb. The RCDF was originally set at 1% of gross revenues of operators, with a ceiling at 2.5% pursuant to the Uganda Communications Act, 1997. ITU (2004) Licensing the era of liberalization and convergence, available at http://bit.ly/2wAvI0i

632 Host Net Uganda Limited petitioned the Constitutional court to enjoin the Cabinet's decision to have money collected from communications companies pursuant to the universal service fund remitted to the consolidated fund. The argument against the diversion is that the money collected is earmarked for ICT-based objectives. Kiyonga, D (2014) *Govt sued over ICT money*, available at http://bit.ly/2Fbu6cl

633 Office of the Auditor General (2016) *Report of the Auditor General on the Financial Statements of the Uganda Communications Commission for the Financial Year Ended 30th June 2015*, available at http://bit.ly/2KcRdqI

634 UCC (2017) *RCDF Policy 2017/18-2021/22 (RCDF III)*, available at http://bit.ly/2JnM6D8

## ANNEX C: UNIVERSAL SERVICE FUND POLICIES AND USE

The following represents a sample of USF policies from DFS countries.

**Kenya:** The Kenya Communications (Amendment) Act, 2009, establishes the Kenya 'Universal Service Fund'[635] which authorizes the Communications Authority of Kenya, the regulatory authority for communications, as manager and administrator.[636] The purposes of the fund are to 'support widespread access to ICT services, promote capacity building and innovation in ICT services in the country.'[637] A levy of 0.05% of a telecom licensees annual gross revenue is imposed[638] and is anticipated to close universal service gaps for voice within 10 years and data within 47 years.[639]

The fund began collection in 2013 but has met with objection by telecom operators and the regulator as (i) there was no provision in the Kenya Information and Communications (Amendment) Act of 2013 defining a role for industry stakeholders the fund's management and its Universal Service Advisory Council (USAC);[640] (ii) want to amend the indefinite duration of the USF to end once its purposes is completed;[641] and (iii) have objection to the Kenyan President's mandate to use Sh1 billion for disbursement to aid the country's cyber-security efforts and which falls outside of the USF's purpose.[642]

**Malaysia:** The 'Universal Service Provision' (USP) is the country's universal service initiative with stated objectives as (quote): (i) Provide collective and individual access to communications in underserved areas and to underserved groups; (ii) Encourage the use of ICT to build a knowledge-based society; (iii) Contribute towards the socio-economic development of local communities; (iv) Bridge the digital divide. [643] It also includes ten essential universal service provisions including expansion of over 1,000 new communication towers to provide 2G and 3G mobile coverage in areas with poor or non-existent coverage, add mobile broadband coverage for 3G and 4G LTE into underserved areas, a smart device initiative to lower smartphone prices if consumers purchase a one year mobile Internet subscription.[644] The USP is managed by the telecom regulator, the Malaysian Communications and Multimedia Commission.[645] 'Regulation 27 of the USP Regulations requires all licensees (Except for Content Applications Services Provider (CASP) license holder), whose weighted net revenue derived from the designated services exceeds minimum revenue threshold of RM2 million in a calendar year to contribute 6% of the weighted net revenue to the USP Fund.'[646] Disbursement of funds for 2016 was 123% of the amount contributed to the USP, for the first time exceeding the amount collected for the present year.[647] Notable achievements included the Commission building 1,402 new communication towers and upgrading 2,050 existing towers under the Mobile Broadband Coverage Expansion initiative, increasing the national broadband penetration rate to 81.5%.[648]

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[635] Communication Authority of Kenya (2018) *Purpose of the Fund*, available at https://bit.ly/2HtgV8V
[636] *ibid*
[637] *ibid*. For full list of objectives, Communications Authority of Kenya (2018) *Universal Service Fund Framework*, available at https://bit.ly/2j0kc8u
[638] Communications Authority of Kenya (2018) *Universal Service Fund Framework*, available at https://bit.ly/2j0kc8u
[639] *ibid*
[640] Wanjiku, R (2014) *Kenya starts Universal Service Fund implementation*, available at https://bit.ly/2HrB1jR
[641] Communications Authority of Kenya (2018) *Universal Service Fund Framework*, available at https://bit.ly/2j0kc8u
[642] Mukinda, F (2018) *Uhuru's order piles pressure on CA boss Wangusi*, available at https://bit.ly/2vHxiNl
[643] Malaysian Communications and Multimedia Commission (2018) *Universal Service Provision*, available at www.mcmc.gov.my/sectors/universal-service-provision
[644] *ibid*
[645] *ibid*
[646] Malaysian Communications and Multimedia Commission (2016) *Annual Report Universal Service Provision 2015*, available at http://bit.ly/2jKs0bp
[647] *ibid*
[648] *ibid*

