

Bridging the Digital Divide in Hungary:

A Call for Technology-Neutral Broadband Policies



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Agenda



- › Hungary Gigabit Program and VHCN / EU BEREC Guidelines
- › New Applications / New Demand. How Much Broadband Do We Really Need?
- › Broadband Access Technologies Options: FIBER, LTE/5G, WIFI FWA and ngFWA
- › Imagine “*Wireless Fiber*” in mid-band Spectrum (3/5/6 GHz)
- › Wireless Technologies Driving the FWA Performance Enhancements
- › Mobile Networks Not Designed for Home Broadband
- › Real Customer References in 5 GHz and 6 GHz
- › The Future of Broadband: A Hybrid Access Network Approach

Call for Tech-Neutral Broadband Access Networks ...

Hungary Gigabit Program and VHCN / EU BEREC Guidelines

- › **Gigabit Magyarország 2030** (Hungarian Government Program) part of the *National Digitalisation Strategy 2022–2030*
- › overseen by the **Ministry of Energy's State Secretariat for Infocommunications** (previously under the Ministry of Innovation and Technology)
- › defines the objectives, funding instruments, and timelines to achieve nationwide gigabit-capable coverage by 2030
- › **NMHH** (Hungarian telecom regulator) – supervisory role
 - Market regulation & competition, Spectrum management, Infrastructure access, Quality & consumer protection

Hungarian Government owns the program, while NMHH ensures the regulatory environment allows the networks to be built, operated, and used fairly and effectively

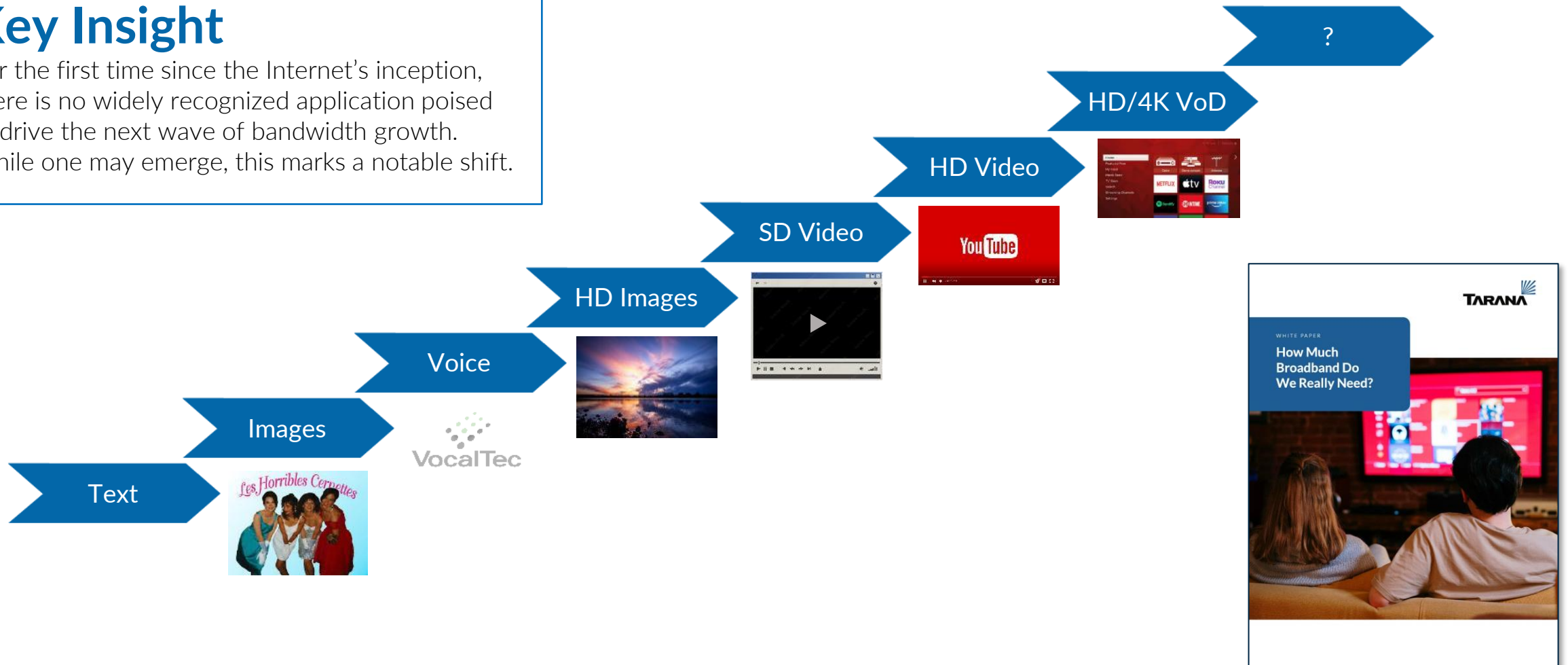
- › **BEREC** (EU agency-level body) that brings together the national telecom regulators from all EU Member States (e.g. NMHH in Hungary, Ofcom in the UK, BNetzA in Germany, etc.)
- › **VHCN** (Very High-Capacity Network) - **EU regulatory term**, defined in the European Electronic Communications Code (EECC). **VHCN is a fixed or wireless communications network that can deliver gigabit-class performance:**
 - **Fiber-to-the-premises (FTTP)** qualifies by default
 - Other technologies (e.g. upgraded cable, advanced fixed wireless, 5G) can qualify if they deliver **comparable high capacity, reliability, and quality**

