UNLOCKING LAST MILE CONNECTIVITY WITH **TRANSCELESTIAL**

Total Funding Raised since Dec 2016: **US$14m**

Deep Tech V.C.

AIRBUS VENTURES, wavemaker, ef., AirTree VENTURES, KICKSTART, 500, partech, TEKTON VENTURES, SparkLabs

Government Investors

edbi, CAPVISTA, SEEDS Capital, Enterprise Singapore, SGINNOVATE

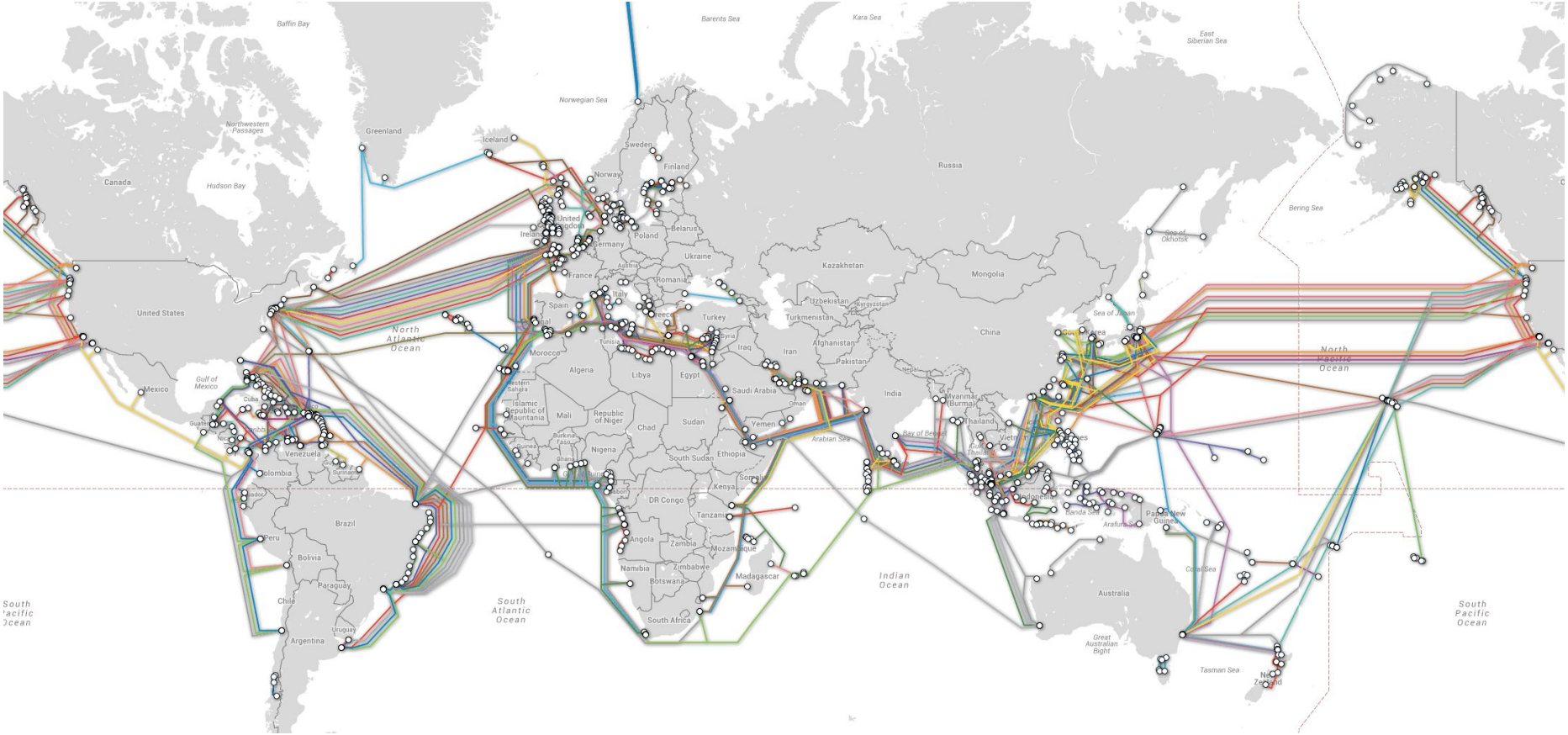
Key Angels

Michael Seibel
CEO, Y-Combinator
Co-Founder, Twitch & SocialCam

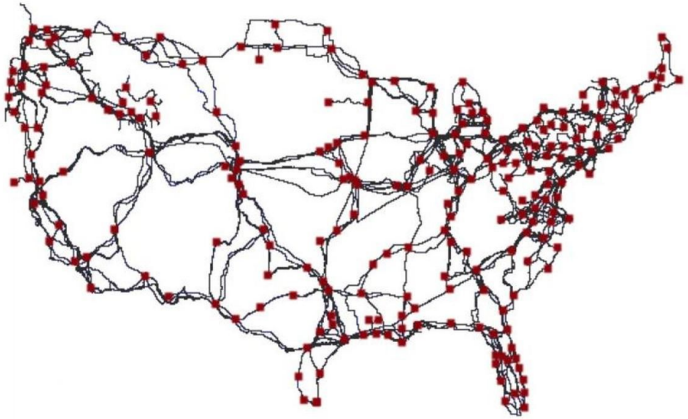
Charlie Songhurst
Ex-Head of Corp, Microsoft

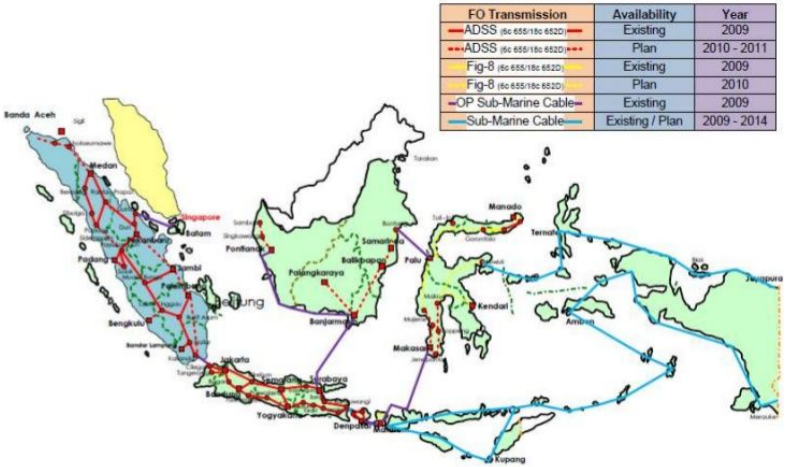
Last Mile High-Speed Connectivity Challenge

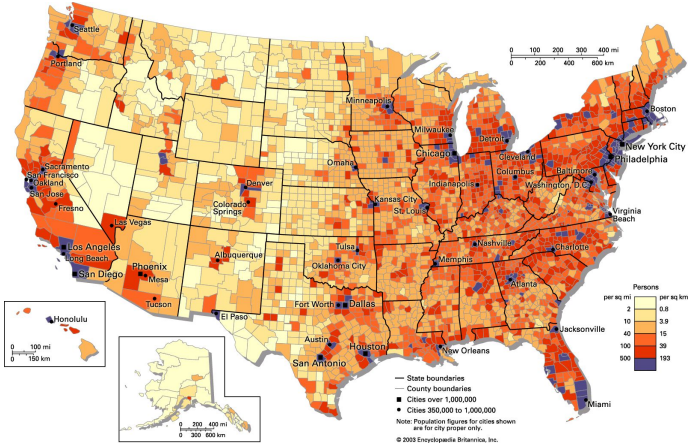
Nearly half the global population is not connected to the internet

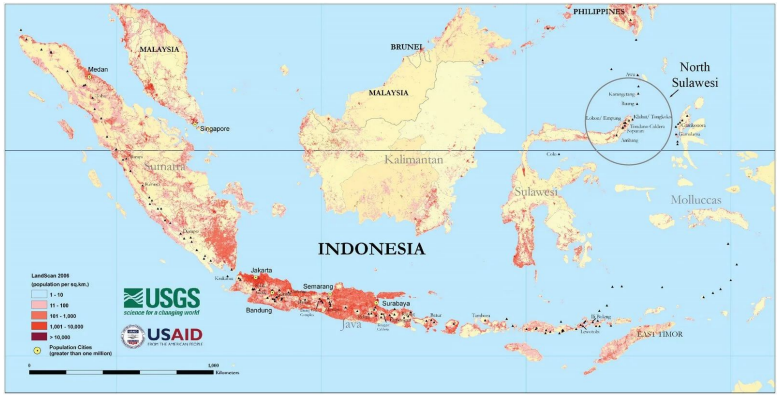


DISTRIBUTION CHALLENGE - INTER-CITY → US vs APAC



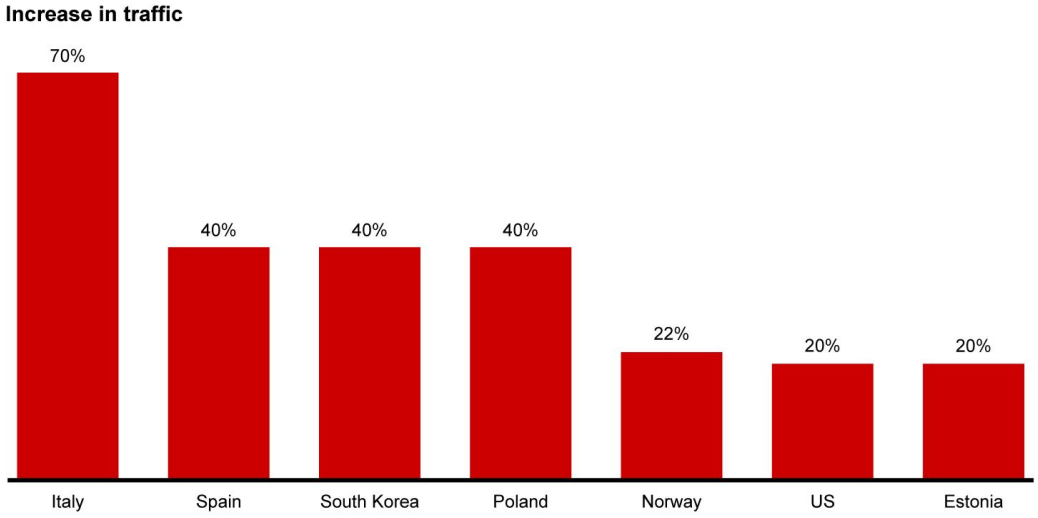






ESTABLISHED, SPACIOUS → EMERGING, SPONTANEOUS

Net Positive Long Term Impact of COVID-19 on Telecom, Enterprise Connectivity



Notes: Exact time frames of surges vary; data is not exhaustive
Source: Literature search

