WIRELESS GLOBAL CONGRESS
WIRELESS BROADBAND ALLIANCE

25 MAY – 8 JULY, 2021

WI-FI: POWERING INNOVATION SERIES

Creating new possibilities for Carriers, Enterprise, Cities and Things.

#WGCAmericas | #wifirevolution
#lovewifi

WIRELESS GLOBAL CONGRESS
WIRELESS BROADBAND ALLIANCE

Welcome & Opening Remarks

STEVE NAMASEEVAYUM

Director, Membership & Industry Alliances

Wireless Broadband Alliance

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JUNE 10, 2021

Connecting the Wi-Fi Enabled Enterprise

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Wi-Fi Powering Innovation Series

Full Program Agenda

May 25th & 26th – WBA Members Only Working Sessions

May 27th – WBA Members Only Working Sessions: **Briefing for Asia-based members**

WI-FI POWERING INNOVATION SERIES: 08:30 PT; 1130 ET; 15:30 GMT; 23:30 Singapore

Thursday June 3rd	Thursday, June 10th	Thursday, June 17th	Thursday, June 24th	Wednesday, June 30th	Thursday, July 8th
Wi-Fi Innovations Connecting Your World – Leadership Conference	**Connecting the Wi-Fi Enabled Enterprise**	**Wireless Innovation, Operation & Customer experience – Where next for operators?**	**Wi-Fi Innovation For Hospitality**	**Connected Cities get Smarter with Wi-Fi in the 5G Era**	**Carrier Grade Wi-Fi delivering the future for the Smart Connected Home**

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Connecting the Wi-Fi Enabled Enterprise

Steve Namaseevayum

Wireless Broadband Alliance

Mark Edwards

Walmart Global Tech

Gabriel Desjardins

Broadcom

David Tokunaga

Boingo Wireless

Irvind Ghai

ON Semiconductor

Jim Allison

Capitol Corridor Joint Powers Authority

Thomas Locke

GlobalReach Technology

Lakshmi Thanayankizil Ph.D.

General Motors

Tyson Marian

Plume Design

Wi-Fi innovations Connecting Your World - Leadership Conference

TODAY'S AGENDA	
08:30am (Pacific time)	**Welcome & Opening Remarks** Steve Namaseevayum, Director, Membership and Industry Alliances, Wireless Broadband Alliance
08:35am (Pacific time)	**Fireside Chat - Retail 2021+** Mark Edwards, Principal Network Engineer, Walmart Global Tech
08:45am (Pacific time)	**6 GHz Enterprise Wi-Fi** Gabriel Desjardins, Director of Product Marketing, Broadcom
09:00am (Pacific time)	**Enterprise Transformation at the Edge** David Tokunaga, Vice President of Product and Business Development, Boingo Wireless.
09:15am (Pacific time)	**The Odd Couple: 5G & 6E** Irvind Ghai, Vice President, Marketing ON Semiconductor
09:30am (Pacific time)	**Panel Discussion** Boingo Wireless, Broadcom, ON Semiconductor
09:50am (Pacific time)	**Amenities and Advancements with On-Train Passenger Wi-Fi** Jim Allison, Manager of Planning, Capitol Corridor Joint Powers Authority
10:00am (GMT)	**The Future of In-Flight Wi-Fi** Thomas Locke, Chief Technology Officer, GloablReach Technology
10:15am (Pacific time)	**Ready for the Road ahead – Spectrum Needs and Wi-Fi** Lakshmi Thanayankizil Ph.D. Wireless Connectivity Specialist, General Motors
10:25am (Pacific time)	**A Revolutionary Approach to Addressing the Small Business Market** Tyson Marian, Chief Commercial Officer, Plume Design
10:40am (Pacific time)	**Panel Discussion** Capitol Corridor Joint Powers Authority, General Motors, GlobalReach Technology, Plume Design
11:00am (Pacific time)	**Close** Steve Namaseevayum, Director, Membership and Industry Alliances, Wireless Broadband Alliance

WIRELESS GLOBAL CONGRESS
WIRELESS BROADBAND ALLIANCE

‘Fireside Chat’ - Retail 2021 +

MARK EDWARDS

Principal Network Engineer

Walmart Global Tech

Walmart

6 GHz Enterprise Wi-Fi

GABRIEL DESJARDINS

Director of Product Marketing

Broadcom

6 GHz Enterprise Wi-Fi

Gabriel Desjardins
Director, Product Marketing
June 10, 2021

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Agenda

Technology Trends

Performance Benefits

Big Picture

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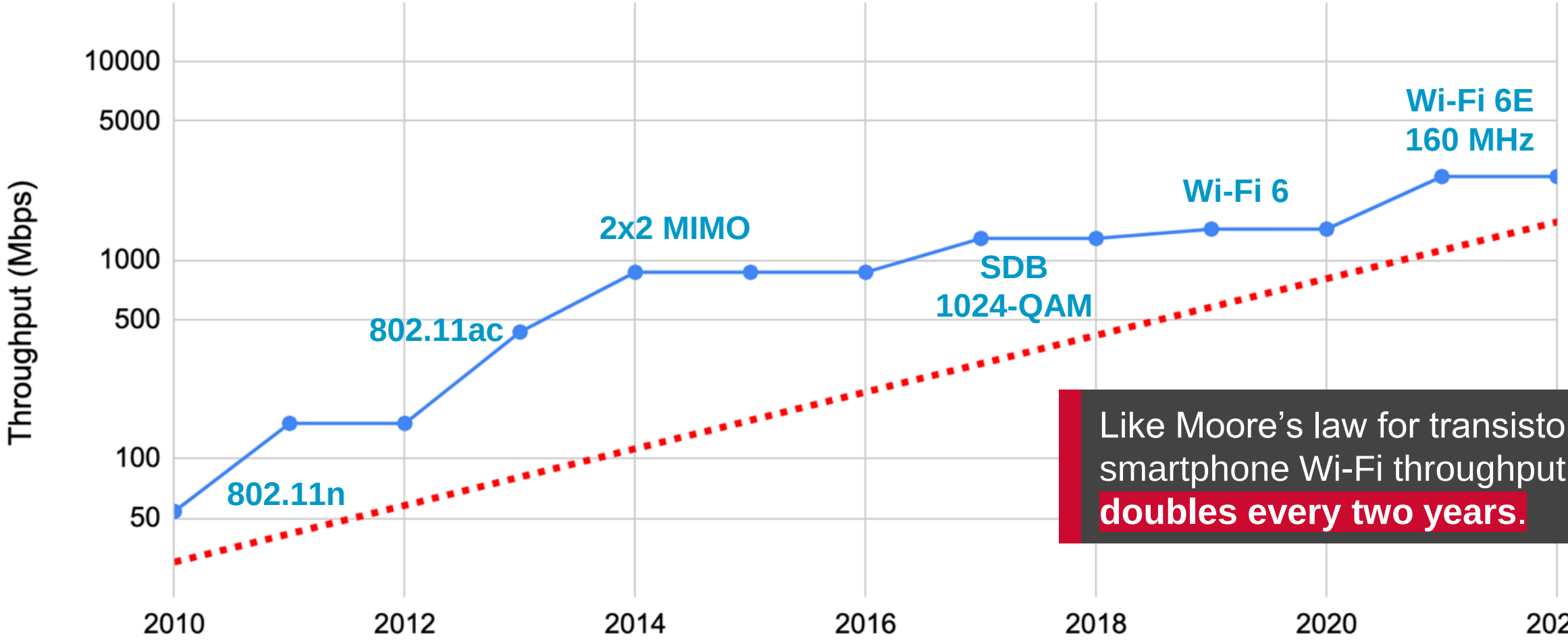
Technology Trends

Moore’s Throughput Law



Like Moore’s law for transistors, smartphone Wi-Fi throughput **doubles every two years.**

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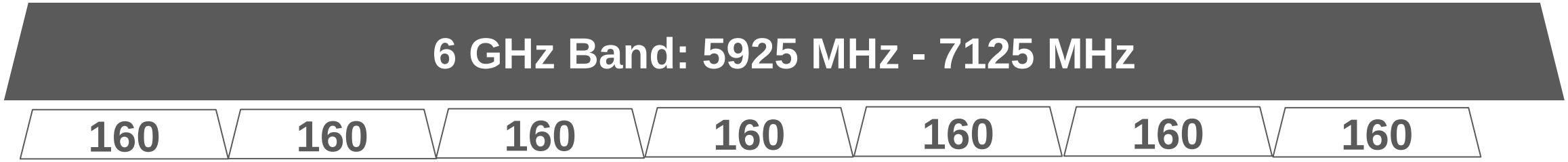
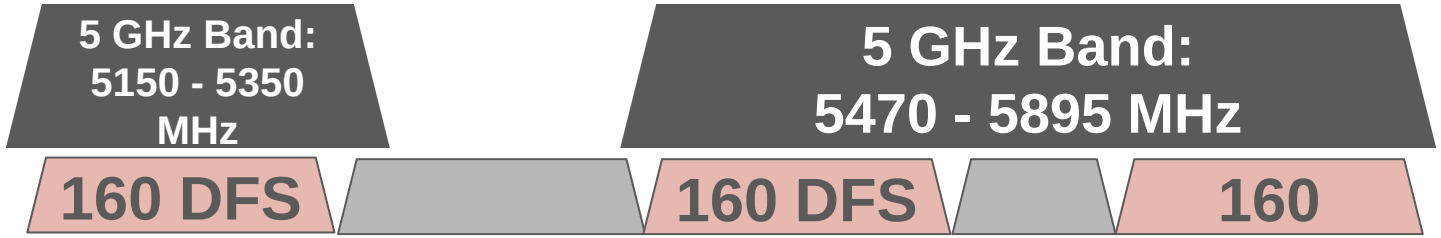
6 GHz is Critical

New 6 GHz spectrum designated for Wi-Fi in more than half the world*



160 MHz channels with no interference



Brings wide channels to homes, enterprises, venues, and dense environments

Fulfill the promise of 6 GHz

** Spectrum designated by nations comprising 54% of world GDP as of May 19, 2021*

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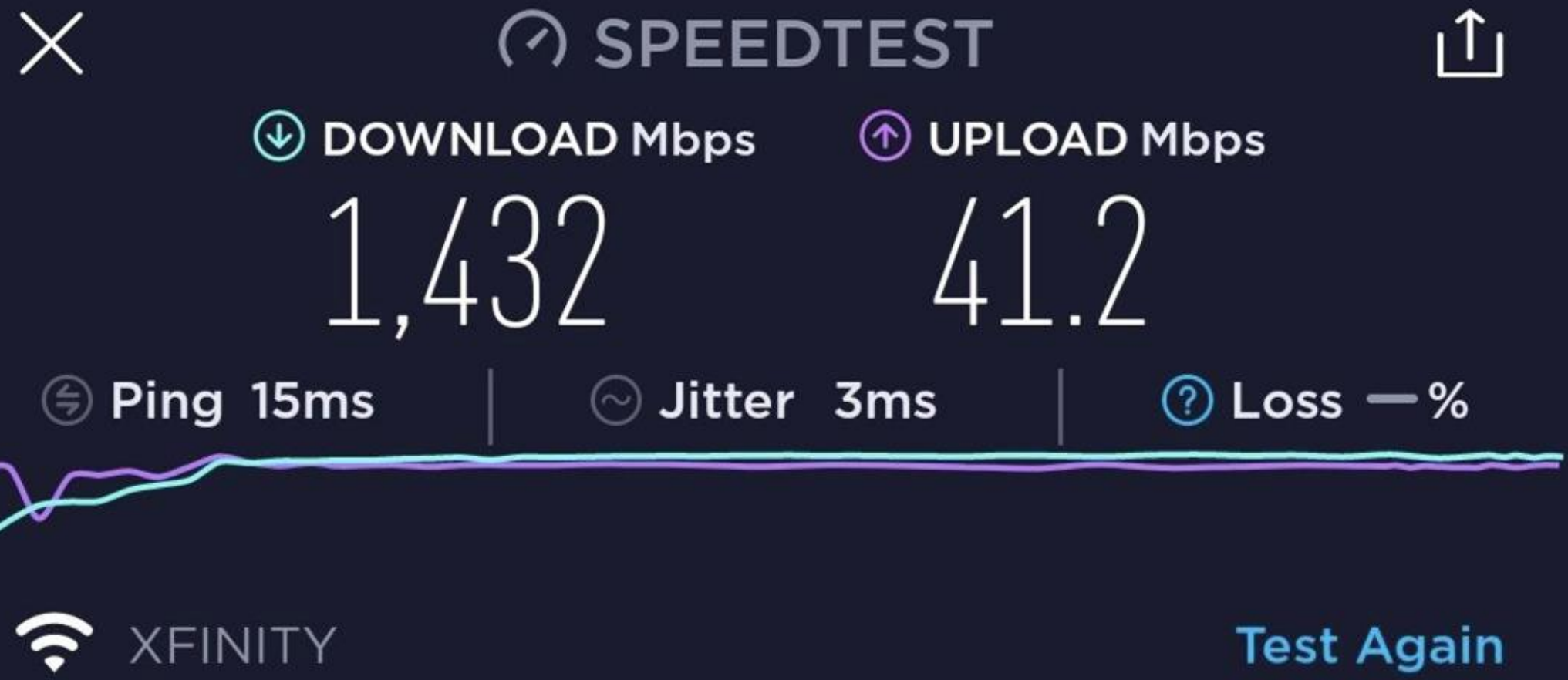
Gigabit Wi-Fi is Already Here

Wi-Fi speeds on the way to 10G



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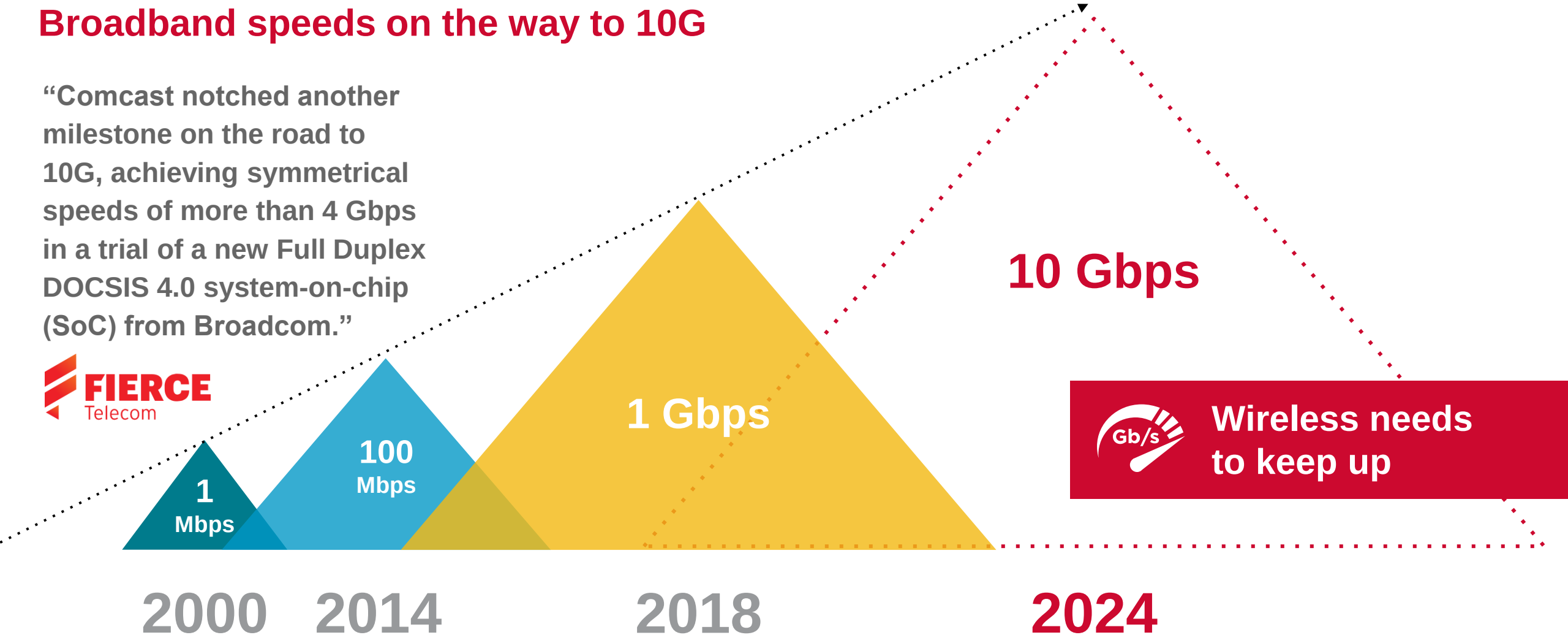
No-Limit Backhaul

Broadband speeds on the way to 10G

“Comcast notched another milestone on the road to 10G, achieving symmetrical speeds of more than 4 Gbps in a trial of a new Full Duplex DOCSIS 4.0 system-on-chip (SoC) from Broadcom.”

FIERCE Telecom



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Enterprise 2022

Key Use Cases

6 GHz Spectrum

10G Broadband

Convergence of use cases, new 6 GHz spectrum and 10 gigabit broadband.

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Performance Benefits

6 GHz Roadmap Vision

How can we further improve Wi-Fi KPIs?

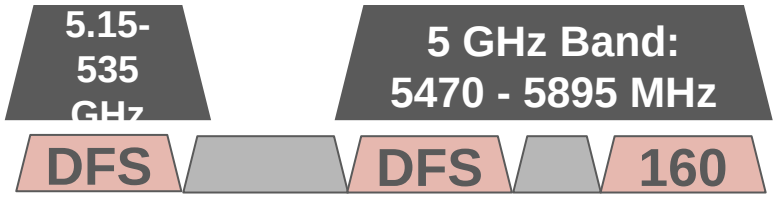
Speed:
Maximum benefit from wider channels

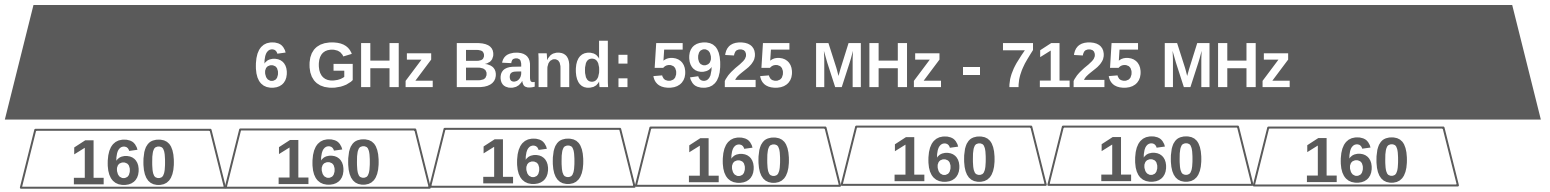
Range:
Widest area Gigabit speeds and longer range

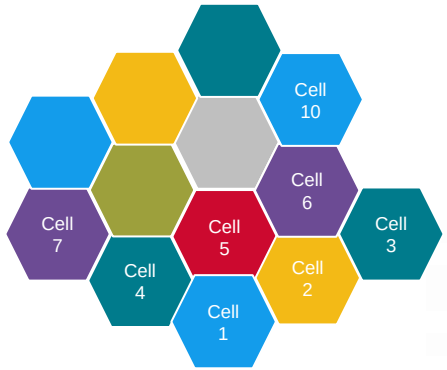
Latency:
Minimize with more spectrum and clear channels

- Whole home mesh network coverage
- Seamless cloud sync & download
- 16k video streaming & screen-sharing
- Lag-free video calling
- Low-latency augmented reality

