PSCE Oxford - December 9th 2015
Timo Bakker

Future 5g capabilities
Implications for Public Safety

3.9Bn
People connected to the Internet in 2017

720%
Increase in video traffic 2012–2017

320M
More tablets sold in 2014 than laptops and desktop computers combined

>50Bn
Enterprise networking market revenue in 2017 (US $)

~10Bn
Things connected to the Internet in 2020

440%
Increase in cloud and data center traffic 2012–2017

2.3X
Increase in mobile broadband speed by 2019

2X
Increase in cloud computing market 2013–2017

More.....

IoT: THE NEXT STEP IN INTERNET EVOLUTION

Pre-internet era

Internet of **Content**

Internet of **Services**

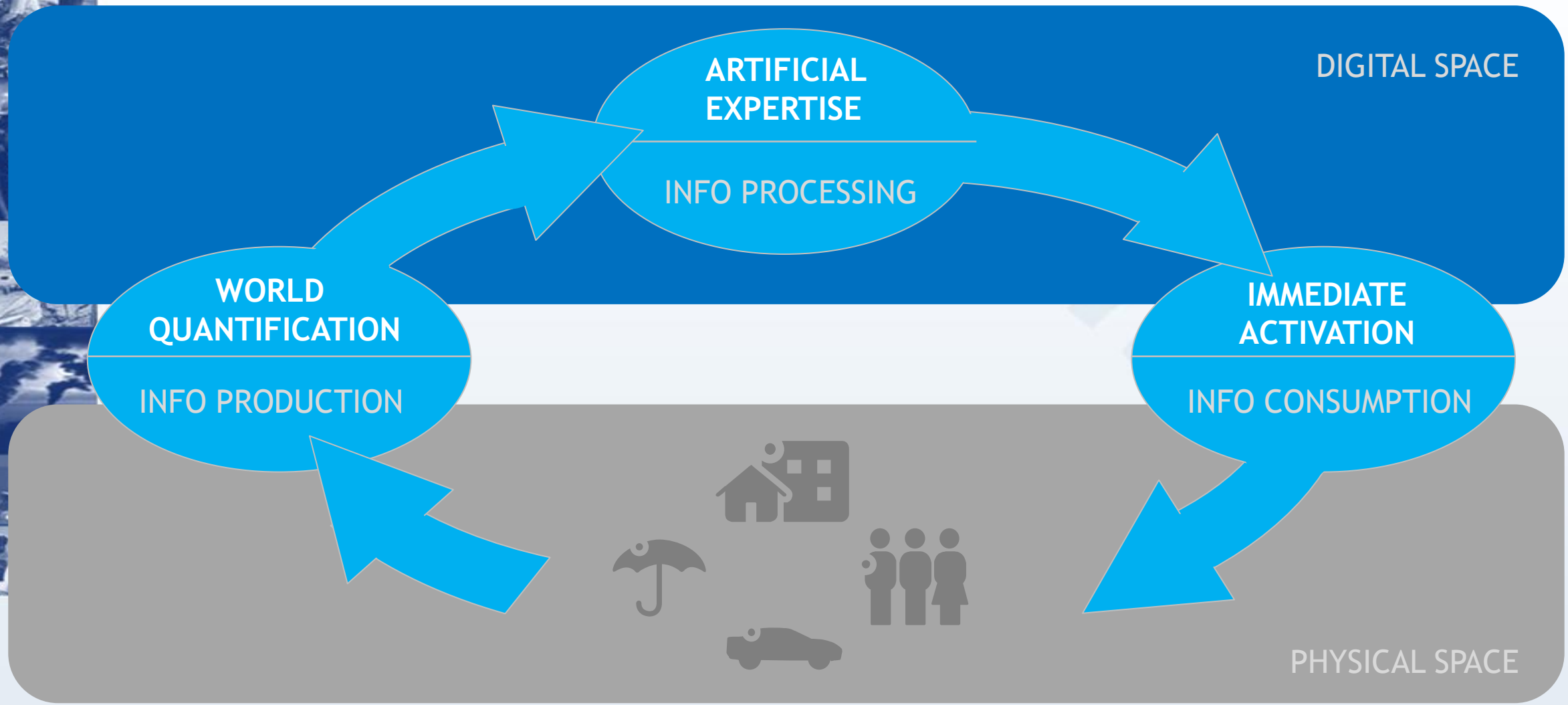
Internet of **People**

Internet of **Things**

H2H + WWW + Web 2.0 + Mobile & social +

Machine comms, big data & context

INFORMATION FLOW SHIFTS



THE THIRD WEB ERA

ASSIST

TIME

TRUST

WEB

MORE LIVE MOBILITY

MORE LIVE CONTROL

INTERNET

MOBILE INTERNET

INTERNET OF THINGS

1.

2.

3.

QUANTIFIED PRODUCTS = EXPERTISE

NOVAWO® New Retro Women Lady Bohemian Soft Scarf Large Beach Shawl Scarves (Red)

by Novawo

151 customer reviews

List Price: ~~$29.99~~

Price: $2.99 + $4.99 shipping

You Save: $27.00 (90%)

In Stock

Worn last week: 756 people

Average washing cycles: 32

Impression impact: optimism, flexibility, curiosity, balance

PROFESSIONAL ADVICE (SHOP CLERKS, REVIEWERS)