References:

- https://www2.deloitte.com/global/en/pages/about-deloitte/articles/covid-19/understanding-covid-19-impact-on-the-telecom-sector.html
- https://www.ifc.org/wps/wcm/connect/1d490aec-4d57-4cbf-82b3-d6842eecd9b2/IFC-Covid19-Telecommunications_final_web_2.pdf?MOD=AJPERES&CVID=n9nxogP
- https://www.bain.com/insights/telcos-and-coronavirus-three-steps-to-manage-the-crisis/

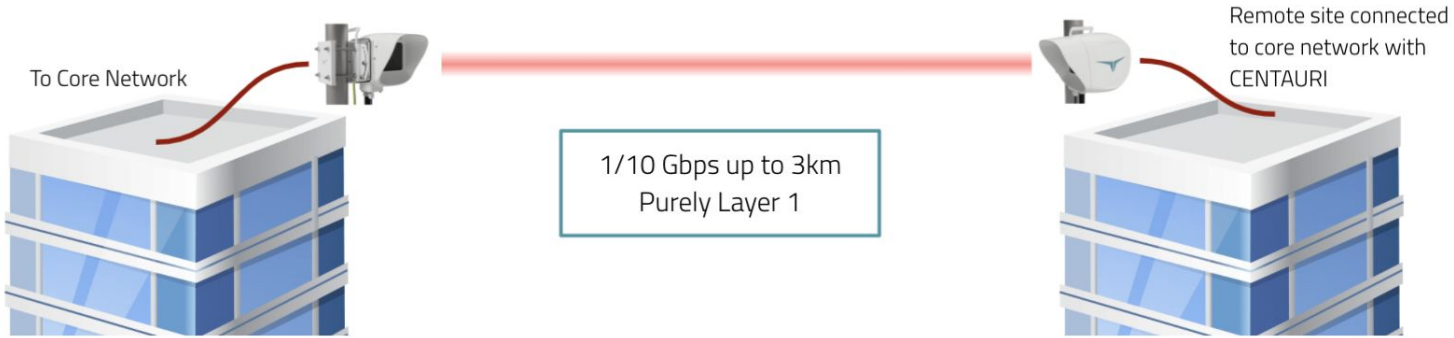
Network usage across Fixed Line (FTTX) and Mobile has **jumped 25-40% in most countries**.

1. **Move from Copper to Fiber-Optics for FTTX**
2. **Workplace-as-a-service packages to Enterprise**
3. **Increased Enterprise on-prem to cloud**

Forcing telcos/ISPs to adopt **short term infrastructure improvements (quick deploying tech)** + increased long term improvements (FTTX, 5G investments)

Wireless Fiber Optics/Laser Communication 101

What's the first thing you think of when you hear someone say "Free-Space Optics"



- Wireless Fiber Optics/Laser communications is a **line of sight technology** which uses a narrow light beam/laser to provide optical connection between two systems without fiber
- Wireless Fiber Optics can transmit data, audio and video at **very high speeds with very low latency**
- **Highly secure** because light is transparent to spectrum/RF analyzers and **intercepting a narrow beam of light is very difficult and unlikely**

1. **Price**
2. **Pointing, Acquisition and Tracking (Setup)**
3. **Size**
4. **Reliability**

CENTAURI 1/10G

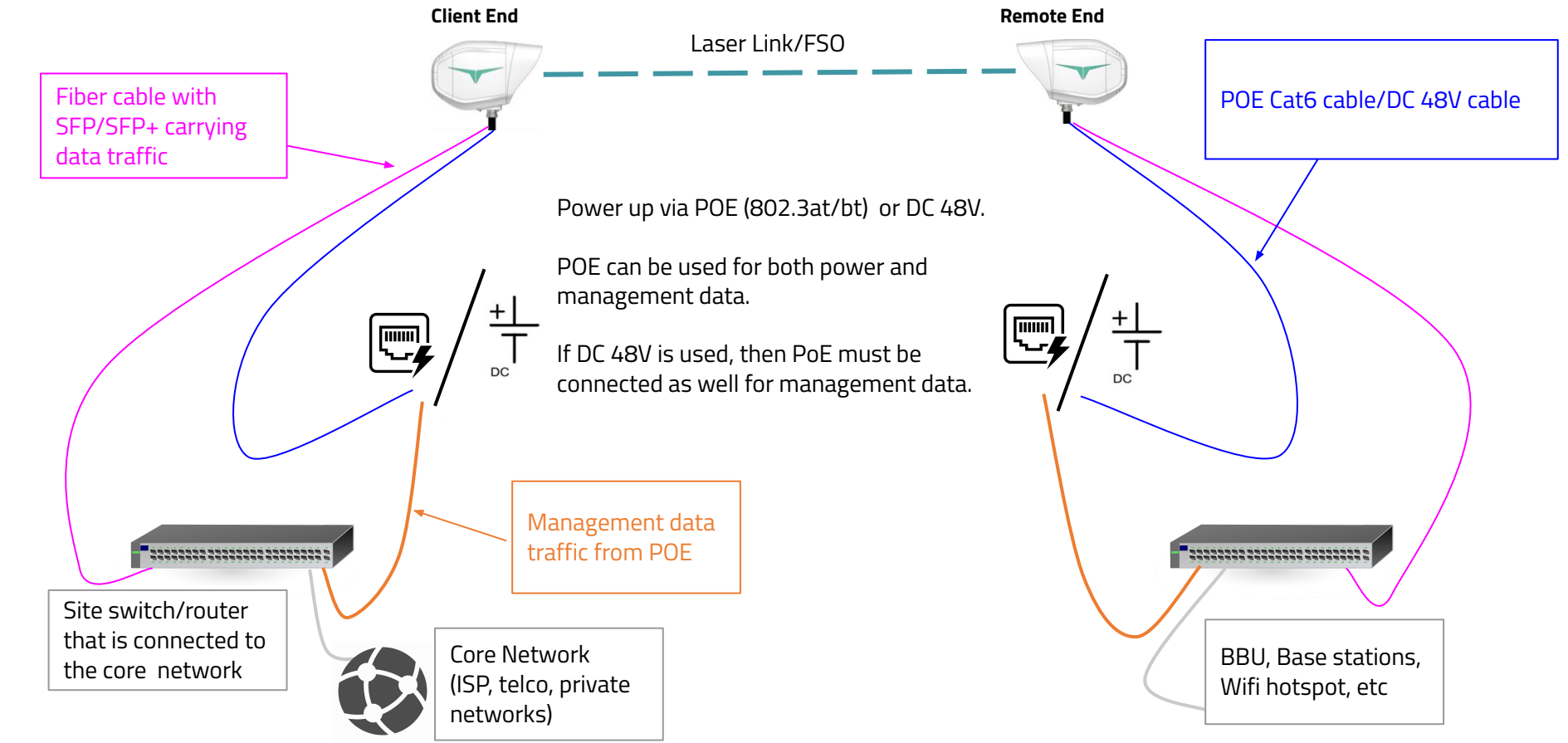
Leverages our Wireless Laser Communication technology to create a wireless distribution network between street-level poles and traditional cell towers a.k.a.
LAST MILE CONNECTIVITY

