

University of Surrey – 5G Innovation Centre

Stuart Revell



Agenda

13:30 – 15:45 Moderator: Stuart Revell, 5G Innovation Centre, University of Surrey
Session 3: Plotting the path to 2020 and beyond

As we continue to move forward with the development of 5G technologies and solutions, we move closer and closer to realising the vision of connectivity for people and objects everywhere. 2020 is universally seen as the target for wide scale 5G rollout, but this is not where the challenge will end – it is estimated that 5G technologies will peak in around 2040, so it is essential that the groundwork that is being put in now does not only consider the short term requirements for network rollout, but also looks beyond to the requirements to enable its growth and a sustainable future. This session will plot both the short and long term path to widespread 5G adoption by first looking at the transition period in the lead-up to 2020 and how to best manage the shift from 4G to 5G; and then to the longer term future and at the challenges and opportunities ahead as we look to ensure a sustainable 5G future.

- 13:30 – 13:50 Presentation: From previous generations to 5G: An integrated and robust IoT platform
Stuart Revell, 5G Innovation Centre, University of Surrey
- 13:50 – 14:10 Presentation: Next Generation Internet Protocols: 5G & the Internet, finding the best path together
Andy Sutton, Principal Network Architect, BT UK
- 14:10 – 14:30 Presentation: Toward 5G Deployment in 2020 and Beyond
Takehiro Nakamura, VP and Managing Director of 5G Laboratory, NTT DOCOMO, Inc.
- 14:30 – 15:45 Panel Discussion: Delivering a sustainable and long-term 5G future
- Bernard Barani, Deputy Head of Unit, Dir E, Network Technologies, European Commission
 - Ruy Pinto, Group Chief Operations Officer, Inmarsat plc (on behalf of ESOA)
 - Mike Short, Vice President, Telefónica Europe
 - Bashir Gwandu, Chairman, Commonwealth ITU Group

What is the 5GIC?

Based at the University of Surrey (UoS) in the Institute of Communications Systems (ICS)

World's largest academic/industry research partnership & test facility for the development of future 5G Communications.

£5m from Enterprise M3 LEP to support:

- 5GIC test facilities development
- Step-out 5GIC facilities to SMEs within the region
- Create 5G Incubation Facilities at key locations within the region
- Develop links to other LEPs such as Bucks & Thames Valley

£58m already invested by industry partners (below)

£12m investment from the Higher Education Funding Council.

UK based and with significant international connections to China, Korea & Japan

EM3 Board link between 5GIC and China Britain Business Council.



