Role of Wi-Fi 6 in Broadband Access and Need for New Spectrum

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Agenda

- Internet Connectivity Status
- Wi-Fi 6 – Technical Attributes
- Public Wi-Fi Networks and PM-WANI
- Wi-Fi 6, WiFiGig and 5G
  - 5G Use Cases/Services and Wi-Fi 6
- Rural Broadband Connectivity
  - Rural Broadband Connectivity in India - Challenges
  - IEEE P2061 Network Architecture
  - BharatNet

The Pandemic Reinforced the Need for Improved Connectivity

JANUARY 19, 2021

When internet comes home: E-learning in Indian villages during COVID-19

As learning went digital due to COVID-19, a group of teachers working in India's villages took internet to people's homes, making education more inclusive.

by SMITA AGARWAL | 4 min read

COVID-19
A wake-up call for Indian Internet Service Providers

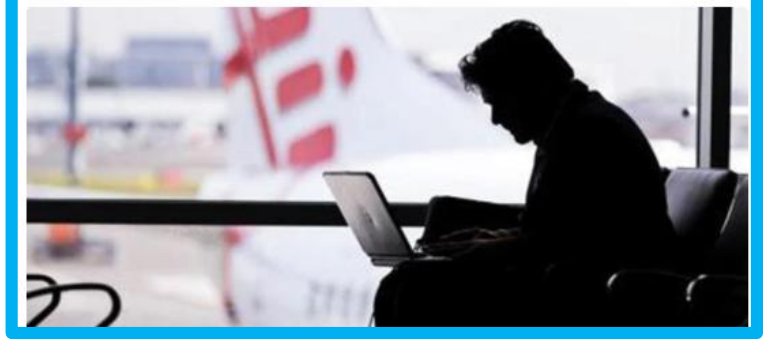
INDIAN STUDENTS EXCLUSIVE

QS I-GAUGE

INDIA NEWS

India's internet consumption up during Covid-19 lockdown, shows data

Data from the department of telecommunications showed that between March 22 and March 28, Indians consumed an average of 307,963 TB or 307 petabytes (PB) of data.



Business Standard SPECIAL ON CORONAVIRUS

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Connectivity for corona crisis

Prime Minister Narendra Modi's call for COVID-19 Solution Challenge on MyGov is a welcome effort towards involving private sector in times of a national crisis

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Covid-19 pandemic risks a lost generation in India as digital divide widens

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Explained | Increase in digital connectivity but there are many who are still left out

Priscilla Jebaraj

NEW DELHI, NOVEMBER 15, 2021 01:45 IST
UPDATED: NOVEMBER 15, 2021 11:22 IST

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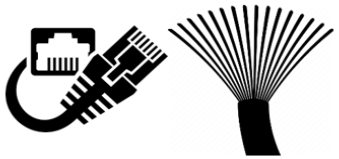
Internet/Broadband Access- How is it enabled?

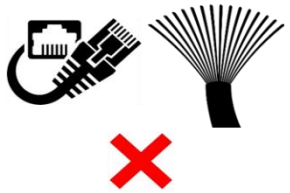
Developed Countries



Mostly enabled through wired communication infrastructure, Fiber and DSL

Developing Countries

Cellular Technology - Primary broadband access mechanism



Fiber/DSL Infrastructure - Inadequate

Challenges in using Cellular Technology in Rural Areas

- Focus on urban usage scenarios
- Limited support for rural connectivity requirements in specs
- No compelling commercial reasons to target rural areas

Public Wi-Fi Networks

- Wi-Fi Technology Usage by Mobile Users
  - Major Economies : 50 -70% of Total Usage Time
  - India : < 10%
- Public Wi-Fi Hotspots
  - Expected to reach 600+ million in 2023

Ref: TRAI Recommendations on Proliferation of Broadband through Public Wi-Fi Networks
Cisco Annual Internet Report (2018–2023)

Public Wi-Fi Networks – Policies in India

- National Digital Communication Policy 2018
  - Wi-Fi Hotspots - Key Mechanism for Broadband Proliferation
- TRAI Recommendations on Public Wi-Fi Networks
  - Promote Open Public Wi-Fi Access
- Prime Minister's WiFi Access Network Interface (PM-WANI) on December 09, 2020
  - Provision of Public WiFi Hotspot Providers
    - Public Data Office (PDOA), PDO Aggregator
    - Currently ~56K WiFi hotspots deployed under PM-WANI

Data Volume in 2027 – Estimates for India

- Data Traffic Estimates for Users - India 2027
  - Most households likely to have broadband access by 2027
  - Conservative Estimates
    - Assuming ~linear growth
  - Realistic Estimates
    - Inline with other forecasts
- Even a conservative estimate indicates
  - Huge data volume by 2027
  - ~23 Exabytes monthly
  - ~275 Exabytes annually