CROWD RATINGS

AUTOMATED PRODUCT QUANTIFICATION

AUTONOMOUS CAMERAS FOR MACHINE GENERATED CONTENT

PERSONAL MOMENTS

amateur soccer matches, birthday parties, theme park visits,

AUTOMATED JOURNALISM

enhancing/replacing professional reporting

PUBLIC SAFETY

fires, accidents, natural disasters, …

IoT – REQUIREMENTS

LOW ENERGY

- >5 years of operation with single battery

WIDE AREA

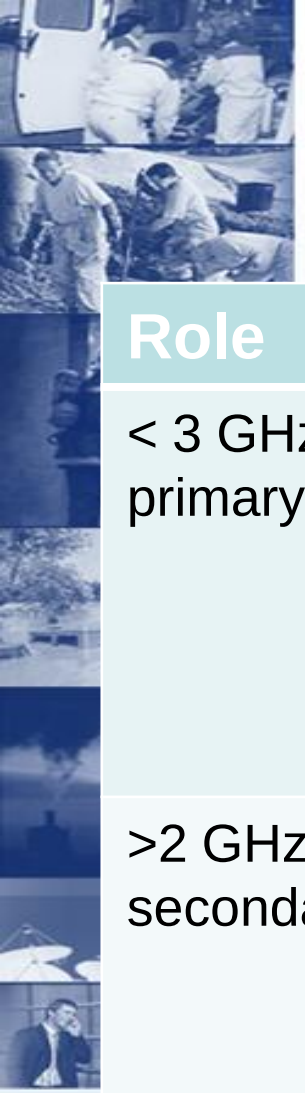
- Reliable coverage for sensors
- Traditionally less covered areas (rural)
- Indoor (cabinets, cellars)

HIGH DENSITY

- 200,000 devices / km2
- Effect of combined use cases (various verticals)
- Challenging to showcase in trial

LOW COST

- Modem cost $1-$5
- Current cellular modem costs
  - GSM/GPRS: $10
  - 3G: $30
  - 4G: $40



5G SPECTRUM TARGET BANDS

Role	European	APAC	America
< 3 GHz primary	700 (available 2019?) 900 (after 2/3G switch off) 2100 (after WCDMA leaves core band)	600 (new band) 900 (after 2/3G switch off) 2100 (after WCDMA leaves core band)	600 (new band) 850 (after 2/3G switch off)
>2 GHz secondary	2100 2300 3500 4-6 GHz (new bands)	2100 2300 (not in China) 3500 4-6 GHz (new bands)	1900 AWS4 2500, 3500 4-6 GHz (new bands)
>20 GHz	Prefer new global harmonised band “somewhere 20 GHz” that is not an existing microwave link band (i.e. not 28 GHz). To be decided at WRC-19		

5G RADIO: IMPACT OF KEY DRIVERS ?

Driver	LTE Evolution	Low band 5G (< 6 GHz)	High band 5G (>20 GHz)	Network evolution
Mobile broadband	MIMO, HetNet and CoMP features	Higher spectrum efficiency	Peak bitrates Massive capacity	Flexible anchor
Innovative services	Capacity	Short packet Low latency	Scheduled low latency service	Policy based networking
Crowds	Capacity	Contention access	Massive capacity	Local anchor Connectionless service
Mission critical	Public safety features	Low latency	Scheduled low latency service	Prioritization
Battery life		Contention access		Connectionless service
Non traditional devices	MTC features (to bridge gap until 5G)	Contention access		Connectionless service

“MEGATRENDS”
that will drive security over the coming years

- New technologies
- Internet of Things in public safety
- Debate on public safety and information retention
- Web intelligence and Big Data in law enforcement
- Legacy systems replaced with newer technology

Source: Frost & Sullivan November 4th 2015
Technologies that they expect to have a big impact on security in the coming years

USE CASES PUBLIC SAFETY MARKET RESEARCH

- “Unmanned aerial systems” - also known as drones
- “Wearable Devices”
- “Predictive and proactive approach to security.”
- "higher video resolution" isn't one of the use cases
  - Is it maybe what you do with it that counts or taken for granted due to 4G ?

Source: Frost & Sullivan November 4th 2015
Technologies that they expect to have a big impact on security in the coming years

5G USE CASES ACCORDING TO MGMN

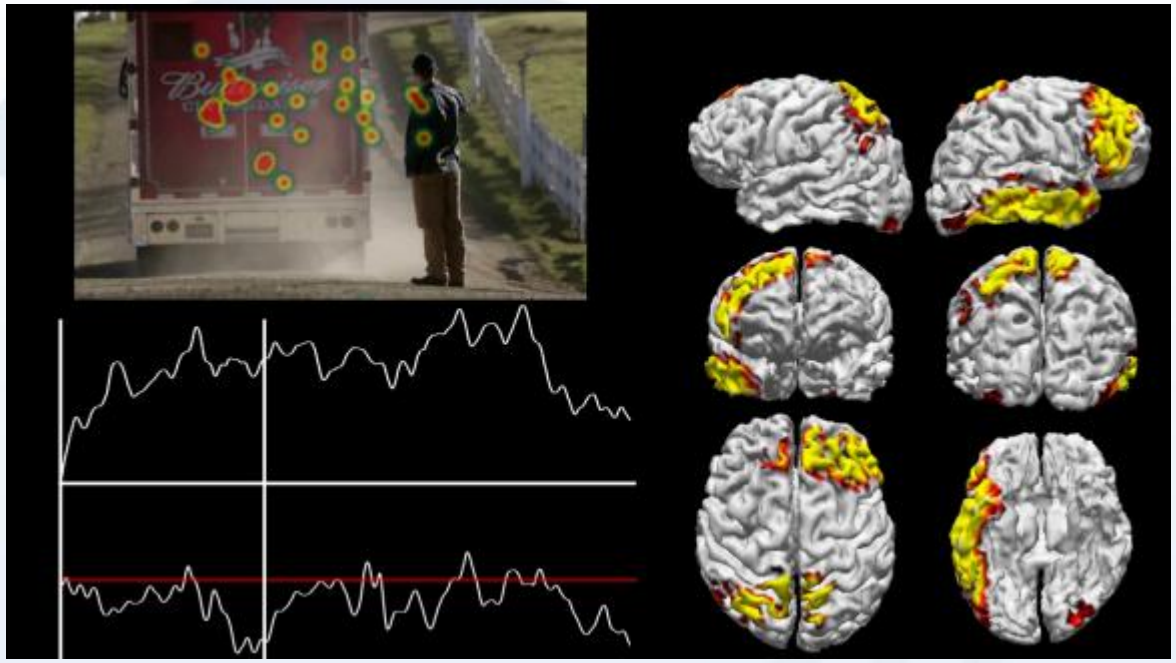
Broadband access in dense areas PERVASIVE VIDEO	**Broadband access everywhere** 50+ MBPS EVERYWHERE	**Higher user mobility** HIGH SPEED TRAIN	**Massive Internet of Things** SENSOR NETWORKS
Extreme real-time communications TACTILE INTERNET	**Lifeline communications** NATURAL DISASTER	**Ultra-reliable communications** E-HEALTH SERVICES	**Broadcast-like services** BROADCAST SERVICES