enterprise **m3**
Driving prosperity in the M3 corridor

Chemring
Technology Solutions

ROHDE & SCHWARZ

ascom

HUAWEI

BT

EE

Telefonica

O₂ 
vodafone

CATAPULT
Connected Digital Economy

mycomOSI

TEOCO

BBC

Ordnance Survey

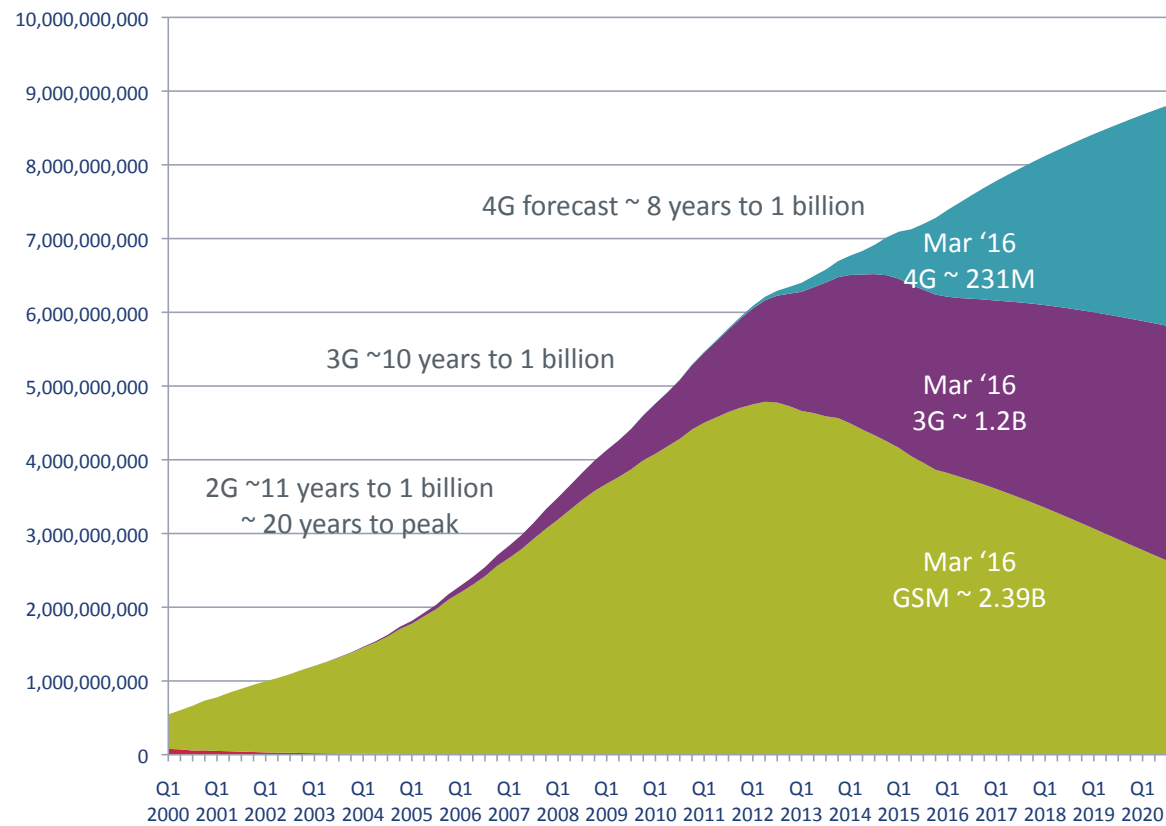
Ofcom

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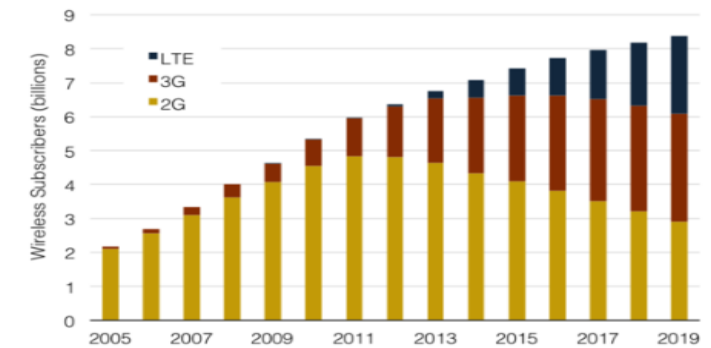
Imagination

工業技術研究院
Industrial Technology
Research Institute

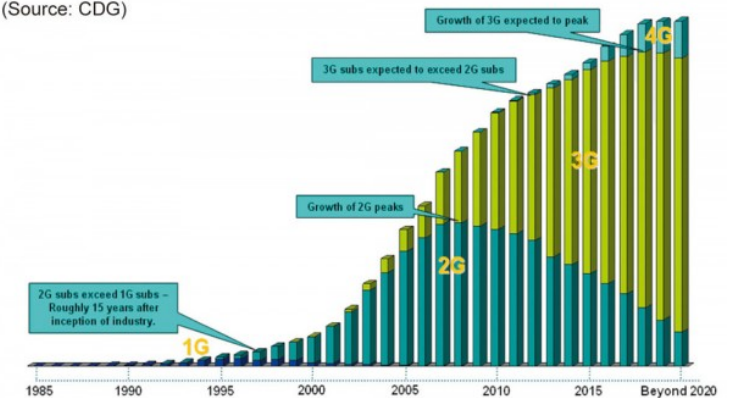
Mobile Subscriber Evolution (excluding m2m)



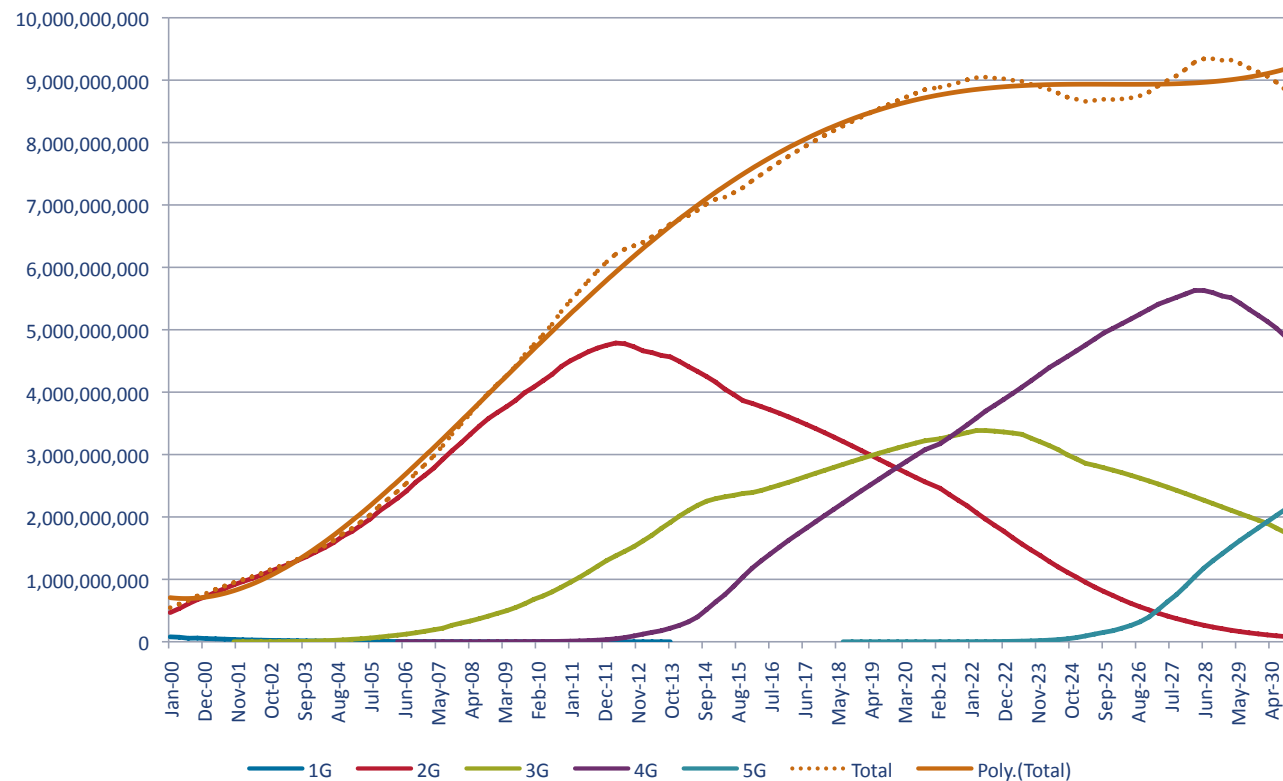
Wireless Subscribers by Technology, 2005-2019



