Connecting the Last Mile, a Fundamental of Digital Transformation

Presented at the ITU Workshop for Europe and CIS "ICT Infrastructure as a Basis for Digital Economy"

Kiev, Ukraine, 14 May 2019

Aminata A. Garba

International Telecommunications Union

Outline

- Introduction
- Technologies for Last Mile Connectivity
- Business and Policy Models for Last Mile Connectivity
- ITU Project on Last Mile Connectivity
- Conclusion

Introduction

- The Digital Transformation requires using digital technologies in various activities of an organization/country to improve efficiency and livelihood.
  - Digital transformation has been ongoing for many years
  - Resurge (last few years) with many organizations undergoing digital transformation
  - Different organizations/countries are at different stage of the process
- Digital Transformation Tools
  - Tools for diagnostic and prognostic
  - A national digital transformation strategy and plan
  - A comprehensive solution for a digital transformation
  - A mean to monitor/evaluate the digital transformation process and take corrective measures

Introduction (cont.)

- **Infrastructure** is central for enabling digital transformation through universal, sustainable, ubiquitous & affordable access to ICT services
- **Last mile Connectivity (also referred to as first mile connectivity)**
  - In most places, the main backbone network exists
    - But connectivity does not reach many people to their homes or work places
    - Especially the rural and remote areas
    - The last mile connectivity is defined as the connectivity between the main backbone network and the users'
  - Accelerating the digital transformation requires:
    - Connecting the unconnected to the broadband core networks
    - Choosing efficient, cost-effective and fast deployment technologies, business and policy models to improve accessibility

Last Mile Connectivity Technologies

- **Diverse technologies are used**
  - **Wireless technologies**
    - Mobile Cellular
    - Satellite
    - Wi-Fi
    - LAN and IoT technologies
    - Etc.
  - **Wired technologies**
    - Fiber optic
    - Coaxial Cable
    - Asymmetric digital subscriber line (ADSL)

- **Diverse application requirements**
  - Energy consumption
  - Range
  - Bandwidth
  - Mobility
  - Cost

- **Technologies have different**
  - Signal penetration
  - Frequency use
  - Cost
  - Market size
  - Age, integration

Mobile Cellular Technologies

- **Spectrum regime:** Licensed
- **Coverage:** Wide area or metropolitan area
- **Data rate:** increasingly high
- **Evolution:** 5 generations
  - **1G :** Analog
  - **2G** : Digital
  - **3G :** Voice and data **(**Broadband)
  - **4G :** Broadband evolution, LTE, LTE advanced, Multimedia
  - **5G :** High data rate, intensive M2M, low delay, etc.

		Real World (avg)		Theoretical (max)		Availability
		Download	Upload	Download	Upload	
2.5G	GPRS	32-48Kbps	15Kbps	114Kbps	20Kbps	Today
2.75G	EDGE	175Kbps	30Kbps	384Kbps	60Kbps	Today
3G	UMTS	226Kbps	30Kbps	384Kbps	64Kbps	Today
	W-CDMA	800Kbps	60Kbps	2Mbps	153Kbps	Today
	EV-DO Rev. A	1Mbps	500Kbps	3.1Mbps	1.8Mbps	Today
	HSPA 3.6	650Kbps	260Kbps	3.6Mbps	348Kbps	Today
	HSPA 7.2	1.4Mbps	700Kbps	7.2Mbps	2Mbps	Today
Pre-4G	WiMAX	3-6Mbps	1Mbps	100Mbps+	56Mbps	Today
	LTE	5-12Mbps	2-5Mbps	100Mbps+	50Mbps	End 2010
	HSPA+	-	-	56Mbps	22Mbps	2011
	HSPA 14	2Mbps	700Kbps	14Mbps	5.7Mbps	Today*
4G	WiMAX 2 (802.16m)	-	-	100Mbps mobile / 1Gbps fixed	60Mbps	2012
	LTE Advanced	-	-	100Mbps mobile / 1Gbps fixed	-	2012+

Figure from: http://sudhakarreddymr.wordpress.com/2011/06/01/difference-between-1g-2g-2-5g-3g-pre-4g-and-4g/

