Earth and Sky – Developments in 5G, 6G, and LEOs

TFI Technology Conference – January 25th 2024 – Austin, Texas

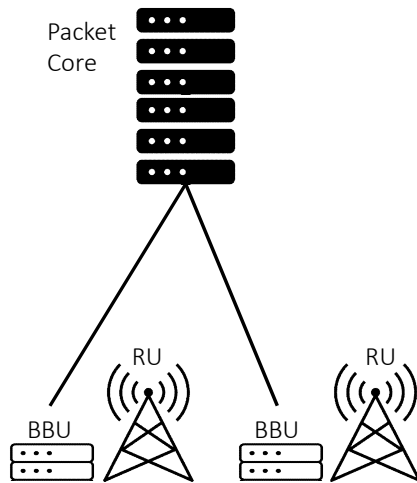Roger Entner   617.823.3363   roger.entner@reconanalytics.com

RECON
ANALYTICS

Mobile Network Evolution: Hardware Becomes Software – Part 1

Purpose Built, Distributed Radio Access Network

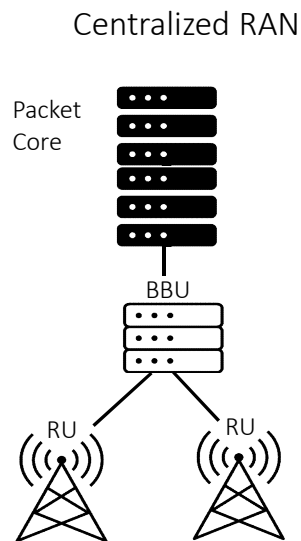Legacy Non-Virtualized

Packet Core

RU

RU

BBU

BBU

RU= Radio Unit
BBU = Base Band Unit

- Mobile network operator owns the RU, BBU, and the packet core network

- All network elements are purpose built, the hardware and software cannot be separated from each other

- The RU and BBU, supplied by a single vendor, are collocated at distributed sites

- Packet core network is centralized at one or more regional locations

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Mobile Network Evolution: Hardware Becomes Software – Part 2

Purpose Built, Centralized Radio Access Network
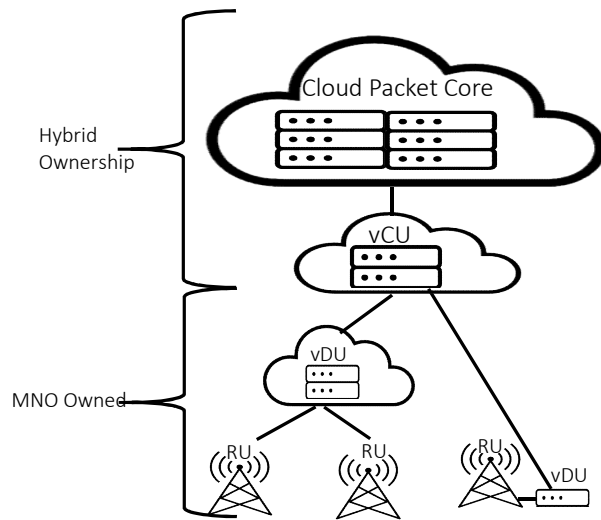
Centralized RAN

Packet Core

BBU

RU   RU

RU= Radio Unit
BBU = Base Band Unit

- Mobile network operator owns the RU, BBU, and the packet core network

- All network elements are purpose built, the hardware and software cannot be separated from each other

- Single vendor supplies both the RU and the BBU

- The RU is deployed at distributed sites

- The BBU is centralized at a metro location

- Packet core network is centralized at one or more regional locations

- Centralized RAN can save the mobile operator on site rental costs as the cost per square foot is more expensive at the distributed tower site, and allows for better synchronization between the RUs

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Mobile Network Evolution: Hardware Becomes Software – Part 3