(Source: CDG)



Mobile Subscriber Evolution (excluding m2m) extrapolated to 2030



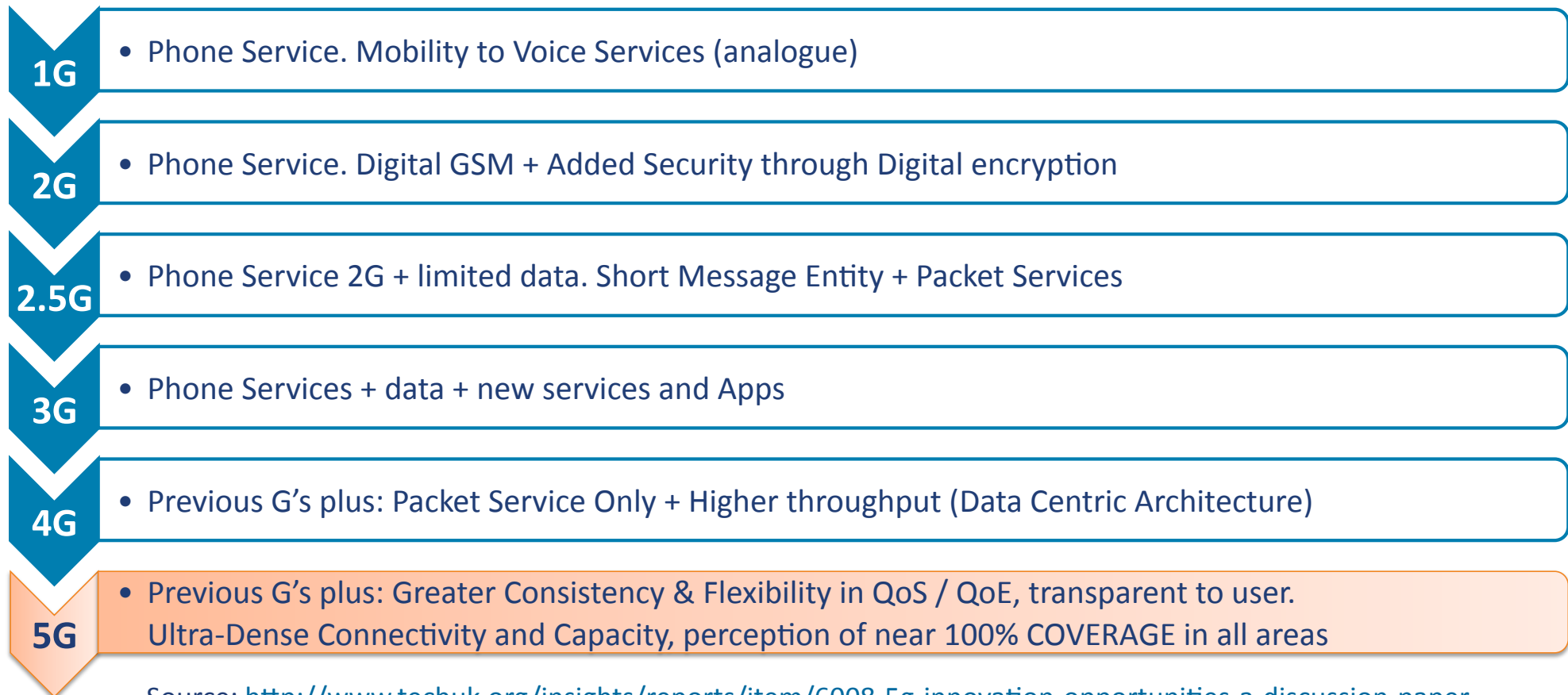
Assumptions

- Growth rate and profile follow previous generations
- April 2016 to 2020 GSMA forecasts
- 2020 to 2030 Extrapolated scenario using historical profiles by RTACS ltd.

Technology	Introduction Year	Peak Year
2G	1991	2012
3G	2001	2022
4G	2007	2028
5G	2018	2039

Source: GSMA and RTACS Ltd.

