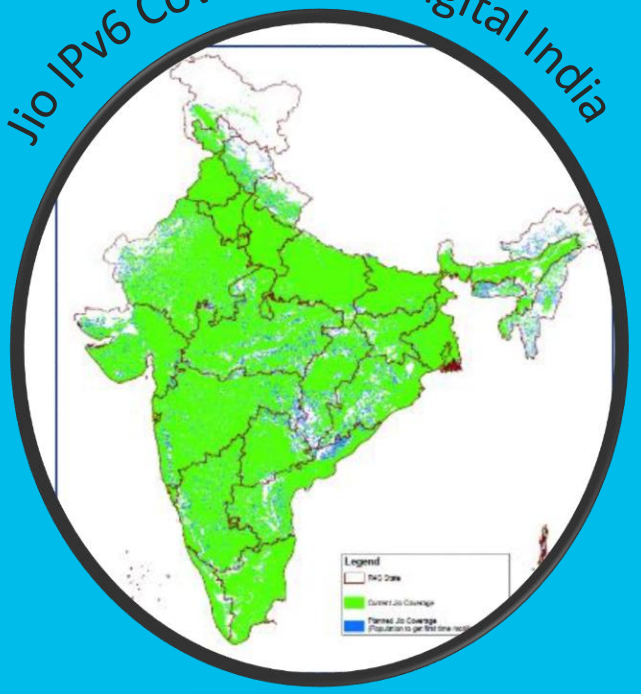
IPv6-only adoption challenges and standardization requirements



B.Nagaraj, Sr. EVP
Head, Planning & Engineering, Reliance Jio

07th Oct 2021

Coverage

1. Jio strategy and approach
2. Present status
3. Challenges
4. Solution options
5. Support required

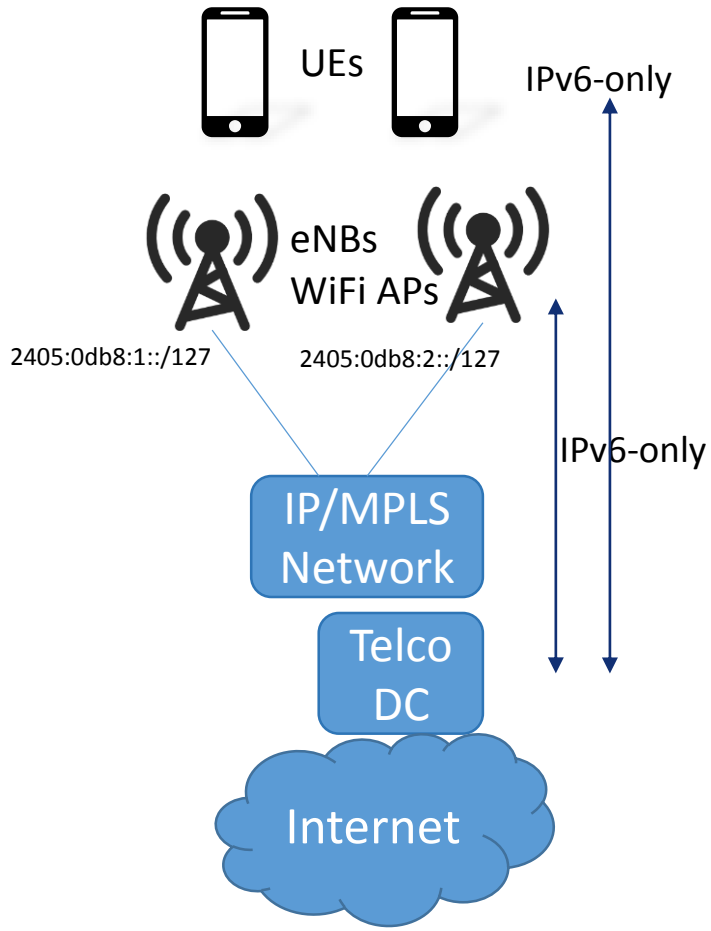
Jio's 2015 IPv6 approach

- Study on IP eco-system in 2015 reveals
  - Completely open market for user devices
  - Highly price sensitive geography
  - IPv6 adoption by OEMs at very niche stage
  - Early adoption by ASP/CDN providers
  - No adoption or slow approach by OSS/BSS, IP transport, cloud and applications
- Drive for IPv6 started at early
  - Mandated IPv6 a MUST for any technology selection
  - Formulated joint development program with OEMs
  - Encouraged SIM vendors to adapt IPv4v6 communication for SIM's