**Rwanda:** The Presidential Order of 05/01 of 13/03/2004[649] established the Universal Access Fund (UAF). The UAF is an administrative entity which is managed and administered by the ICT regulator, the Regulatory Board of the Regulatory Authority,[650] which determines the rate of the contribution for the UAF. Per the ITU, the fund has received numerous grants from donors and primarily the World Bank, which formed 68% of the total contributions as of 2009.[651] The amount payable by 'public operators' (telecommunications networks open to the public) shall not exceed 2.5% of gross annual revenues net of interconnection payments from all operators, is set by the Board annually,[652] and is current at 2%.[653]
There is little information about how the funding was spent although it can be surmised that some might have been spent on the launch of its public-private partnership launching an LTE open access network. Korea Telecom Rwanda Networks (KTRN)[654] is the 51% privately owned and 49% government owned provider, which states plans to provide universal broadband access.[655] The joint venture was established in 2013 and is reported to have covered 95% of Rwanda at the end of 2017.[656] The GSMA has deemed this of limited success to date,[657] which points out some of the shortcomings of certain open access networks, such as the relatively flat pricing in Rwanda since its rollout.[658]

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649 RURA (2003) *Presidential Order No. 05/01 of 12/03/2004 determining the functioning of the universal access fund and public operator's contributions*, available at http://www.rura.rw/uploads/media/pl05.pdf
650 The Regulatory Board of the Regulatory Authority (RURA) is 'a legal entity created by Law Nº 09/2013 of 01/03/2013… with the mission to regulate certain public utilities, namely: telecommunications network and/or Telecommunications services, energy, water, sanitation, media and postal services and transport of goods and persons. RURA (2017) *RURA Service Charter*, available at https://bit.ly/2HLG4Pm
651 ITU (2013) *Universal service funds and digital inclusion for all*, available at http://bit.ly/2jGXnDt
652 RURA (2003) *Presidential Order No. 05/01 of 12/03/2004 determining the functioning of the universal access fund and public operator's contributions*, available at http://www.rura.rw/uploads/media/pl05.pdf
653 GMSA (2014) *Sub-Saharan Africa- Universal Service Fund study,* available at https://www.gsma.com/publicpolicy/wp-content/uploads/2012/03/Sub-Saharan_Africa_USF-Full_Report-English.pdf, ITU (2013) *Universal service funds and digital inclusion for all*, available at https://www.itu.int/dms_pub/itu-d/opb/pref/D-PREF-EF.SERV_FUND-2013-PDF-E.pdf
654 Rwanda Networks (2018) *Rwanda Networks,* available at https://www.ktrn.rw/
655 For information about universal broadband access, see Section 7.2.2.
656 Tumwebaze, P (2018) *4G internet network coverage reaches all districts –KT Rwanda,* available at http://www.newtimes.co.rw/Section/read/226815/
657 GMSA (2017) *Wholesale Open Access Networks,* available at http://bit.ly/2jK43Rg
658 Blum, S (2017) *Open access does not guarantee open broadband competition,* available at https://www.tellusventure.com/blog/open-access-not-guarantee-open-broadband-competition/

## ANNEX D: WIRELESS OPEN ACCESS NETWORKS

This annex summarizes the background and progress of several publicized examples of WOAN implementation efforts around the globe.

**Kenya:** In 2010, in an effort to both lower prices and expand mobile coverage, the Kenya Ministry of Information and Communication announced[659] its intent to create an LTE WOAN to cover 98% of the population[660] using the 2.5 and 2.6 GHz frequency bands held by government agencies.[661] It intended to create a PPP where the government would contribute the capital and private partners provide the capital and expertise.[662] Kenya also faces problems of mobile coverage dominance of MNO Safaricom, which leading competitors insist cannot be feasibly approached without incurring substantial losses.[663] Safaricom's dominance also extends into the mobile money market.[664]

In 2013, Safaricom abandoned the project citing substantial government delays and objecting to the use of the 2.6 GHz band instead of the digital dividend, concurrently renewing its operational license for 10 years.[665] After Safaricom announced plans to build its own 4G network which appeared likely to compete with the proposed WOAN,[666] the project stalled indefinitely, coupled with industry skepticism about its likelihood to proceed.[667]

**Mexico:** With América Móvil controlling near 80% of Mexico's fixed line and 70% of mobile telecommunications market, the Mexican government decided to solve its market dominance problem with the establishment of a WOAN.[668] It began creating structural reforms in 2013,[669] writing the plan into the Mexican Constitution in 2014.[670] The framework for execution was agreed between the Secretario de Comunicaciones y Transportes (SCT) and Mexico's telecom regulator, Instituto Federal de Telecomunicaciones (Ifetel),[671] with expectations of reaching

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659 Balancing act (2018) *Kenya's Government goes ahead with partnership to build out LTE infrastructure*, available at https://bit.ly/2qPPJuI

660 GMSA (2017) *Wholesale Open Access Networks,* available at https://www.gsma.com/spectrum/wp-content/uploads/2017/07/GSMA_SWN-8-pager_R3_Web_Singles.pdf

661 Muller, R (2010) *Open access LTE network to cut broadband costs*, available at https://bit.ly/2HDLlbR, TeleGeography (2010) *Government withholds 4G spectrum, calls for open-access network*, available at https://bit.ly/2Hll2HO

662 Free Market Foundation (2018) *Case Studies on Wireless Open Access Networks – Kenya*, available at http://eolstoragewe.blob.core.windows.net/wm-122664-cmsimages/WOANcasestudyKenya.pdf

