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LOS ANGELES SEPT 12-14 2018

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5G: Beyond Mobile Broadband Seminar

Wednesday 12 September | MWC Americas 2018

#MWCA18

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Dr. Niko Bayer

Senior Project Manager

Deutsche Telekom

#MWCA18

Network slicing and its application in campus networks for Industry 4.0

Dr. Nico Bayer, Deutsche Telekom AG

Future Networks Seminar @ MWCA
5G Beyond Mobile Broadband
12.09.2018

LIFE IS FOR SHARING.

Network slicing to ADDRESS VERTICALS' BUSINESS NEEDS.

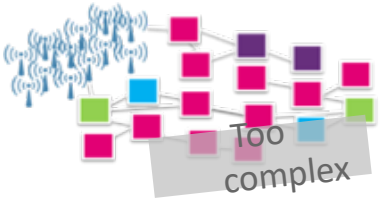
Situation: Diversity of use cases call for flexibility

5G Networks need to support flexible levels of:

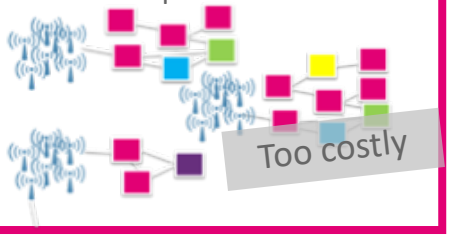
Mobility, Latency, Bandwidth, Coverage, Functionality , …

Challenge: Limitation of classic solutions

„All in One" Network

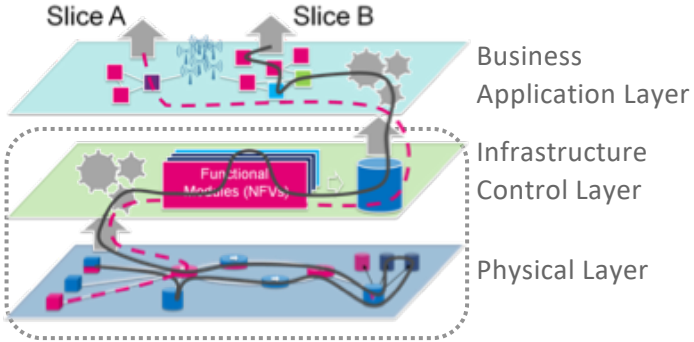


Multiple Networks



Solution: Multiple logical network build on one physical infrastructure

Strong capabilities for tailored solutions, guaranteed resources and fast provisioning



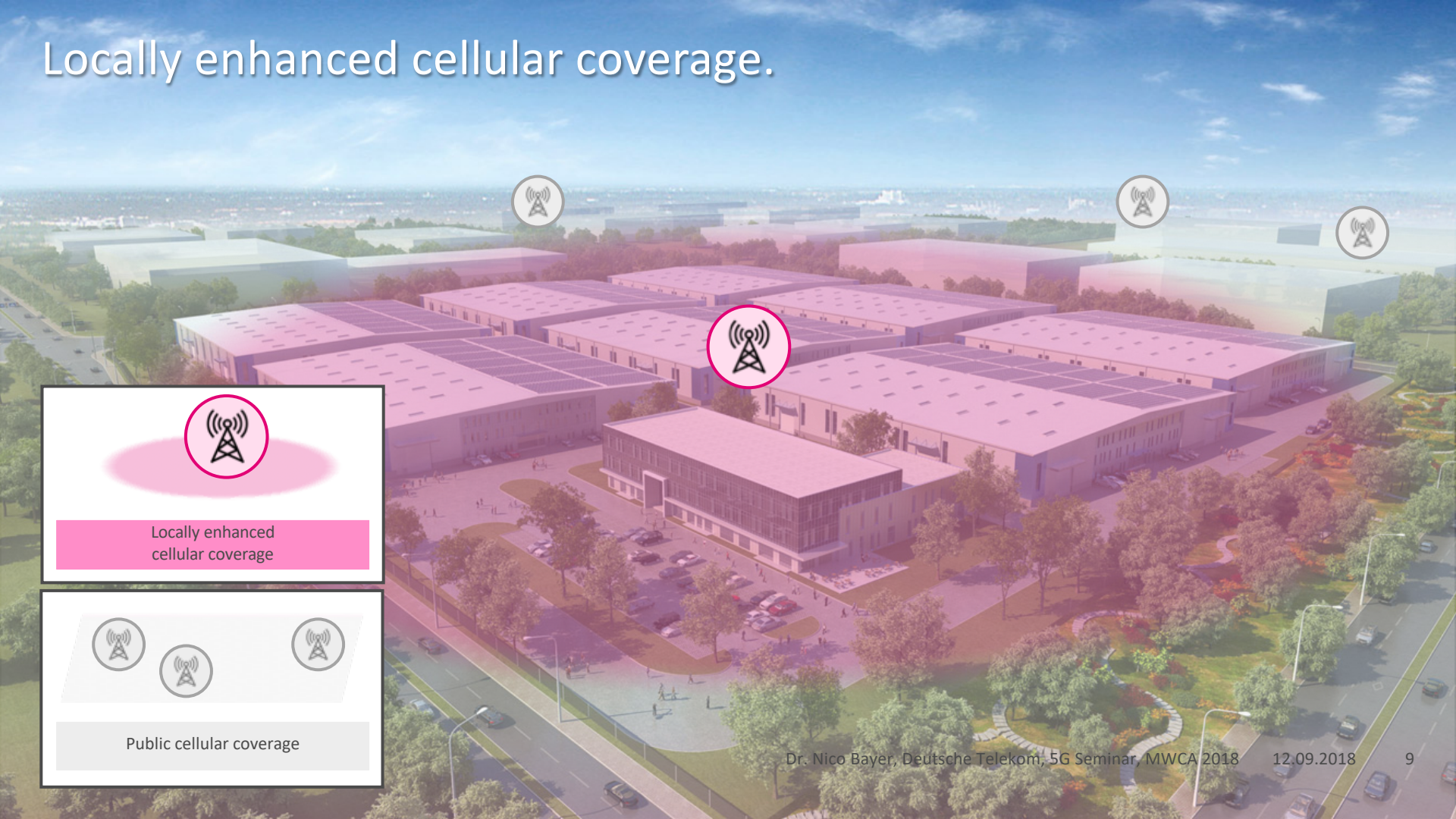
Use case: Campus networks for industry 4.0.

Example for a campus Area.

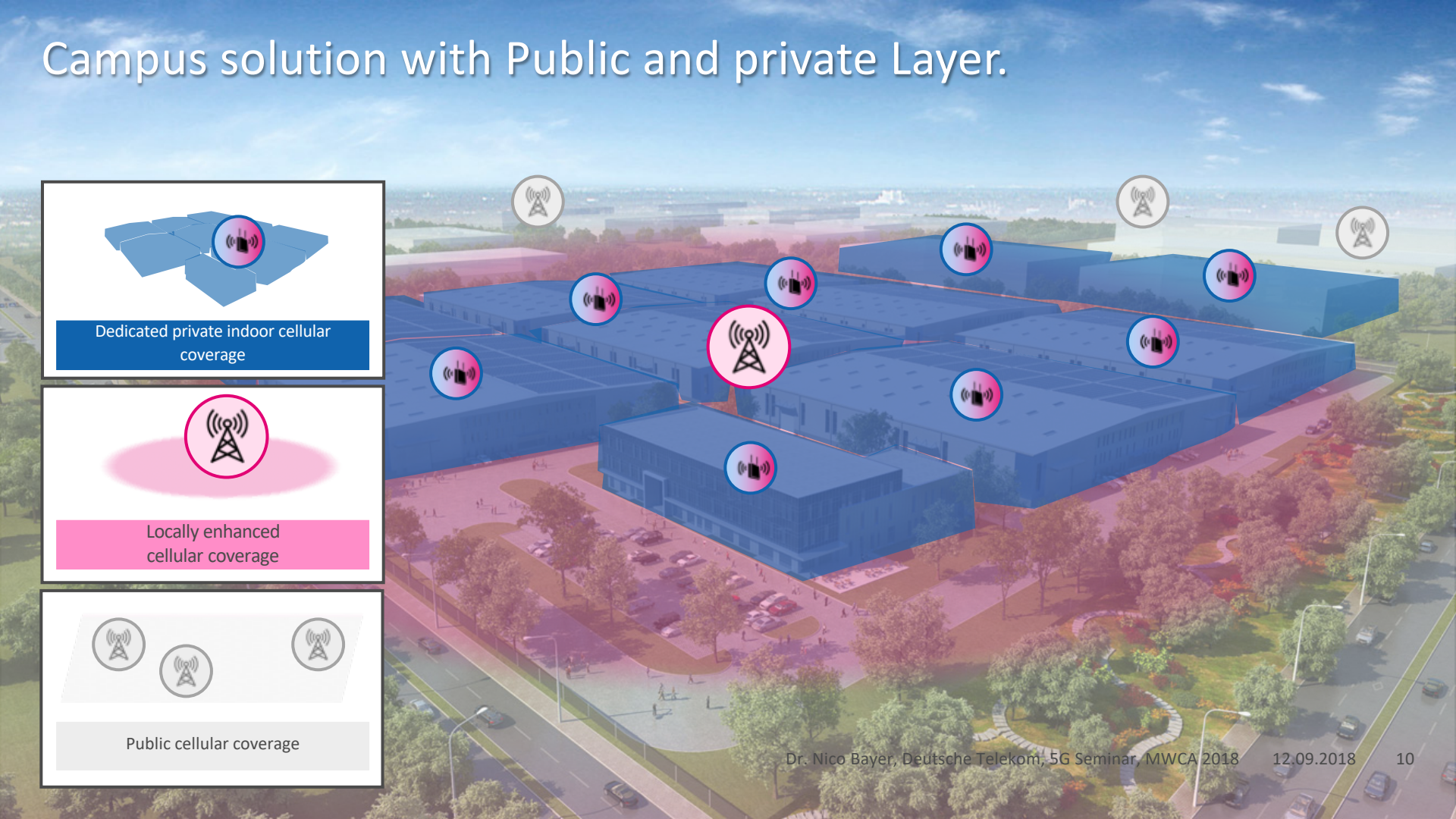
Public Network Coverage.

Public cellular coverage

Locally enhanced cellular coverage.



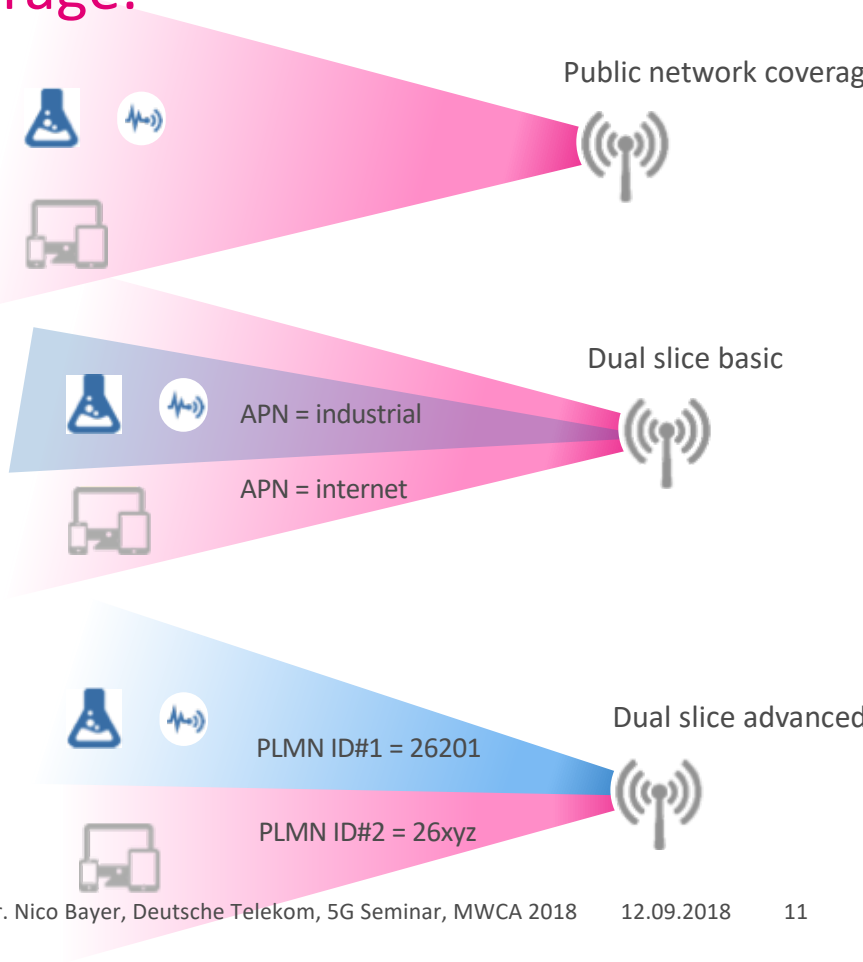
Campus solution with Public and private Layer.



Provide both public and private coverage.

