



Twenty Eighth National  
Conference on Communications



# Workshop on “Standards Driven Research” at NCC 2022

24 May 2022, 1000-1700 IST



# Workshop on “Standards Driven Research” at NCC 2022

Participation of Academia in Standards Driven Research

Frugal 5G Networks (IEEE P2061)

How our research in rural broadband communication led to  
standardization work under IEEE

By

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# Agenda

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- Background
  - Gram Marg @ IIT Bombay – led by Prof Abhay Karandikar
- Key Challenges to Rural Broadband Connectivity
- Rethinking 5G Requirements for Rural Connectivity
- Solution for Rural Connectivity
- Frugal 5G Networks - IEEE P2061

# Connecting the Unconnected - Key Challenges

## Sparsely Populated Settlements

Small Clusters of Population within vast open spaces



## High CAPEX & OPEX

Spectrum cost

Cost of backhaul

## Scarcity of Resources

Uninterrupted electric power supply from the grid

Low Average Revenue per user

## Challenges of Manageability

Unavailability of trained manpower

# Rethinking 5G Requirements for Rural Areas

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- Large coverage area support
- High speed connectivity to clusters of population
- Affordable solution
  - Low cost backhaul solutions - Wireless backhaul instead of Fiber
  - Lower spectrum cost – Unlicensed spectrum
  - Energy efficient solution – Wi-Fi (WLAN)
- Mobility Support not very important
  - Mobility required but not very high speed
  - Only a small % of mobile users

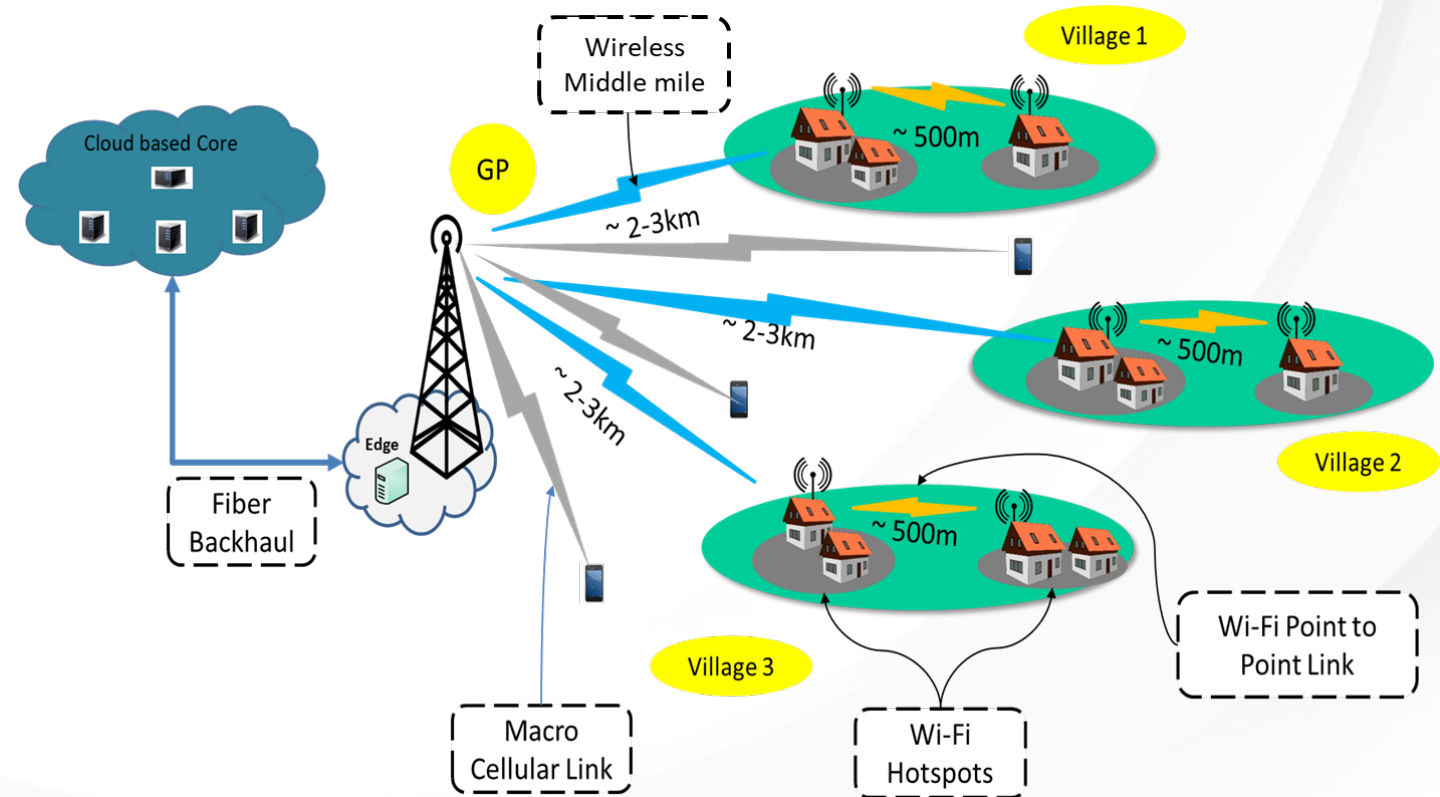
# Rural Broadband Network - Architecture