VHCNs are the **foundation of the EU's Digital Decade 2030 targets** aiming for **gigabit connectivity** for all households and wireless/5G coverage **everywhere!**

New Applications, New Demands

Key Insight

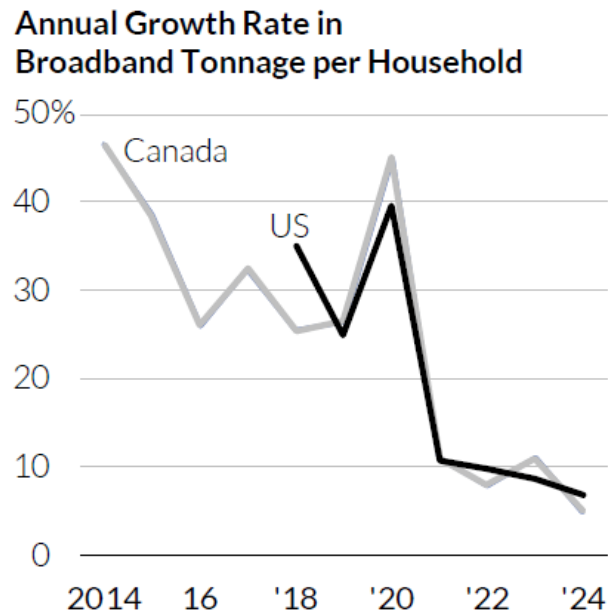
For the first time since the Internet's inception, there is no widely recognized application poised to drive the next wave of bandwidth growth. While one may emerge, this marks a notable shift.



How Much Broadband Do We Really Need?

More Users, but slowing Growth

- › 2020 COVID Effect:
 - 35-50% increase in Europe
 - 20% increase in the U.S.
 - 30-40% increase in Japan & Asia Pacific



Sources: CRTC, OpenVault [4]

Apps Driving Bandwidth Demand

- › Downstream / Upstream Traffic (Fixed Access Links)

Top App Categories by Volume (MB per day) – 2023 View^[3]

Downstream			Upstream		
App	% DL	DL MB	App	%UL	UL MB
Video	39	5,700	File Sharing	28	319
Social Media	18	2,600	Video	13	153
Television	11	1,600	Communication	12	134
File Sharing	9	1,300	General Web Apps	11	128
Device Gaming	7	1,100	Social Media	9	107
General Web Apps	6	889	VPN	5	61
Communication	2	249	Device Gaming	4	52
VPN	2	234	Conferencing	2	27
Audio	0.7	98	Television	2	25
Conferencing	.3	47	IoT	1	15
Cloud Gaming	.07	11	Peer to Peer	0.3	4
IoT	.03	4	Audio	0.3	3
Peer to Peer	.03	4	Cloud Gaming	0.03	0.3
Other	5	753	Other Apps	11	125
Total	100	14,500	Total	100	1,200

- › Video Streaming: The King of Consumption

Video Format	Netflix	YouTube	Disney+	Amazon Prime
720p (HD)	3	2.5		
1080p (HD)	5	5	5	5
4K (UHD)	15	20	25	No indicators

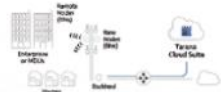
Broadband Technologies: FIBER, LTE/5G, low-cost FWA and ngFWA

- **Fibre-to-the-Home (FTTH) remains the gold standard** for broadband performance; however, deploying it in rural and low-density areas presents significant challenges where **advanced fixed wireless solution (FWA/ngFWA)** are **capable to deliver fibre-class gigabit-speeds services** and driving the hybrid broadband models.
- **Fast network expansion, revenue acceleration, and operational efficiency** are **key factors** in today's competitive market!

