

5G

5G SPECTRUM: QUANTUM & PRICING

27TH JUNE 2019

*VL SHANKAR,
SR. VICE PRESIDENT,
RELIANCE JIO*



- ❖ Vision of Digital India
- ❖ 5G Features & Adoption
- ❖ Spectrum Plan for India
- ❖ Spectrum Auction Around the World
- ❖ India's Uniqueness
- ❖ Forward Path for India



Prime Minister's vision for India

- \$5 Trillion Economy by 2025
- \$1 Trillion Digital Economic Value
- Digital Consumer base is 2nd

largest in the world

- \$10 Trillion Economy by 2032



<https://www.financialexpress.com/economy/modis-10-trillion-dream-commit-to-make-india-worlds-third-largest-economy-by-2032-says-bjp-manifesto/1541466/>

<http://pib.nic.in/PressReleaselframePage.aspx?PRID=1565669>

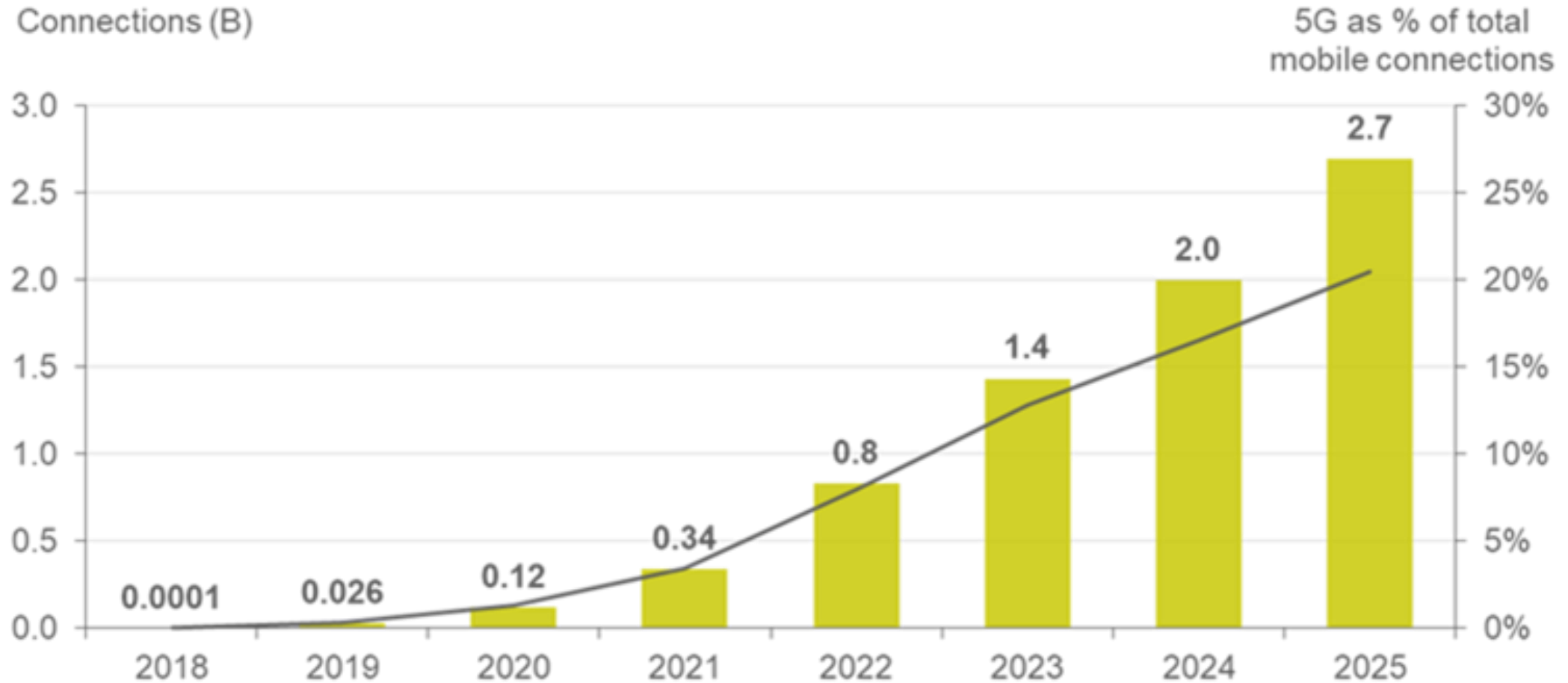
NEED FOR A SUPER FAST DIGITAL INFRASTRUCTURE



