



Connecting the Unconnected

Frugal 5G Network - Addressing the Challenges of Rural Broadband Connectivity

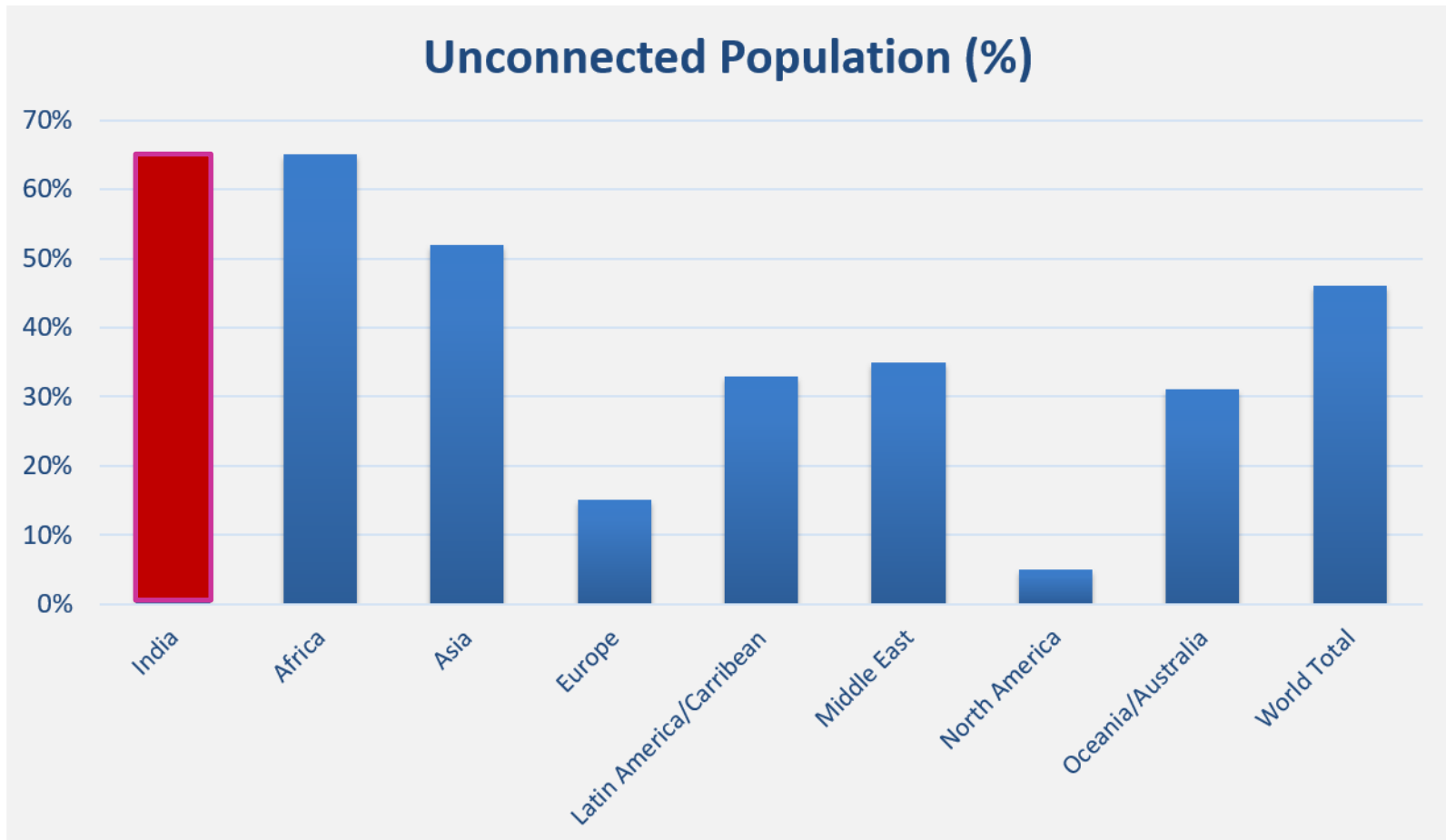
WWRF 5G Huddle 2020

Pranav Jha

Indian Institute of Technology Bombay, India

pranavjha@ee.iitb.ac.in

Internet Connectivity Status: Worldwide



Almost 50% of the world population is unconnected - Majority in Developing World

Source: <https://www.internetworldstats.com/>

Internet/Broadband Access – How is it enabled?

