"Frugal 5G": Connecting the Unconnected World !

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Outline of the Talk

- Broadband Penetration Status in India and Rest of the world

- Challenges in Affordable Broadband

- Re-thinking 5G Requirements for connecting the unconnected world

- Frugal 5G architecture

- IEEE ComSoc Frugal 5G RRSA

Broadband Penetration Status: Worldwide
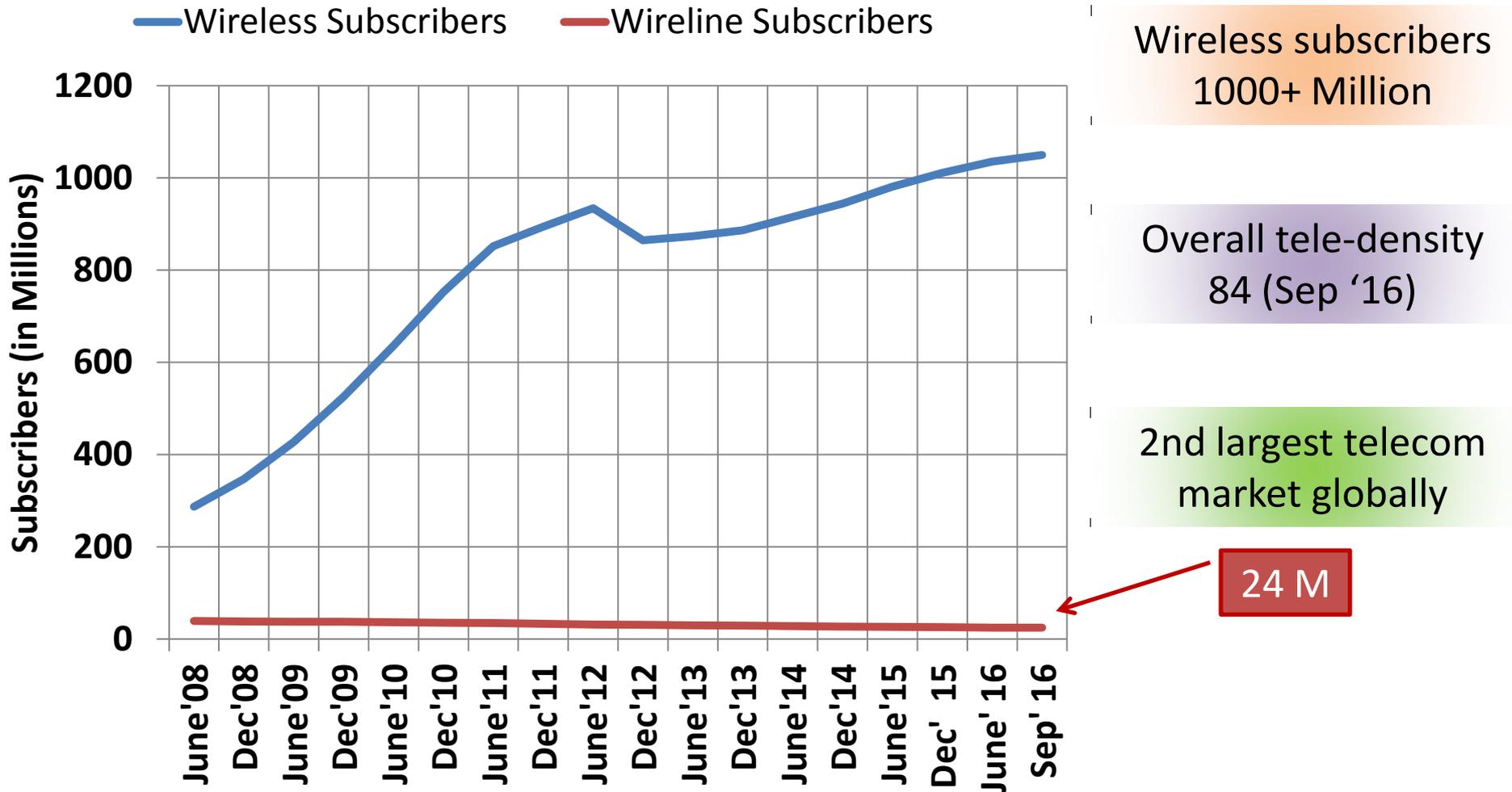## Around half of the global population is unconnected
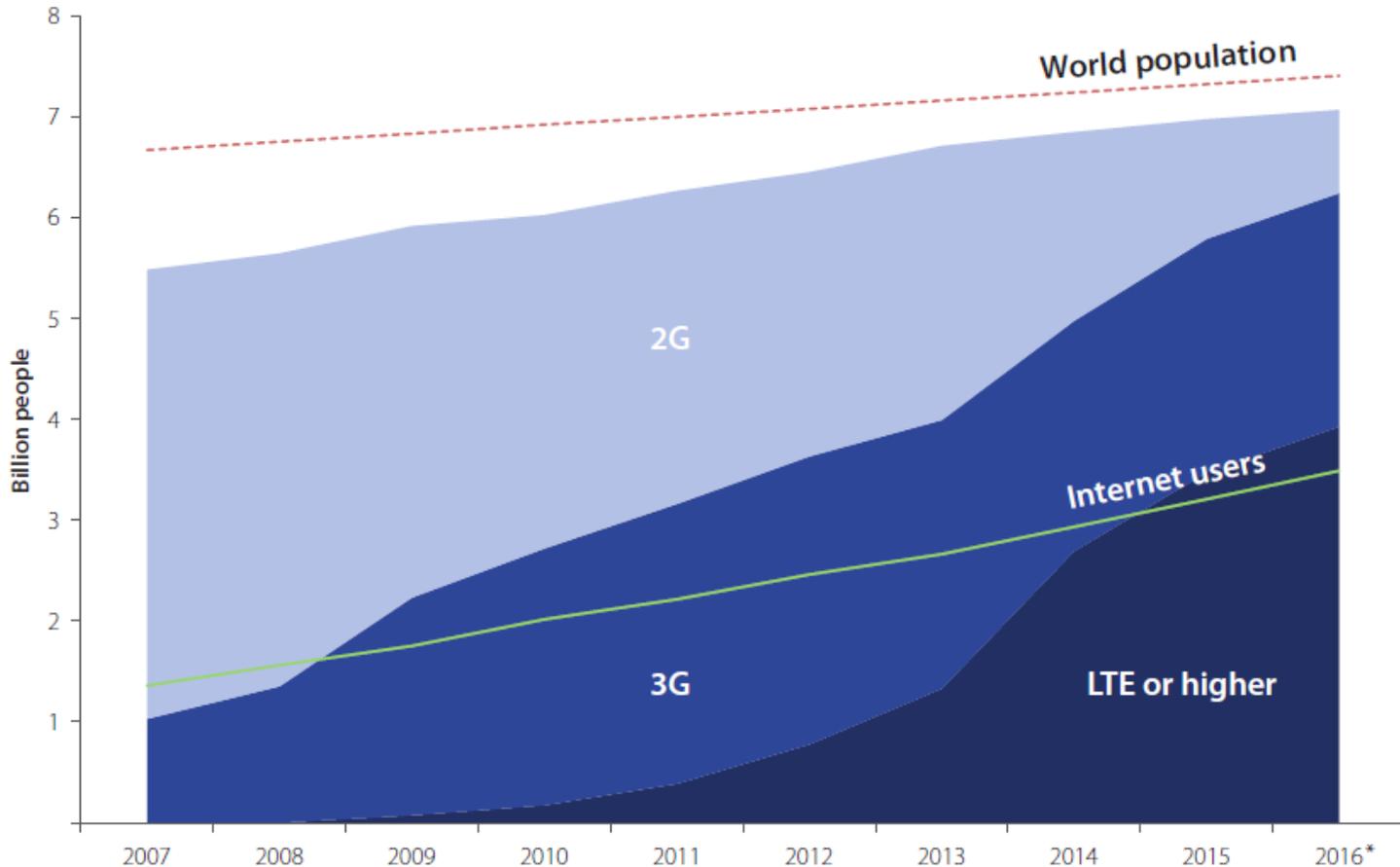
Source: International Telecommunication Union