5G : A PHILOSOPHY

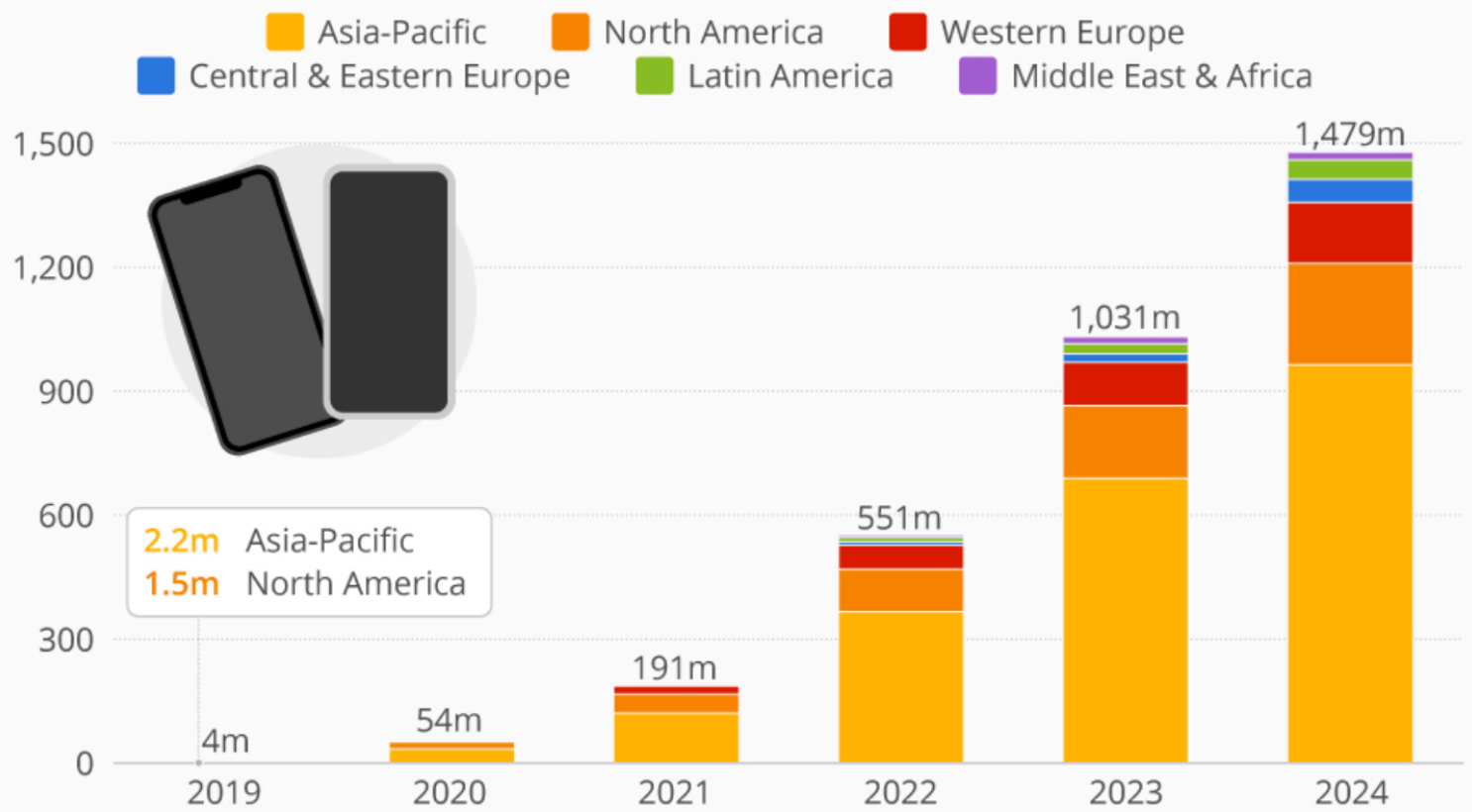
- More about end user services & experience
- Unlike 3G/4G, less about Radio Technology
- Spectrum agnostic