Mobile Data Traffic Estimation (India) (Human Users)

Parameter	Value	Unit	Remarks
India Population	1,40,00,00,000	-	Rough estimate (Internet Data)
Total No of housholds in the country	35,00,00,000	-	Average 4 persons/household
Conservative Estimate			
Contention Ratio	0.1	-	One family out of 10, accessing Internet at a time
Required Data Rate/household	2	Mbps	
Required Data Rate for the country (bits/s)	70,000	Gbps	
Monthly Data Requirement of the Country (total data)	23	Exabytes	
Realistic Estimate			
Contention Ratio	0.1	-	One family out of 10, accessing Internet at a time
Required Data Rate/household	5	Mbps	
Required Data Rate for the country (bits/s)	1,75,000	Gbps	
Monthly Data Requirement of the Country (total data)	57	Exabytes	

Wi-Fi 6 - Key Technical Attributes

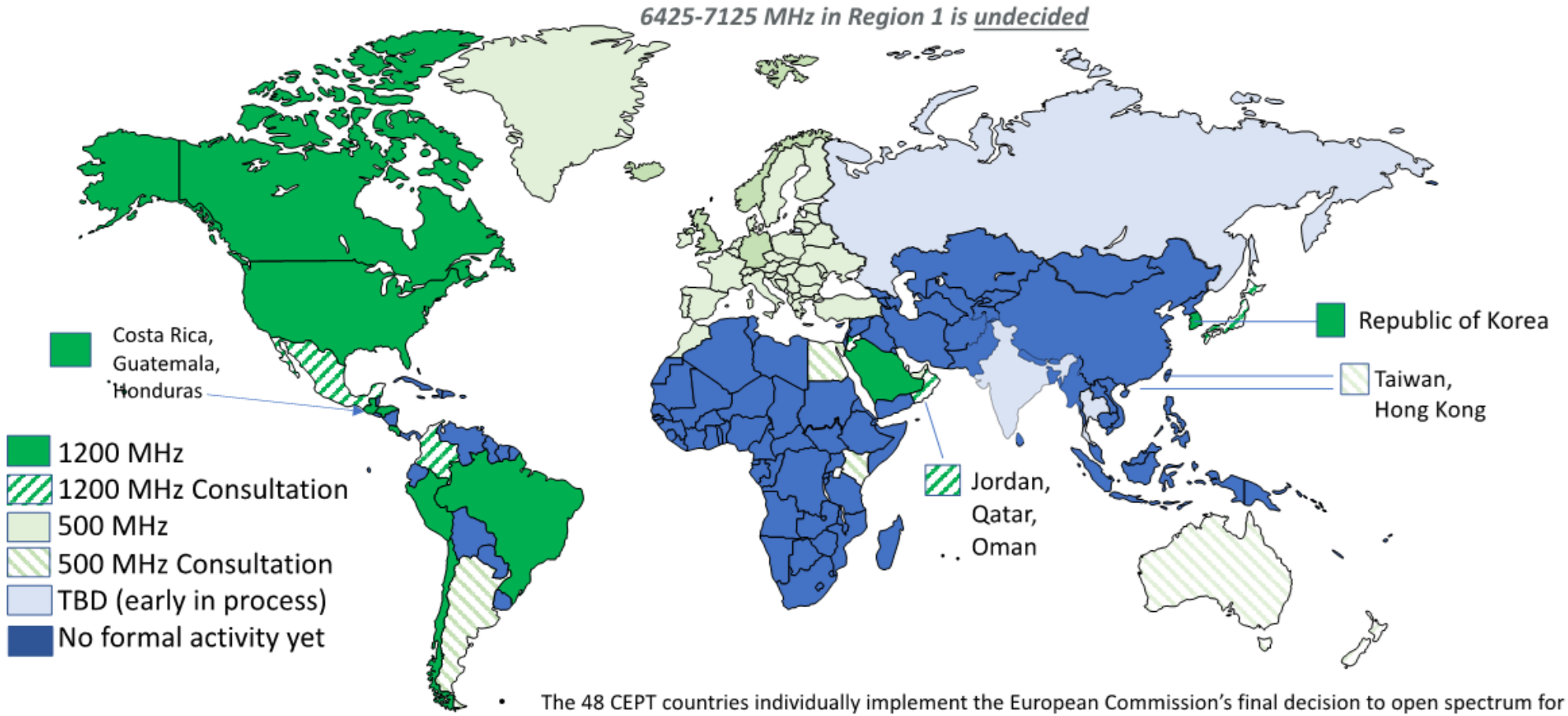
- Dual-band
- OFDMA Support
  - Large Number of Subcarriers - 1024
  - Long Symbol Duration - 12.8 µs
  - High Modulation Order - 1024 QAM
- Data Rate - 9.6 Gbps
- Large Channel Bandwidth – Up to 160 MHz
- 8x8 MU-MIMO - Both Downlink and Uplink
  - Supports Up to 8 users Simultaneously
- Uplink Resource Scheduling by Access Point
  - Centralized Scheduling – Improved Contention Handling