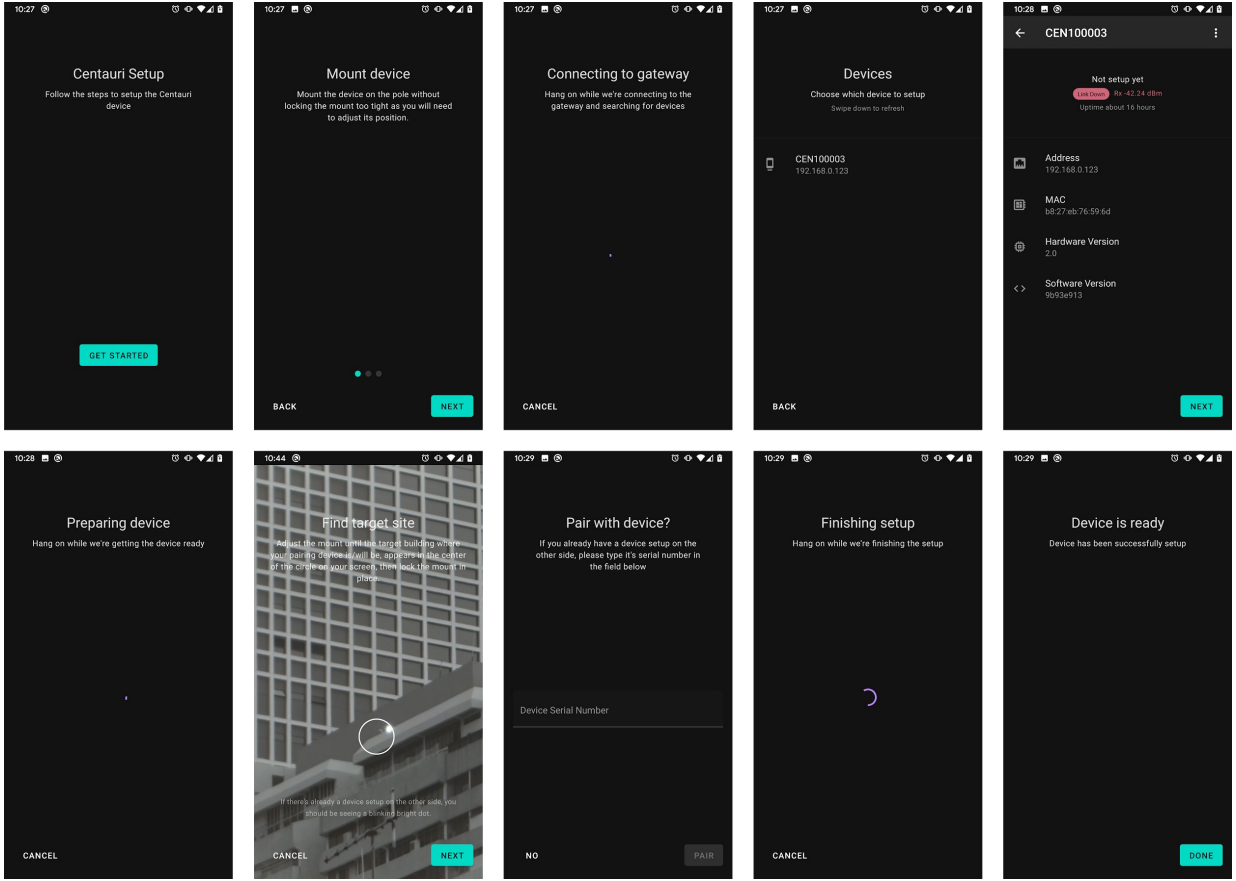
CENTAURI delivers fibre-like speeds to customers at fraction of the cost.

1, 10Gbps
Full Duplex Consistent Data Rate

<3 km
Reliably under Equatorial Region P rain conditions

- Auto-tracking and installation software enables **fast installation in <10 min.**
- **< 3kg** enable one person installation
- **Low power consumption** at less than 20W or 32W enable the use of solar power
- **Auto-tracking enable correction of pole/tower movement** due to heat expansion, vibration cause by wind and rain


Client End
Remote End
Laser Link/FSO
Fiber cable with SFP/SFP+ carrying data traffic
POE Cat6 cable/DC 48V cable
Power up via POE (802.3at/bt) or DC 48V.
POE can be used for both power and management data.
If DC 48V is used, then PoE must be connected as well for management data.
DC
DC
Management data traffic from POE
Site switch/router that is connected to the core network
Core Network (ISP, telco, private networks)
BBU, Base stations, Wifi hotspot, etc

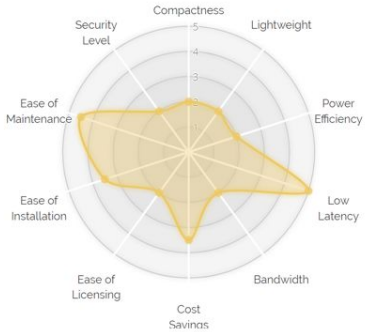


App-based installation guides operators through the on site deployment.

Entire link installation time take **~10 mins** (end-to-end) compared to a **2-day** installation period for existing microwave OR a **few months** compared to fiber

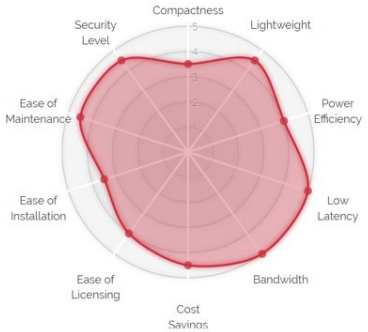
Microwave

(scale of 1-5, 5 being the best)



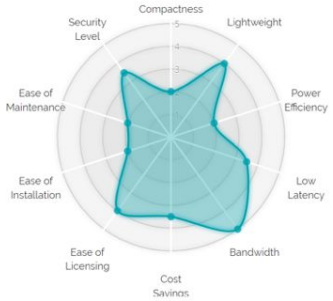
Free Space Optics

(scale of 1-5, 5 being the best)



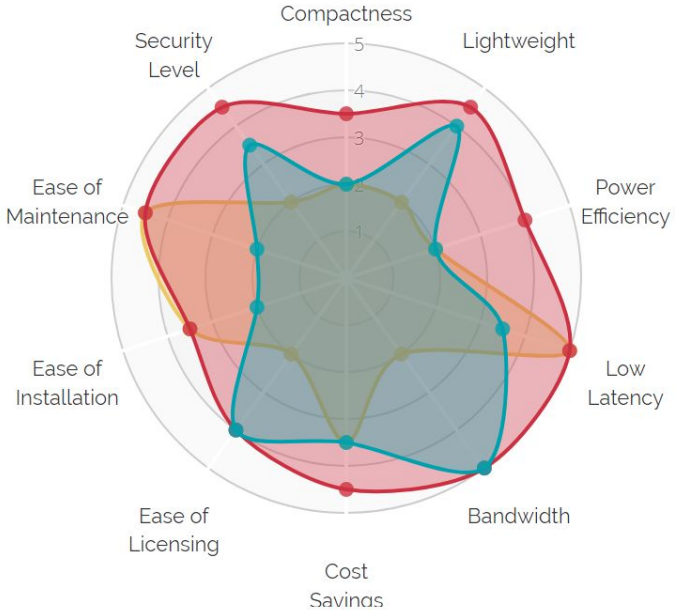
Fiber Optics

(scale of 1-5, 5 being the best)