Virtual/Cloud Radio Access Network

Cloud Packet Core

Hybrid Ownership
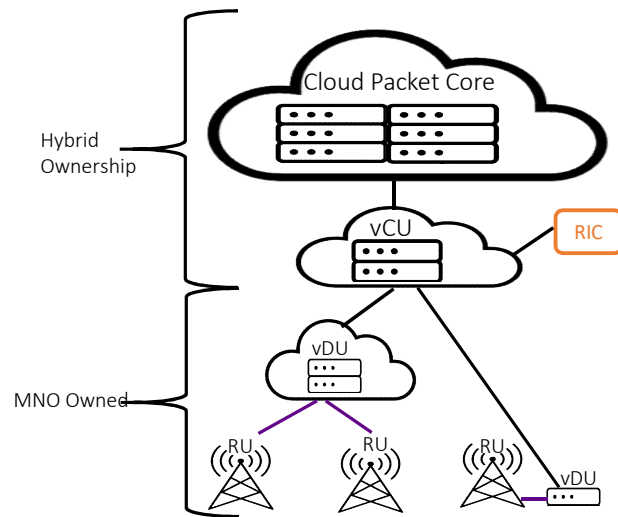
vCU

vDU

MNO Owned

RU   RU   RU   vDU

RU= Radio Unit
vDU = Virtualized Distributed Unit
vCU = Virtualized Central Unit

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- Network elements have been virtualized or made cloud-native; software and hardware have been disaggregated
  - For faster introduction of new features and functionality as the software is independent of the underlying server/hardware
- The BBU is split into two network elements a distributed unit (vDU) and a centralized unit (vCU)
  - vDU remains at or near the radio site while the vCU is centrally located within the metro region and supports multiple sites
  - vCU saves MNO money as network capacity can be shared among multiple sites
- RU, vDU vCU will be provided by a single vendor
- Ownership is mixed
  - MNO will still own the RU and vDU
  - Multiple ownership models for vCU and cloud packet core – fully owned by MNO, fully owned by a cloud service provider, or owned by both MNO and cloud service provider

Mobile Network Evolution: Hardware Becomes Software and Open – Part 4

Open Virtual/Cloud Radio Access Network

RU= Radio Unit
vDU = Virtualized Distributed Unit   —— = Open Fronthaul
vCU = Virtualized Central Unit   RIC = Radio Intelligent Controller

- The interfaces between the radio access elements are open, allowing for multi-vendor radio access network
  - Most notable open interface is the fronthaul, or connection between the RU and the vDU
  - Open fronthaul allows MNO to mix different vendors between the RU and the vDU/vCU
  - Mixing vendors helps MNO save on costs and allows the MNO to work with best of breed suppliers
- Open RAN introduces a new network element called radio intelligent controller (RIC)
  - RIC allows for third-party applications for new network features and functionality that the are not supplied by the RU/vDU/vCU vendors
  - RIC can help MNO save money such as through improved energy management or increase revenues through introduction of a new service

