



# Research Agenda for Next Generation Broadband Wireless Access in India

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# Digital Divide



Population Density Map  
(source: [www.reliefweb.int](http://www.reliefweb.int))

- 600 Million Cellphone subscribers
  - Only 30% subscribers from rural India
- Low Geographical Coverage
  - Only 60% of India
  - 25% of villages covered
- Very Low Broadband penetration

# TRAI Recommendation: An approach to rural telephony (March 2009)

Broadband practically non-existent in rural India

USOF schemes suggested – high speed Internet access, e-governance, ICT application

Wireless broadband as preferred mechanism

**Wireless  
Broadband**

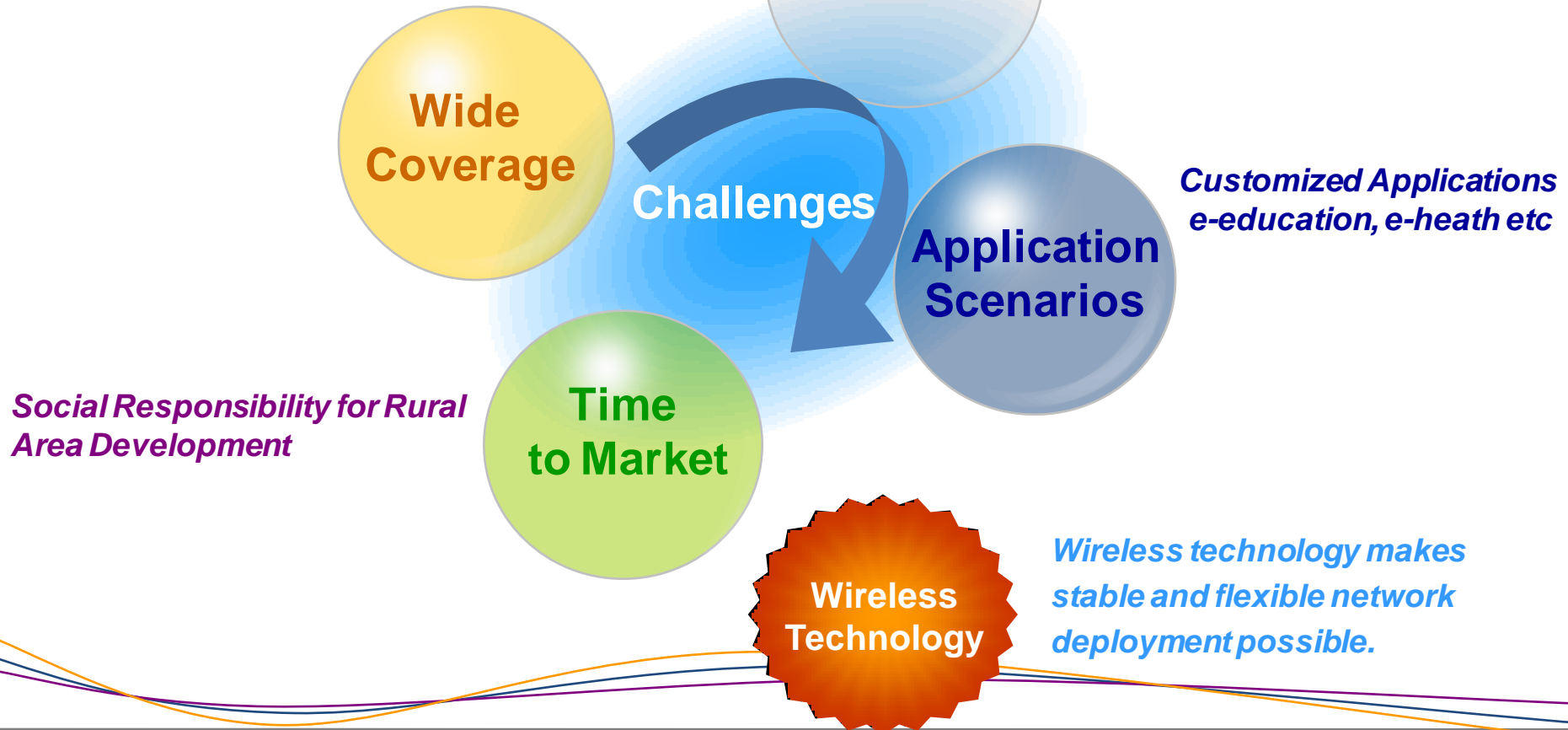
**USOF  
Schemes**

**Suggested Measures for accelerated growth**

# Challenges to Bridge Digital Divide

*Wide Spread and Low Density of Potential Customers*

*Lack of Transmission, Power*



# Technical Challenges: Driving Research Agenda

## **Backhaul connectivity**

Low cost wireless backhaul