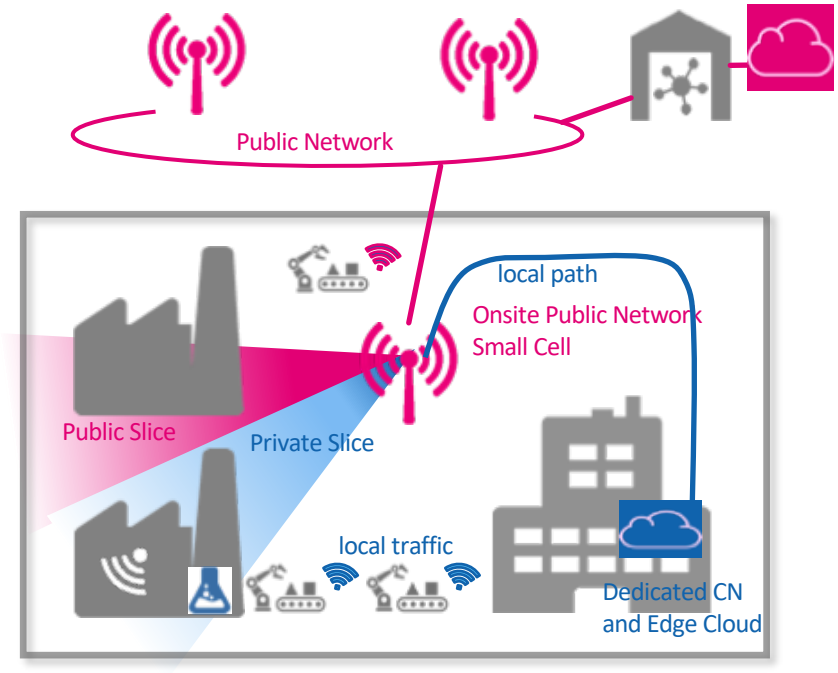
Dual slice approach.

- 1st step: Provide public coverage on Campus (as today, business model network-as-a-service)
- 2nd step: Use RAN to fulfil the demands for both public as private network
- Independent from RAN technology used (LTE, 5G NR), this can be seen as an early implementation of "5G network slicing"
- Basic solution based on APN/IP VPN (available today, business model network-as-a-service)
- Advanced solution based on separate PLMN ID



Dual slice Advanced solution.

“dUAL SLICE” to provide public and private network.



- Reuse of public infrastructure / cells to construct the 2nd layer – private slice
- Combined radio layer with guaranteed resources and dedicated PLMN ID
- Managed 2nd Core Network, to keep traffic local and achieve high customer autonomy
- Network-as-a-Service (NaaS) offering matching the customer demand and understanding of a private network
- Mid term: Customer self-admin, dashboard, ..

5g enables many use cases and drives value in the manufacturing industry.

Shop / Factory Floor

Smart Production –
Think big, Make it personal, Cut the wires

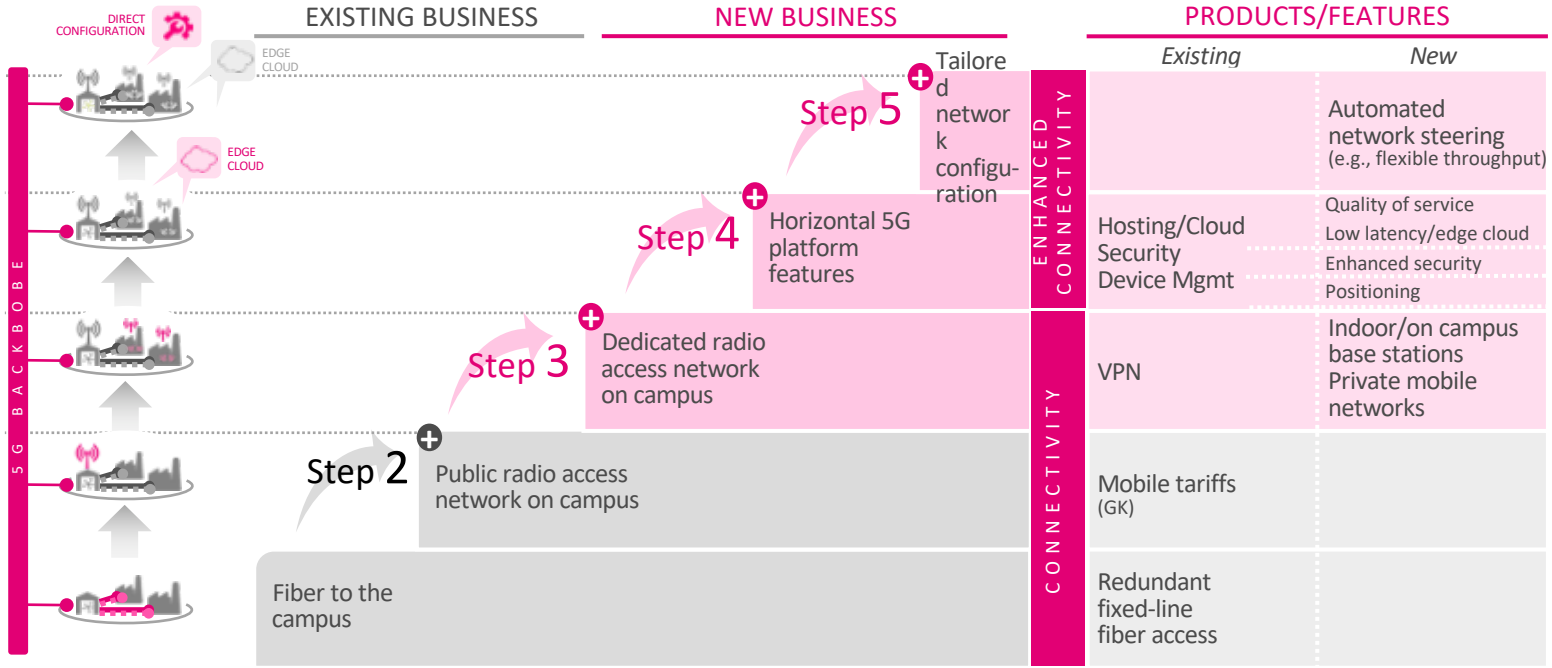
Remote Monitoring & Control –
Take & share control, Repair before the crash

Smart Logistics & Supply Management –
Keep it moving, Track everything

Office Floor

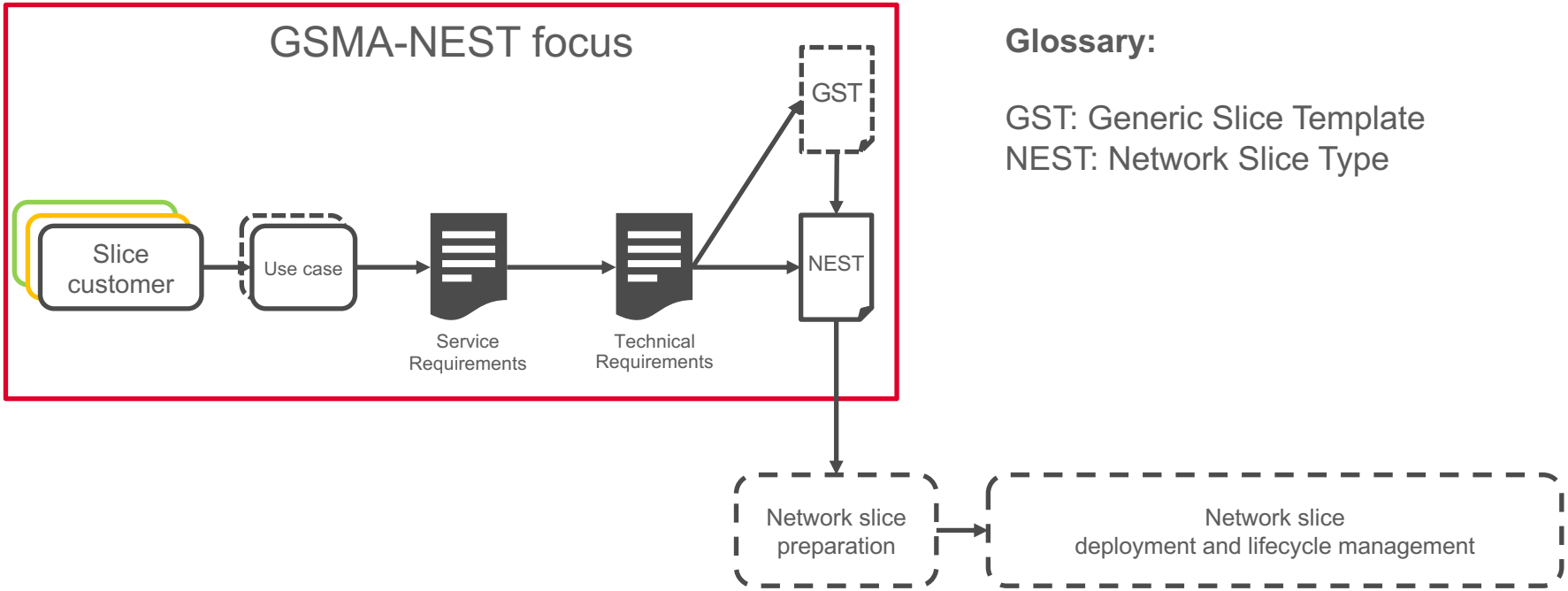
AR/VR –
Make complex tasks easy

Campus networks consist of multiple layers and Will need to be implemented in steps.



GSMA Network Slicing Taskforce (GSMA-NEST).

Definition of a common language for network slicing.

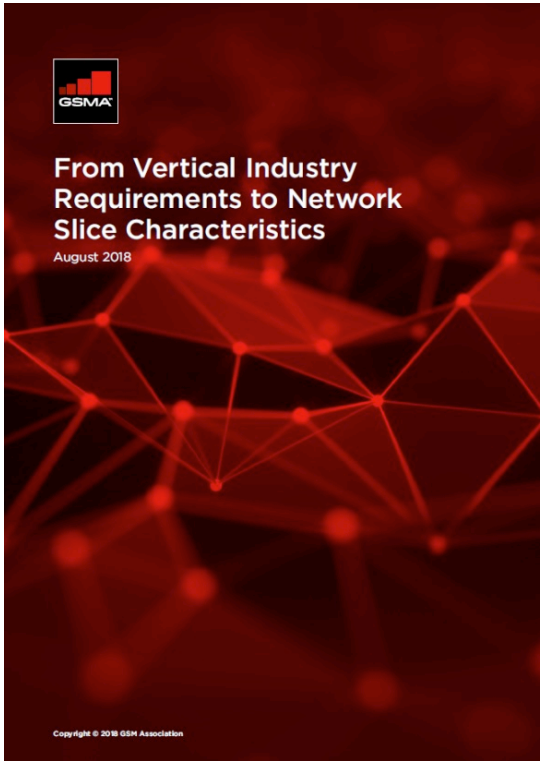


Glossary:

GST: Generic Slice Template
NEST: Network Slice Type

Recen deliverable of GMSA-NEST.

Get your personal copy after the seminar.



conclusions.

- 5G is a major paradigm shift to satisfy future customer demand
- 5G networks will be built in SW and will provide a multitude of networks addressing verticals' business needs
- Campus networks is a promising use case and a good example of a step-wise introduction of network slicing
- For global success and high customer satisfaction a common language and a common way of characterizing network slices is required

Thank you!

Contact

Dr. Nico Bayer
nico.bayer@telekom.de

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Humberto La Roche

Principle Engineer

Cisco

#MWCA18

The Future of Edge Computing

Future Networks Seminar: 5G Beyond Mobile Broadband

Humberto J. La Roche

Principal Engineer – CTO Organization, Service Provider Networks

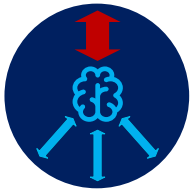
September 12, 2018

Multi-Access Edge Computing (MEC)

MEC or Edge Computing, is the architectural principle of moving services to locations where the services can (1) have lower latency to the device for QoE or app benefit, (2) implement offload for greater efficiency, or (3) perform computations that augment the capabilities of devices and reduce cost of transport

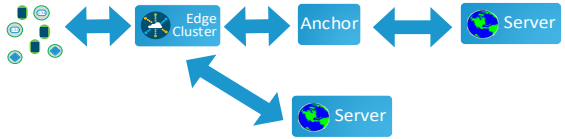
Latency Reduction

Edge Offload



Data Reduction

Reducing latency between services and consumers will create a better QoE & allow for new B2B2X services



Edge offload will enable less expensive and lower latency path from the edge hosts towards the services

Edge nodes can perform data analytics (ML inference) to perform bandwidth reduction and/or compute offload compensating for less capable devices