1G to 5G evolution

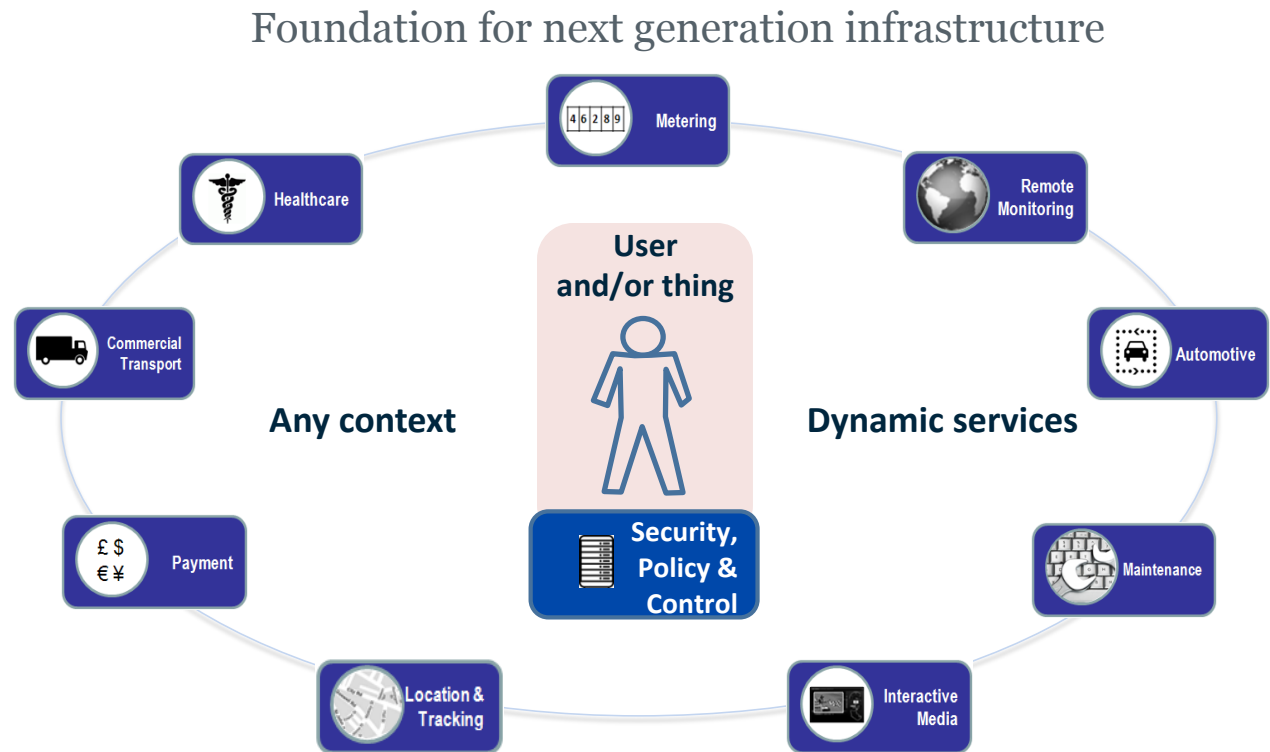


Source: <http://www.techuk.org/insights/reports/item/6008-5g-innovation-opportunities-a-discussion-paper>

5G vision, seamless services with perception of sufficient bandwidth and coverage in any context

Market drivers and use cases for 5G

- **Competitiveness**
 - Coverage
 - Capacity
 - Business model CAPEX / ARPU
 - Efficient Spectrum utilisation
 - Explosive digital growth
 - Businesses
 - Services
 - Data
- **Internet of Things / Vertical / Tactile**
 - Critical infrastructure
 - Smart Cities
 - Health & Social care
 - Sports & Fitness
 - Travel
 - Rail
 - Automotive
 - Planes
- **Safety & Security**
 - Finance / payments
 - Public safety
 - Cyber security through design
- **Extreme video**
 - Virtual & Augmented reality
 - Higher resolution -> SD -> HD -> UHD
 - Broadcast
 - On demand



Next generation services enabled, abstracted complexity

Technology and innovation opportunities

		NETWORK INNOVATION (Network of Networks and interworking)				RADIO INNOVATION (including licensed and licence-exempt)		
Core 5G requirements		Mobile (Cellular)	Fixed (Satellite, Broadcast, xDSL, Fibre, Wireless)	Content delivery (CDN – edge / user)	Core Networks / Management (SDN/NFV)	<1GHz	1-6GHz	>6GHz
1	1-10Gbps connections to end points in the field (i.e. not theoretical maximum)	5G Radio Access Technology	Access technologies	Content / stored data nodes near to the EDGE and USERS	Backhaul and core network connectivity	Leveraging best available existing air interfaces and evolution to 5G RAT		Developing new technologies and 5G RAT
2	1 millisecond end-to-end round trip delay (latency)	CROSS NETWORK = 5G DIGITAL FABRIC Interworking Innovation enabled through Trials and Test Beds. Including cross boundary Security, Policy, Control, Identity and Monetisation				MULTIPLE RADIOS = 5G DIGITAL FABRIC Spectrum usage and management innovation enabled through trials and test beds. Multiple networks, bands and/or air interfaces and control and/or user plane		
3	1000x bandwidth per unit area							
4	10-100x number of connected devices							
5	(Perception of) 99.999% availability							
6	(Perception of) 100% coverage							
7	90% reduction in network energy usage	MAJOR CHALLENGE - Radical low energy technology evolution at multiple levels for each area: materials, device, systems and cross network						
8	Up to ten year battery life for low power, machine-type devices							

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5G vision, seamless services with perception of sufficient bandwidth and coverage in any context



Four keys areas:

1. High Speed Broadband (HSB)
2. Network Availability, Capacity & Coverage (AC&C)
3. Massive Internet of Things (MIoT)
4. Critical Internet of Things (CIoT)

Underpinned by extremely LOW POWER (LP)