663 Leading competitors Airtel and Telkom both insist that, without a solution such as tower sharing, an attempt to expand existing 2G and 3G coverage or deployment of 4G service would incur substantial losses. Maina, S (2018) *Kenya's Telecoms Competition Recommendations a Fight Against Safaricom (Part I)*, available at https://bit.ly/2vJX97k

664 Exacerbating Safricom's substantial market dominance of mobile money service, M-Pesa, is the fact that M-Pesa is still not yet interoperable with other competing mobile money solutions. Abuya, K (2018) *Communications Authority (CA) to Finally Announce Findings of Kenyas Telecoms Competition Clause*, available at https://bit.ly/2HIV6Fm

665 Free Market Foundation (2018) *Case Studies on Wireless Open Access Networks – Kenya*, available at http://eolstoragewe.blob.core.windows.net/wm-122664-cmsimages/WOANcasestudyKenya.pdf, TeleGeography (2013) *Safaricom renews licence, abandons 'open access' LTE project*, available at https://bit.ly/2qUTtdm

666 Heuler, H (2015) *Stuck in the slow lane: Why Kenya's public 4G network isn't up to speed*, available at www.zdnet.com/article/stuck-in-the-slow-lane-why-kenyas-public-4g-network-isnt-up-to-speed/

667 Free Market Foundation (2018) *Case Studies on Wireless Open Access Networks – Kenya*, available at http://eolstoragewe.blob.core.windows.net/wm-122664-cmsimages/WOANcasestudyKenya.pdf, GMSA (2017) *Wholesale Open Access Networks,* available at http://bit.ly/2jK43Rg

668 Cooper, D (2018) *A state-Run wireless network isn't a crazy idea, just ask Mexico*, available at www.engadget.com/2018/02/08/state-run-wireless-network-mexico-australia/

669 Levy, I (2015) *The shared wholesale network: an experiment made in Mexico*, available at www.observacom.org/the-shared-wholesale-network-an-experiment-made-in-mexico/

670 Diario Official de la Federación (2014) *Directo*, available at https://bit.ly/1zCzcYq

671 Tower Xchange (2017) *Tower Xchange*, available at https://bit.ly/2K9oeV0

universal coverage by 2023.[672] In 2015, the country's 'Red Compartida'[673] plan was officially announced[674] to form a PPP to build a nationwide LTE WOAN using 90 MHz of contiguous 700 MHz frequency band spectrum.[675]

An agreement to build the network was reached in November 2017 with a multinational consortium, Altán Redes,[676] at a cost of USD 7 billion.[677] The network is expected to launch at the end of March 2018 with 30% population coverage and expectations of reaching 92.2% by 2023.[678] Infrastructure partners Nokia Corp. and Huawei Technologies Co. Ltd. Were added in 2018 for the buildout,[679] with 4.5G implemented at launch and a seamless software upgrade to 5G when the protocol is fully standardized. Skeptics of the project point to the fact that there was only one other bidder, Rivada Networks, who was disqualified for failing to meet a bid requirement[680] with controversy surrounding the award process.[681] Others questioning the need for the WOAN point to the success of an AT&T investment into two small carriers which led to a significant price drops after the carrier's entry into the Mexican marketplace.[682]

**Rwanda:** In March 2013, the government of Rwanda and Korea Telecom Corporation (KT) entered into a joint venture PPP.[683] KT invested USD 140 million and agreed to deploy a last-mile LTE WOAN using the 800 MHz and 1800 MHz frequency bands, deliverable within three years and achieving 95% population connectivity.[684] The

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672 The official plan calls for coverage to reach 92.2% population coverage by 2023. Morris, I (2017) *Can Mexico's Wholesale 4G Plan Defy the Odds?*, available at https://ubm.io/2Hr14HX

673 'Red Compardita' is Spanish for 'shared network.'

674 Red Compardita is a project of the Ministry of Communications and Transport with goals to 'Increase the telecommunication services coverage; Promote competitive prices; Enhance the quality of services according to international standards' and capitalize on the benefits of the 700 MHz frequency bands among other socioeconomic benefits. Red Compartida (2018) *Project,* available at www.sct.gob.mx/red-compartida/index-eng.html. The project was announced by the Secretary of Communications and Transportation on 3 November 2015. Secretaria de comunicaciones y transportes (2015) *Publica sct solicitud de manifestaciones de interes para el despliegue de la red compartida mayorista,* available at https://bit.ly/2ADPgkE

675 Jackson, D (2017) *Mexico awards Red Compartida wholesale broadband deal to Altan group; Rivada Networks disputes decision*, available at https://bit.ly/2K9zm4e

676 Altan Redes (2018) *Who We Are*, available at altanredes.com/en/quienes-somos/

677 Red Compartida is a $7-billion-USD privately funded project that will be operated by a Public-Private-Partnership (PPP), wholesale-only, and will cover at least 92.2% of the population in Mexico with the most advanced mobile services. ITU (2018) Red Compartida, available at www.itu.int/net4/wsis/stocktaking/projects/Project/Details?projectId=1514835212, Altan Redes (2016) 'The roll-out of Red Compartida will be carried out through a Public-Private Partnership (PPP), a project that is expected to generate investment in excess of $7 billion over the life of the concession.' Altan Redes (2016) *ALTÁN Consortium wins the international tender process for Red Compartida*, available at https://bit.ly/2JmhWzX