- Developed Countries
 - Mostly enabled through wired communication infrastructure, Fiber and DSL
- Developing Countries
 - Fiber/DSL Infrastructure - Inadequate
 - Cellular Technology - Primary broadband access mechanism

Wireless Technology for Rural Broadband Connectivity

Existing and Emerging Wireless Cellular Standards

- Typically focussed on urban usage scenarios
 - 5G technology targets - 10 Gbps data rate, 1 ms latency, 500 km/h mobility
- **Challenges and Characteristics of Rural Connectivity not factored into specification and design**
- Variations in use cases across regions, countries, continents ignored

Operators

- Roll out networks in urban/semi-urban areas
- No compelling commercial reason for them to target rural areas

Rural Broadband Connectivity – Characteristics and Challenges (1/2)

- Affordability of Solution
 - Rural Areas
 - Relatively Smaller Population Density
 - Low Income and Low ARPU
 - Smaller Revenue per Square Mile
 - Assumes greater significance in developing countries
- Sparsely Populated Areas and Clustered Settlements
 - Small Clusters of Population with Vast Open Areas in between
 - Providing similar type of service over a large geographical area may be inefficient
- High Speed Mobility not Important
 - High Speed Mobility use cases (e.g. high speed trains) not important in Rural Areas
 - Especially in developing countries
 - Fixed Broadband Access - The Key

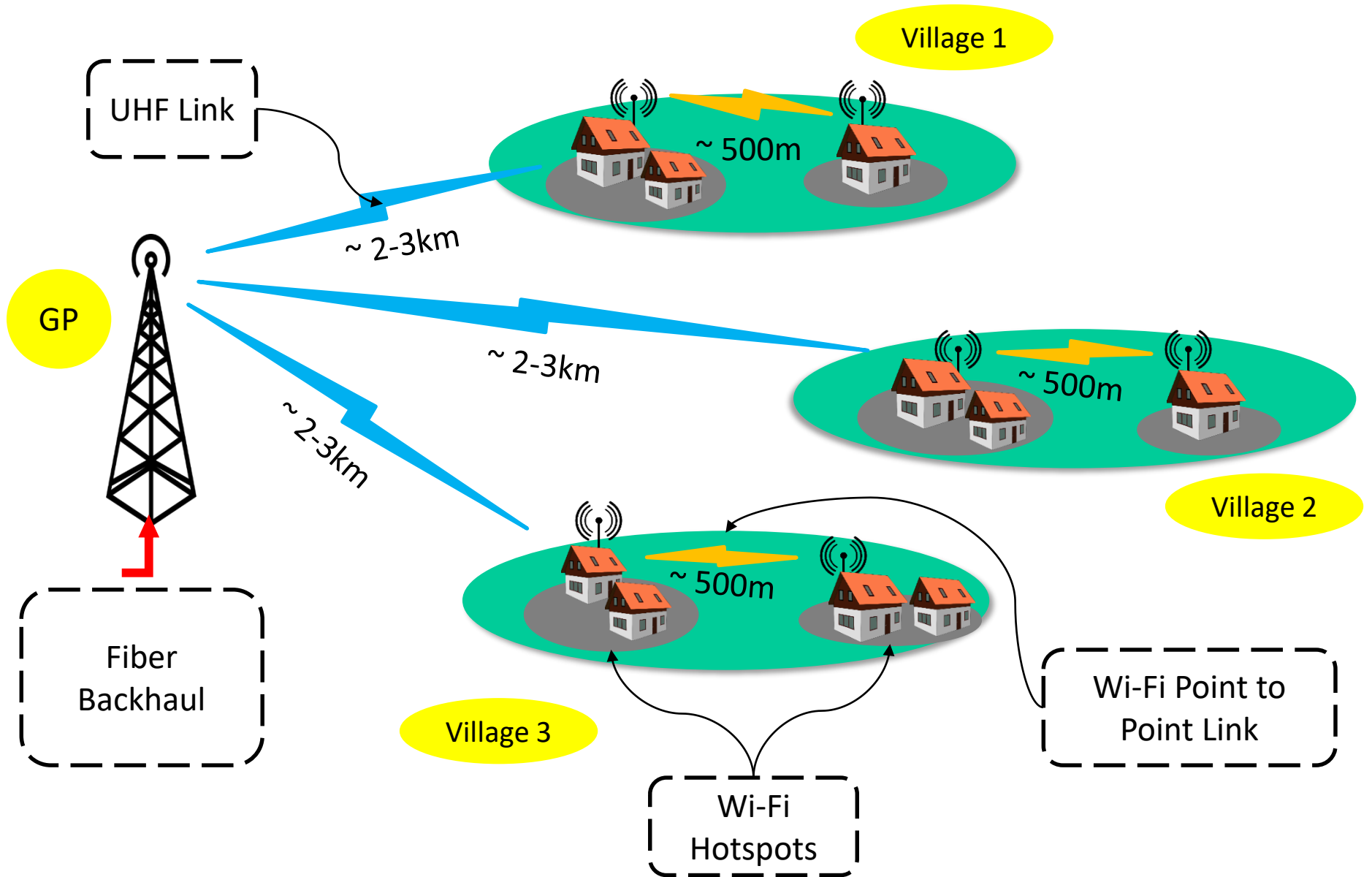
Rural Broadband Connectivity – Characteristics and Challenges (2/2)