- User equipment
- Networks
- Nodes
- Components

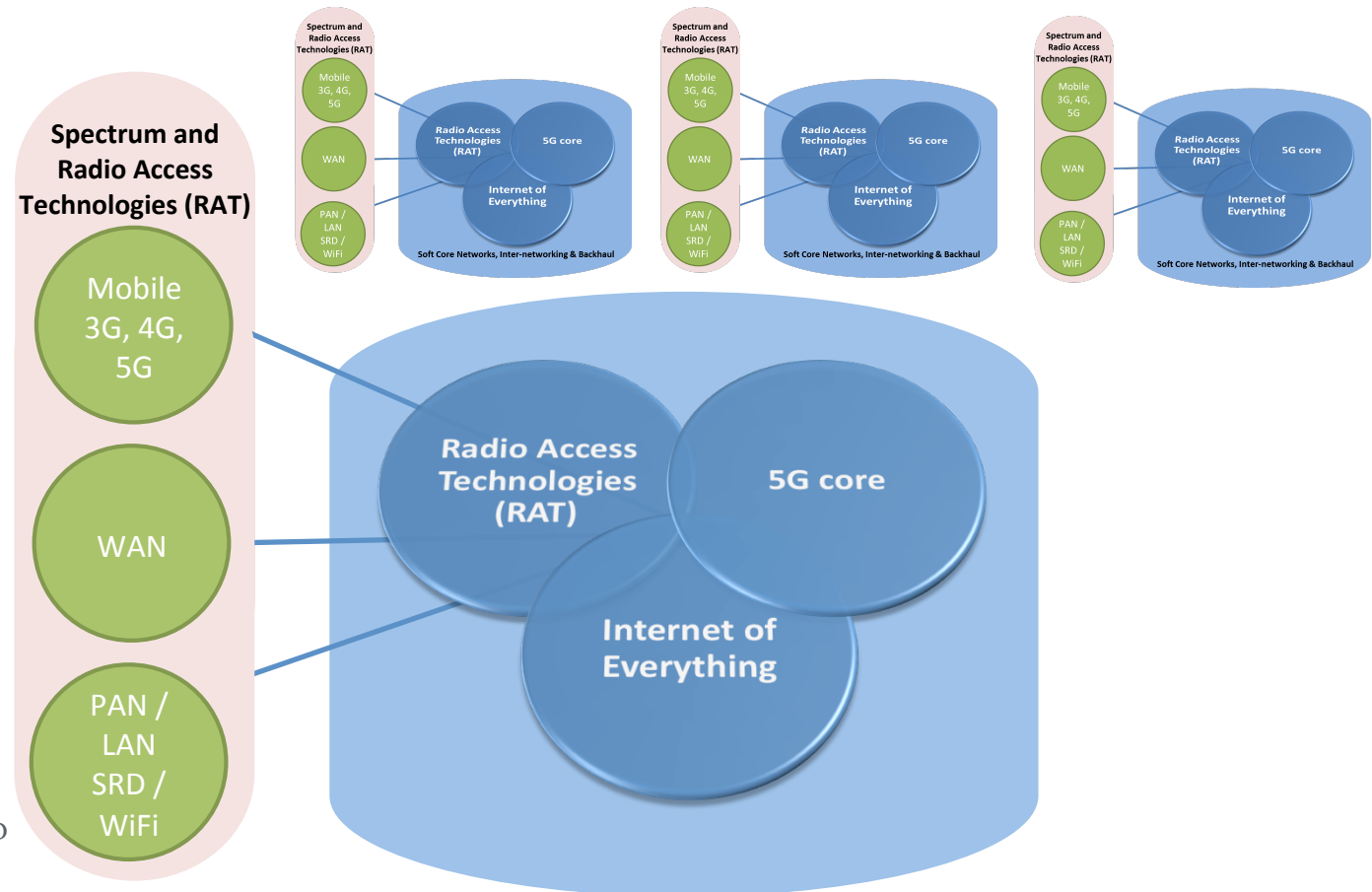
Operating seamless across network boundaries