Wi-Fi 6/6E and 5G Use Cases

- Wi-Fi 6/6E – Important Access Technology for 5G
  - Support for 5G Use Cases (Esp. Stationary & Low Mobility Users)
- Wi-Fi Integrated with 5G Core as Non-3GPP Access
  - Shown Later
- Excellent Support for Public Wi-Fi and eMBB Use Cases
  - Hotspots
  - Work in Cloud
  - Online Classroom
  - HD Video, Conferencing
  - Virtual Reality
  - Social Networking
- Support for IoT Use Cases
  - Smart Homes
  - Smart Cities

6 GHz License-Exempt Spectrum Allocation as of September 15

Pending decisions in APAC: Australia, Hong Kong, Japan, Malaysia, New Zealand and Taiwan



- The 48 CEPT countries individually implement the European Commission's final decision to open spectrum for unlicensed. Some will proceed by consultations, while others will adopt the decision by an administrative change. The 27 European Union Member States, all of which are also CEPT members, will implement the European Commission's final decision to open spectrum for unlicensed on or before December 1st, 2021.

6 GHz Spectrum Situation in India

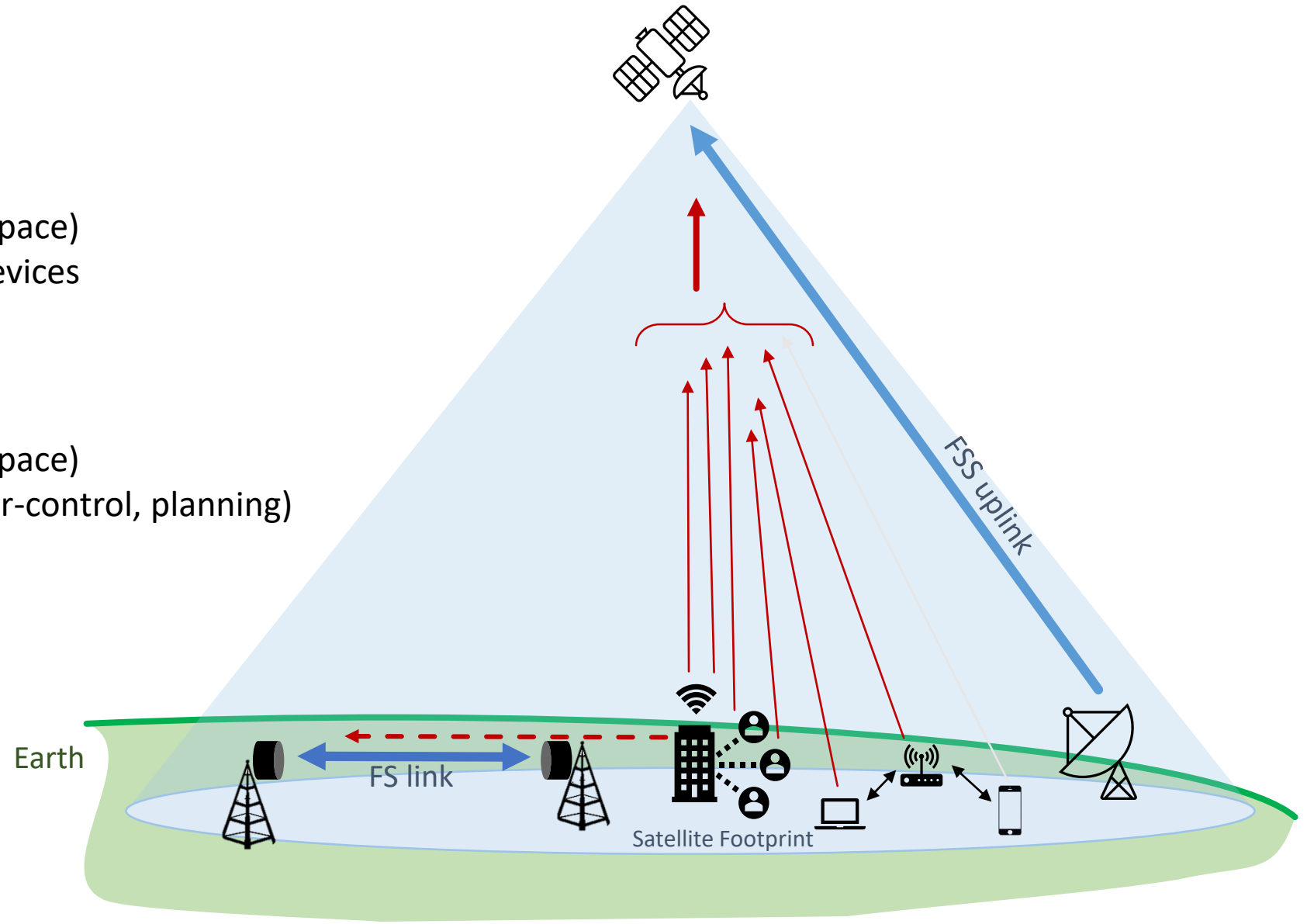
Spectrum Allocation in India		
Spectrum Band	**Services**	**Remarks**
5925 – 6700 MHz	Fixed Fixed Satellite (Earth-to-space) Mobile	Note 1
6700 – 7075 MHz	Fixed Fixed Satellite (Earth-to-space) (space-to-Earth) Mobile	Note 1 Note 2 Note 3
7075 – 7125 MHz	Fixed Mobile	Note 1