Satellite Technologies

- **Spectrum regime:** Licensed
- **Coverage:** Wide area
- **Data rate:** increasingly high
  - Modern satellites induce low propagation delay
  - Satellite in lower orbits used for data services (orbits between 400 and 1,000 miles above the earth's surface)
  - Increase in capacity: high Throughput (100s – 1000 Mbps uplink)
- **Advantages:** Offers the possibility to connect remote and hard-to-access places
  - Used in some cases as a preferred last mile connectivity solution
- **Challenge:** Satellites cost, considered high, is the main limitation
- **Case study:**
  - Mexico is using satellite technology to connect thousands of villages and millions of people in rural and remote areas through new business models
  - Small satellites argue the reduced cost for satellite services

Source: ITU Symposium on small satellite regulation https://www.itu.int/en/ITU-R/space/workshops/2016-small-sat/Pages/default.aspx

Optical Fiber Technology

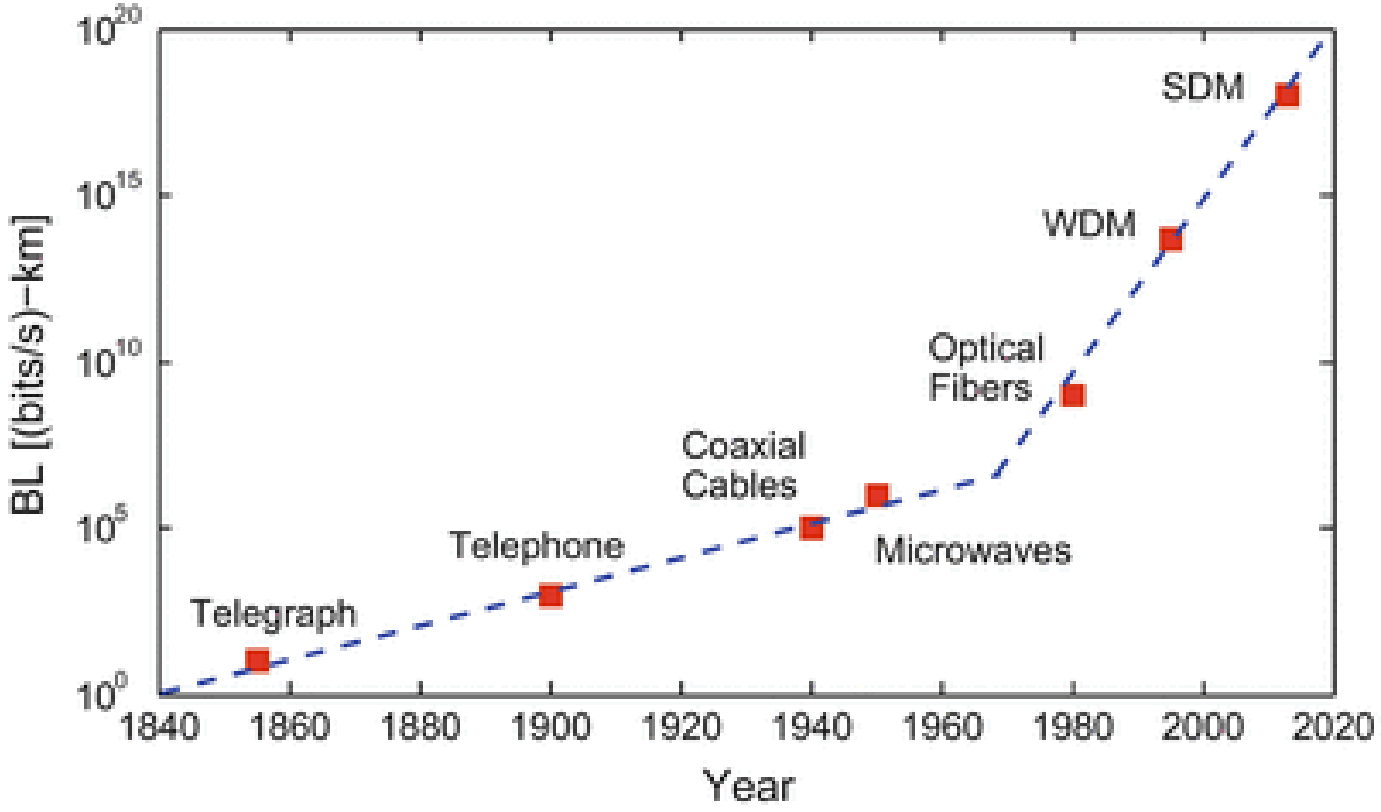
- Fiber is used until the premise, e.g., home
- **Coverage:** Wide area
- **Data rate:** Very high (highest)
  - Figure shows evolution of communication technologies. last 3 are optical fibers technologies