- Public
- Private

5G & IoT scope – traditional view

Market drivers and use cases for 5G

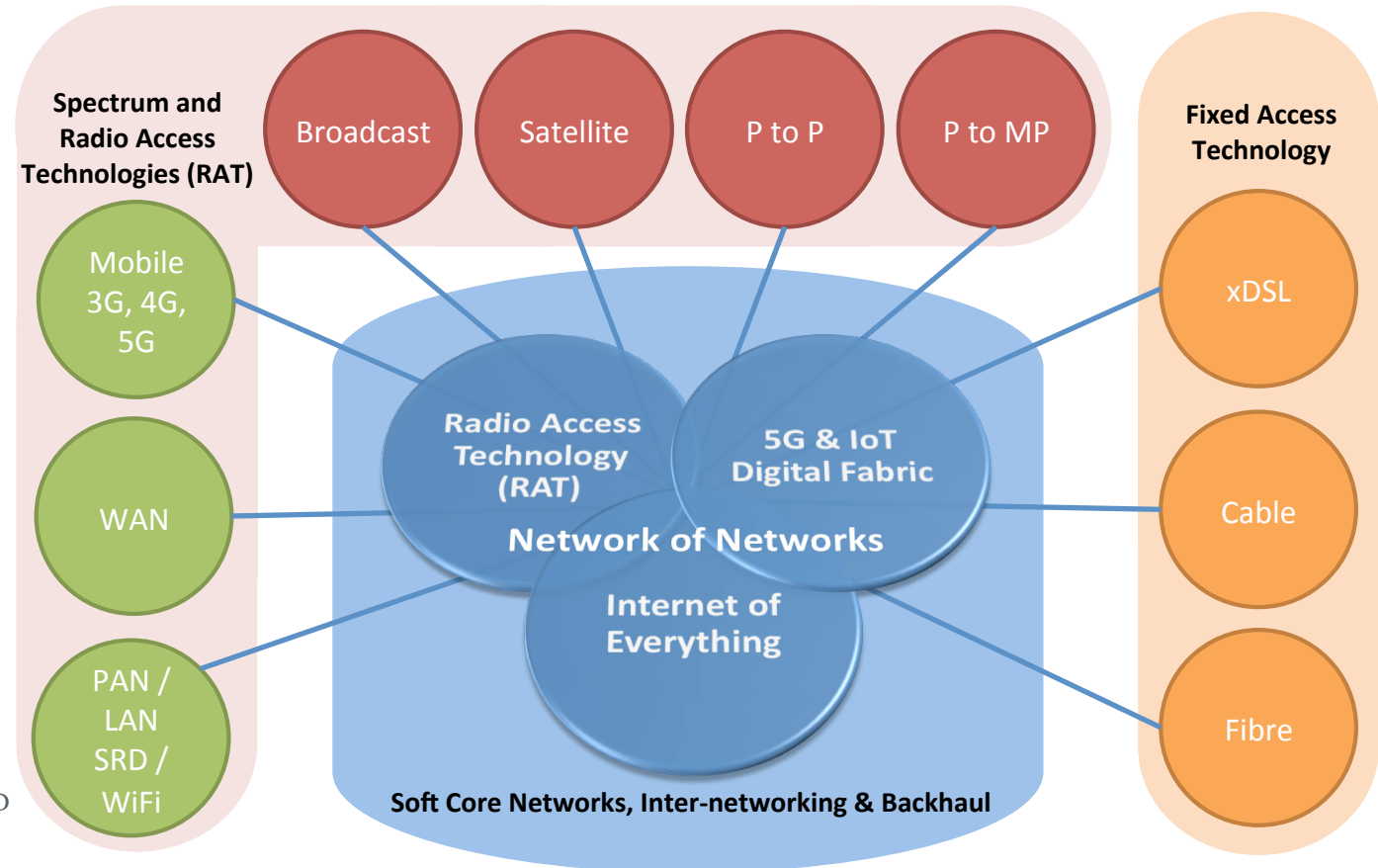
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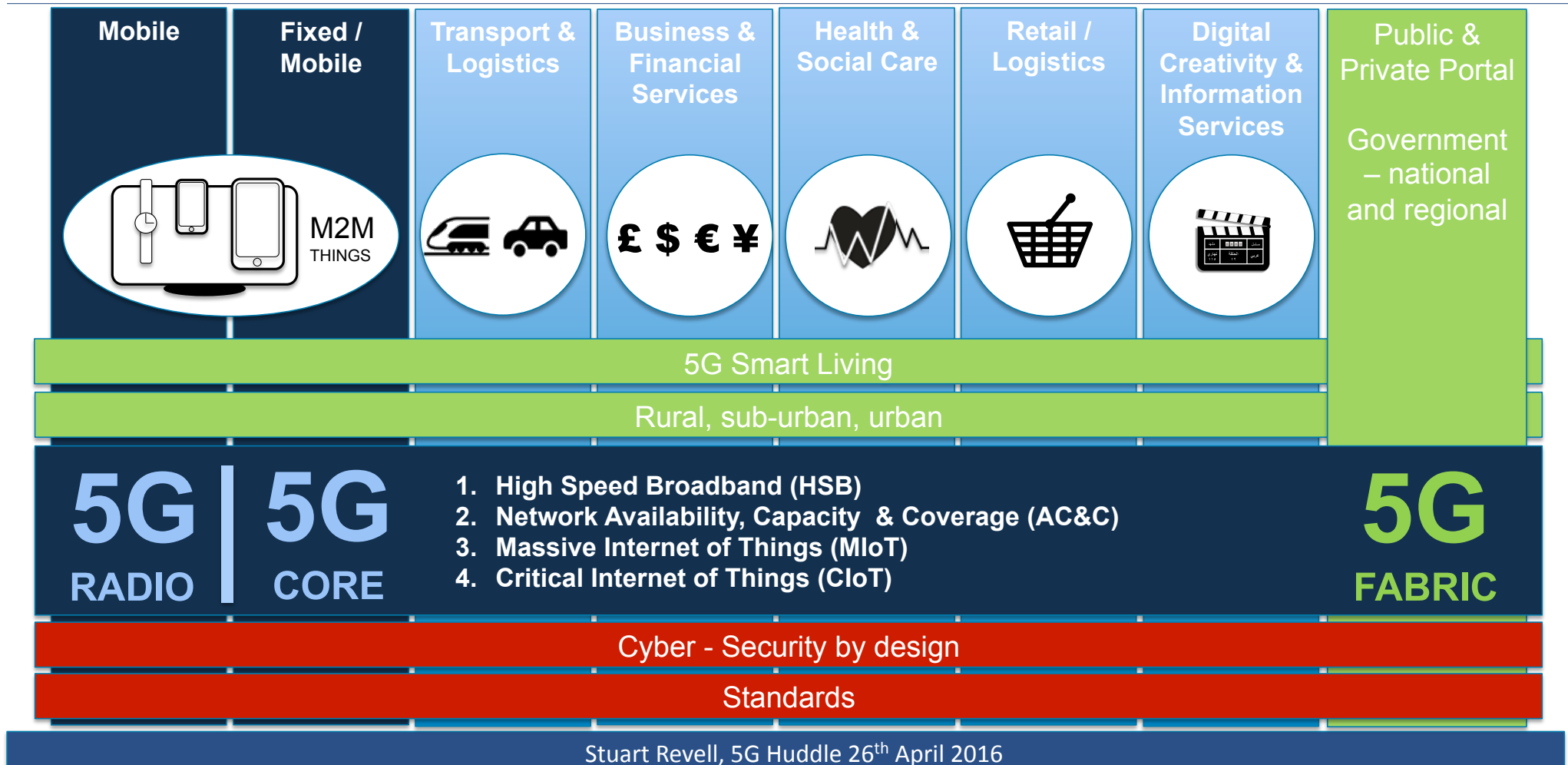
5G & IoT, scope and evolution – Network of Networks Vision