Dual stack was difficult but took challenge to uplift industry

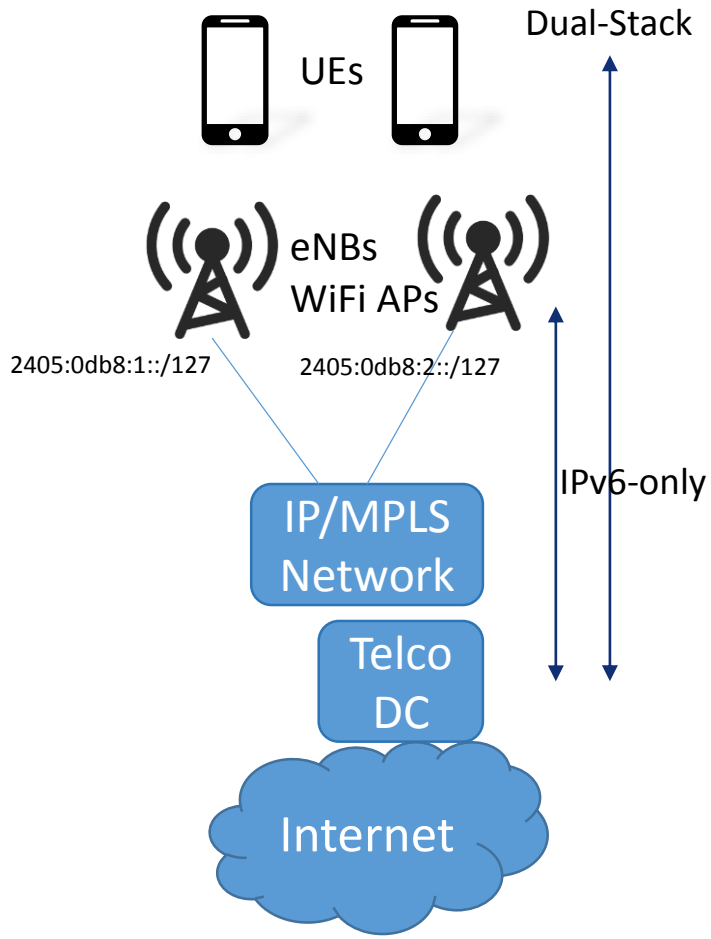
Current 2021 State – IPv6-only

- IPv6-only for 4G VoLTE User Equipment (UEs)
  - ✓90% get IPv6-only (/64 prefix) for VoLTE
- IPv6-only for network infrastructure
  - ✓100% for eNB, Small cells, Access points
- IPv6-only for management plane
  - ✓100% for all IP devices routers, switches etc..
- IPv6-only for Utilities (power systems, surveillance systems etc.)
  - ✓100% for SMPS, Access control systems etc.