Boost Enterprise Speeds

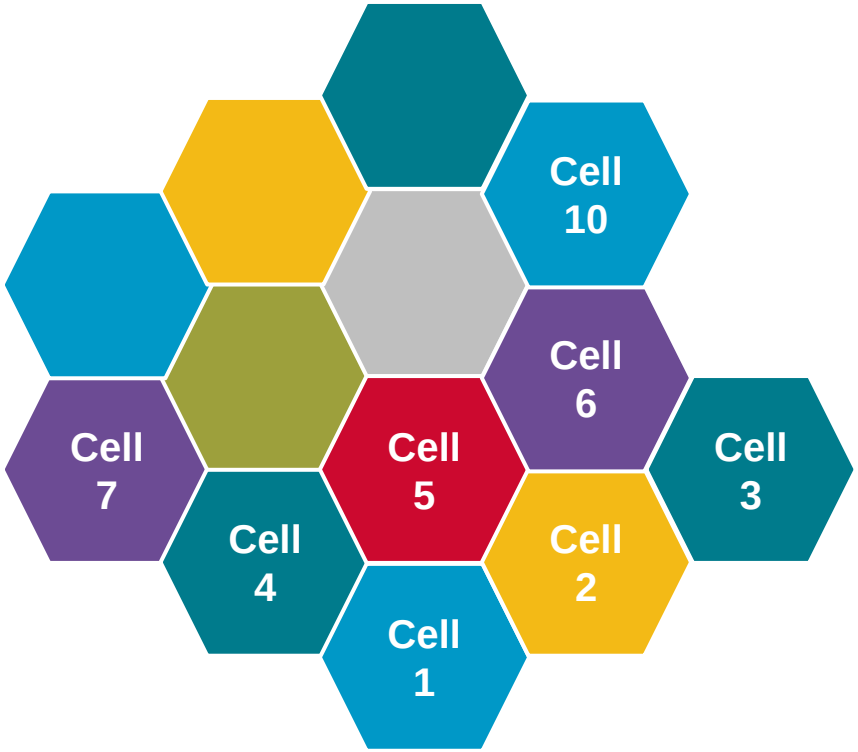






5 GHz
40 MHz Channels

6 GHz
160 MHz Channels



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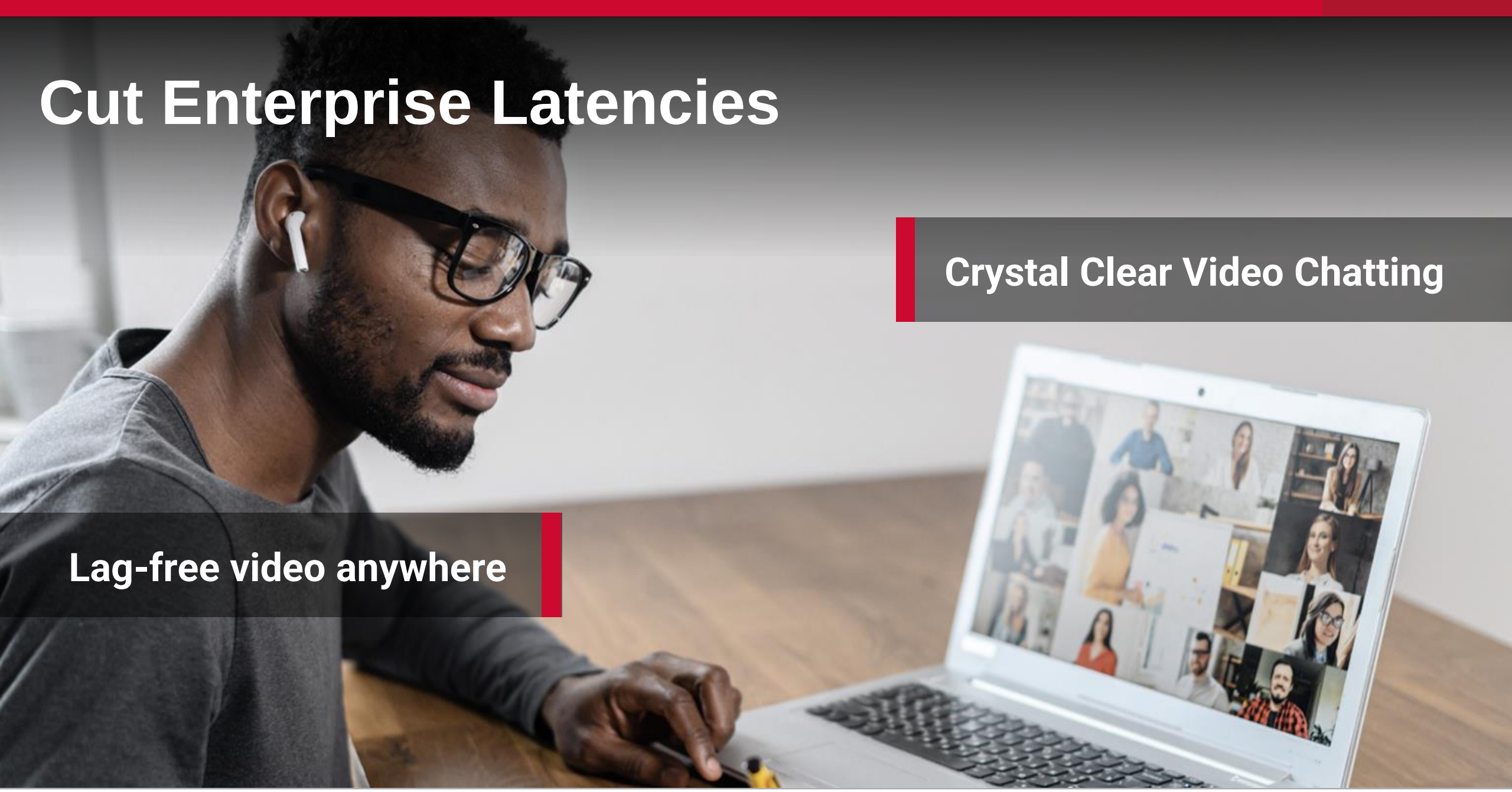
Cut Enterprise Latencies



Crystal Clear Video Chatting

Lag-free video anywhere

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Wider Coverage

Full-field coverage with Wi-Fi 7 AFC

Better rate vs range with 160 MHz channels

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Enable New Use Cases

Many new product classes

Small size and low power are critical

Applications need high QoS

Guarantee performance with multiple links, high data rates and low latency

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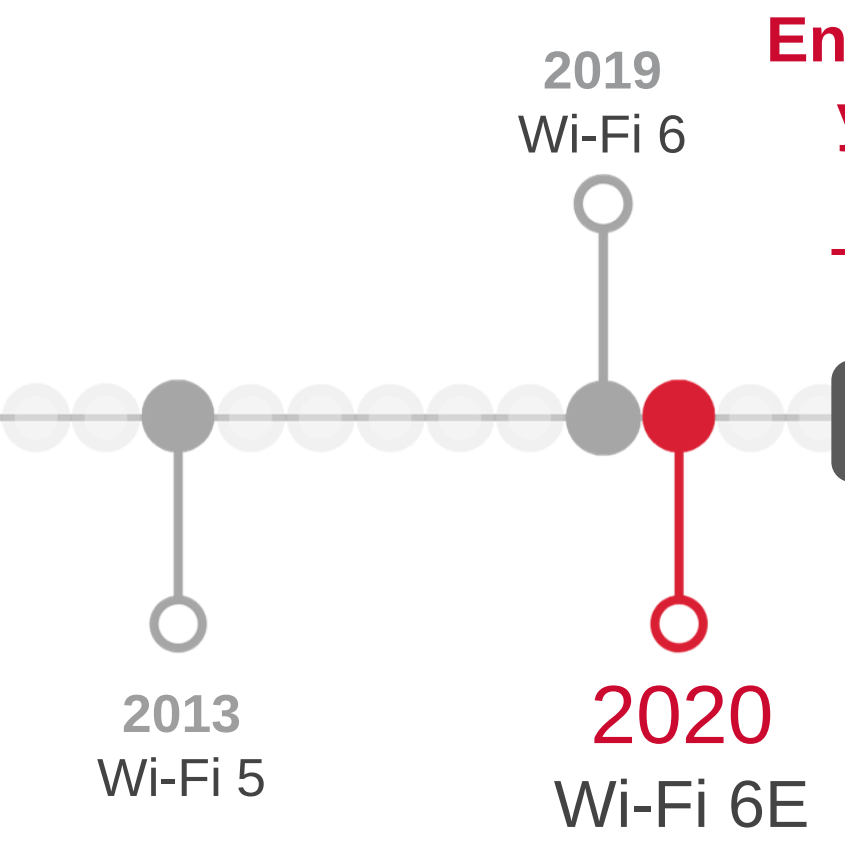
Big Picture



Enable the next 20 years of Wi-Fi

Wi-Fi 7

Speed++
Range++
Latency--


AR/VR


Education


Telemedicine


Video


Offices


Training


High speed tethering


Venues

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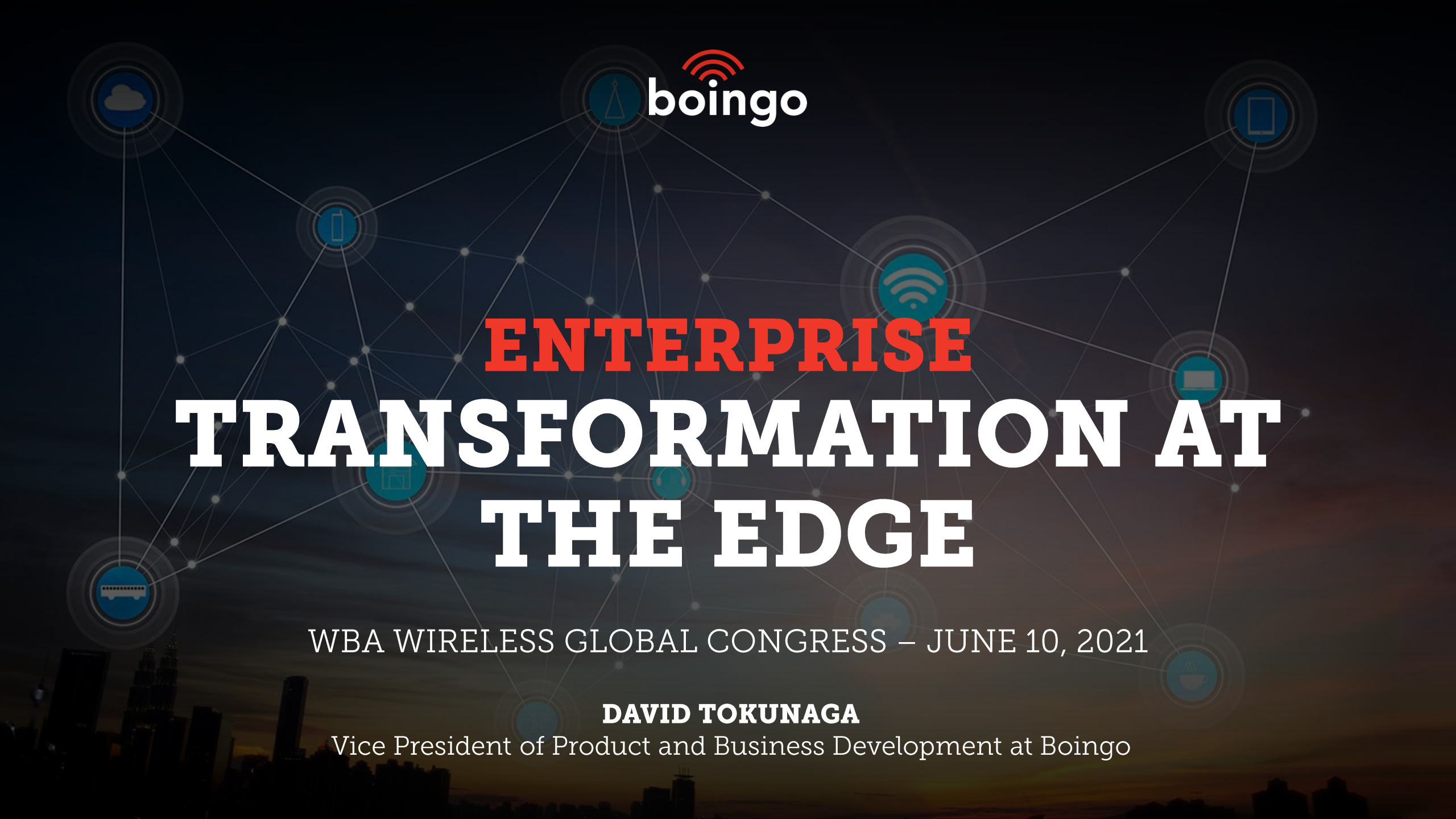
BROADCOM®
connecting everything®

Enterprise Transformation at the Edge

DAVID TOKUNAGA

Vice President of Product and Business Development

Boingo Wireless



ENTERPRISE TRANSFORMATION AT THE EDGE

WBA WIRELESS GLOBAL CONGRESS – JUNE 10, 2021

DAVID TOKUNAGA
Vice President of Product and Business Development at Boingo

WORLD CLASS WIRELESS

FOR THE

WORLD'S PREMIER ENTERPRISES

Boingo delivers unparalleled wireless solutions at iconic venues serving more than

1 BILLION CONSUMERS ANNUALLY

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The Enterprise Opportunity

Why 5G is the first ‘G’ for business.

70%

CEOs who view the enterprise segment as the most important mobile opportunity for the 5G era

69%

Enterprises who are adopting or planning to adopt 5G in the next one to three years

79%

Business and technology decision-makers believe 5G will have a significant impact on their organization

Sources: GSMA, EY, Accenture

boingo

Wi-Fi 6 for Enterprise

ENHANCED

Efficiency

Speed

Capacity

Performance

- DENSE/DEMANDING ENVIROMENTS
- SUPPORT GROWING MOBILE TRAFFIC
- ACCOMMODATE FUTURE USE CASES
- CONNECT MORE DEVICES
- QUICKER RESPONSE TIMES

São Paulo/Guarulhos International Airport
1st airport-wide Wi-Fi 6 network

Rockefeller Center
22 acres of Wi-Fi 6 in NYC

Q2 Stadium
Wi-Fi 6 powers Austin FC stadium

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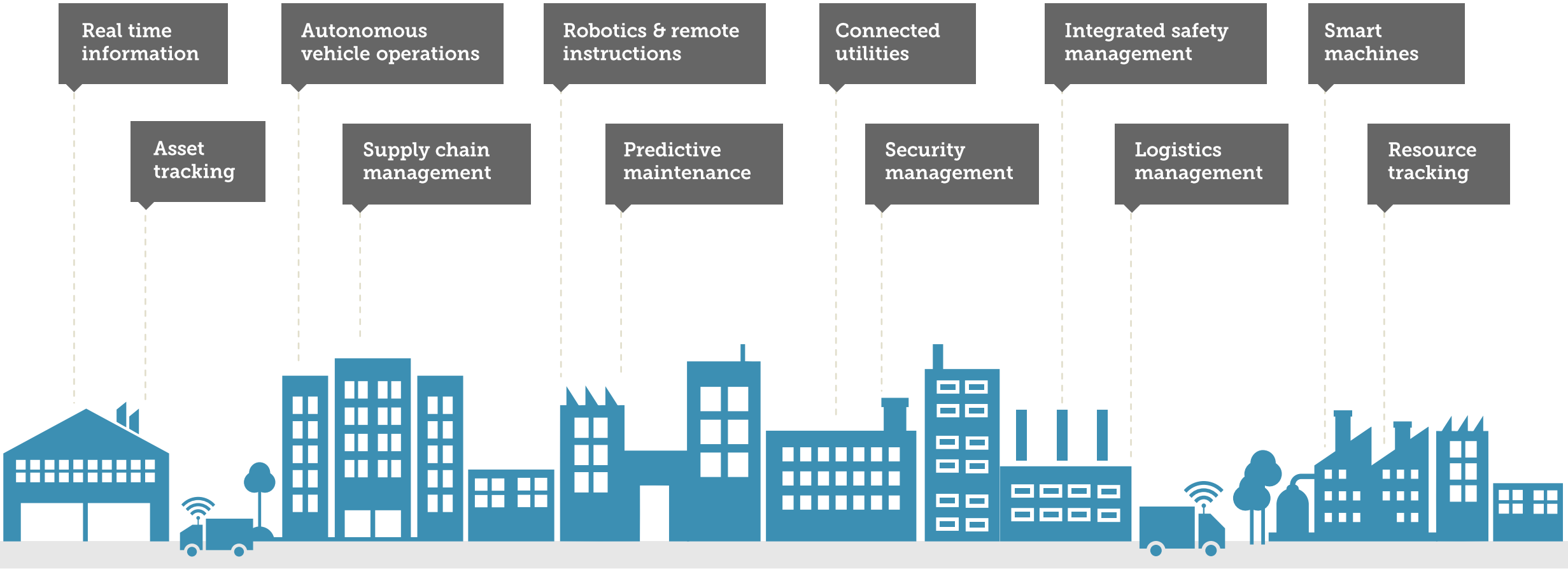
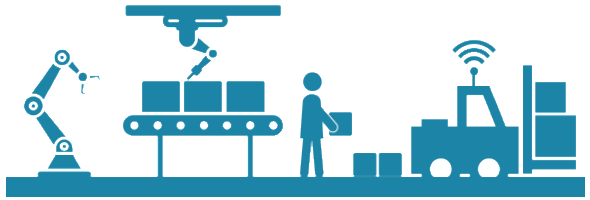
Driving the Demand



Source: KPMG

Industries Reimagined

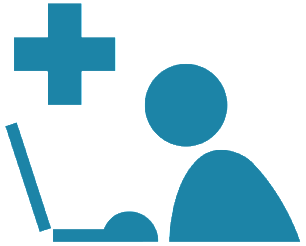


MANUFACTURING

- Logistics management
- Connected utilities
- Quality assurance
- Factory asset tracking
- Robotics

TRANSPORTATION

- Video surveillance
- Private communications
- Utilities monitoring
- Push-to-video/push-to-talk



HEALTHCARE

- Remote diagnosis and treatment
- Remote surgery
- Secure data management
- Private communications

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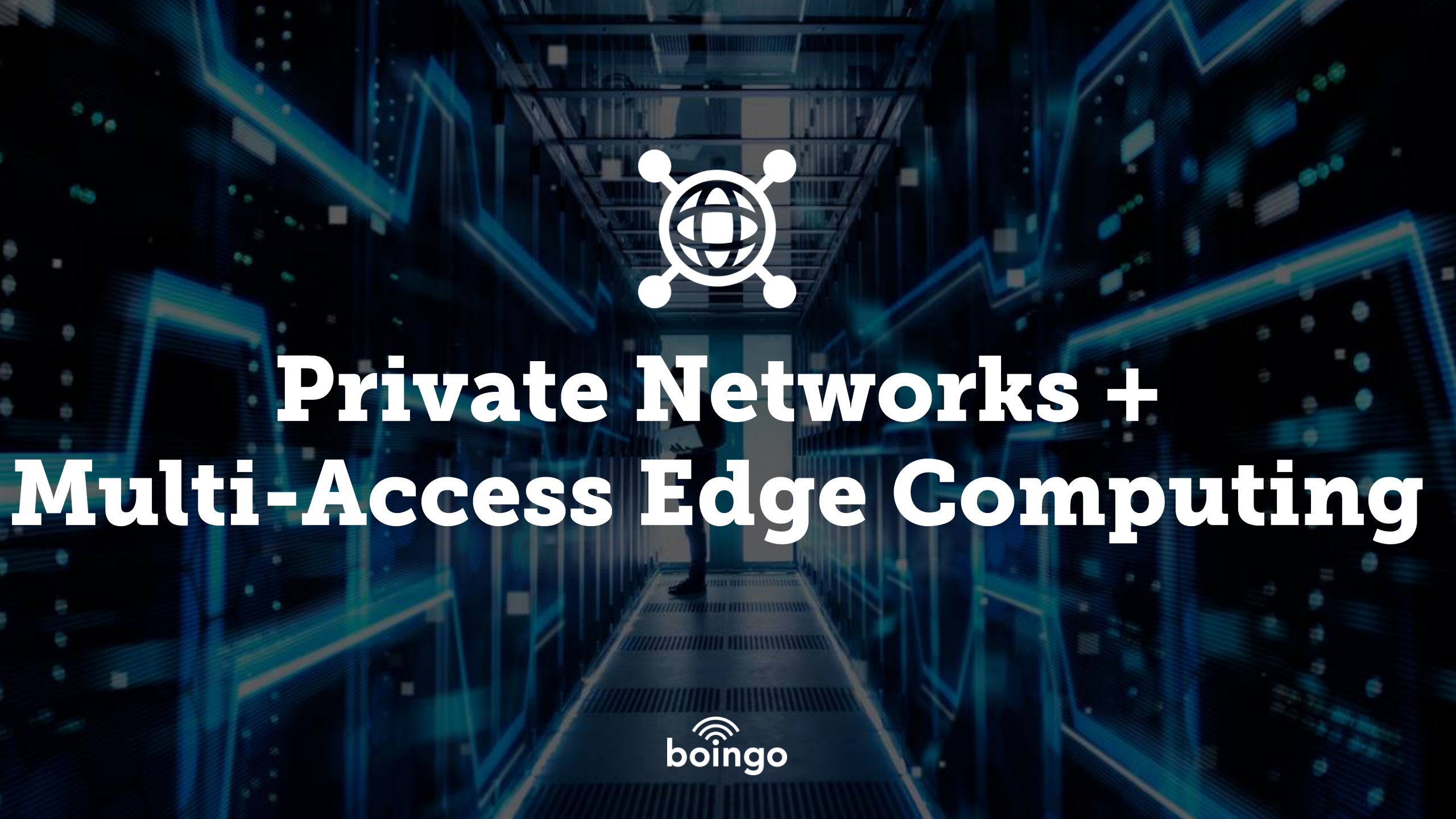

Private Networks + Multi-Access Edge Computing

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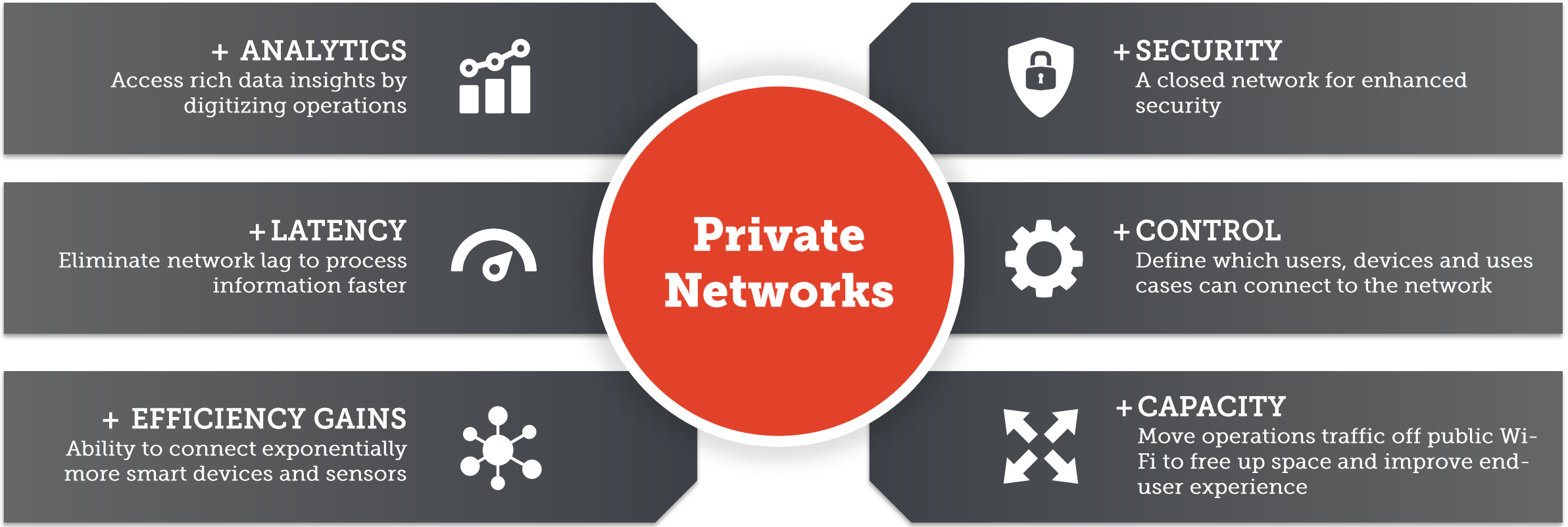
Private Networks

A private wireless network provides dedicated, secure bandwidth to transform operations.