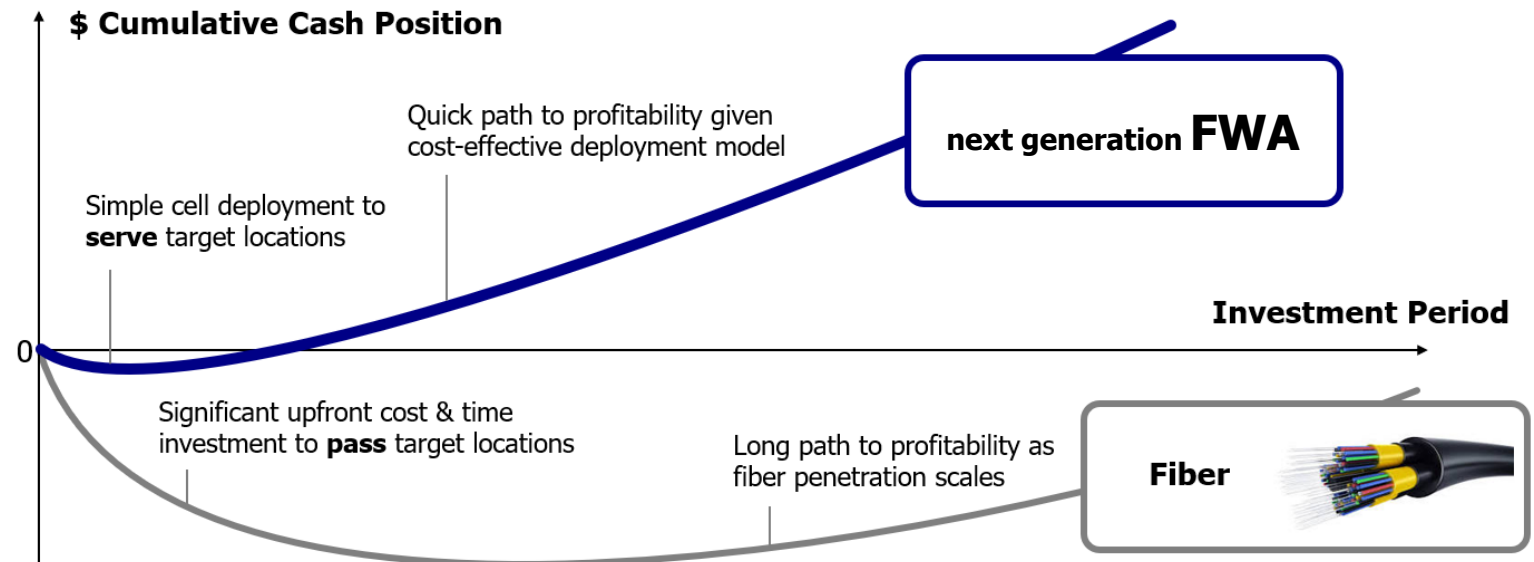
Save your 4G/5G Spectrum

Save your 4G/5G spectrum.

Tarana's next-generation fixed wireless access platform can help meet the demand for capacity



Fibre / FTTH Deployment

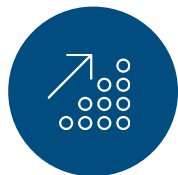


Imagine mid-band FWA Technology can provide ...

... completely new Performance and Business Model



- **Fiber-class per-household speeds** (100 Mbps to 1+ Gbps) and low latency, with support for symmetric (100 Mbps down / 100 upstream)



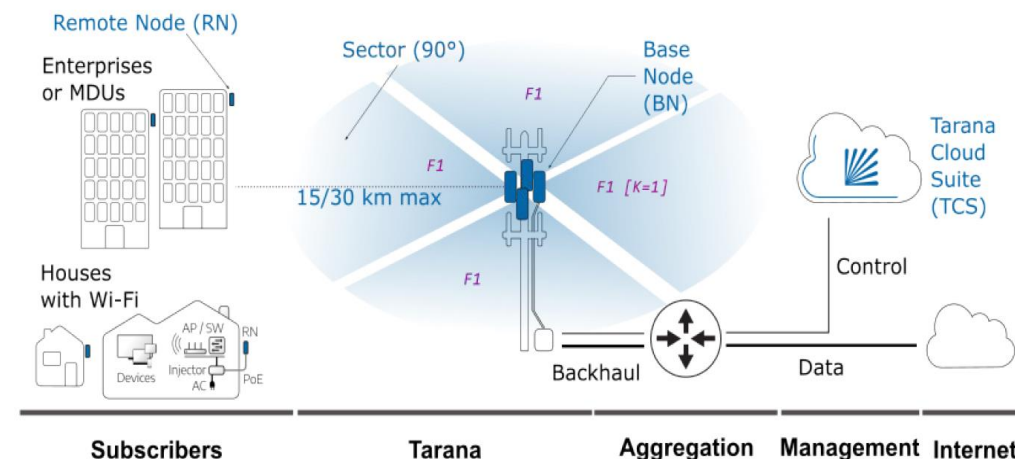
- **High capacity** per neighborhood for economically scalable deployments, long-reach
- Solid connections **despite obstacles** in the way (like other houses, trees, and vehicles moving on the streets) and interference from other wireless networks



- **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, quick, and easy installation** at the home, and ideally customer self-installation
- Built Correctly, **Wireless Has Unbeatable Uptime/Resilience**
- **UK & EU regulatory compliant & certified**
- **Great complement to fiber network**