Large Coverage Area Cells (5G/LTE) to provide ubiquitous connectivity

Small Cells (WiFi Hotspots) as high speed access points

Wireless Middle Mile Network to backhaul data from Wi-Fi APs

Heterogeneous Networks (Large Coverage area cells along with small cells)



“Towards Enabling Broadband for a Billion Plus Population with TV White Spaces”

Animesh Kumar, Abhay Karandikar et.al.,  
IEEE Communications Magazine, July 2016

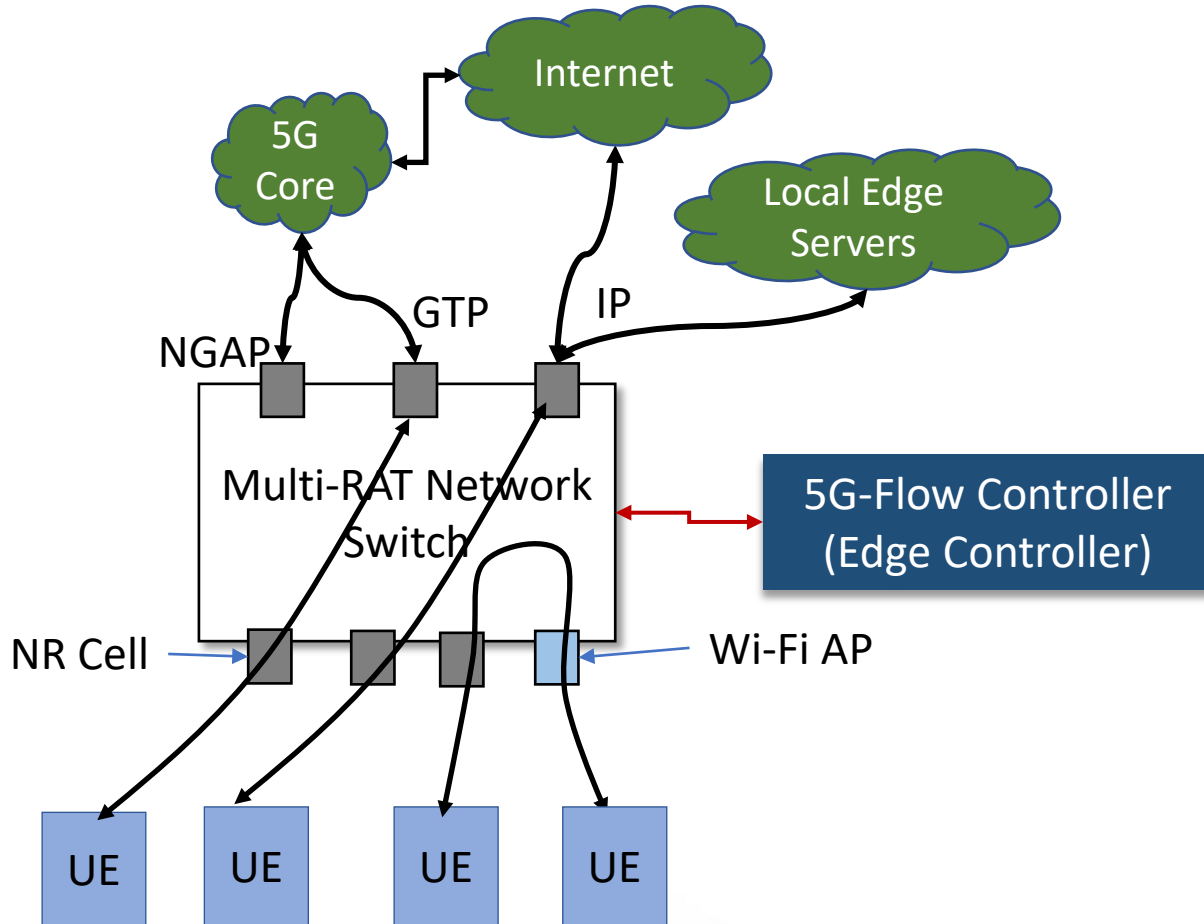
“Connecting the Unconnected: Towards Frugal 5G Network Architecture and Standardization”

Meghna Khaturia, Pranav Jha and Abhay Karandikar  
IEEE Communication Standards Magazine, June 2020

# Rethinking 5G Requirements for Rural Areas (contd.)

- Cellular mobile network has two key parts – RAN and Core
  - RAN (distributed) used for - last mile access
  - Core (centralized) used for
    - User mobility
    - RAN control
    - Authentication and Access control
- Core and RAN tightly coupled in existing cellular networks
  - Cellular RAN can't work in a standalone manner (w/o Core)
- Usage of Core Network - Is it always necessary?
  - e.g., for users not mobile or with limited mobility (within a village)?
- Edge computing and communication (w/o Core) in rural networks
  - Support localized service delivery and communication
  - Local authentication and access control
- Can we decouple RAN from Core?

