



# 5G, ANY SERVICE ANY CAST SPECIAL GENERATION

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# 5G INNOVATION CENTRE

LARGEST OPEN INNOVATION CENTRE ON 5G



# University of Surrey, 5GIC



Thursday, 19 April 2018

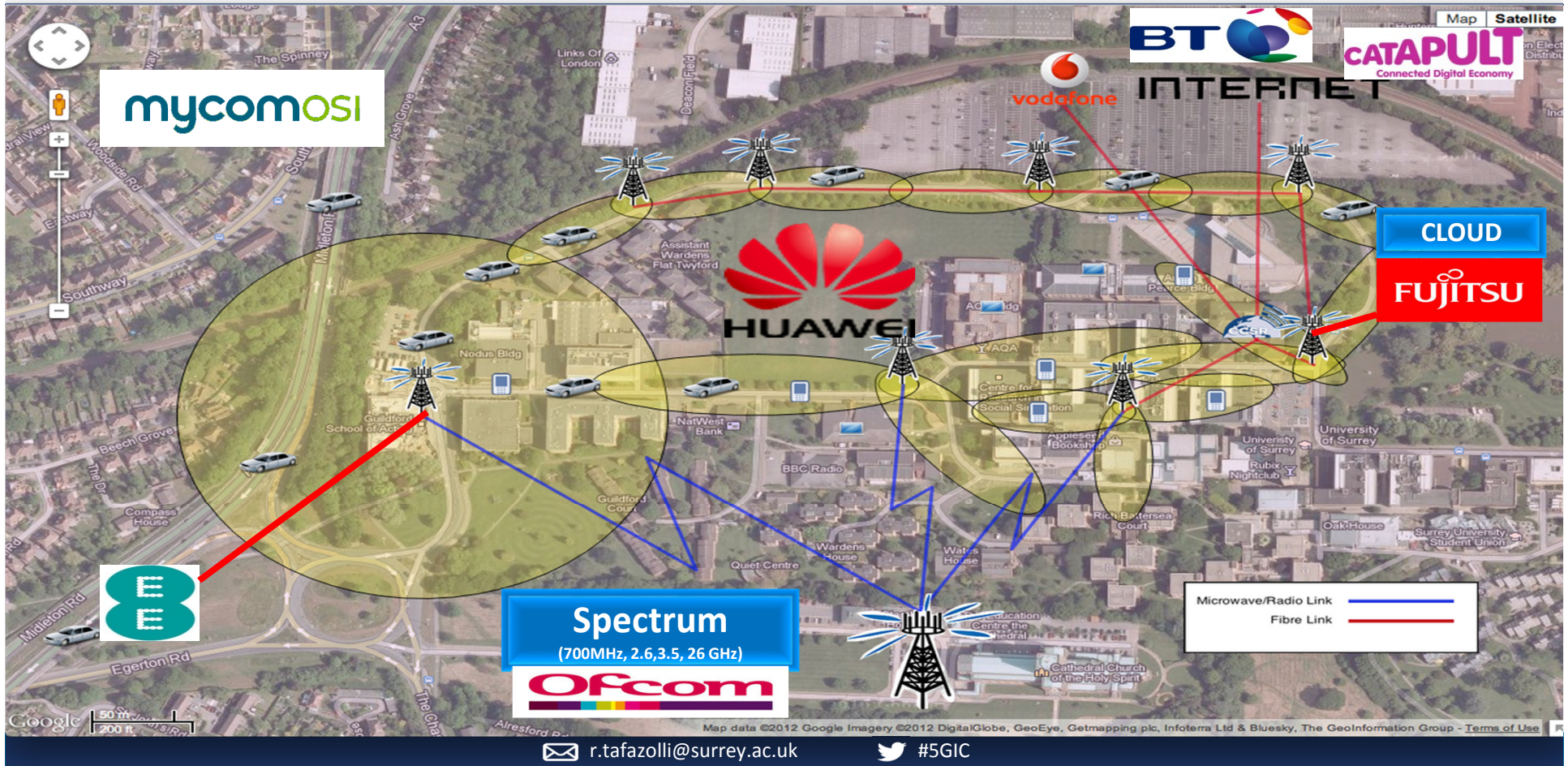
 [r.tafazolli@surrey.ac.uk](mailto:r.tafazolli@surrey.ac.uk)

 #5GIC

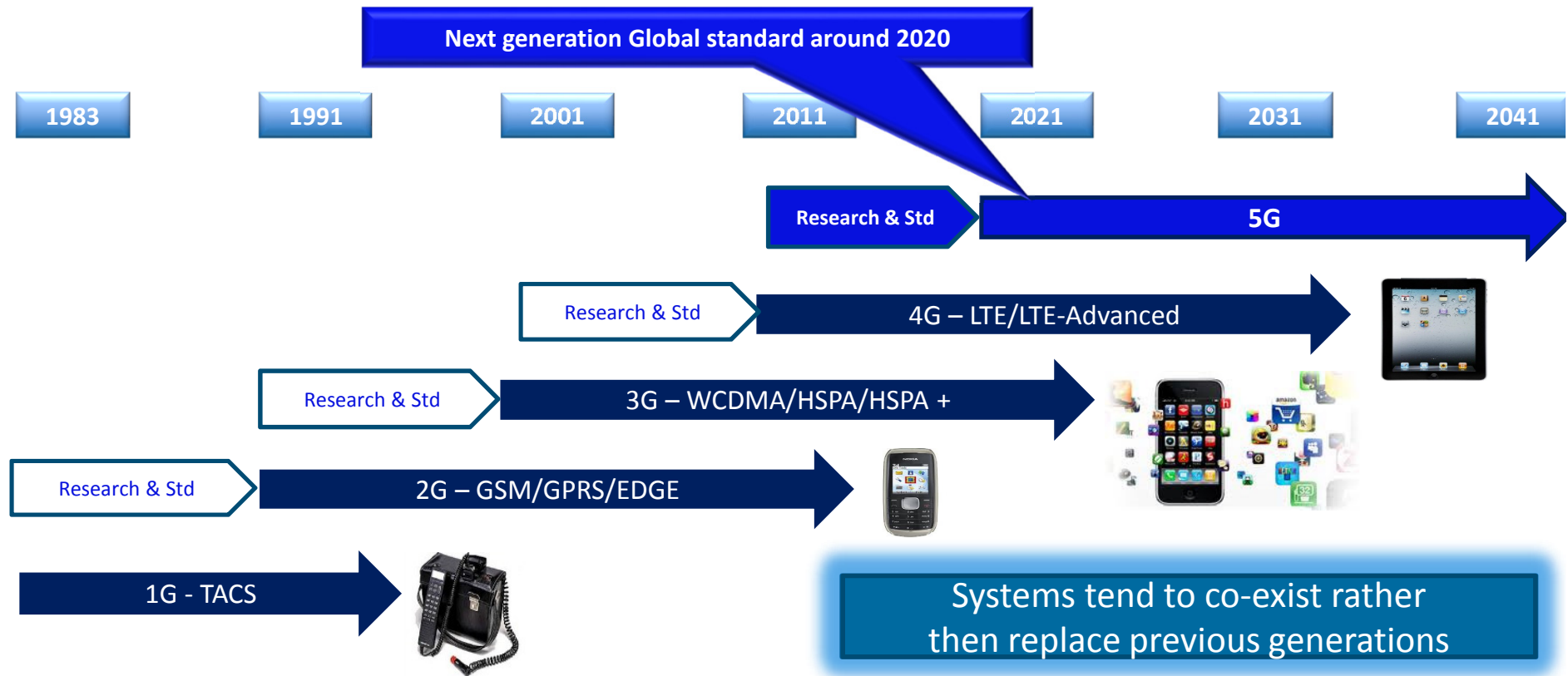
# ART OF POSSIBILITIES?



