5G opportunities and challenges for automotive

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‘Connected’ ≠ ‘autonomous’ vehicles
Observed trends and future opportunities
Overarching challenges
‘Connected’ ≠ ‘autonomous’ vehicles

Observed trends and future opportunities

Overarching challenges
Future convergence: electrified, connected, autonomous, shared
Defined levels of automation

- **L0**: Driver only
  - Driver continuously in control of speed and direction
  - No intervening vehicle system active
  - Example: Park Assist

- **L1**: Assisted
  - Driver continuously performs the longitudinal or lateral dynamic driving task
  - The other driving task is performed by the system

- **L2**: Partial Automation
  - Driver must monitor the dynamic driving task and the driving environment at all times
  - System performs longitudinal and lateral driving task in a defined use case
  - Example: Traffic Jam Assist

- **L3**: Conditional automation
  - Driver does not need to monitor the dynamic driving task nor the driving environment at all times; must always be in a position to resume control
  - System performs the lateral and longitudinal dynamic driving task in all situations in a defined use case
  - Example: Highway Patrol

- **L4**: High automation
  - Driver is not required during defined use case
  - System performs the lateral and longitudinal dynamic driving task in all situations encountered during the entire journey. No driver required
  - Example: Urban Automated Driving

- **L5**: Full automation
  - Driver only
  - System performs longitudinal and lateral driving task in a defined use case. Recognises its performance limits and requests driver to resume the dynamic driving task with sufficient time margin
  - Full end-to-end journey

SAE J3016
Connectivity: enabling V2X
Three types of connected vehicles communication

Tactical, or ad-hoc (V2V, V2I)
Three types of connected vehicles communication

Strategic (V2C, V2I, mesh)
Three types of connected vehicles communication

Infotainment (V2C)
Technology take-up as a percentage of total UK vehicle fleet

Do autonomous vehicles need connectivity?
‘Connected’ ≠ ‘autonomous’ vehicles

Observed trends and future opportunities

Overarching challenges
Connected vehicle services today and in the future

- Vehicle-to-Infrastructure (V2I)
- Vehicle-to-Vehicle (V2V)
- Vehicle-to-Cloud
- Vehicle-to-Person
- Smartphone Mirroring
- High-Definition Map Updates
- Navigation
- Emergency Call
- Stolen Vehicle Tracking
- Roadside Assistance
- Software-over-the-air
- Insurance
- Mobility Services
- Entertainment
- Location-based Services
- In-car WiFi
- Fleet Management
- Remote Vehicle Interaction

Connected car services
New opportunities upstream and downstream

Component suppliers
Aftermarket
Service, repair and maintenance
Insurance

But how many of these require 5G?
New added value 5G can deliver to connected vehicle users may lie in cross-vertical applications/use cases.
Mobility as a Service / Intelligent Mobility
Value shifts in the automotive industry

Source: PwC Connected Car Report 2016

Share addressable by today’s OEM model declining to less than 70%

Share addressable by new entrants (digital services, mobility, new technology supply, Fintech, startup EV players) growing to more than 45% or $3.5 trillion

Share addressable by OEM declining from ~70% to less than 50%

Share that can be captured by new entrants growing to 60% or $360 billion

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A crowded ecosystem

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UK testing ecosystem

Illustration courtesy of C-CAV
‘Connected’ ≠ ‘autonomous’ vehicles
Observed trends and future opportunities
Overarching challenges
Some overarching challenges

• Four key challenges: coverage, reliability, bandwidth and capacity.
  ➢ The automotive industry welcomes 5G and its potential.
  ➢ Services such as content streaming (e.g. Netflix on the go) and IoT applications may benefit from high bandwidth and capacity.
  ➢ But many connected vehicle services today and in the near future can be deployed with existing 3G and LTE.
  ➢ Many safety-critical use cases require low latency and uninterrupted, ubiquitous coverage – even with just 3G, LTE-V or ITS G5.
  ➢ Connectivity is not a pre-requisite for autonomous vehicles.

• ITS G5 and C-V2X: VHS vs Betamax all over again?
• How can V2V and V2I be monetised?
• The double-edged sword of connectivity – the more connected, the more vulnerable.
Mobile network coverage on the UK road network

Almost 4,600 miles (2%) of British roads have no 2G coverage from any network provider, whereas only 43,000 miles (18%) and 119,000 miles (48%) have full 4G and 3G coverage respectively.

<table>
<thead>
<tr>
<th></th>
<th>Full network coverage</th>
<th>Partial network coverage</th>
<th>No network coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2G</strong></td>
<td>211,753 (86%)</td>
<td>28,975 (12%)</td>
<td>4,561 (2%)</td>
</tr>
<tr>
<td><strong>3G</strong></td>
<td>119,057 (48%)</td>
<td>111,679 (45%)</td>
<td>14,554 (6%)</td>
</tr>
<tr>
<td><strong>4G</strong></td>
<td>43,070 (18%)</td>
<td>65,950 (27%)</td>
<td>136,271 (56%)</td>
</tr>
</tbody>
</table>

Note: percentages might not add up to 100% because of rounding. Partial network coverage means that at least one of the four network providers – Vodafone, O2, EE, Three - will offer a signal.

Technology choice

- CAR2CAR Communication Consortium favours the adoption of ITS-G5 (aka 802.11p, WAVE or DSRC) for V2V and V2I communication.
- ITS-G5 uses 5.9 GHz frequency band; deployment on connected corridors.
- Increasing number of OEMs considering cellular for V2X – LTE followed by 5G.
- OEMs and telcos joining forces – e.g. 5GAA, ConVeX, Towards 5G, UK CITE, DT A9 Germany.
- What’s important: European-wide harmonisation, commonality and interoperability.
Technology choice

Illustration courtesy of 5G Automotive Association
To be monetised or for public good?

POTHOLE ALERT RESEARCH

Jaguar Land Rover is researching a new connected car technology that will allow a vehicle to identify the location and severity of potholes, broken drains and manhole covers. It will then share this data in real time with other vehicles and with road authorities to help them prioritise repairs.

Cameras (in front windscreen) could take an image of the pothole.

Data also shared with roads authorities, together with GPS location, to aid repairs.

Car could also scan the road ahead.
A connected car is not smartphone on wheels
Securing connected vehicles: the more connected, the more vulnerable

Security Assessments
- Hardware Review
- Subsystem Penetration Test
- Concept Reviews
- Vehicle Penetration Test
- Source Code Audit

Monitoring of real world attacks
- Monitoring of threats, e.g. hacker and tuner scene.

Incident Management
- Incident Response for Automotive Security.
- Technical analysis of hack attacks and Statements.

Mandatory Security Approval for Cars, Functions, ECUs and Digital Services.
Approval of state-of-the-art security for all vehicles, components, services.

Illustration courtesy of BMW Group
Automotive’s wish list

- **Ubiquitous connectivity** on the entire UK road network so as to make the UK the market of choice to deploy CAVs and related services.
- Ofcom to mandate MNOs to extend coverage to the entire UK road network as a condition for 5G licences auction.
- Ofcom to study the feasibility of and consider introducing in-country roaming across mobile networks.
- CAV CR&D projects, test beds and trials ought to include cellular (LTE, 5G) in addition to ITS G5.
- Clarity on the UK 5G roadmap, deployment strategy and roll-out phases across industry verticals – for better informed planning and investment decisions.
- A national programme to exploit UK 5G capabilities by convening and orchestrating cross-sectoral trial and demonstration projects.
- Safety-critical messages must be prioritised.
THANK YOU

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