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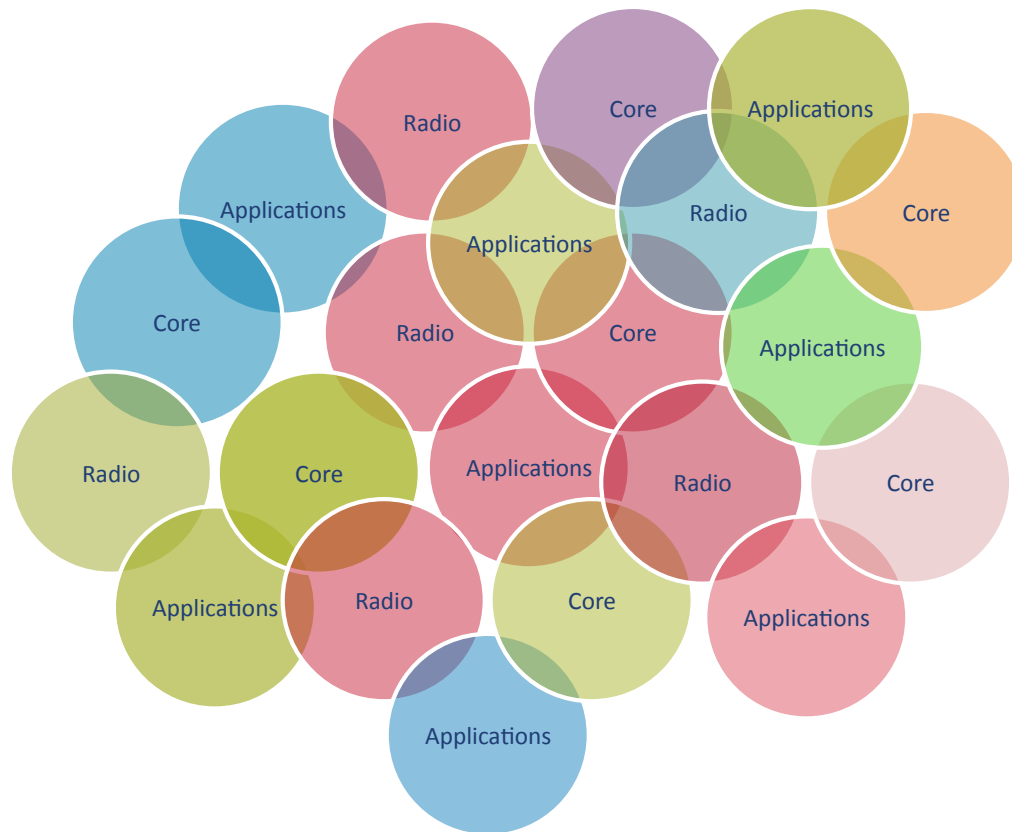
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Verticals – 5G technology pull, network of networks



Network of Networks – Design for collaboration across boundaries



Next generation networks recognising that borders exist.

- Multiple network owners
- Internet 'not fit for purpose' in next generation digital world
- Market Place & Digital Fabric - People and services must seamlessly connect with:
 - Context awareness
 - CoS
 - QoE
 - QoS (prioritisation)
 - Security
 - Payment across chain