A New Solution to the Persistent Broadband Dilemma

A complete reengineering of
wireless optimized for FWA

ngFWA

Fundamental Advance #1
Reliable, High Speeds Without Line-of-Sight



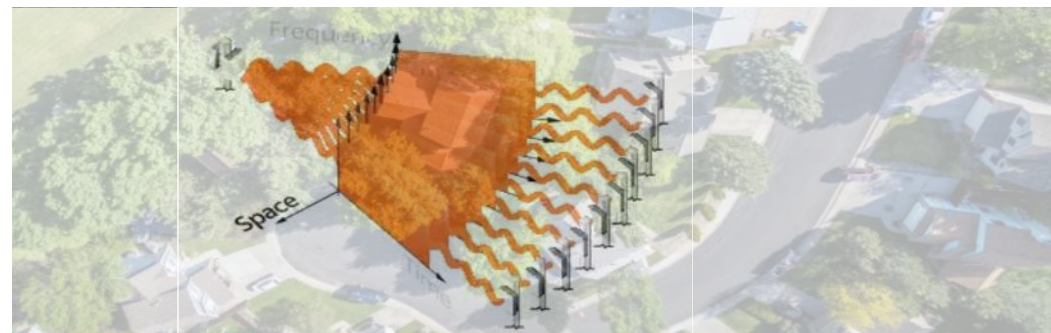
Fundamental Advance #2

Carrier-Class Operation with Interference Cancellation



Fundamental Advance #3

Capacity Multiplication via Advanced Spatial Multiplexing



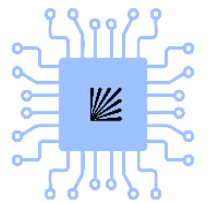
Technology Driving the FWA Performance Enhancements

Key Technology Elements	Performance Benefits
Cooperative (distributed) MMIMO	Large antenna array, digital processing at BN and RN
High-precision digital beam/null-forming	The foundation: extremely well-controlled radio energy
Closed-loop beamforming adaptation	Collaboration between base and remote nodes further improves digital beamforming accuracy
Multipath equalization and combining	Applying signal processing across domains yields optimal results with diffraction, reflection, and motion
Adaptive self-interference cancellation	Huge spectral efficiency gains through dense co-channel link operation
Continuous unlicensed interference cancellation	Yields licensed-class reliability in unlicensed/shared spectrum

Unique Algorithms

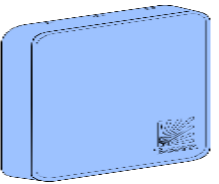


Custom Silicon



Digital Signal Tflops

ngFWA System Designs



Mobile Networks Are Not Designed for Home Broadband

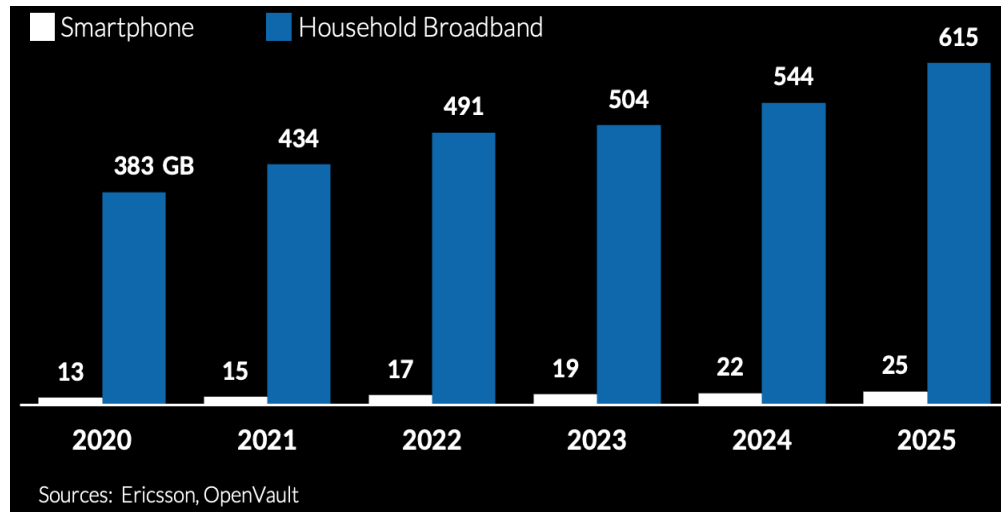


**One fact
makes all the
difference:**

The average
household
consumes:
30-50x
more data per
month with
these:

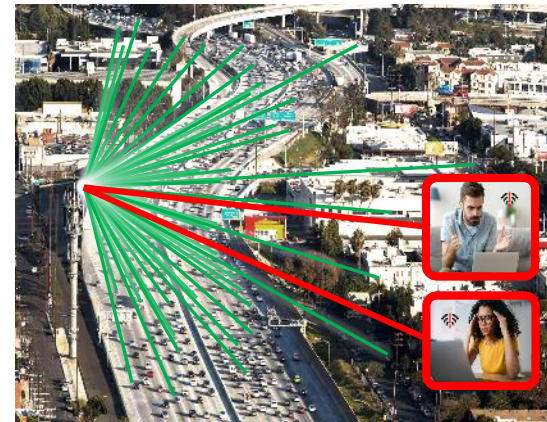


... vs this:

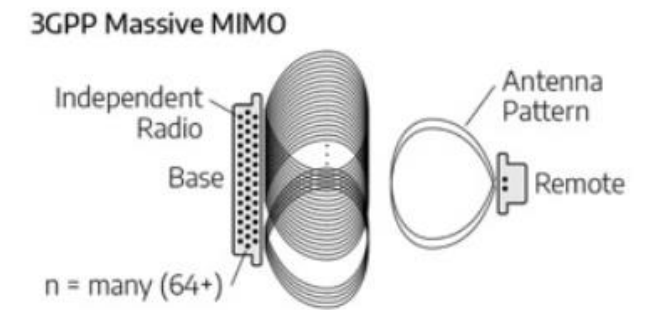


North America Mobile/Home Broadband, Monthly Usage

... for about the **same** monthly ARPU!



3GPP and mobile have limited spectrum and capacity



Comparing C-band 5G FWA vs. ngFWA in 5 GHz (unlicensed bands)

Spectral Efficiency:

Expected NLoS Performance:

+/- 3,5km from BTS/BN (~12dB excess pathloss)
80 MHz / 2x 40 MHz

Expected LoS Performance:

Rural Areas, distance in km from BTS/BN
80 MHz / 2x 40 MHz
DL / UL Network Traffic Profile 1: 4.50:1

Bidirectional Beamforming:

- Auto-converged Retro Directive Beamforming

Adaptive Burst Interference Cancellation:

Adaptive Multi-path Equalization:

- near perfect multipath re-integration (on all receivers !)

K=1 Spectrum Reuse:

Realistic # of connected FWA CPEs (per sector):

5G (3GPP)