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Agenda

1. Future Infrastructure
2. Services and Use Cases
3. Summary

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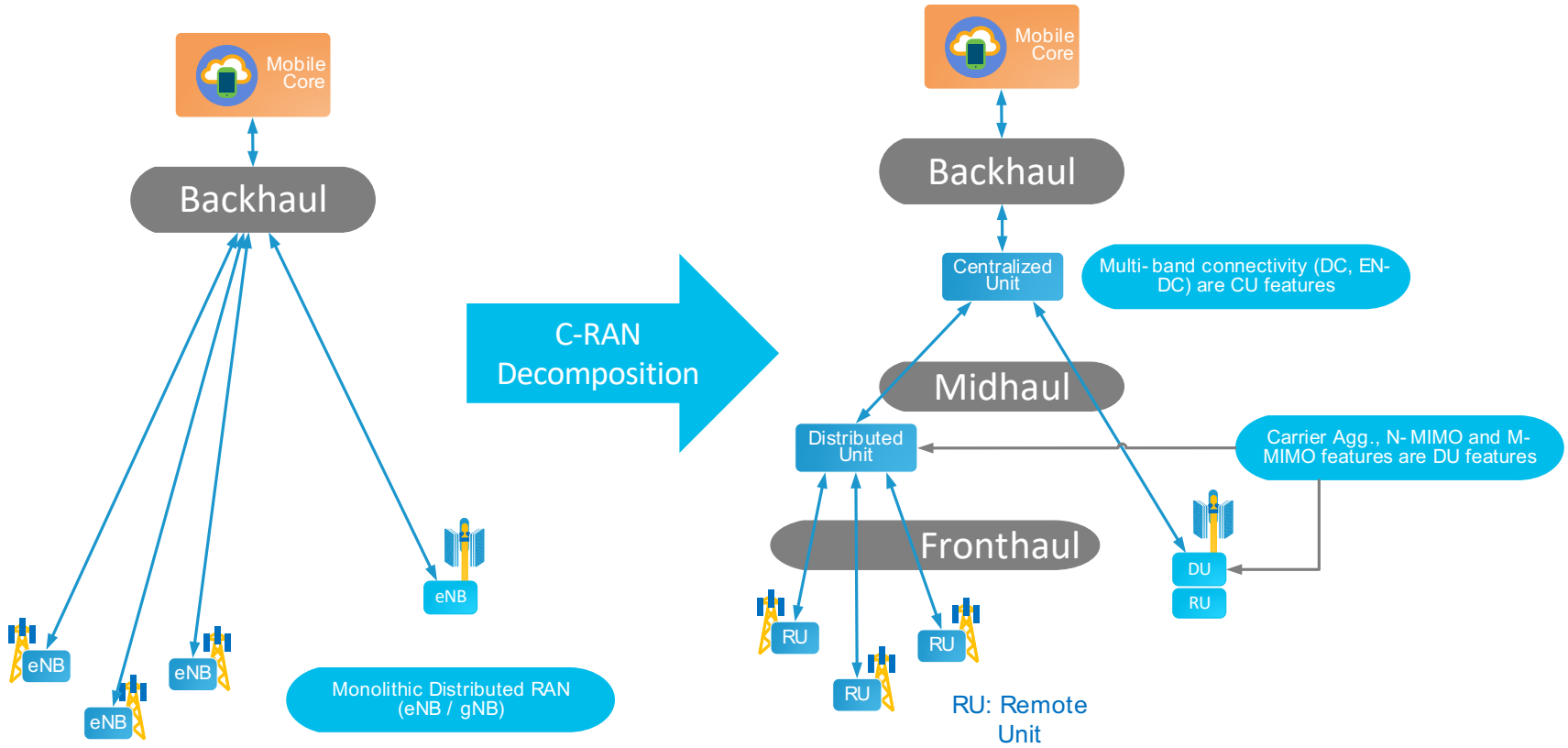
Future Infrastructure

The Introduction of Cloud RAN



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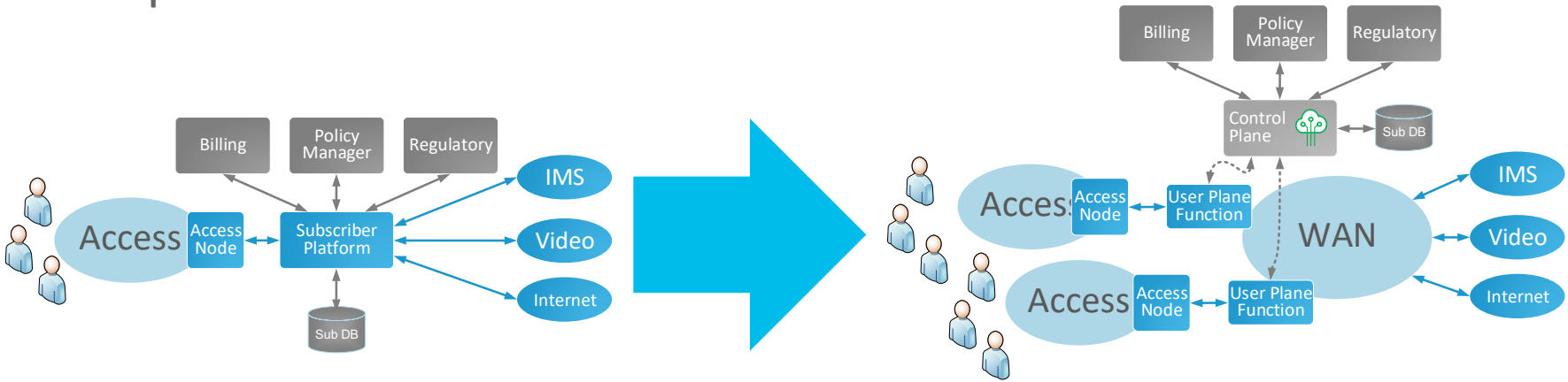
Decomposition as a Trend



Conventional Subscriber Management

Disaggregated Subscriber Management

Subscriber Management Decomposition

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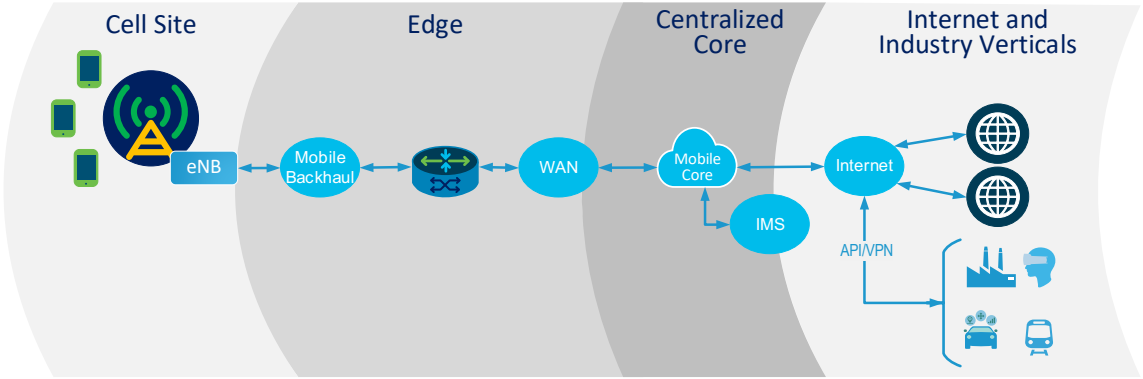
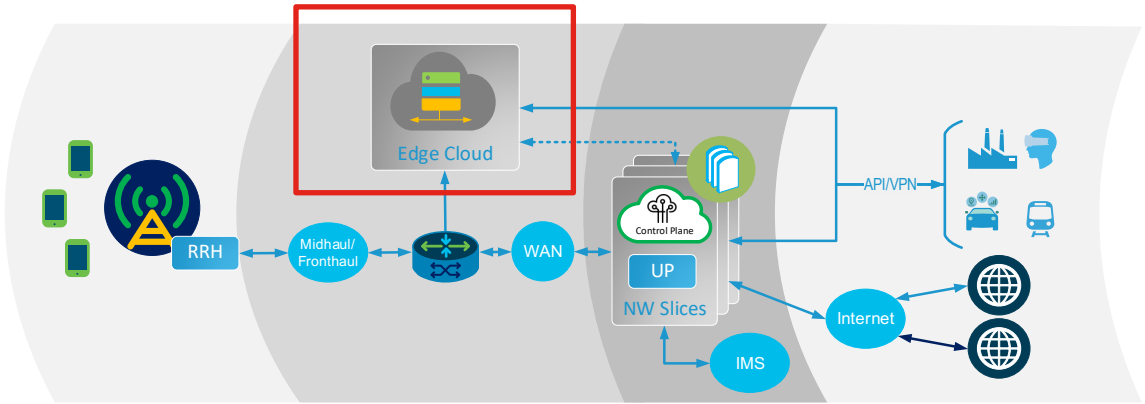
Convergence to the Edge



LTE Mobile Network

5G Mobile Network



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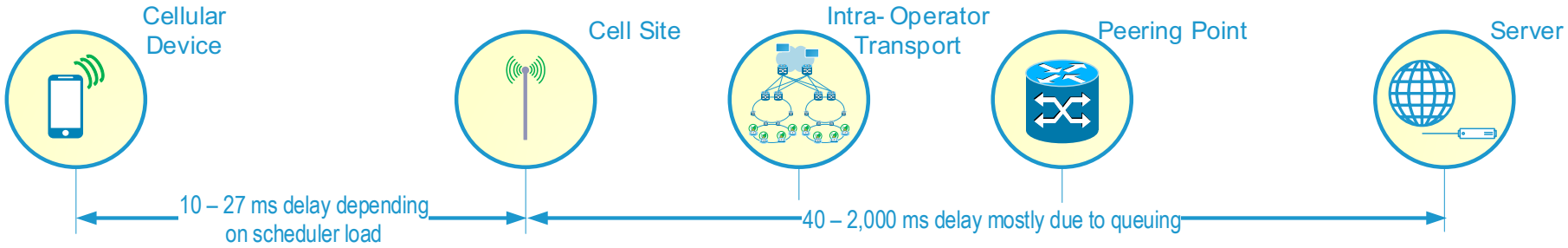
Latency Management in Mobile Networks



Major Contributions to Delay

RAN Scheduler	The time-slotted nature of the signal processing stack implies servicing UL/DL users will occur in multiples of the TTI and will be larger depending on the number of users served. About $25\ ms$ in LTE but lower with NR.
Switching	Incurred through processing a packet/frame within the network element: $\sim \mu s$
Serialization	Delay incurred in constructing a packet/frame: depends on link bandwidth.
Propagation	Speed of light related. About $5 - 7\ \mu s/km$.
Queuing	Consequence of oversubscription. Spikes in traffic are queued in egress interfaces pending bandwidth availability. Queuing delay is controllable

Controlling Queuing Delay via IP QOS is Equivalent to Controlling Latency

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Take-aways

- Decomposition is driving the emergence of clouds
  - In RAN ➔ Cloud-RAN
  - In Mobile Core ➔ CUPS ➔ 5GC
  - Even in BNG ➔ vBNG
- Pure and simple:

Proximity ≠ Low Latency

- A good IP QoS design can support low latency

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Future Services

Use Case Taxonomy for the Edge

Infrastructure Use Cases

These provide the operator with the resources by means of which they can create edge services

Operator Branded Services

These are consumer-oriented services provided with the operator brand name

Services to Businesses

These are services offered to enterprises (e.g. public cloud providers, IOT

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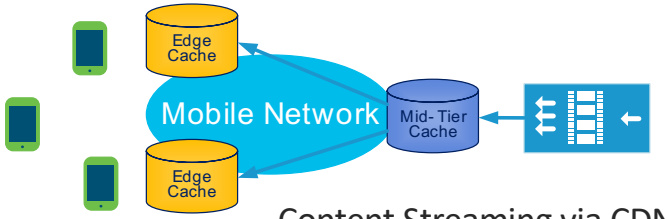
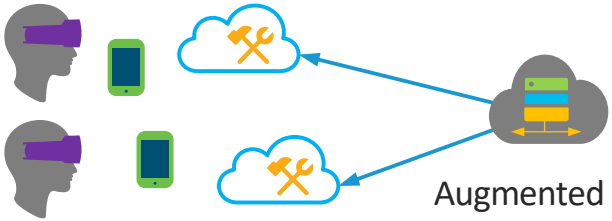
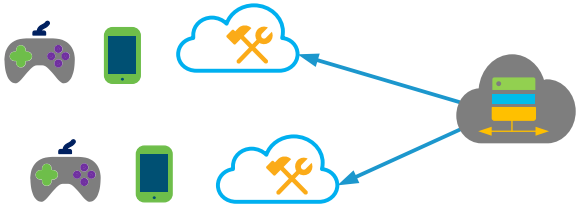
Use cases



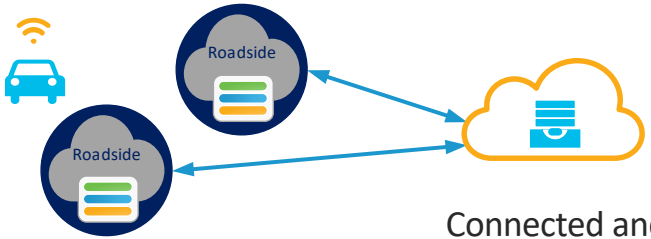
Content Streaming via CDN



Augmented Reality



Gaming and Virtual Reality



Connected and
Autonomous Vehicle

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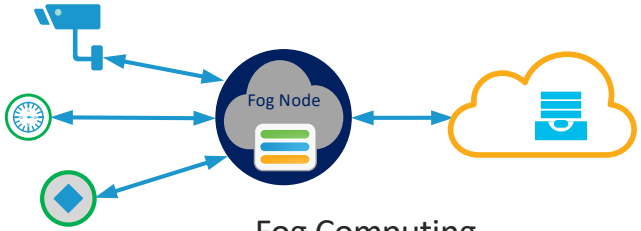
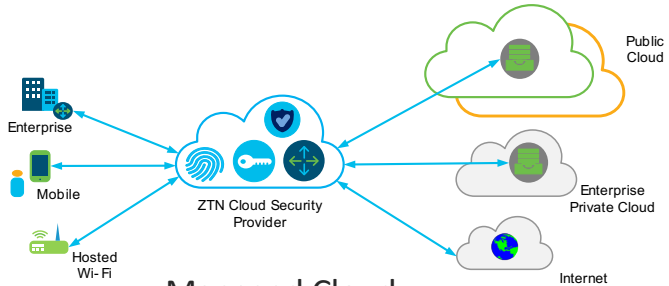
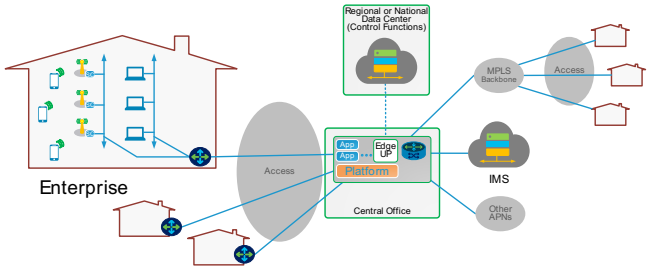
Use cases