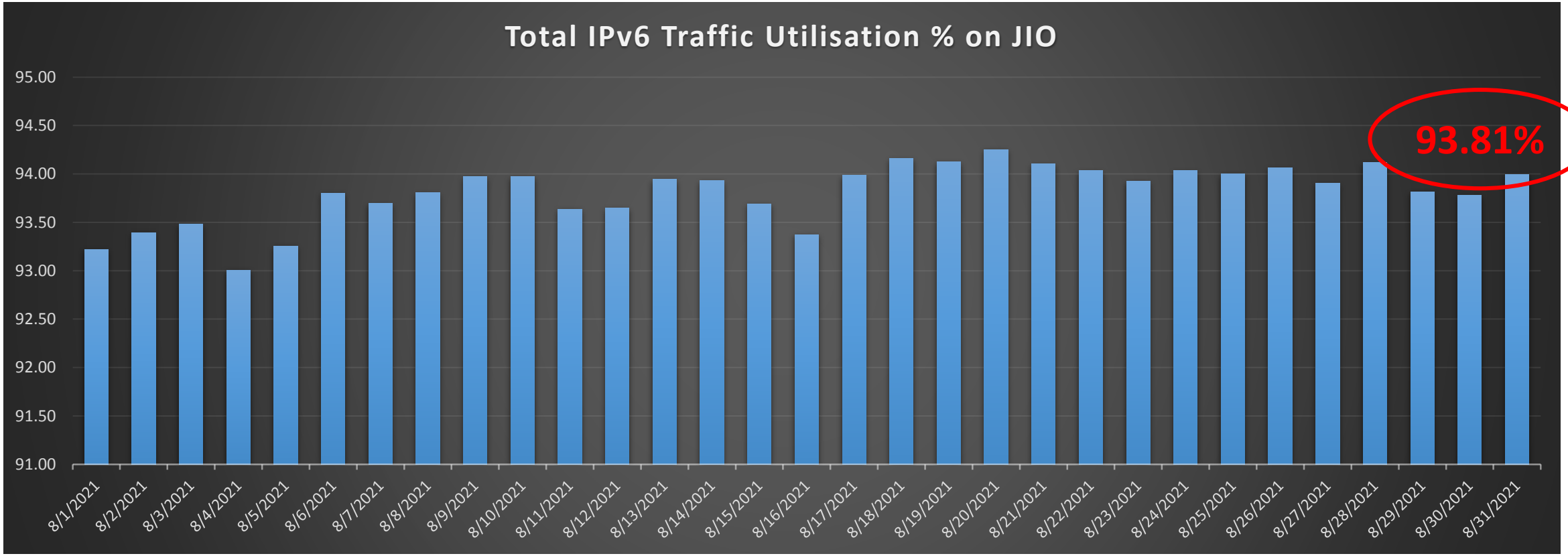


Current State – dual stack

- Dual-stack 4G LTE and FTTh HSI services
  - User devices, devices behind hotspot/tethering
  - Applications, Public and private Content
  - NAT unavoidable
- Dual-stack Enterprise services
  - Legacy office LAN/WAN systems and application
  - Public IPv4 a MUST requirement
- Dual-stack OSS/BSS
  - Mediation, fault, perf, DNS, AAA etc..
- Core network infrastructure
  - ISIS-MT (RFC5120), BGP etc.



IPv6 requests and data consumption -Jio Cloud



- 93.81% requests served on IPv6 amounting to 95% data
- Approx. 50% requests on Jio on IPv4 from other operators

Source: Jio internal

IPv6-only Challenges – devices & chipsets ..(1 of 4)

- Device OEM and chipset challenges
  - ↓~ 8%* chipsets fail in cLAT compliance (RFC6877)
    - ↓OEM implementation issues. Same chipset work in one device but fail in another
  - ↓~ 5-10%* devices fail VoLTE testing on IPv6
  - ↓SIM firmware/driver limitations in upgrading IPv4 to IPv4v6 through TCP session
- Operator and environment challenges
  - ↓SIM cards inventory in market have only IPv4 programmed
  - ↓Unable to programme IPv4v6 in SIM due to device offline
  - ↓Devices management impact if IPv6-only assigned
  - ↓Impact services during roaming—work arounds using IR MACD to avoid impact