5G as % of Total Mobile Connections



Global 5G Adoption to Take Off in 2021

Forecast of 5G smartphone subscriptions by region



India - Current Status

- **1.1 Billion** Mobile Subscribers
- **550 Million** smartphone users
- Smartphone adoption **increasing** on a daily basis

India will account for a major portion of the subscribers in the APAC region that will adopt 5G

Forecast as of November 2018
Source: Ericsson Mobility Report



South Korea

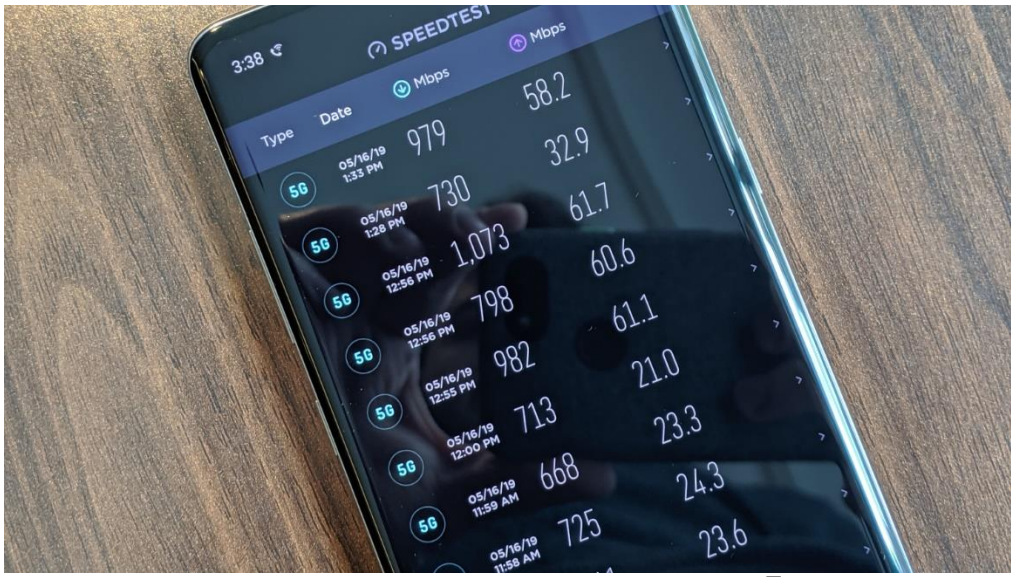
- ❖ Total of **1 Million 5G subscribers** across 3 operators in **3.5 GHz Band**. Expected to cross **3 Million** subscribers by the **end of 2019**
- ❖ **Good outdoor coverage** has been implemented with **fall back to 4G** for indoor coverage.
- ❖ **28 GHz band** will be activated by **next quarter** of 2019

<https://venturebeat.com/2019/06/12/south-korea-hits-1-million-5g-subscribers-in-69-days-beating-4g-record/>

USA

- ❖ 5G made operational by Verizon in **Chicago and Minneapolis** and a few other cities in the **28 GHz band**.
- ❖ Currently being used as a **5G hotspot**
- ❖ Initial smartphones (**Samsung Galaxy S10 5G**) are now available in the market.

<https://www.tomsguide.com/us/verizon-5g-network-launches,news-29797.html>



Test Results on Verizon 5G network

Smartphone Manufacturer	Model	System Operator	Release Date
Samsung	Galaxy S10 5G	Korea (SKT, KT, LG U+)	April 2019
		US (Verizon)	May 2019
	US (AT&T, Sprint, T-Mobile) / Australia / France / Germany / Italy / Spain / Switzerland / UK	4Q 2019	
	Galaxy Note 10 (5G Version)	US (Verizon)	May 2019
LG	V50 ThinQ	US (Sprint, Verizon)	May 2019
Huawei	Mate X	China (China Mobile) / Europe	July 2019
Xiaomi	Mi Mix 3 5G	Europe / China	May 2019
Motorola	Moto Z3 with 5G Moto Mod	US (Verizon)	April 2019
ZTE	Axon 10 Pro 5G phone	Europe / China	May 2019
Google	Pixel 4	US (Verizon)	4Q 2019
Nokia	5G Nokia Android phone	US / Western Europe	In Early 2020
Apple			In 2020

Major smartphone manufacturers have already started releasing 5G enabled smartphones, which clearly shows that the 5G networks are ready to rollout around the world in the immediate future.