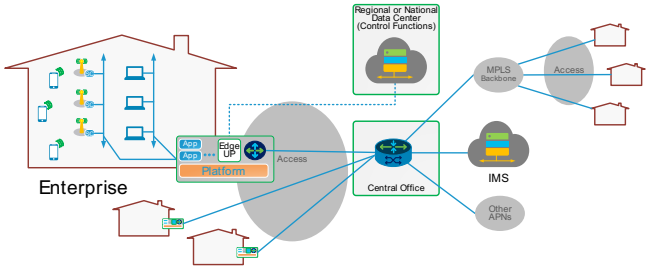
Fog Computing



Managed Cloud Security (e.g. ZTN)



Network-Hosted Computing



Enterprise-Hosted Computing

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Examples of Private Radio Use Cases

Use Case		Description	RTT / PLR
Public Safety		Highly reliable systems deploy to support public safety (police, first responders)	$10 - 100\ ms$ $PLR \sim 10^{-3} - 10^{-5}$
Factory Automation		Highly reliable real-time control of machines and systems in production lines	$0.25 - 10\ ms$ $PLR \sim 10^{-9}$
Intelligent Transportation		Autonomous driving and optimization of road traffic (platooning and overtaking)	$0 - 100\ ms$ $PLR \sim 10^{-3} - 10^{-5}$
Robotics and telepresence		Remote control with synchronous visual-haptic feedback	$10 - 100\ ms$
Virtual Reality/ Augmented Reality/gaming		Other applications for VR/AR and gaming exist beyond prior discussion. See reference	$1\ ms - 40\ ms$
Health care		Tele-diagnosis, tele-surgery	$1 - 10\ ms$
Smart Grid		Switching on/off electrical sources to compensate for demand fluctuations	$100\ ms$

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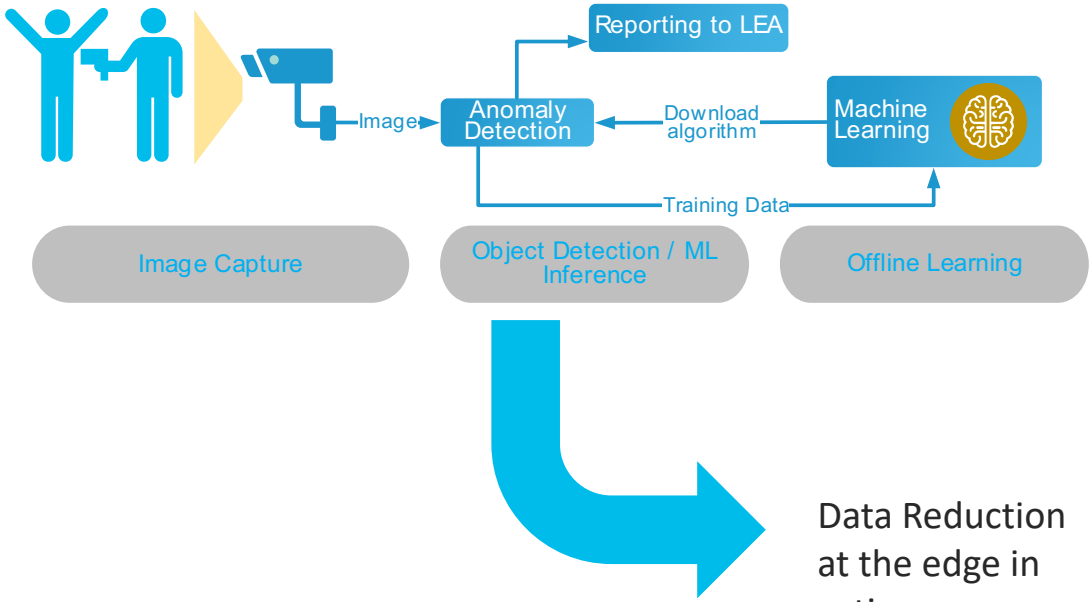
Summary

Sometimes the MEC Node is not what you Suspected!



Data Reduction at the edge in action

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Summary

- Low latency and data reduction use cases, along with offload, contribute to the reasons why edge computing is interesting
- With the advent of 5G, an infrastructure edge is also emerging: we think it can made synergistic with services revenue
  - The infrastructure uses decomposed RAN and core and IP QoS to flexibly deploy cloud compute
  - The location of the edge is determined also by the IP network supporting services: IP QoS makes a difference!
- We believe there are many promising use cases… These require a business model

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Drew Schneider

Assistant Director of Security

Port of Long Beach

#MWCA18

September 12, 2018
Future Networks Seminar
Los Angeles, CA

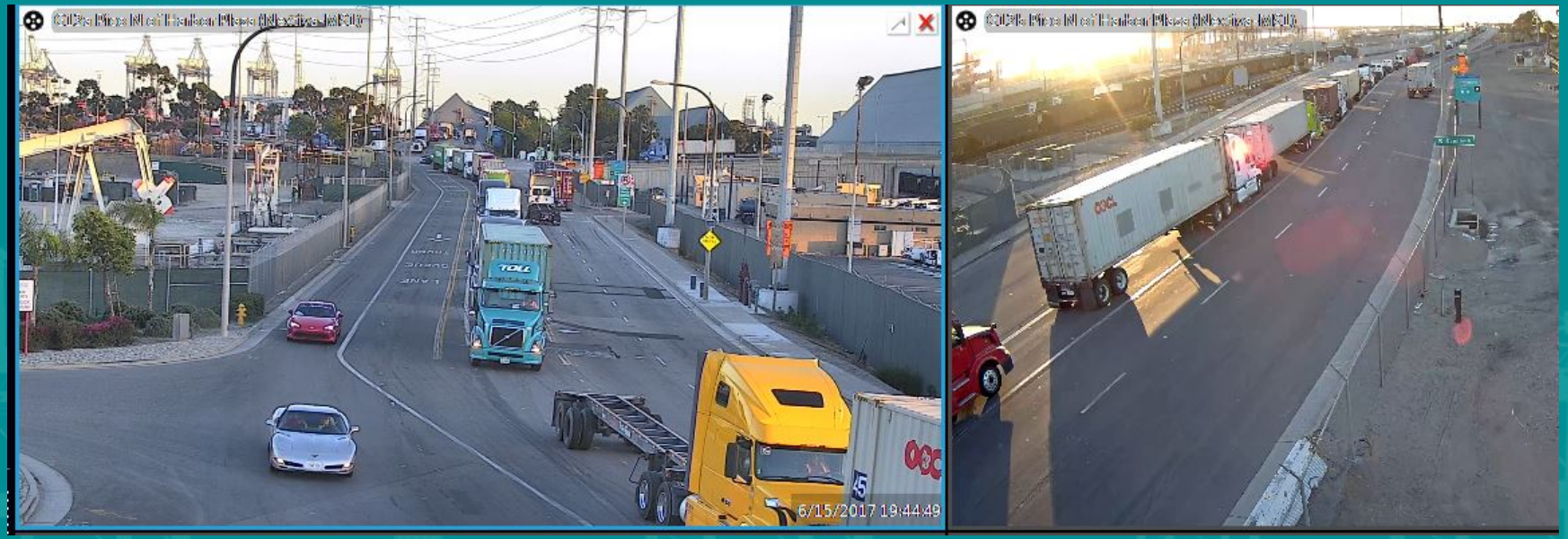
Port of **LONG BEACH**

LEVERAGING COMMUNICATIONS TECHNOLOGY TO PROVIDE MARITIME DOMAIN AWARENESS

Drew Schneider C.P.E.
Assistant Director of Security

2nd Busiest Port in the U.S.

To Protect the Port and Facilitate the Flow of Commerce




HARBOR PATROL


LONG BEACH POLICE

ABOVE WATER

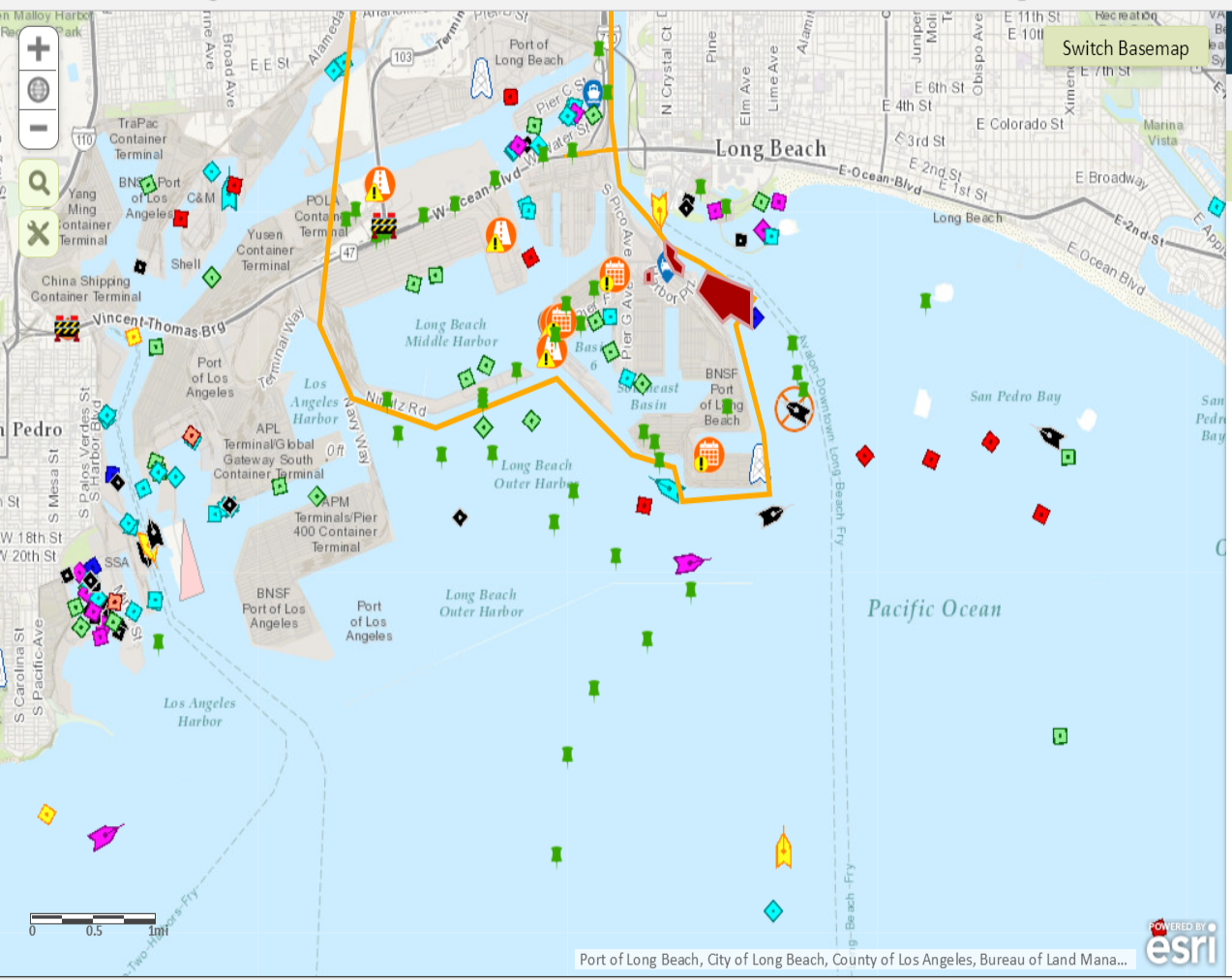
Camera Systems (4)
CAD
ALPR (in process)
Access / Badging / Alarm Systems
Web Portal (Secured)
PA /AM Radio / Audio Visual
PIMS Information Signs
Barriers & Special Gates
Radar
Virtual Port Con-ops system

WATER LEVEL

Radar System, Vessel Acquisition & Vessel Tracking Systems
Blue Force Tracking
Small Vessel ID System (in process)
Cameras on Vessels
Public Safety Vessels

UNDER WATER

Sonar Detection System
ROVs & Underwater filming
Dive Teams



VIRTUALPORT

Viewing LIVE data... My event types only

Home VESSELS

All Vessels /

Details: Refresh

CARNIVAL IMAGINATION

Vessel Information (source: marine exchange)

309933000 MMSI	
CARNIVAL IMAGINATION NAME	**9053878** IMO
C6FN2 CALL SIGN	**262.00000000** LENGTH IN METERS
BHS COUNTRY OF ORIGIN	**--** SOURCE
MPR VESSEL TYPE	**Carnival Cruise** OPERATOR
	Carnival Cruise AGENT

Follow Vessel | Vessel Photo(s) | More information

Historical Tracks | Social Media Search | Protect

20170618_083141 ....jpg
20170618_083141.jpg
15171096_101020....jpg
Imperial-War-Mus....jpg
Show all

The Challenge


CARACAS


LBCT
LBCT


FIRE
15
15
FIRE
20
20

Port of
LONG BEACH

The Green Port

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Dong-Hi Sim

Head of Global Standards

SK Telekom

#MWCA18

THIS IS 5G | SK telecom

Invisible Technology to interact with Augmented Human

Dong-Hi SIM (a.k.a Donghee Shim)
Head of Global Standards
SK Telecom

Next Smartphone?