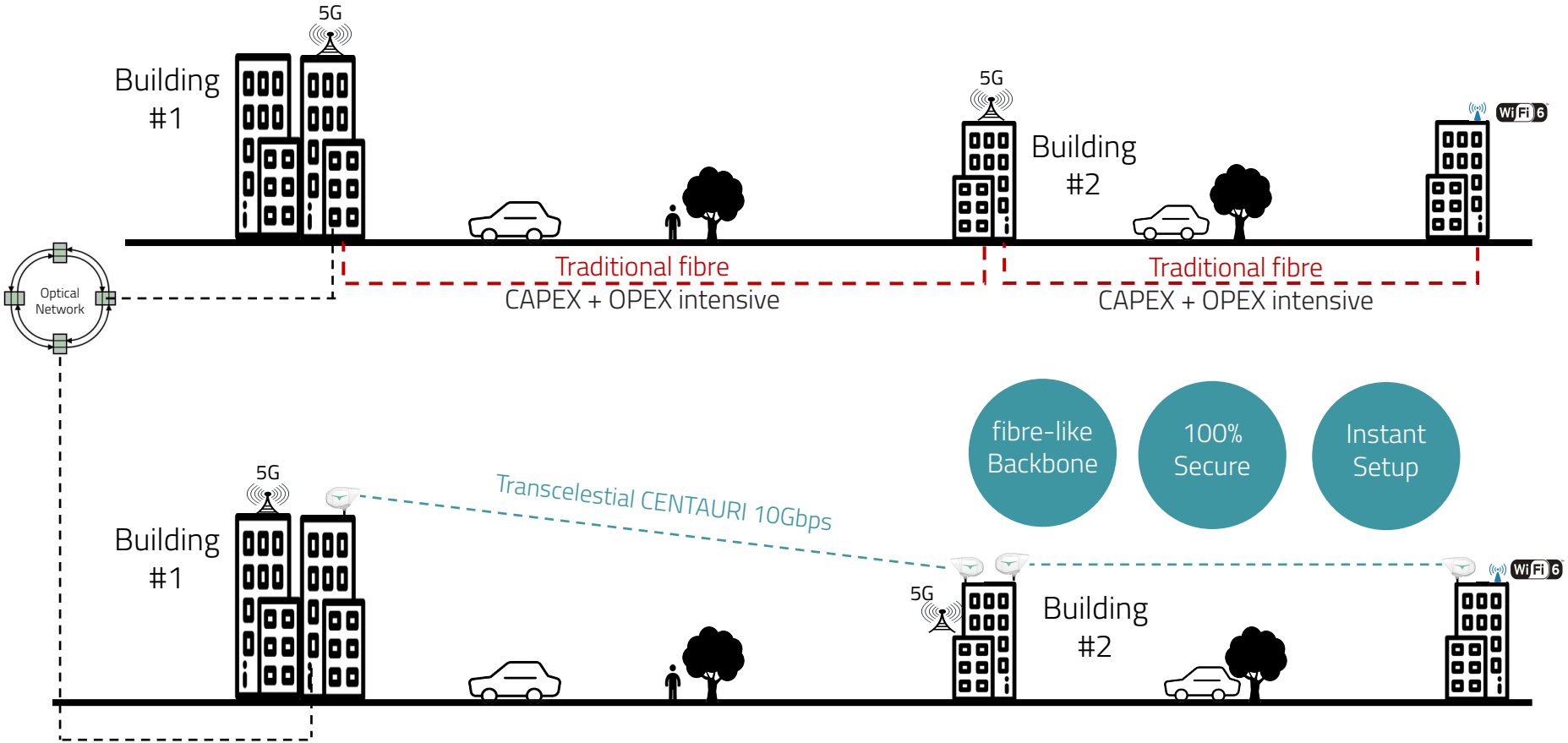
Comparison

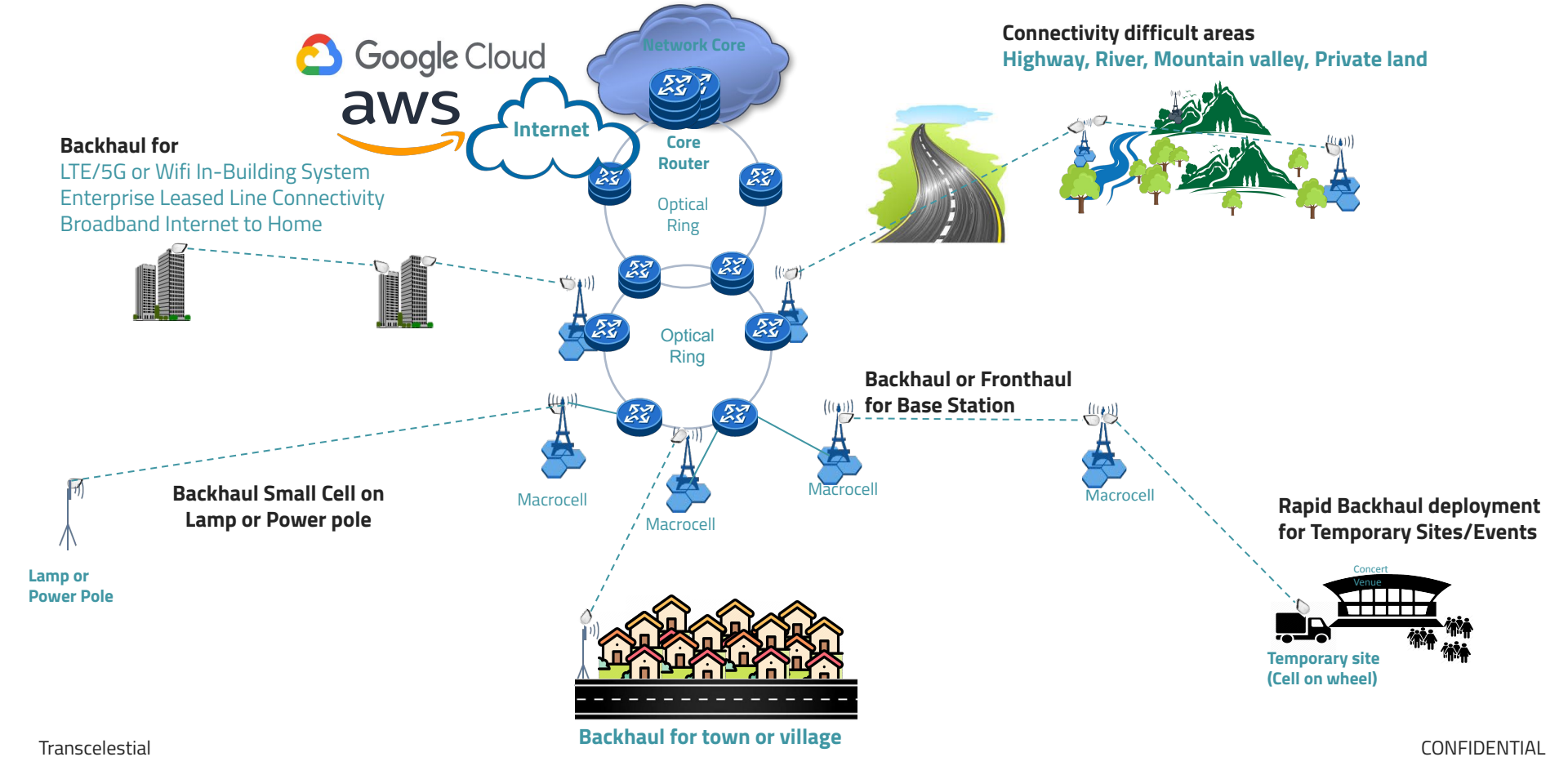
(scale of 1-5, 5 being the best)



EVERYTHING IS BUILT, ASSEMBLED AND TESTED IN SINGAPORE

Use Cases


5G
Building #1
5G
Building #2
Wi Fi 6
Optical Network
Traditional fibre
CAPEX + OPEX intensive
Traditional fibre
CAPEX + OPEX intensive
fibre-like Backbone
100% Secure
Instant Setup
5G
Transcelestial CENTAURI 10Gbps
Building #1
5G
Building #2
Wi Fi 6



Success Stories

SK telecom

TELECOM INFRA PROJECT

facebook

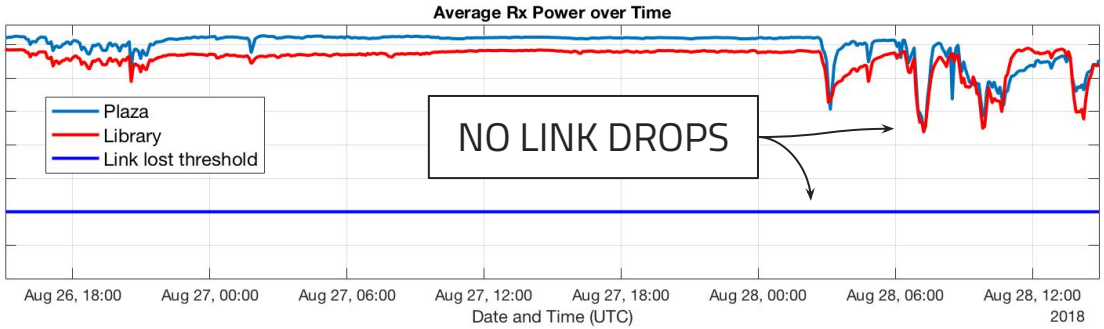
GigaWiFi Wireless Backhauling (Pilot Case)

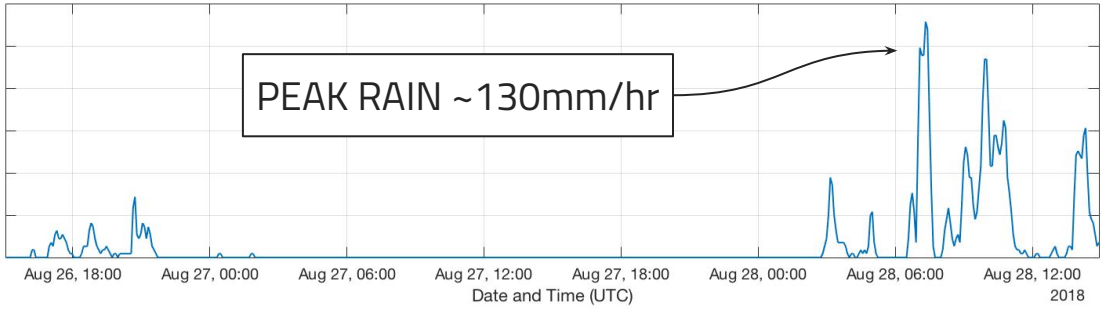
From L to R: June Shin McCarthy (Facebook TIP), Rohit Jha (CEO - Transcelestial), Mohammad Danesh (CTO – Transcelestial), Jiyong Lee (SK Telecom)

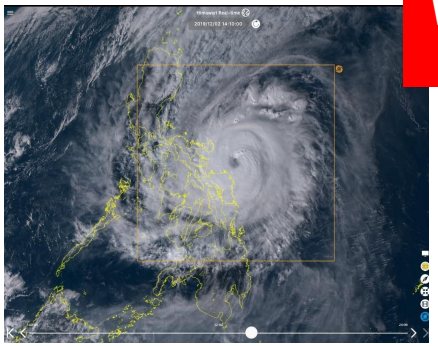
From L to R: SK Telecom Network Infrastructure, R&D and Innovation Team; Between Danesh and Rohit, the Transcelestial on-site team

Rooftop with Transcelestial prototype deployed

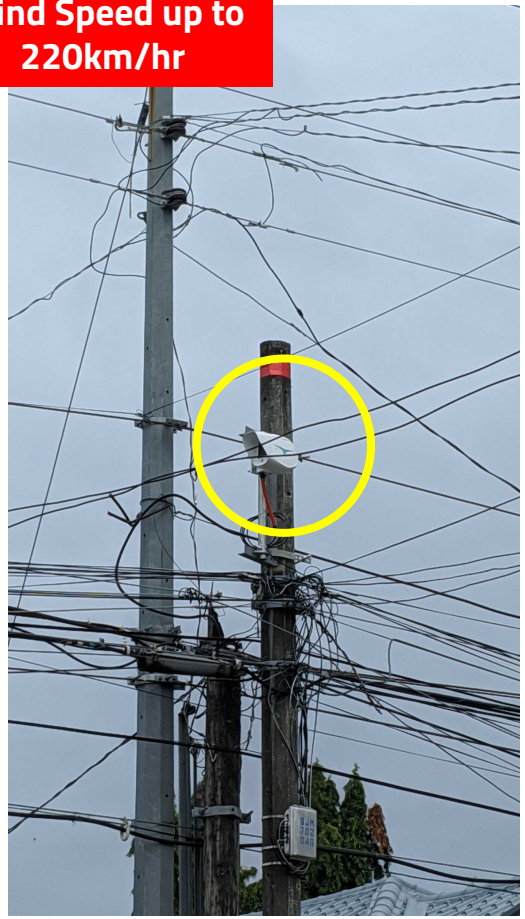
Soulik Typhoon (CAT 3) Performance during SK Telecom Pilot Testing Q3 2018