Around 84% of global population lives in regions covered by wireless broadband (3G/4G) but the adoption rate is only 47%
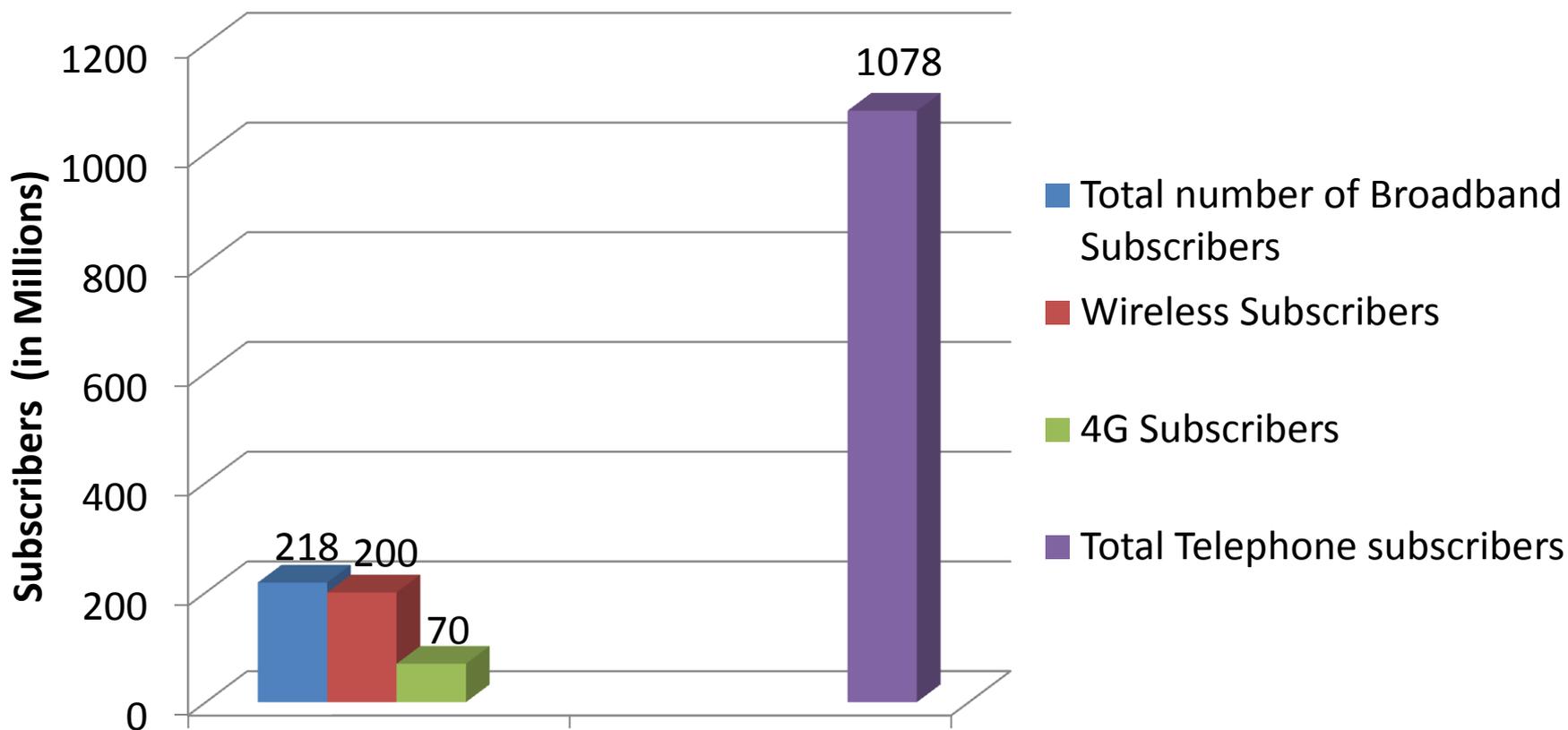
# Telecom in India: Subscriber Base