678 Morris, I (2017) *Can Mexico's Wholesale 4G Plan Defy the Odds?*, available at https://ubm.io/2Hr14HX

679 Morris, I (2017) *Can Mexico's Wholesale 4G Plan Defy the Odds?*, available at https://ubm.io/2Hr14HX

680 Business Wire (2017) *Rivada Poses Questions for the Mexican Government About Red Compartida*, available at http://bit.ly/2K48JfY

681 Rivada alleged that in addition to an unusual disqualification of its bid for a minor technicality, it also alleged misconduct by the regulator, sabotage and undue influence. Paul, M (2018) *Auditors criticise $7bn Mexican tender process that Declan Ganley's Rivada alleged was 'rigged'*, available at https://bit.ly/2HrOwDZ; Atkinson, C (2017) *Peter Thiel caught up in $7B lawsuit over Mexican wireless contract*, available at https://nyp.st/2iM5HE7

682 Cramton, P & Linda, D (2015) *Mexico's wireless giants don't want to share*, available at capx.co/mexicos-wireless-giants-dont-want-to-share/

683 Pursuant to a public private partnership in 2013, KT Rwanda Networks Ltd, formerly Olleh Rwanda Networks, is Rwanda's 4G LTE infrastructure company which is jointly owned 49% by the Government of Rwanda and 51% by SK Telecom Co., Ltd of South Korea. It has built and provides a wholesale mobile broadband network being sold to MNOs. KT Rwanda Networks Ltd (2018) *About*, available at www.ktrn.rw/about

684 KT Rwanda Networks has announced that it has reached 95% population connectivity in 2018 with all Rwandan districts having 4G mobile coverage. KT Rwanda Networks (2018) *Coverage Maps*, available at https://www.ktrn.rw/coveragemap, Tumwebaze, P. (2018) *4G internet network coverage reaches all districts - KT Rwanda*, available at http://www.newtimes.co.rw/section/read/226815, Garcia, J M & Kelly, T (2015) *The Economics and Policy Implications of*

government laid out a 4,500 km national fiber backbone at a cost of USD 130 million.[685] Rwanda's coverage was and remains among the highest levels in Sub-Saharan Africa, primarily as a result of the country's small size and unusually high population density.[686] After launching in 2014 as Olleh Rwanda Networks, the PPP later rebranded to KT Rwanda Networks,[687] during which time it faced several LTE tariff reductions[688] to address substantial price differences with existing 3G services and limited hardware availability.[689]

In late 2017, Rwanda's retail market shrunk to two MNOs after the Rwanda Utilities Regulatory Authority (RURA),[690] the country's telecom regulator, approved of Bharti Airtel's purchase of Tigo[691] (57.4% market share compared to MTN's 42.6%) along with a 75.6% mobile penetration rate.[692] In January 2018, KT Rwanda Network announced that the 4G LTE network it has expanded now covers all 20 districts and 95% of the country, up from 8% in 2014.[693] As less than a handful of companies sell retail 4G services at equal wholesale costs and no new MVNOs have appeared, some have questioned the market incentive to engage in price competition.[694] But the short period of Rwanda's WOAN operation and very recent statement of reaching near universal coverage makes evaluation of the project's performance premature.

**South Africa:** South Africa is a country in need of new spectrum for mobile data use.[695] It is Africa's largest ICT market,[696] with 75% mobile broadband penetration and 160% SIM card penetration, 95% by unique user. It has 4

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*Infrastructure Sharing and Mutualisation in Africa*, available at https://bit.ly/2qSHDRM, GSMA (2016) *Best practice in mobile spectrum licensing*, available at http://bit.ly/2vMUtGr

685 FT (2015) *Rwanda's vision of an ICT-enabled economy*, available at https://www.ft.com/content/fc318106-deda-11e4-b9ec-00144feab7de. A separate fibre network is operated by Liquid Telecom.

686 'Rwanda's coverage stands among the highest in Sub-Saharan Africa, behind only Burkina Faso and South Africa. This may be explained, at least in part, because the population density of the small country is among the highest in the world, which reduces network deployment costs.' Garcia, J M & Kelly, T (2015) *The Economics and Policy Implications of Infrastructure Sharing and Mutualisation in Africa*, available at https://bit.ly/2qSHDRM, GSMA (2016) *Best practice in mobile spectrum licensing*, available at http://bit.ly/2vMUtGr

687 Tashobya, A (2106) *Why Olleh Rwanda Networks rebranded to KT Rwanda Networks*, available at www.newtimes.co.rw/Section/read/201939/, TeleGeography (2016) *4G wholesaler ORN changes name ahead of planned African expansion*, available at https://bit.ly/2qUGg5a