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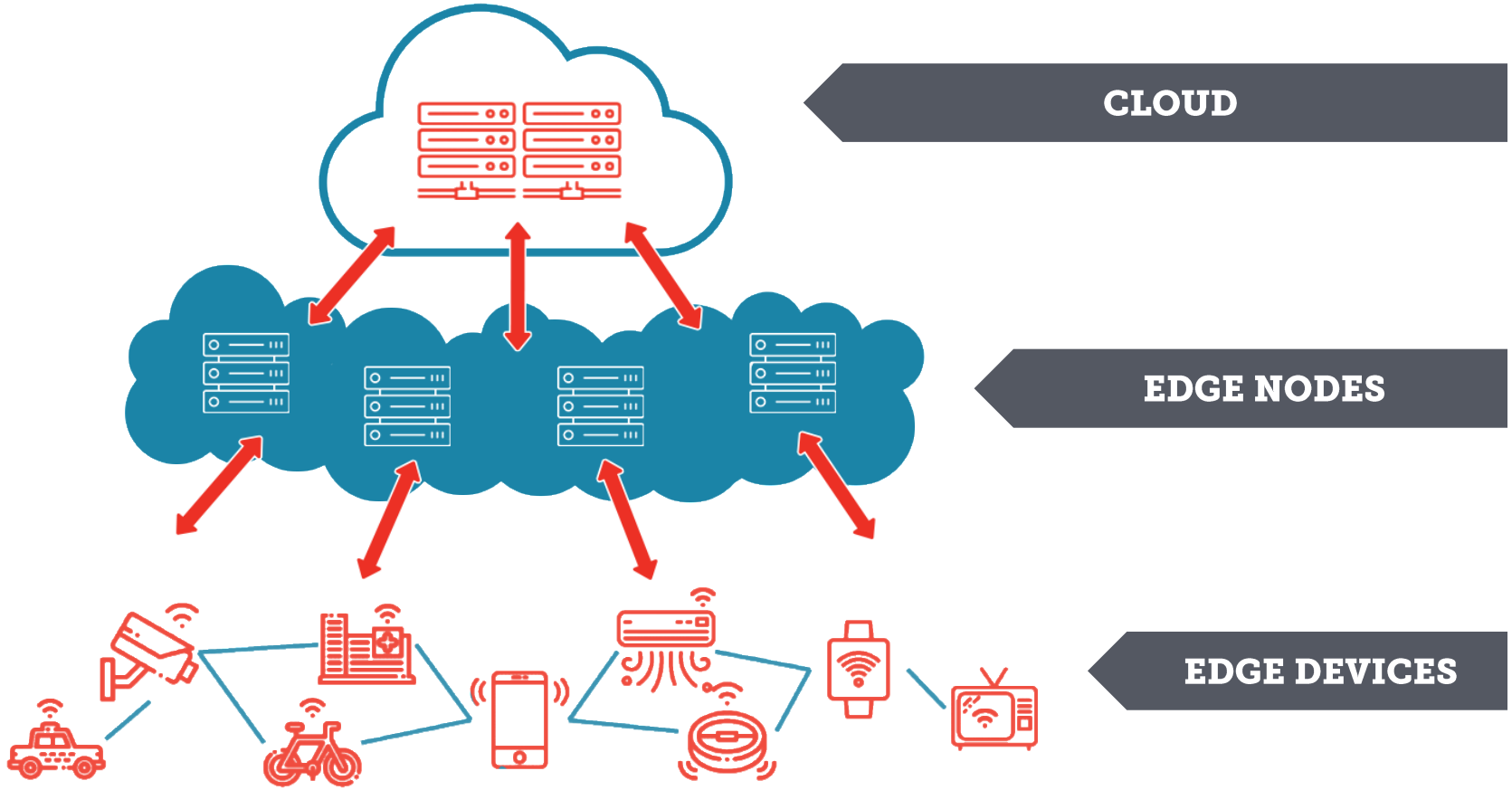
Edge Compute is Key

Edge delivers **more control, reliability, security** and speed



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Delivering Outcomes Enterprise Demand

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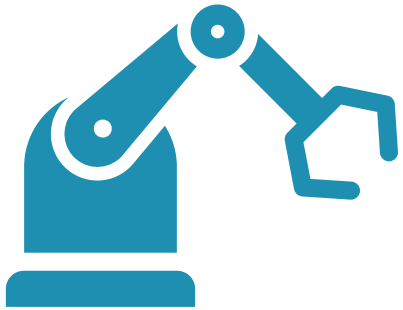
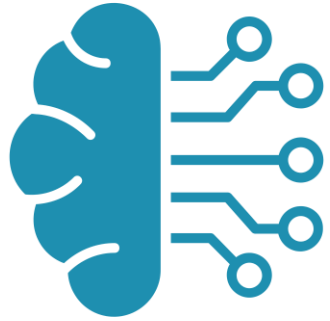
Final Thoughts



DESIGN FOR THE ENTERPRISE USE CASES

TAKE A CONVERGED APPROACH TO LEVERAGE THE BEST OF ALL TECHNOLOGIES



DRIVE INNOVATION

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David Tokunaga
dtokunaga@boingo.com

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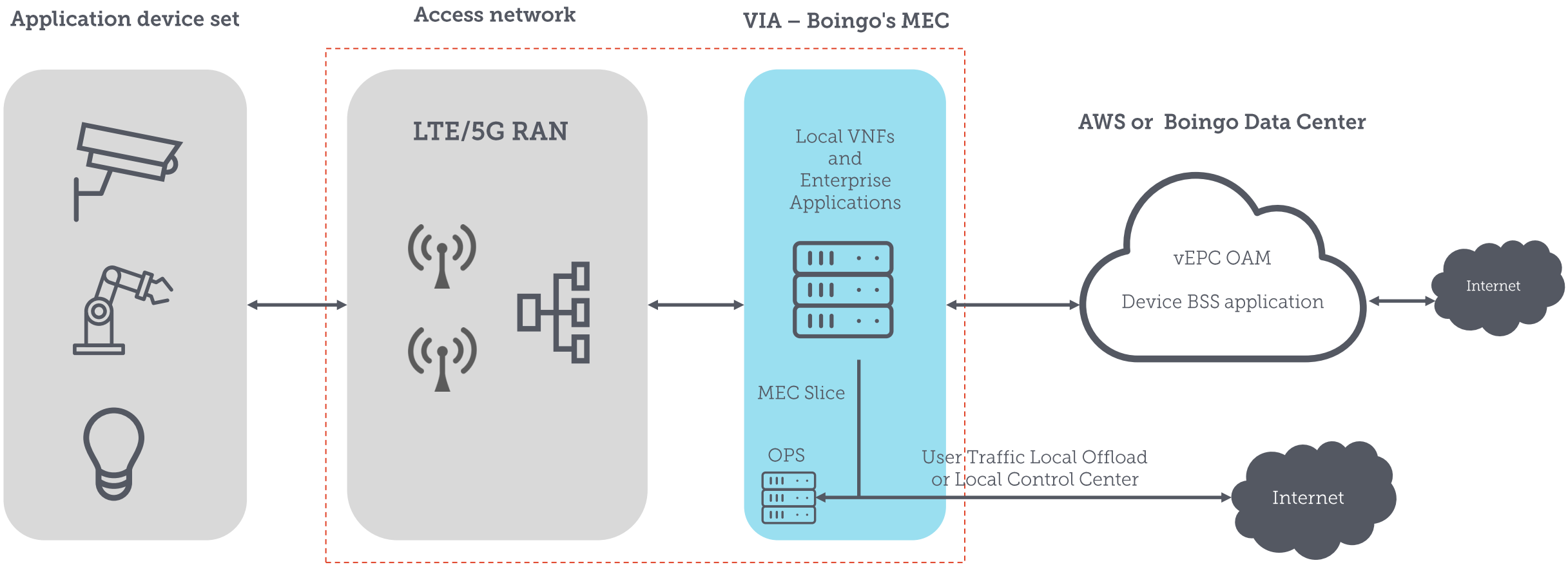
Boingo's MEC Approach



The Odd Couple: 5G & 6E

IRVIND GHAI

Vice President, Marketing.

ON Semiconductor

FOR ENERGY EFFICIENT INNOVATIONS

THINK ON.

www.onsemi.com

The Odd Couple: 5G & Wi-Fi 6E

Irvind Ghai

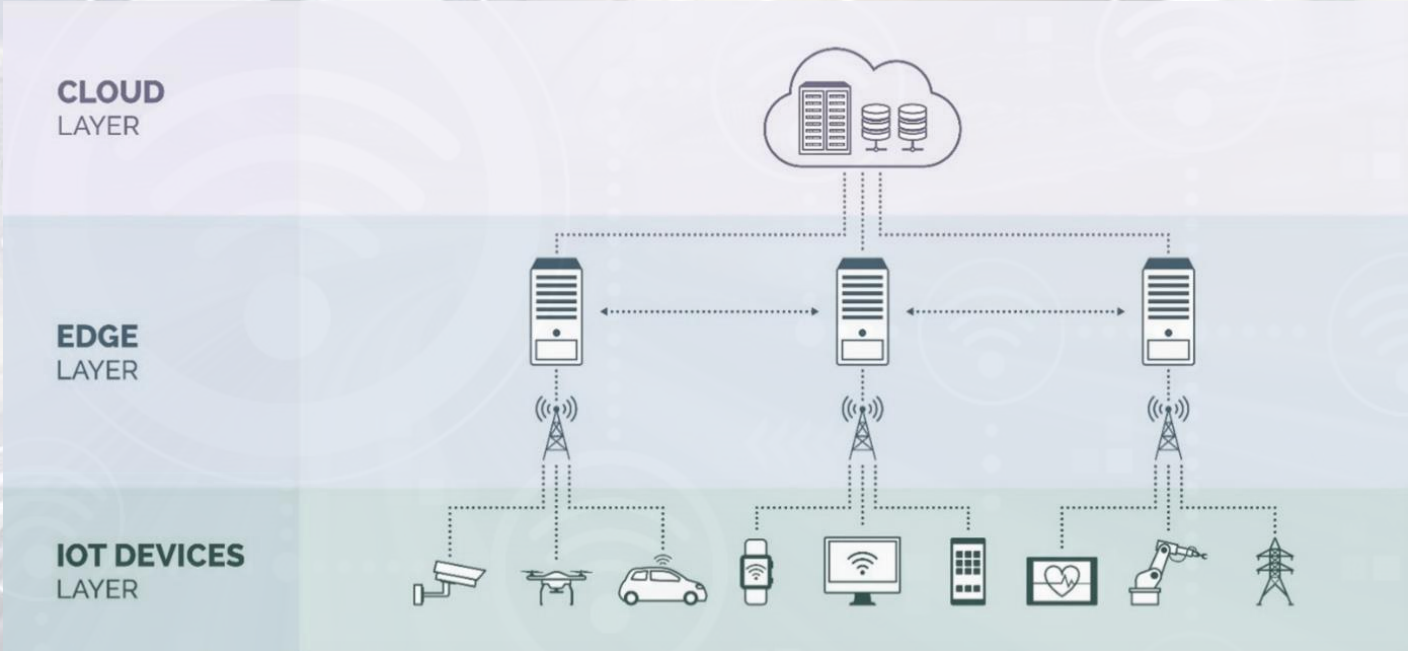
Irvind G

Odd Couple: Conflict, Coexistence, Convergence…

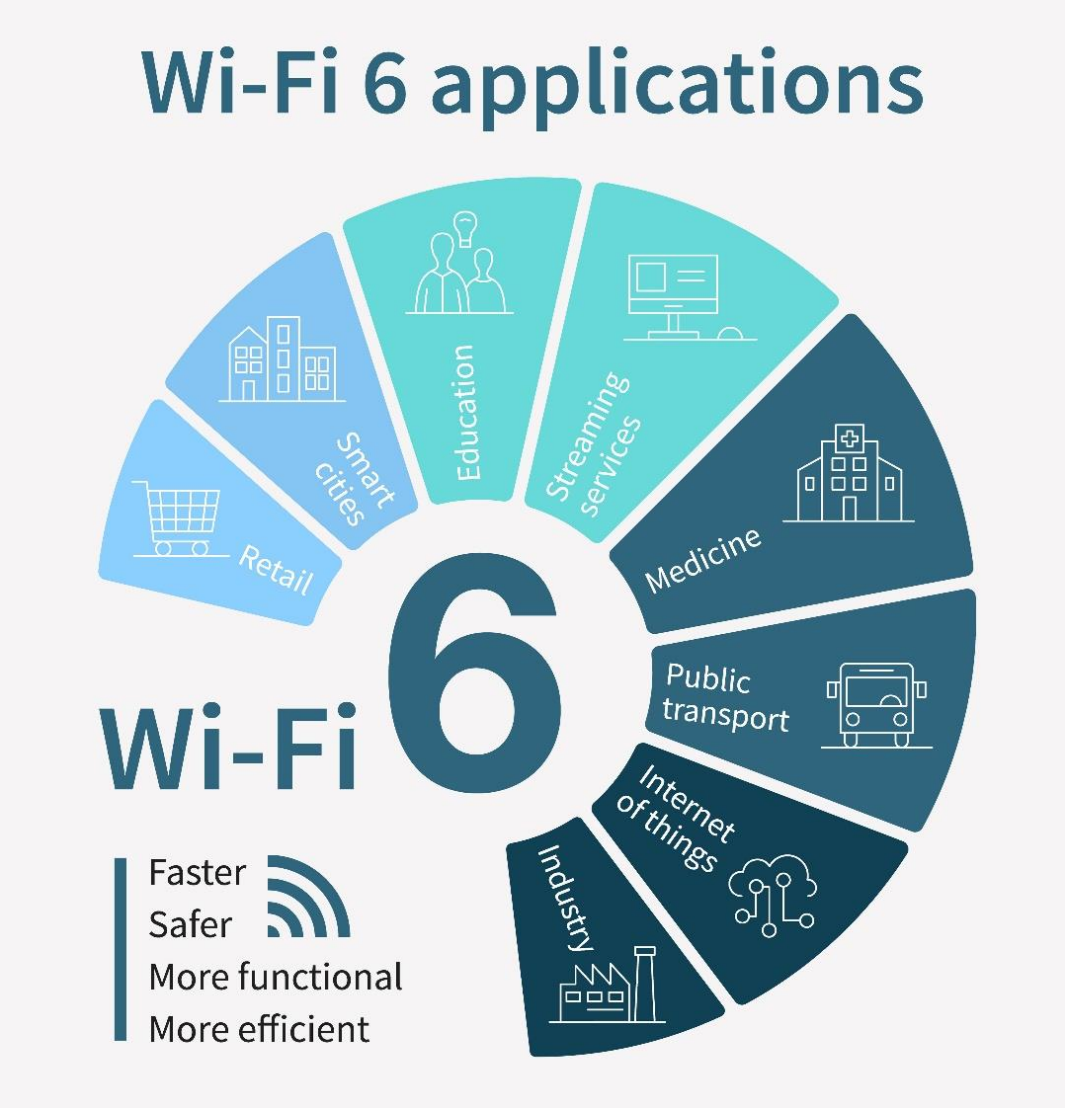
- Connectivity Edge Compute Drivers
- Wi-Fi Examples on the Edge
  - Analytics
  - Motion Detection
  - Predictive Maintenance
- 5G & Multi-Access Edge Compute (MEC)
- Wi-Fi 6E: Features & Value
- 5G & Wi-Fi 6E Convergence
- Opportunity & Next Steps

Edge Compute Drivers

- Compute Capability in Devices
- Lots of Data
- Real Time Action

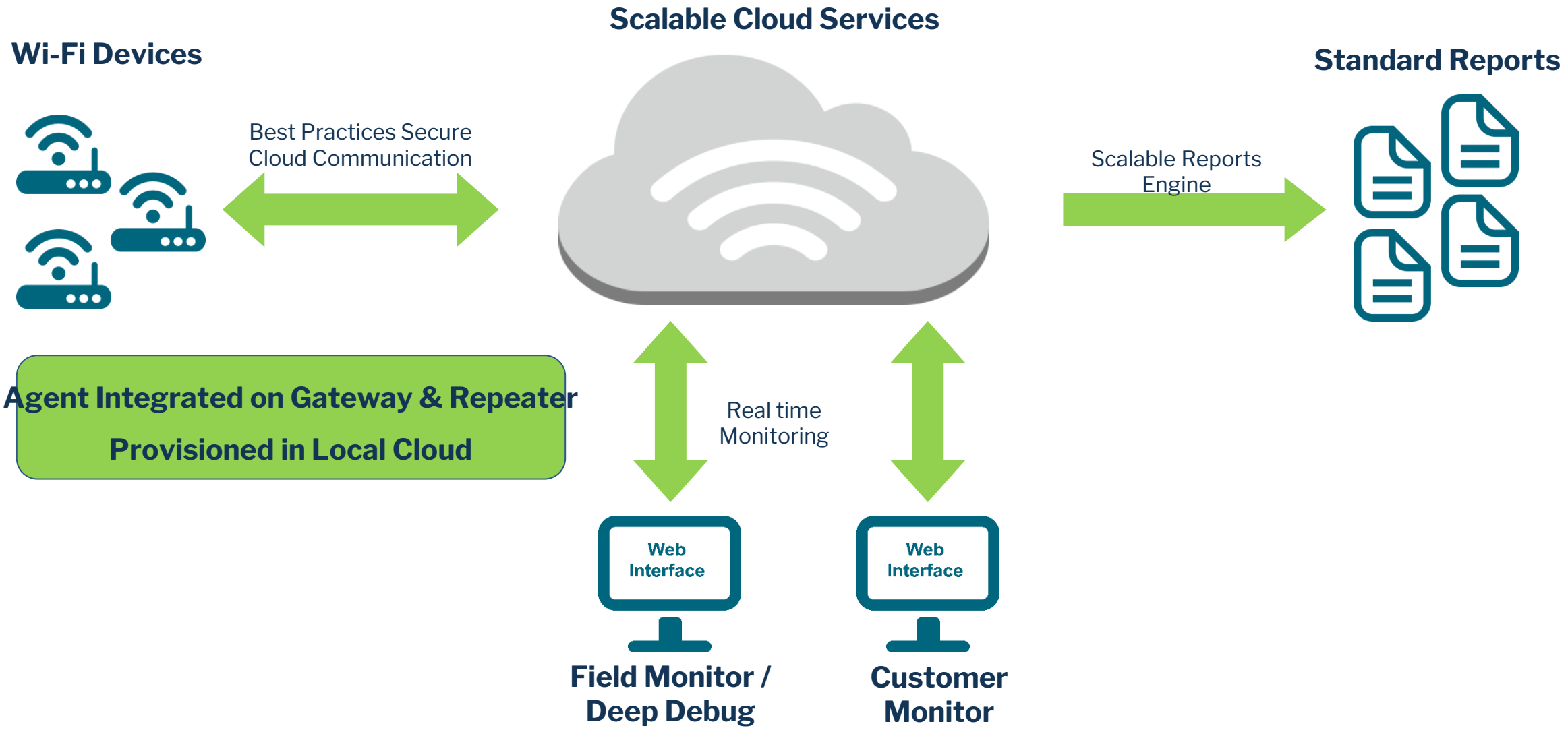


Wi-Fi's Role on the Edge



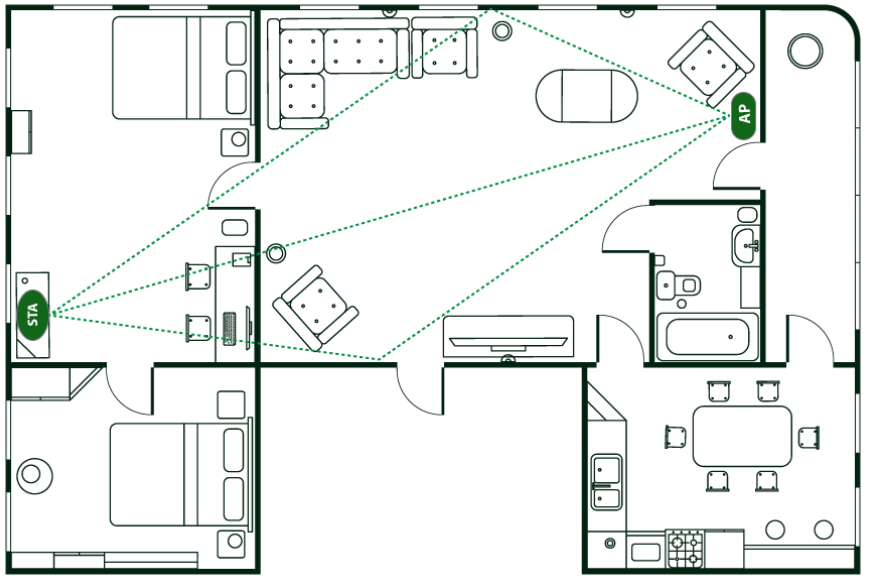
- Analytics
- Motion Detection
- Predictive Maintenance