NGMN has developed twenty five use cases for 5G - https://www.ngmn.org

NEW public safety use case (civilian intelligence info)

Quantification of immediate and mid-term (emotional) impact of atomic content assets in the World Wide Lab

Need assessment as a combination of historical data and current mental state readings of many people detected in a dense geo area by GPS



RESULT: ALERT IN CONTROLE ROOM FOR EVENT CHECK

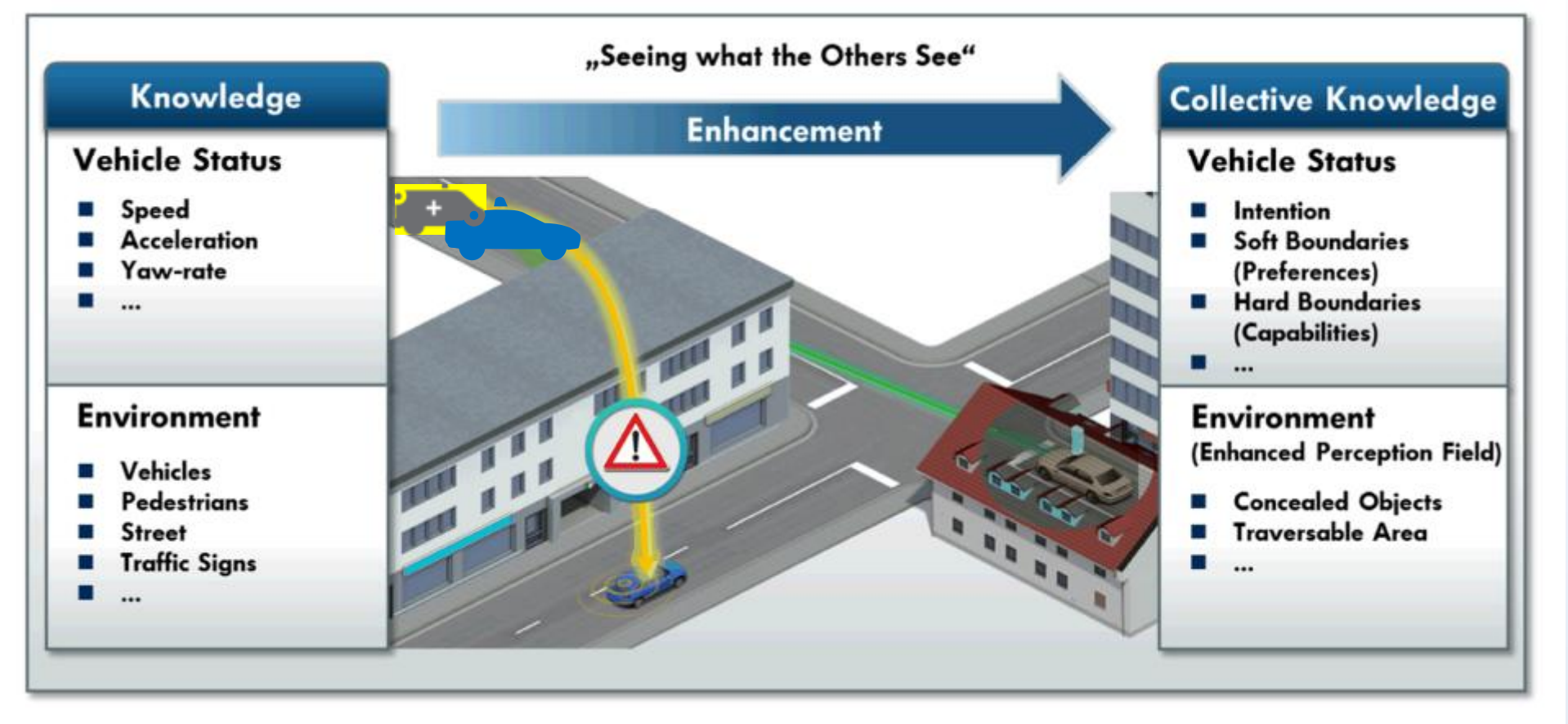
NEW public safety use case (first responder contact)

WEARABLES: 6W4U – Key features
Safe patrol concept: enhanced protection with SOS module for better interaction with patrols in the field
Connected and interactive with the command-and-control centre
- Secure notification of events and alerts

Situational awareness at a glance
- Textual information
- Map display
- Easy-to-read pictograms

Multiple modes for each mission and context: discreet / normal / detailed
Non-intrusive wearable device
Built-in sensors (camera, microphone, etc.) to **contribute to the common operational picture**

NEW public safety use case (enhanced patrol info)