5G Fixed Wireless Access Has a Coverage Advantage over Cable and DSL

Verizon's Nationwide 5G C-Band FWA Spectrum

Average Spectrum Depth
120.00 — 200.00

© 2024 Mapbox © OpenStreetMap
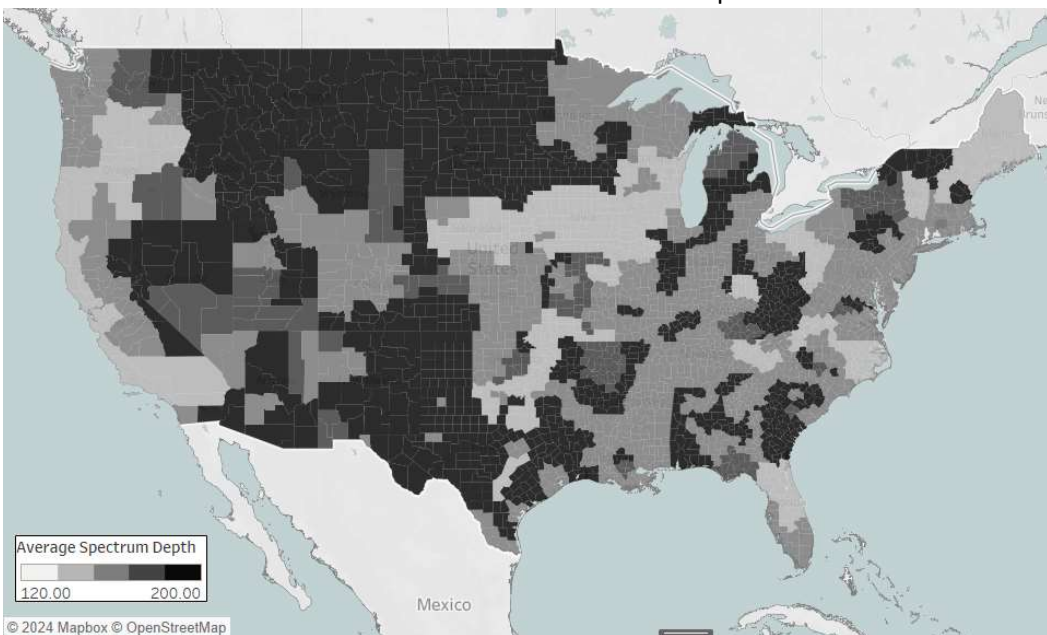
- The U.S. big 3 mobile operators have all launched FWA using their 5G networks
  - Services available in all markets, not just rural

- FWA footprints are nationwide while economics and technology limit the coverage of fiber, cable, and DSL

- For example: Verizon has 100-200MHz of C-band 5G FWA spectrum nationwide
  - Residential service plans start at $35/month
  - Downlink speeds ranging from 50Mbps to 1Gbps depending on service plan
  - Theoretically 4.8Gps is possible VZ deploys more spectrum
  - No equipment fees

There is Clear Satisfaction Hierarchy in the Consumer Broadband Market: FWA > Fiber > Cable > DSL

Broadband: NPS Heatmap by Provider & Connection Type
Recon Analytics Data - Mobile and Home Broadband Service

On a scale from 0-10, how likely would you be to recommend your current ISP considering your home internet experience with the following?

		Complete Experience	Web browsing experience	Streaming audio experience	Adding new devices to the network	Installation was convenient & easy	Streaming video experience	Easy to understand bill	Existing devices stay connected to the network	Download speed	Connecting & maintaining WiFi connection	Upload speed	ISP website is easy to use	Billing Support over the Phone	Technical support over the phone	Value for price	Online self-help customer service	In-store experience
Fixed Wireless	Verizon FWA	55.3	57.3	58.0	58.4	63.0	54.9	54.7	53.8	53.1	54.3	50.4	51.2	47.5	45.9	55.2	46.0	46.6
	T-Mobile FWA	33.3	35.9	34.7	37.3	47.1	29.3	39.4	28.0	26.1	24.3	22.1	29.8	24.8	22.1	36.2	19.2	21.0
Fiber	Frontier	18.8	28.8	28.2	26.0	21.6	25.0	22.2	22.7	23.1	21.1	23.9	13.5	3.9	-0.1	10.8	0.3	-10.0
	AT&T	13.9	20.9	20.9	17.9	14.2	18.9	13.5	14.6	18.2	13.5	16.3	4.7	-1.2	-2.2	3.3	-5.4	-6.8
	Verizon Fios	13.1	22.2	20.4	17.8	13.4	18.2	9.1	16.8	17.6	16.7	14.5	-1.2	-6.8	-7.1	-5.3	-10.4	-13.1
	CenturyLink	12.1	19.7	22.9	20.6	13.5	15.6	18.5	16.6	15.4	13.8	12.7	0.3	-10.2	-11.5	11.5	-11.6	-16.1
	Optimum	11.4	22.1	19.3	19.0	9.9	14.8	11.8	13.1	14.9	8.6	10.0	7.0	-0.7	-4.7	-3.1	-3.8	-12.4
Cable	Xfinity	-2.8	11.4	10.0	8.6	6.1	6.3	0.0	3.6	4.0	1.9	-3.0	-7.0	-17.2	-18.4	-20.5	-19.2	-15.7
	Cox	-3.4	11.0	8.6	9.3	6.5	4.0	6.2	1.1	0.9	-0.3	-6.5	-1.5	-10.9	-12.3	-24.9	-14.7	-16.4
	Spectrum	-3.8	8.4	7.0	6.9	4.9	3.2	4.3	-0.5	-0.7	-2.6	-6.8	-4.5	-13.1	-12.0	-20.3	-16.7	-21.3
	Optimum	-15.2	1.5	-1.8	-2.1	-2.0	-6.8	-6.1	-9.2	-9.8	-9.6	-15.4	-16.1	-24.2	-26.4	-33.8	-31.9	-29.2
DSL	AT&T	-8.8	0.5	-1.7	0.4	1.5	-6.5	0.5	-6.6	-14.3	-7.3	-15.1	-10.6	-16.3	-19.0	-18.5	-21.7	-20.9
	CenturyLink	-15.4	-4.8	-5.7	0.3	2.3	-16.3	6.4	-11.0	-25.2	-15.7	-30.5	-14.3	-23.0	-29.5	-14.0	-29.9	-39.3
	Frontier	-24.8	-10.6	-13.7	-11.6	-4.7	-17.9	-6.3	-14.9	-26.4	-18.2	-28.5	-18.6	-18.2	-19.6	-26.3	-31.0	-36.0
Grand Total		2.3	13.8	12.5	11.9	10.3	8.7	7.2	6.0	5.6	4.3	0.4	-1.4	-9.5	-10.4	-12.1	-13.0	-13.6

