5G Beyond the Hype: Value & Building Blocks

‘Enabling the Digital Fabric’

Stuart Revell
External Engagement Advisor
5G Innovation Centre (5GIC)
University of Surrey

Mobile +44 (0) 7836 512787
Email stuart.revell@rtacs.com
The 5G Innovation Centre (5GIC) at the University of Surrey is now the largest UK academic research centre dedicated to the development of the next generation of mobile and wireless communications. Bringing together leading academic expertise and key industry partners in a shared vision, the 5GIC will help to define and develop the 5G infrastructure that will underpin the way we communicate, work and live our everyday lives in the future.

The 5GIC has been set up to drive the delivery of a mobile communications and wireless connectivity capable of meeting the needs of tomorrow’s connected society and digital economy.
5G design goals / aspirations

Future eco-system, Network of Networks - providing functionality to address multiple use cases, leveraging common approaches and infrastructure.

**eMBB - Enhanced mobile broadband**
- 1-10Gbps connections
- Cell DL 20 Gbps / UL 10 Gbps
- Indoor 10 Mbps per $M^2$
- User experience DL 100Mbps / UL 50 Mbps
- Orchestration of fixed / mobile eco-system
- Latency 4ms user plane / 10 to 20 ms control plane

**mMTC - Massive machine type communications**
- 1,000,000 per $KM^2$

**URLLC - Ultra-reliable and low latency communications**
- Deterministic quality of service
- Low Latency 1ms user plane / 10 to 20 ms control plane
- Highly secure / resilient

**Increased availability, coverage and capacity**
- (Perception of) 99.999% availability
- (Perception of) 100% coverage

**Mobility modes**
- Stationary 0 km/h
- Pedestrian 10 km/h
- Vehicular 10 - 120 km/h
- High Speed 120 - 500 km/h

**Operating seamlessly across boundaries**
- Public / Private
- Technical / Commercial
### Technology required to make it work

<table>
<thead>
<tr>
<th><strong>5G RADIO</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• 5G Radio Access Technologies (RAT)</td>
<td></td>
</tr>
<tr>
<td>• Non 5G Radio evolution and usage (e.g. WiFi, 3G, 4G)</td>
<td></td>
</tr>
<tr>
<td>• Co-existence and interference</td>
<td></td>
</tr>
<tr>
<td>• Spectrum</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>5G CORE</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Core Network Evolution / Slicing</td>
<td></td>
</tr>
<tr>
<td>• Leveraging, connecting and evolving all ICT assets (e.g. Mobile, Fixed, Fibre, Broadcast, Satellite)</td>
<td></td>
</tr>
<tr>
<td>• 5G RAT ready, previous G’s and other Air Interfaces</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>5G FABRIC</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Network of Networks / System of Systems</td>
<td></td>
</tr>
<tr>
<td>• Operator to Operator</td>
<td></td>
</tr>
<tr>
<td>• Operator(s) to Vertical(s)</td>
<td></td>
</tr>
<tr>
<td>Digital Fabric (Technology)</td>
<td></td>
</tr>
<tr>
<td>Digital Market Place (Commercial)</td>
<td></td>
</tr>
</tbody>
</table>

Radio Access Technology (RAT) is the underlying connection technology for a radio based communication network. Mobile phones support several RATs in one device such as Bluetooth, WiFi, and 3G, 4G or LTE.

The **CORE** is the central part of a telecommunications network that provides various services to customers who are connected by the Access network.

Network Slicing is a proposal to create ‘slices’ of network that are optimised for different things e.g. latency or throughput so that industries with very different priorities can achieve what is important for them.