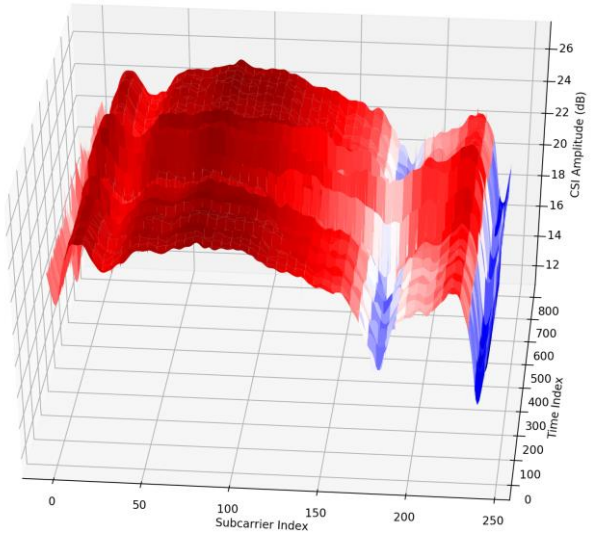
Analytics



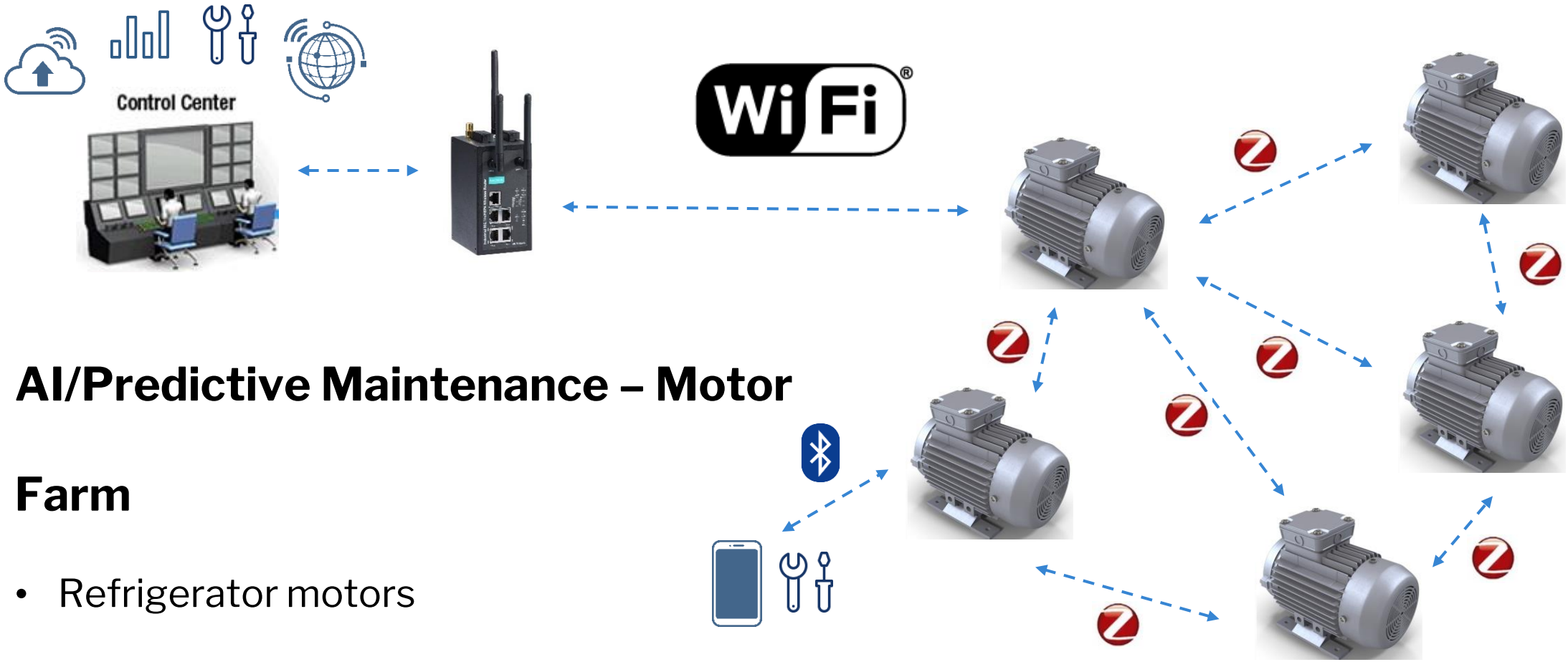
Motion Detection

- Leverage Wi-Fi's RF Characteristics
- Detect Changes in the Channel
- Extract Data for Edge Processing





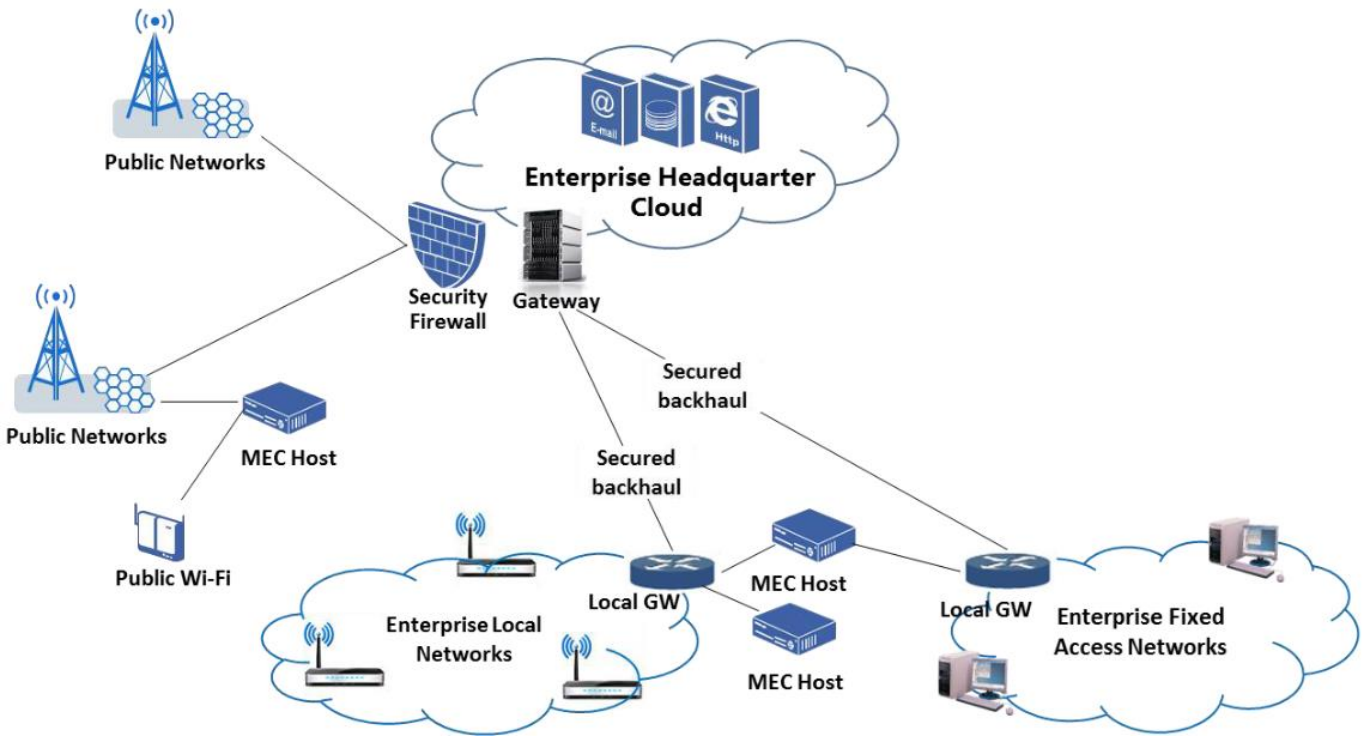
Predictive Maintenance



AI/Predictive Maintenance – Motor Farm

- Refrigerator motors
- Local BLE maintenance access
- Wi-Fi to Cloud and to a Control Center

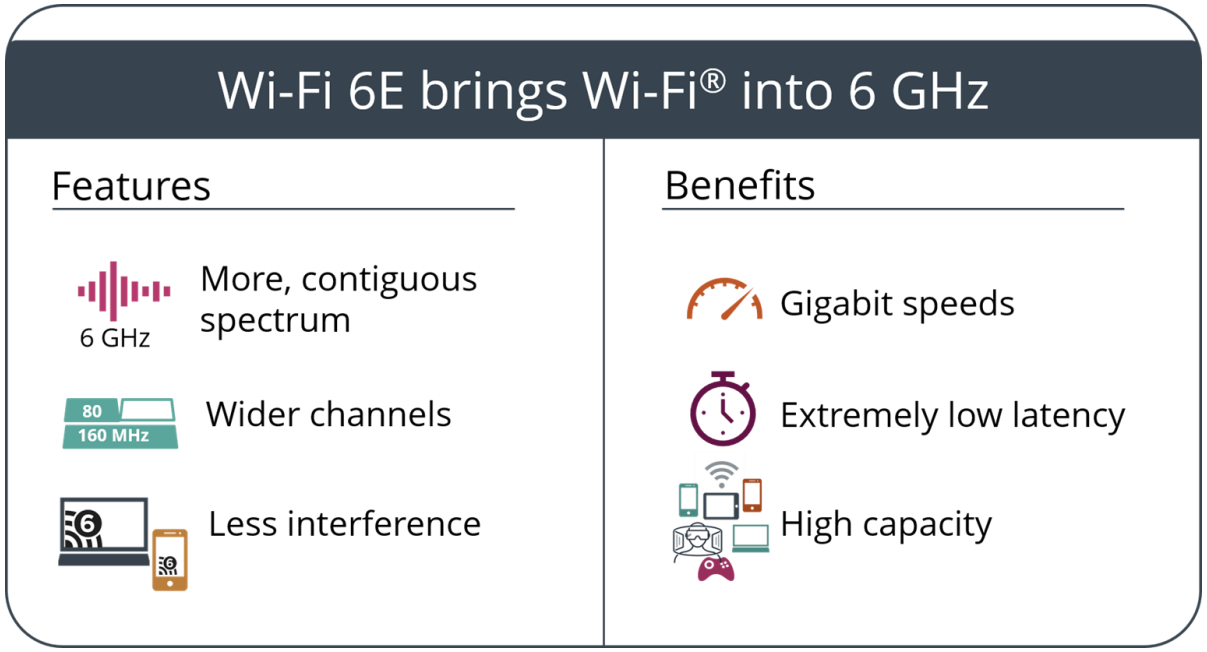
Multi-Access Edge Compute (MEC) & 5G



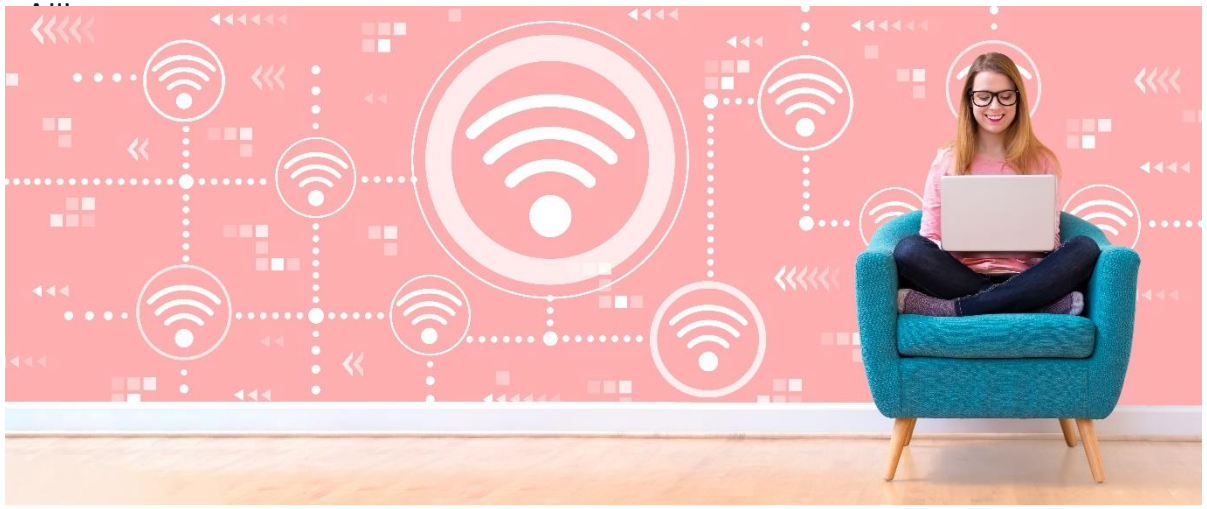
*
ETSI

- Adds an Element of Mobility
- 5G System Architecture
- Access Agnostic

Wi-Fi 6E



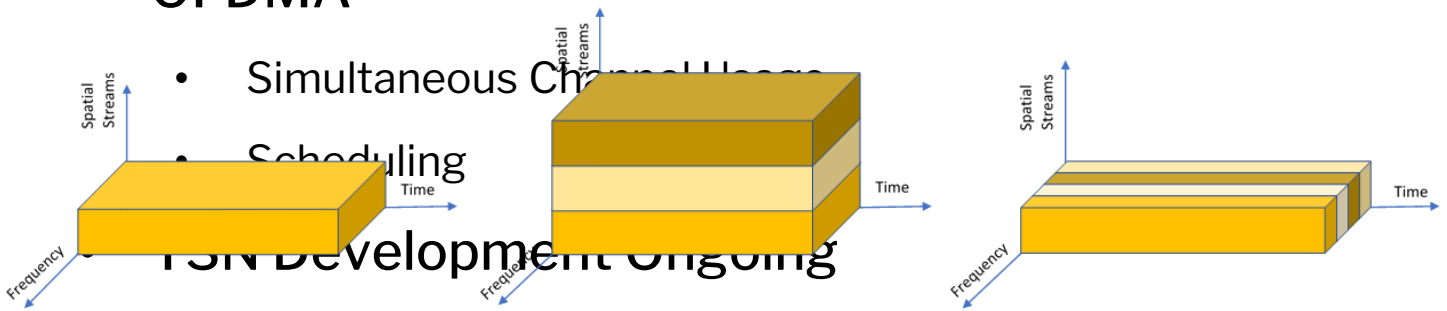
* Wi-Fi



- Capacity & Speed – Data Intensive Transfers
  - 6GHz Spectrum
  - More 160MHz channels
  - MU-MIMO
- Congestion & Latency – Time Sensitive Apps
  - OFDMA
  - Scheduling & less channel contention
  - 6GHz helps reduce management clutter
  - 6GHz will avoid legacy clients
- Range & Power – Maximize Battery
  - Target Wait Time (TWT)
  - 6GHz low power Wi-Fi (VLP)
  - Additional Radios (e.g. Zigbee Coexistence)

Features That Make A Difference…

- Reduced Management Clutter
- Enterprise 160MHz
  - 6GHz Frequency Reuse
  - Headless Device Onboarding (Key for M2M IIoT)
- MU-MIMO
  - Multiple Devices Supported Simultaneously
  - Both Uplink & Downlink
- OFDMA
  - Simultaneous Channel Usage
  - Scheduling
- TSN Development Ongoing
  - 802.Qbv Enhancements for Scheduled Traffic
  - 802.1Qbu Frame Preemption
  - For Traffic across Wired & Wireless



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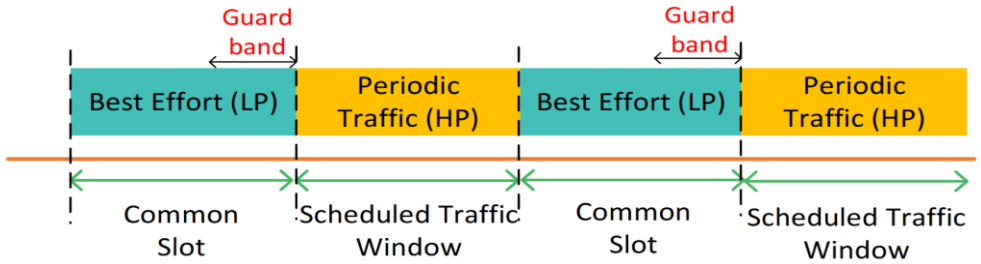
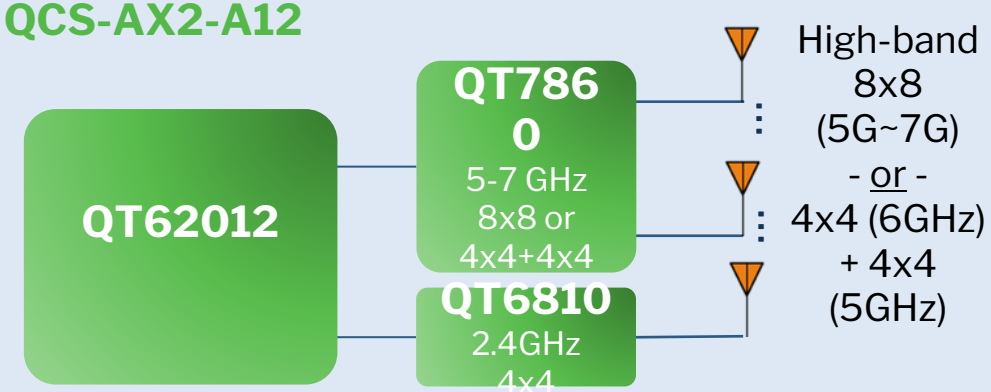


Time Sensitive Networking

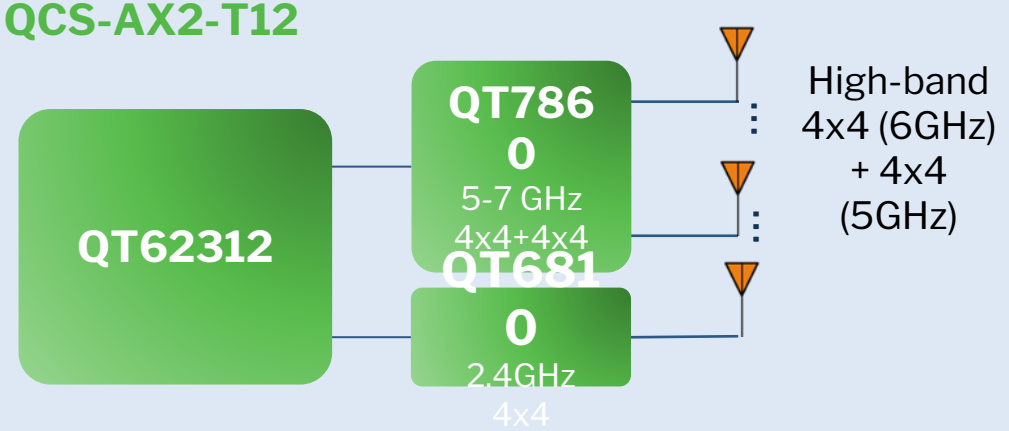
Our Wi-Fi 6E Platforms

QCS-AX2-A12



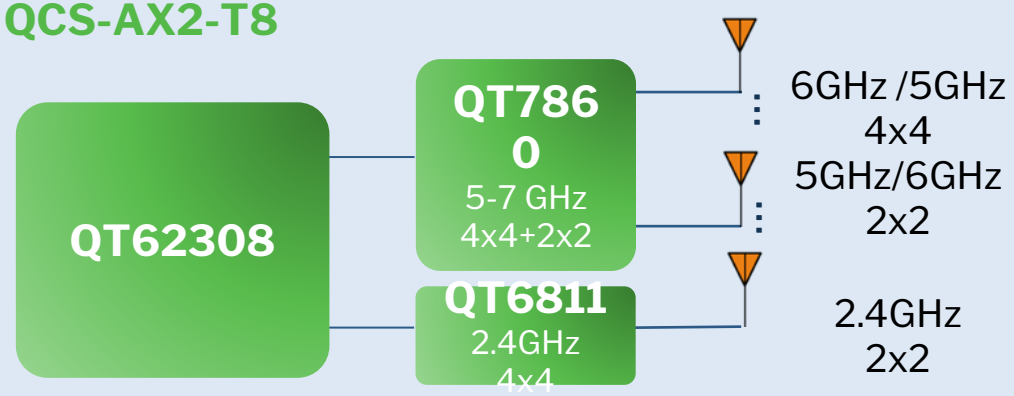
AdaptivMIMO 8x8 or 4x4 Tri-band
Router/Premium GW

QCS-AX2-T12



Tri-band Concurrent 4x4
Performance, Cost Effective AP/GW & Mesh

QCS-AX2-T8



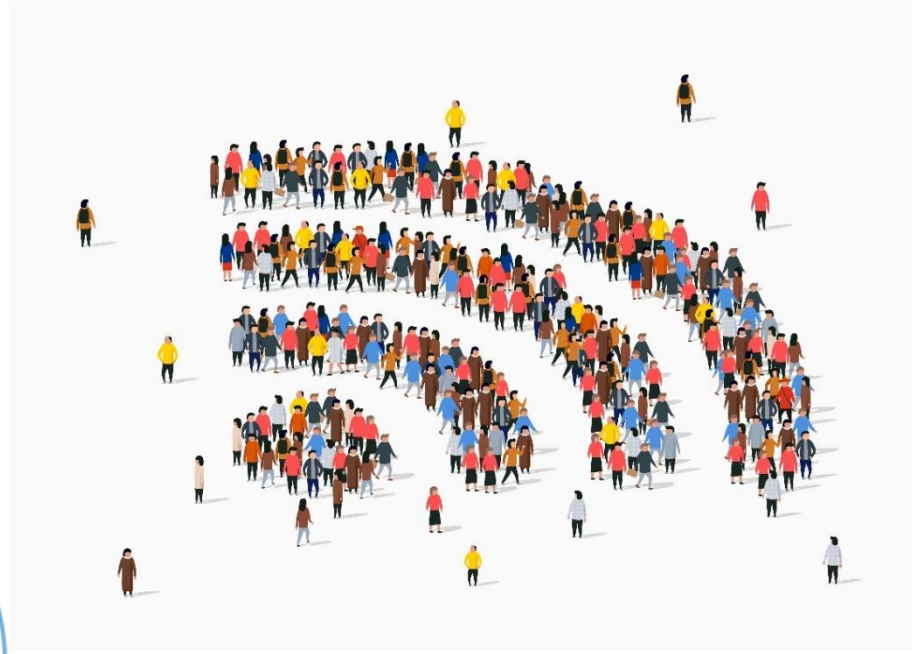
Tri-band Concurrent
Mainstream AP/GW & Mesh