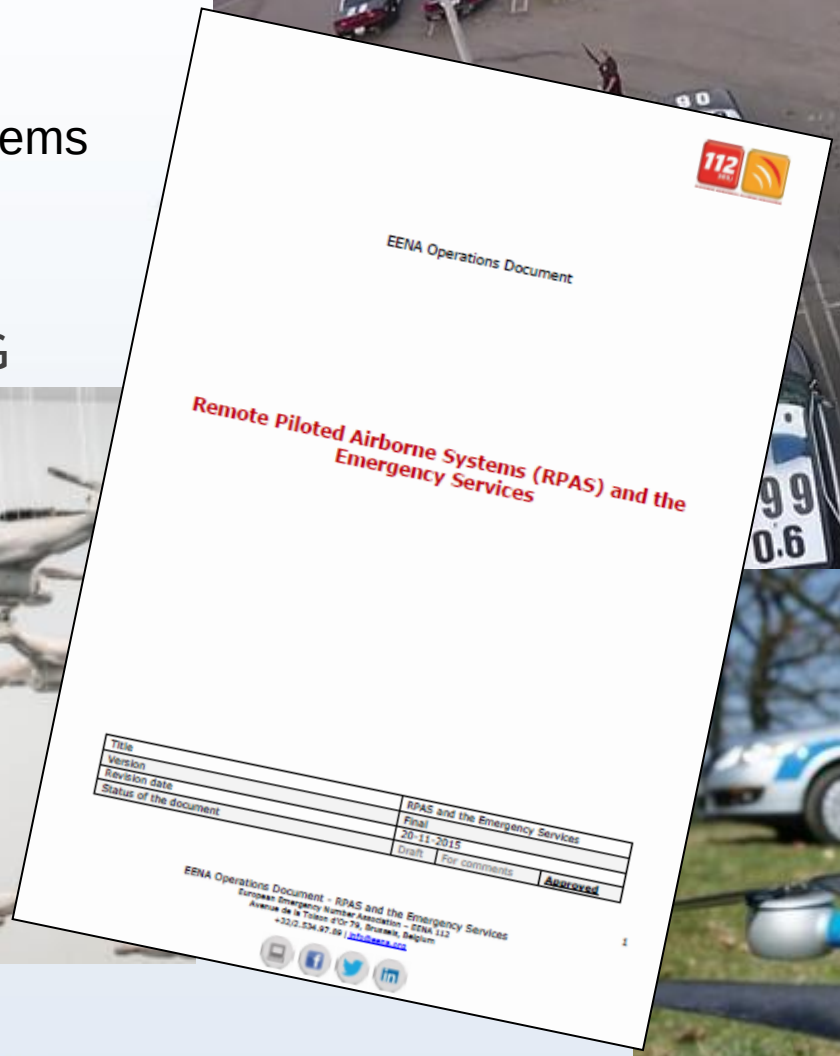


Collective knowledge through collective perception

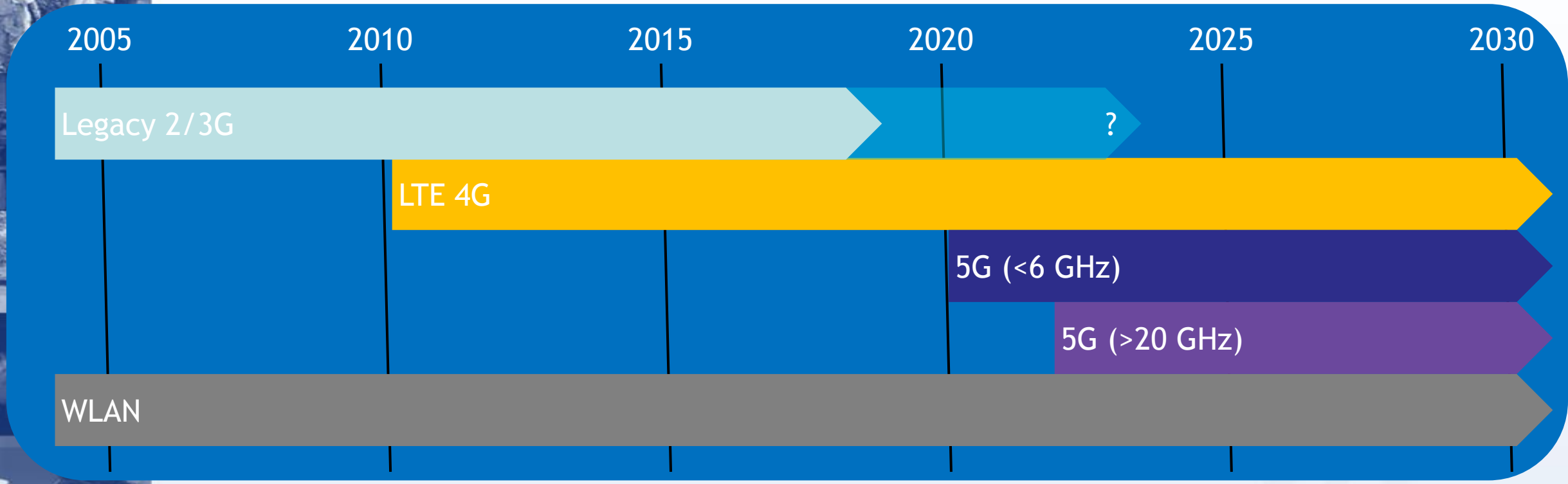
NEW public safety use case

RPAS (Drones)
Remotely Piloted Airborne Systems
for dense urbun surveillance

Swarm of RPAS support with 5G

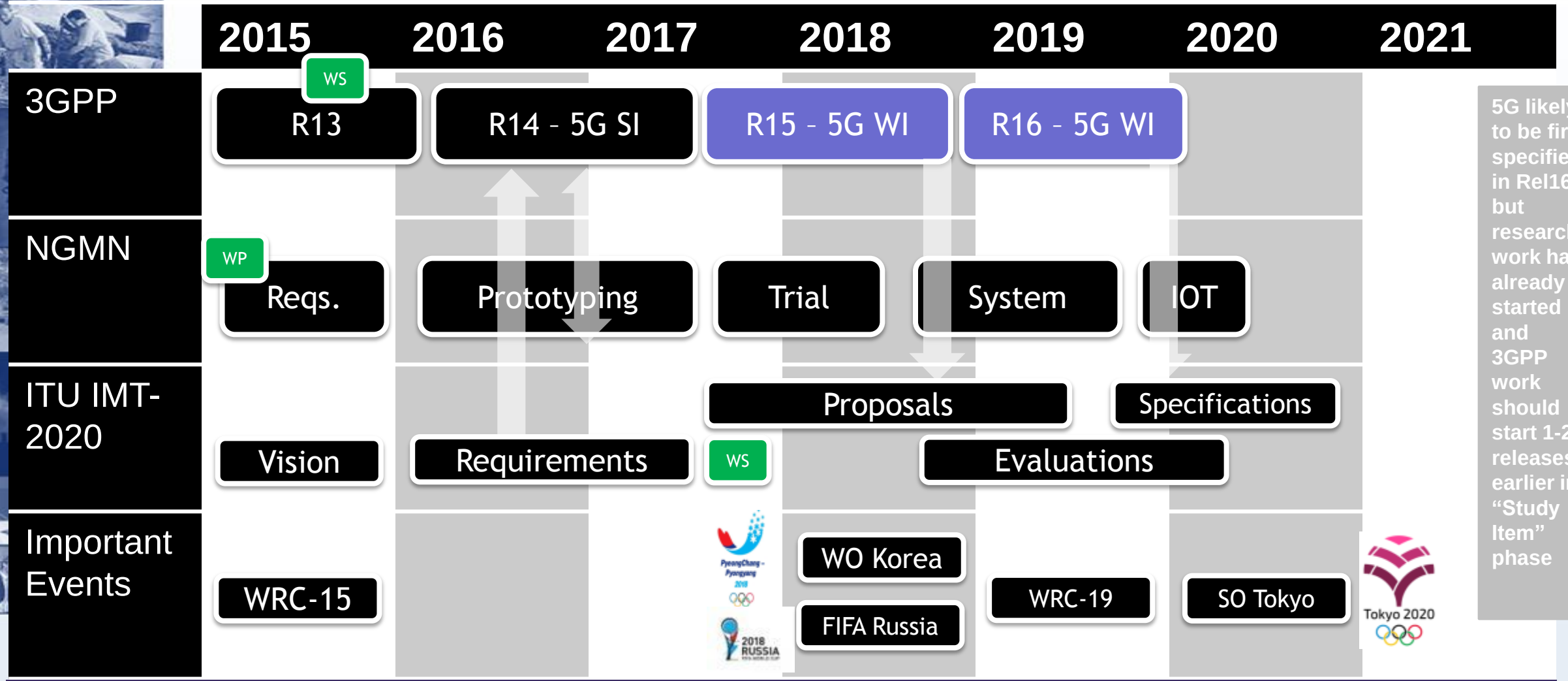


TIMING: LTE EVOLVES & 5G IS COMING



- LTE
  - Evolution continues well after 5G launch
- 5G
  - Low band deployed from 2020 first on macro cell then on small cells
  - High band on small cell follows as 5G capacity needed

TIMING: 5G ROADMAP, STANDARDS & TRIALS



Trials prior to 2019 cannot be standards based

3GPP "LTE Public Safety" STANDARDIZATION ROADMAP

1st commercial LTE network

3GPP Roadmap

08 ... 10 11 ... 15 16 17 18 19

IoT & Big Data C2

Rel-8 (LTE)

Rel-10 (LTE-A)

Rel-12 (PS Intro.)

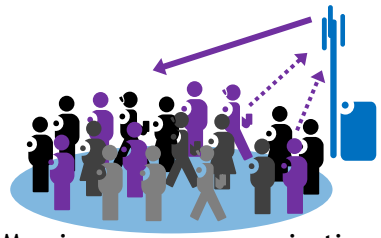
Rel-13*

Rel-14*

Rel-15* (*5G Intro.*)