Note 1:	6425-7075 MHz: passive microwave sensor measurements are carried out over the oceans.
	7075-7250 MHz, passive microwave sensor measurements are carried out.
Note 2:	In making assignments in the band 6700-7075 MHz to space stations of the fixed-satellite service, administrations are urged to take all practicable steps to protect spectral line observations of the radio astronomy service in the band 6650-6675.2 MHz from harmful interference from unwanted emissions.
Note 3:	The space-to-Earth allocation to the fixed-satellite service in the band 6700-7075 MHz is limited to feeder links for non-geostationary satellite systems of the mobile-satellite service.

Coexistence with FS and FSS

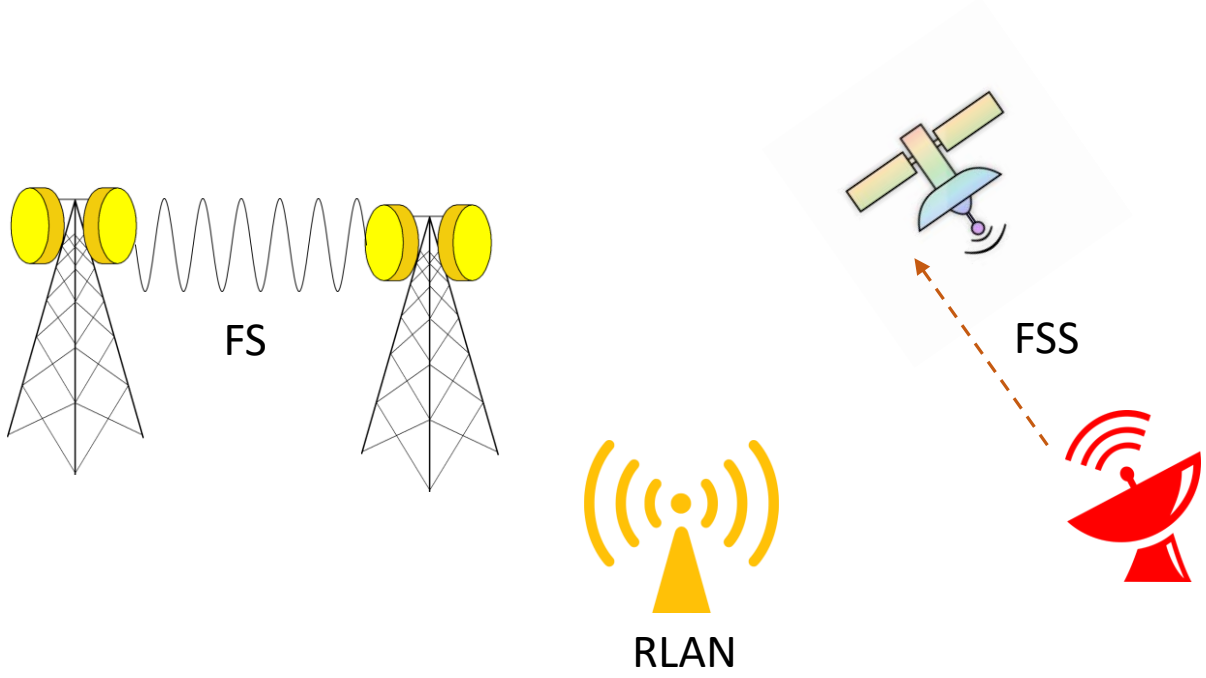
1. RLAN interfering into FSS (Earth-to-space)
   - Collective effect of all RLAN devices within Satellite Footprint