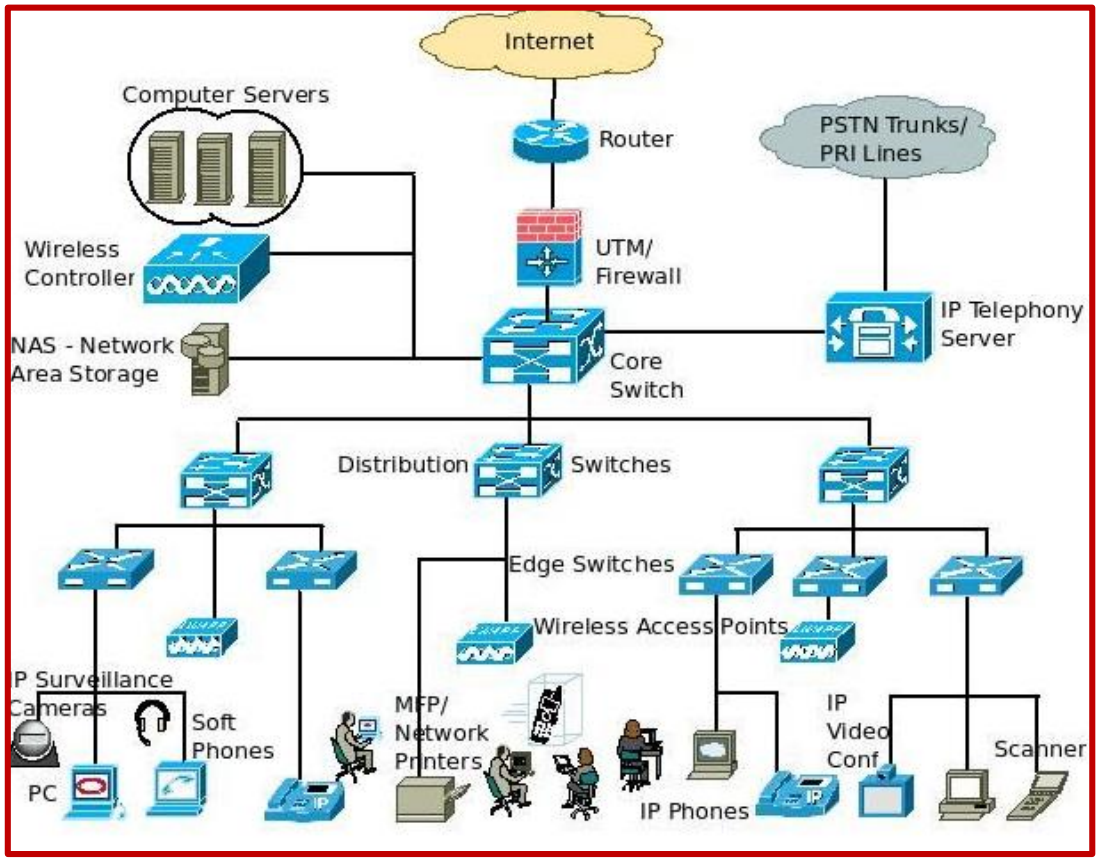
* Jio internal testing and validation

Challenges – IoT and connected home ..(2 of 4)

- Use cases
  - ✓Home automation, security surveillance
  - ✓Smart metering, building automation
  - ✓Healthcare and automobile
- Product limitations
  - ✓ >90% DVR/NVR, cameras support only IPv4
  - ✓Sensors need IPv6 support
  - ✓Firmware dependencies to be prioritised from major suppliers

Challenges – Enterprise businesses ..(3 of 4)

- Priority & motivation issue rather technology
- Demand for IPv4 growing
- Unused public IPv4



Slow transition stressing TSP/ISP to provide IPv4 and delaying transition to IPv6

Challenges - Health of web contents on DS/IPv6 ..(4 of 4)

Category: Ecommerce & shopping	
Rank	websites
1	amazon.com
2	ebay.com
3	amazon.co.jp
4	rakuten.co.jp
5	amazon.de
6	aliexpress.com
7	walmart.com
8	amazon.co.uk
9	etsy.com
10	taobao.com

Category: Finance	
Rank	websites
1	paypal.com
2	chase.com
3	tradingview.com
4	coinmarketcap.com
5	binance.com
6	investing.com
7	wellsfargo.com
8	bankofamerica.com
9	capitalone.com
10	intuit.com

Category: Games	
Rank	websites
1	twitch.tv
2	roblox.com
3	steampowered.com
4	chess.com
5	steamcommunity.com
6	gamewith.jp
7	5ch.net
8	app.link
9	linkkf.app
10	douyu.com

(as of 21st Sept 2021)

Guess support of DS/IPv6 on top 60 web sites in 6 categories ???