The **5G FABRIC** is a new concept to connect multiple Networks and / or Services using common approaches and interfaces across different networks and boundaries. This will enable a common eco-system for all developers, users and network owners / operators (including PUBLIC / PRIVATE).
## 5G core requirements mapped to Radio innovation

<table>
<thead>
<tr>
<th>5G Design Aspirations</th>
<th>RADIO ACCESS TECHNOLOGY (RAT) (including licensed and licence-exempt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1-10 Gbps connections. Minimum user experience DL 100Mbps / UL 50 Mbps</td>
<td>&lt;1GHz</td>
</tr>
<tr>
<td>2 1 ms end-to-end round trip delay (latency)</td>
<td>Leveraging best available existing air interfaces and evolution to 5G RAT</td>
</tr>
<tr>
<td>3 Bandwidth per unit area</td>
<td>MULTIPLE RADIOS = 5G DIGITAL FABRIC</td>
</tr>
<tr>
<td>• Cell DL 20 Gbps / UL 10 Gbps</td>
<td></td>
</tr>
<tr>
<td>• Indoor 10 Mbps per M²</td>
<td></td>
</tr>
<tr>
<td>4 Massive machine type communications 1,000,000 per KM²</td>
<td></td>
</tr>
<tr>
<td>5 (Perception of) 99.999% availability</td>
<td>Low capacity, good for control / coverage</td>
</tr>
<tr>
<td>6 (Perception of) 100% coverage</td>
<td></td>
</tr>
<tr>
<td>7 Significant reduction in network energy usage</td>
<td></td>
</tr>
<tr>
<td>8 Up to ten year battery life for low power, machine-type devices</td>
<td></td>
</tr>
</tbody>
</table>
5G Network Architecture

5G SDN/NFV CORE

- Business Application Layer
- Business Enablement Layer
- Infrastructure Resource Layers
  - eMBB
  - mMTC
  - URLLC

End to end management and orchestration

5G FABRIC

Common Information Layer

NETWORK OF NETWORKS

- 5G FABRIC
- RATs

Radio Access Technologies

- 3.5 GHz
- 700 MHz
- 26 GHz
- WiFi
- LTE 2.6 GHz
- Other TBD

Slices

Mobile World Congress Presentation – February 2017
Sectors: verticals and horizontals, public and private

1. Enhanced mobile broadband
2. Network availability, capacity & coverage
3. Massive machine type communications
4. Ultra-reliable and low latency communications

Cyber - Security by design
Standards
5G on the road

The 5G Innovation Centre at the University of Surrey will showcase its innovative research which presents a 5G vision for the automotive industry including a proposition to create a sliced architecture which has the potential to change the car journey experience and value proposition as we know it.

This is based on five key network slices:

- **AUTONOMY & SAFETY:** providing new ways of making the process of driving safer, easier and more comfortable

- **INFOTAINMENT:** the use of real time information, entertainment and content to deliver an enhanced driver experience

- **TELEMATICS:** systems to provide new services and car connectivity for increased driver efficiency and accessible information

- **VEHICLE SENSING:** using sensors to generate information for driver use and for wider distribution, providing community benefits to other road users and organisations

- **CONNECTING SERVICES:** exploring exciting new architectures, creating instant user experience working across multiple physical and virtual boundaries
Autonomy and safety

Common infrastructure and eco-system, delivering multiple use cases:

• Mobile to consumers on the move
• Secure communications to professionals and emergency services
• Machine to machine for safety, critical services and autonomy (e.g. Vehicle to Vehicle and Vehicle to Infrastructure, Train to Trackside)
• Critical infrastructure monitoring and preventive maintenance
• Enhanced routing and load balancing – increasing rail and road utilisation and efficiency.
5G Automotive Example

Mobile World Congress Presentation – February 2017
Digital Market Place, enabled by common 5G eco-system

Business & Users

Market Place

5G Fabric

Network 1

Network 2

Network 3

Network......
Standards – Traditional + Verticals

Technology Building Blocks
- Systems, integration and interoperability

Technology PUSH – Trials and Test Beds
- Vertical engagement

Technology PULL – Trials and Test Beds
- Vertical use cases

2017/8 ICT Standards
- Building consensus and scale

2017 to 20xx Verticals Standards

Service and Apps, Socio-economic challenges
- Health & Social Care
- Modern Built Environment
- Energy & Utilities
- Transport

5G DIGITAL FABRIC
End to End Network Architecture – defining and implementing ‘Network of Networks’