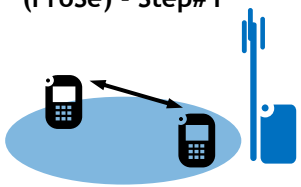
3GPP Rel-12 For PS

Group Communications System Enablers (GCSE)



Massive group communications

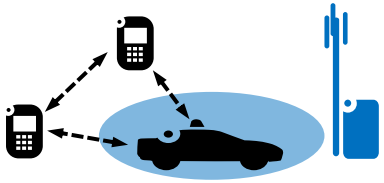
Proximity Services (ProSe) - Step#1



Direct mode operations

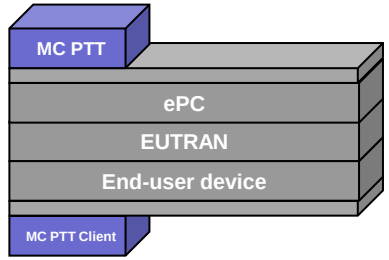
3GPP Rel-13 For PS (Work items)

ProSe - Step#2



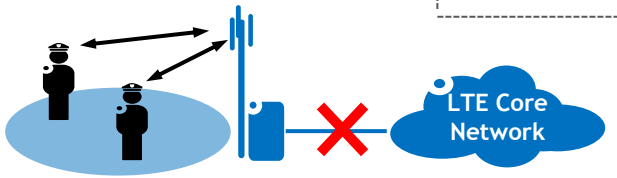
Direct mode operations (Relay)

Mission-critical PTT over LTE (MCPTToLTE)



Push-to-Talk (PTT) (Application layer)

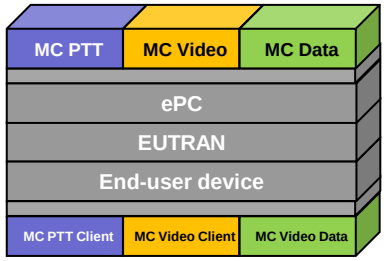
Isolated E-UTRAN Operations (IOPS) - Step#1



eNode-B fallback mode

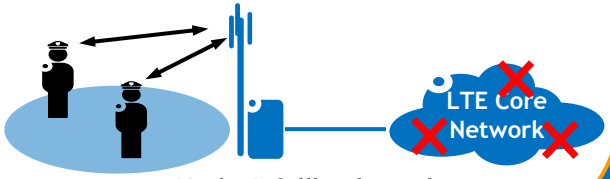
3GPP Rel-14 For PS (Study items)

(MCVIDEOoLTE)
(MCDATAoLTE)



Mission-critical Voice & Video & Data Communications

IOPS - Step#2



eNode-B fallback mode

Rel-x*: 3GPP specifications not available yet

WHEN CAN WE TEST CRITICAL APPS ON 5G TESTBEDS ?