Remember?

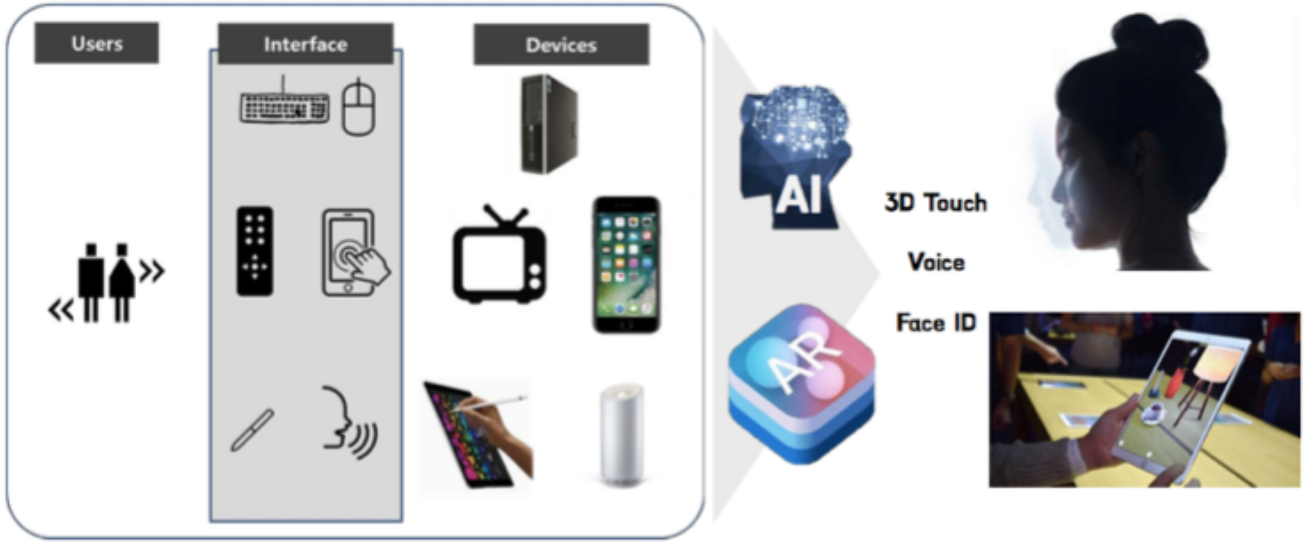
The early stage of smartphone

5G or even Beyond?

Computation getting cheaper
Sensor Fusion
Big Data

Technology becomes
Embedded & Invisible

Signals for Integrated UI



What is Human in next 10 years?

①

Boundaryless

Real↔Digital
Producer↔Consumer


②
Humans getting more Augmented
Anticipatory
Amazon Anticipatory Shipping
Amazon Wants to Ship Your Package Before You Buy It
Multisensory
Disney, REVEL
Disney, AIREAL
SOLO+JOAN TRENCH COAT
$279
How to interact with Objects and Spaces?

③

Everything becomes Media

Sharable Presence

Passionate Real Story

Challenge, Boldness, Success, Fame, Victory

Unfinished Story as a Main Character

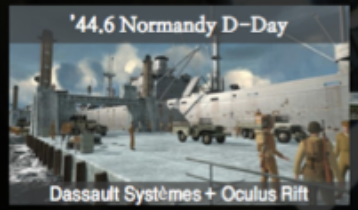
Immersive media on the spot

④

Consuming Mixed Reality itself

Transcendent Blended Reality
New Time & Space

- Vivid Historical Sites



- Carrying the Space

Futuristic Voyage?

Meaningful Interaction
with Real & Digital

- Digital & Real Space Bondage

- Mixing Digital & Real Objects

⑤

Personal Experiences stored & replayed

- What do you like
- are Enthusiastic about

Sensors & Wearables will store vivid experiences even can be replayed

- Who are you talking to
- What kind of talk

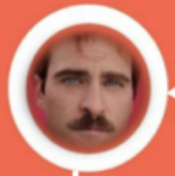
- Bedtime habit
- What kind of dream

Private life

- Should be Concerned

Human-Machine Partnership

Machine knows too well Humans? →



← Humans too dependent on Machines?

From de-stress

- Automation
- Helping decision making
- Offloading labors
- Distributed Machines seamlessly fulfill our wants & needs

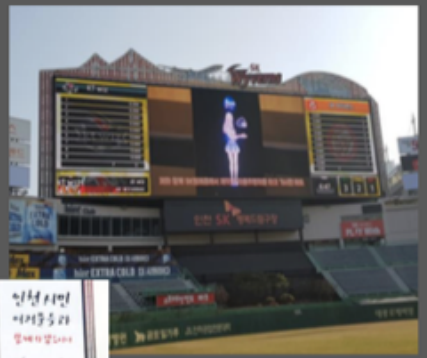
Interfering & Controlling

- Beyond helping becomes interfering
- Big brothers manipulating our lives?


SK Telecom's efforts

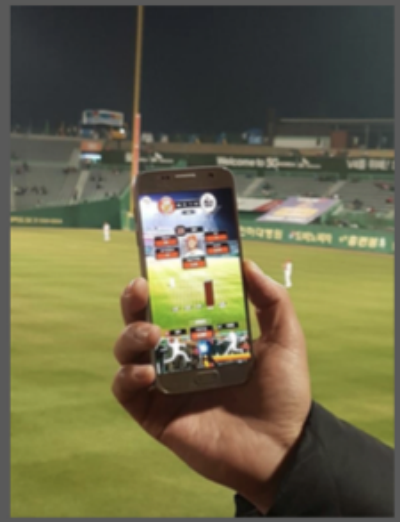
5G Stadium Showcase ('18.3)

5G infra and Autonomous Driving Car provided immersive experiences to 25K audiences in Inchon Baseball Park



Hologram in Big-board

5G Autonomous Driving Car

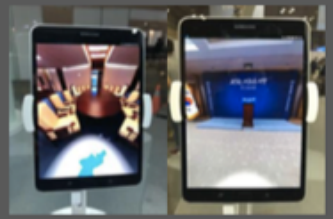


AR Game

2018 Inter-Korean Summit ('18.4)

5G infra and media technologies provided immersive experiences to the Press in KINTEX Press Center

SKT Booth in Press Center



360 Live Streaming

Smart Wall

5GX Game Festival ('18.8)

5G technologies was applied to the Live Game

5G Battle Zone

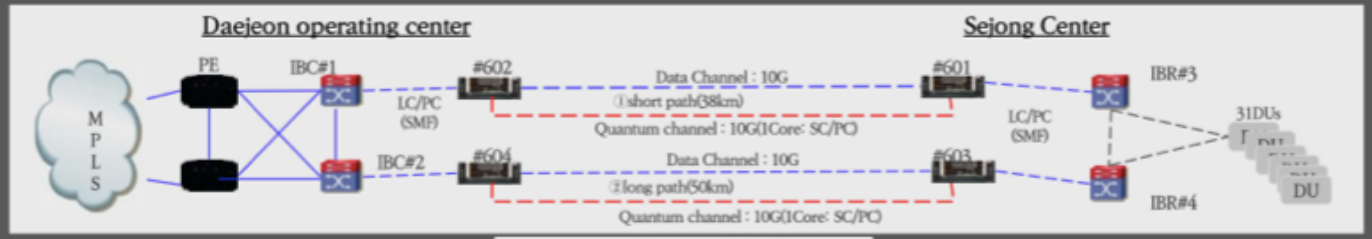
5G Game Zone

5G BS, Device

360 VR

QKD Deployment for advanced Security

SKT deployed its Quantum Key Distribution system for LTE network
with 350,000+ subscribers in Sejong City in South Korea



QKD system in Daejeon

Sejong coverage

QKD system in Sejong

SKT invested in 'ID Quantique', the global leader in Quantum-safe crypto solutions

Technology should become

Invisible

to interact with Augmented Human


THIS IS 5G
SK telecom

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Vanessa Kuroda

Wireless and Comms Architect, Altiscope

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#MWCA18

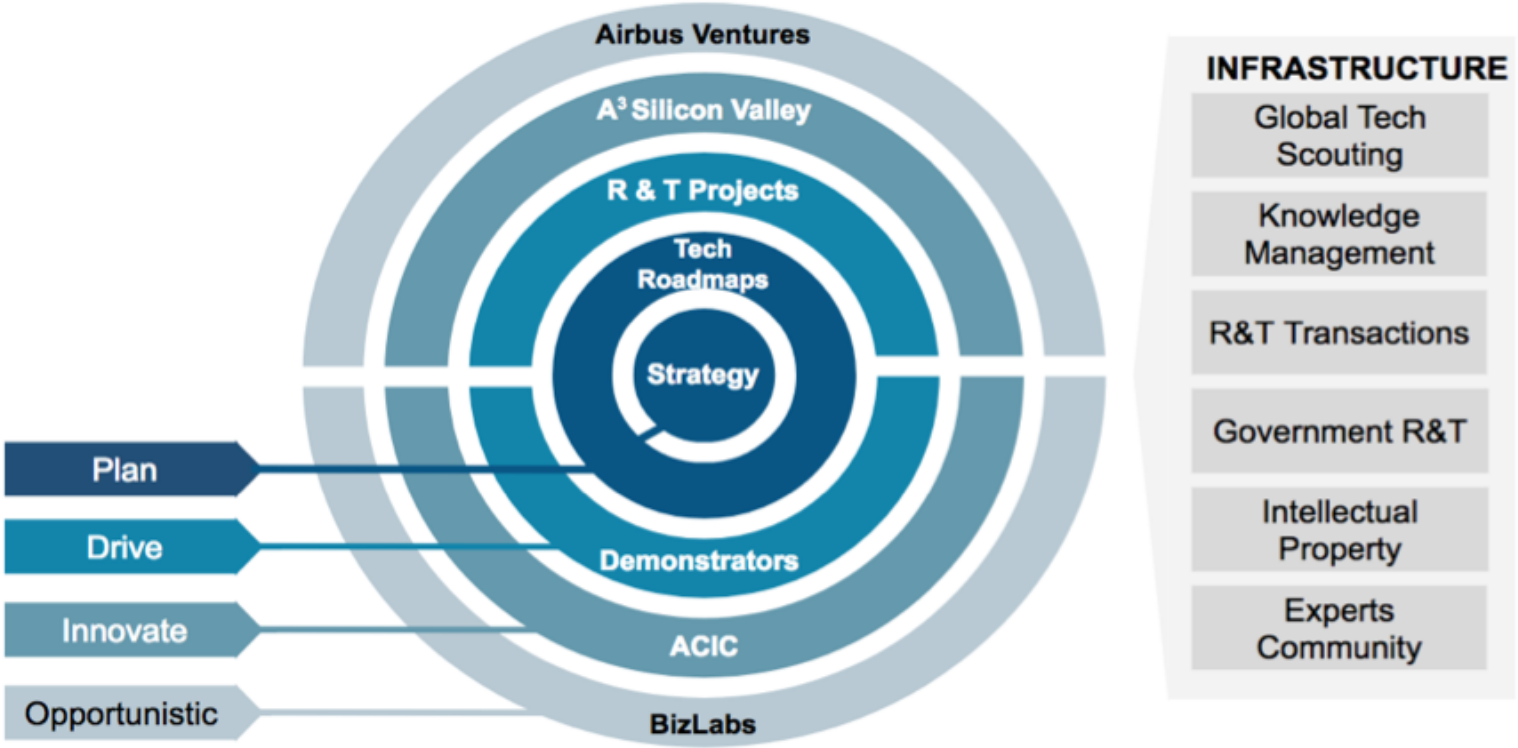
Air taxis, drones, and planes: Exploration of 5G for UTM

Mobile World Congress Americas: Beyond Mobile Broadband, Sep 12, 2018

Vanessa Kuroda

Wireless & Comms Architect, Altiscope, A³ by Airbus vanessa@altiscope.io

Airbus Research, Technology, and Innovation Ecosystem



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Some of Our Past and Present Projects