2. RLAN interfering into FSS (Earth-to-space)
   - Coordination (database, power-control, planning)



Coexistence Study

- Coexistence study undertaken by Broadband India Forum (with my inputs and advice)
- Objective
  - Study sharing between RLAN devices in 6 GHz band (5,945-7,125 MHz) and Fixed Service (FS) microwave stations in India and Fixed Satellite Service (FSS) uplinks over India
- Methodology: Monte-Carlo simulation where in each iteration,
  - Drop simultaneously active RLANs in proportion to the population density (per GWPv4)
  - Assign to each RLAN an EIRP, body loss (if client), bandwidth, center frequency, and height from the distributions
  - Use statistical propagation models
  - FS: compute I/N from all RLANs in India within 150km of each FS
  - FSS: compute I/N from all RLANs within the satellite view



Conclusion: RLAN devices across all types and frequency channels do NOT cause interference to FS or FSS links

RLAN Parameters for the Study

Channel Bandwidth

Independent

BW: 20-160 MHz

Indoor v/s Outdoor

Independent

Static assumption.
Market Survey
- Indoor: LPI/Std
- Outdoor: Std
- VLP

EIRP

Body Loss

Dependent on Indoor/Outdoor

- LPI: Indoor
- Standard Power: Outdoor

Height

Dependent on Indoor/Outdoor, Urban/Rural

Building height

Urban / Rural

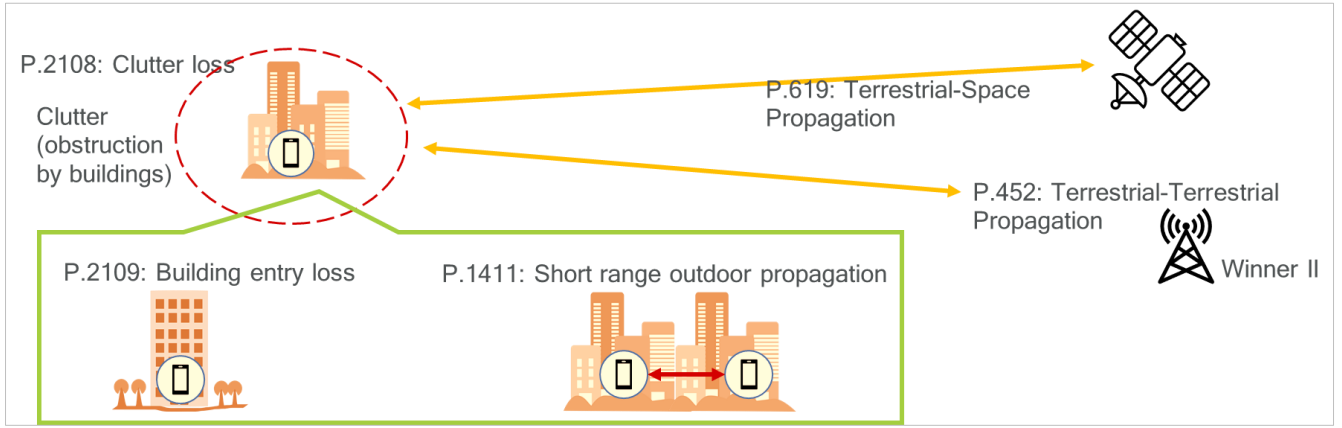
Independent

Country Statistics

Used for
1. RLAN drop calculation
2. Propagation Model choice

Parameter	Values
Total Population (2025 UN estimates)	1.4 Billion
Devices per person	10 (1 high capacity + 9 IoT)
Total Wi-Fi devices	14 Billion
Existing Wi-Fi Spectrum (2.4 and 5 GHz)	560 MHz
New Spectrum considered	1200 MHz
Market Penetration of 6 GHz	45%
Devices utilizing 6 GHz	68.18% (1200/(560+1200))
Total 6 GHz devices considered in study	4.4 Billion

Choice of Propagation Models



FS Sharing

- Considered two typical scenarios
  - Urban (Delhi NCR)
  - Rural (Alwar)
- Assumptions
  - Assumed FS link parameters from TEC
  - FS link locations from Base Station data set
- Simulation over 100k Monte Carlo Simulation runs
- Conclusions
  - Low average I/N occurrence probabilities

Scenario	I/N > 6 dB	I/N > 0 dB
Alwar	0.015 %	0.002 %
Delhi	0.254 %	0.04 %

  - RLANs in the three device classes operating over a 20, 40, 80, or 160 MHz channel bandwidth do not cause harmful interference to an FS link.