# IMPACTFUL RESEARCH



# WIRELESS STANDARDS EVOLUTION – 5G



Timescale getting shorter between Research/Standardisation and Commercialisation

**5G IS**

vision

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# NOT JUST MORE OF THE SAME



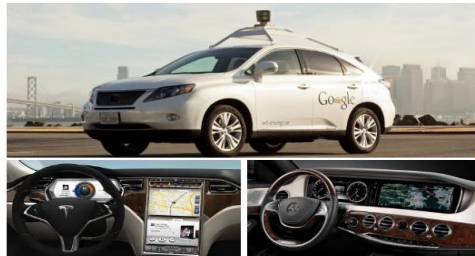
Transformative Wireless connectivity

# COMMUNICATIONS & AUTOMATION

Connectivity + Intelligence (AI and Machine Learning)

Automation

A Car or a Computer on Four Wheels?



KPCB

Data to information transformation



Blurring boundaries between real and cyber worlds



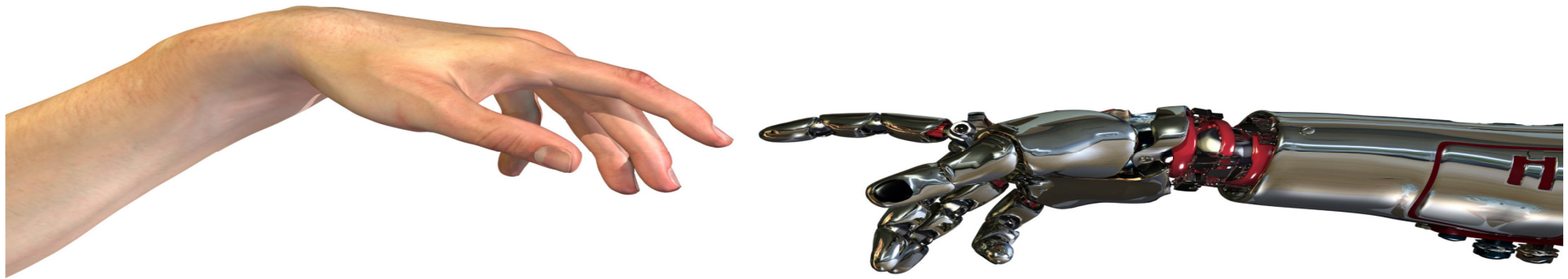
Connected Devices of small and large sizes and capabilities

(robots, cars, sensors, actuators, smart phones ..... driverless cars)



**5G is**

Enabler of Connected Economy and Society



**WIRELESS CONNECTIVITY  
BETWEEN PEOPLE AND DEVICES  
FOR THE PEOPLE**

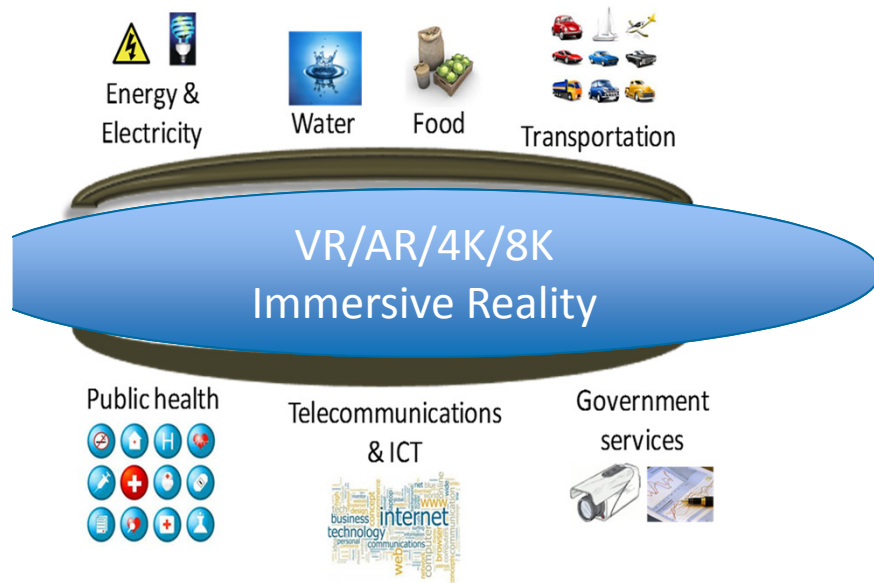
## COVERAGE AND CAPACITY

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### ONE SIZE DOES NOT FIT ALL!