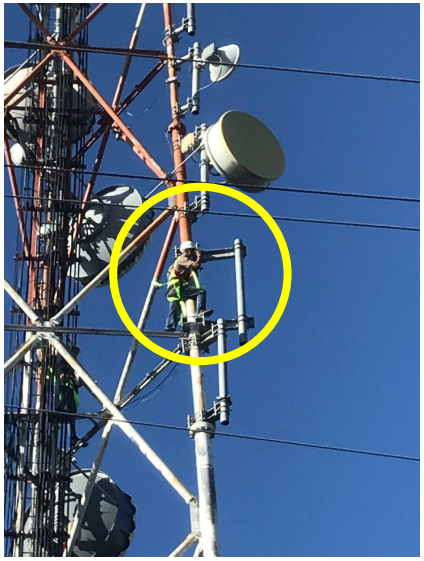






Wind Speed up to 220km/hr





Rohit Jha

rohit@transcelestial.com

#06-04, 101 Eunos Ave 3, Singapore 409835

@trans_celestial

AirGig™

Leveraging power lines to deliver internet to more communities

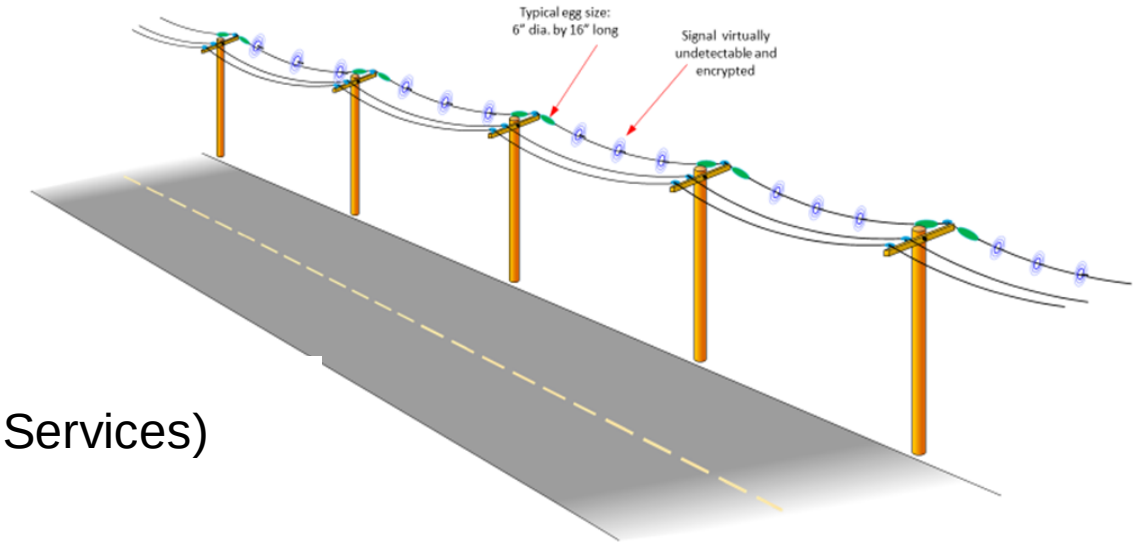
2-Way Smart Grid for Solar / Wind Renewable Energy, EV Charging

Irwin Gerszberg
AT&T Fellow, Distinguished Member of Technical Staff
irwin@att.com

The Stories behind AirGig™
https://youtu.be/rLJM25K6nUs

AirGig™ New Power Utility Transmission Breakthrough

57% of the world's rural population disconnected from the world wide web



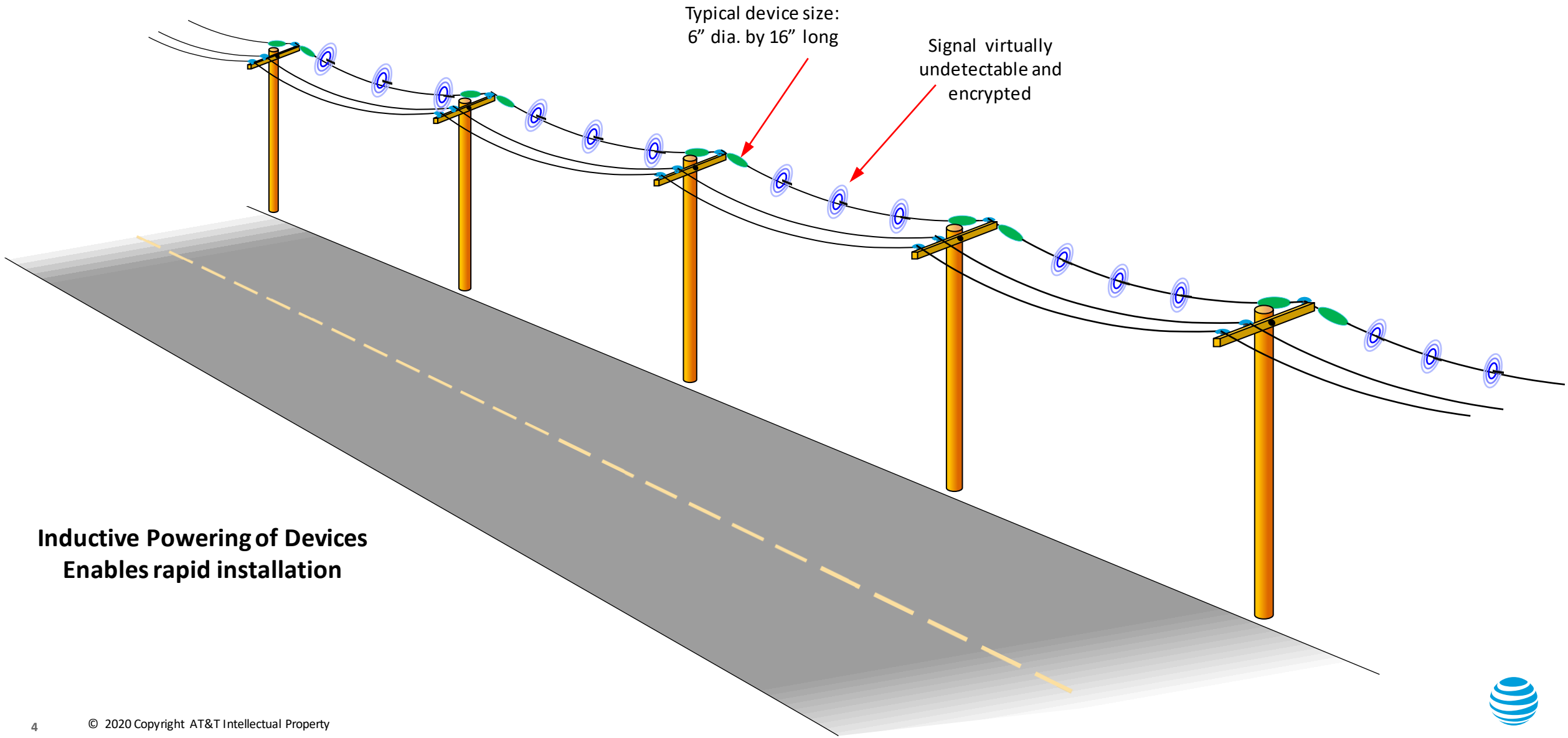
- High-Speed Broadband wherever you have electric service
- Power Infrastructure that does both (Smart Grid + Broadband Services)
- Leverages existing power infrastructure, accelerated deployments & lower cost
- Enables 2-way smart-grid power applications, Solar / Wind Clean Renewable Energy, EV Charging

Video Introduction to AirGig

AirGig Video - 5 minutes

- Story of the AirGig™ invention at AT&T (2 minutes)
- See AirGig™ being installed on Electric Utility Poles (3 minutes)

AirGig™ Illustration - Basic Implementation



Inductive Powering of Devices
Enables rapid installation

AT&T AirGig™ contacts for more information

- Irwin Gerszberg – AT&T Fellow, Distinguished Member of Technical Staff irwin@att.com
- Glenn Del Grosso – Lead Intellectual Property / AT&T Licensing & Sales gd2762@att.com
- Patricia Cartwright – Lead Intellectual Property / AT&T Licensing & Sales pc163h@att.com
- Jeffrey Farah – Director IP Technology / Patent Development & Operations jf4373@att.com

Emerging Technology for Connectivity

Accelerating Digital Transformation in LDCs, SIDS and LLDCs

5G technology

ITUWebinars, 7 July 2021

Jyrki Penttinen, GSMA North America

Dr. Jyrki Penttinen
Senior Technology Manager, GSMA

Assists operator members with the adoption, design, development, and deployment of GSMA specifications and programmes ensuring interoperability and standardisation is met

Author of telecom books such as *5G Explained* and *Wireless Communications Security*

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jpenttinen@gsma.com

@jyrki_penttinen

Blog amazon.com/author/jype

Contents

5G technology

- ✓ Development
- ✓ Requirements and capabilities

Ensuring service level

- ✓ Voice service continuum

Special aspects of LDCS, LLDCS, and SIDS

- ✓ How 5G can ease paving the way for future

5G theory vs. practice

ITU IMT-2020 presents demanding requirements for the 5G technologies.

The ITU has approved systems complying with the IMT-2020 of 3GPP and TSDSI (Telecommunications Standards Development Society India).

Nevertheless, transitioning from previous generations to 5G in practice will have different requirements and implications depending on the readiness of each region.