FSS Sharing Conclusion

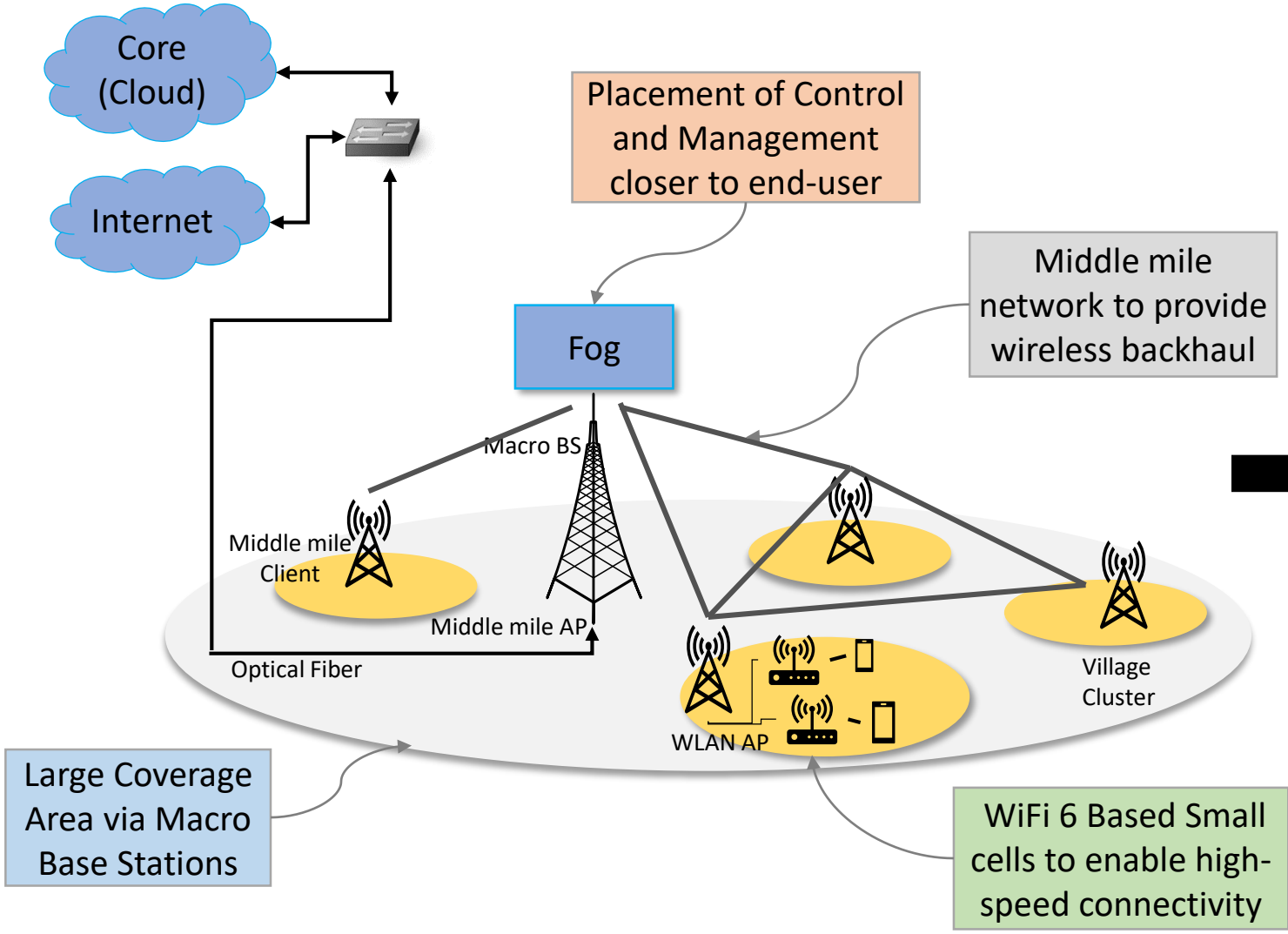
I/N < -26.8 dB for satellites in all channels

RLANs in the three device classes operating over a 20, 40, 80, or 160 MHz channel bandwidth do not cause harmful interference to an FSS uplink in the 6 GHz band.

Rethinking Broadband access Requirements for Rural Areas

- Low cost Solution
  - Low Cost Backhaul Solutions - Wireless backhaul instead of Fiber
  - Lower Spectrum Cost
- Limited or No Mobility Support
- Energy efficient solution
- Large coverage area support

IEEE P2061 –Architecture for Low Mobility Energy Efficient Affordable Broadband Access