Category: Sports	
Rank	websites
1	espn.com
2	marca.com
3	as.com
4	cricbuzz.com
5	futbol24.com
6	mlb.com
7	livescore.com
8	premierleague.com
9	sports.yahoo.com
10	goal.com

Category: top visited websites	
Rank	websites
1	google.com
2	youtube.com
3	facebook.com
4	twitter.com
5	instagram.com
6	baidu.com
7	wikipedia.org
8	yandex.ru
9	yahoo.com
10	xvideos.com

Category: Cloud Service Providers	
Rank	websites
1	www.kamatera.com
2	www.serverspace.us
3	www.linode.com
4	aws.amazom.com
5	www.scalahosting.com
6	www.cloudways.com
7	us.ovhcloud.com
8	www.liquidweb.com
9	www.digitalocean.com
10	www.vultr.com

Sources: https://www.similarweb.com/top-websites, https://ipv6-test.com/validate.php, https://www.guru99.com/cloud-computing-service-provider.html

Challenges - Health of web contents on DS/IPv6 ..(4 of 4)

(as of 21st Sept 20201

Category: Ecommerce & shopping		
Rank	websites	DS /IPv6
1	amazon.com	✗
2	ebay.com	✗
3	amazon.co.jp	✗
4	rakuten.co.jp	✗
5	amazon.de	✗
6	aliexpress.com	✗
7	walmart.com	✗
8	amazon.co.uk	✗
9	etsy.com	✗
10	taobao.com	✗

Category: Finance		
Rank	websites	DS /IPv6
1	paypal.com	✗
2	chase.com	✗
3	tradingview.com	✗
4	coinmarketcap.com	✗
5	binance.com	✗
6	investing.com	✓
7	wellsfargo.com	✗
8	bankofamerica.com	✗
9	capitalone.com	✗
10	intuit.com	✗

Category: Games		
Rank	websites	DS /IPv6
1	twitch.tv	✗
2	roblox.com	✗
3	steampowered.com	✗
4	chess.com	✗
5	steamcommunity.com	✗
6	gamewith.jp	✓
7	5ch.net	✗
8	app.link	✓
9	linkkf.app	✓
10	douyu.com	✗

Category: Sports		
Rank	websites	DS /IPv6
1	espn.com	✓
2	marca.com	✗
3	as.com	✗
4	cricbuzz.com	✗
5	futbol24.com	✗
6	mlb.com	✗
7	livescore.com	✗
8	premierleague.com	✗
9	sports.yahoo.com	✗
10	goal.com	✗

Category: top visited websites		
Rank	websites	DS /IPv6
1	google.com	✓
2	youtube.com	✓
3	facebook.com	✓
4	twitter.com	✗
5	instagram.com	✓
6	baidu.com	✗
7	wikipedia.org	✗
8	yandex.ru	✓
9	yahoo.com	✓
10	xvideos.com	✗

Category: Cloud Service Providers		
Rank	websites	DS /IPv6
1	www.kamatera.com	✗
2	www.serverspace.us	✗
3	www.linode.com	✓
4	aws.amazom.com	✗
5	www.scalahosting.com	✗
6	www.cloudways.com	✗
7	us.ovhcloud.com	✗
8	www.liquidweb.com	✓
9	www.digitalocean.com	✓
10	www.vultr.com	✓