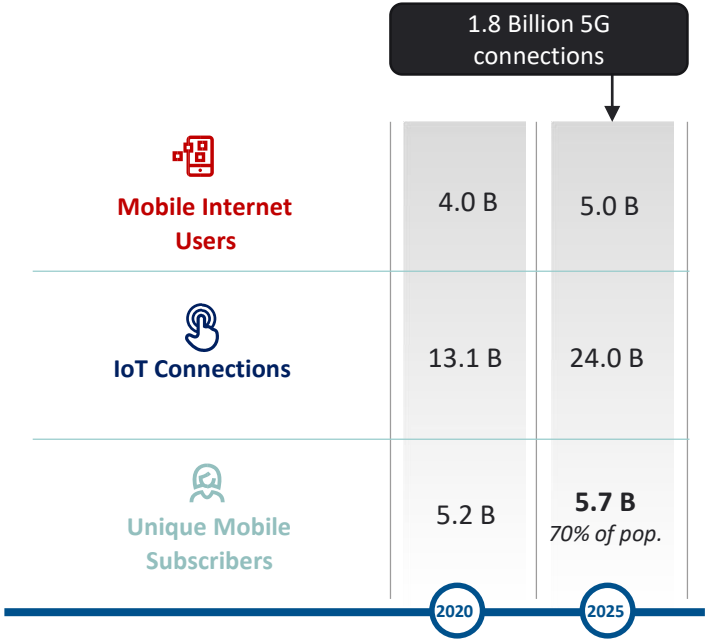
5G evolves

Although 5G networks are capable of providing faster data speed and lower latency compared to any of the previous generations, 5G also has many other benefits such as its capability to serve different user types, or verticals, and their varying use cases more efficiently via Network Slicing.

Consumers can start enjoying the enhanced performance of 5G gradually along with the evolving specifications, new devices and expanding networks.

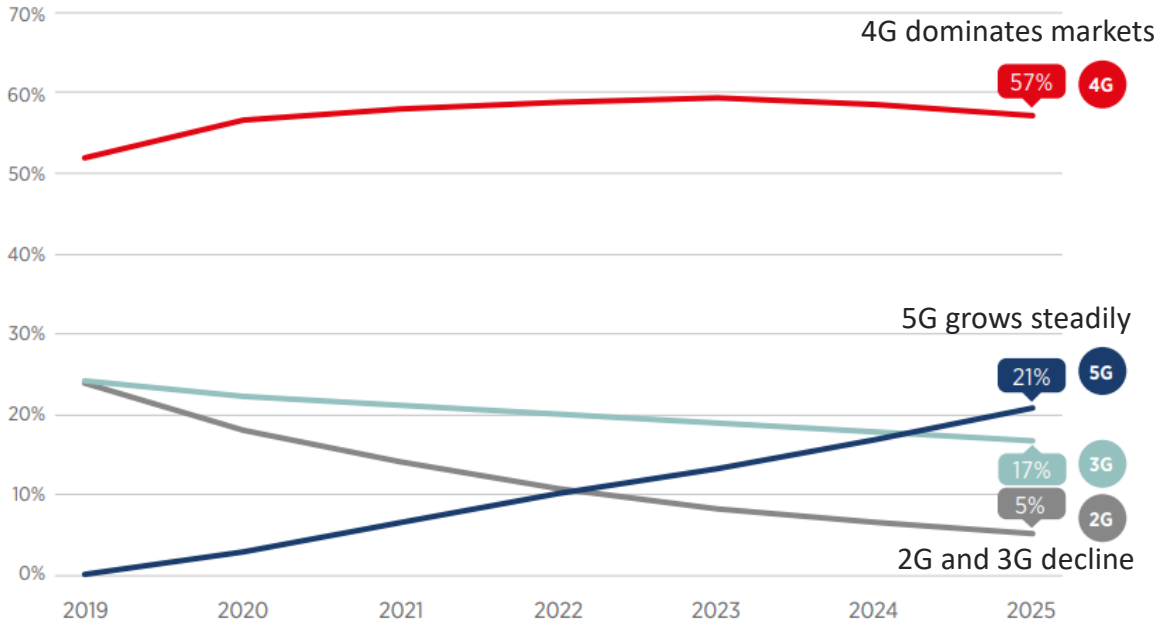
Mobile communication market development

- 5G is an opportunity to create an agile, purpose-built network tailored to the different needs of citizens and the economy.
- 5G will allow operators to move beyond connectivity and collaborate across sectors.
- 5G provides a platform on which new digital services and business models can thrive.
- The commercial 5G networks are widely deployed in 2020s – the 5G era.



https://www.gsma.com/mobileeconomy/

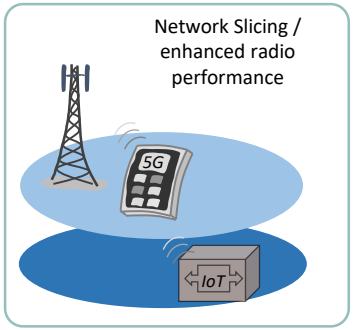
5G is taking off – while 4G paves the way

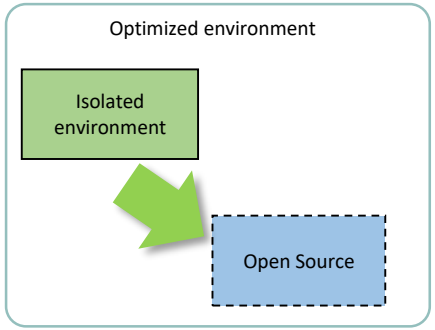


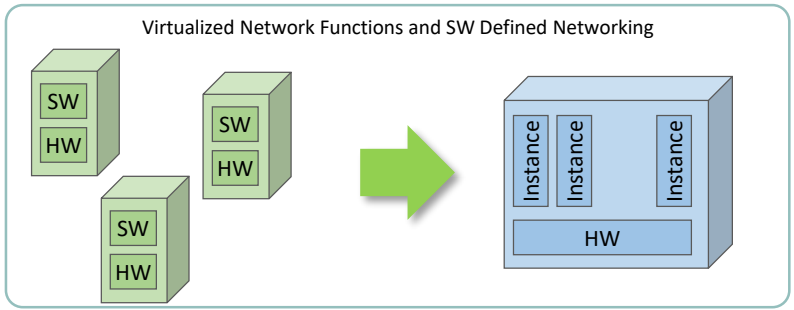
Source: GSMA Intelligence, 2021

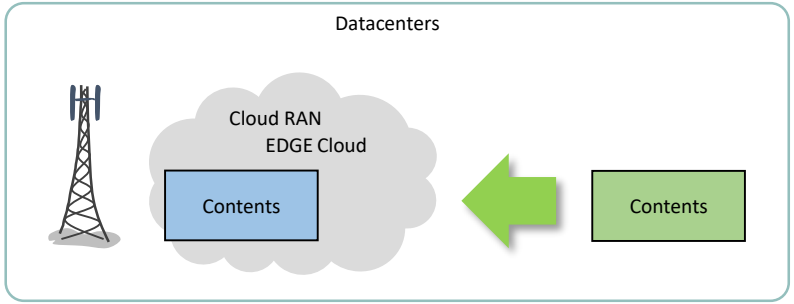
What makes 5G?

