TARANA

BROADBAND REINVENTED

Fixed Wireless Access
Challenges, approaches, way-forward

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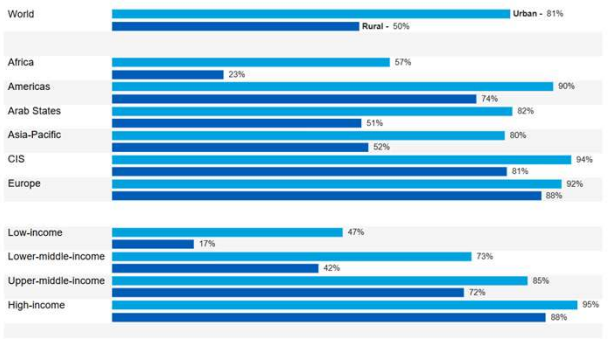
Global Broadband Connectivity

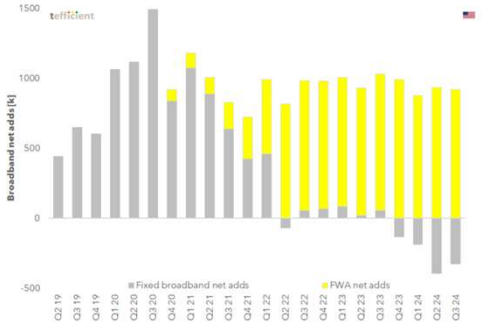
- Broadband: FCC defines broadband as an internet connection having a minimum of 25 Mbps download speed and 3 Mbps upload speed

- Huge portion of the world still lacks broadband access
  - Rural / Urban divide
  - Economic divide
  - Geographic divide



Source: ITU

- Fixed wireline broadband stagnating (at least in the USA)
  - Cost and regulatory compliance for laying fiber

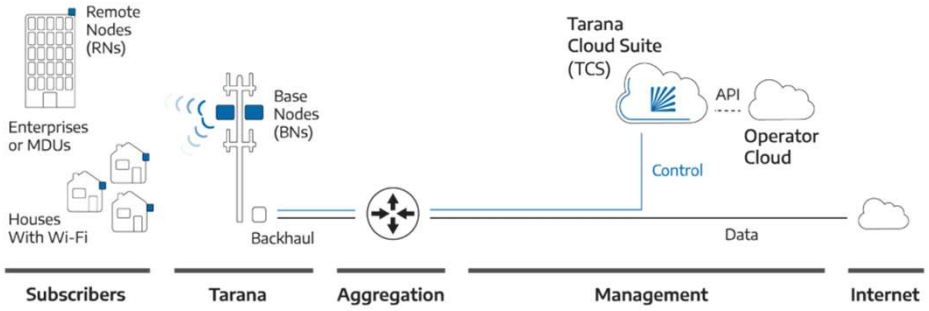


Source: tefficient

- Satellite broadband has challenges
  - Weather related issues
  - Latency and speed

Fixed Wireless Access

- FWA: Broadband access to subscribers via a wireless technology between two fixed transceivers using a variety of wireless technologies (including but not limited to 3GPP and Wi-Fi)
  - Tarana has a purpose-built solution – ngFWA
  - Operates in CBRS, 5GHz and 6GHz bands

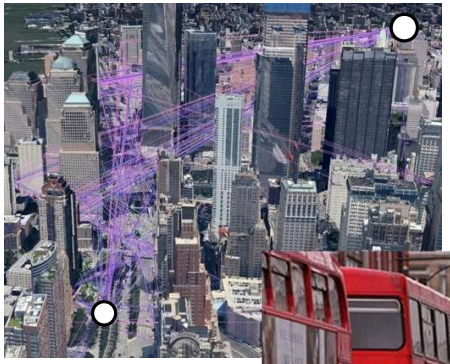


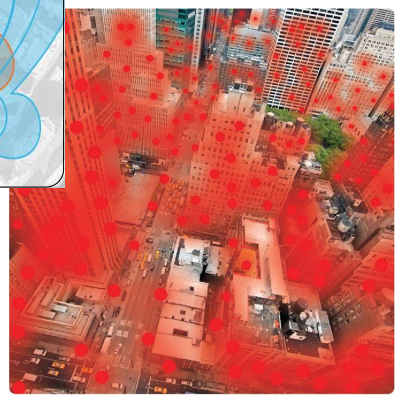
- 3GPP based FWA
  - Technology is optimized for mobility
  - Uses expensive and scarce licensed spectrum
  - But uses already deployed 4G/5G infrastructure

- Wi-Fi based FWA
  - Technology is optimized for local coverage
  - Opportunistic shared channel access makes it less unreliable