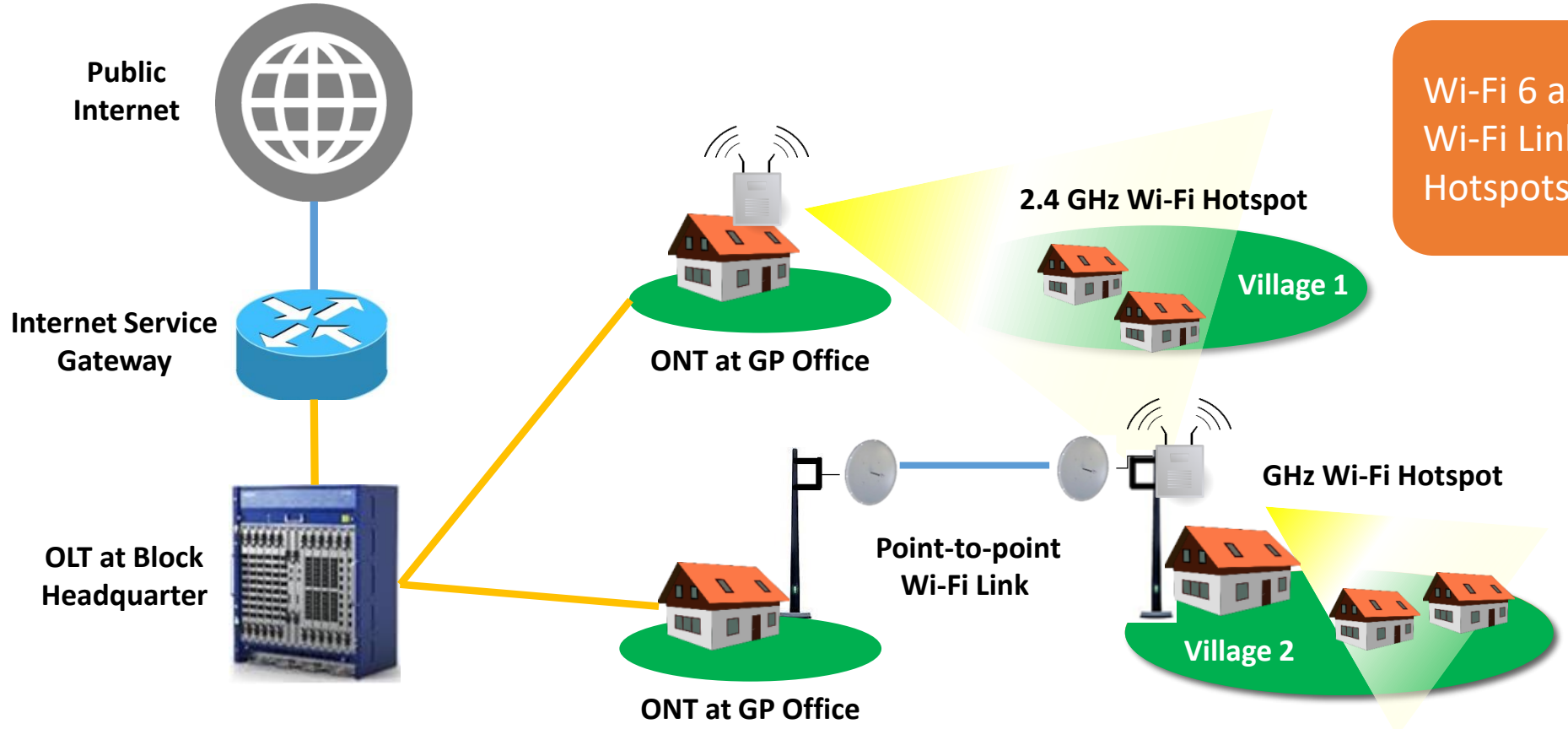
IEEE P2061

Refers to the vision of providing broadband access to rural areas by addressing rural area requirements and challenges

Wi-Fi 6 Can Support both Wireless Backhaul and Wi-Fi hotspots

Source: Khaturia M, Jha P and Karandikar A, IEEE Communication Standards Magazine, June 2020