688 Bizimungu, J (2016) *Olleh Rwanda slashes 4G internet prices by 30 per cent*, available at https://bit.ly/2Fblv9z

689 '…prices were originally considered prohibitively high and in February 2015 oRn was obliged to reduce its LTE tariffs by 70%, from RWF4,100 to RWF1,300 per GB and further reductions in tariffs have been required in 2016. Additionally, take-up of LTE services in Rwanda has been low, in part due to the high prices for LTE packages, but also due to the unaffordability of LTE devices. This has left a tranche of 800 MHz and 1800 MHz spectrum underutilized.' GSMA (2016) *Best practice in mobile spectrum licensing*, available at http://bit.ly/2vMUtGr

690 RURA is Rwanda's telecom and ICT regulator. RURA (2018) *Background*, available at www.rura.rw/index.php?id=44

691 Tashobya, A (2018) *RURA approves Tigo takeover*, available at www.newtimes.co.rw/Section/read/228259/, Tumwebaze, P (2018) *2017 review: Airtel takeover of Tigo Rwanda operations jolted telecom sector*, available at www.newtimes.co.rw/Section/read/227179/, The New Times Rwanda (2018) *Rwanda's mobile telephone penetration rises slightly to 75.5% in November*, available at https://bit.ly/2HrZdm0

692 RURA (2018) *Active Mobile Telephone Subscriptions as of 31st January 2018*, available at https://bit.ly/2HXk4ic

693 Mushimiyimana, D (2018) *4G internet network coverage reaches all districts - KT Rwanda*, available at www.newtimes.co.rw/Section/read/226815/

694 Free Market Foundation (2018) *Case Studies on Wireless Open Access Networks - Rwanda*, available at https://bit.ly/2FKv93P

695 Gilbert, P (2018) *Long wait for spectrum clarity may soon be over*, available at https://bit.ly/2sQ8Y7w; See also Barton, J (2017) *Depleted spectrum allocation derails Vodacom's 4G deployment*, available at https://bit.ly/2CVglkR

696 Zibi, G (2018) *Analyzing South Africa's Controversial 4G Wholesale Plan*, available at https://bit.ly/2HUeTzn

MNOs, but is dominated by MTN and Vodacom.[697] Marketplace data prices among the highest in the continent[698] and mobile broadband plans offered on terms which favor a smaller pool of wealthier customers.[699] The NTA and government have made it a priority to reduce mobile data costs, including allowing data bundle rollovers to the next billing cycle. MNO network expansion though has been saddled by insufficient spectrum availability in the 900 MHz frequency band[700] - with additional concerns about the sub-1GHz and 2.6GHz bands[701] - and exacerbated by the country's substantial delay of its switchover to digital television to free spectrum as part of a 'digital dividend.'[702] Political infighting and court battles between the telecommunications ministry and the NTA over spectrum-related jurisdiction has exacerbated the delay.

A white paper produced in 2016,[703] later approved by the South African cabinet in 2017 in the draft Electronic Communications Act (ECA) Amendment Bill, promised a solution for new spectrum availability, expansion of 4G access to unconnected areas, and the end of market domination of incumbent MNOs. It proposed a WOAN be created pursuant to a 'public-private sector-owned and managed consortium.'[704] New spectrum would be allocated to a pool from which MNOs would be required to purchase at least 30% of their spectrum, potentially relinquishing their currently licensed spectrum upon expiration in 2028.[705] This new spectrum was to come from the telecom

[697] 'The mobile market is highly concentrated; the two largest players, Vodacom and MTN, control around 80% of sector revenue, and nearly 90% of the sector's operating income.' Zibi, G *Analyzing South Africa's Controversial 4G Wholesale Plan*, available at www.connectingafrica.com/author.asp?Section_id=531&doc_id=739575

[698] Research ICT Africa (2016) *State of prepaid market in South Africa: Submission to the Parliament of South Africa on 'The Cost to Communicate in South Africa'*, available at https://bit.ly/2HsNinU, Mochiko, T (2017) SA's big data rip-Off, available at www.businesslive.co.za/fm/fm-fox/digital/2017-05-05-sas-big-data-rip-off/

[699] du Plooy, E (2017) *#DataMustFall: Why SA's data pricing needs a revolution*, available at https://bit.ly/2thGt1p, Fin24 (2017) *Cwele: Data costs still too high*, available at www.fin24.com/Tech/News/cwele-data-costs-still-too-high-20170524.

[700] McLeod, D (2017) *We have run out of spectrum: Vodacom*, available at techcentral.co.za/run-spectrum-vodacom/76040/.