- Scarcity of Power from the Grid
 - May not always be Available - more so in developing countries
 - Capability to use renewable energy sources, when required
 - Usage of technology with lower power consumption
- Some Areas may be Remote and Difficult to Access
 - Deployment of Wired Infrastructure takes more time and is costlier
 - Wireless Technology more suitable
- Local Content Generation and Storage
 - Reduces Cost
 - Less dependence on connectivity to Cloud
 - Important in Countries with Diverse Population & Culture – People may not be knowing English and other commonly used language on Internet
- Manageability
 - Ease of Manageability quite important due to Cost and Access Constraints, especially in Developing Countries

Fiber Deployment Status in Rural India

- Project Bharatnet, an initiative of the Govt. of India *
 - To lay Fiber to support broadband connectivity in Rural India
 - Possibly the biggest Rural Broadband Project world-wide
- Laying Fiber to all “Village Offices” in the country
 - In India, a cluster of villages (typically 3-6 villages) form a unit called “Gram Panchayat” (GP)
 - A total of 250 thousand GPs in the country
 - Every GP has an Office - “Village Office”
 - One Village Office in a cluster of 3-6 villages in an area of 10-12 Km²
- Fiber Deployment Status
 - 130 thousand village offices have been connected with Fiber till date
 - Remaining offices to be connected by 2020
- An Important Issue, to be resolved
 - How to Connect Surrounding Villages to the “Village Office”
 - No Mechanism Devised so far

How to Connect the Villages to a GP?