Trials : PyeongChang Winter Olympics, 2018

Korea Telecom showcased the following use cases / applications during various Winter Games using high speed 5G networks in the 28GHz Band.

Sync view

Interactive time slice

Omni view

360 Virtual Reality

5G autonomous vehicles

Applications requiring very high capacity links that are possible only with very large spectrum



Trial : 5G Mobile in a moving car @ 305 Km/Hr

- ❖ **Using 28GHz**
- ❖ **Beam-forming**
- ❖ **1.1Gbps data transmission**
- ❖ **Live Relay of 4K Video uplink
from Mobile**
- ❖ **Handover @ 290 km/hr**

Rugby WC , Sep 2019

- ❖ **Launch of pre-commercial 5G services
for smartphone users**

Demo for 2020 Olympics

- ❖ **Partnership with Sohgo Security
Services**
- ❖ **Demo of an advanced security service
for the opening ceremonies of the 2020
Olympics.**
- ❖ **Use of Artificial intelligence (AI) with
drones fitted with an HD 4K camera**

5G SPECTRUM PLAN FOR INDIA





eMBB, URLLC

High Band

For very high capacity

Above 6GHz

24.25 – 29.5GHz

eMBB, URLLC, mMTC
(no deep coverage)

Mid Band

For both coverage & capacity

2GHz – 6GHz

3.3 – 3.6GHz

eMBB, URLLC, mMTC
(wide area coverage,
deep indoor)

Low Band

For extended coverage

Below 2GHz

700MHz

❖ **GOLDEN BAND:** 300 MHz BW from 3.3 to 3.6 GHz.

❖ **Current Usage**

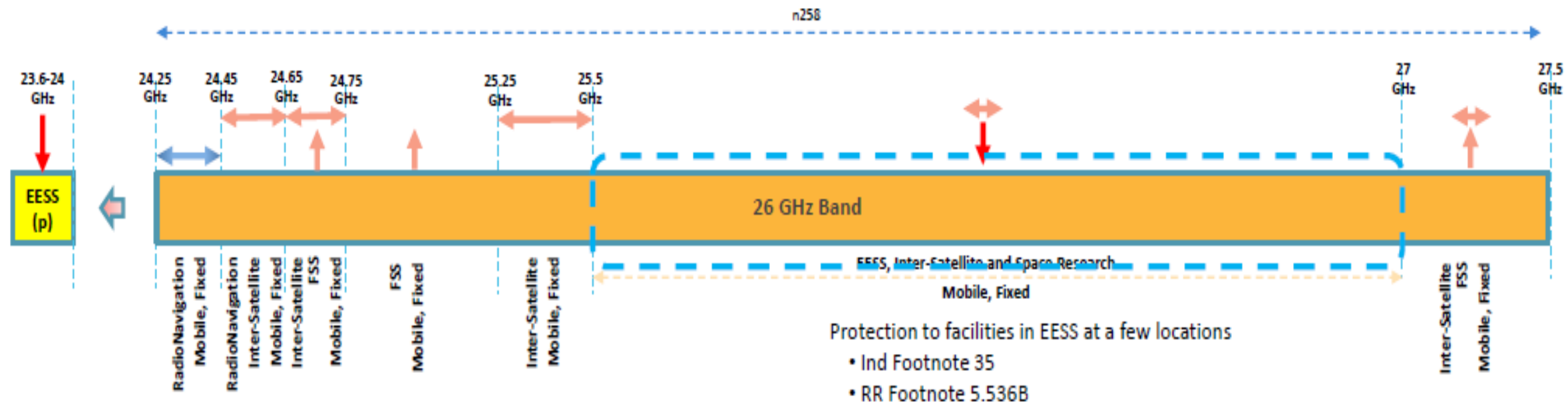
- **3.3 – 3.4GHz (100 MHz BW)** : Allocated to Indian Navy for use in coastal regions (land-sea communication)
- **3.4 – 3.425GHz (25 MHz BW)**: Allocated to ISRO for control channels of C-band NAVIC satellites
- **3.425 – 3.6GHz (175MHz BW)**: Available for 5G