1/6/2023 through 1/12/2024 n= 160,976

Recon Analytics Data
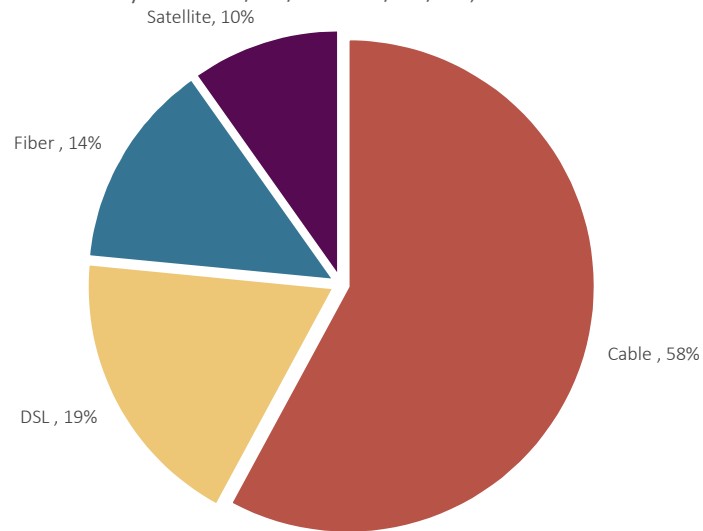
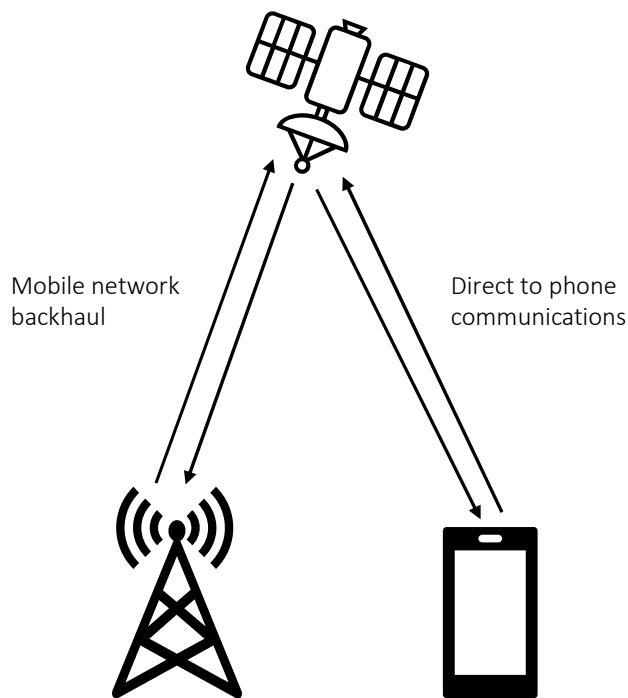# FWA High NPS Scores Impacting Cable and DSL the Most