- Vendor specifcations expected to be ready by 2020
- 2018 testbed should be in full swing
- What can be tested depends heavily specialification matrurity for 5G application enablement & the early availibility of 5G chipsets for the forseen use case
  - Alcatel-lucent expect that (ultra) broadband & low latency will get priority on short burst IoT type solutions
  - First chipsets will be a bit bulky (today 5G test device is suitcase size → evolution from shoe box to smartphone-like size to follow)
  - First chipsets will be very expensive and will not be energy efficient from day one

  => IoT apps will come right after, first being deployed with LPWA technology adn LTE-MTC and after migrate to 5G infrastructure

- Ultra-broadband and low latency will be very interesting enablers for public safety: high-definition surveillance feeds, remote control van reconnaissance drones en robotics (save and rescue, etc), augmented reality apps

FROM 2018 DEMO CAPABILITY, EARLY 2020 TESTBED IN DENSE URBUN AREA

LPWA =Low Power Wide Area Networks

5G DISASTER EMERGENCY COMMUNICATIONS SOLUTIONS TRIAL

On **November 24 2015**, South Korean telecom operator KT unveiled specialized disaster emergency communications solutions, such as ‘drone LTE,’ ‘backpack LTE’ and ‘satellite LTE.’
The drone LTE, a flying miniature version of a base station, is the world’s first drone-based ultra-light, ultra-small movable base station outfitted with key equipment.

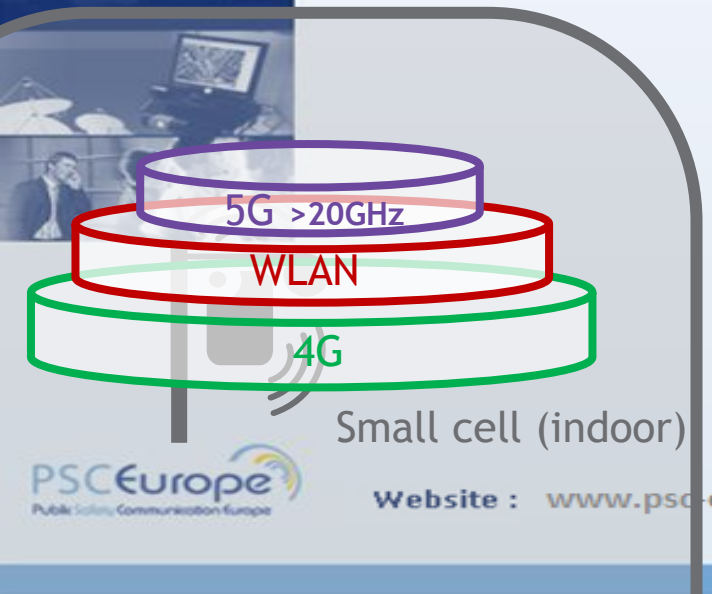
The drone LTE is expected to play an important role in expediting rescue operations in disaster-struck, inaccessible areas where communication is cut off.
To provide the drone LTE service, five drones will fly in formation to cover an area as large as the size of Yeouido. Since drones can stay aloft for up to 20 minutes, drone stations will be employed to enable long-distance communication services.
For disasters in mountainous areas and maritime disasters, KT has come out with the backpack LTE and satellite LTE solutions. The backpack LTE is a small 9-kilogram LTE base station that comes in the form of a backpack.
The satellite LTE is a solution that takes advantage of satellite networks to meet the emergency communications needs of islands and enable maritime communication without the necessity of setting up fiber-optic cables or microwave transmission networks.

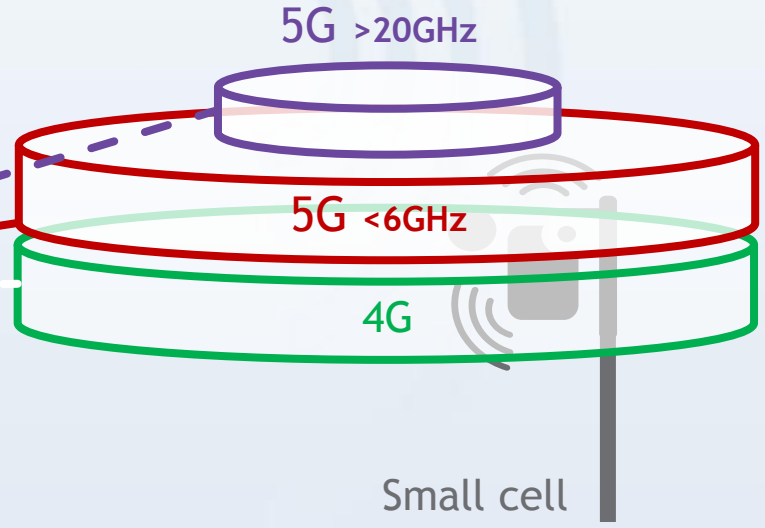
Mapping network capabilities to radio technologies and features