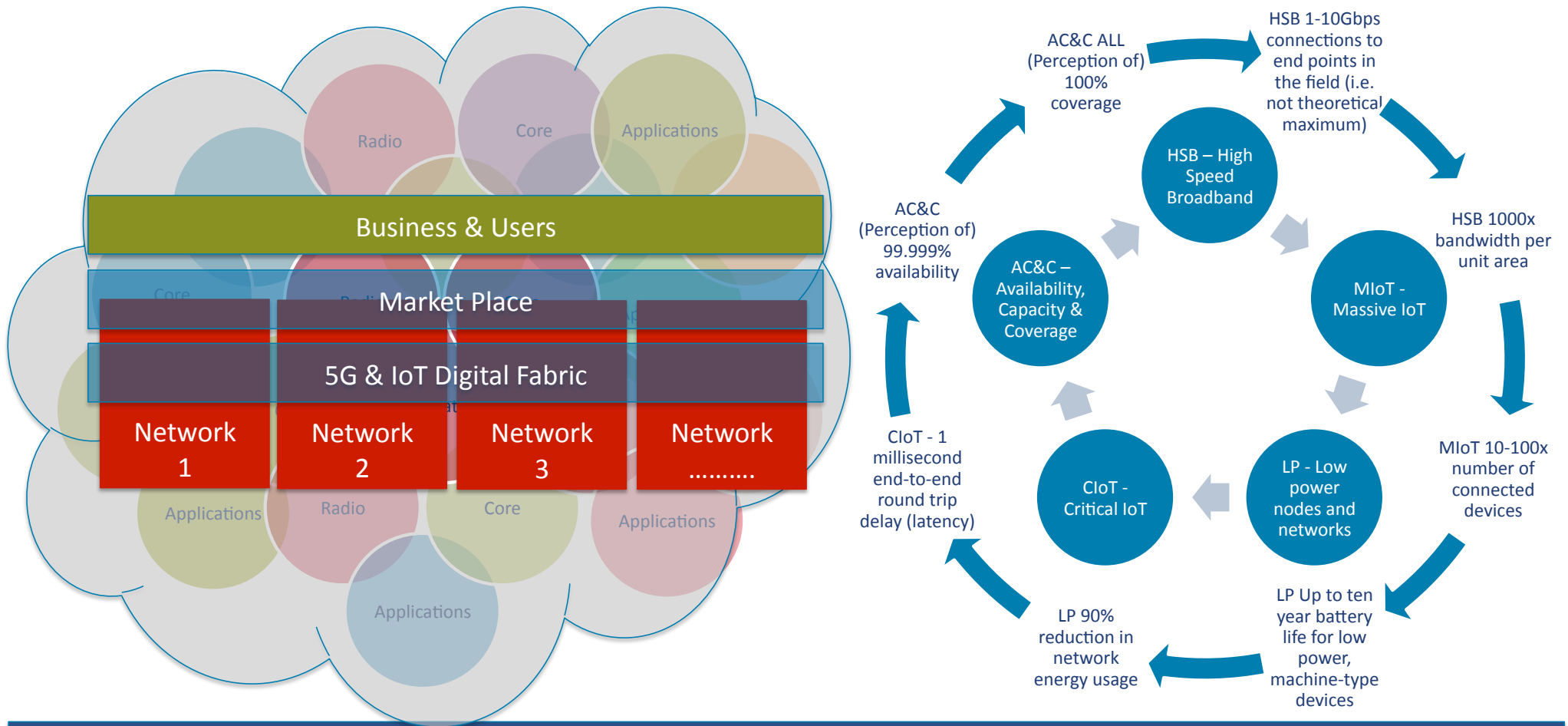
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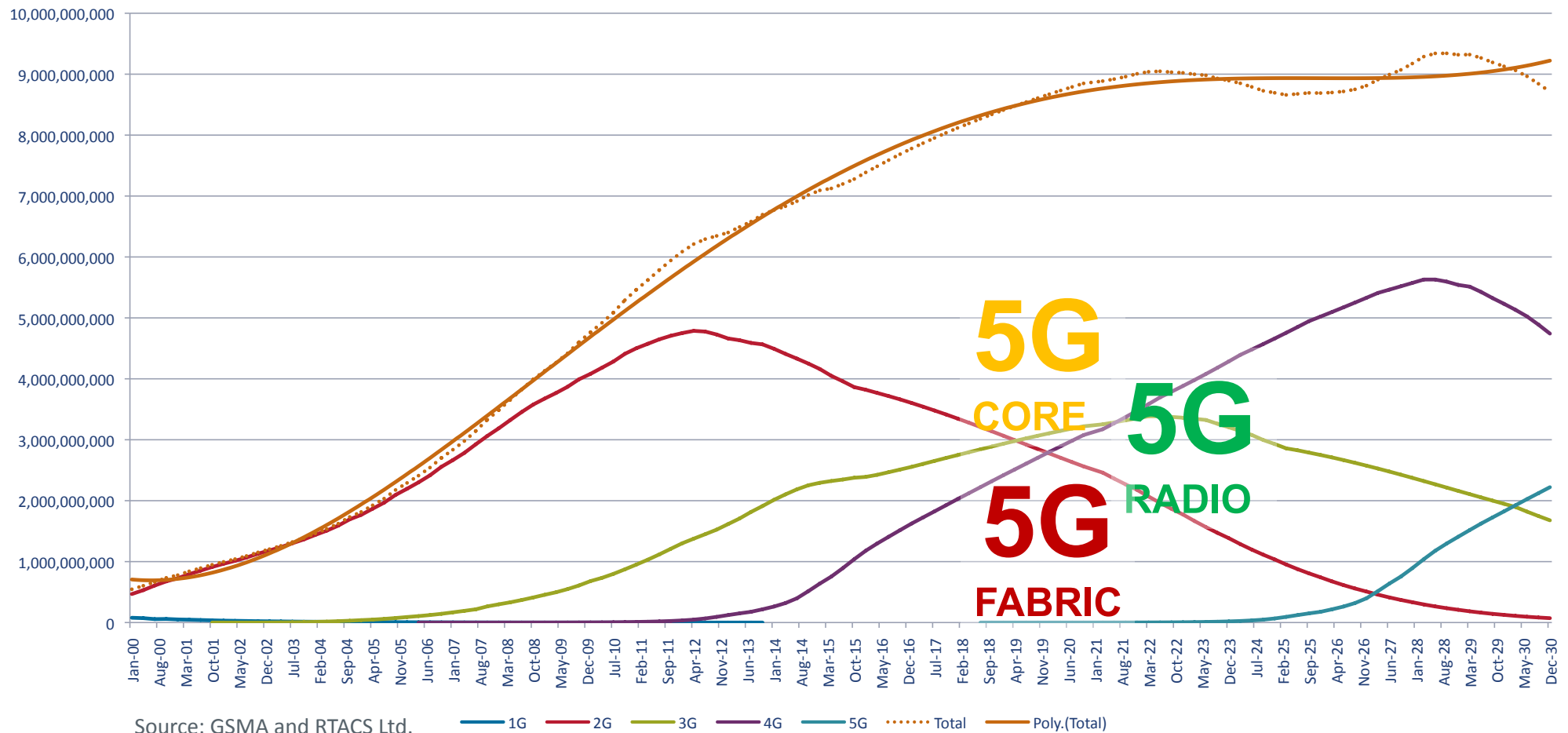
5G & IoT Digital Fabric - Design for collaboration across boundaries



Discussion points

5G RADIO	5G Radio Access Technologies Non 5G Radio evolution and usage Co-existence and interference Spectrum
5G CORE	Core Network Evolution Leveraging, connecting and evolving all ICT assets 5G RAT ready, previous G's and other Air Interfaces
5G FABRIC	Network of Networks • Operator to Operator • Operator(s) to Vertical(s) Digital Fabric (Technology) Digital Market Place (Commercial)

Mobile Subscriber Evolution (excluding m2m) extrapolated to 2030



Stuart Revell, 5G Huddle 26th April 2016

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... any Questions?