Advantages

- High performance
- High capacity of the fiber
- Low error rates in the transmission

Challenges

- High cost of installing fiber to each premise
- The end to end path needs to have similar performance
- **Case study:** Fiber to the promises is used in many urban areas, especially in developed countries

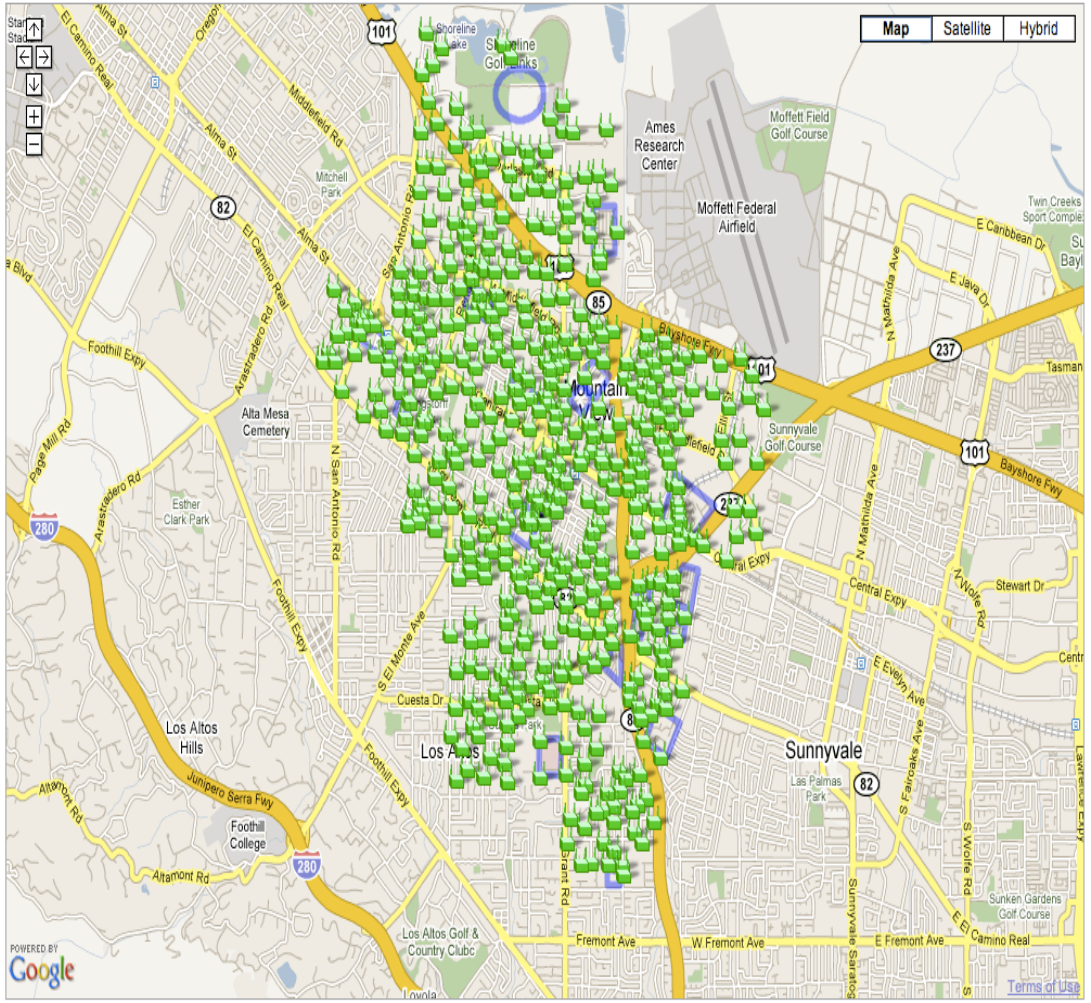


Ref: "Optical Communication: Its History and Recent Progress" Springer book by Govind P. Agrawal