- Only 25% in top 60
- Overall would be much lower

12 sites in Aug-2020 increased to just 15 in Aug-2021

rovider.html

IPv6-only Solution options and support required

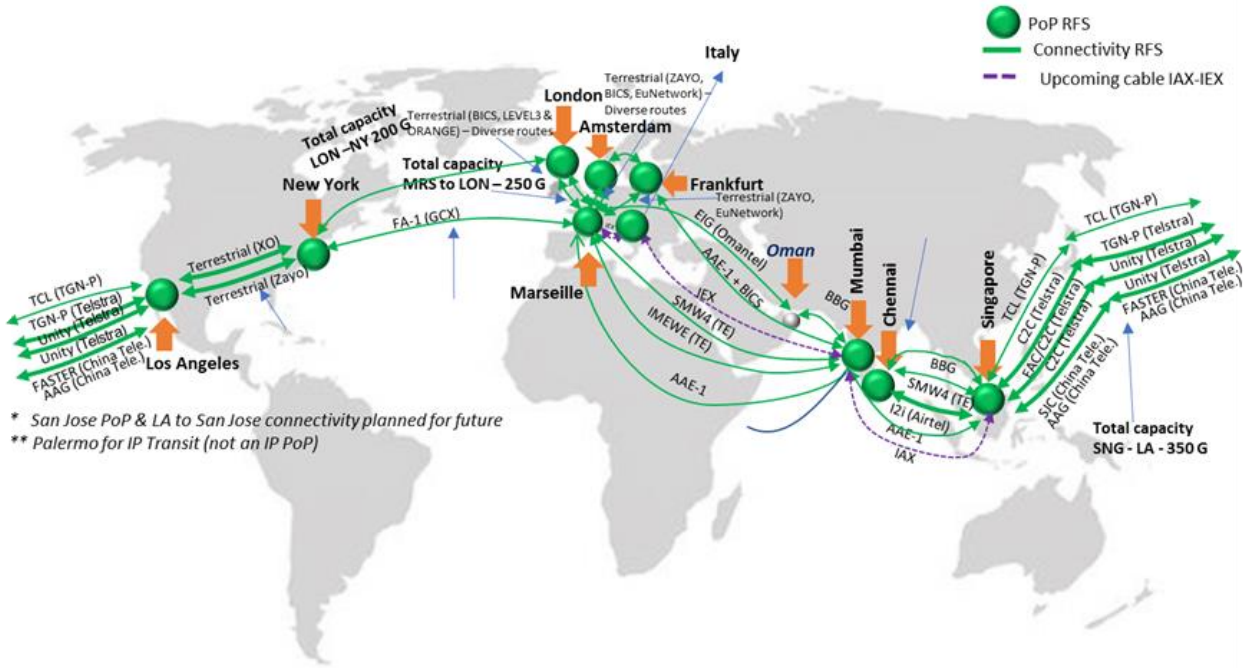
- cLAT (RFC6877) compliance standardization on mobile devices for
  - Chipset used on mobile devices
  - OEM compliances
- SIM firmware compliance for TCP based profile update
- MAPT (RFC7599) improvements required for FTTh/home services
  - For efficient use of public IPv4 resources
  - To meet regulatory requirements
- IPv6 support in chipset used by OEMs for
  - DVR/NVR, Cameras
  - IoT devices and sensors

IPv6-only Solution options and support required

- Timing and Sync standardization
  - IEEE1588v2, ITU-T G.8275.2 support on IPv6
  - PTP unicast over LACP
- Motivation for Enterprise/Business services
  - Beyond technology
  - Develop differentiated services only on IPv6
- Wider implementation of IPv6 based Control plane
  - SRv6 – reality now
  - LDPv6 (RFC7552)

Thank you for your attention

Jio's Global presence



Reserved IPv4 prefixes for shared address pace

- RFC6890 (updated in RFC8190)
  - 10.0.0.0/8 16 Mn RFC1918 private use
  - 100.64.0.0/10 04 Mn RFC6598 shared address space

  - 0.0.0.0/8 16 Mn RFC1122 This host on this NW
  - 127.0.0.0/8 16 Mn RFC1122 loopback
  - 240.0.0.0/4 256 Mn RFC1122 reserved
- Private use of assigned blocks
  - Many class A blocks e.g. 21/22/29/30.0.0.0/8 being used as private only

- TSP/ISP need above blocks to meet subscriber scalability & operational simplicity
- Availability of routable blocks assigned for private use