~4-5 bits / Hz

DL 250 Mbps
UL 15 Mbps

3 km: 500 Mbps
5 km: 400 Mbps
9 km: 200 Mbps

NO

NO

NO

NO

30

ngFWA

~20 bits / Hz

DL 400 Mbps
UL 80 Mbps

3 km: 750+ Mbps
5 km: 600+ Mbps
9 km: 500+ Mbps

YES

YES

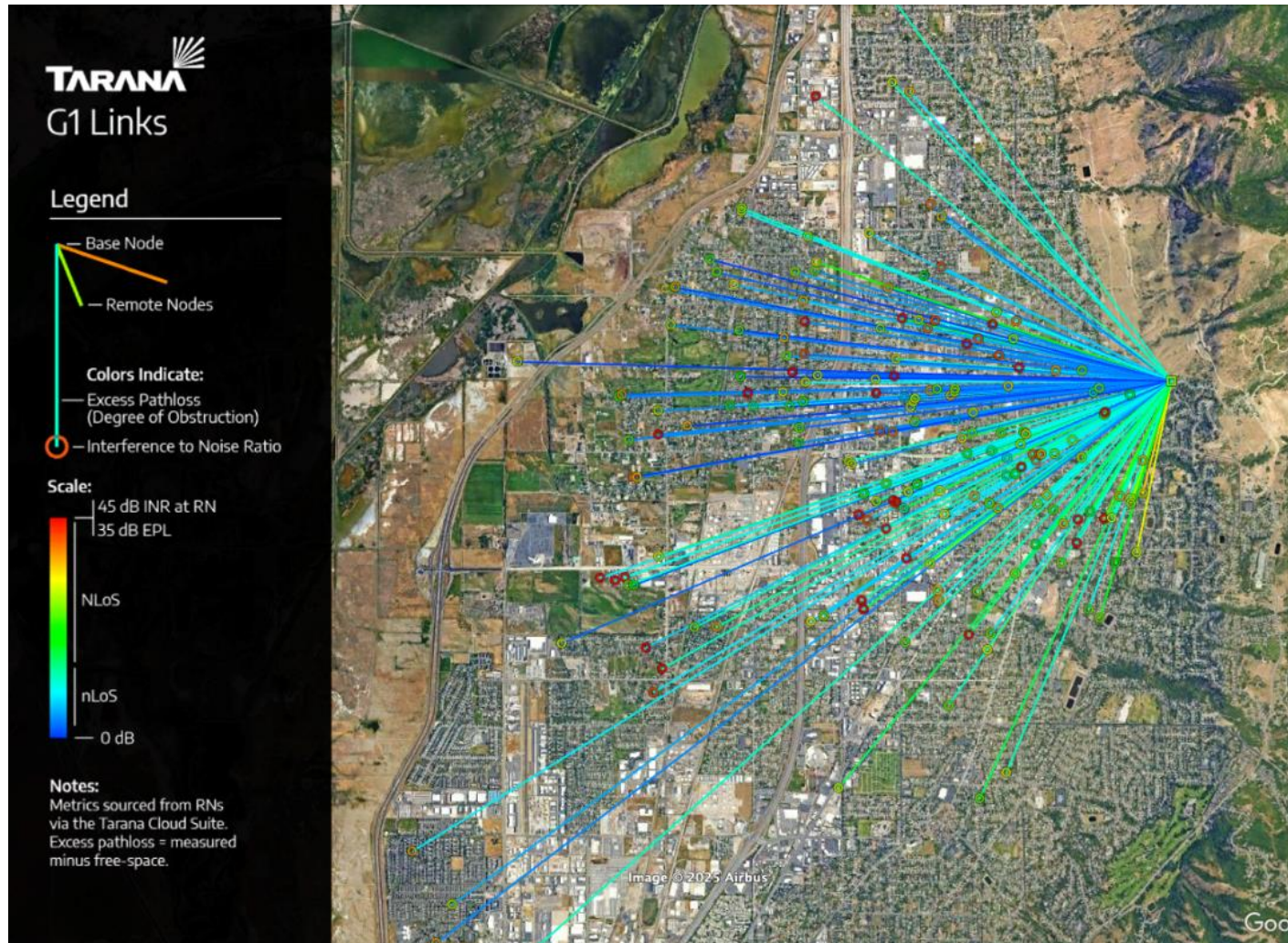
YES

YES

120

Note: *expect 50-100 Mbps throughput degradation in sub-urban areas (w/ higher interference margins) i.e. 700+ Mbps aggregate speed for 3km, or 500+ Mbps for 5km LoS, etc. using Tarana G1

5 GHz ngFWA Real Customer Reference



Echo Broadband

1 BN, 5 GHz

187 RNs

RF Link Average:
515/115 Mbps

Customer SLAs:

22%

240 Customers
500 Mbps Plan

33%

358 Customers
300 Mbps Plan

45%

500 Customers
150 Mbps Plan

...and this is on G1 in mostly 5 GHz

6 GHz ngFWA Real Customer Reference

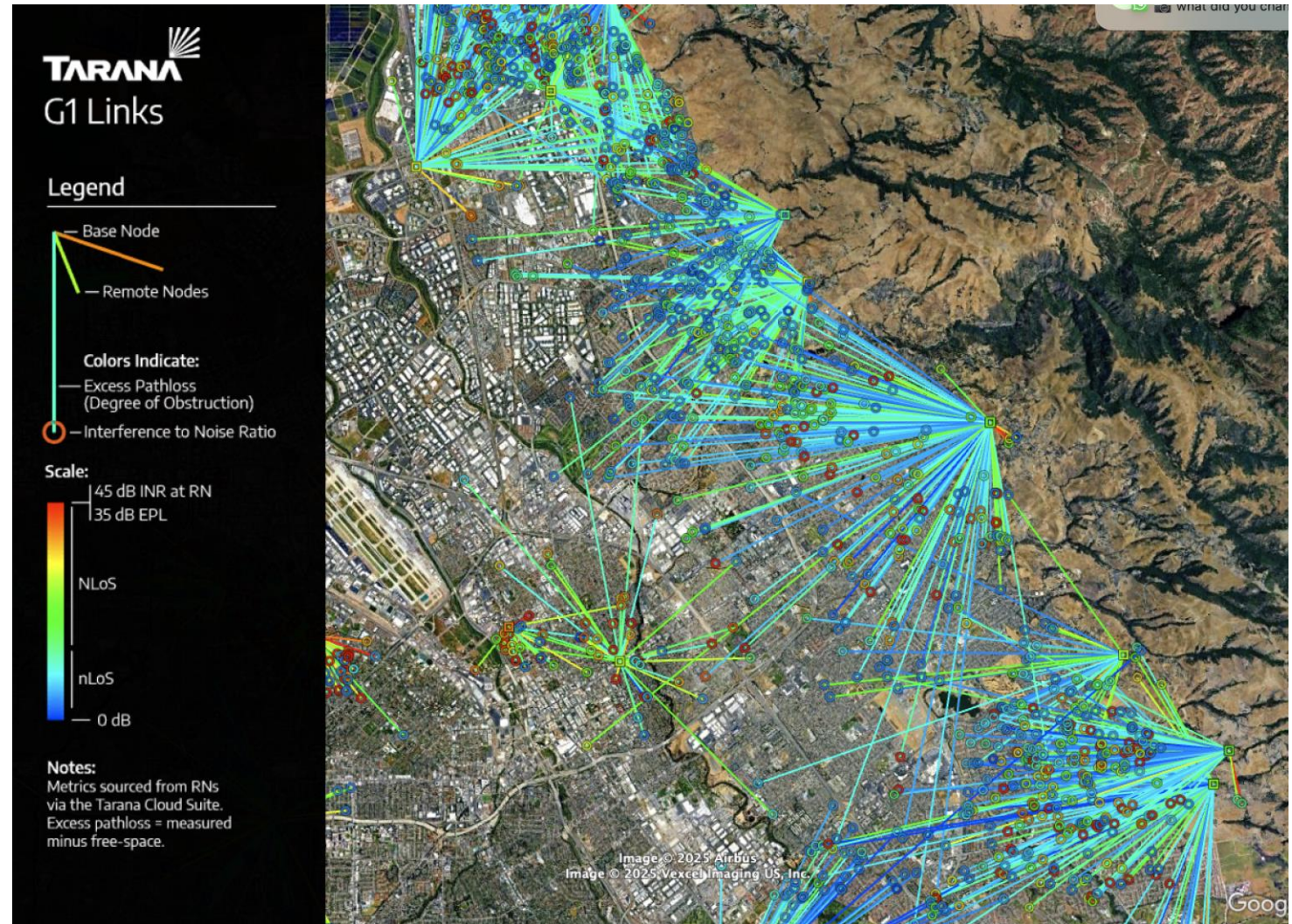
Twist/Sail Internet

48 BNs, 6 GHz

2,000 RNs & growing

RF Link Average:

660/155 Mbps



Hybrid Customer Case: Fibre/FTTx + FWA (5 GHz) + mmWave

Airband Broadband, UK



Fibre 150  150 Mbps with unlimited usage ↑↓ 150Mbps download & upload speed £ 50% off for 24 months - save £396 Nokia WiFi 6 mesh router included ✓ 24-month contract (no price hikes) ✓ Free survey and installation	Fibre 300  300 Mbps with unlimited usage ↑↓ 300Mbps download & upload speed £ 50% off for 24 months - save £456 Nokia WiFi 6 mesh router included ✓ 24-month contract (no price hikes) ✓ Free survey and installation	Fibre 600  600 Mbps with unlimited usage ↑↓ 600Mbps download & upload speed £ 50% off for 24 months - save £576 Nokia WiFi 6 mesh router included ✓ 24-month contract (no price hikes) ✓ Free survey and installation	Fibre 900  900 Mbps with unlimited usage ↑↓ 900Mbps download & upload speed £ 50% off for 24 months - save £696 Nokia WiFi 6 mesh router included ✓ 24-month contract (no price hikes) ✓ Free survey and installation	AirSpeed 40  40 Mbps with unlimited usage ↓ Up to 40Mbps download speed £ 50% off for 24 months - save £396 Nokia WiFi 6 mesh router included ✓ 24-month contract (no price hikes) ✓ Free survey and installation	AirSpeed 150  150 Mbps with unlimited usage ↓ Up to 150Mbps download speed £ 50% off for 24 months - save £456 Nokia WiFi 6 mesh router included ✓ 24-month contract (no price hikes) ✓ Free survey and installation	AirSpeed 400  400 Mbps with unlimited usage ↓ Up to 400Mbps download speed £ 50% off for 24 months - save £576 Nokia WiFi 6 mesh router included ✓ 24-month contract (no price hikes) ✓ Free survey and installation	AirSpeed 1000  1000 Mbps with unlimited usage ↓ Up to 1000Mbps download speed £ 50% off for 24 months - save £696 Nokia WiFi 6 mesh router included ✓ 24-month contract (no price hikes) ✓ Free survey and installation
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Fibre / FTTx

low cost
FWA/WIFI

Tflop
ngFWA

Tflop
ngFWA

mmWave

The Future of Broadband: A Hybrid Access Network Approach

- › **The future of broadband deployment isn't a binary choice between fiber and wireless**
- › **Fiber** is the right choice when density meets demand, offering virtually unlimited bandwidth in the right conditions
- › **Fixed Wireless** excels where fiber falters – bridging the digital divide in complex terrains w/ costly fiber deployments
- › A **hybrid approach** is about leveraging **the strength of fiber and wireless** to achieve the mission of **connecting everyone affordably!**
- › By integrating FWA into their broadband strategies, service providers can **maximize coverage, accelerate revenue, and meet critical funding program** requirements while ensuring high-quality service for customers!

Call for tech-neutral networks ...