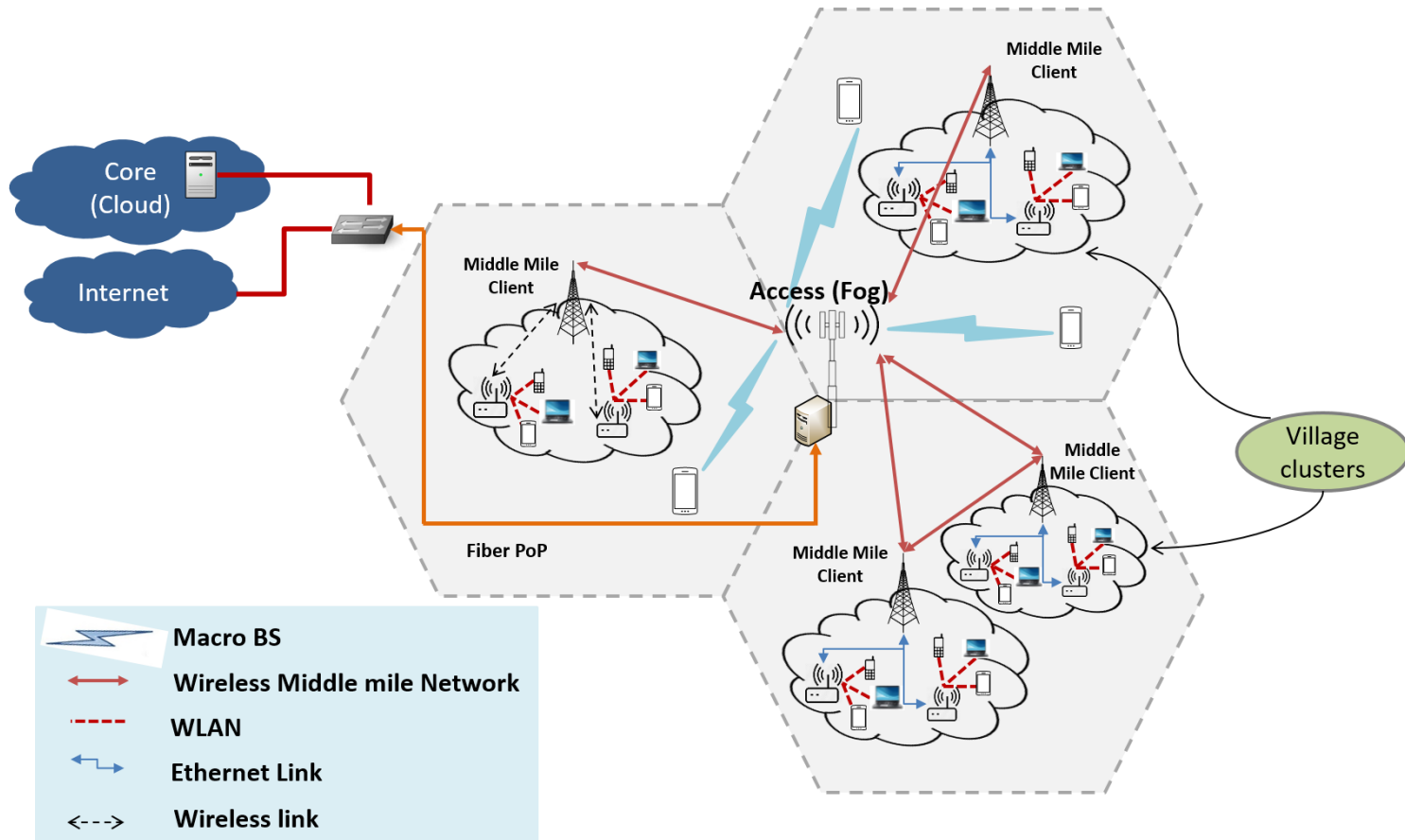


Where Does It Lead Us?



Frugal 5G Networks

Frugal 5G Network Architecture (1/2) (*Under Development*)



SDN based unified RAN Control

Efficient service delivery, Independent Evolution of control/data plane entities

Usage of Virtual Network Functions

Cost-effective System

Intelligence at the edge

Enables Local Communication & Optimizes Resource usage

Frugal 5G Network Architecture (2/2) (*Under Development*)

- Large Coverage Area Cells to provide Ubiquitous Connectivity
 - Provide Basic Connectivity
- Small Cells (WiFi Hotspots) as access points for high speed data connectivity
 - WiFi devices are very low cost devices
- Wireless Middle-Mile Network to carry data from/to Wi-Fi Hotspots
- Usage of SDN, NFV and Edge(Fog) Computing
 - Cloud and Fog based Architecture – Intelligence at the Edge
 - Software Defined Networking
 - Separate control and data plane
 - Integrated Multi-RAT Control in RAN
 - NFV – Usage of COTS & Open Source Based Platforms

Thank you