- **LOW+ MEDIUM+ HIGH DENSE CELLS**
  - **CAPACITY LIMITED**
  - **COVERAGE LIMITED**
  
- **5G DEPLOYED WITH 4G AND WiFi**
  - **PIONEER FREQUENCY BANDS**
    - **700MHZ → COVERAGE**
    - **3.5 GHZ → CAPACITY AND COST**
    - **26 GHZ, MILLIMETRE BAND → ULTRA HIGH CAPACITY**

## ONE NETWORK INFRASTRUCTURE SERVING ALL INDUSTRY SECTORS



- Programmable
- Resilient
- Low delay, high reliability
- 1000x more capacity than 4G
- One Million connections per km<sup>2</sup>



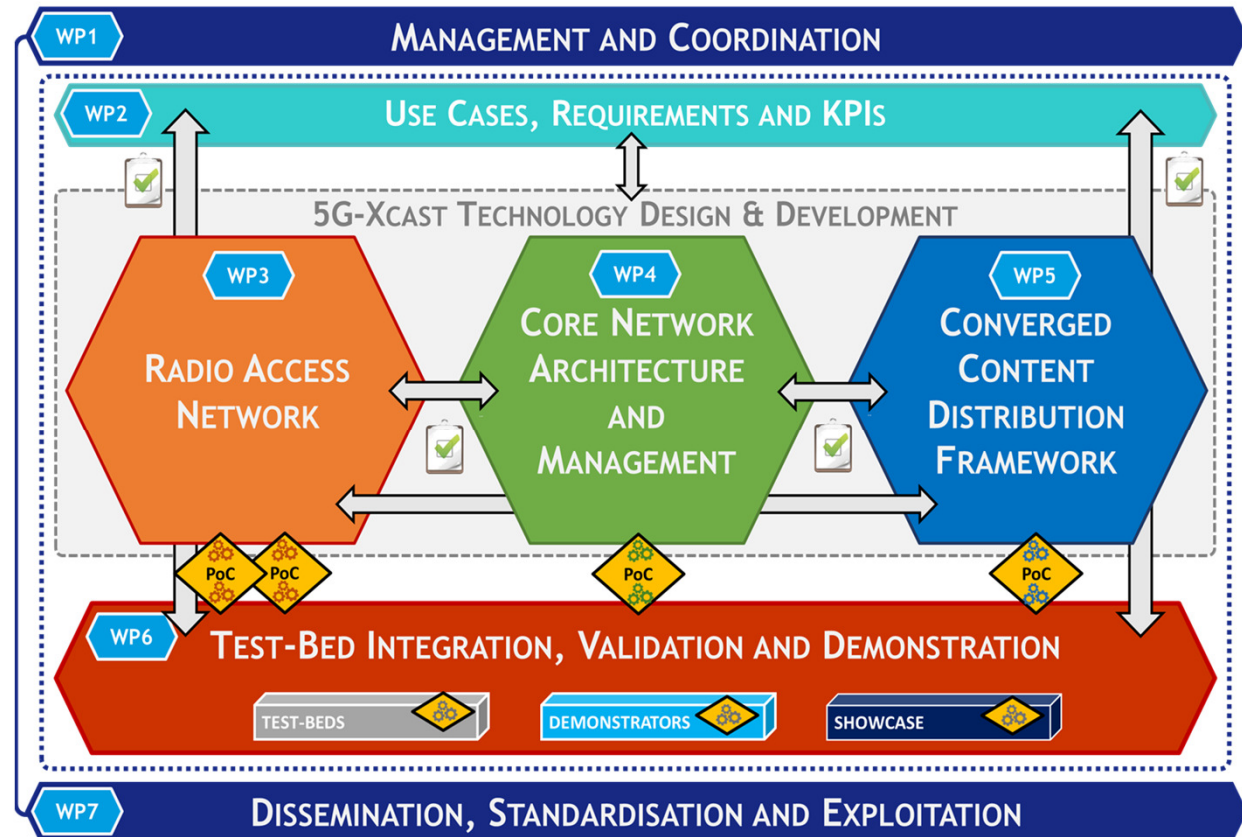
# 5G MULTICAST AND BROADCAST



<http://5g-xcast.eu/>



Scope of Project



PTM Vertical Sector

### **MEDIA & ENTERTAINMENT (M&E)**

- HYBRID BROADCAST SERVICES
- VIRTUAL/AUGMENTED REALITY BROADCAST
- REMOTE LIVE PRODUCTION