## **Low ARPU**

Low cost infrastructure  
Tight integration with IP  
Infrastructure sharing

Technical  
Challenges

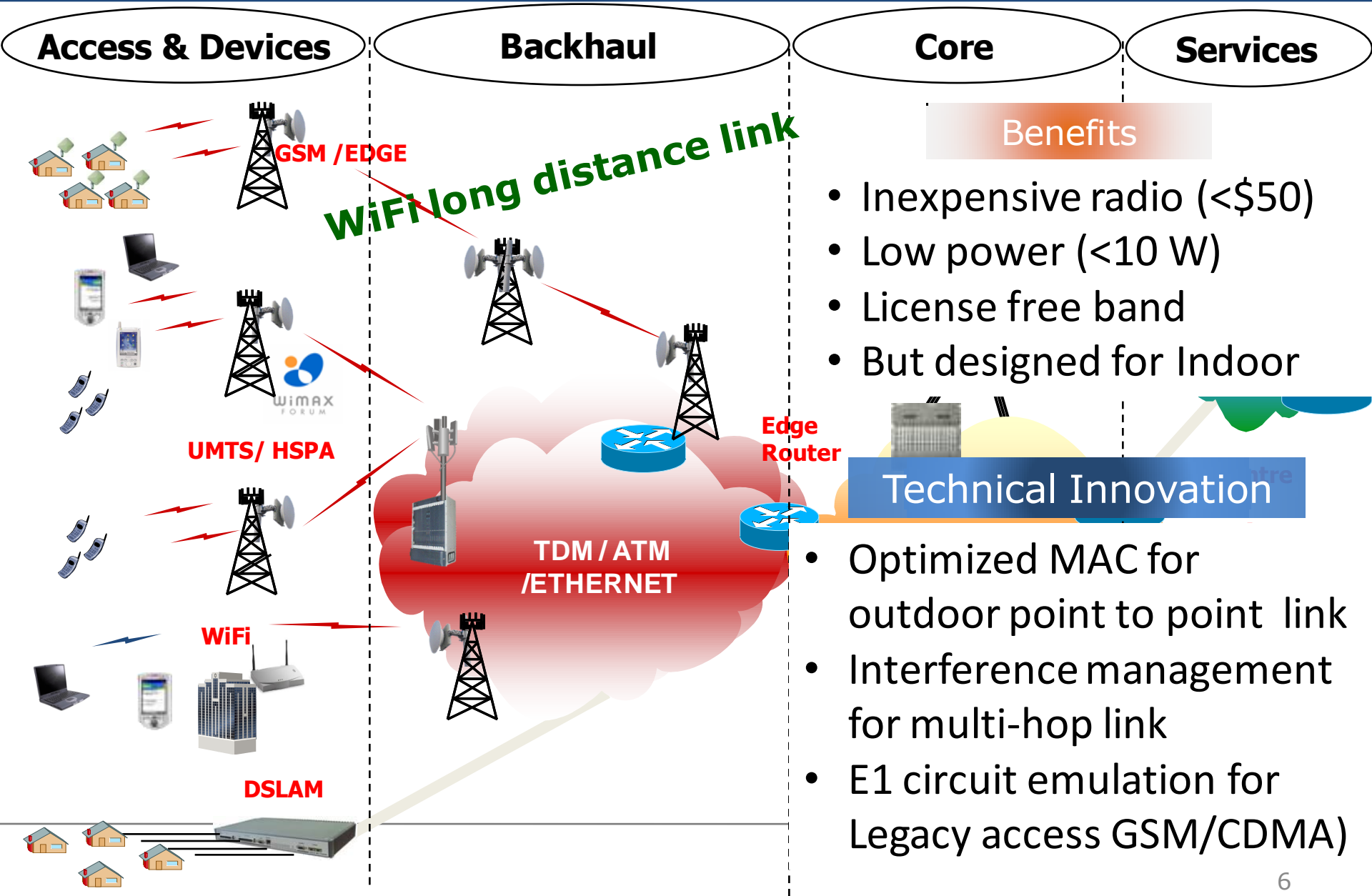
## **DSL like experience**

Architecture for high speed  
High speed spectral efficiency at cell edge

## **Power Supply**

Very high energy efficiency

# Backhaul



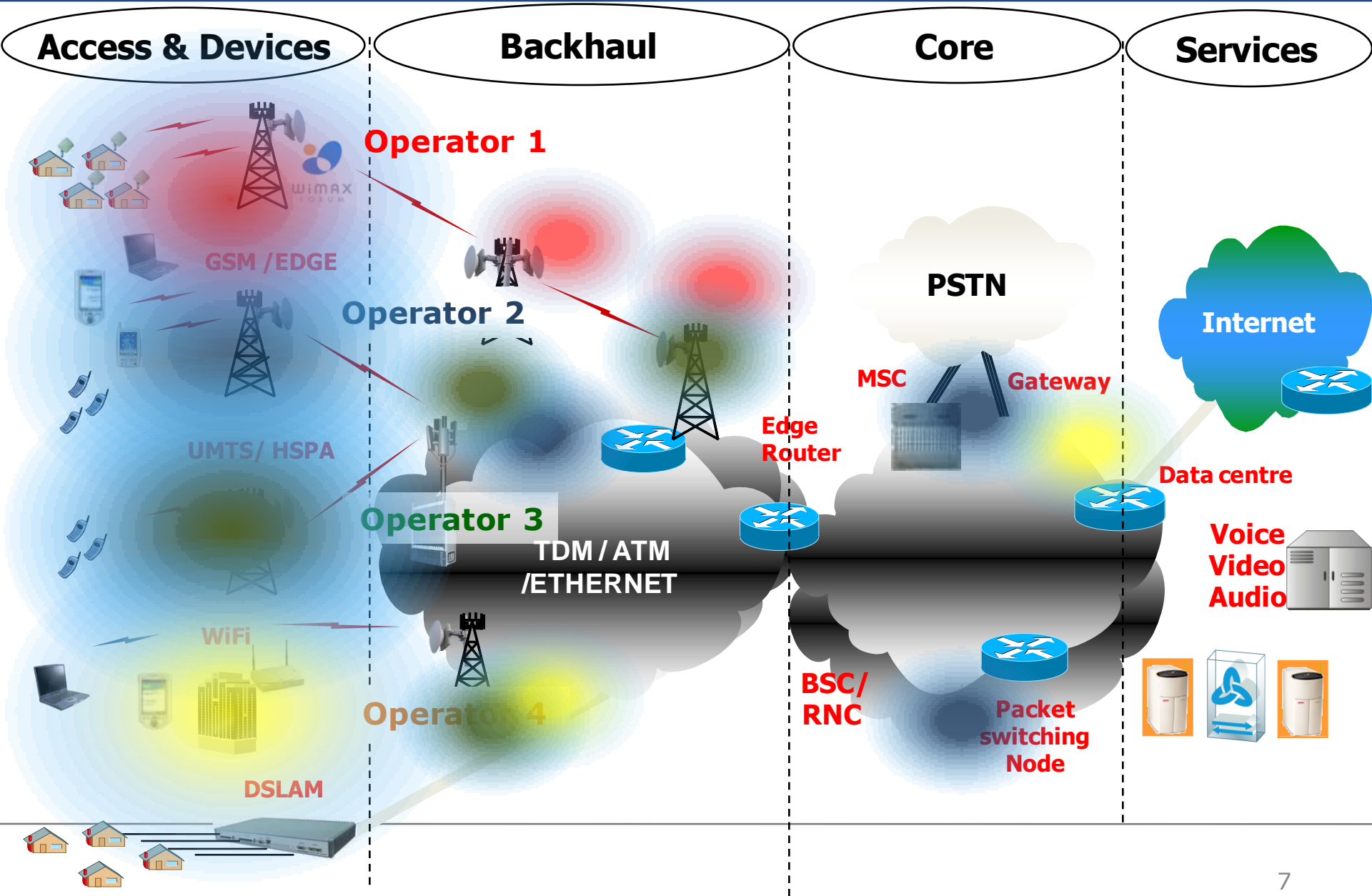
## Benefits

- Inexpensive radio (<\$50)
- Low power (<10 W)
- License free band
- But designed for Indoor