Wi-Fi Technology

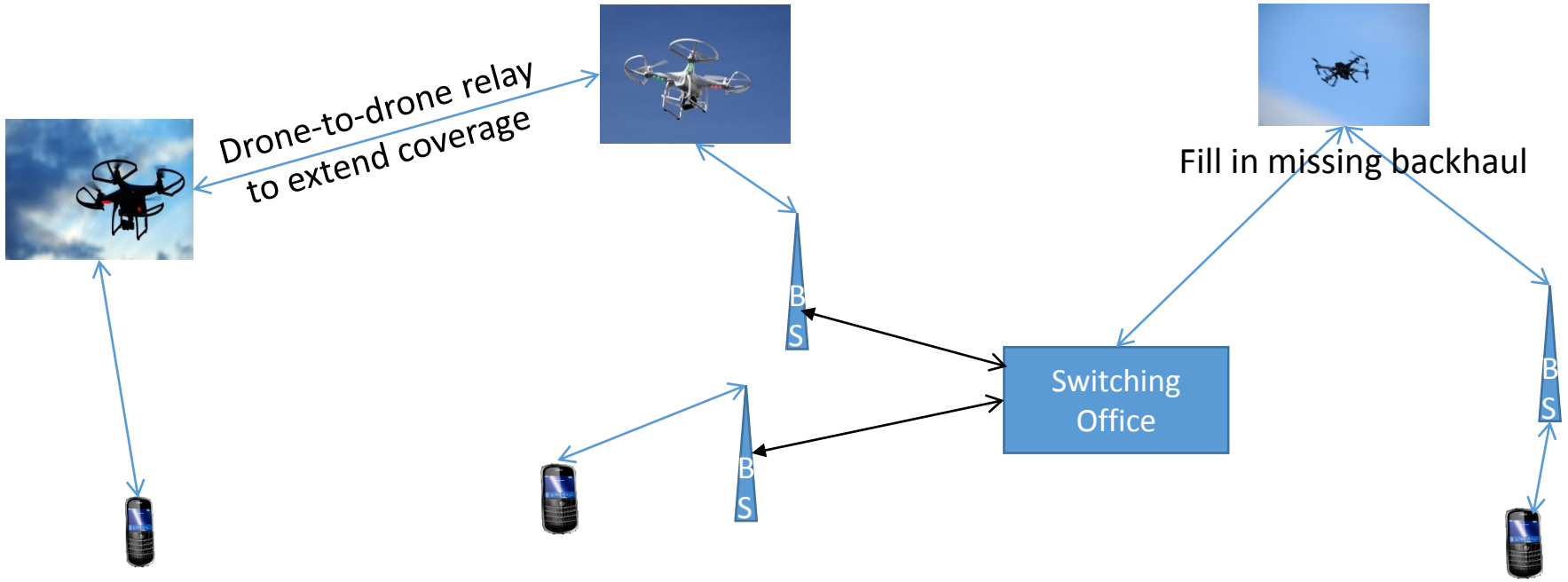
- **Family of 802.11 standards**
- **Spectrum Regime:** Unlicensed spectrum band (ISM, 2.4 GHz, band)→ Low cost
- **Coverage:** Local area network, e.g., campus
- **Data rate:**
  - 802.11a (initial version) ~54 Mbps
  - Increased data rate e.g., 2.4 Gbps expected for 802.11ax (Wi-Fi 6) with ratification expected in Q4 2019)
    - Multiple antennas, (2 antennas at the transmitter and 2 antennas at the receiver)
    - OFDMA (orthogonal frequency division multiple access)
- **Advantage**
  - Good candidate if the backbone is not far from the locality
  - Wi-Fi technology has been used to create mesh networks
- **Challenge**
  - Reduced range, i.e., not applicable when the backbone is far
- **Case study**
  - In India, several rural areas have been connected using Wi-Fi as last mile connectivity solution

Google Wi-Fi Network in CA



High Altitude Platform Station (HAPS) and UAVs

- Many projects aiming to deliver connectivity to people in unserved/ underserved communities
  - **Drones** (Unnamed Aerial Vehicle, UAVs) to serve as mobile base stations to provide connectivity, as shown in figure below
    - **Case study**: The Airbus Zephyr, a series of lightweight solar-powered UAV
  - Google Loon , using a network of balloons flying 20 km up traveling on the edge of space