Subscriber Base

Wireless subscribers 1000+ Million

Overall tele-density 84 (Sep '16)

2nd largest telecom market globally

24 M

Source: The Indian Telecom Services Performance Indicator Reports, TRAI

Broadband Penetration Status: Indian Scenario

As of 9th January, 2017

Subscribers (in Millions)

- 218 — Total number of Broadband Subscribers
- 200 — Wireless Subscribers
- 70 — 4G Subscribers
- 1078 — Total Telephone subscribers

Around 1 billion people do not have broadband access in India

Urban and Rural Challenges
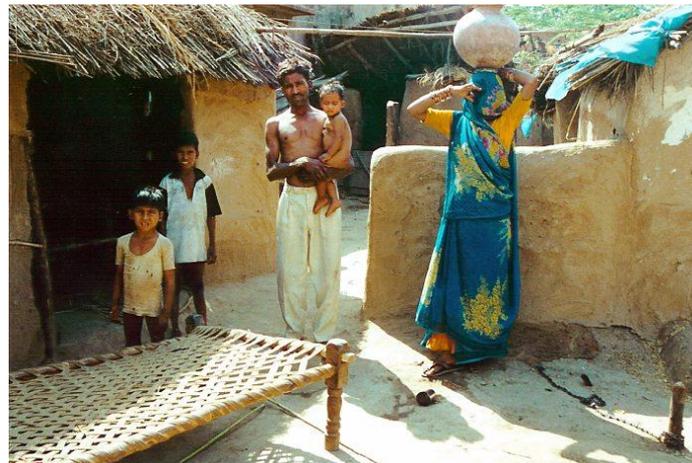
Images from Wikipedia- Digital Divide: Mumbai; an Indian village

Urban India or metro cities have optional access to broadband

Rural India, even though it contributes 50% to the GDP, has no access to broadband (mere 1.5%)

Challenges in Rural Areas

ARPU/Total Revenue

CAPEX & OPEX

Tele-density is just 52%

Government Initiatives

USOF

BBNL

NOFN/ BharatNet

Challenges in Connecting Rural India

Low Average Revenue Per User

Unavailability of Fiber Backhaul

Intermitant Availability of Electricity

Rural Broadband: BharatNet/Gram Panchayats

- Approximately, 13 % Gram Panchayats have been connected.

- 6,38,619 villages will still remain unconnected even if all Gram Panchayats are connected by BharatNet i.e. 2.56 Villages per Gram Panchayat

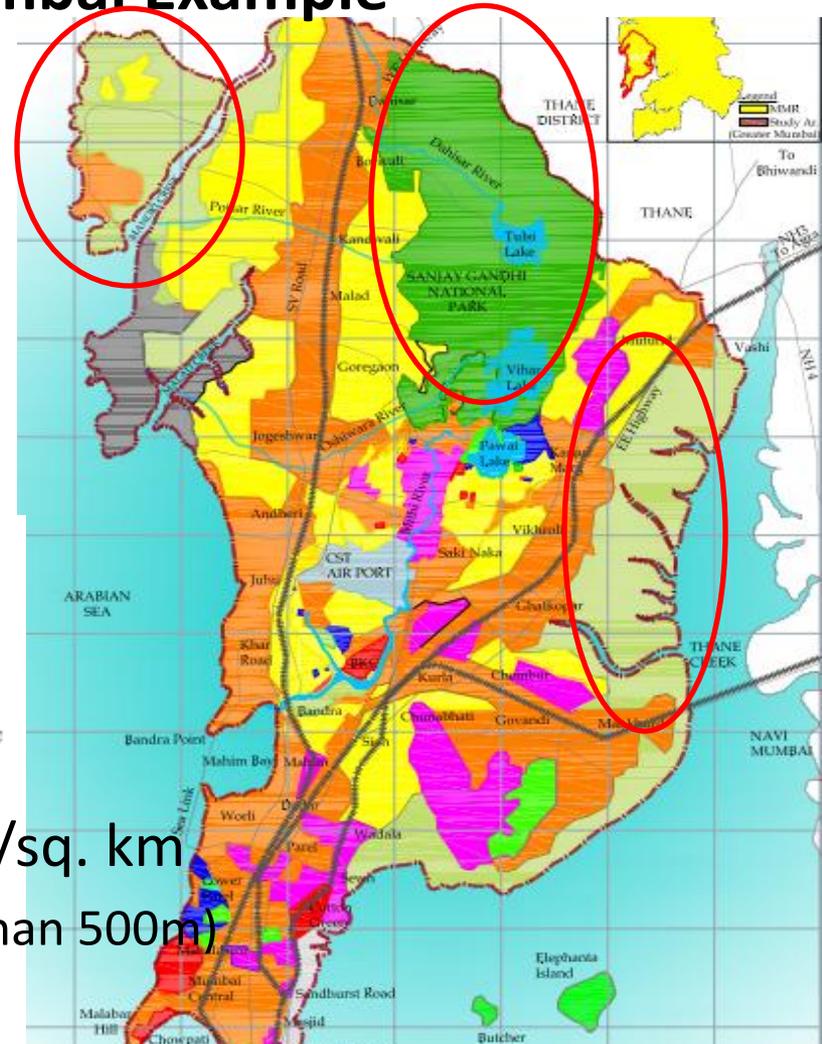|	
Number of Blocks (BhartNet Phase-I)	6,382
Number of Gram Panchayats (BhartNet Phase I/II)	2,50,000
Number of Villages	6,38,619
Avg. number of Gram Panchayats per block	40
Avg. number of Villages per Gram Panchayat	2.56
Avg. number of Hamlets per Village	4
Number of Gram Panchayats connected by BharatNet	32,272
Number of Active Gram Panchayats	4,754

Traffic Growth in India – 5G?