Voom

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TRANSPOSE

AHANA

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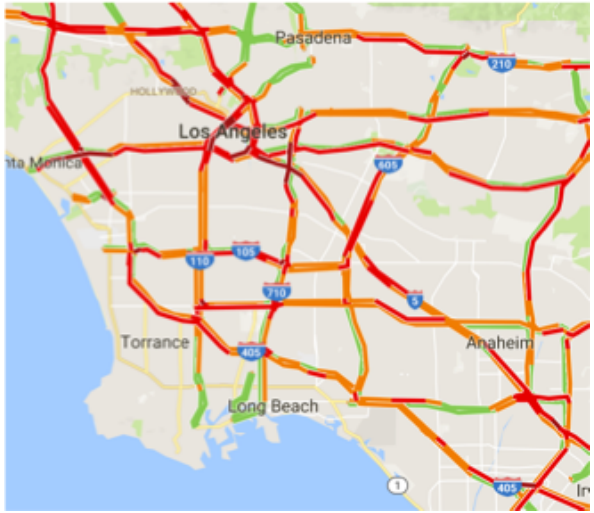
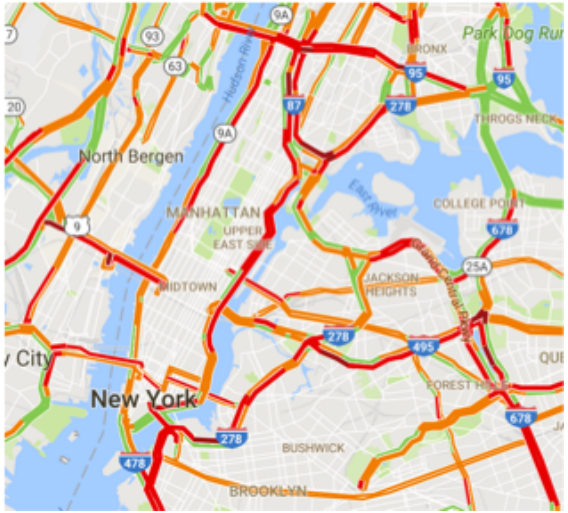
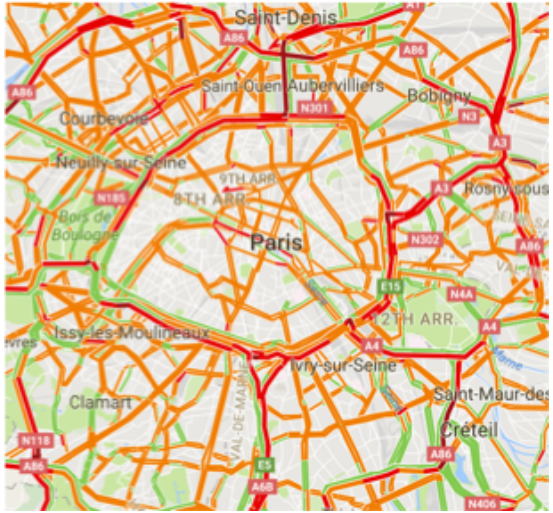
Tackling Urban Traffic Congestion

Typical Rush Hour Traffic







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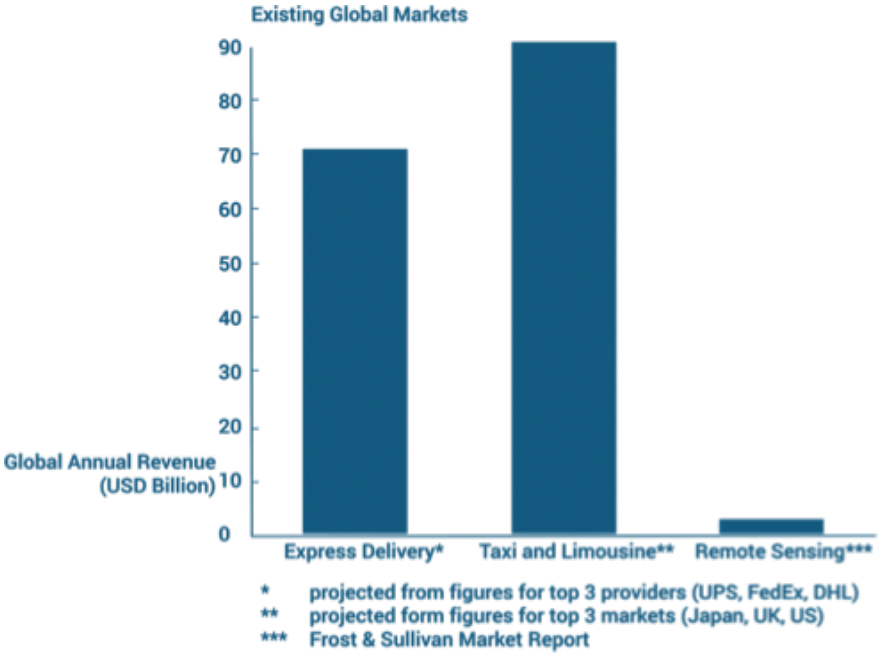
Market Opportunity: Urban Air Mobility (UAM)

$150B Current Market

Express Delivery and Taxi / Limousine



Reduction in cost / flight hour allows for market capture

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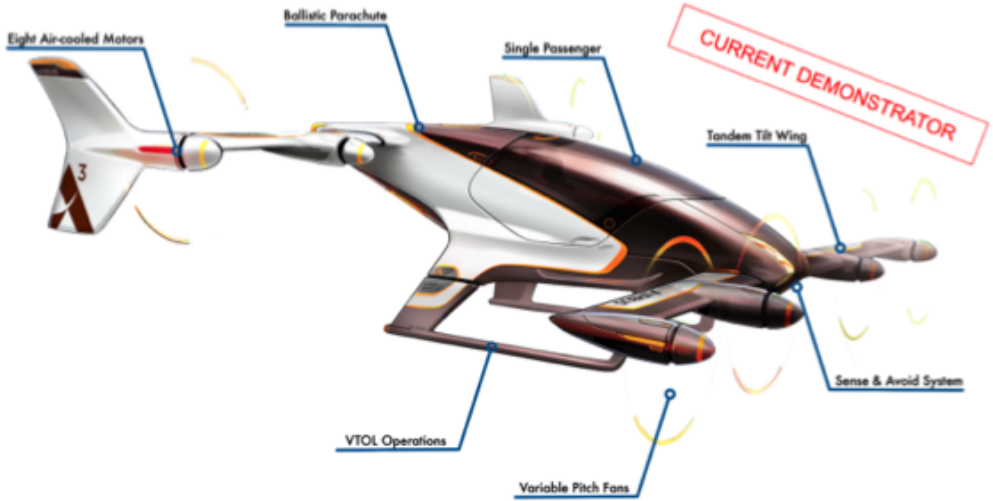
A³'s Vahana - Alpha



Enablers: Autonomy, Distributed Electric Propulsion, On-demand Transportation, High Volume Manufacturing

Airbus Collaboration: Batteries, Certification, Autonomy (Sense and Avoid), UAM Strategy

Next: additional flight tests, next phase design (2-4 PAX), Certification with FAA, EASA

***α*-capabilities:** 90kg cargo load, 50km range, 200 km/h speed

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Altiscope Approach

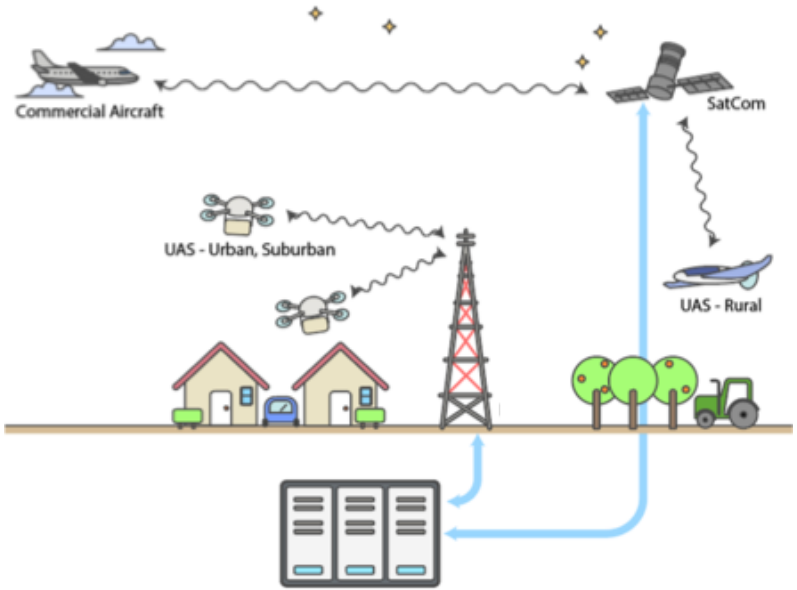
Partner with ecosystem to:

Understand policy impacts

Standardize communications and mission risk assessment between UAS and ATM

Simulate, study and design the future UTM architecture

Key enabler for UAM



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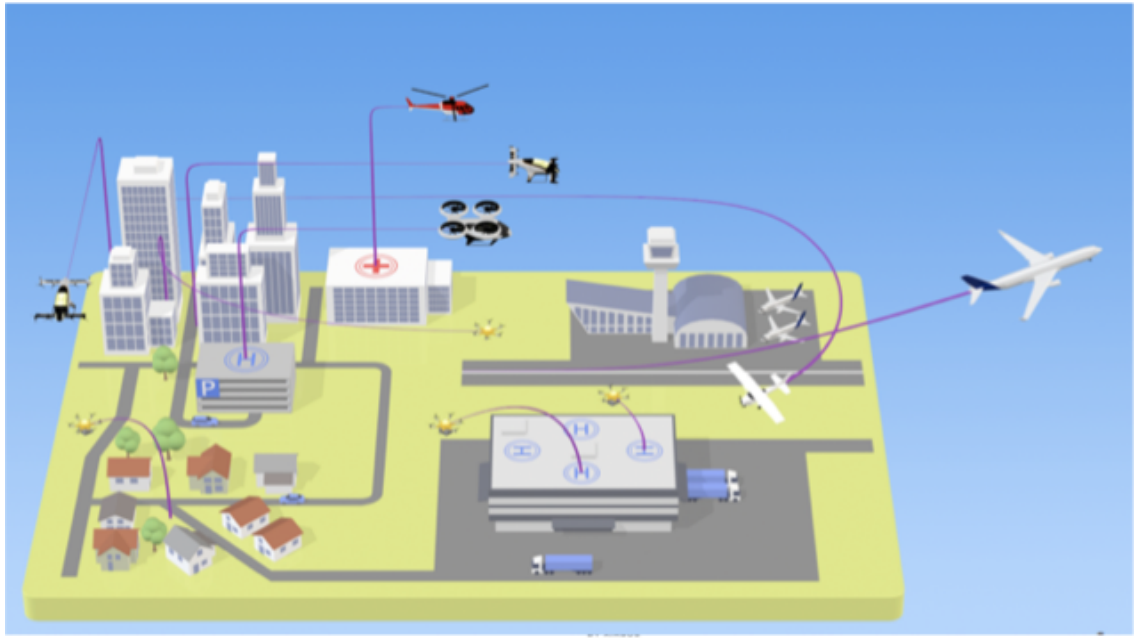
www.altiscope.io

Safety and Security are Paramount

In order to use 5G/mobile networks for UTM/UAS, networks must have high integrity and availability, because without those, catastrophic loss of life could occur



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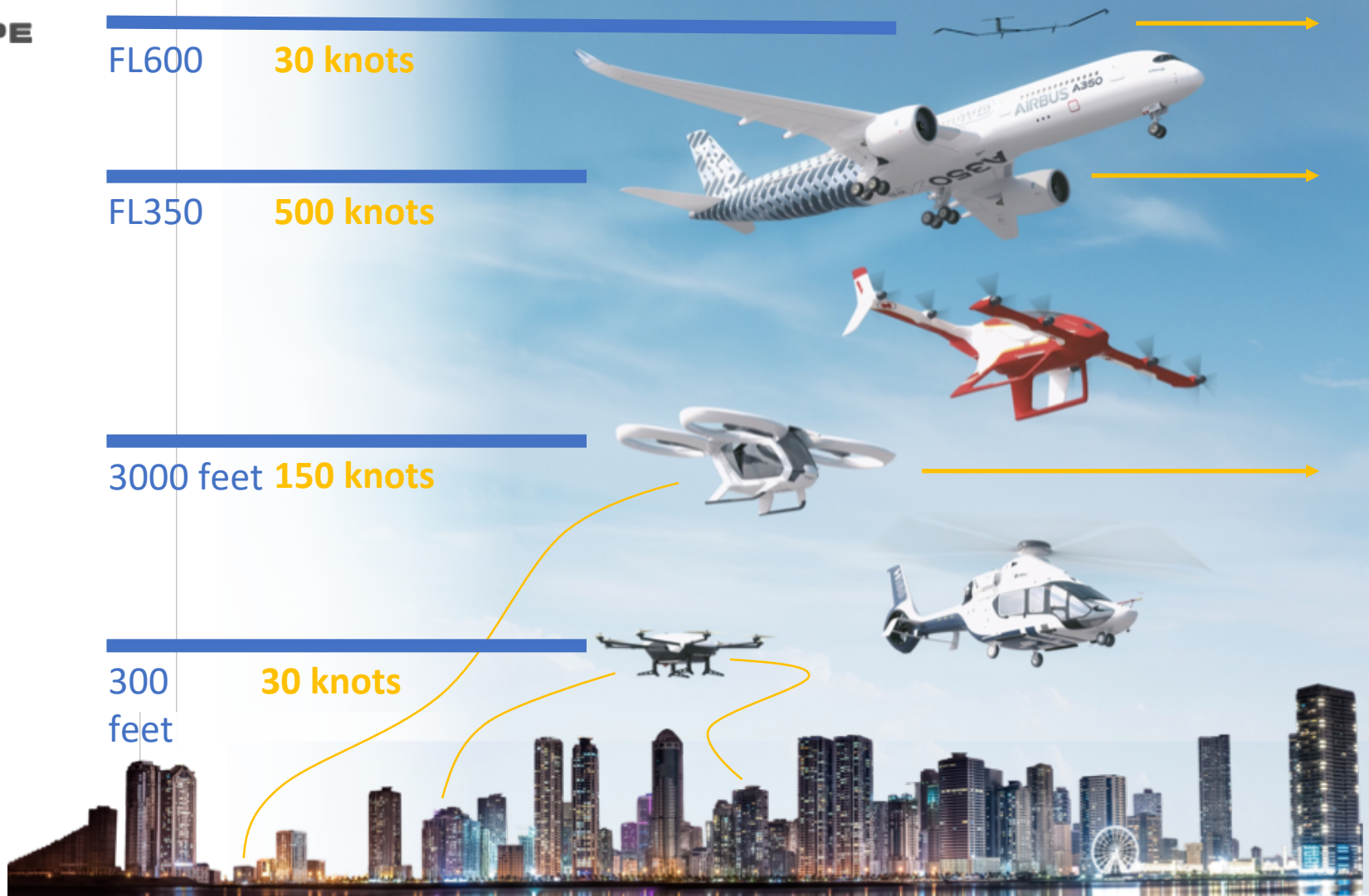
FL600 30 knots