- OBJECT BASED BROADCASTING

### **PUBLIC WARNING (PW)**

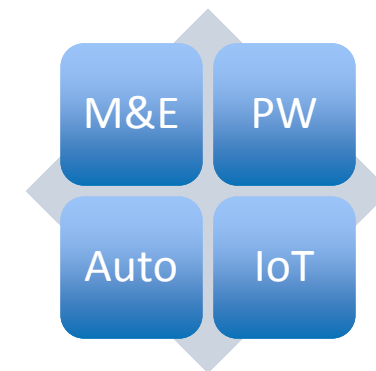
- MULTIMEDIA PUBLIC WARNING ALERT

### **AUTOMOTIVE (AUTO)**

- V2X BROADCAST SERVICE

### **INTERNET OF THINGS (IoT)**

- MASSIVE SOFTWARE AND FIRMWARE UPDATES





# Hybrid Broadcast Service

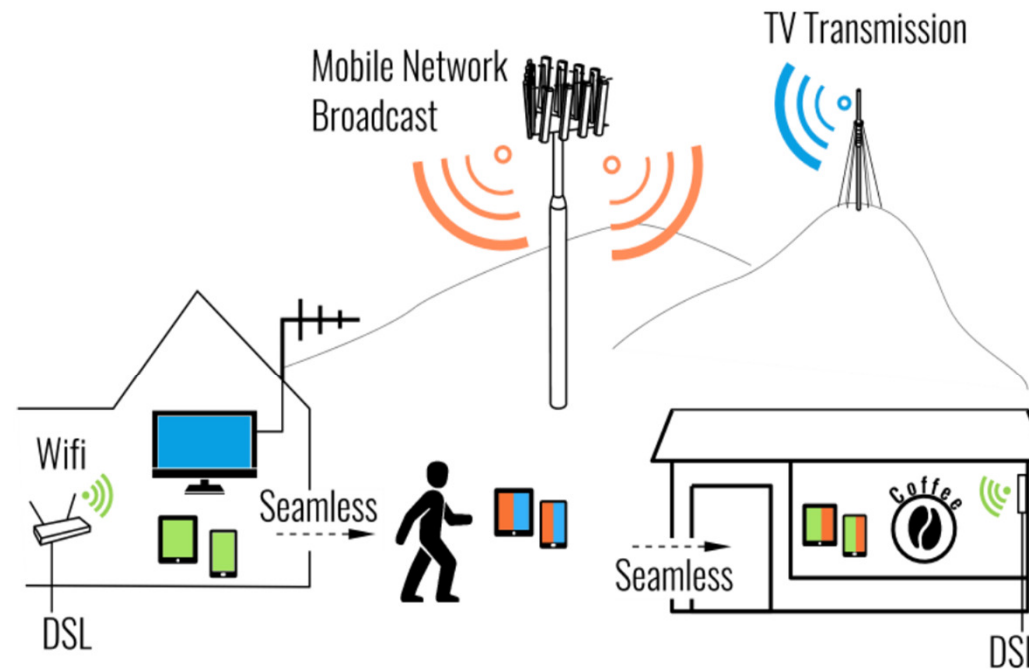


Figure 1 – Use case M&E 1: Hybrid broadcast service; combinations of networks and technologies give a seamless experience as the user moves between different locations

## Virtual/Augmented Reality Broadcast

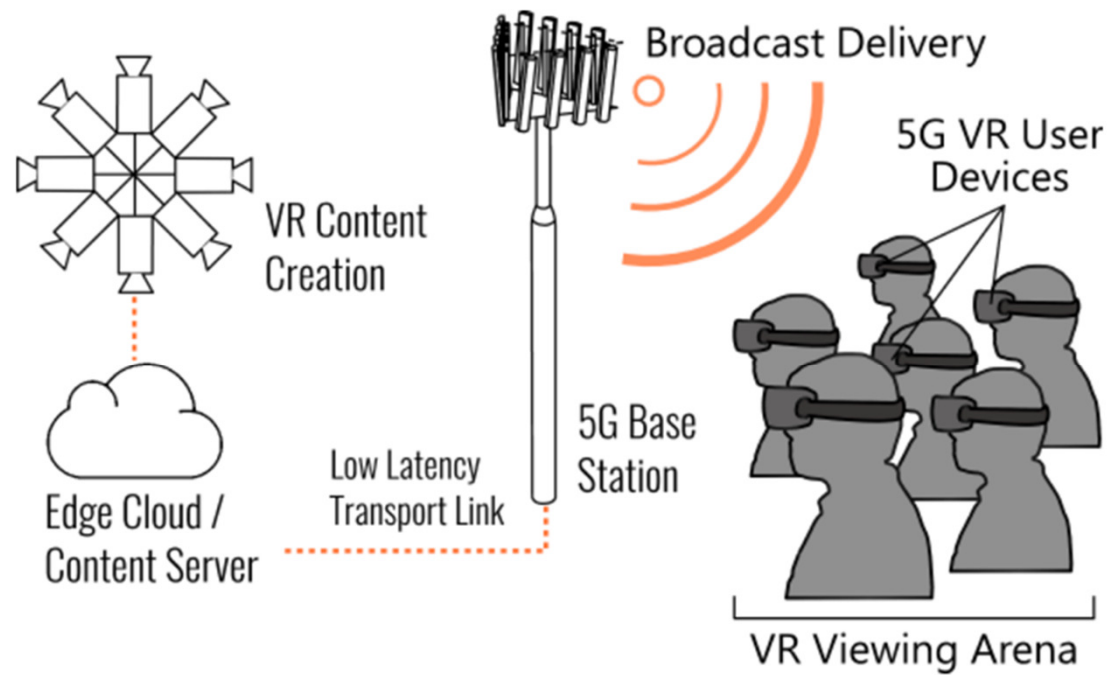


Figure 2 – Use case M&E 2: Virtual/augmented reality broadcast

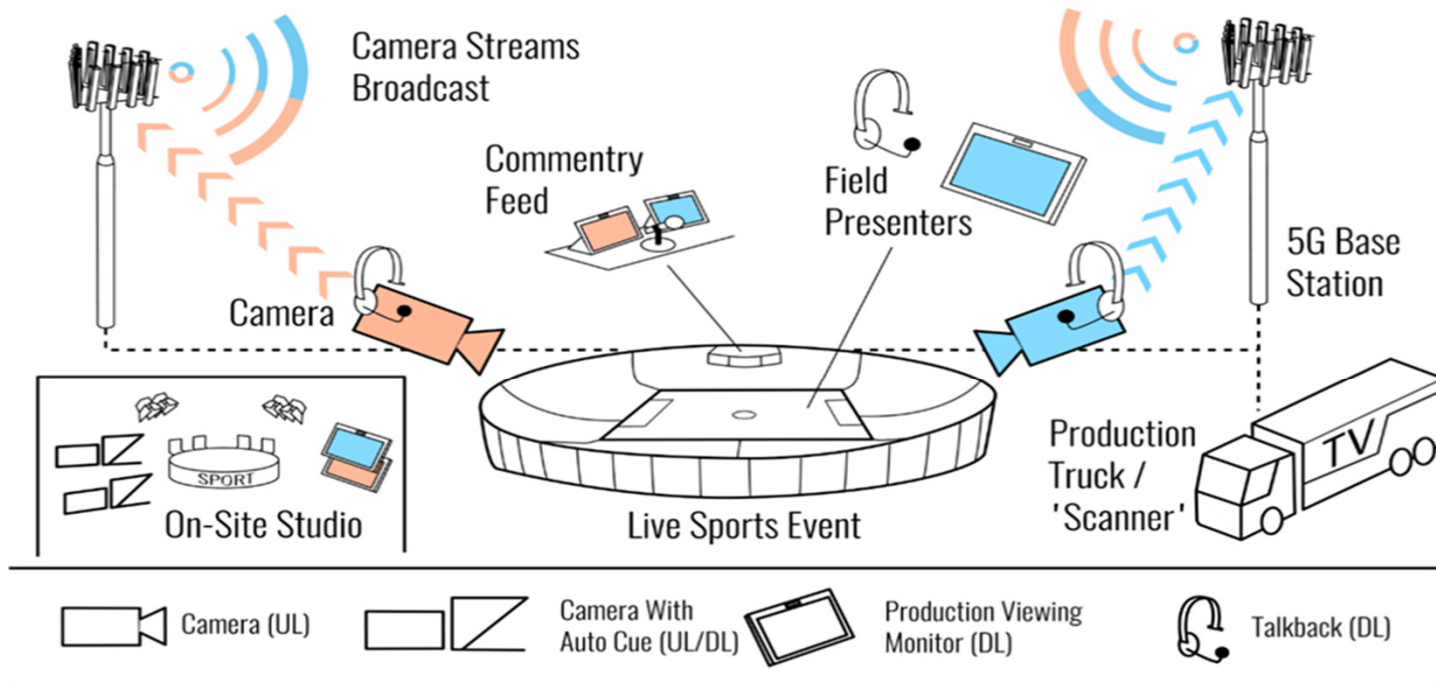
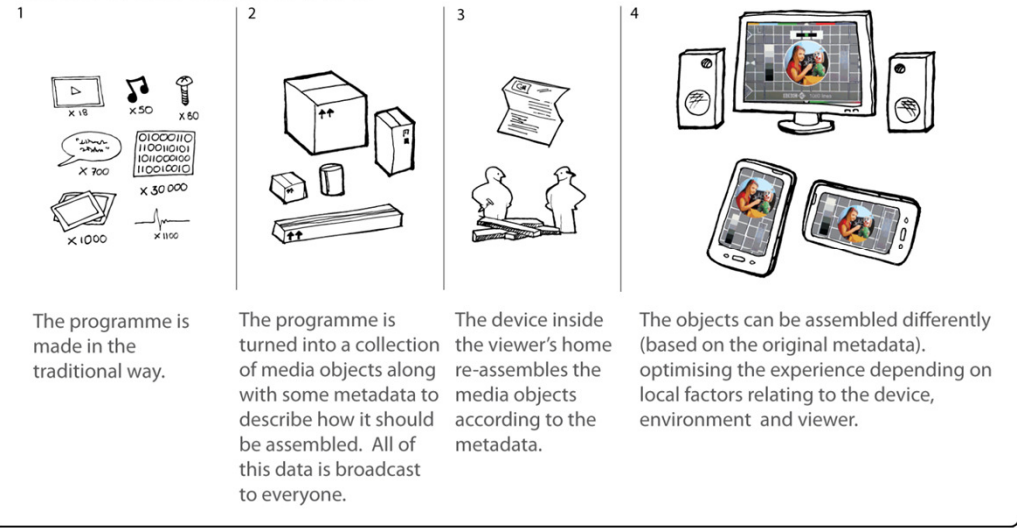