- India needs primary broadband connectivity to 250 M homes, for 250 GB/month being delivered at 2 Mbps

- Translates to 100 Exabytes per month for India alone which is 8x the expected global mobile traffic by 2017!!
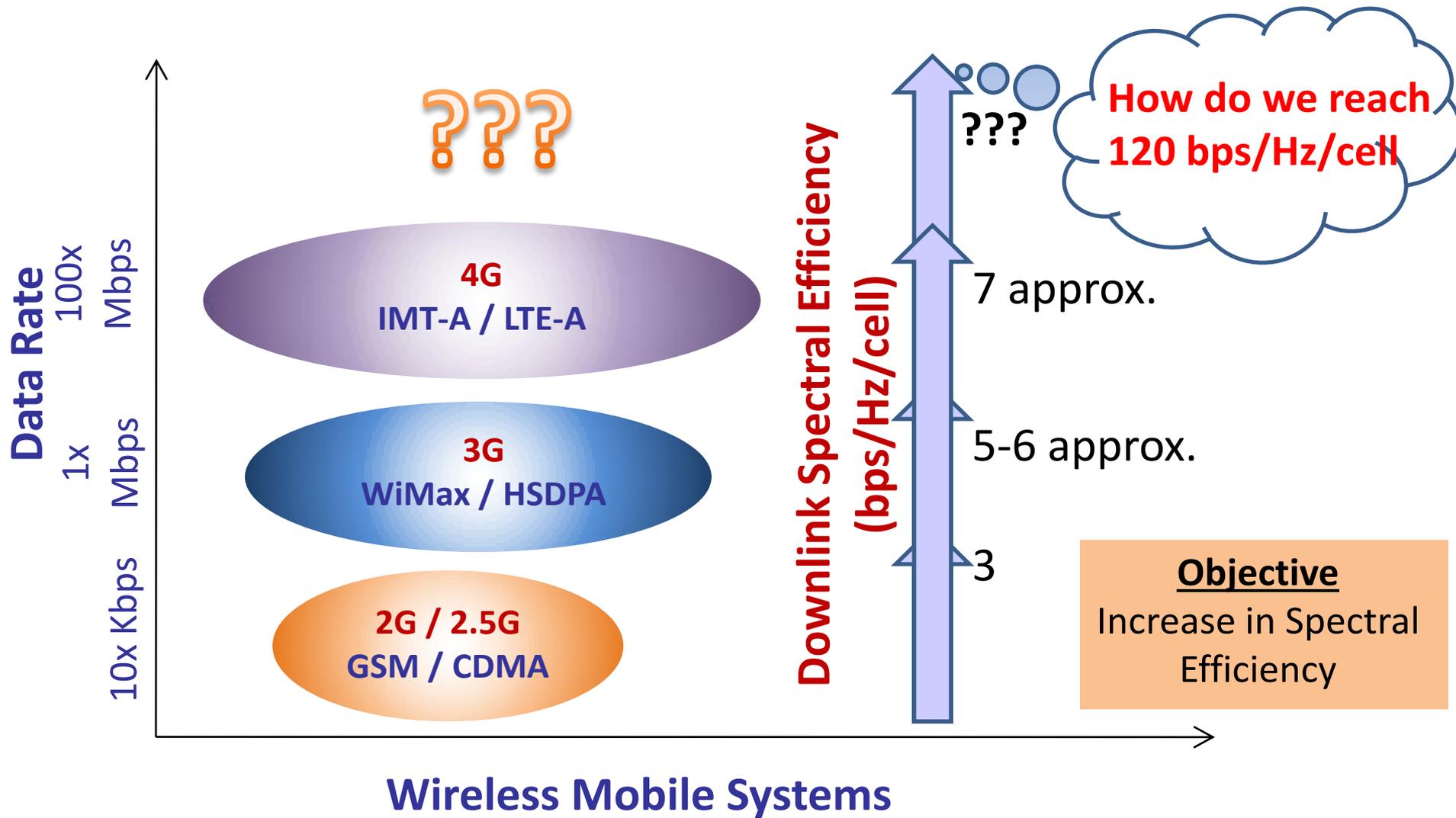
Future Wireless Broadband Demand

Broadband through Wireless – Mumbai Example

- Population density – 21k/sq. km

- Approx 34% wet land and forests

- Actual population density
  ~ 90-100k/sq. km in some areas
  or even more

- 25k households/sq. km

- Assume 100% households have
  broadband

- 2 Mbps per household

- Very high capacity required: 50Gbps/sq. km
  - Assuming 3-4 cells/sq. km (radius less than 500m)
  - We need about 12 Gbps per cell

Legend:
- Residential
- Commercial
- Mixed Landuse
- Industrial
- Public Semi-Public
- Transportation
- Water Bodies
- No development
- Reserve Forest
- Recreational/Gr.

With 100 MHz per cell (multiple operators and multiple technologies) ~ whopping 120 bps/Hz/cell !!!

Evolution of Wireless Systems

Data Rate

100x Mbps

1x Mbps

10x Kbps

???