What FWA Subscribers Had Previously for Broadband
Q: Prior to joining [FWA Provider], what type of internet connection did you have?
Study Date 10/13/23 - 11/10/23; n=520

Satellite, 10%

Fiber , 14%

DSL , 19%

Cable , 58%

- FWA is not the connectivity choice of last resort; consumers are leaving other broadband services to subscribe to FWA

- Older access technologies like cable and DSL are most vulnerable for losing subscribers to FWA with approximately 77% of current FWA users saying they previously had cable or DSL

- This only adds to cable MSO's ongoing woes as they are also losing video customers

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Recon Analytics Data

Low Earth Orbit Satellites are Improving Mobile Network Services

Mobile network backhaul

Direct to phone communications

- LEO satellites play an important role in enhancing mobile service deployment in rural areas

- LEO can be for both direct to phone communications or backhaul base stations

- LEO partnerships:
  - AT&T Wireless has selected AST SpaceMobile for rural network coverage
  - T-Mobile announced plans to use Starlink for LEO connectivity to smartphones in areas not covered by T-Mobile's network
  - Verizon has selected Amazon's Kuiper Project for rural mobile network backhaul
  - Apple iPhone 14 & 15 use Globalstar for emergency SOS messaging

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Low Earth Orbit Satellites are Ideal for Rural Fixed Broadband

Starlink Brings New Competition to Home Broadband Market

Starlink Net Promoter Score vs. Broadband Tech Types
Study Dates 5/12/23 - 7/27/23; n=87,955

Bar chart values: Starlink 36, Fixed Wireless 20, Fiber 16, Satellite -2, Cable -3, DSL -8
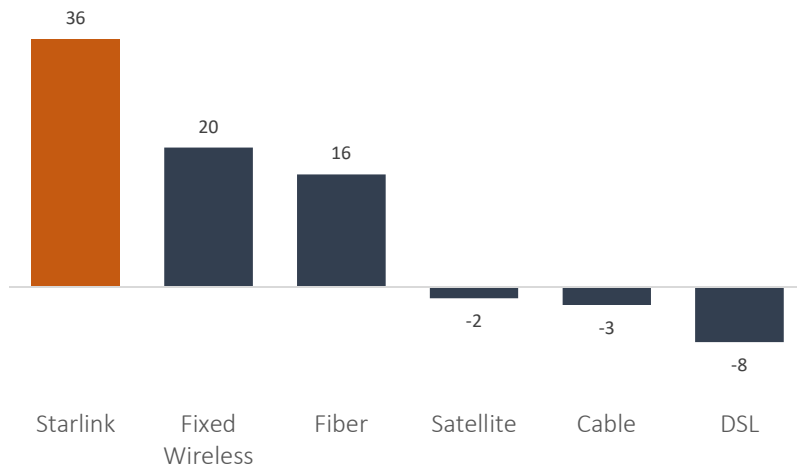
Data includes early FWA results where satisfaction was lower than it is today, as FWA services have matured

- LEO reaches places that fiber will never go and FWA has yet to reach
  - The business model for LEO fixed broadband is to target rural areas where homes have clear sky access
- Low earth orbit allows for better speeds and latency than legacy satellite broadband options
- Starlink offer unlimited residential service for $120/month
  - CPE costs is $599
  - Speeds advertised are 25-100Mbps downlink; 5-10Mbps uplink
  - Latency 25-60ms
- Starlink net promoter scores are higher than those of other access technologies

Thank You

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