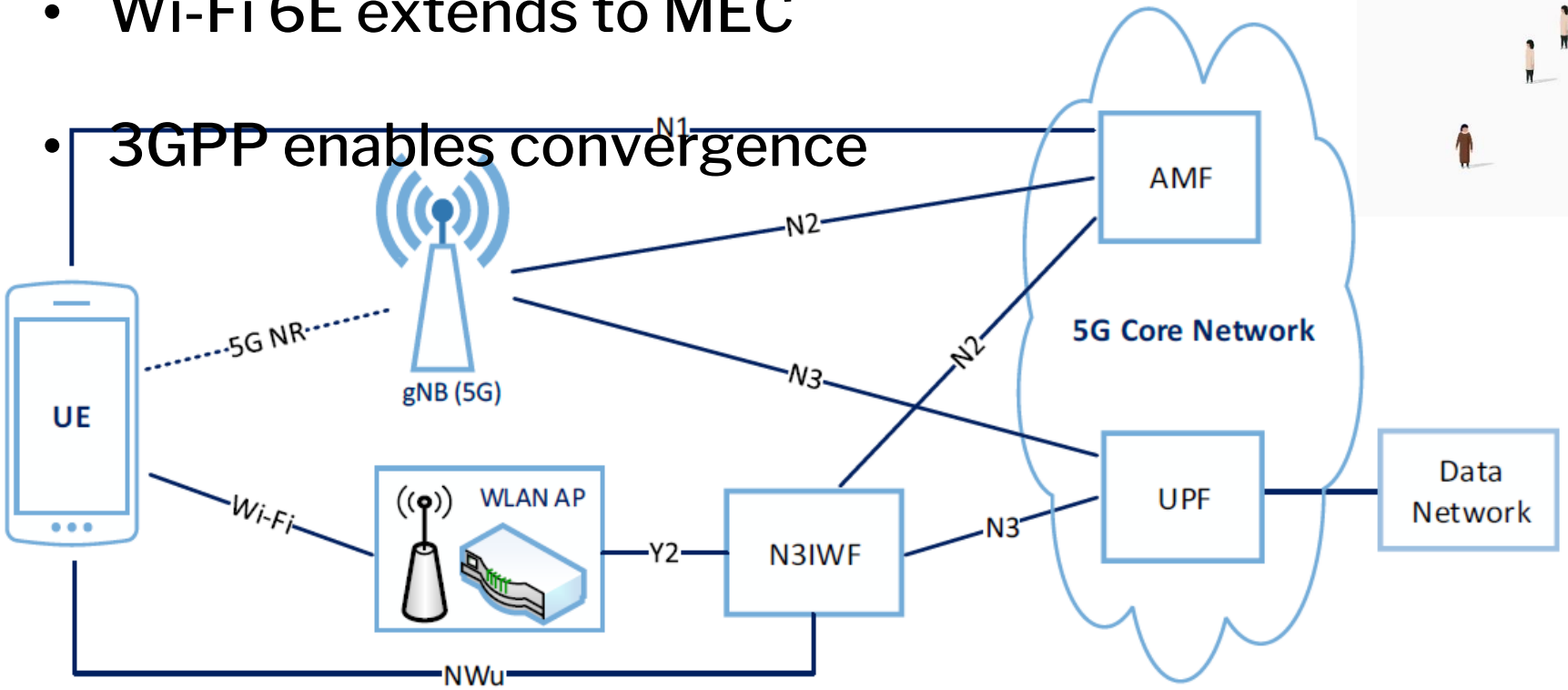
QCS-AX2-S5

Single Band “Sidecar”
Extension of existing ecosystem into 6GHz

5G & Wi-Fi Convergence

- Wi-Fi is a key part of Edge Devices today
- Wi-Fi 6E extends to MEC
- 3GPP enables convergence





* WBA

Odd Couple: Coexistence

Collaboration

- MEC 28
- 3GPP Wi-Fi Only UE support
- Convergence Architectures

Continued Innovation

- Throughput continues to increase
- TSN efforts underway
- Wi-Fi 7 further addresses:
  - Deterministic enhancements
  - Multi link replication

The Odd Couple: 5G & Wi-Fi 6E

Thank You!

Irvind
G

WIRELESS GLOBAL CONGRESS
WIRELESS BROADBAND ALLIANCE

Panel Discussion

Steve Namaseevayum

Wireless Broadband Alliance

Gabriel Desjardins

Broadcom

David Tokunaga

Boingo Wireless

Irvind Ghai

ON Semiconductor

Amenities and Advancements in On-Train Passenger Wi-Fi

JIM ALLISON

Manager of Planning

Capitol Corridor Joint Powers Authority

Amenities and Advancements in On-Train Passenger Wi-Fi

Jim Allison

Manager of Planning

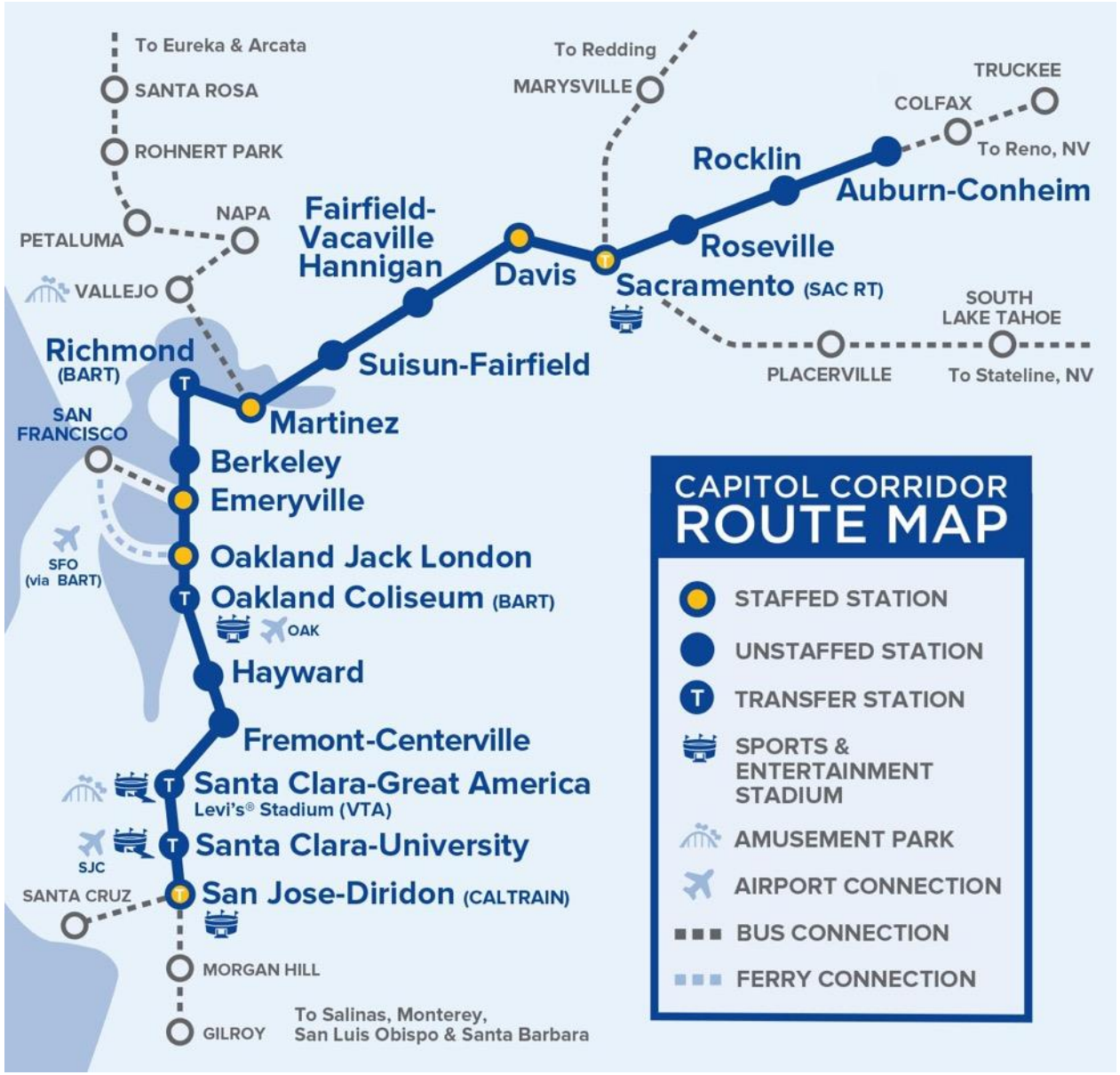
Capitol Corridor Joint Powers Authority (CCJPA)

Two context slides next

Context always matters…

About Capitol Corridor Intercity Passenger Rail

- 171-mile corridor
- Roughly Hourly Service
- Jobs and Housing imbalance pushes long commutes
  - Long-distance commuters
  - Productivity en-route (Wi-Fi)
- Trip Purposes
  - 60 percent business/work travel
  - 40 percent leisure travel
  - Pre-pandemic under 7,000/day
- Administrative Structure
  - CCJPA administers via State funds
  - Union Pacific Railroad owns the tracks
  - Amtrak operates the service
  - Rolling stock owned by the State



CCJPA’s On-Train Wi-Fi

Service Integration Partner: Nomad Digital

Nomad Digital: Global on-train Wi-Fi/Comms provider

Backhaul: Can be trackside, but most properties use commercial SIM contracts to aggregate cellular capacity in time/space along the route; CCJPA uses 7 aggregated SIMs per train.

Branding: CCJPA presently has a T/C landing & then portal page.

Content: Trip tracker, audio books, music, newspaper RSS feeds, station information, etc., part of the CCJPA assets for marketing/comms.

Challenges: On-train bandwidth is best-efforts; reading internet experience and managed to create a more equitable experience for all

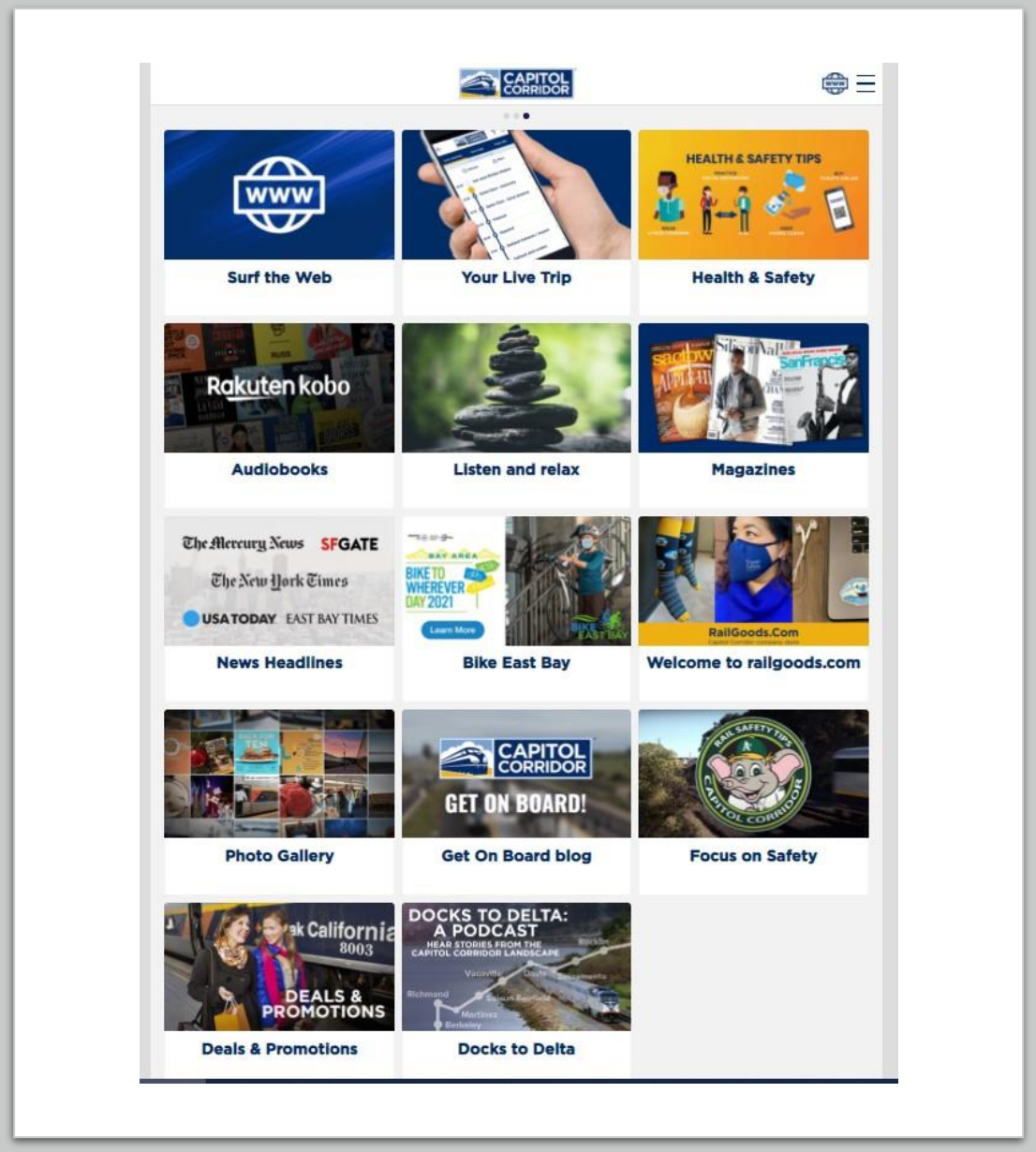
Nomad Digital

smarter trains, connected passengers

Open Roaming for CCJPA

•Nomad Digital must be the one to adopt this – as such:

- Working on a **proof-of-concept** with a Wi Fi enhancement company. They develop firmware for Access Points (APs). Their software can go on ND APs. They already have passpoint/open roaming.
- This will soon move to **bench testing** where the focus will be on how this will look on different user devices, but…
- **How is this linked to the portal concept?**
    - ND customers like to showcase on-board entertainment/portal stuff
- **Use case is there** – ND customers have asked about the core capabilities of open roaming before, just not in those terms; fantastic that a solution using standards is emerging. CCJPA is not the only customer asking for this…

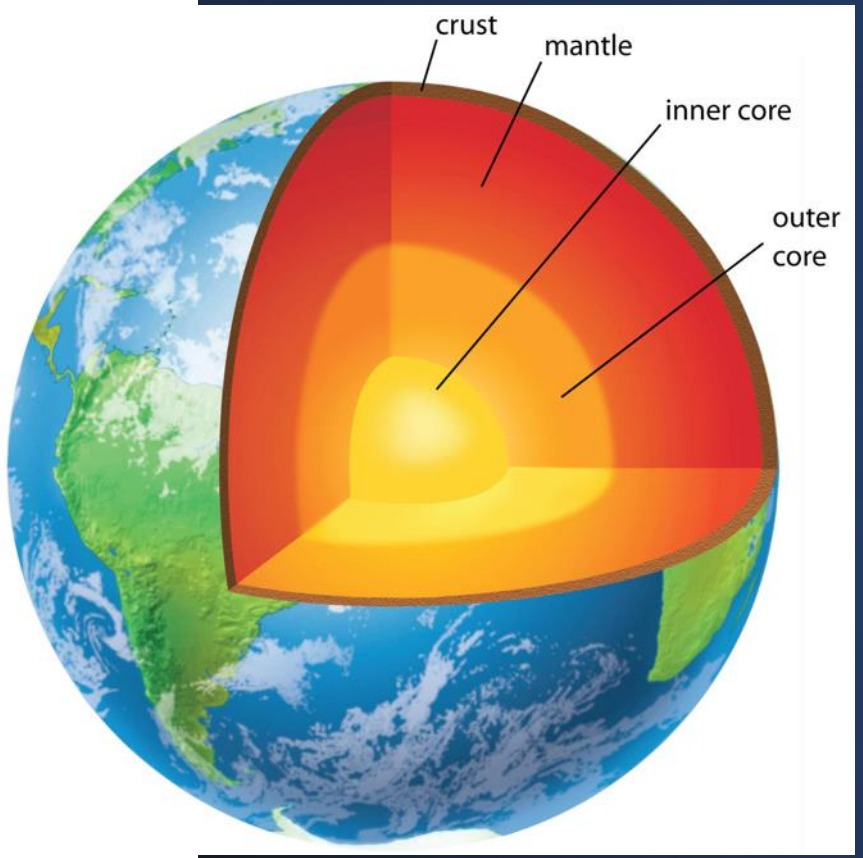


Sticking with a metaphor

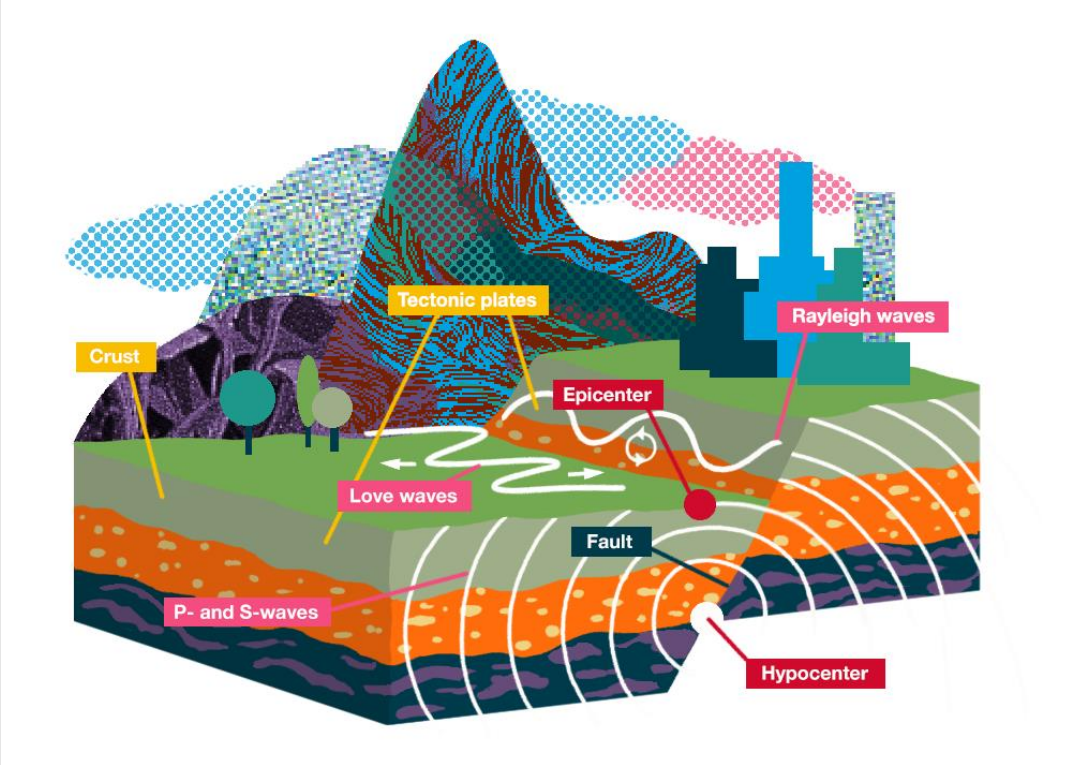
Who doesn’t like geology and plate tectonics?

Observational Metaphor (from NDs perspective)

- Inner and outer core seem formed:
  - Open roaming technical core is developed.
  - Joining with this standard, there is a true authentication
- The mantle equates to the shell of Open Roaming
  - This seems to be forming in the way APs can configured
- The crust does not seem quite formed
  - There are bigger commercial questions which need consideration from the ND and their customer's perspective.



Earthquakes are caused when positions shift due to pressure: Understanding how Open Roaming is translated through train operators and their integrator to the much larger world is key to reducing pressure



- **Consistency of how this is deployed** on handsets and handsets is a concern at least for now – this is where the work lies
- It can work relatively easily – but also needs to **fit within the ND operating environment** – ND needs to be thoughtful.
- ND will also have a role of providing advice to ND customers – **how to position this solution** with other media material around it and such
- Train operators do and will have concerns about "**losing control of the customer**".

Avoiding fractures by minimizing friction

- CCJPA and other train operators that offer Wi-Fi are asking ND:
  - How do people in general opt in for the CCJPA if they have multiple profiles?
  - Where do you go if you are NOT authenticated?
  - How do you get the certificate?
  - How do you join the club?
  - 3rd party authentication that you have already (e.g., Marriott), but do you join an CCJPA train automatically? If you do or don't, what are the commercial options?.
  - Will CCJPA be an open roaming provider, will ND be the provider, or how will others get our ND or CCJPA profile?

How ever these are answered, there needs to be a testing/adoption phase and, as well, latitude for strategic business decisions (customer engagement, data, etc.) must be preserved for the venue.

Can Open Roaming lead to “Open Ticketing”?

- Open roaming (because it uses real identity) seems to be robust enough to support open ticketing.
  - SSID (proximity) based ticketing
- We would have to validate the trust in the ticketing option for all parties.
  - Getting on/off – is this part of the payment process or validation?
- But why stop there…??

Deeper into the “Open Ticketing” concept

•Transit layers across all manner of urban transport (bus, to urban tram/subway, to commuter/intercity trains) can each be mobile Wi-Fi hotspots.

•Open Roaming across platforms – literally (the platform, the train station, the bus, etc.) can allow previously barriered systems seamlessly connect.