	5G				
Radio band	**Below 3 GHz**	**3-6 GHz**	**Above 6 GHz**	**LTE Evolution**	**WLAN**
Ultra broadband	CoMP	Massive MIMO Wider carriers	Peak bitrates Massive capacity	MIMO, HetNet and CoMP	Multi-RAT and Boost
Consistent experience	Bandwidth, CoMP Coverage	Bandwidth, CoMP	Massive bandwidth but highly selective	Bandwidth, CoMP Coverage	Bandwidth
Ultra low latency	Scheduled and contention low latency service	Scheduled low latency service	Scheduled low latency service	n/a	Contention low latency
Short burst	Contention access Short packet Connection capacity	n/a	n/a	MTC features	Contention access Short packet
Radio layer role	5G coverage and bandwidth Specialized services Contention access	Bandwidth extension Low latency Very high bitrates	Bandwidth extension Low latency Extreme bitrates	LTE coverage Bandwidth extension	Bandwidth extension

5G Radio = Low Band Control Plane + Any/All Band User Plane, Optimized for each Traffic Type

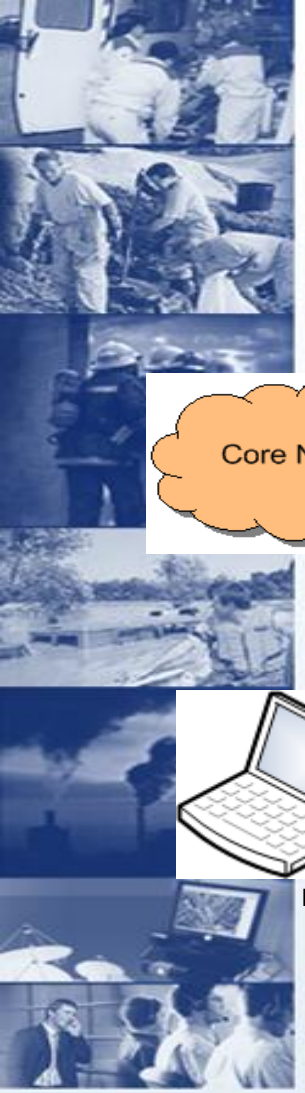
5G DEPLOYMENT AND 4G FLEXIBLE BY DESIGN





1. LTE with carrier aggregation and dual-connectivity to small cell layer
2. New 5G carrier on macro layer: Wide area coverage for new services, improved efficiency and control
3. Coverage extended on small cell
4. Massive capacity: Additional 5G carriers above 20 GHz on small cells
5. Additional 5G carriers in cellular bands on macro and small cells

COEXISTANCE 4G + 5G – ALU BELL LABS



Core Network

S1 Interface (X2)

4G Metro FDD
+modifications

Common Radio
(2.6 GHz,10 MHz)

RF Channel

4G UE
(legacy)

Shared

5G UE

Ethernet

Ethernet

5G UL R

4G+5G Pr
(Common

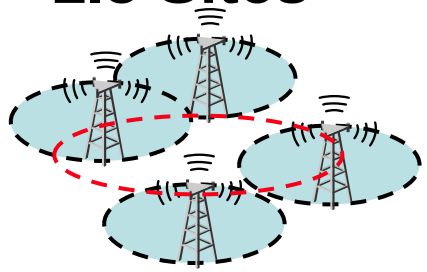
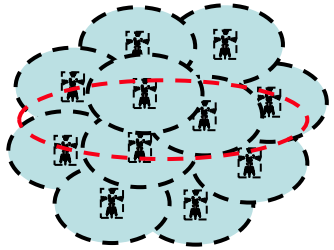
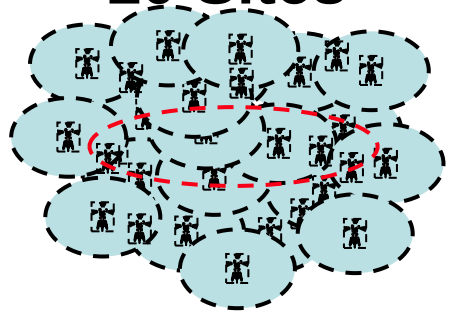
By spring 2016: Third party developer may test applications (Bell Labs)

Mobile Control Panel for Machine Control

SPECTRUM: IMPACT OF FREQUENCY BAND

PPDR BUSINESS CASE

Higher Frequencies → Lower Range → More Sites Needed

1 Site	~1.5 Sites	~3.5 Sites	~10 Sites
			
400 MHz	**700 MHz**	**1.8 GHz**	**> 6 GHz**

Higher Frequencies → Higher Deployment and Operations Costs

> 20Ghz no RF millimetric propagation modelling available yet

4G & 5G PPDR BUSINESS MODELING
DELIVERING BROADBAND SERVICES IN 4G & 5G MIX

Control Room

Shared
(Based on a commercial LTE network)

Control Room
IoT/Big Data enrichment
Video

Basic MNO	G-MVNO
Regular 4G subscribers	Added value 4G services • QoS control • User/Device management • E2E security

Dedicated

- Dedicated 4G spectrum and infrastructure
- Can be combined with G-MVNO

PPDR Voice/Data

5G

Hybrid

4G

32% (15M)
PMR users on public broadband networks in 2018**

700K
PMR users on dedicated broadband networks in 2018**

*G-MVNO = Government Mobile Virtual Network Operator; ** source: IHS Technology "Critical Communications Broadband – World – 2014"