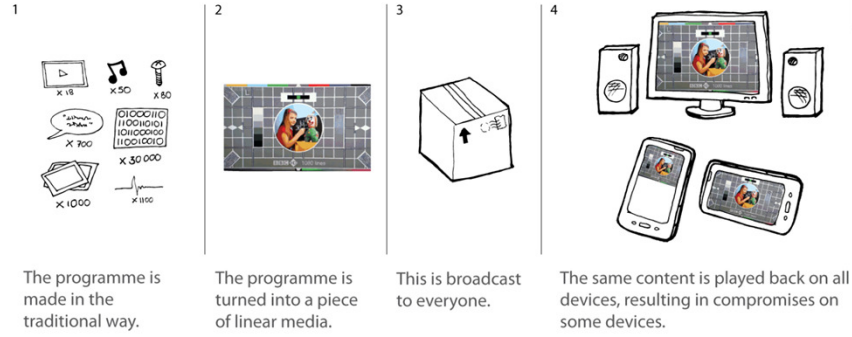
Figure 3 – Use case M&E 3: Remote live production; multiple users often require the same feed, making the use of point-to-multipoint more efficient than point-to-point



## OBJECT BASED BROADCASTING



## TRADITIONAL BROADCASTING



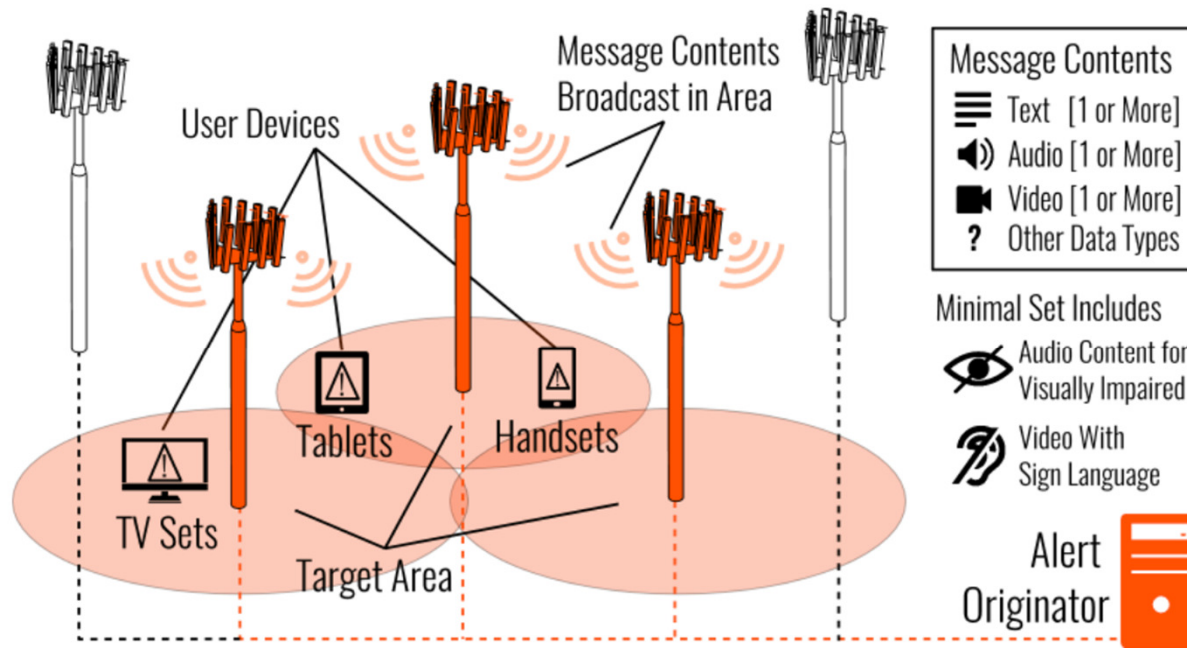


Figure 4 – Use case PW 1: Multimedia public warning alert

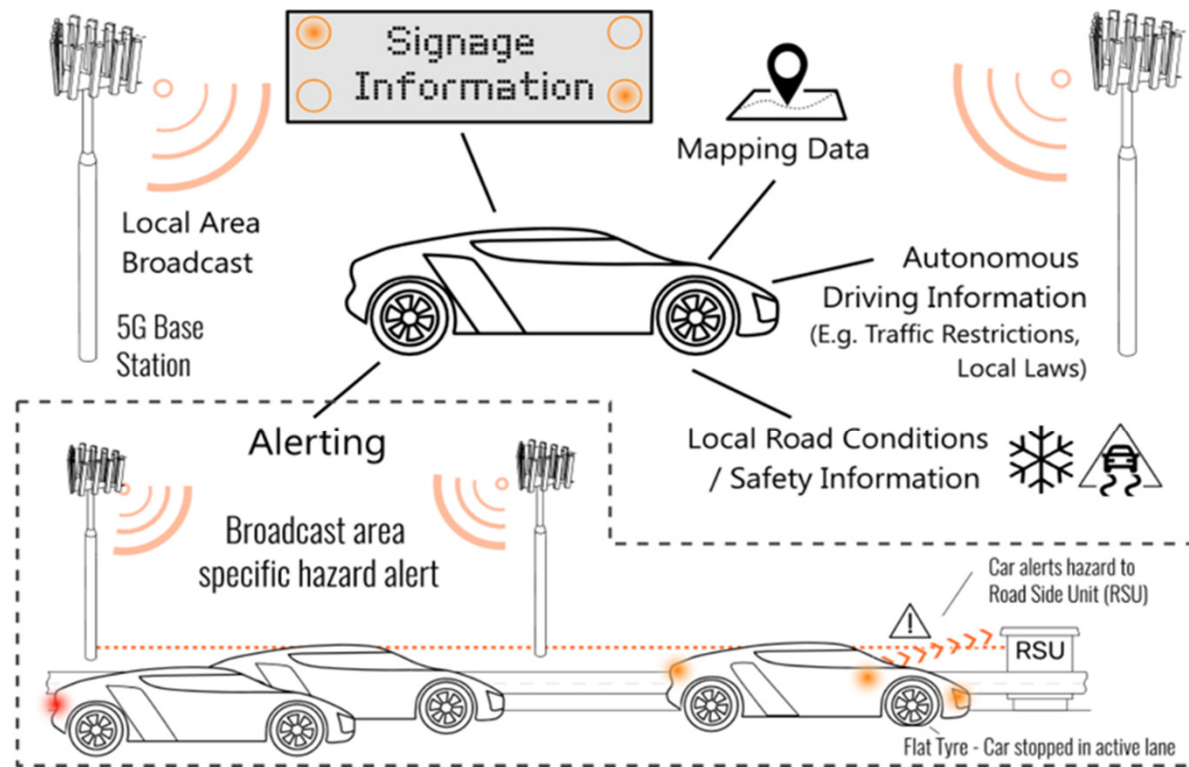


Figure 5 – Use case Auto 1: V2X broadcast service