Challenges with FWA

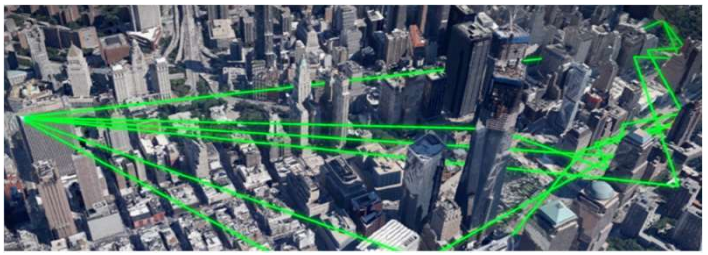
- Line of sight is not always possible
  - Near and Non line-of-sight suffers from fading
- Sensitive to dynamic obstructions
- Co-channel interference reduces spectral efficiency
- External interference (esp. in shared spectrum)
- Others
  - Outdoor deployments, passive cooling
  - Cost and power constraints
  - Harder to test in the lab
    - Multi-user, multi-path fading and interference
  - Tools to predict NLOS performance and plan network expansions
  - Provisioning, managing, debugging a network at scale of millions



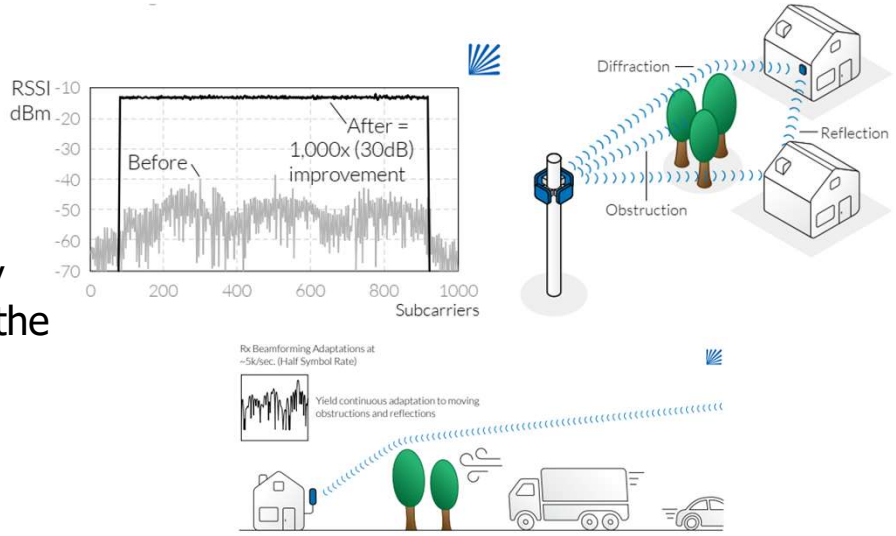


Tarana Approach – Non Line-of-Sight

- Adaptive beamforming on both sides of the link
  - Multiple antenna beamforming extends NLOS and nLOS range significantly in urban/suburban areas without needing poles/towers at client sites
  - System gain increase by ~27 dB using TX and RX beamforming and power gain

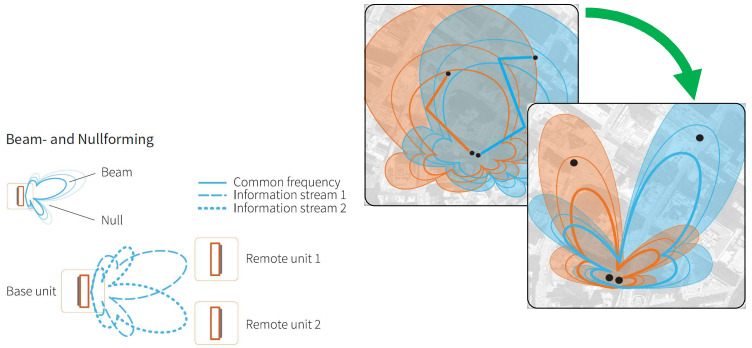


- Adaptive multipath equalization
  - Adaptive beamforming at half the symbol rate (~5k/sec) to eliminate the decay in signal quality that would otherwise occur over the duration of the system's 5 ms frame.