5G RESEARCH PROJECT INITIATIVES INVOLVEMENT

FANTASTIC 5G

http://fantastic5g.eu/

5GNOW

5th Generation Non-Orthogonal Waveforms for Asynchronous Signalling

http://www.5gnow.eu/

MiWaveS

Heterogeneous Wireless Networkswith Millimeter-Wave Small Cell Access and Backhauling

http://www.miwaves.eu/

FERMIS

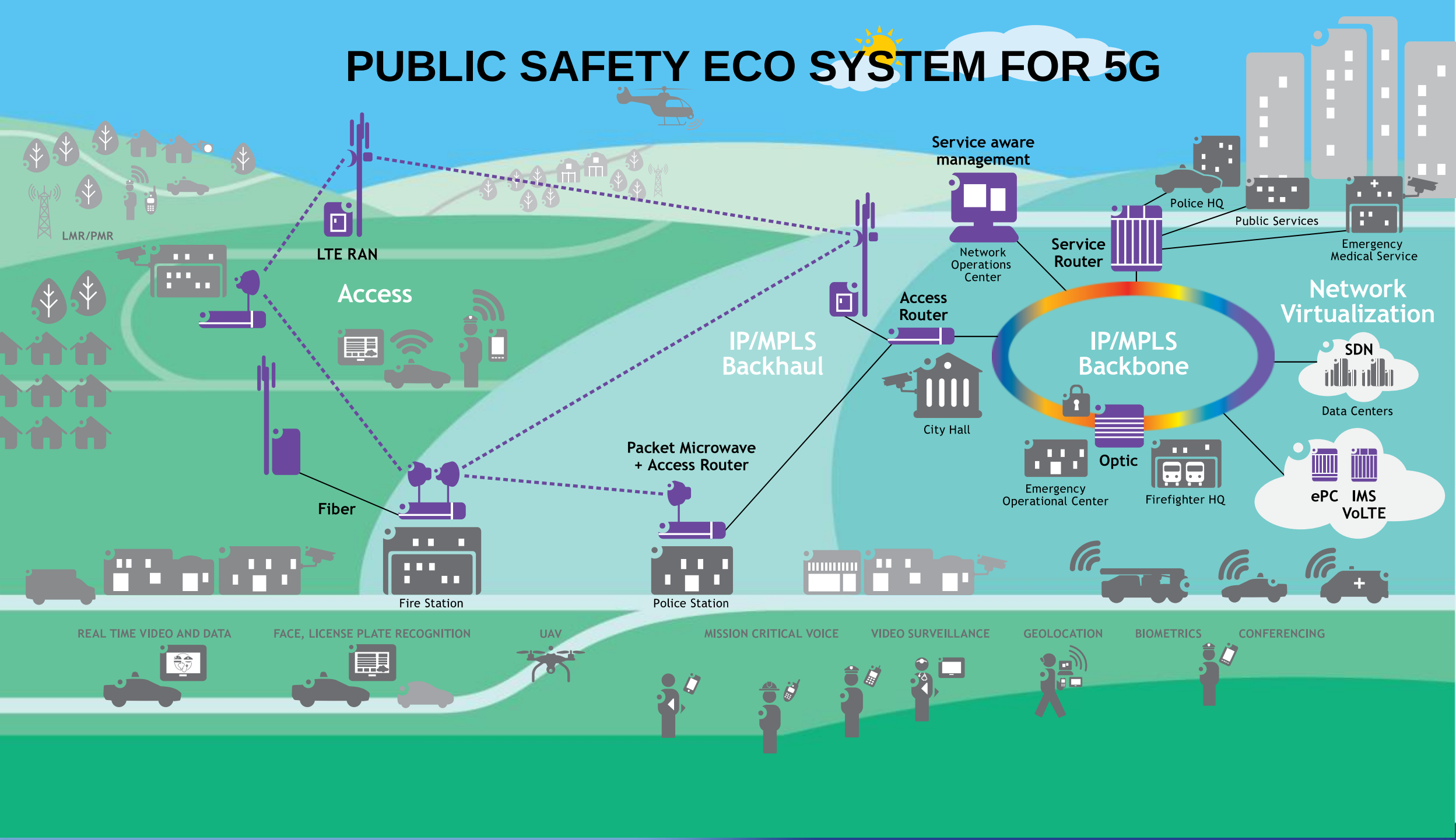
FERMIS -**F**ire **E**vent **R**emote **M**anagement **I**nformation **S**ystem

http://www.fermis-project.eu

METIS II

The METIS-II project will build upon METIS and other ongoing projects related to 5G, but go significantly beyond the achievements in these projects

https://www.metis2020.com/


PUBLIC SAFETY ECO SYSTEM FOR 5G
LMR/PMR
LTE RAN
Access
Fiber
Fire Station
Packet Microwave
+ Access Router
Police Station
IP/MPLS
Backhaul
Service aware
management
Network
Operations
Center
Access
Router
City Hall
IP/MPLS
Backbone
Service
Router
Police HQ
Public Services
Emergency
Medical Service
Network
Virtualization
SDN
Data Centers
Optic
Emergency
Operational Center
Firefighter HQ
ePC
IMS
VoLTE
REAL TIME VIDEO AND DATA
FACE, LICENSE PLATE RECOGNITION
UAV
MISSION CRITICAL VOICE
VIDEO SURVEILLANCE
GEOLOCATION
BIOMETRICS
CONFERENCING

FOOD FOR THOUGHT

1. Regulatory Framework

- In pioneer network deployment phase, there are regulatory framework requirements on privacy of data, ownership of data, etc

2. Sensors Framework

- Sensors, Camera etc would be the eyes/sensors that provides key inputs into the network
- With a 5G Public Safety network supporting/requiring multiple different sensors/devices, a key question is on the on-boarding process of these multiple devices, managing the devices, regulating the devices

3. End-to-End Security Framework

- Regulators need looking at the end-to-end security framework, from the source of data, delivery of data, processing of data etc … beyond just the network security, sensors

SO WHAT IS 5G ?

IT IS ABOUT
IMPROVING THE PERFORMANCE
FOR THE FIRST RESPONDERS

IT IS ABOUT
ENABLING NEW TYPES OF APPLICATIONS
AND TERMINALS

IT IS ABOUT
MAKING THE NETWORK MORE AGILE
AND OPTIMUM FOR EACH APPLICATION

Alcatel·Lucent

Timo Bakker
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