BharatNet Wi-Fi Service Delivery Model

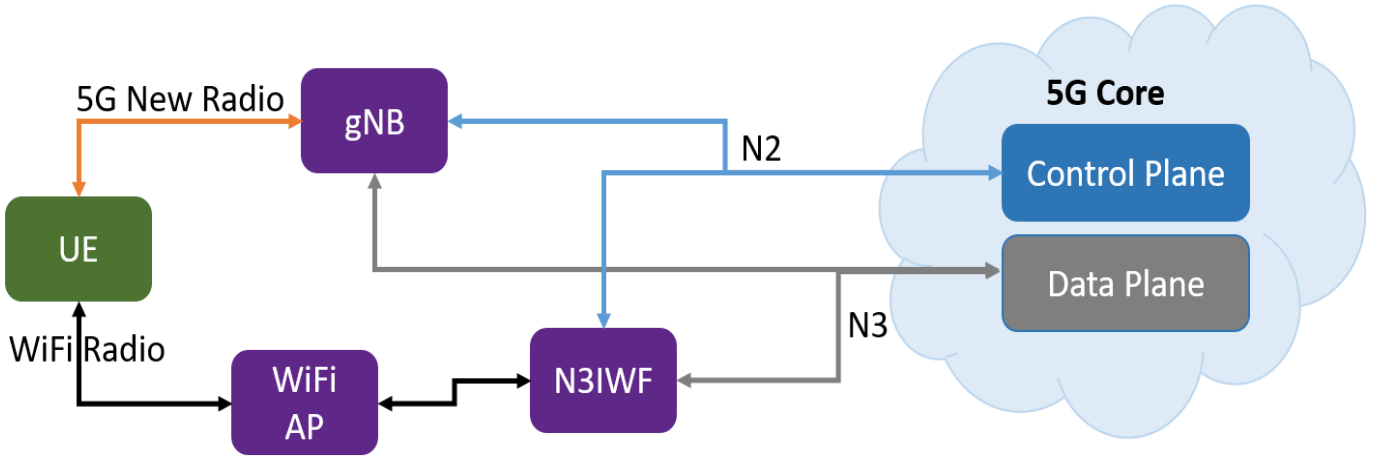


Wi-Fi 6 as Point-to-Point Wi-Fi Links as well as Hotspots

WiFi Hotspots for Service Delivery at all 2.5 Lakh GPs under BharatNet is proposedQ

Emerging Mobile Network Architecture

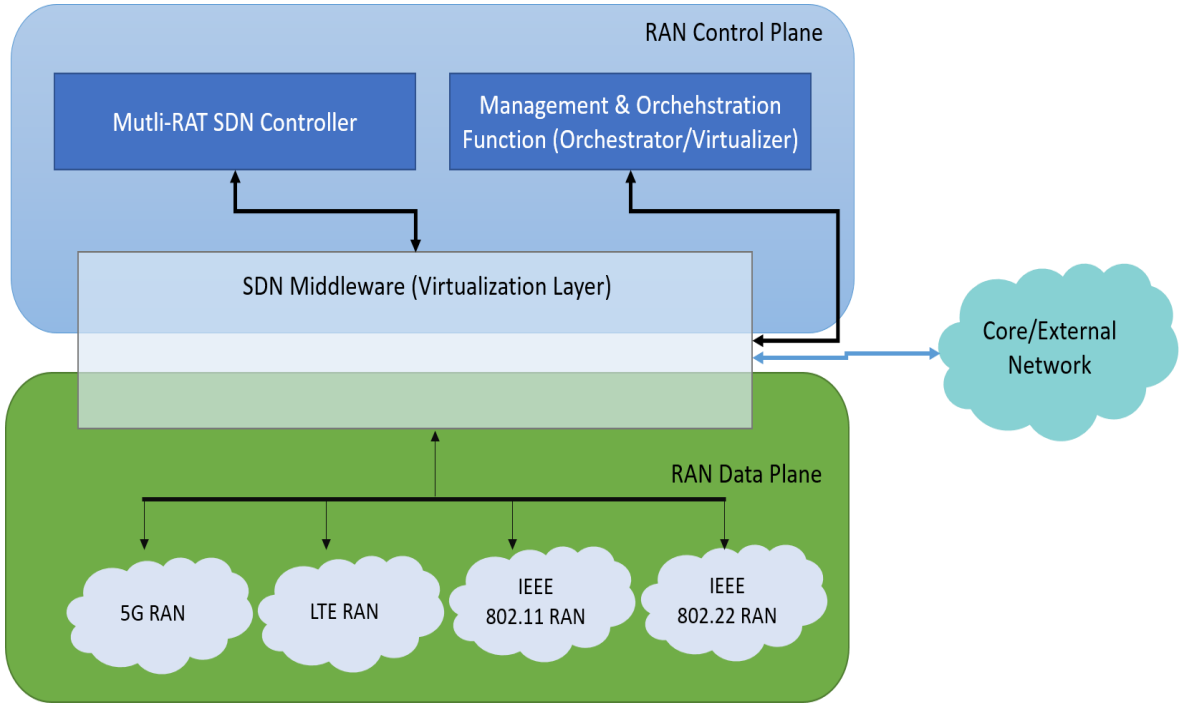
- Increased Network Densification
- Multi-RAT Networks - Presence of 3GPP & Non-3GPP Access (e.g. Wi-Fi)
- Unified 5G Core
- Common Interface towards Core for Access Networks
- Wi-Fi an Important Access Technology for 5G



Fragmented Decision Making in RAN
Need for Unified Control of Multi-RAT RAN

IEEE P 1930.1 – Unified Multi-RAT RAN

SDN Middleware	• Abstract Information Model of underlying RAN • Through Virtual Network Entities
SDN Controller	• Control and Management of the Access Network
Management and Orchestration Entity	• To Orchestrate & Manage the SDN Middleware over RAN Infrastructure
Radio Access Network Infrastructure	• Access Points, Base Stations, Network Interworking Functions



Summary

- WiFi 6 offers huge opportunity for public WiFi network and support for 5G use cases
- With IEEE P1930 and IEEE P2061, WiFi6 enabler for Low Cost Low Mobility Energy Efficient architecture for rural broadband connectivity
- Need for regulatory and policy changes
  - Fulfill the goals of NDCP 2018 and PM-WANI
  - Coexistence studies have shown no interference to satellite services

THANK YOU