4G
IMT-A / LTE-A

3G
WiMax / HSDPA

2G / 2.5G
GSM / CDMA

Downlink Spectral Efficiency (bps/Hz/cell)

???

7 approx.

5-6 approx.

3

How do we reach 120 bps/Hz/cell

Objective
Increase in Spectral Efficiency

Wireless Mobile Systems

What does India need for 5G?

- Can we have more efficient use of spectrum?
  - Cost is transferred to end-customer
  - Makes the solution unaffordable
- Do we need to support high-speed mobility (300 km/h)?
  - in cities 40-60 km/h; 80-100 km/h on highways
  - Mobility is required but Fixed Primary Access is key
- Do we need to address multiple device connectivity?
  - Urgent need is for primary broadband connectivity

We need a focussed and cost-effective solution!

Rethinking 5G Requirements

- Low cost solutions
  - Low Device costs
    - Simpler Hardware and RF Design reducing the device costs
  - Low cost Connectivity / backhaul solutions
    - Using wireless backhaul/middle mile instead of fiber
  - Lower spectrum cost
    - Efficient usage of spectrum
    - Using network sharing options to share spectrum across Radio Access Technologies (RATs) across operators

- Limited mobility support
  - Mobility is required but not very high speed
  - Fixed primary access is the key

Rethinking 5G Requirements (Contd.)

- Energy efficient solutions
  - Lowering system energy consumption
  - Support for operation in power saving mode
  - To enable working off non-conventional energy sources

- Large coverage area support
  - Support for large cells to reduce CAPEX and OPEX
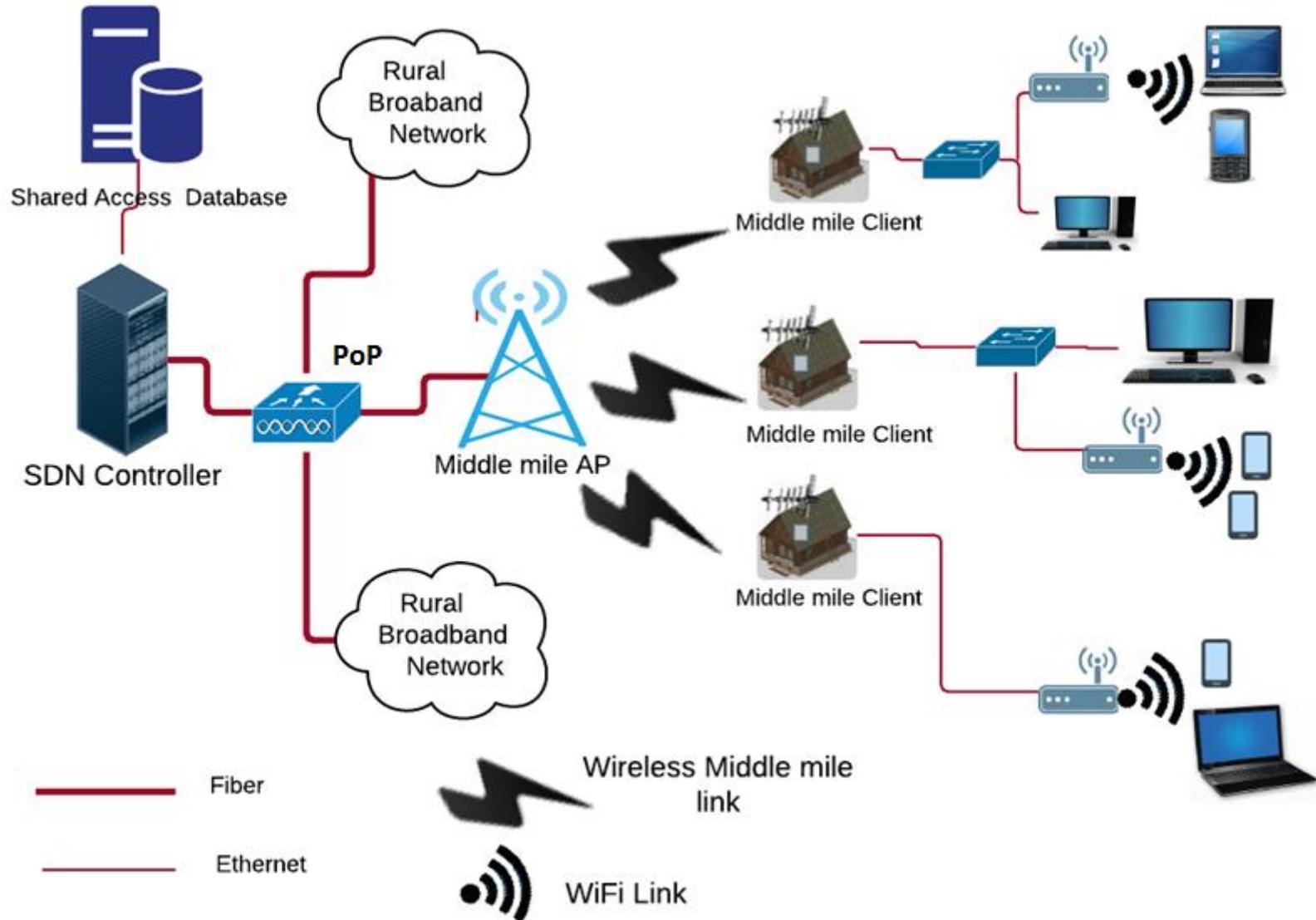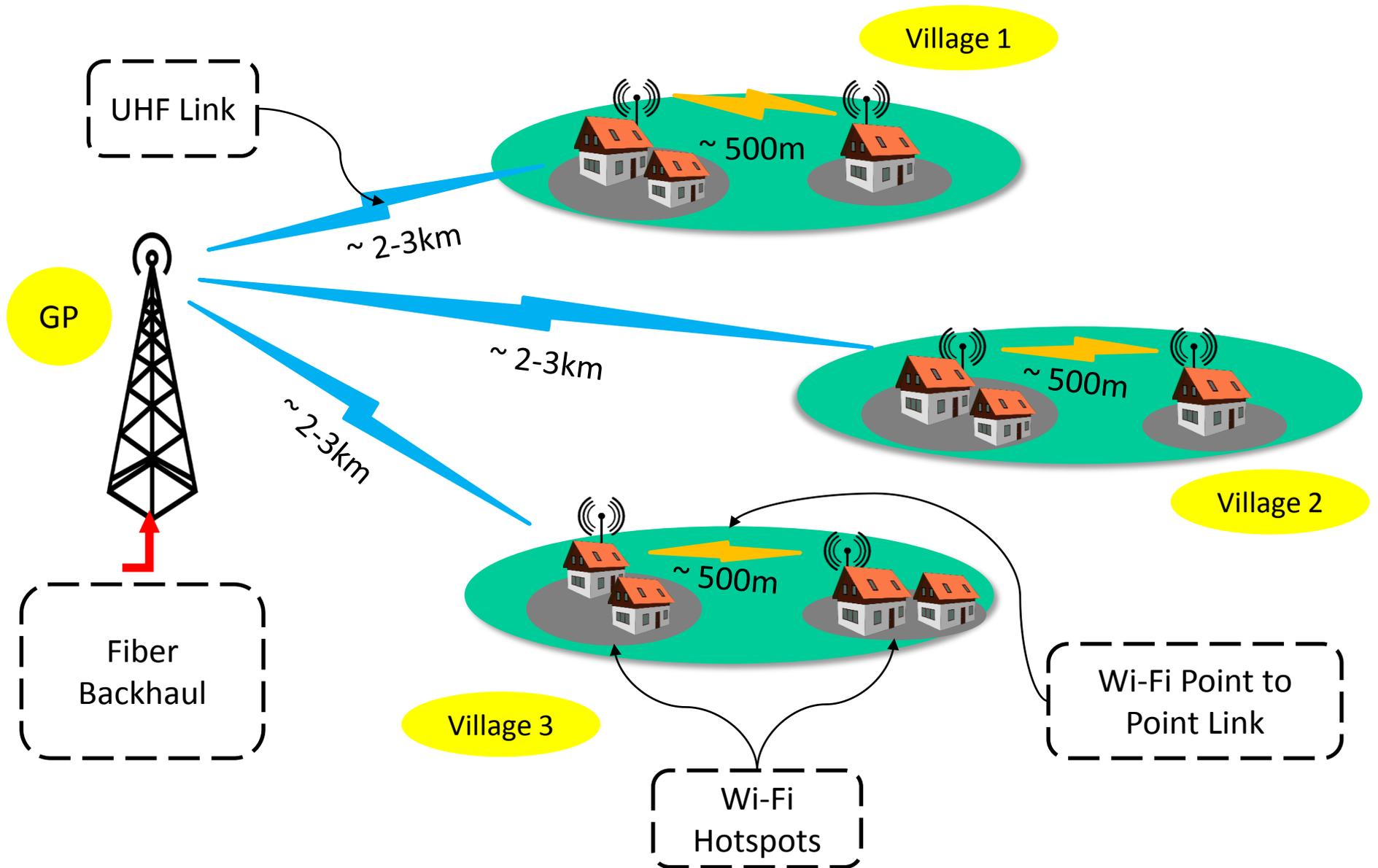
- Less stringent availability requirements