[701] Mzekandaba, W (2018) *WOAN plans don't solve SA's spectrum woes*, available at https://bit.ly/2zif9o6

[702] South Africa missed the ITU deadline date to switchover from analog to digital broadcasting by June 17, 2015 as a result of an ongoing dispute whether to encrypt television set-top boxes. van Zyl, G (2016) *Why govt's TV box saga is hurting SA internet*, available at http://bit.ly/2Impvql. A final decision was rendered in favor of non-encryption of set-top boxes in February 2018. Phakathi, B (2018) *Department confirms set-Top boxes will not be encrypted*, available at https://bit.ly/2JlroUi

[703] Department: Telecommunications and Postal Services (2016) *National Integrated ICT Policy White Paper*, available at http://bit.ly/2L1r1A0

[704] 'The (W)OAN will be a public-private sector-owned and managed consortium, and will consist of entities that are interested in participating. Participants may include, but not be limited to, current holders of electronic communications service (ECS) and electronic communications network service (ECNS) licenses, infrastructure companies, private equity investors, SMME's, ISPs, OTT players and MVNO's.' Department: Telecommunications and Postal Services (2016) *National Integrated ICT Policy White Paper*, available at https://bit.ly/2oqa1Ho, For more details on how the proposed ownership of the WOAN has varied and potentially deviates from the original proposal, see van de Groenendaal, H (2018) *Government does not want to own the WOAN*, available at https://bit.ly/2yIUQAO

[705] MTN, Vodacom and four other telecom companies were reported to reach an agreement with the Minister of Telecommunications and Postal Services on a hybrid model, to purchase at least 30% of the proposed WOAN and ensuring its viability in being permitted to keep the broadband radio spectrum licenses until expiration in 2028. Roelf, W (2017) *S.Africa allows telecoms operators to keep broadband spectrum until 2028*, available at https://bit.ly/2P0r2cR; Tredger, C (2017) *ITWebAfrica*, available at https://bit.ly/2FAYiOc; In September 2018, the minister published the spectrum report of the Council for Scientific and Industrial Research (CSIR) and a draft policy for direction. Vermeulen, J (2018) Minister publishes CSIR spectrum report and draft Policy Direction, available at https://bit.ly/2P00eJP; See also Mzekandaba, W (2018) *WOAN plans don't solve SA's spectrum woes*, available at https://bit.ly/2zif9o6

regulator's[706] previously planned auction of 15 year licenses for 4G,[707] which was legally halted by the Minister of Telecommunications and Postal Services.[708]

During August 2018, the Cabinet approved an amended version of the Electronic Communications Amendment Bill[709] which includes the formal introduction of the WOAN and several new telecommunications clauses, including a 'use it or lose it' (within 2 years) requirement for the use of spectrum by licensees.[710] The Bill was tabled in Parliament on September 19, 2018 for debate.[711] And In September 2018, the Council for Scientific and Industrial Research (CSIR) also released its proposed policy[712] (with invitation for comments) on the minimum amount of available spectrum which can be allocated to the WOAN, with for some of the remaining spectrum being left to address critical industry shortages by licensing to commercial operators.[713] Additionally, the Minister of Telecommunications and Postal Services withdrew legal action, settling as a result of the production of the draft policy and the hybrid compromise sharing spectrum between the WOAN and commercial operators, which may ease the path towards new spectrum licensing.[714]

At present, the South African government appears to be moving towards the adoption and implementation of a WOAN but its ultimate path is unclear, which includes continued and significant industry contention, concerns about depleted spectrum availability and allocation delays.[715]

**Russia.** A plan to provide universal broadband service through a WOAN failed, primarily as a result of the Russian government allowing the WOAN provider to act as both wholesaler and retailer.[716] Subsequently, MNOs have rolled out their own LTE services, leaving the revival of the plan unlikely.[717]

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706 The Independent Communications Authority of South Africa (ICASA) is the regulator of communications, broadcasting and postal services.

707 ICASA announced new spectrum available for assignment as 2×30MHz in the 700MHz band (703MHz-733MHz/758MHz-788MHz), 2×25MHz in the 800MHz band (796MHz-801MHz/837MHz-842MHz) and 2×70MHz and 1×25MHz in the 2.6GHz band (2500MHz-2570MHz/2620MHz-2690MHz/2595MHz-2615MHz). 'Invitation to apply for a radio frequency spectrum licence to provide mobile broadband wireless access services for urban and rural areas using the complimentary bands, 700MHz, 800MHz AND 2.6GHz', Government Gazette, Republic of South Africa (2016) *Invitation To Apply For A Radio Frequency Spectrum License To Provide Mobile Broadband Wireless Access Services For Urban And Rural Areas Using The Complimentary Bands, 700 MHz, 800 MHz and 2.6 GHz*, available at http://bit.ly/2KnJPbc

708 van Rensburg, D (2016) *Icasa spectrum auction postponed*, available at https://bit.ly/2EUWt3F 'This approach has been taken, as the Department argues that a market-based approach could favour those with deep pockets, instead of granting spectrum where it could have the greatest socio-economic value.' Patz, E (2018) *Due date for comments on controversial Electronic Communications Amendment Bill extended*, available at https://bit.ly/2CQskA1

709 Republic of South Africa (2018) *Electronic Communications Amendment Bill*, available at https://bit.ly/2CSEkku

710 Vermeulen, J (2018) Minister publishes CSIR spectrum report and draft Policy Direction, available at https://bit.ly/2P00eJP; Republic of South Africa (2018) *ibid*

711 Ellipsis (2018) *Electronic Communications Amendment Bill* (2018), available at https://bit.ly/2PyIa9d

712 CSIR (2018) *Invitation to Provide Written Comments on Proposed Policy and Policy Directions to the Authority on Licensing of Unassigned High Demand Spectrum*, available at https://bit.ly/2yG2RX6