❖ The remaining BW of 175 MHz which will further be **shared** between three or more operators will **not suffice for a true 5G experience**.

❖ For a true 5G experience, about **90-100MHz / MNO** will need to be provisioned.

❖ Shifting of the 100MHz used by Indian Navy to another spectrum can provide around **275MHz BW** there by providing additional BW for 5G that can be shared by all operators

High Band: 26 GHz Spectrum (24.5 to 27.5GHz)



- ❖ Identification of 26GHz spectrum for 5G is an **Agenda Item (1.13) in WRC-19** of the ITU
- ❖ Provides **2 – 2.5GHz bandwidth** (24.5 to 27.5GHz) for 5G
- ❖ EESS (Earth Exploration Satellite Services) Protection:
 - Guard Band required to protect EESS. Size of Guard Band depends on quality of EESS sensors
 - As seen in America & Europe, guard band of **250Mhz-GHz is required** depending on the quality of EESS sensor.
 - Use of **good quality sensors** will enable keeping the guard band to a **minimum of 250MHz**.

High Band: 28 GHz Spectrum (27.5 – 29.5 GHz)

- ❖ 27.5 to 29.5GHz: **2 GHz bandwidth** available in this band. ITU will include this as part of WRC-23 for IMT

 - ❖ **Co-existence with Satellite Services in India:**
 - ❖ Allocated to Fixed Satellite Services.
 - ❖ Interference studies done by ITU as part of **TG5-1 (Technical Group)** shows that **co-existence of FSS ground station and 5G base station is possible.**
 - ❖ Co-ordination between MNOs & Satellite Operators required at locations where Ground Stations are deployed.

 - ❖ **Commercial Launch:**
 - ❖ **USA :** Already launched by Verizon in Chicago, Minneapolis and a few other cities.
 - ❖ **South Korea:** Q3 2019
 - ❖ **Japan:** Pre-commercial services in **Sept 2019** during the Rugby World Cup
- ❖ **Co-existence between 5G base stations and Satellite ground stations** has been **mutually agreed** by the MNOs and Satellite operators in USA. Similar arrangements **can be done in India too.**

5G SPECTRUM AUCTION AROUND THE WORLD



3.5 GHz

100 MHz	100 MHz	80 MHz
SK Telecom	KT	LG U+
\$1.1 Bn	\$870 Mn	\$728 Mn

- 10 year license
- Launched in April 2019
- 1 Mn subscribers in 69 days

28 GHz

800 MHz	800 MHz	800 MHz
SK Telecom	KT	LG U+
\$186 Mn	\$186 Mn	\$186 Mn

- 5 year license
- Rollout of service to commence in Q3 2019



TOTAL AUCTION PRICE = 3.61 TRILLION WON / \$3.04 BILLION

3.5 GHz

<u>100 MHz</u>	<u>100 MHz</u>	<u>100 MHz</u>	<u>100 MHz</u>
NTT-D	KDDI	SoftBank	Rakuten

4.5 GHz

<u>100 MHz</u>	<u>100 MHz</u>	<u>-</u>	<u>-</u>
NTT-D	KDDI	SoftBank	Rakuten

28 GHz

<u>400 MHz</u>	<u>400 MHz</u>	<u>400 MHz</u>	<u>400 MHz</u>
NTT-D	KDDI	SoftBank	Rakuten

- ❖ 5G services to be commercialized by 2020 by all 4 operators
- ❖ KDDI & Softbank by March 2020
- ❖ Rakuten by June 2020

<https://5gobservatory.eu/japan-assigns-5g-spectrum-to-four-operators/>



Pricing not available for Japan's auction

24 GHz

100 MHz*

ATT

\$982 Mn

100 MHz *

T-Mobile

\$803 Mn

*7 blocks of 100Mhz were auctioned per area.