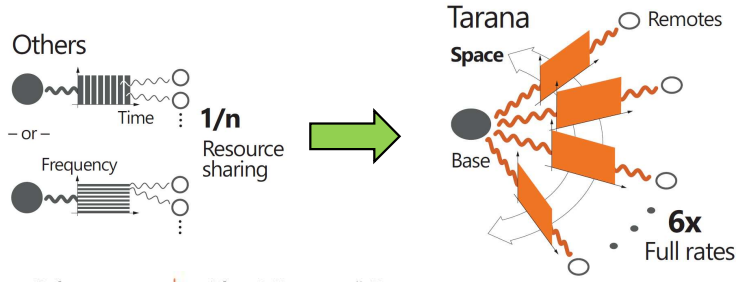


Tarana Approach – Interference

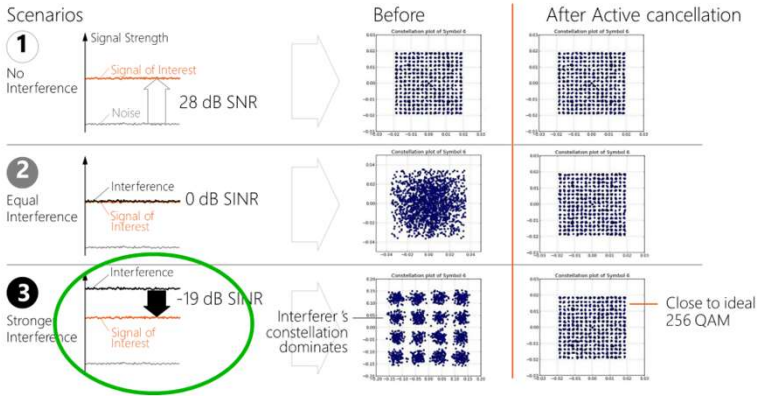
- Deep nulls to improve spectral efficiency



- 3-D space/time/freq scheduler to improve multi-user experience



- Active interference cancellation



Indian (and other developing world) scenario

- Telco dominance over ISPs
- Limited shared spectrum availability
  - CBRS and 6GHz not currently available
- Rapid growth in fixed wireless subscribers

As on 30th September, 2024, top five Broadband (Wired+Wireless) Service providers

S.N.	Name of the Service Provider	Subscriber base (In million)
1.	Reliance Jio Infocomm Ltd	477.94
2.	Bharti Airtel Ltd.	285.17
3.	Vodafone Idea Ltd.	126.36
4.	Bharat Sanchar Nigam Ltd.	37.73
5.	Atria Convergence Technologies Limited	2.27
Market Share of Top Five Vs Total Broadband (Wired+Wireless)		**98.42%**

As on 30th September, 2024, top five Wired Broadband Service providers

S.N.	Name of the Service Provider	Subscriber base (In million)
1.	Reliance Jio Infocomm Ltd	14.16
2.	Bharti Airtel Ltd.	8.48
3.	Bharat Sanchar Nigam Ltd.	4.23
4.	Atria Convergence Technologies Limited	2.27
5.	Kerala Vision Broadband Ltd.	1.22
Market Share of Top Five Vs Total Wired Broadband		**69.61%**

Segment–wise Broadband Subscribers and Monthly Growth Rate in the month of September, 2024

Segment	Broadband subscribers (in million)		Monthly growth rate in the month of September, 2024
	As on 31st August 2024	As on 30th September 2024	
Wired subscribers	42.84	43.63	1.83%
Fixed Wireless subscribers (Wi-Fi, Wi-Max, Point-to-Point Radio & VSAT)	0.91	0.99	9.01%
Mobile devices users (Phones and dongles)	905.46	899.79	-0.63%
Total	**949.21**	**944.40**	**-0.51%**

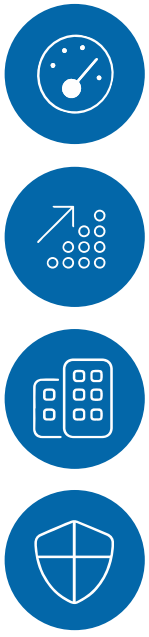
Source: TRAI Sep 2024

Tarana embraces 6GHz

- G1+6 and G1x2 – world's first FCC-certified 6GHz FWA product
  - CBRS (3 GHz) or unlicensed (UNII 3, 4, 5 & 7)
  - 1.6 Gbps aggregate capacity per link
  - 3.2 Gbps capacity per sector / 12.8 Gbps capacity per cell
  - 250 subscribers per sector / 1000 subscribers per cell
  - Works in NLoS and nLoS conditions
  - Cancels interference
  - Fiber-class speeds and reliability at a fraction of the time and cost to deploy
  - Also certified for 6 GHz operation in Canada

- RNv – cost effective remote node
  - Operates in unlicened band (UNII 3, 4, 5 & 7)
  - Optimal for LoS and nLoS deployments

A Completely New Business Model with Tarana's ngFWA



- **Fiber-class per-household speeds** (100 Mbps to 1+ Gbps) and low latency, with support for symmetric (100 Mbps down / 100 Mbps upstream)
- **High capacity** per neighborhood for economically scalable deployments
- Solid connections **despite obstacles** in the way (like other houses, trees, and vehicles moving on the streets) and interference from other wireless networks
- **Consistent service quality** throughout the neighborhood, to support subscription plan marketing, sales, and fulfillment
- High-quality service **in unlicensed spectrum** to avoid the high cost of licensed spectrum
- **Simple installation** at the home, and ideally customer self-installation