713 McLeod, D (2018) Government's spectrum licensing plans revealed, available at https://bit.ly/2Dfvqym

714 McLeod, D (2018) *Cwele withdraws Icasa lawsuit, paving way for spectrum licensing*, available at https://bit.ly/2ERyUsF; Vermeulen, J (2018) Minister publishes CSIR spectrum report and draft Policy Direction, available at https://bit.ly/2P00eJP

715 McLeod, D (2017) *Operators given more time on contentious telecoms bill*, available at https://bit.ly/2HsS5FU; South African Government News Agency (2018) *Delays in digital migration a concern*, available at https://bit.ly/2qaauAe

716 Free Market Foundation (2018) *Case Studies on Wireless Open Access Networks - Russia*, available at http://bit.ly/2Ii18Os;, GSMA (2017) *Wholesale Open Access Networks*, available at https://bit.ly/2HSpieU

717 Free Market Foundation (2018) *Case Studies on Wireless Open Access Networks - Russia*, available at http://bit.ly/2Ii18Os; GSMA (2017) *Wholesale Open Access Networks*, available at https://bit.ly/2HSpieU

## ANNEX E: DEPLOYMENT PLANNING

### DESIGN AND FUNDING

**Funding.** Funding is provided via: Direct subsidy and use of USF – Discuss. Also consider the below infrastructure sharing where towers are being built and financed by individual companies or financed. Note also that WOAN are being used so funding is from government and sometimes combination of public-private partnerships.

### LOCAL FACTORS

**Real Estate.** A mobile base station may be situated on owned or leased property. In addition to securing agreements necessary to obtain rights to access and use the site from a landowner or obtain ownership, additional requirements may be present such as local ordinances and zoning law pertaining to the operation of a mobile base station. These legal issues are discussed below.

**Required Permissions.** Zoning laws and ordinances on any level may define policies, procedures and limits to constructing an operating a mobile base station. In any instance, licenses and permits will be needed for construction and development of the property and any structure thereon and may include the use of specialized equipment.[718] Other licenses and permissions will be necessary for operation. Jurisdictions may charge a fee for placement of a mobile base station within its boundaries. The requirement of permissions to be obtained at each level, especially at local and municipal levels, can create numerous layers of governmental red tape and substantially hamper the progress of expansion of mobile networks and their coverage.

**Environmental, Visual and Aesthetic Impact.** Local law and ordinances among other factors[719] may be impacted by the disruption of the local aesthetic. Local residents and government may be unhappy with a visual intrusion caused by a large artificial edifice being constructed in a natural environment. Zoning ordinances may limit location and additional care will be necessary to deal with fragile or special or preserved landscapes. Camouflage is often recommended but implementation demands that it not impact upon coverage range and quality of service.

### LEGAL

**Health and Safety.** Health and safety measures are necessary, such as for the amount of electromagnetic radiation generated within the area and its potential impact. This issue is of noticeable concern when discussing microwave transmissions as well as the implementation of new 5G networks and their greater intensity and exponential demands for greater data provided at greater speeds, such as introduced by technology as the Internet of Things (IoT).[720]

**Conflict of Law.** Laws at different jurisdictional levels can apply with regard to the licensing, construction and operation of a mobile base station and tower as well as which body of government is able to regulate activity. Conflicts of law may exist and determination of which law preempts the other is of paramount importance. Ideally

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[718] Towerpoint Capital (2018) *Cell Phone Tower Construction*, available at https://bit.ly/2HW7kZ7

[719] Housing Department (1996) *Telecommunications Antennae and Support Structures: Guidelines for Planning Authorities', Department of the Environment and Local Government*, available at https://goo.gl/bv8WXC

[720] Roe, I (2017) *Potential health effects of 5G network unknown: expert*, available at https://ab.co/2vFJZIP

national or regional law would support construction of mobile base stations and clear barriers to construction and operation,[721]although this is not always the case.[722]

## LOGISTICAL FACTORS

**Power Sources.** A source of electrical power is needed to operate a base station. Optimally electrical cables can or have been run to the site. Telecommunications network cables may include access to power. Gasoline is often used to power mobile base stations in remote areas but these are less reliable, require constant and regular fuel deliveries, and are subject to a high degree of vandalism and theft, especially in Africa.[723] Also to take into account is the fact that gasoline remits a significant amount of pollution. Renewable energy such as solar and wind power can also be used but these sources may generate less power than demanded by equipment.[724]

**Access Roads.** The success of a mobile base station e with relative ease via terrestrial transportation is of significant importance. Locations with challenging or non-existent established roadways will make fuel deliveries of fuel for power generators a difficult task. Regular and emergency maintenance tasks will also be difficult to accomplish. Those with skill levels necessary to perform upgrades and maintenance may be more readily unavailable.

**Radio Coverage and Interference.** A determination should be made regarding the coverage which can be provided by construction of a tower at a certain location. Impact can come from environmental conditions and topology, such as elevation level. Also impacting upon coverage are current and potential interference levels and signal noise generated from within the surrounding area.