- AT&T bid for **831 licenses**
- T-Mobile bid **1,346 licenses**

28 GHz

850 MHz

Verizon

\$505 Mn

- 2 Blocks of **425MHz**
- Verizon bid for **1066 licenses**
- Licenses are for Upper Microwave **Flexible Use Service** authorizing both fixed and mobile operation.



<https://venturebeat.com/2019/06/03/fcc-names-winners-of-2-7-billion-24-28ghz-millimeter-wave-auctions/>

TOTAL AUCTION PRICE = **\$2.7 BILLION**

2 GHz

<u>40 MHz</u>	<u>40 MHz</u>	<u>20 MHz</u>	<u>20 MHz</u>
DT	Vodafone	Telefonica	Drillisch
€851 Mn	€800 Mn	€381 Mn	€335 Mn

2 GHz band : Total of 120 MHz
- 1.92 – 1.98 GHz
- 2.11 – 2.17 GHz

3.6 GHz

<u>90 MHz</u>	<u>90 MHz</u>	<u>70 MHz</u>	<u>50 MHz</u>
DT	Vodafone	Telefonica	Drillisch
€1.3 Bn	€1.07 Bn	€1.04 Bn	€735.2 Mn

3.6 GHz band : 3400 MHz – 3700 MHz



TOTAL AUCTION PRICE = €6.7 BILLION / \$7.58 BILLION

3.7 GHz

80 MHz	80 MHz	20 MHz	20 MHz
Vodafone	Tel. Italia	Iliad	Wind Tre
€1.7 Bn	€1.7 Bn	€484 Mn	€484 Mn

700 MHz

20 MHz	20 MHz	20 MHz	-
Vodafone	Tel. Italia	Iliad	Wind Tre
€683 Mn	€680 Mn	€676 Mn	

26 GHz

200 MHz	200 MHz	200 MHz	200 MHz
Vodafone	Tel. Italia	Iliad	Wind Tre
€32.6 Mn	€33 Mn	€33 Mn	€32.6 Mn

- 3.7 GHz: 3.6GHz-3.8GHz
- 26 GHz: 26.5GHz-27.5GHz
- 700 MHz: 694MHz-790MHz

Licenses are valid until 2037, although the 700MHz frequencies won't be opened until July 2022

<https://blog.telegeography.com/italian-5g-auction-causes-concern>



TOTAL AUCTION PRICE = €6.55 BILLION / \$7.2 BILLION

COUNTRY	BAND	PRICING (Rs. Crs / MHz)
South Korea	3.5 GHz	61 – 77
	28 GHz	1.6
Germany	2 GHz	148 – 165
	3.5 GHz	92 – 112
Italy	700 MHz	266
	3.7 GHz	165
	26 GHz	1.2
USA	24 GHz	28 – 35
	28 GHz	4.2

PRICING OF INDIA'S SPECTRUM SHOULD BE SIMILARLY ATTRACTIVE

INDIA'S UNIQUENESS



❖ America / Canada:

- Very large countries with **sporadically populated towns**. Large swaths of unpopulated territory.
- **Fiber deployment** to the hinterlands **not very feasible or even economical**.
- This necessitates **satellite coverage** that will provide Fixed Wireless Broadband connectivity.