Frugal 5G – Envisioned Architecture

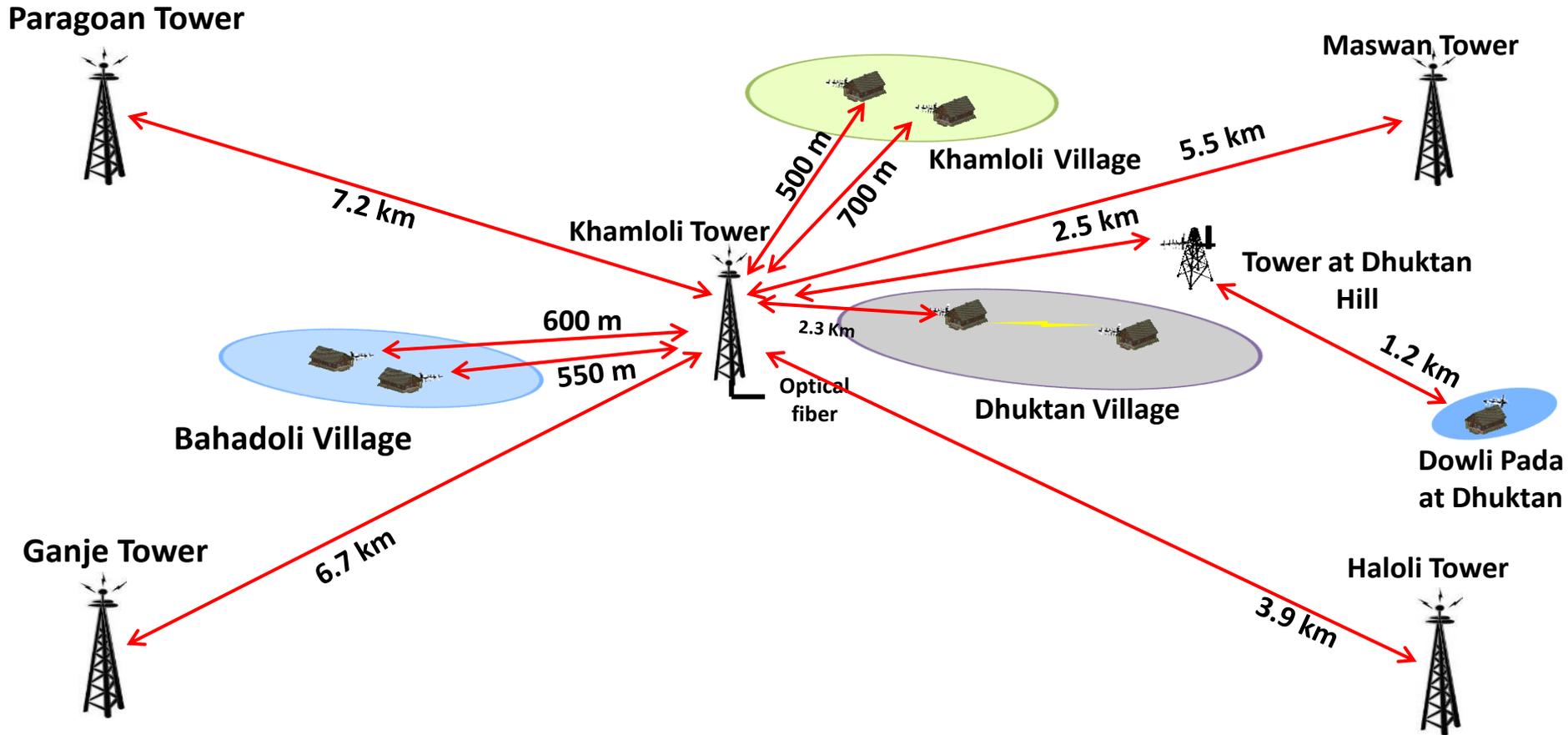# Rural Broadband

Network Topology of UHF TV Band Pilot at Palghar

Paragoan Tower

Maswan Tower

Khamloli Village

5.5 km

7.2 km

500 m

700 m

Khamloli Tower

2.5 km

Tower at Dhuktan Hill

600 m

2.3 Km

Bahadoli Village

550 m

Dhuktan Village

1.2 km

Optical fiber

Dowli Pada at Dhuktan

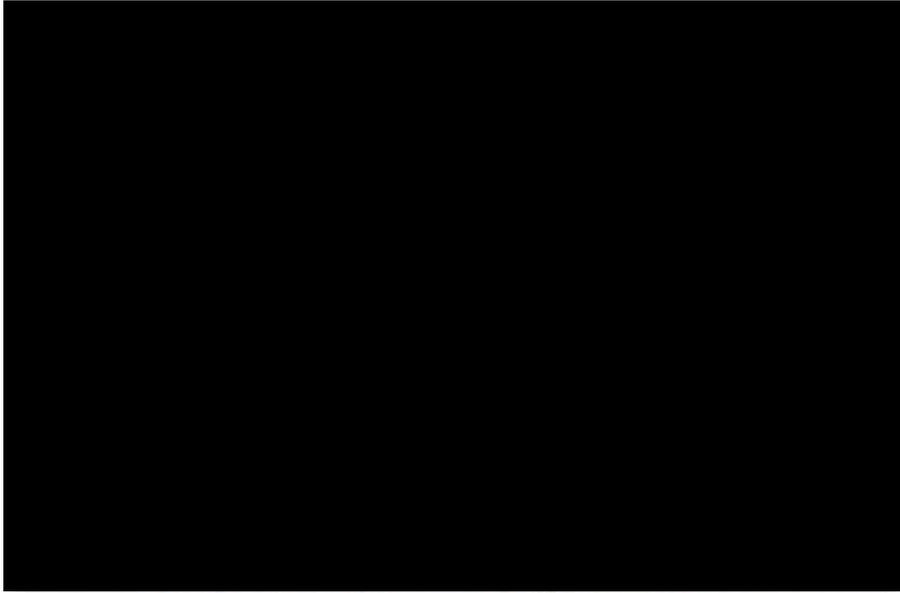**Ganje Tower**

6.7 km

Haloli Tower

3.9 km

Technology Development

# Our Deployment on Field

Villagers using Internet

Affordability status of Internet in India

- India is a lower middle income country
- GDP per capita at about US$ 1,800 in 2016
  - Approximately 22% of its population living below the national poverty line
- There are still areas where incomes are very low
  - Internet services would remain unaffordable for many at the bottom of the pyramid

Sustainable Finance Model:
Public Private Panchayat Partnership Model

4P Model

Panchayat

Public

Private
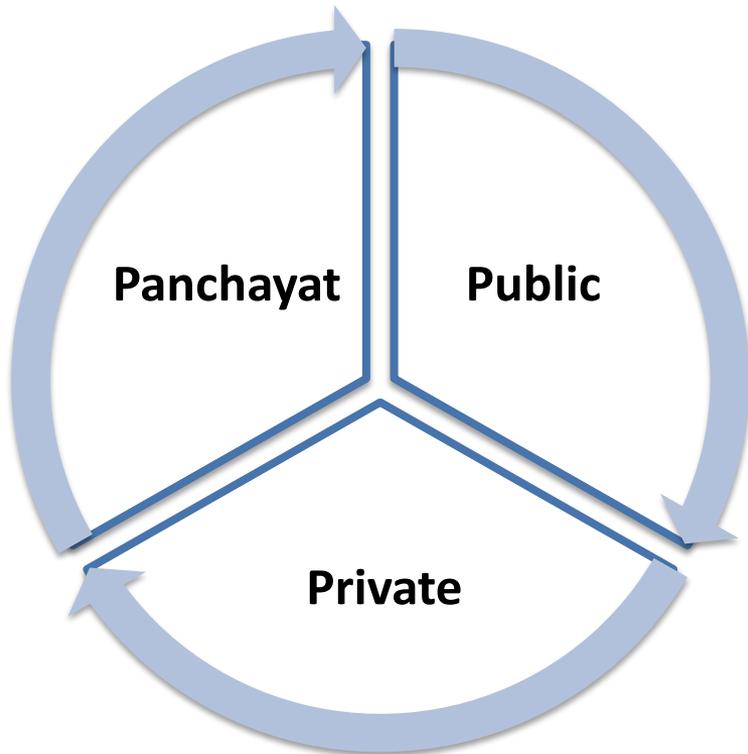
Multi stakeholder partnership model