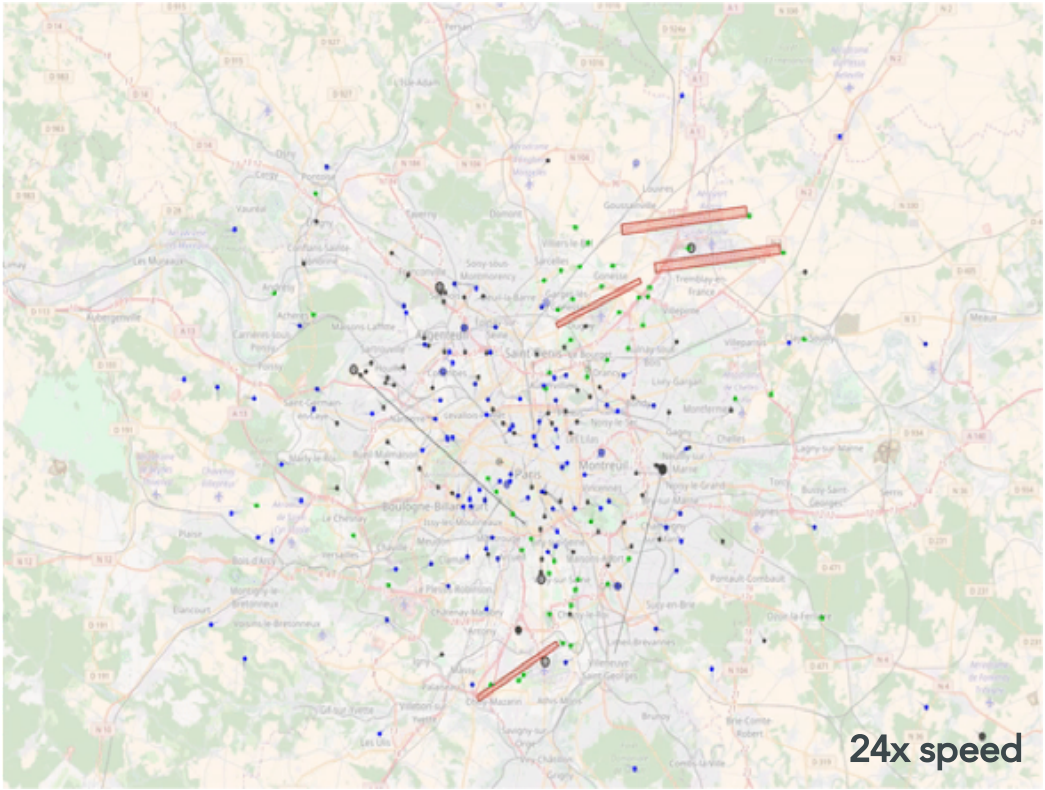
FL350 500 knots

3000 feet 150 knots

300 feet 30 knots



Paris - Today vs. 2035 Altiscope Sim Output



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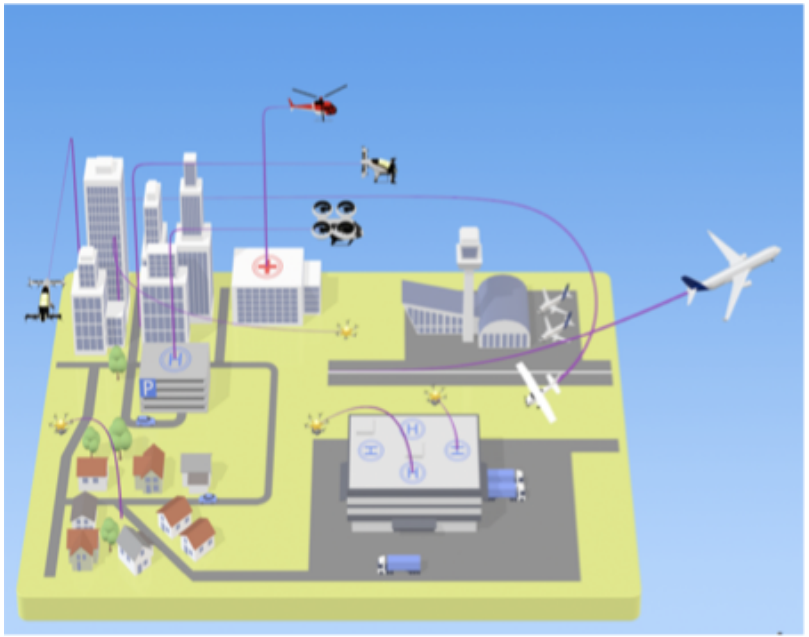
More Topics for Mobile Industry to Consider

- Safety criticality, emergency/aviation-grade
- Competitive Marketplace =
  - Multiple players
  - Multiple operators
- Seeing multiple base stations at once
  - Interference
  - Handovers
- Privacy
- Security
- Reliability
- Range
- Positioning - backup to GPS
- Number of (added, flying) users



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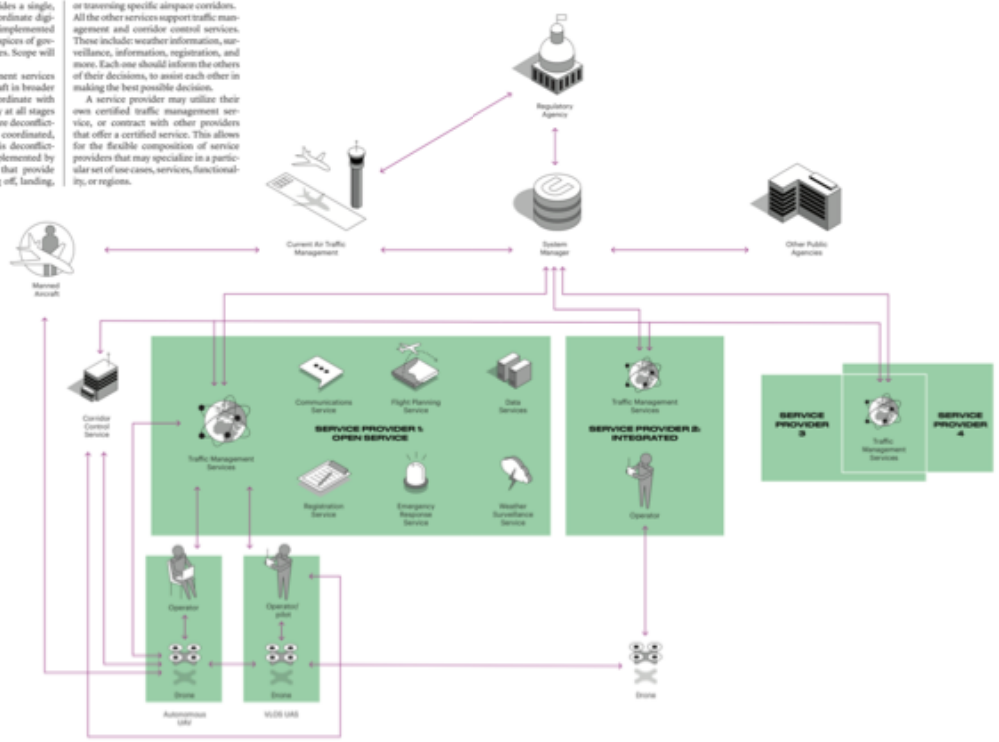
A UTM Service Stack

The system manager provides a single, authoritative system to coordinate digital traffic services. This is implemented and operated under the auspices of government regulatory agencies. Scope will vary between countries.

Digital traffic management services manage the flights of aircraft in broader airspace. The services coordinate with each other to ensure safety at all stages to ensure that flight plans are deconflicted, aircraft maneuvers are coordinated, and emergency response is deconflicted rapidly. These are complemented by corridor control services that provide guidance for drones taking off, landing, or traversing specific airspace corridors. All the other services support traffic management and corridor control services. These include: weather information, surveillance, information, registration, and more. Each one should inform the others of their decisions, to assist each other in making the best possible decision.

A service provider may utilize their own certified traffic management service, or contract with other providers that offer a certified service. This allows for the flexible composition of service providers that may specialize in a particular set of use cases, services, functionality, or regions.



UTMBlueprint.com

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Sign up for “Closing the Loop”
and download the UTM Blueprint:

utmblueprint.com

Vanessa Kuroda
Wireless & Comms Architect, Altiscope, A³ by Airbus
vanessa@altiscope.io

Backup

Future Communication Needs

- **Altitude**
  - Targeting 10km-100 km cruise at 1000-3000 feet above ground level (AGL)
  - **To what altitudes does 5G plan to support?**
- **Vehicle to Vehicle (V2V)**
    - Automatic Dependent Surveillance-Broadcast (ADS-B) or modification
    - Potential information sharing (could be cellular)
- **Vehicle to Infrastructure (V2I)**
    - Command & Telemetry (C&T) link to UTM
      - Could be safety critical - **Can 5G/URLLC meet these needs?**
    - Payload data streaming
      - Higher bandwidths

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Vehicle to Infrastructure, con...

- **Vehicle to Infrastructure**
  - Interaction with corridor control
    - Clearance to enter
      - Vehicle would pass:
        - Reservation/Aircraft ID (~UID ~128 bits)
        - Timecode - When vehicle expects to be there
        - Nature of request - i.e. Permission to Enter
      - Corridor Control Service would respond with
        - Clearance valid for next *n* number of seconds
        - Refresh every ~4 seconds until vehicle passes through corridor
      - Can 5G support this type and frequency of activity for many drones, presumably over a busy area?
    - Tracking in corridor
    - Emergency Response
      - Safety critical - how does 5G handle this?

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Can 5G (and beyond) Support the Number of Expected UAVs?

https://medium.com/altiscope → **Tools**

What year are you basing these numbers on?

A1. Year	2040

For the following figures, enter the values for your area. On the right are Worldbank data sources for these values.

A2. Population	6,000,000	source: https://data.worldbank.org/indicator/SP.POP.TOTL
A3. GDP (US$)	184,969,000,000	source: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD
A4. Total Land Area (sq km)	263,310	source: https://data.worldbank.org/indicator/AG.LND.TOTL.K2
A4. Urban Land Area (sq km)	292	source: https://data.worldbank.org/indicator/AG.LND.EL5M.UR.K2
A6. Agriculture Land Area %	42.20%	source: https://data.worldbank.org/indicator/AG.LND.AGRI.ZS
A7. Forest Land Area %	38.80%	source: https://data.worldbank.org/indicator/AG.LND.FRST.ZS