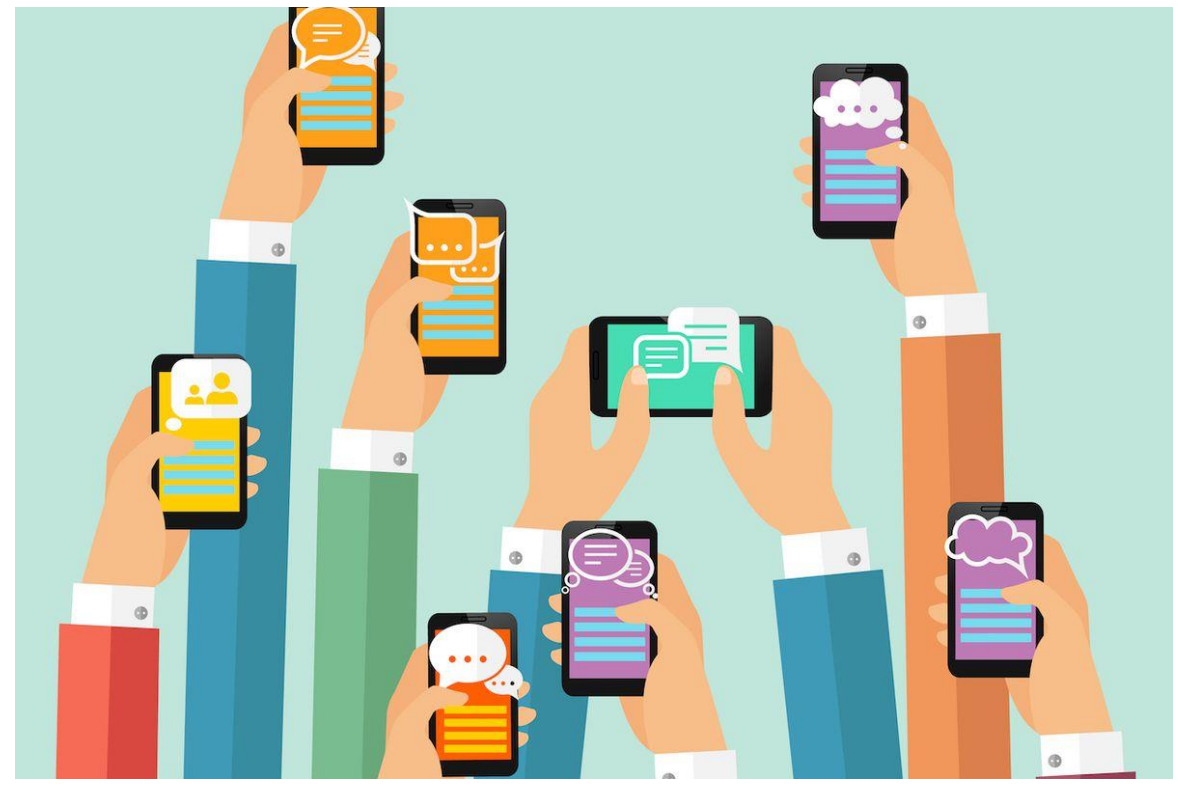
❖ India

- Geographically a smaller country with **evenly spread out population**.
- Most of the populated cities/towns/villages are not more than **4-5kms from each other**.
- **95% of the geographical area** is already covered by **terrestrial 4G network**
- **Use of satellite:** Limited to very far off places like the North East, J&K and the Islands.

>95% OF INDIA CAN BE COVERED BY TERRESTRIAL 5G NETWORK

India's Unique Data Consumption Pattern

- ❖ Ranked #1 in Global Data Consumption. Total Data flow > 4 major MNOs in USA
- ❖ Video Centric behavior:
 - ❖ YouTube, Hotstar, JioTV, Netflix, Amazon Prime
 - ❖ Social media like Whatsapp, FB, Instagram, etc.
- ❖ Ind-Pak CWC2019 match – 11 Million Hotstar viewers.
- ❖ 800+ TV channels. Each major channel has its own Mobile App (Zee, Sony, Eros Now, Alt Balaji, etc)
- ❖ All major channels will eventually upgrade to 4K/8K
- ❖ Very High Capacity 5G networks are a MUST.



INDIA'S APPETITE FOR DATA CONSUMPTION MUST BE MET

Usage in Kedarnath

- ❖ **Kedarnath:** Important religious destination
- ❖ **Explosion of tourist population**
 - ❖ 7.3 lakhs pilgrims in 45 days
 - ❖ 36,000 / day
- ❖ High concentration of users observed on 4G network
- ❖ Very high data consumption, especially **upload of photos/videos on Whatsapp, Facebook, Instagram**
- ❖ Requires very high capacity terrestrial network.