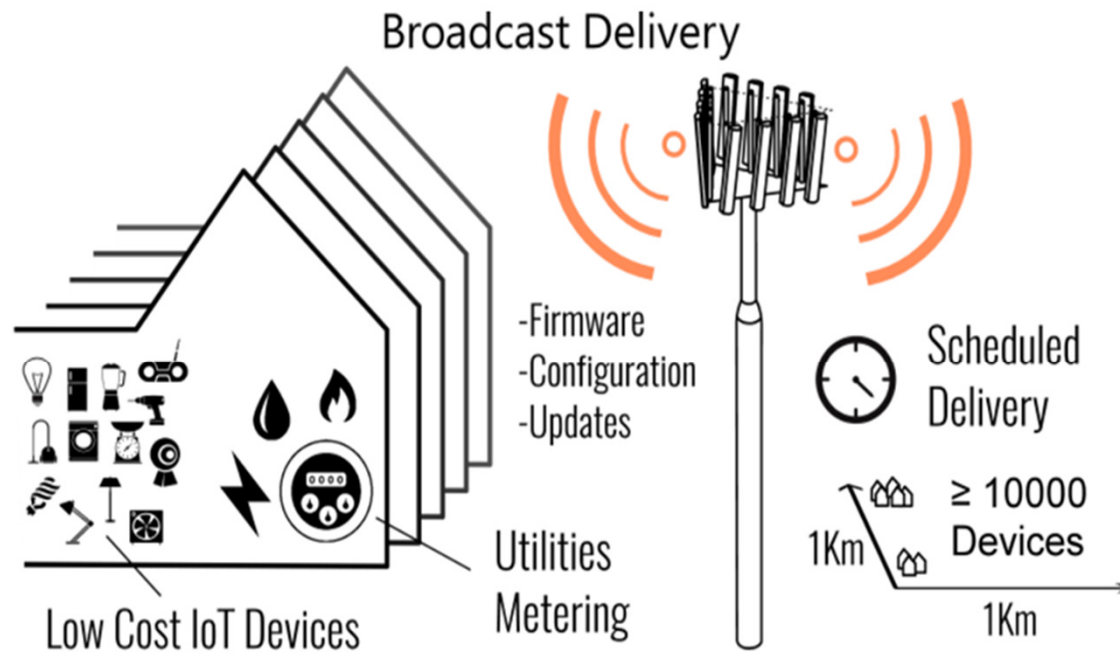


Figure 6 – Use case IoT 1: Massive software and firmware updates

## 4G EMBMS LTLP-WHY NOT

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BANDWIDTH FOR 72 MB/S, INDOOR PORTABLE AND MOBILE

### SPECTRAL EFFICIENCY @ CELL EDGE:

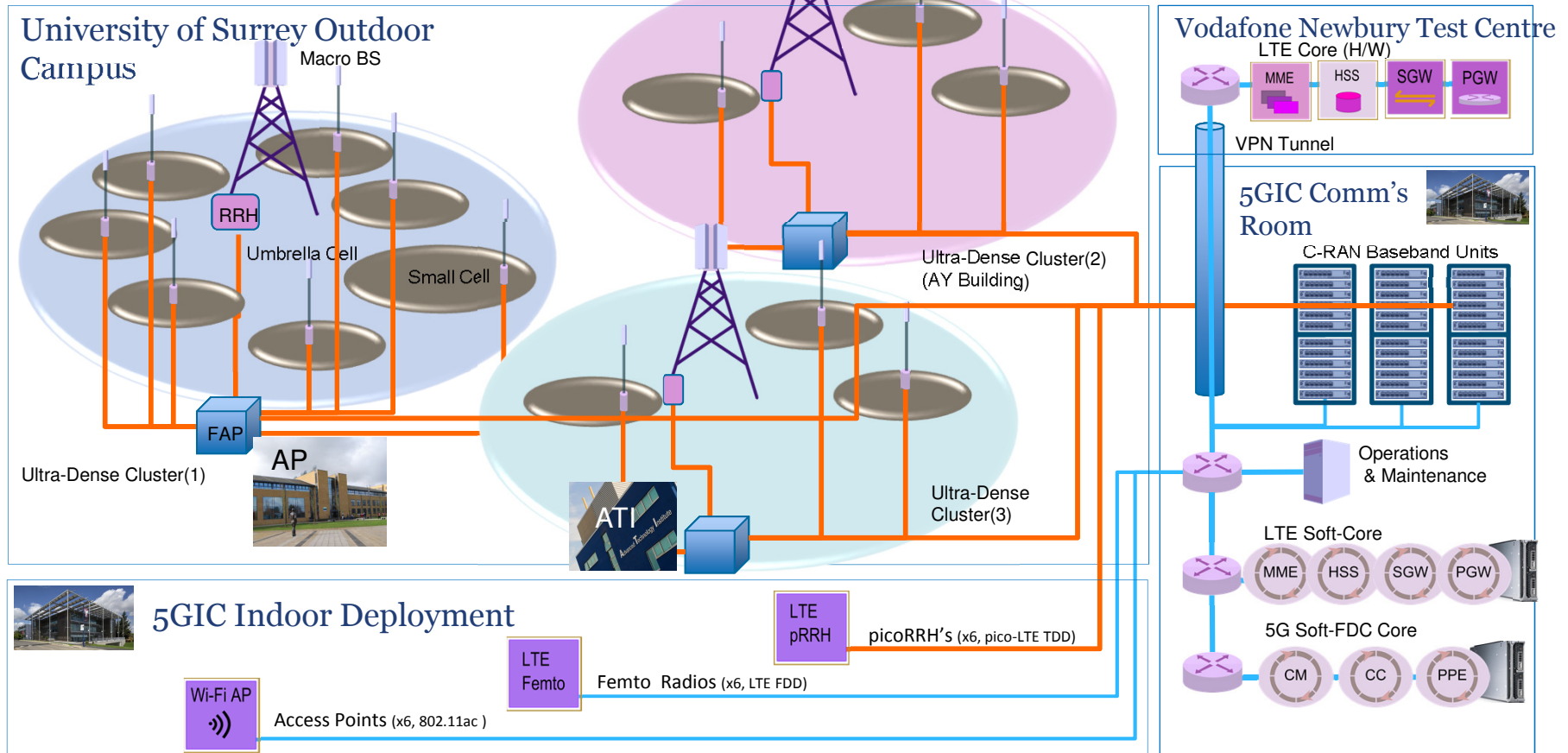
- ISD: 2 -TO-10 KM
- SE: 2.7-TO-0.5 B/S/HZ
- BW: 80-TO-1200 MHZ