- Virtualization and open architecture model
- Network Slicing
- Edge computing





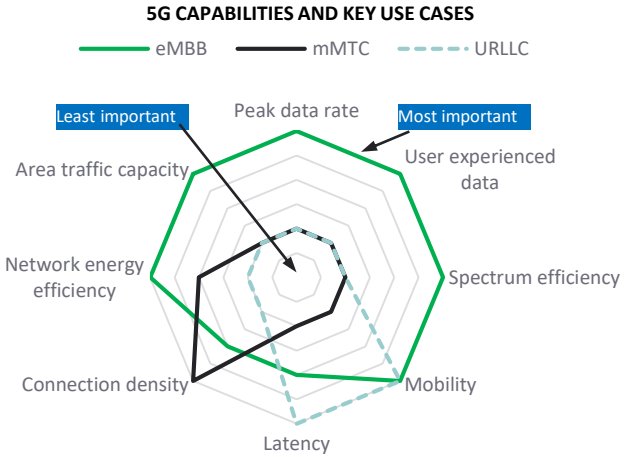


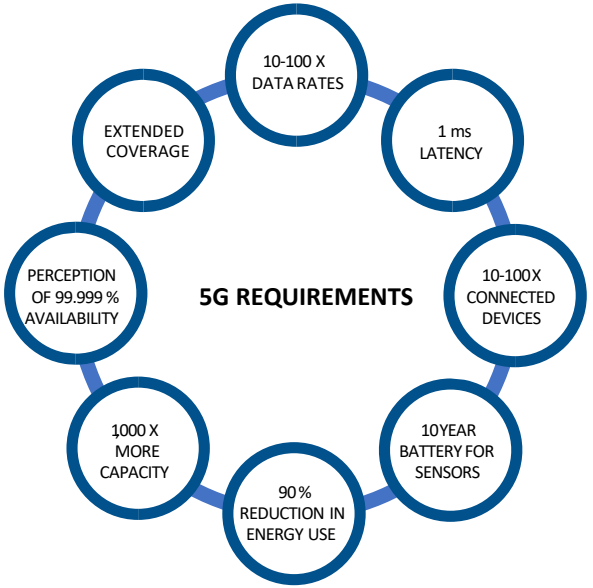


Source: 5G Simplified

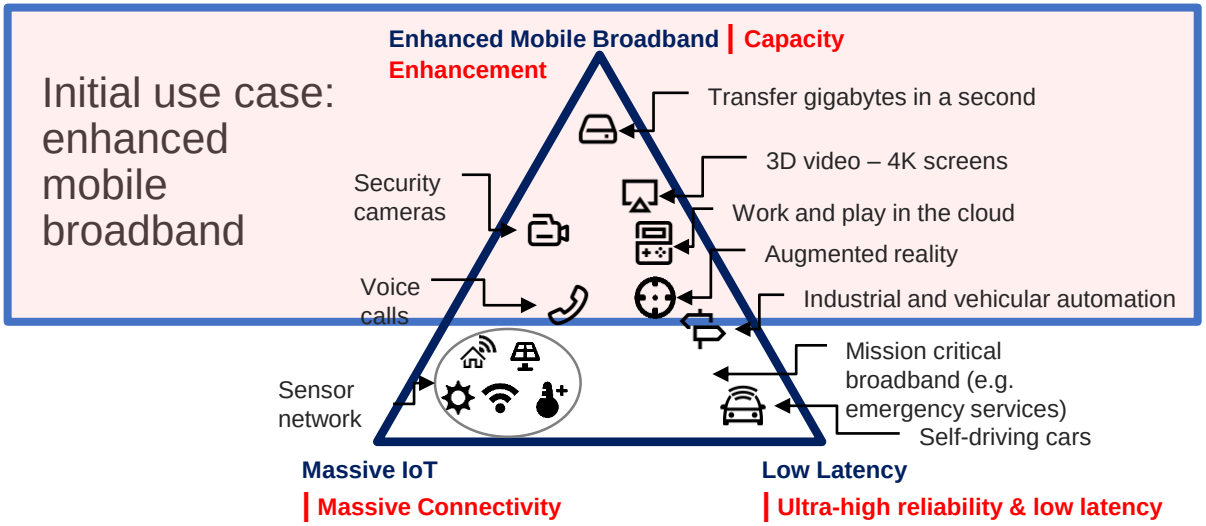
5G performance figures

- 5G provides superior user experience, faster data speeds and better latency values compared to current 4G networks





5G optimizes communication link for use cases



Source: ITU-R WP5D/TEMP/548-E: IMT Vision - "Framework and overall objectives of the future development of IMT for 2020 and beyond", February 2015

How GSMA supports ecosystem?

- **Eases interoperability**
  - Roaming
  - Network slicing
  - Smooth evolution for voice and data service evolution

- **Provides guidelines to ecosystem**
  - Best practices for deployment, such as 5G architectural options
  - Knowledge and guidelines on EMF

Challenges of emerging terrestrial technology

- **Least developed countries - LDC**
  - Often characterized by sparsely populated, large land and rural areas where terrestrial communication infrastructure is outdated or missing and challenging to roll out

- **Landlocked developed countries - LLDC**
  - LLDCs lack direct access to the sea that can lead to remoteness from world markets, high transport and transit costs, possibly outdated ICT infrastructure, and thus negative economic development

- **Small island developing states - SIDS**
  - Numerous islands add up to communication costs

5G opportunities in LDC, LLDC, and SIDS

- **Spectrum**
  - To serve efficiently, 5G networks require sufficient bandwidth – in idea scenario, on low bands (coverage), mid bands (sweet spot), and high bands (capacity)
  - 5G provides means to combine licensed and unlicensed access
- **Security**
  - 5G enhances security architecture to cope better the evolving cyber attacks
- **5G as an enabler**
  - Small cells
  - Integrated wireless backhaul
  - Satellite component
  - Support of wide set of use cases such as Fixed Wireless Access

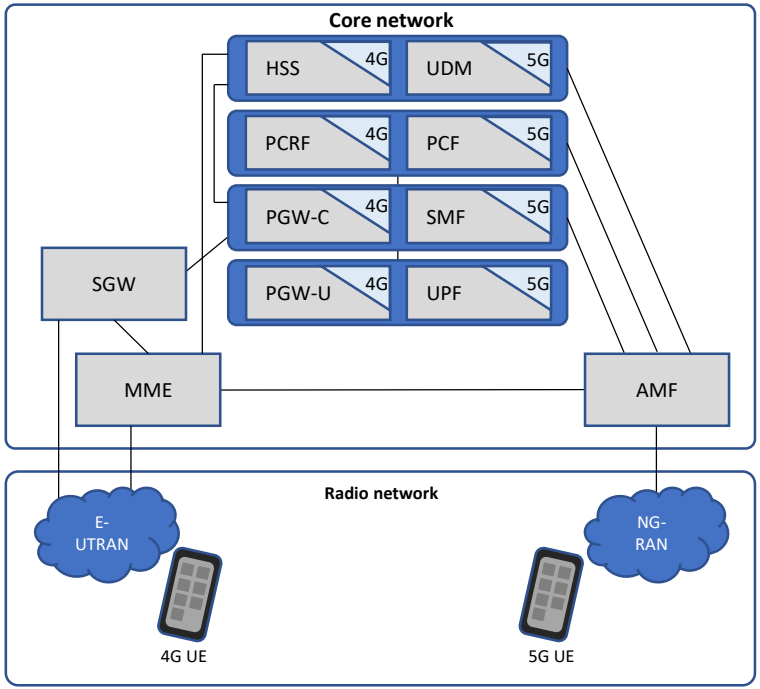
5G opportunities in LDC, LLDC, and SIDS

- **Use case optimization**
  - 5G provides optimized means to utilize and deliver optimal resources and performance to services such as remote eLearn and eHealth

- **Extra layer of public safety**
  - 5G can provide additional, redundant emergency channel to fortify existing infrastructure in emergency situations such as natural disasters
  - Evolved location service

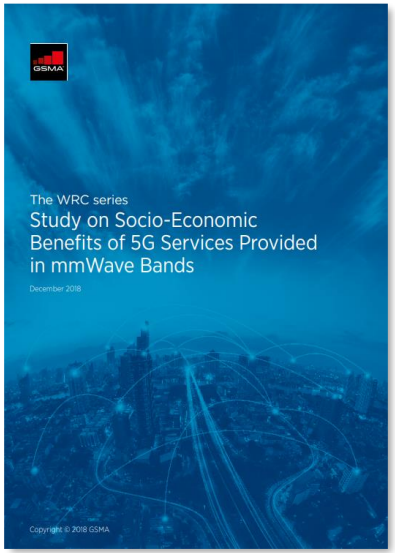
Continuum of networks and services – voice

- 5G supports native voice calls via VoNR and ECP fallback as intermediate solution
- The sun-setting of 2G and 3G networks will have a big impact on voice evolution
  - LTE and 5G only support Packet Switched connectivity
  - The means to perform Circuit Switched fallback will be impossible along with the 2G and 3G switch-off
- Affordable 4G devices that support VoLTE benefit the consumers
- Decommissioning of 2G/3G requires VoLTE



5G is a needed upgrade

- With growing number of unique users, mobile networks have greater reach than any other technology.
- The importance of mobile communications, and its centrality to daily life, will become even more profound in the 5G era.
- 5G alone is forecast to contribute $2.2 trillion to the global economy over the next 15 years.
- For more information, see the GSMA report '*Study on Socio-Economic Benefits of 5G Services Provided in mmWave Bands*' (Ref[1])



Ref[1] - https://www.gsma.com/spectrum/wp-content/uploads/2019/10/mmWave-5G-benefits.pdf

Resources

GSMA

- GSMA report ‘Study on Socio-Economic Benefits of 5G Services Provided in mmWave Bands’
- GSMA PRD NG.116, network slicing templates
- GSMA Start-ups and Mobile in Emerging Markets: Issue 4, Winter 2018

ITU

- IMT-2020 Requirements: Rec. M.2083
- ITU-R M.2410: minimum technical performance requirements of IMT-2020 radio interface technologies.
- ITU-R M.2411: requirements for providing service, spectrum, and technical performance.
- ITU-R M.2412: guidelines for the technical, spectrum, and service) criteria in the IMT 2020 evaluation.

3GPP

- 5G use cases: TR 22.891
- Service requirements for the 5G system: 3GPP TS 22.261

Thank You

www.gsma.com/northamerica
jpenttinen@gsma.com

July 7, 2021

Qualcomm

Emerging terrestrial technology for connectivity

Elizabeth Migwalla,
Vice President, International Government Affairs
Qualcomm International, Inc.