•Pressure from urban areas to be universal – but GOVERNANCE is in the way – the open roaming world overcomes that and provides…interoperability

•Interoperability leads to open ticketing which unifies and helps the ease of using all forms urban transport – and competes with EMV but there is an implication in similar backend systems that support payment authentication and account management

Summary

•Open roaming for passenger rail is:

- A fantastic core standard that unifies so many of the ‘needs’ that rail operators have expressed to their Wi-Fi network operator
- Needs more refinement on the commercial side of things for consumers, venue “owners”, and integrators
- Disruptive in a “threat OR opportunity” way to rail operators in the ways of maintaining their customer relationship.
- For customer identity management is scary at rail operator scale, but probably enticing at the big data/tech scale. Societal questions…
- Enticing in the ways of providing seamless ways for customer ticketing payments in ways that can bypass intractable governance barriers between systems

The Future of In-Flight Wi-Fi

THOMAS LOCKE

Chief Technology Officer

GlobalReach Technology

Thomas Locke
Chief Technology Officer, GlobalReach Technology Inc.
Chair of the Seamless Air Alliance Networking Group

Future of In-Flight Wi-Fi

Passpoint

Captive Portal API

globalreach

In-flight Connectivity (IFC) - Benefits of Passpoint

New Revenue Streams

Secure Connectivity

Subsidization of Internet Access

Mobile App Adoption

Event Based Marketing

Passenger Identification

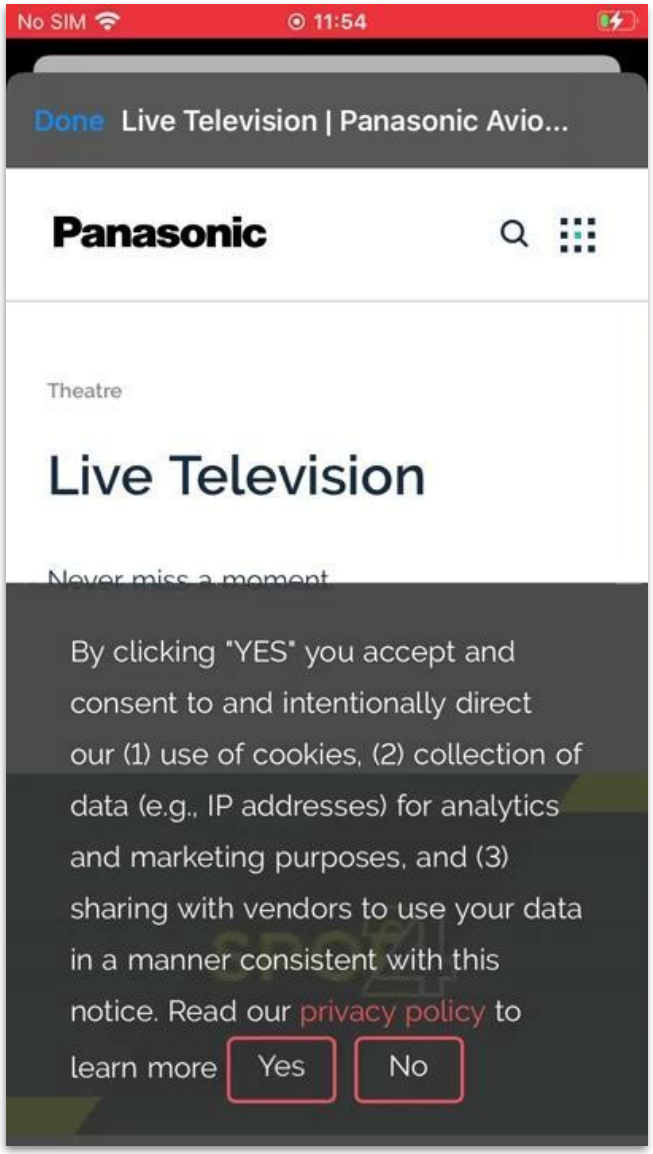
globalreach

Aviation Passpoint Landscape

- 802.11u WAPs - Not ubiquitous
- WBA Inflight Working Group
- Seamless Air Alliance
- Multiple Passpoint trials
- OpenIFC
- WBA OpenRoaming

globalreach

Mobile App - Passpoint Provisioning, Authentication and Marketing



globalreach

So what is Captive Portal API (Capport)?

Traditionally devices perform a connectivity check by automatically sending a HTTP probes when joining a Wi-Fi network to force a HTTP interception. This allows the end user's device to get redirected to the captive portal and to begin the provisioning process.

With Capport, DHCP options can now be utilized for captive portal discovery. This new standard allows the network to advertise that it is "captive" to the device rather than rely on traffic interception, while also enabling information to be published to the end user, such as session and venue information.

✓ No traffic interception
✓ Captive aware
✓ Session information
✓ Venue URL (full browser)
✓ System notification message
✓ Apple support
✓ Android support
✓ Coexists with traditional captive portal services

globalreach

In-flight Connectivity (IFC) - Benefits of Captive Portal API

Increase Uptake Rates

No Traffic Interception

In-flight Portal
(Venue URL)

Media Rich Content

PAX Session information

PAX Device Notification

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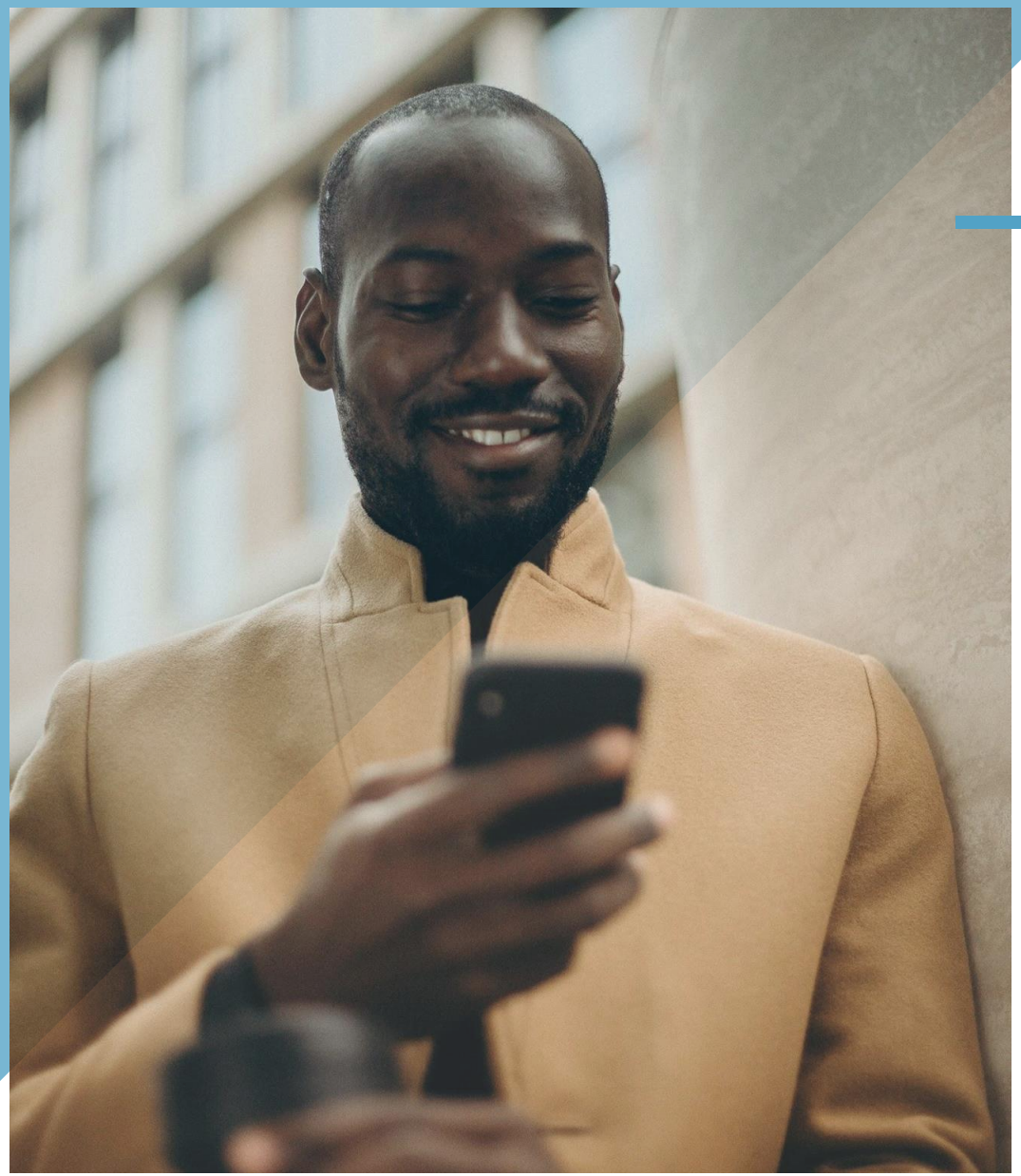


How Captive Portal API Works ?

DHCP Option: 114 (Captive-Portal)

Length: 38

Value: https://globalreachtech.com/captive-portal/api

DHCPv6 Option: 103 (Captive-Portal)

Length: 38

Value: https://globalreachtech.com/captive-portal/api

IPv6 RA Option: 37 (Captive-Portal)

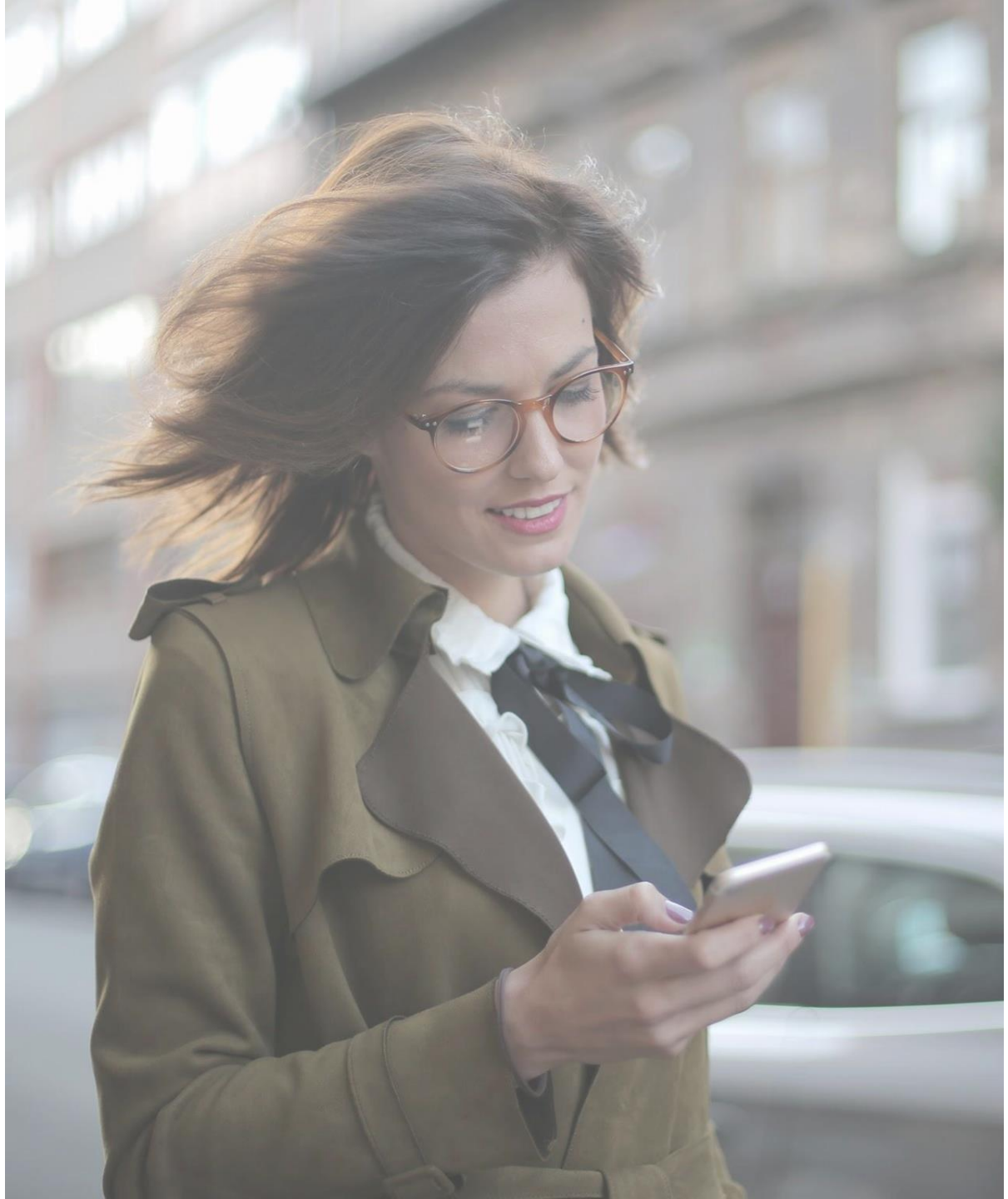
Length: 38

Value: https://globalreachtech.com/captive-portal/api

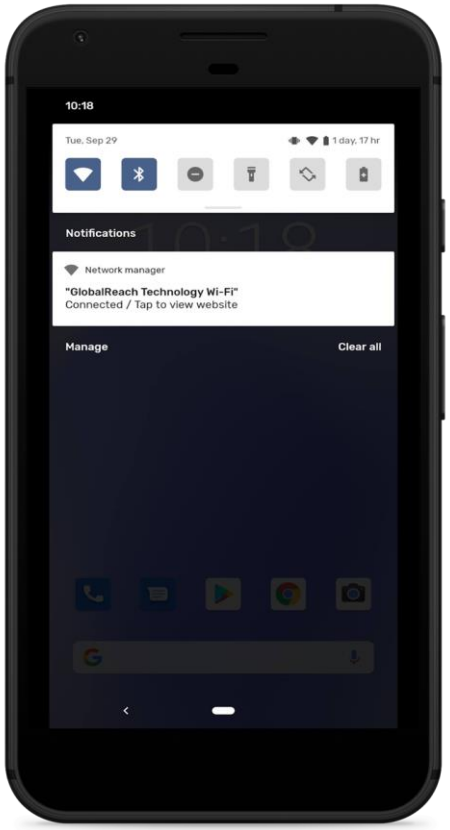
globalreach

Captive Portal API Response

```
HTTP/1.1 200 OK
Cache-Control: private
Date: Mon, 28 Sep 2020 11:03:18 GMT
Content-Type: application/captive+json
{
    "captive": true,
    "user-portal-url":
"https://ifc.globalreachtech.com/portal",
    "venue-info-url":
"https://ife.globalreachtech.com/movies",
    "seconds-remaining": 326,
    "can-extend-session": true
}
```



Captive Portal API: Venue URL Flow



System Message

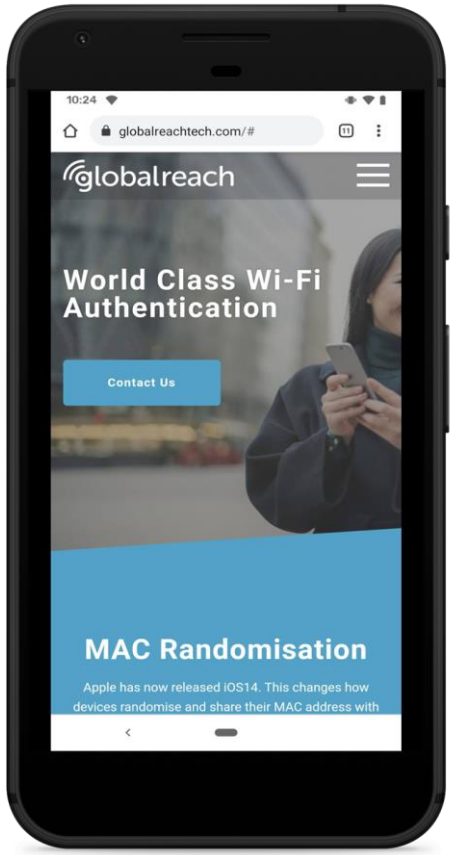
Can be accessed anytime by swiping down

Lock Screen

Stays permanently whilst connected to the network

Venue URL

(Full browser / No CNA)



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thomas.locke@globalreachtech.com | + 44 20 7831 5630

Ready for the Road ahead: Spectrum Needs and Wi-Fi

LAKSHMI THANAYANKIZIL Ph.D.