Ref: Figure reused from a joint proposal with Tim Brown

Business and Regulatory Models

1. **Large Operators** (e.g., mobile service providers, satellite providers)
   - Usually operate under a licensing regime
   - Use licensed spectrum
   - Offer traditional voice and data
     - **Advantage**: have a large coverage and some guaranteed quality of services
     - **Challenge**: Reluctant to serve some areas considered with to have low return on investment
     - **Case Study:** This is the traditional business model for mobile cellular or satellite service providers, e.g., Deutsche Telecoms, France Telecoms
2. **Mobile Virtual Network Operator (MVNO)**
   - Do not own the network
   - Use networks of large(r) operators with specific business agreement
   - Create their own business model
     - **Advantage:** Can increase accessibility by providing different business models, e.g., provide prepaid when the larger operator provides postpaid services, e.g.,
     - **Challenge:** MVNO have the same coverage as the large operator since they use the same network, hence do not present a solution to extend connectivity
     - **Case study:** Voiceworks Netherlands, Welcome Italia, a B2B telecommunications provider, Transatel launched over 150 MVNOs with expertise in Machine-to-Machine connectivity and IoT (Internet of Things)

Business and regulatory models (cont.)

3. Small Operators, e.g., Internet Service Providers (ISP)

- Operate under authorization (Less stringent than a license and most times free or low with low fees)
- Usually small to mid-sized operators
- Can operate in unlicensed (e.g., Wi-Fi) or licensed regime spectrum
- In some countries they can provide data and voice but in many countries, they provide only data and are not allowed to provide voice over IP using a number, to "protect" the large operators who pay fees.
  - **Advantages**: Increase competition
  - **Challenge**: Their geographical coverage is rather small and therefore, do not mostly cover remote areas
  - **Case study:** Business case for small operators has been experimented in various countries in Latin America

Business and regulatory models (cont.)

4. Community Networks

- Usually very small networks managed by the community itself
- Different business models exist
  - **Advantage:** Allows unconnected community to be connected
  - **Challenge:** Sustainability of the community network is rather a challenge
  - **Case study:** Community networks have been experimented in many countries, particularly in Central and Latin America

5. Hybrid Model

- Interesting models arise when combining two or more business models
- **E.g., Large Operators and small Operators:** Small operator can provide the local solution to the last mile connectivity and big operator provides capacity to connect to the Internet.
  - **Advantages**: Can allow expanding the geographical connectivity
  - **Challenge**: necessitate a fair model to allow accessibility (low cost)
  - **Case study:** This model has been experimented in different places, e.g., in India

ITU Last Mile Connectivity Project: Objectives

Objective: Provide guidelines, toolkits and solutions to support ITU Members in setting last miles connectivity infrastructure and applications in order to close the connectivity gap

- Increased access to broadband
  - Increased last mile networks
  - Interconnection of (local, national and regional) networks
- Reduced cost of access
- Increased development of digital Skills
- Enhanced development and use of local solutions, applications, content & data

ITU Last Mile Connectivity Project: Deliverables

- Compilation of case studies, from different regions of the world, on last mile connectivity solutions
- Analysis of the use of different technologies, policies, regulations and business models to provide citizens with affordable and accessible last mile connectivity solutions
- Guidelines and/or toolkits for setting, maintaining and using last mile connectivity solutions
- Capacity building for local applications development as well as innovations
- Local data and content production, storage and processing
- Implementation of last mile connectivity solutions

ITU Last Mile Connectivity Project: Implementation

- The project will be implemented by the ITU and various partners
  - The project will be under the umbrella of the ITU
  - Potential partners are invited to provide contributions in any part of the study
    - Case studies
    - Last mile connectivity technologies
    - Sustainable business solutions for last mile connectivity
    - Regulations and Policies
    - Applications
    - Implementation of the last mile connectivity solutions
    - Financing the project implementation
- The contributors and their organizations will be recognized (as contributors or authors)

Please contact Aminata A. Garba, aminata.amadou-garba@itu.int, for more information, questions or interests about the ITU Last Mile Connectivity Project

Thank You