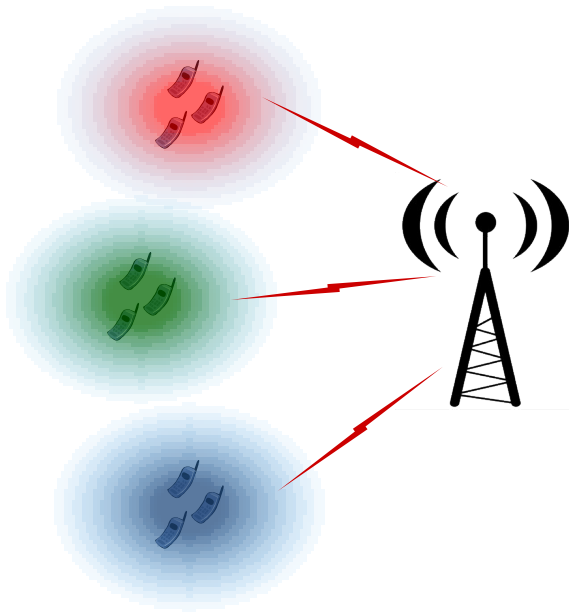
## Technical Innovation

- Optimized MAC for outdoor point to point link
- Interference management for multi-hop link
- E1 circuit emulation for Legacy access GSM/CDMA)