# 5G-Flow - Intelligent Edge Control

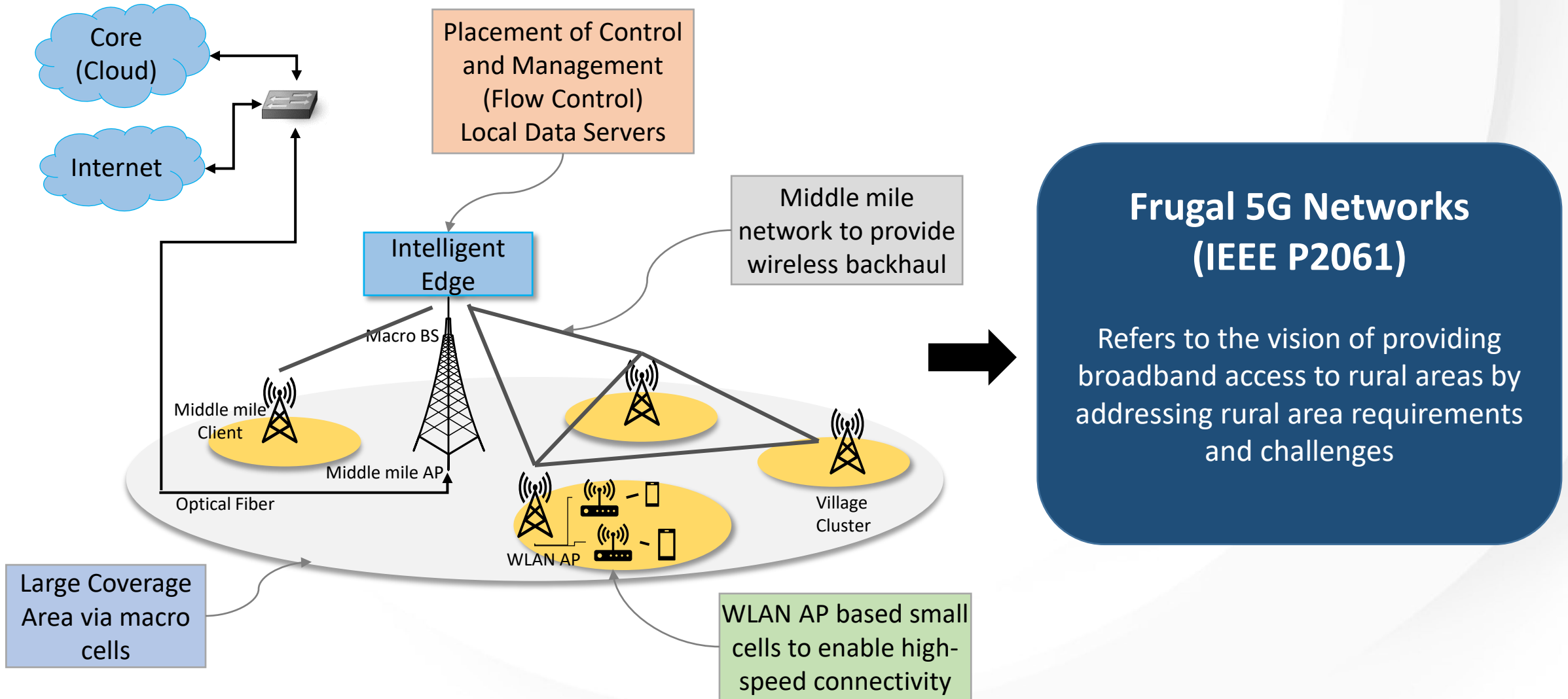


5G-Flow Network architecture allows usage of cellular technologies (5G NR...) without involving CN

- UE's connectivity with RAN decoupled from it's connectivity with CN
- UE-Core communication as an Overlay
- 5G-Flow controller sets up the flow entry and creates data bearers at RAN to enable direct connectivity with Internet and localized communication within RAN
- Service Delivery from Edge



# IEEE P2061 Frugal 5G Networks (*Bringing together different elements as part of IEEE standards*)



# IEEE P2061 Architecture - Key Working Principles

- **Heterogeneous Network with Unified Access Control**
  - Unified control of macro cells, small cells and wireless middle-mile
  - Wireless backhaul integration
  - Path set up either through macro cell or middle-mile and WLAN
- **Decoupled RAN and Core**
  - Direct Internet connectivity support from RAN (w/o Core)
  - Optional connectivity to Core
- **Intelligent Edge**
  - Localized communication support within RAN
    - End-to-end data path may be fully contained within a single edge element
    - Reduced end-to-end latency
    - Optimized resource utilization
    - Improved network resilience



# Thank You

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