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[721] The US Telecommunications Act of 1996 Section 253 states 'no state or local statute or regulation may prohibit or have the effect of prohibiting the ability of any entity to provide any interstate or intrastate telecommunications service.' League of Minnesota Cities (2017) *League of Minnesota Cities Information Memo: Cell Towers, Small Cell Technologies & Distributed Antenna Systems*, available at https://www.lmc.org/celltowers
[722] GSMA (2017) *The Mobile Economy Latin America and the Caribbean 2017,* available at https://goo.gl/dFJEg6
[723] TowerXchange (2013) *How to protect your sites from theft of fuel and equipment*, available at https://bit.ly/2Hp2oeg
[724] Ike, D, Adoghe, A & Abdulkareem, A (2014) *Analysis of Telecom Base Stations Powered By Solar Energy,* available at http://www.ijstr.org/final-print/apr2014/Analysis-Of-Telecom-Base-Stations-Powered-By-Solar-Energy.pdf, Chamola, V & Sikdar, B (2016) *Solar Powered Cellular Base Stations: Current Scenario, Issues and Proposed Solutions,* available at https://www.ece.nus.edu.sg/stfpage/bsikdar/papers/commag_vc_16.pdf

## ANNEX F: SPECTRUM ASSIGNMENT TYPES[725]

**1. Sale**

- + Quick method, results are seen almost immediately.
- + Seller is able to set any price, allowing for high returns
- + Outcome is certain, either the seller gets the price they want, or they retain the spectrum
- - Buyers may be disincentivized to buy due to high prices, which can delay technology advancements.
- ● Use: Early era US Wireless spectrum sales in the 1980s.

**2. Administrative**

- + Allows for usage of fees to offset the cost of managing the spectrum
- + Conditions can be set to require optimal usage of spectrum and requirements on what licensees must offer
- + Spectrum remains owned by the government, but is being licensed out for use, allowing for additional revenue streams in later use (i.e. re-licensing after the initial term expires, or deciding to eventually sell the spectrum)
- - Does not generate optimum revenue. This is because the license cost may be set too high to bring in new purchasers, or too low and turning away revenue.
- - Companies may not wish to expend CAPEX if the license term isn't long enough to realize return on investment. This could remove possible licensors, who do not wish to get involved unless they own the spectrum.
- - Can slow the adoption of new technologies, as administrators may not be studying cutting edge technologies and how to best deploy them.
- - Centralized administrations do not have all the information to determine local needs and deploy resources best to fit those needs.
- - This system is highly discretionary, allowing the administrator to determine who receives the license. This allows for corruption, a lack of competition, and a lack of transparency.
- ● Use: India's cellular service started in the 1990s and 2000s as an administrative assignment system.
- ● Use: In the United States, TV broadcasting was administrative in the earlier days of the medium

**3. Auction**

- + Maximizes the return for the seller (i.e. the government).
- + Easy bidding concept, making it simple for bidders to enter.
- + Transparent, as all bidders can see who is bidding on what, and how much they are bidding.
- - Method is slow, can take years before the auction is finalized.
- - The prices that will be realized are uncertain.
- - Objectives of the 'sale' are uncertain because the winner is uncertain. Thus, restraints may not be possible, or other conditions on the buyer.
- ● Use: US PCS Auctions and 3G spectrum licenses.
- ● Use: Many other spectrum auctions around the world.

**4. Dutch Auction**

- + Maximizes the return for the seller (i.e. the government).
- + Easy bidding concept, making it simple for bidders to enter.
- - Method is slow, can take years before the auction is finalized
- - The procedure is slow. Bidders have to be attracted to submit bids, then bids need to be examined, and a winner determined.
- - The prices that will be realized are uncertain.

[725] Data in this annex all provided by Jason A. Buckweitz, Associate Director, Columbia Institute for Tele-Information at Columbia Business School, Columbia University, New York.

- Objectives of the ‘sale’ are uncertain because the winner is uncertain.  Thus, restraints may not be possible, or other conditions on the buyer.
- Use: India issued their 3G and 4G spectrum using a Dutch Auction
- Use: Many other spectrum auctions around the world.

**5. Vickrey Auction**

- \+ Bidders are more likely to reveal their valuation of the spectrum, knowing that they will pay whatever the second highest bidder bids.
- \- No price discovery.  Once the round is over, the spectrum is assigned.  Theoretically a bidder would be willing to go above the highest price that won.  This may receive the maximum the bidder thinks it is worth, but not necessarily what the value of the item actually is.
- \- Susceptible to collusion especially in an auction that only has a few players.
- \- The procedure is slow.  Bidders have to be attracted to submit bids, then bids need to be examined, and a winner determined.
- \- Maximum revenue is not received, as the winner pays the second highest bid, thus turning away revenue
- \- The prices that will be realized are uncertain.
- \- Objectives of the ‘sale’ are uncertain because the winner is uncertain.  Thus, restraints may not be possible, or other conditions on the buyer.
- Was used in Radio Spectrum auction in 1990 in New Zealand.  Was seen as a massive failure as it brought in only 15% of the expected revenue for the spectrum.