Wireless Connectivity Specialist

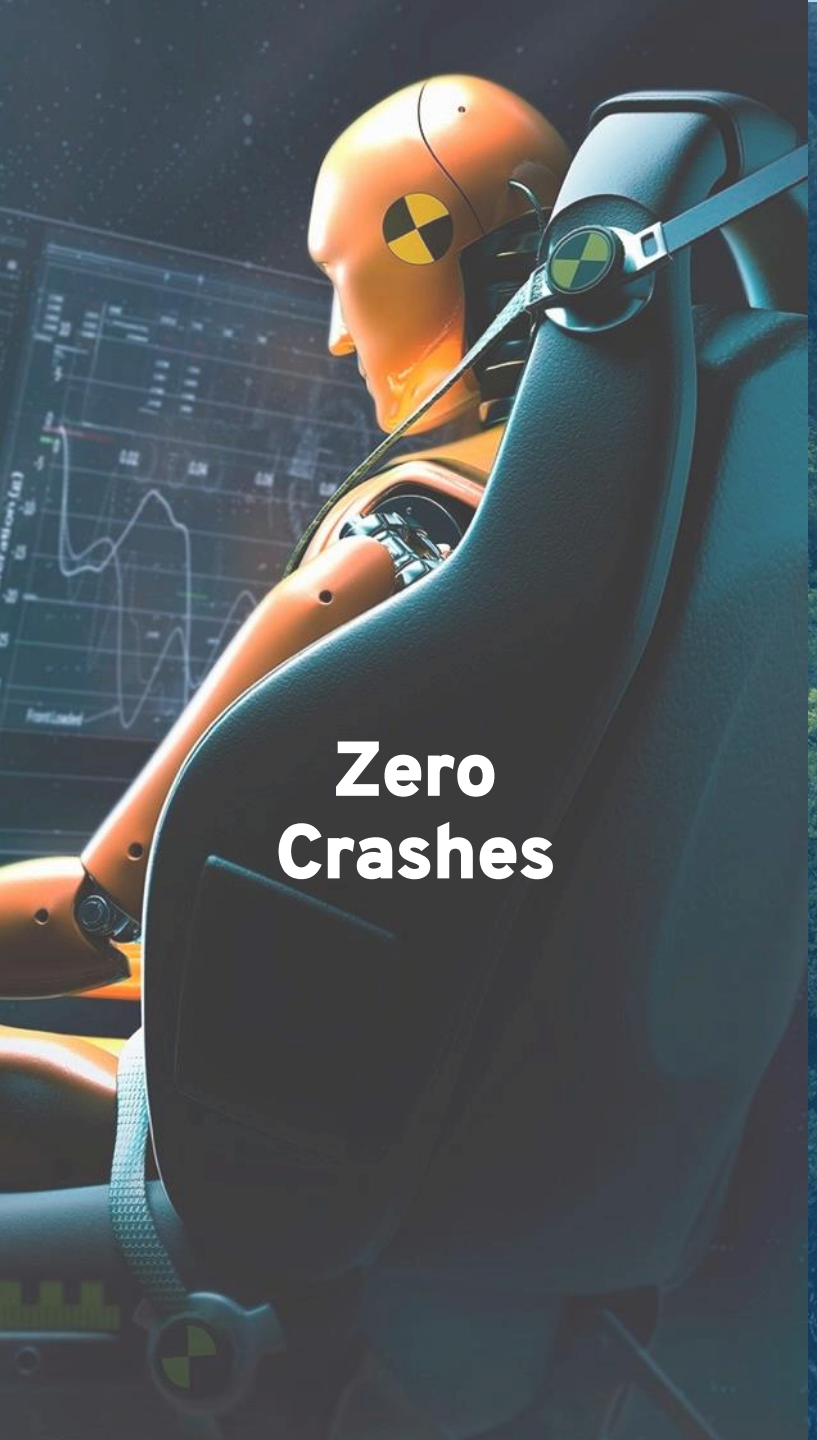
General Motors

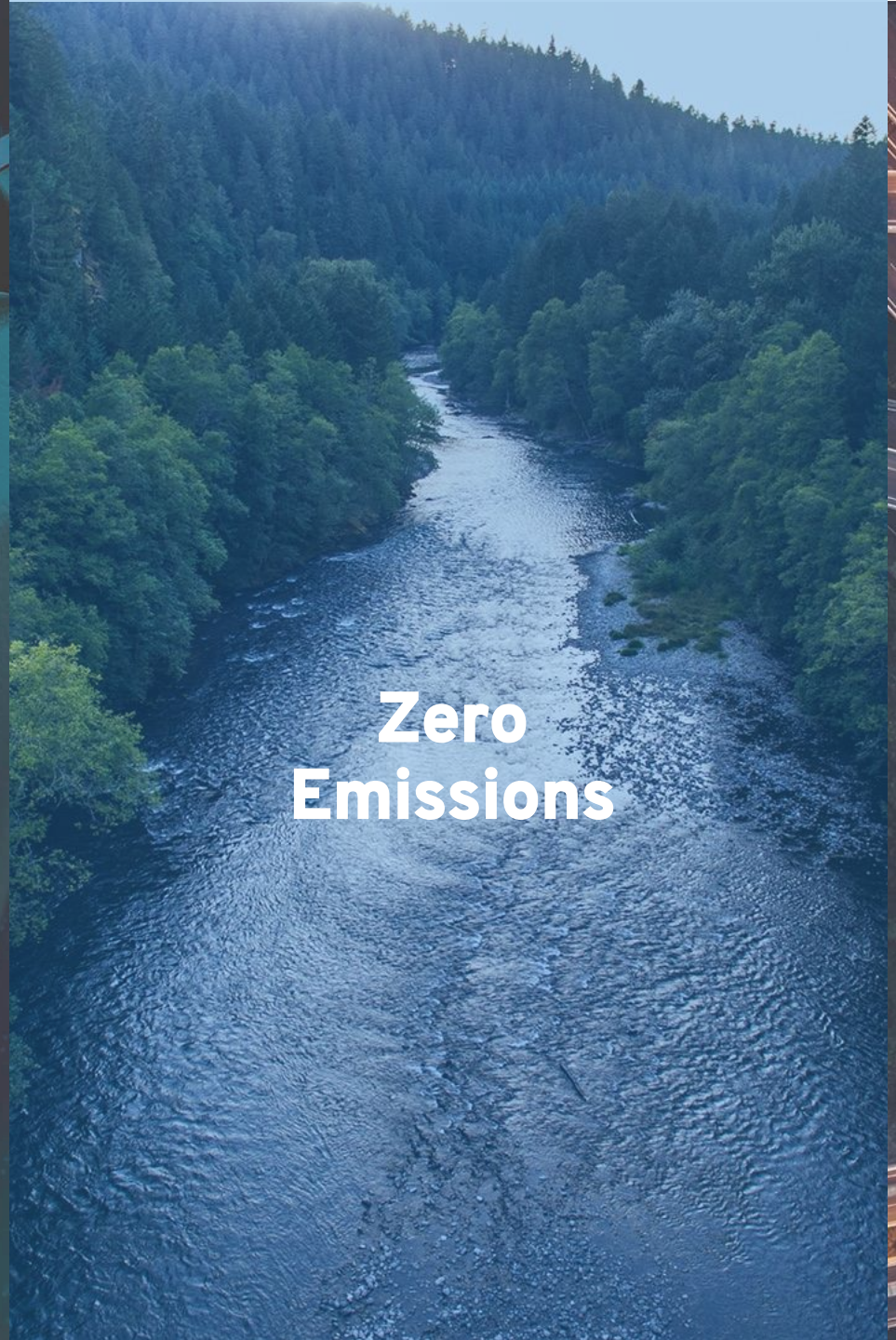
Lakshmi Thanayankizil PhD

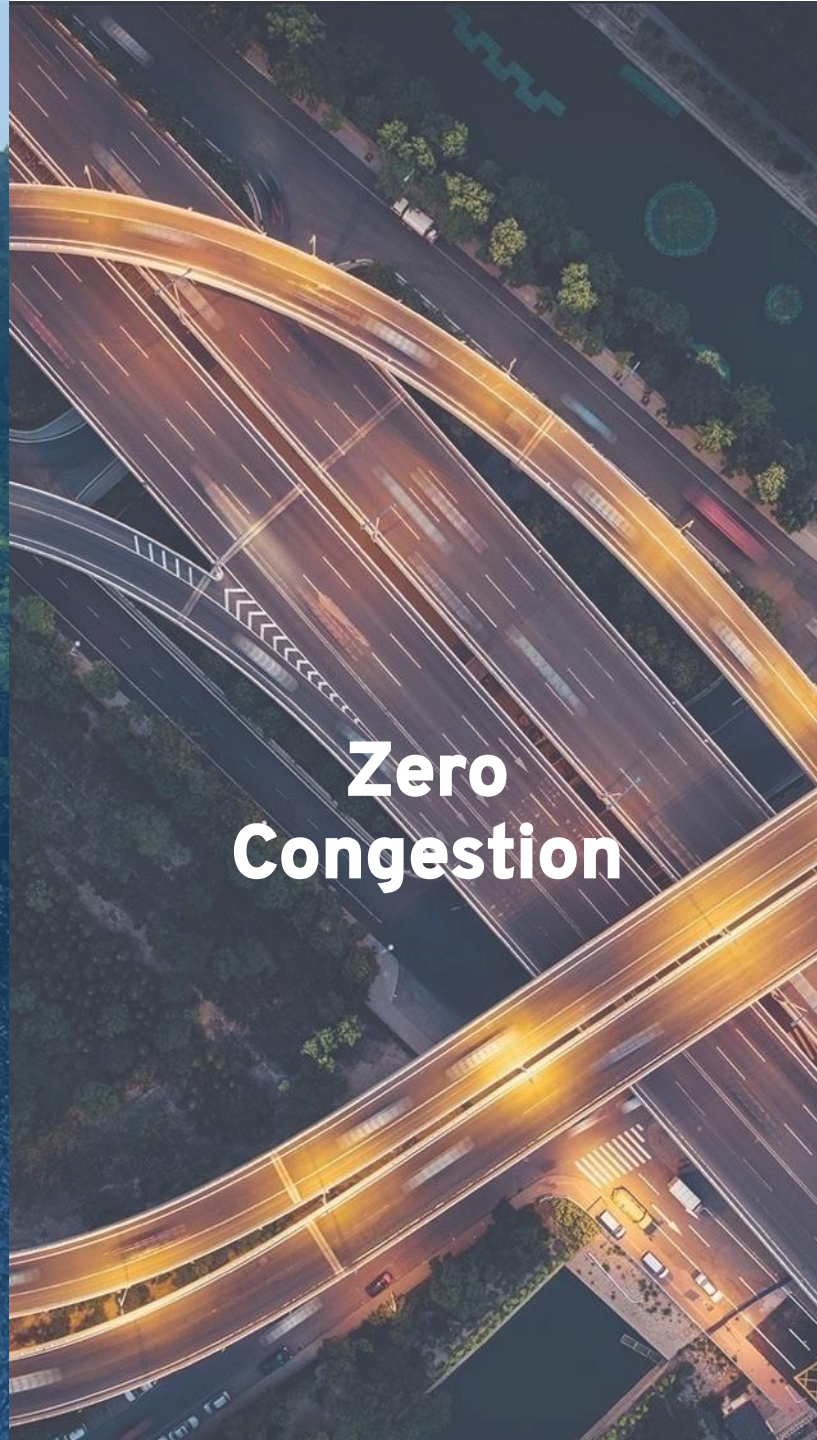
Ready for the Road Ahead: Spectrum Needs and Wi-Fi

Wireless Broadband Alliance | 06/10/2021

A changing world.


Zero
Crashes


Zero
Emissions


Zero
Congestion

CONNECTED VEHICLE – 10 YEARS BACK

Always Connected

Navigation

OnStar

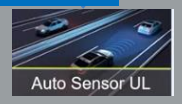
CONNECTED VEHICLE - TODAY

Connected and Protected

Navigation

Over the Air

Safety First



Seamless Experience

Hotspot

Rear Seat

android auto Apple CarPlay

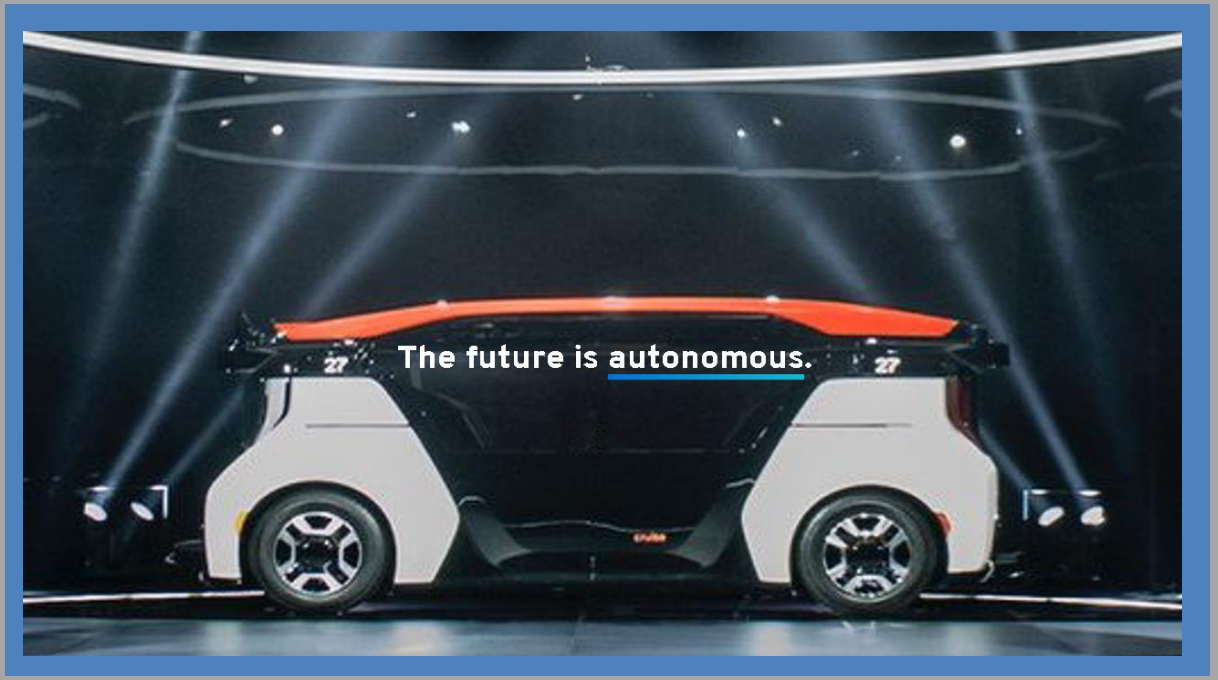
Vehicle Access

Reinventing EV Experience

Wireless Battery

Wireless Power Transfer

CONNECTED VEHICLES – ROAD AHEAD



Unleashing the full potential of connected vehicle requires addressing some of the underlying connectivity challenges

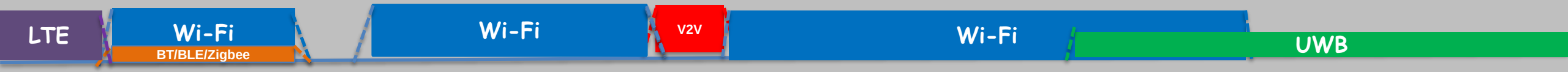
CONNECTED VEHICLES – KEY CONNECTIVITY ISSUES

- Unique Spectrum Needs in a Connected Vehicle
- 5G and Wi-Fi Convergence at Vehicle Speeds

CONNECTED VEHICLES – KEY CONNECTIVITY ISSUES

- Unique Spectrum Needs in a Connected Vehicle
- 5G and Wi-Fi Convergence at Vehicle Speeds

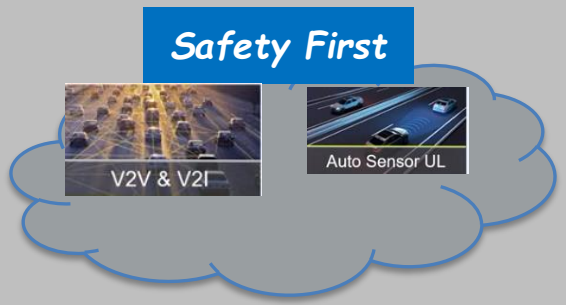
CONNECTED VEHICLE – SPECTRUM NEEDS



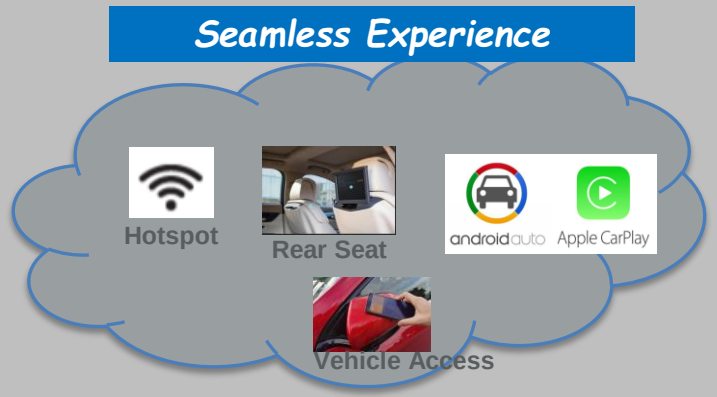
Unique challenges posed by Connected Vehicle features identifies the need to define new coexistence mechanisms between technologies

Connected and Protected

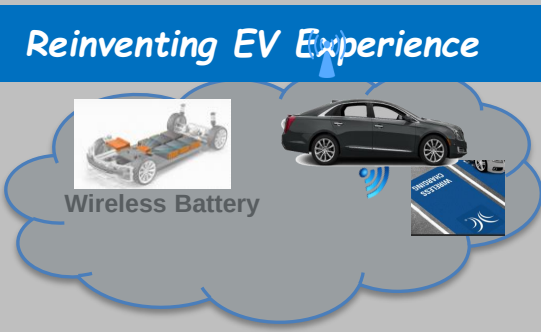
Safety First



Seamless Experience



Reinventing EV Experience



CONNECTED VEHICLES – KEY CONNECTIVITY ISSUES

- Unique Spectrum Needs in a Connected Vehicle
- 5G and Wi-Fi Convergence at Vehicle Speeds

CONNECTED VEHICLE – HETEROGENEOUS WI-FI HANDOVER NEEDS

Vertical Handover challenging in Vehicular Networks as existing standards do not properly account for Vehicular speeds

WE ARE AT THE TIPPING POINT…


A better world ahead.


Thank you.

BACK UP

VEHICLE CONNECTS TO HOTSPOTS: CHALLENGE

Vehicle connecting to Hotspots

- Fast Connection
- Seamless
- Opportunistic
- Convergence
- Secure

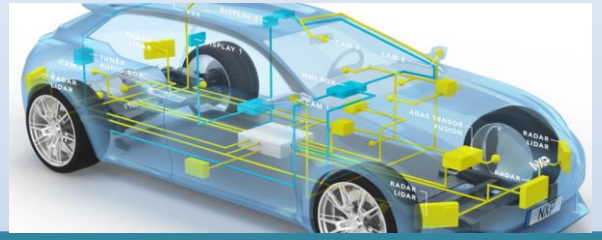
How can vehicles **maximize opportunities for Wi-Fi connectivity**, to meet growing data needs, given challenges around

- Mobility
- Limited Availability of Hotspots
- Stringent Quality Requirements
- Contract Negotiations
- Throughput
- Guaranteed QoS for TSNs
- STA STA – Multiple STA Needs
- 90 perecnt of our data in non time critical

0 – 0 – 0

CRUISE = TODAY
BRIGHT DROP
LUNAR
FLYING TAXI

VEHICLE CONTAINING HOTSPOTS: CHALLENGE



Vehicle containing Hotspots

- Wired QoS
- Redundancy
- Safety
- Wireless Coexistence

How can vehicles leverage Wi-Fi to meet **wired-like Performance for Safety Applications**, as the demand for modules in vehicles to transmit wirelessly grows – given challenges around

- ❖ Wireless Reliability
- ❖ Stringent Safety Requirements
- ❖ Wireless Coexistence

FUTURE TRENDS..

Positioning

Wi-Fi 7

Open Roaming

Wi-Fi 6E

V2I

V2X

Halow

5G

Wi-Fi Aware

Passpoint

Leverage new technologies to continue enhancing safety and experience of our customers.

AUTOMOTIVE FUTURE IS EXCITING ..

THANK YOU

CONNECTED VEHICLE – EVOLUTION

Navigation

Navigation

Over the Air

Hotspot

Rear Seat

android auto

Apple CarPlay

Vehicle Access

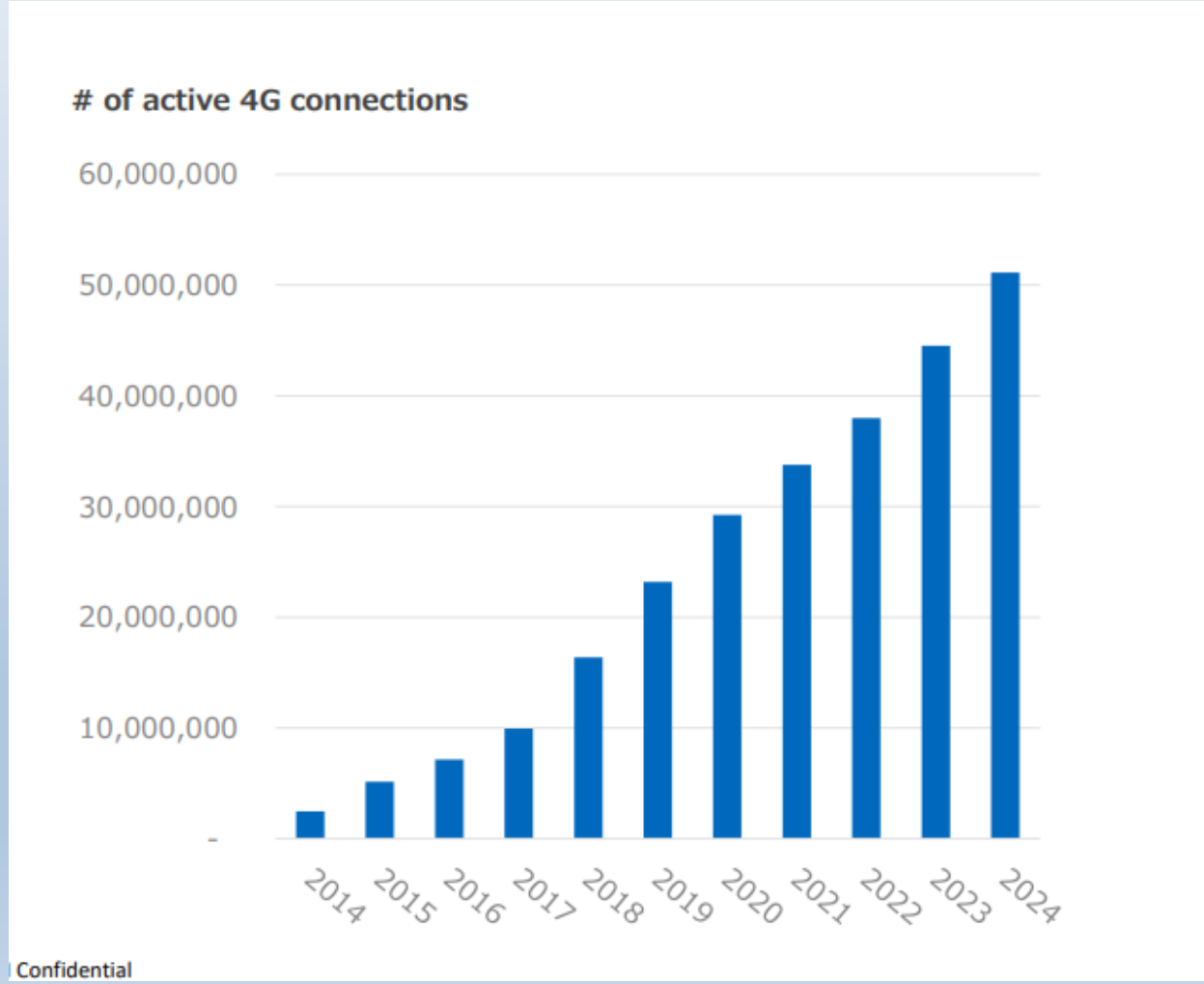
Always Connected

Integration of BYOD

Safety Services

Vehicle Charging Services

AUTOMOTIVE CONNECTIVITY: FORECAST



Slide 1 – what is connected vehicle , how it going to grow, how is it important, what can it enable

Slide 2 – What are the 2 big things that we need to get to to have connectivity ready for connectivity vehicles

- Wireless Coexistence
  - Not Regulatory
- Open Roaming
  - Challenges for Open Roaming in Vehicles –
- 000 is how we ensure Connectivity

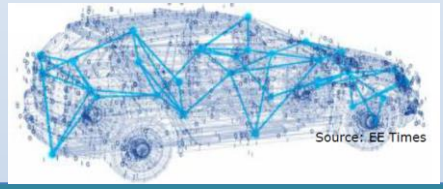
VEHICLE CONNECTIVITY: WHAT IS IMPORTANT

Vehicle connecting to Hotspots

- Fast Connection
- Seamless
- Opportunistic
- Convergence
- Secure

Vehicle as a Hotspot

- Frictionless Handover
- High Efficiency
- Secure
- Forward Compatible



Vehicle containing Hotspots

- Wired QoS
- Redundancy
- Safety
- Wireless Coexistence

A Revolutionary Approach to Addressing the Small Business Market

TYSON MARIAN

Chief Commercial Officer

Plume Design

WorkPass

Plume®

Plume overview

2014

Founded

7

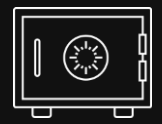
Global locations

330+

Total full-time employees

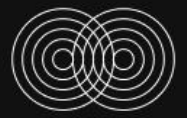
50

Granted US & foreign patents
(54 pending)



$1.35B

Valuation



200+

CSP customers

20M+

Active households

Smart home & small business is the next big “play”

Partnering with Plume enables the deployment of new services and superior experiences to increase ARPU and reduce churn

Adding Mobile and/or OTT Video by fixed line CSPs helps but the market is very competitive, products are hard to differentiate, high MVNO costs pressure margins, and the churn is very high for these services

Plume-powered smart home and small business services are sticky, profitable, and offer rapid ARPU growth, bigger bundles, and differentiation.

The small business market

80M

Approximate number of small businesses worldwide

+

$100B

Estimated value of the small business market to CSPs

Service providers in the small business space have seen major successes

COMCAST

$14B

Estimated annual revenue generated by Comcast's small business offering

Liberty Global

$2B

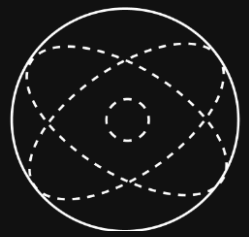
Estimated annual revenue generated by Liberty Global's B2B offering

Bell

$300M

Estimated annual revenue generated by Bell Canada's small business offering

What today's small businesses need



Flawless wireless

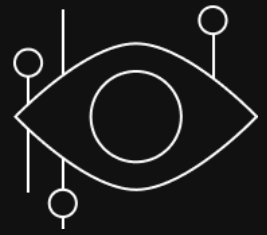
"Fast WiFi is imperative to run my business... My business operations rely on real-time connections"

Jason M.

Intelligent security

"Security is always important"

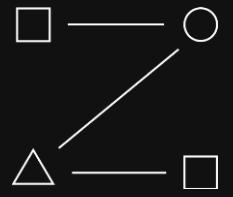
Andrea M.



Productivity capabilities

"More information on how to keep [employees] happy with me and the company would be huge"

Alexis S.

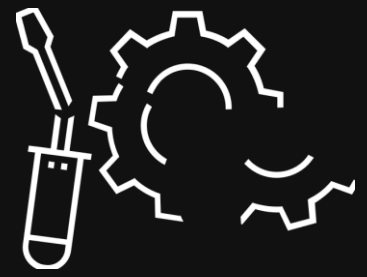


Ease of use

"There can still be frustrations [when working] across the platforms... leading to lost time and productivity"

Igho E.