... stipulated by EU (BEREK) and national Broadband Funding Programs (also for Hungary)



Q & A

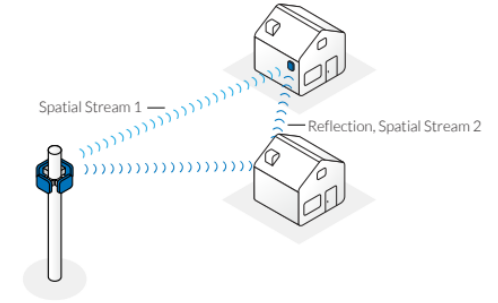
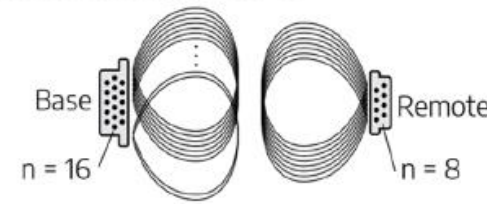
Key Differentiators: Advanced real-time Digital Signal Processing

Fiber-class reliability and performance in Fixed Wireless Access at large scale!

Distributed Massive MIMO (DMM):

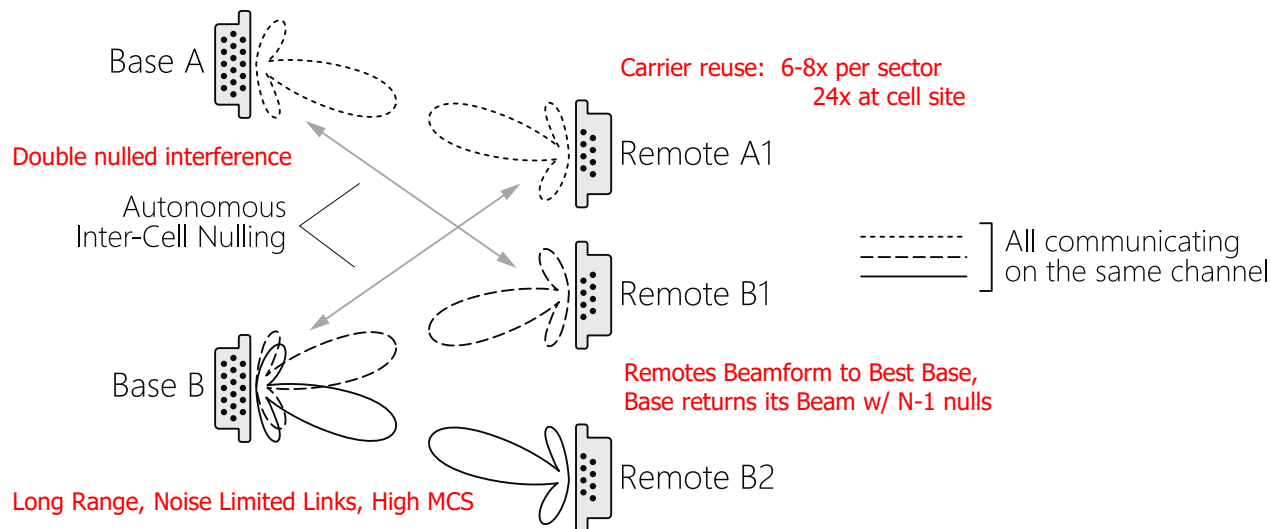
- multi-dimensional signal processing capabilities *at both ends of the link*
- DMM beamforming, null-steering architecture
- Perfect Multipath Integration

Distributed Massive MIMO

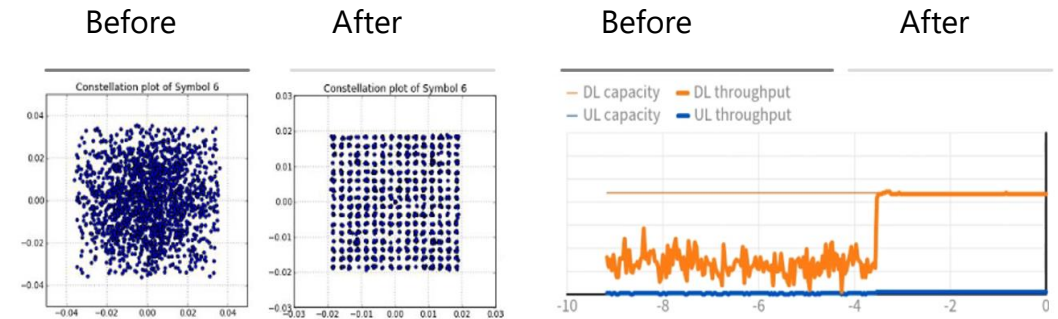


Capacity Multiplication w/ Interference Cancellation

- Using interference cancellation, ngFWA allows many pairwise communications to happen simultaneously
- It creates “virtual wires” shielded from one another



Asynchronous Burst Interference Cancellation (ABIC)



Wi-Fi Interference in 5 GHz Band

- ABIC cancels up to 40 dB of asynchronous interference from any source outside the network and up to 45 dB self-interference or interference of bursty traffic (e.g. Wi-Fi)
- Cancellation occurs in real-time during reception of the transmission