Qualcomm

The R&D Engine

$60+ Billion

in cumulative R&D*

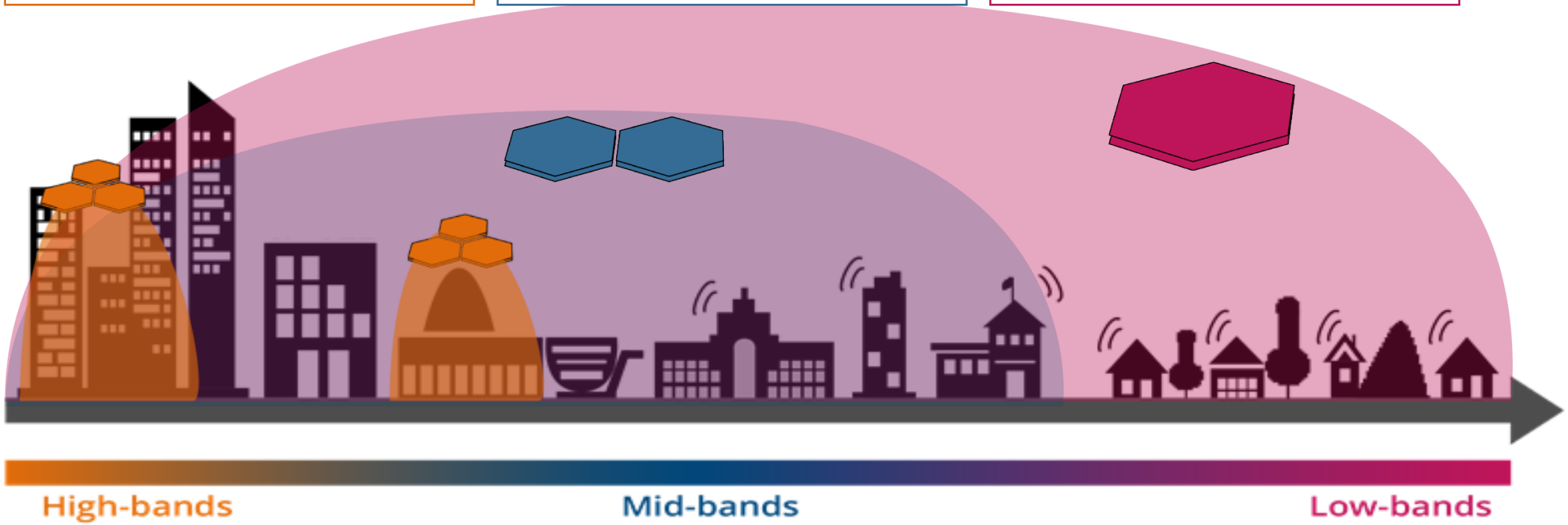
130,000+
Granted patents / pending applications

345+
Cellular licensees

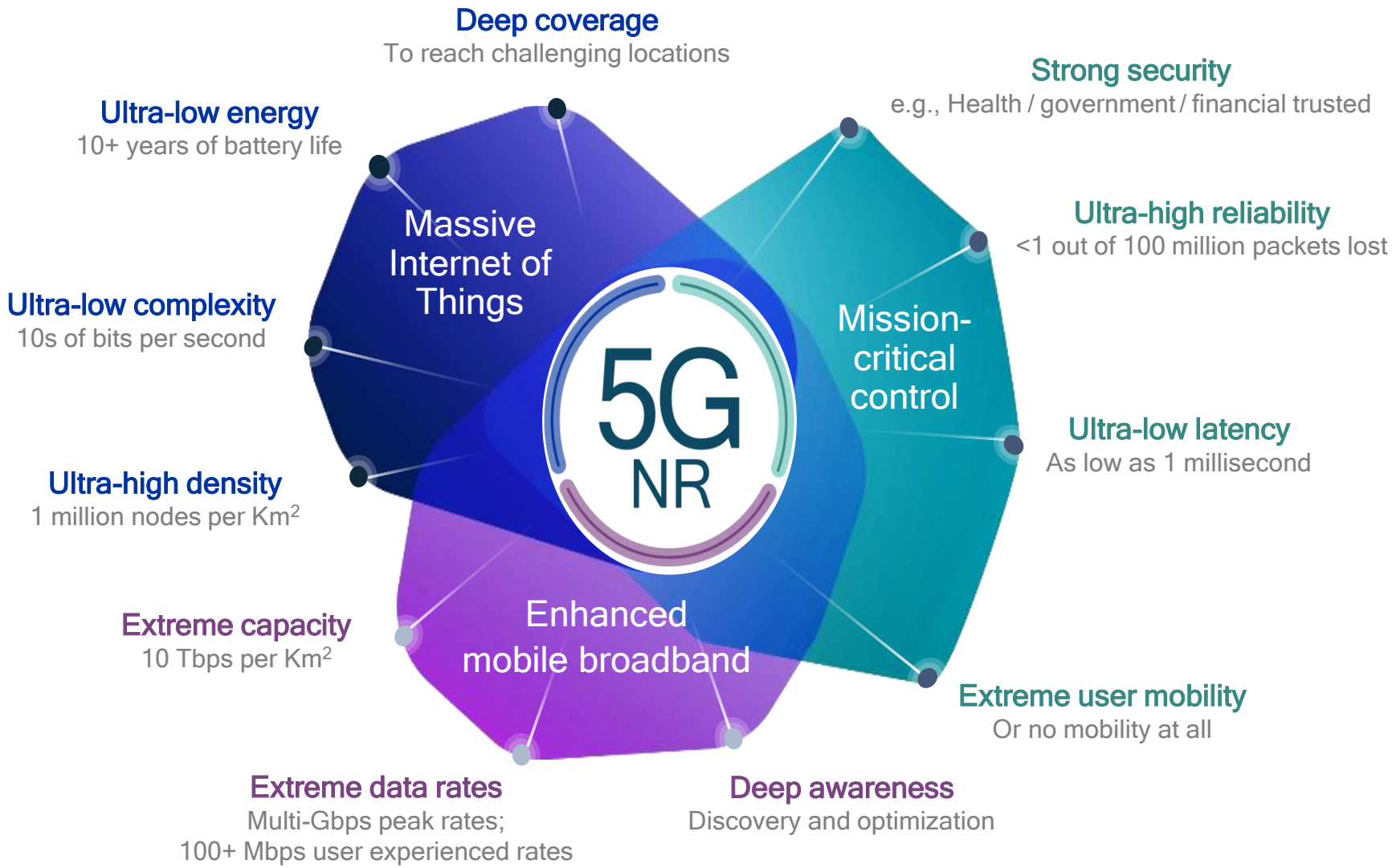
* Cumulative expenditures as of Q4 FY20 since 1985

5G Spectrum for Coverage, Capacity and Ultra Experience

e.g. 24.25 – 29.5, 37.0-43.5 GHz etc	e.g. 2.3, 2.6, 3.3-4.2, 4.4-5 GHz etc	e.g. 600, 700, 800 MHz etc
High & Mid-bands Ultra Experience Layer	Mid-bands Capacity-Coverage Layer	Mid & Low-bands Basic Coverage Layer



5G Motivation and Drivers



Smart Connected Spaces

Smart Spaces are the building blocks for Smart Communities

Smart Verticals

Smart Spaces	Smart Transportation	Smart Campuses	Smart Infrastructure	Smart Manufacturing	Smart Safety and Security	Smart Agriculture
Smart Shops	Smart Stations	Smart Schools	Smart Roads	Smart Factory	Smart Cameras	Smart Livestock
Smart Stations	Smart Operators	Smart Universities	Smart Hospitals	Smart Logistics	Smart Surveillance	Smart Farming
Smart Malls	Smart Traffic	Smart Stadiums	Smart Borders	Smart Warehousing	Smart Access	Smart Horticulture
Smart Display	Smart Crowd Management	Smart Malls	Smart Airports	Asset Management		
Smart Experiences			Smart Ports			
Smart Buildings			Smart Utilities (Power / Water)			
			Smart Grid			

Smart Spaces

5G Use Cases

Enable business opportunities in rural areas

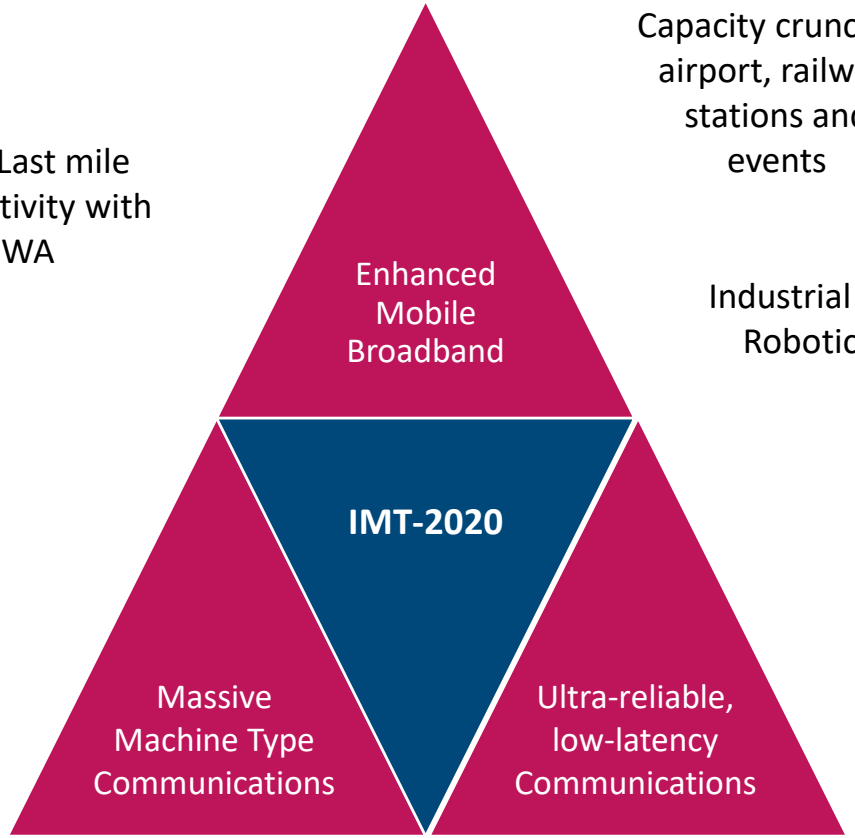
Virtual classes in urban and rural areas

Remote healthcare for urban and rural Areas

Rural Last mile Connectivity with FWA

Smart Agriculture

Child safety - IoT



Capacity crunch at airport, railway, stations and events

Industrial IoT Robotics

Enabling Policies and Regulations

- Policies that support of 5G / IMT-2020 adoption
  - Modernizing existing regulations
  - Infrastructure
  - Site acquisition
  - Public sector as “anchor tenant”
  - License obligations
  - etc.
- Spectrum Policies
  - Technology neutrality
  - Harmonized prioritized bands
  - Channel sizes
  - Innovative spectrum pricing

Qualcomm

Thank you

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