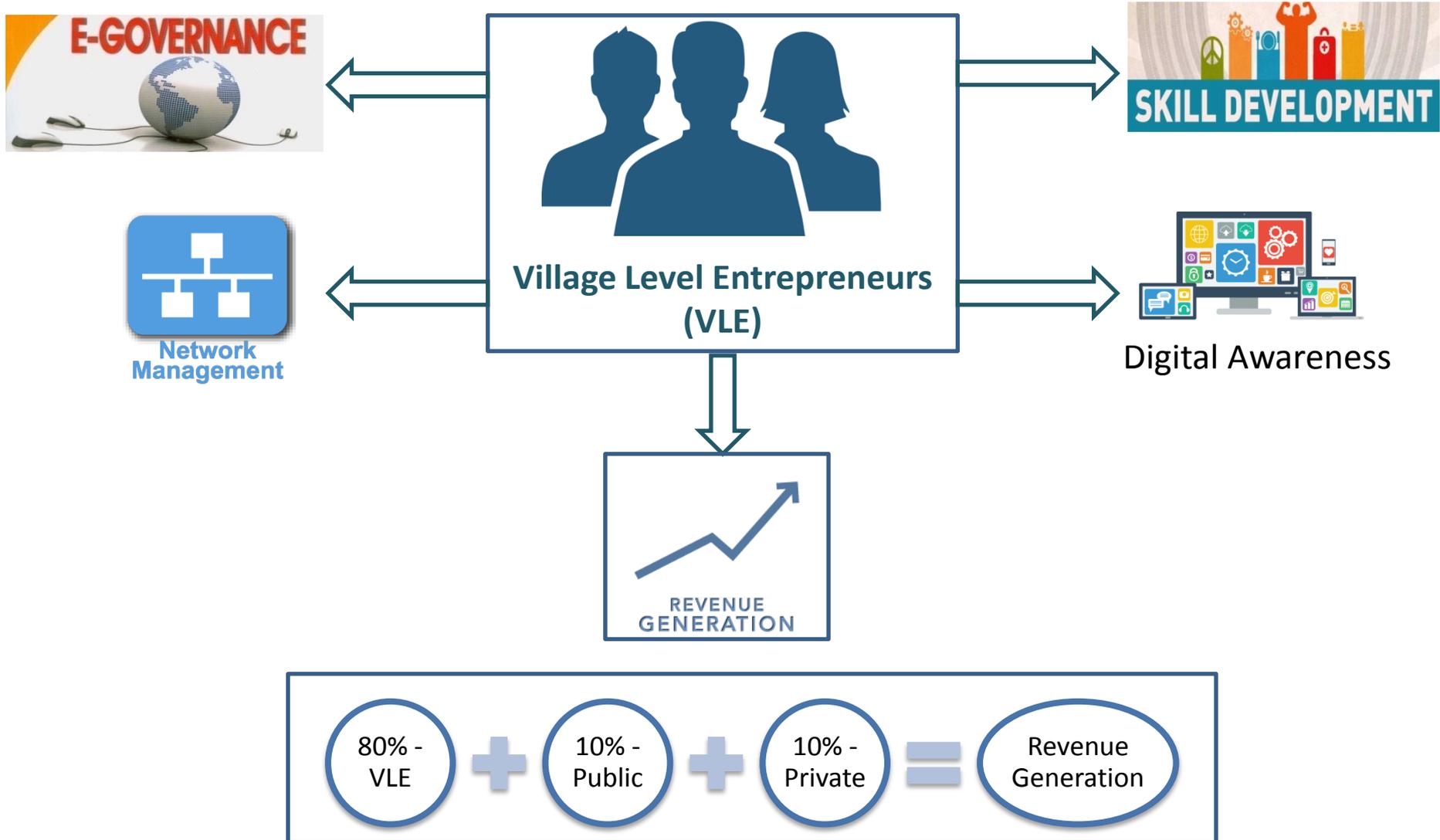Involvement of local entrepreneur and community

Recovering OPEX the key principle

Revenue sharing community model

Localised model (can be adapted to regions)

Modular and scalable model

Socio Economic Outcomes

E-GOVERNANCE

SKILL DEVELOPMENT

Village Level Entrepreneurs (VLE)

Network Management

Digital Awareness

REVENUE GENERATION

80% - VLE **+** 10% - Public **+** 10% - Private **=** Revenue Generation

GRAM MARG

Enabling Rural India Digitally

IEEE Activities related to Frugal 5G

- Frugal 5G Rapid Reaction Standardization Activity Phase
  - Pre-standardization study phase expected to be approved by IEEE ComSoc Board by the end of this month
- SDN based Middleware
  - Standards project P1930.1 approved in December 2016 by IEEE SA Board
  - Working Group formed

Frugal 5G – IEEE ComSoc RRSA Study

- Study & analysis of existing wireless broadband technologies
  - IEEE 802.11 WLAN, IEEE 802.22 WRAN, 3GPP-UMTS, 3GPP-LTE
  - Gap analysis with respect to following requirements
    - Low Cost Solution
    - Reduced Energy Consumption
    - Low Mobility scenarios
    - Usage of non-conventional energy sources

Meet our Team

Thank you