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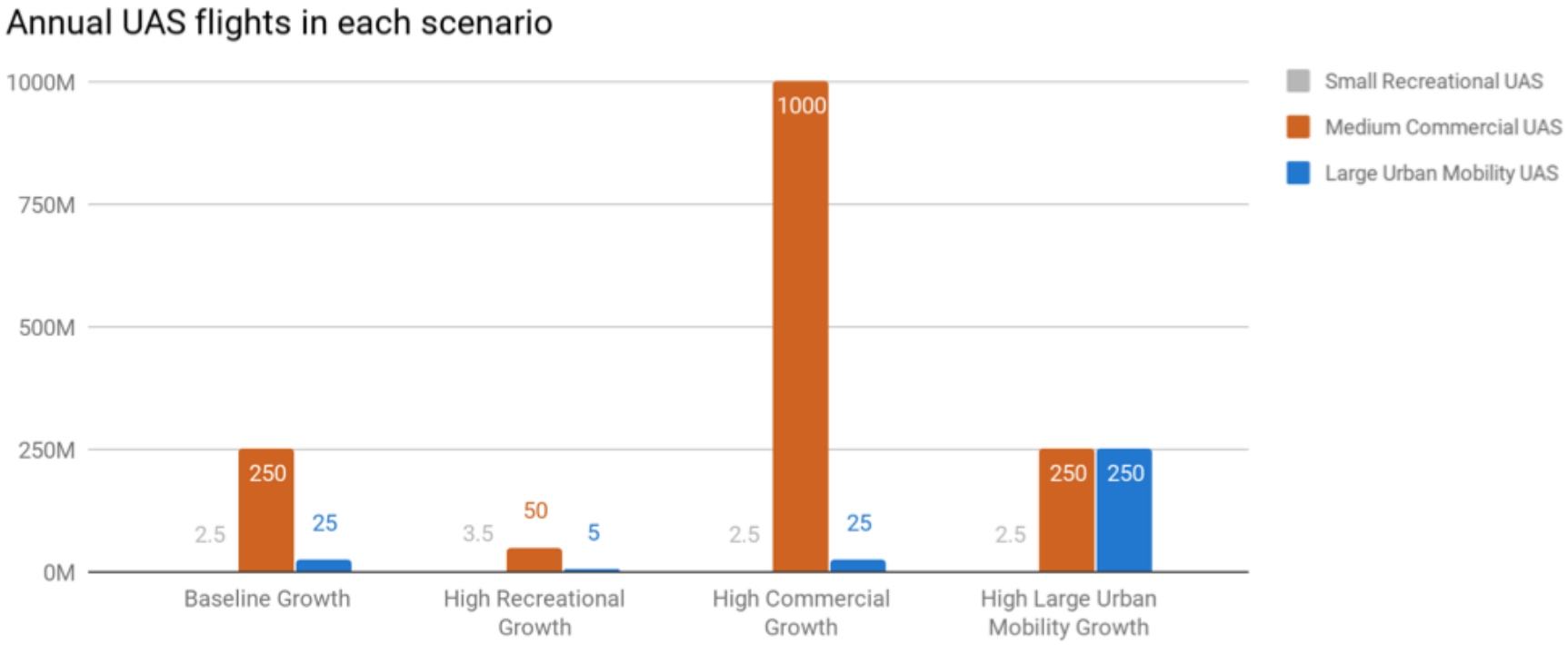
Volume Growth Scenarios by Use Case



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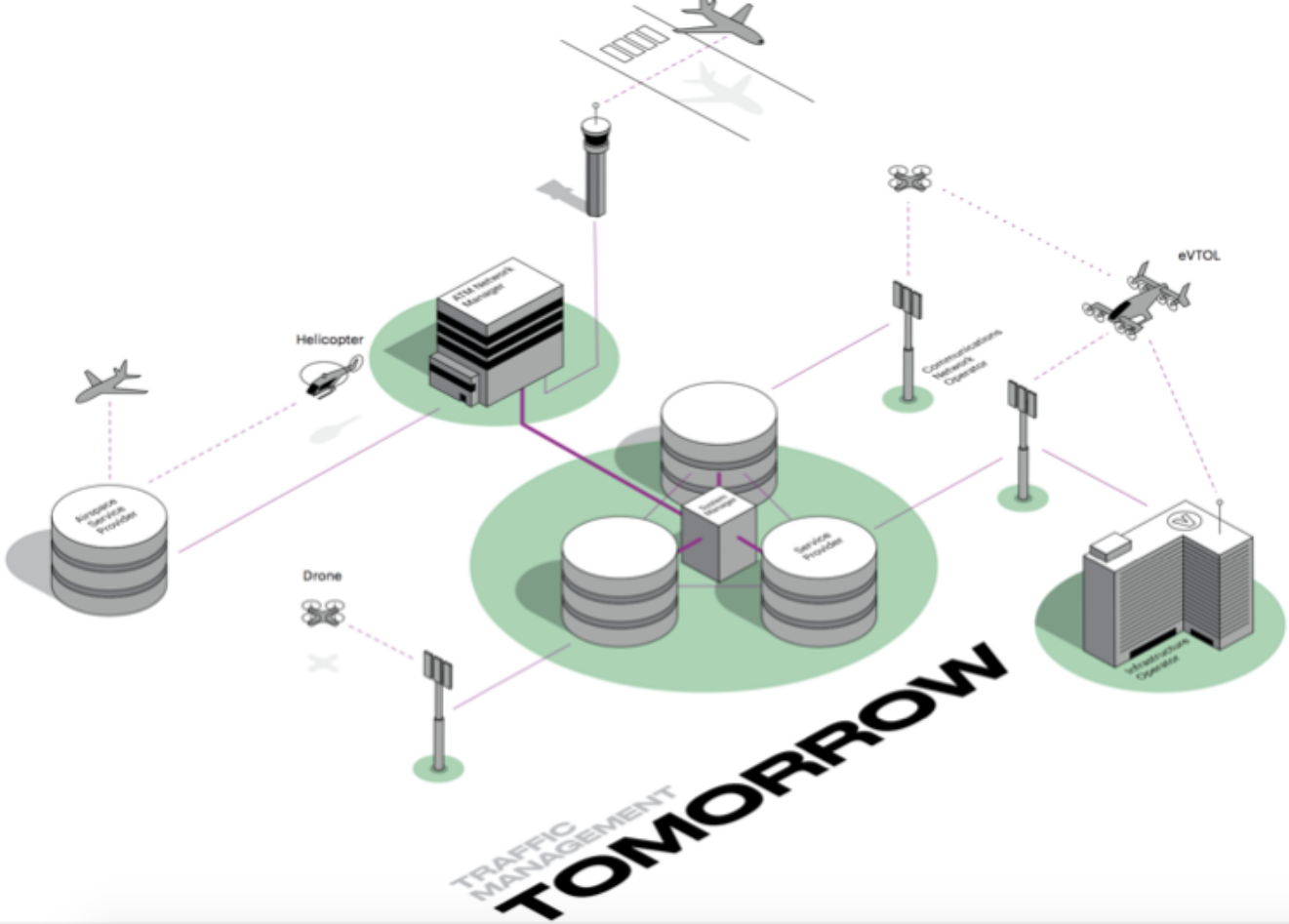

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Gerry Flynn

Director Corporate Technology

Verizon Communications

#MWCA18

5G: Beyond Broadband

Gerry Flynn

September 12, 2018

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“Safe Harbor” Statement

NOTE: In this presentation we have made forward-looking statements. These statements are based on our estimates and assumptions and are subject to risks and uncertainties. Forward-looking statements include the information concerning our possible or assumed future results of operations. Forward-looking statements also include those preceded or followed by the words “anticipates,” “believes,” “estimates,” “hopes” or similar expressions. For those statements, we claim the protection of the safe harbor for forward-looking statements contained in the Private Securities Litigation Reform Act of 1995, as applicable. The following important factors, along with those discussed in our filings with the Securities and Exchange Commission (the “SEC”), could affect future results and could cause those results to differ materially from those expressed in the forward-looking statements: adverse conditions in the U.S. and international economies; the effects of competition in the markets in which we operate; material changes in technology or technology substitution; disruption of our key suppliers’ provisioning of products or services; changes in the regulatory environment in which we operate, including any increase in restrictions on our ability to operate our networks; breaches of network or information technology security, natural disasters, terrorist attacks or acts of war or significant litigation and any resulting financial impact not covered by insurance; our high level of indebtedness; an adverse change in the ratings afforded our debt securities by nationally accredited ratings organizations or adverse conditions in the credit markets affecting the cost, including interest rates, and/or availability of further financing; material adverse changes in labor matters, including labor negotiations, and any resulting financial and/or operational impact; significant increases in benefit plan costs or lower investment returns on plan assets; changes in tax laws or treaties, or in their interpretation; changes in accounting assumptions that regulatory agencies, including the SEC, may require or that result from changes in the accounting rules or their application, which could result in an impact on earnings; and the inability to implement our business strategies.

As required by SEC rules, we have provided a reconciliation of the non-GAAP financial measures included in this presentation to the most directly comparable GAAP measures in materials on our website at www.verizon.com/about/investors.

Yesterday we announced:

“Verizon 5G Home is open for business.”

We are the first company to bring 5G Ultra Wideband Internet service to consumers.

- Residents of Houston, Indianapolis, Los Angeles and Sacramento can visit FirstOn5G.com Thursday at 8am ET to sign up and get more information.

- Fixed Broadband using mmWave spectrum evolving to 3GPP standards soon for even greater bandwidth

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5G Beyond Broadband

To deliver the full potential of 5G, a company must possess three fundamental assets:

- **Massive spectrum holdings, particularly in the millimeter wave bands. This is the only spectrum available today with the bandwidth available to realize the maximum potential for capacity, throughput and latency.**

- **End-to-end deep fiber resources.**

- **Ability to deploy large numbers of small cells.**

5G is only as good as the network it runs on and Verizon brings all three pieces together for its customers through our 5G Ultra Wideband solutions

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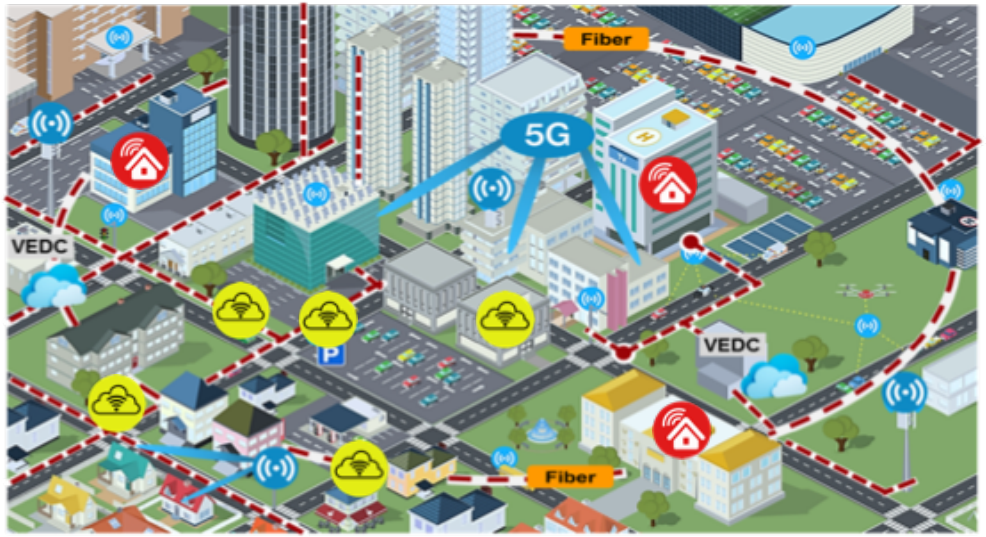
Network architecture for the future.



Intelligent Edge

Low Latency Services

Dense Wireless

Deep Fiber

Mid Band

LAA

Integrated Fiber-Wireless
Small Cell Densification

Cloudification
SDN

Intelligent Caching
Connected Infrastructure

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5G and Intelligent Edge Network

>10Gbps
Peak Data Rates

10-100X
Connected Devices

10X
Battery Life

5G

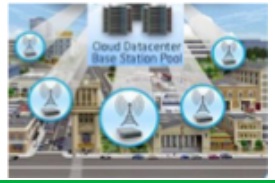
4G

1000X
Mobile Data Volumes

10X
Lower Latency

10-100X
End-user Data Rates

Millimeter Wave Spectrum	Deep - Fiber	Cloud RAN/CORE	Software Defined Networks



Multi-access Edge Compute	Virtualization	Automation	Analytics & Intelligence

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5G Verticals and Use Cases

Smart Cities

- Smart Parking
- Traffic Control
- Infrastructure Health
- Smart Lighting
- Waste Management
- Public safety/surveillance

Smart Home

- Access Control
- Home Security
- Video Surveillance
- Energy Management
- Appliance Control
- Leak Detection
- Smart Metering

Transportation

- Vehicle diagnostics
- Autonomous car
- Drone monitoring
- Remote vehicle control
- Aerial VR experience
- Connected Vehicle
- Smart map/navigation

Energy and Utilities

- Utility Security
- Smart Metering
- Smart Grid

FWA

- In-home video and TV
- High Speed home internet
- Property surveillance & security

Manufacturing

- Raw material/stock tracking
- Industrial AR
- Robotic Control
- Production automation
- Machine monitoring
- Predictive Maintenance
- Production / Safety Monitoring

Healthcare

- Fall detection and prevention
- Medical management
- Remote Diagnostics
- Health Monitoring
- Remote Surgery
- Telemedicine
- Robotic Surgery
- Decentralized Medical Devices

Media, Entertainment, and Retail

- AR/VR
- 4K/8K video
- Live streaming broadcast
- Sport Events live
- broadcast
- Multiplayer mobile games
- Digital Signage
- Next gen social media

eMBB

- Thin Client / Virtual Mobile Infrastructure and Device**
- 5G Broadband Connectivity
- 5G Mobile Hot Spots
- Rich videoconferencing
- 5G Wearables

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Realization of Beyond 5G Broadband

1. **Industry Collaboration & Leadership to accelerate technology development and Industry standards for scale and interoperability**
2. **Human Resources Development of our current and future employees through ongoing education programs, STEM and VZ Foundation Education Programs**
3. **Partnerships: we expanded partnership with Alley to expand 5G Labs to new locations on the East and West Coasts.**
   - Working with a new array of innovators across a variety of verticals, this partnership will further accelerate the development of tomorrow's 5G use cases and experiences. New 5G Labs will be open in Washington DC, Palo Alto CA, Waltham MA, and Los Angeles CA by the end of 2018.
4. **Humanability: Using Tech To Do More New And Do More Good**
   - the differences between engineer, scientist, and student are much fuzzier than they've ever been. So-called amateur tinkerers and hackers are able to come up with transformational projects just as easily as a seasoned technology entrepreneur. At its best, technology can level the playing field, enabling anyone to manifest their big ideas into meaningful actions.

We don’t wait for the future. We build it

Thank you

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