# 5GIC ACHIEVEMENTS AND NEW INVENTIONS HIGHLIGHTS

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# 5GIC TEST-BED: ULTRA-DENSE CAMPUS TEST-BED



# WHAT IS FLAT DISTRIBUTED CLOUD (FDC) ARCHITECTURE?

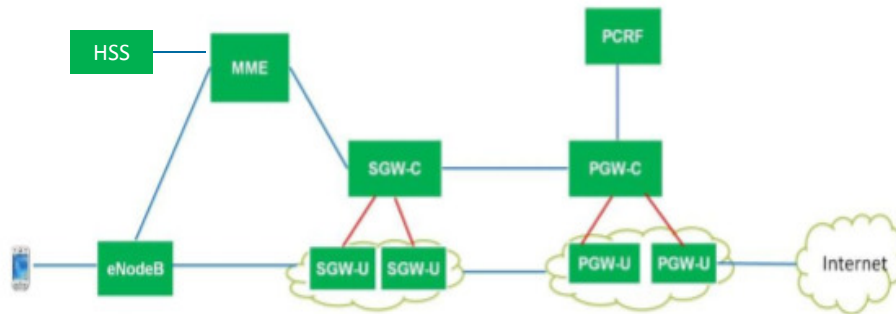
FDC VIRTUALISED , SCALABLE, SECURE AND SUPPORTS CELL-LESS RAN

- **FLATTER THAN PREVIOUS GENERATIONS**

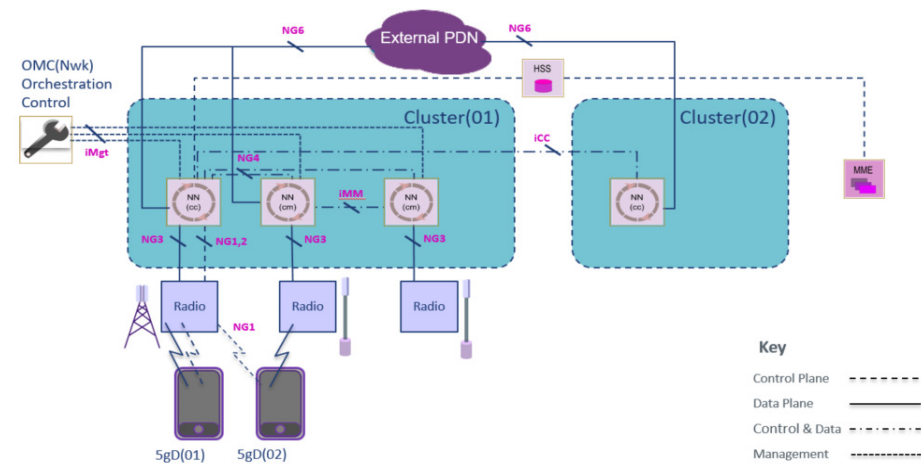
- REDUCING THE NUMBER OF NETWORK LAYERS FROM THREE IN THE LTE TO ONE FOR **70%** OF THE USE CASES AND TWO FOR THE REMAINING **30%**.