# Multi Operator Network



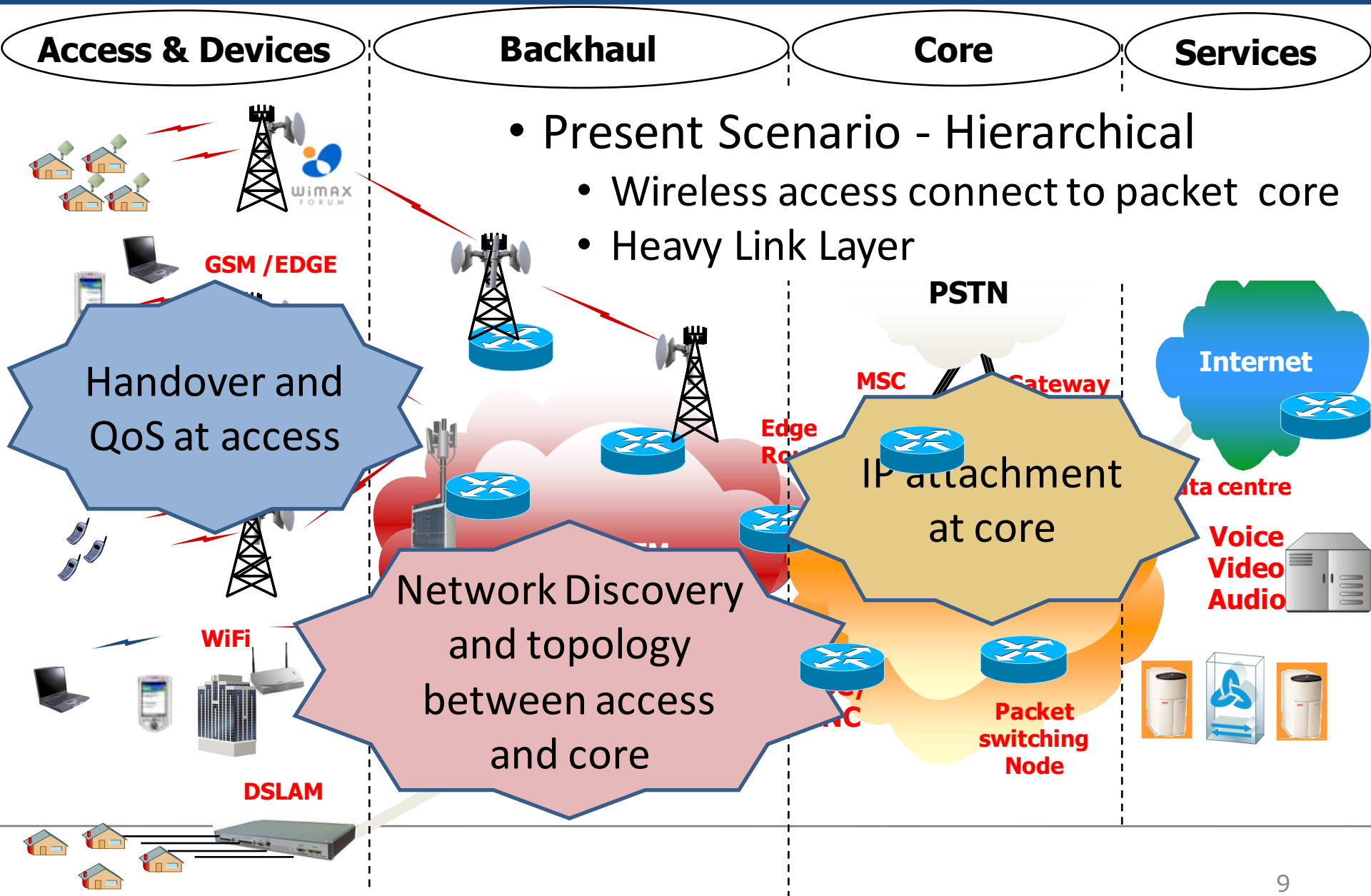
# Virtual Radio Access Networks



- Active Infrastructure Sharing
  - Reduce BoM for RF equipment
  - Improve energy efficiency
  - Optimize backhaul infrastructure
  - Load share ‘roaming’ between operators
- Technical Innovations
  - Intelligent switching to route and bill the user’s traffic
  - Spectrum management
  - Interference management

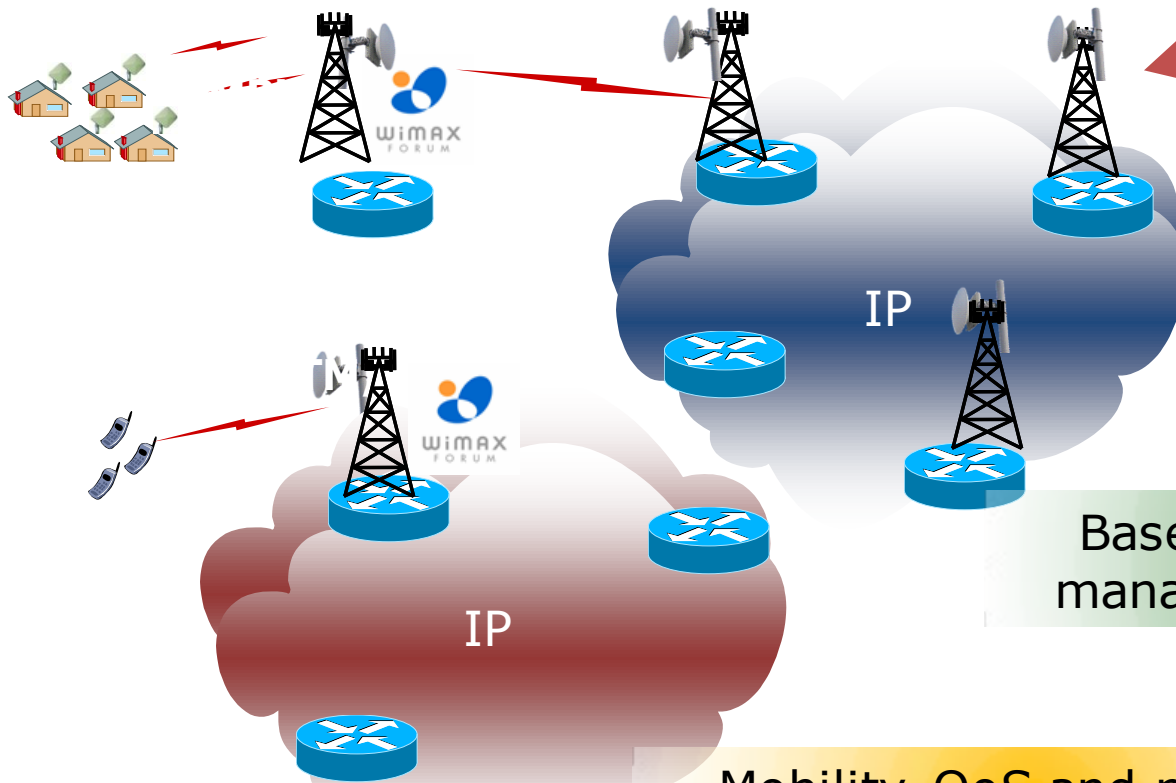


# IP over Distributed Cellular Architecture



# New Paradigm

Wireless access network as  
IP network of base stations



Self Configuring  
Distributed Architecture

Base station cooperate to  
manage topology discovery

Mobility, QoS and network  
discovery managed at IP layer

# Summary

- Backhaul innovations- key to increasing rural coverage
  - FRACTEL project in TTSL-IIT Bombay Center for Excellence in Telecom
- Low cost IP based distributed architecture can bring down cost
  - On going research in IIT Bombay
- Active infrastructure sharing and energy efficient mechanisms also critical for wide spread deployment