Rural Broadband Communication & Frugal 5G
Close to 1 billion people do not have broadband access in India. Penetration much lower in Rural India as compared to Urban India.

Source: Telecom Regulatory Authority India, as on 30th June 2017
Challenges in Connecting Rural India

- Low Average Revenue Per User
- Unavailability of Fiber Backhaul
- Intermittent Availability of Electricity
What does India need for 5G?

• Can we have more efficient usage of spectrum?
  – Spectrum Cost is transferred to end-user
    • Makes the solution unaffordable

• Do we need to support high-speed mobility (300 km/h)?
  – Vehicles moves @ ~40 km/h in cities; ~80 km/h on highways
  – Small % of people use vehicles in rural areas

• Do we need to address multiple device connectivity?
  – Urgent need is for primary broadband connectivity

A focussed and cost-effective solution is required!
Rethinking 5G Requirements

• Low cost solutions
  – Low cost Devices
  – Low cost Connectivity/backhaul solutions
    • Using wireless backhaul/middle mile instead of fiber
  – Lower spectrum cost
    • Efficient usage of spectrum/Usage of Unlicensed Spectrum
    • Using network sharing options to share spectrum across Radio Access Technologies (RATs) and operators

• Limited mobility support
  – Mobility is required but not high speed
  – Fixed primary access is the key

• 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
Rethinking 5G Requirements

- Low Cost
- Low Mobility
- Energy Efficient
- Large Coverage

Frugal 5G
Frugal 5G Research@IIT Bombay

• Investigation in
  • Small Cell based Solution for Rural Broadband Communication
    – Ultra dense deployment of WiFi Hotspots/LTE small cells
    – Backhauled using fiber or TV UHF/5.8GHz/mmWave band
    – Point-to-Multi-Point/Multi-hop Mesh Network as Middle-Mile
  • SDN based control and management of the network
  • Fog and Cloud Computing Paradigm for system design
    – Cloud based SDN controller
      » Control and Management of the Middle-Mile Network
    – Fog/Edge based SDN Controller
      » Local Controller at Middle Mile Client site
      » Backhaul Bandwidth Optimization
      » Content Optimization
  – Propose solution for standardization under IEEE
Frugal 5G Research@IIT Bombay – Fog & Cloud based Architecture

Cloud based Global Controller

Cloud

Internet

Fiber POP

Network controlled by the cloud based controller

UHF Middle Mile N/W LTE/802.x

WiFi Access Network

802.11ac Middle Mile

WiFi Access Point

Ethernet Link

Fog, controlled by the Fog/Edge Controller