- **DISTRIBUTED CLOUD-BASED** → SCALABLE AND NOT SOLELY RELIANT ON LOCAL PHYSICAL RESOURCES

- **SMOOTH MIGRATION** FROM NON-STAND-ALONE TO STAND-ALONE ARCHITECTURE



3GPP, Evolved LTE-A CUPS Architecture



FDC CUPS Architecture

# FDC ARCHITECTURE



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Fully Programmable Network Architecture

- **END TO END NFV**
    - **IMPLEMENTED AND TESTED, IN 5GIC FLAT DISTRIBUTED CLOUD ARCHITECTURE (SEP 2016)**
  
  - **NETWORK SLICING**
    - **NFV/MANO DEPLOYMENT TIME < 2 MINUTES PER VNF OR NSD (<3GBYTE IMAGES)**
    - **(C.F MONTHS FOR CONVENTIONAL DEPLOYMENT)**
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## **CHALLENGE**

- **OPENSTACK NFV PLATFORM IS IN ITS EARLY DAYS FOR TELECOMS CAPABILITY AND INTRODUCES LATENCY AND USER PLANE THROUGHPUT LIMITATIONS**
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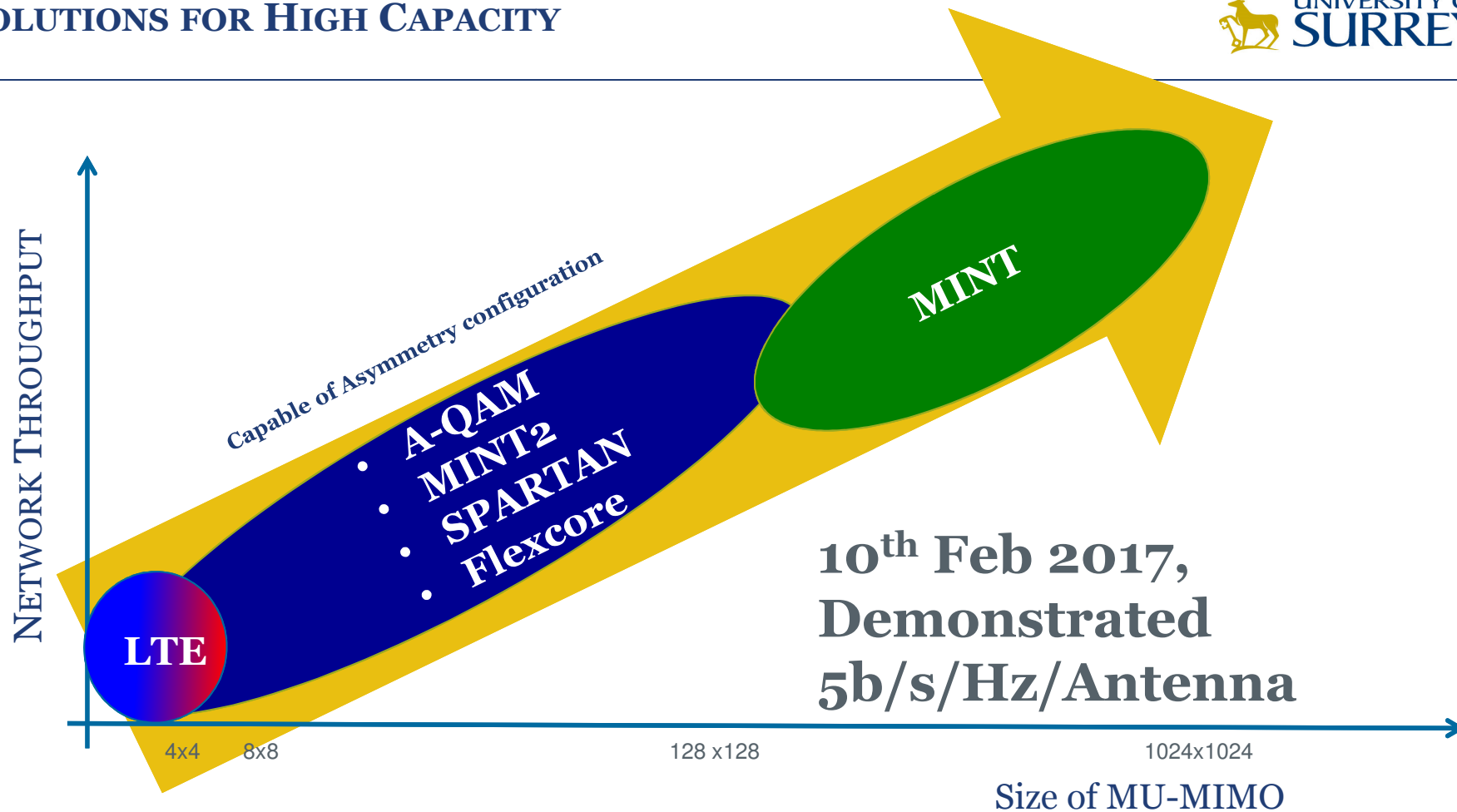


## 5GIC ADVANCES

- **TRANSMISSION OF 4K ( ULTRA HIGH DEFINITION) VIDEO ON A MOBILE NETWORK**
  - **1<sup>st</sup> in the world, Sep 2015**
  
- **NOVEL SCMA TECHNIQUE OF FOR SUPPORT OF massive connectivity OF IOT DEVICES**
  - **300% more connectivity than 4G**
  - **1<sup>st</sup> in the world, Sep 2015**



# SOLUTIONS FOR HIGH CAPACITY



## SUMMARY

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### 5G Network

- **SPECIAL GENERATION**
- **ONE NETWORK TECHNOLOGY FOR ANY SERVICE AND ANY CAST (XCAST)**
- **TOO COMPLEX TO BE MANAGED BY HUMAN OPERATORS**
- **THANKS TO VIRTUALISATION, DYNAMIC NETWORK SLICING CAN SET UP ANY SERVICE/NETWORKS FOR LESS 2 MINUTES**

**THANK YOU**

**HAVE A GREAT DAY**

**BEFORE THAT**

**HAVE AN EARLY EXPERIENCE OF 5G**