<https://www.mensxp.com/social-hits/news/53980-after-pm-modi-rsquo-s-visit-kedarnath-records-highest-ever-visitors-to-the-shrine-in-history-on-opening.html>

INDIA'S APPETITE FOR DATA CONSUMPTION MUST BE MET

❖ **Tariff Comparison: 4G vs Ku Band**

- Terrestrial Wireless Broadband using **4G network**: Rs. 3.3 / GB of data
- Satellite Broadband using **Ku Band**: Rs. 308 / GB

❖ **Projected Ka band (28 GHz) pricing:**

- Assumed that Ka band transponder is **cheaper by 1/3rd**
- Cost around **Rs. 68 / GB**
- **20x more expensive** than mobile data.

Can Satellite Industry match these price points? 

❖ **Subscriber Needs:** Uniform user experience and pricing *irrespective of technology used*

TERRESTRIAL 5G NETWORK CAN PROVIDE AFFORDABLE SERVICE

FORWARD PATH FOR INDIA



To effectively deliver state-of-the-art 5G services with new video centric applications (incl. AR, VR, 4K and 8K), very high bandwidths will be necessary

Band	Frequency	Requirement / MNO
High Band	24.25 to 29.5	1 GHz
Mid Band	3.3 – 3.6GHz	100 MHz
Low Band	<700 MHz	10 MHz

- **South Korea** has provisioned **800MHz / MNO** in 28GHz band for **55 Mn subs**.
- India, with **550 Mn smartphone** users and increasing, will need significantly higher bandwidth to satisfy the data demand.

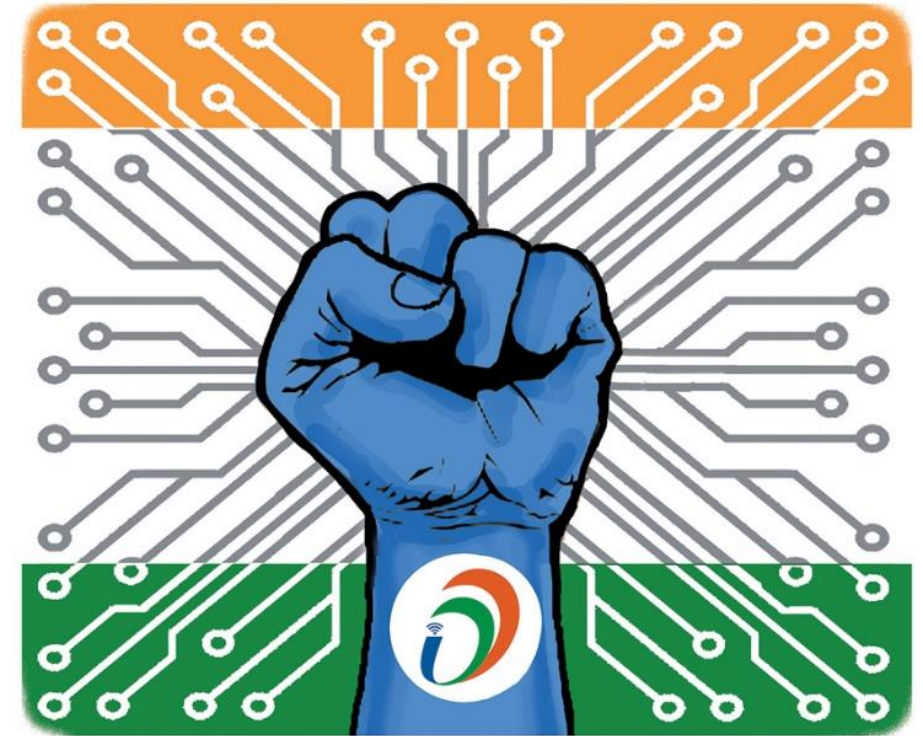
To Conclude ...

- ✓ Vision of \$5 Trillion Economy - Super fast digital infrastructure is a MUST.
- ✓ Terrestrial 5G network – Best Option
- ✓ To provide state-of-the-art services on a 5G network

**VERY LARGE
BANDWIDTHS**



**ATTRACTIVE
PRICING**



THANK YOU