Existing solutions sit between complex and overkill

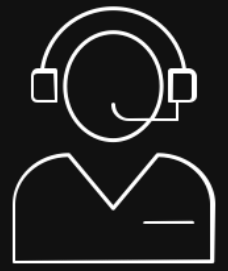


DIY approaches

Zero IT support

Often fail, hurting productivity

Complex



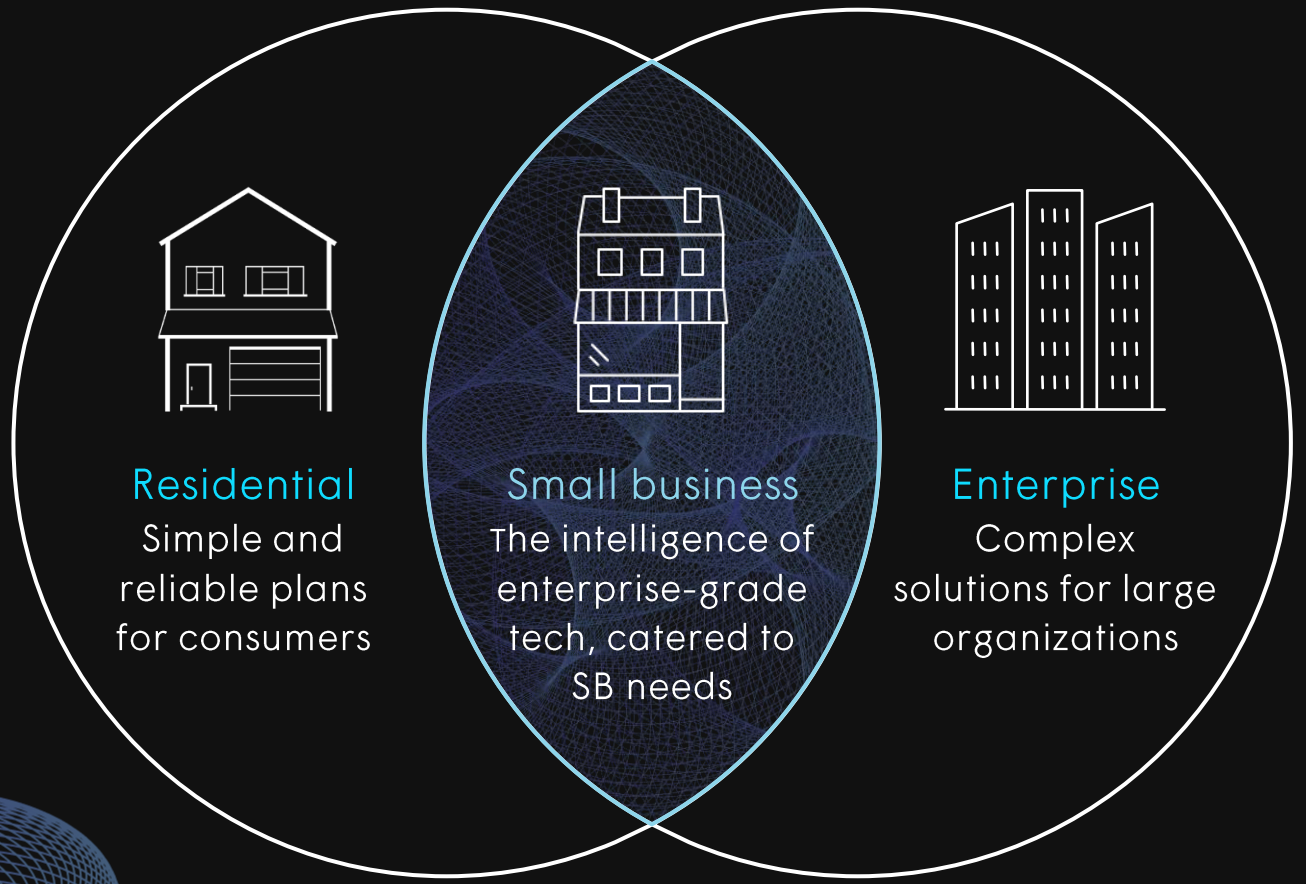
Small business technologies

Professional installation

Enterprise price tag

Overkill

How can CSPs tap into the small business market to open and expand revenue streams?



Introducing WorkPass

The next-generation suite of
smarter small business services

Plume Consumer Experience Management Platform

HomePass
Smart home suite

SERVICES

- **Adapt** — *WiFi + connectivity*
- **Control** — *Access + parental mgmt.*
- **Guard** — *Digital security*
- **Sense** — *Motion detection*
- **Thrive** — *Aging in place*

Haystack
Data prediction & analytics suite

- **Panorama** — *Network analytics dashboards*
- **Signal** — *Predictive algorithm workflows*
- **Frontline** — *Intelligent support tools*

APPLICATIONS

OpenSync + Plume Cloud

Harvest
Marketing insights suite

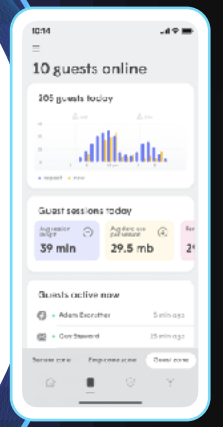
- **Clarity** — *Marketing + audience intelligence*
- **Crusade** — *Campaign automation*
- **Generate** — *Consumer cohort engine*

APPLICATIONS

WorkPass
Intelligent workplace suite

SERVICES

- **Link** — *Mission critical access*
- **Keycard** — *Employee productivity*
- **Shield** — *Information security*
- **Concierge** — *Guest analytics*
- **Flow** — *Property awareness*



Key benefits

Seamless connectivity

Patented adaptive WiFi

Business deployment with auto-LTE backup

Intelligent security

Always-on network monitoring

Segmented zones (3 SSID) with internal firewall

Enhanced productivity

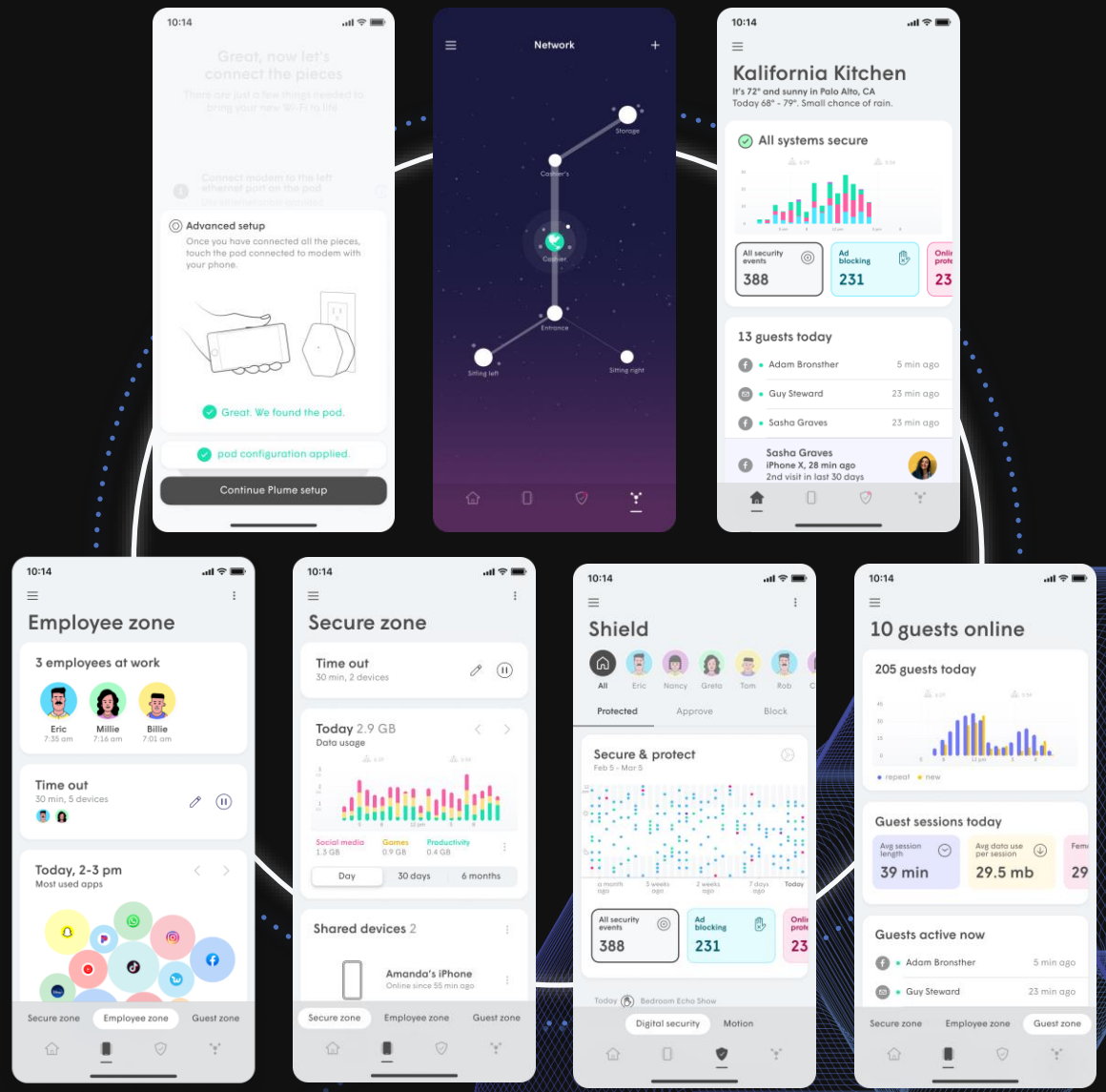
Visitor insights that lead to customer satisfaction

Custom employee profiles

WorkPass app

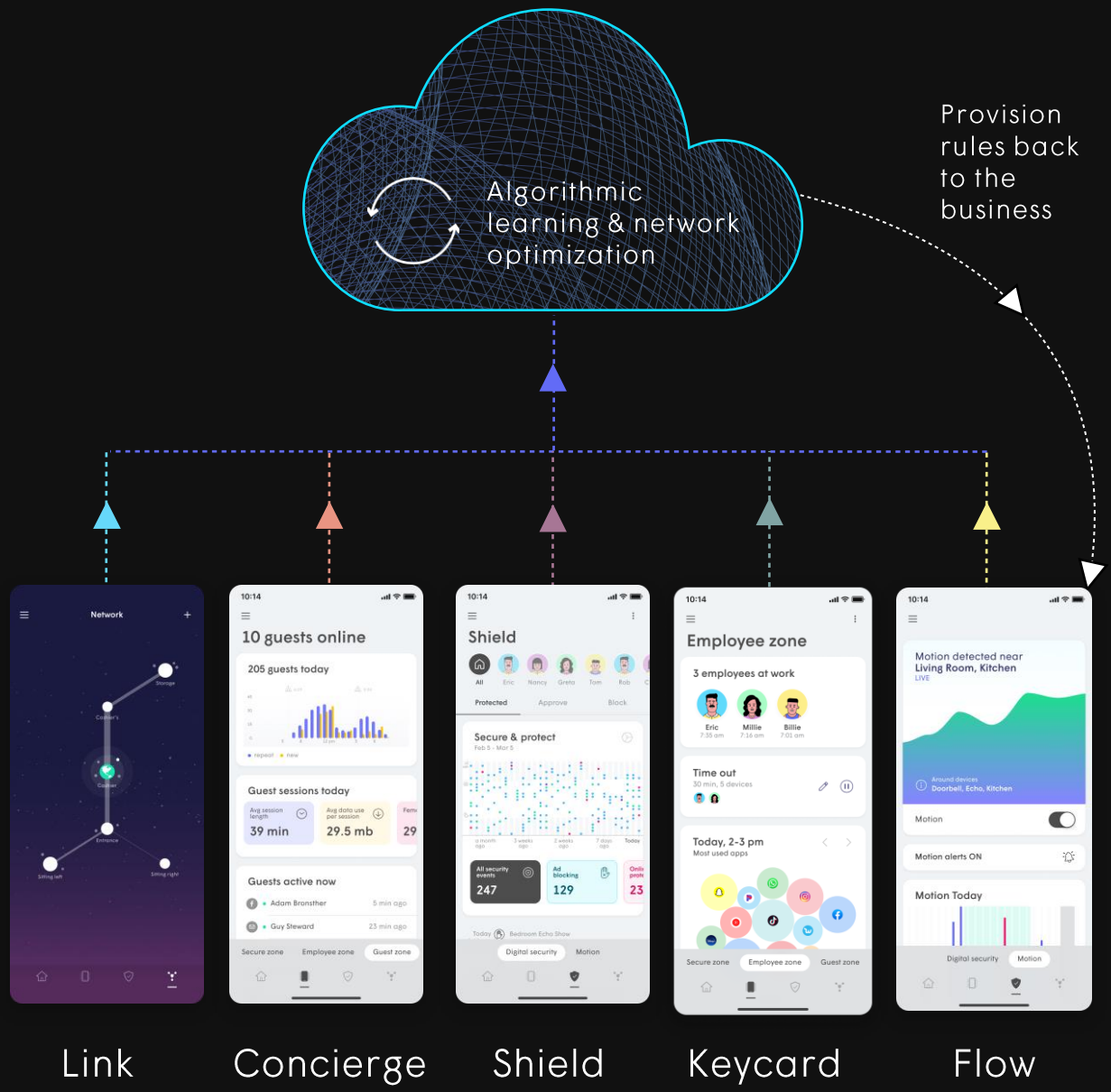
Purpose-built for small business, offering them unparalleled control over their WiFi network—all in the palm of their hand

- Self-install
- Easy onboarding
- Full customization
- Localization



WorkPass

- **Link**
  Fast, reliable, secure connectivity
- **Concierge**
  Personalized business insights
- **Shield**
  Intelligent cyber security
- **Keycard**
  Employee management dashboard
- **Flow**
  Always-on motion awareness



Plume Router with WiFi 6+LTE

Fastest and most compact gateway router

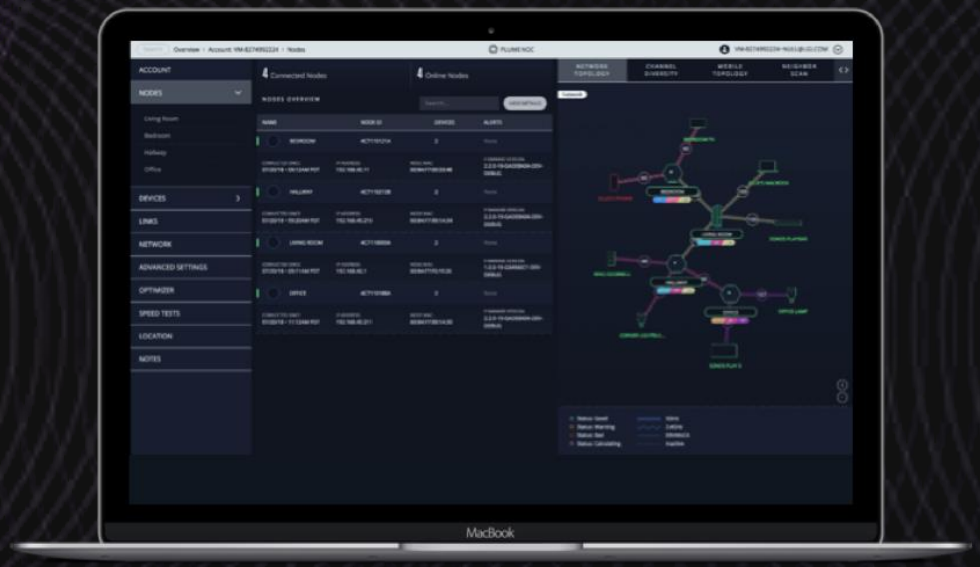
- Tri-band WiFi 6
  - 4x4 - 5GHZ
  - 2x2 - 5GHz
  - 2x2 - 2.4GHz
- 2.5 GbE with PoE
- Integrated LTE backup
- Bring your own provider
  - Physical or eSim
- Mix and match devices
  - Wall-mounted or SuperPod
- Support WPA3
- Dimension
  - 138mm x 126mm x 40mm
- Bluetooth 5.0

Manage and optimize the SBO experience on the back-end

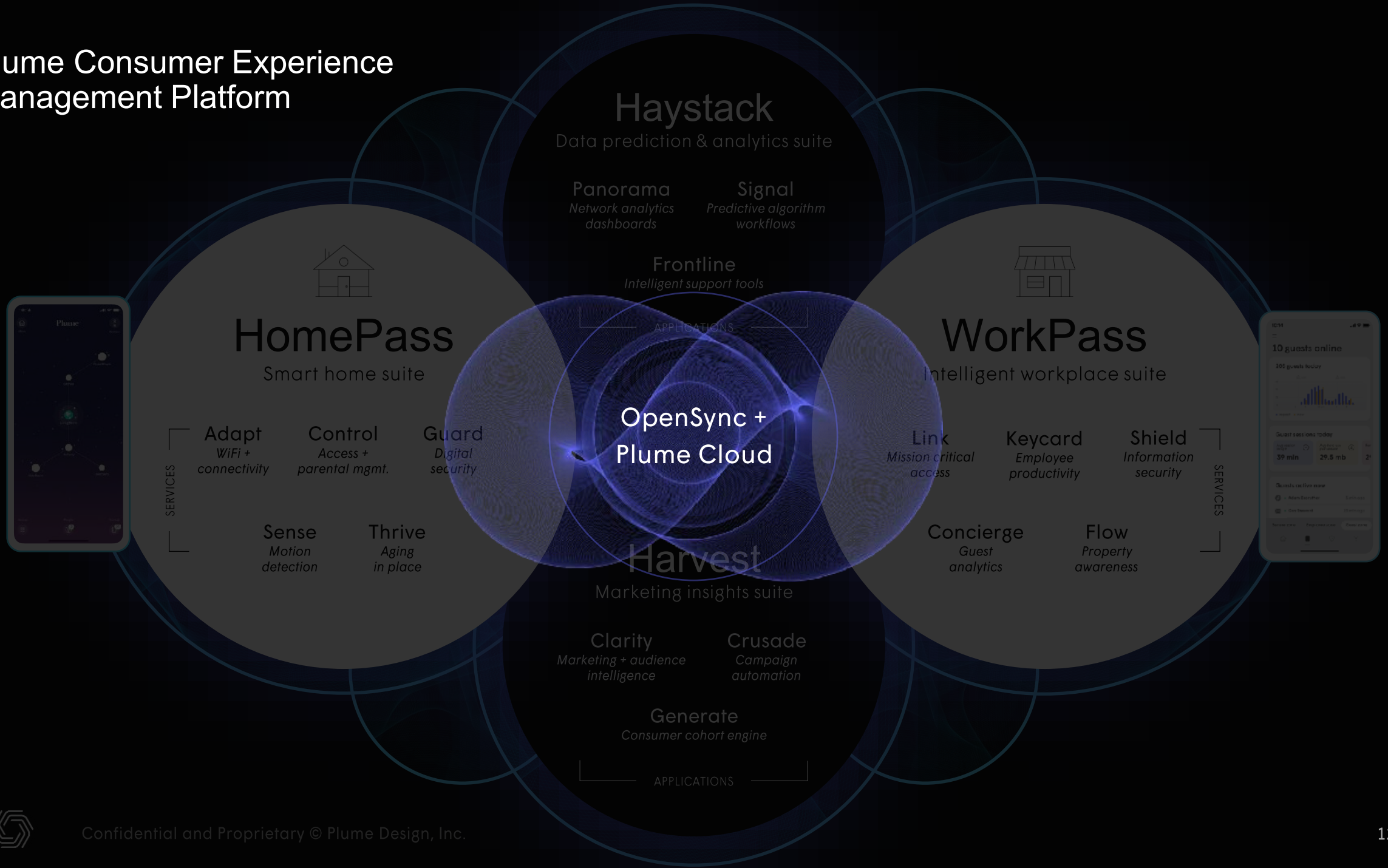
Haystack

Intuitive support tools that deliver informed and proactive service

- AI-powered, predictive network performance insights
- Increased visibility for support staff
- Comprehensive analytics dashboard for customer lifecycle management



Plume Consumer Experience Management Platform



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WIRELESS GLOBAL CONGRESS
WIRELESS BROADBAND ALLIANCE

Panel Discussion

Steve Namaseevayum

Wireless Broadband Alliance

Jim Allison

Capitol Corridor Joint Powers Authority

Thomas Locke

GlobalReach Technology

Lakshimi Thanayankizil Ph.D.

General Motors

Tyson Marian

Plume Design

Closing

STEVE NAMASEEVAYUM

Director, Membership & Industry Alliances

Wireless Broadband Alliance

Wi-Fi Powering Innovation Series

Thursday June 3rd

Wi-Fi Innovations
Connecting your Worl

- Social Impact of Wi-Fi – fro wering the world economy to how Wi- elping the green agenda and bridg e digital divide.
- Future of Wi-Fi – th de ahead – overall market trends.
- L livering the wireless experience for carr nter onsumers and things.
- Regul es for Wi-Fi 7, Wi-Fi 6E and OpenRoa

Thursday June 10th

Connecting the
Wi-Fi -enabled Enterpris

- How can Wi-Fi address the em g needs of enterprise to innovate and post COVID 19.
- Industry 4.0 & IoT: Em opportunities for Wi-Fi in the 5G era.
- D ving the conn revolution in retail and hosp ity pos 19.
- Trains, utomobiles – connectivity into 2030.
- Marketing a cations for Wi-Fi
- Private 5G and Wi-Fi

Thursday June 17th

Wireless Innovation, Operation and Customer experience – Where next for operators?

- The future of wireless networks.
- Delivering a gold standard public Wi-Fi experience – Seamless, secure, permission-based privacy.
- Testing performance and optimization monitoring.
- Wi-Fi 6E & 5G – the road to convergence & OpenRoaming.
- Emerging technologies – Wi-Fi 7, FWA, 802.11be and beyond.

Thursday June 24th

Wi-Fi Innovations
For Hospitality

- Hospitality 2021 – What does the industry need from Wi-Fi operators and service providers.
- Delivering the next generation Wi-Fi experience in hotels and venues.
- Driving loyalty: Marketing applications and analytics for Wi-Fi in the next decade.

Wednesday June 30th

Connected Communities:
Wi-Fi gets Smarter in the 5G Era

- Market trends and drivers for smart cities and connected communities.
- Protecting our citizens: privacy, security and identity.
- Addressing the digital divide through public Wi-Fi.
- The benefits of convergence of 5G and Wi-Fi 6E.
- Monetizing Wi-Fi and the opportunity case for cities and local business.

Thursday July 8th

Carrier Grade Wi-Fi delivering the future for the smart connected Home

- Market trends and drivers for residential Wi-Fi.
- Key enablers for the Work at Home Era post COVID 19.
- Delivering on the connected home experience – Next 5 years of IoT.
- Next Generation of Wi-Fi Capabilities for in-Home (sensing, mesh, AR/VR and more....)

Thank you to our Sponsors

THANKS FOR ATTENDING

Next Time:

June 17th - Wireless Innovation, Operation and Customer experience –Where next for operators?

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