What’s coming!

A glimpse towards and beyond 2020!

Connected and Autonomous Vehicles

Jamie Smith,
C-ITS Strategy Consultant – Smart Transport, Telstra Enterprise
About Telstra
Australia’s Telecommunications and Technology company

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>33K</td>
<td>Employees across more than 20 countries</td>
</tr>
<tr>
<td>1.4M</td>
<td>One of Australia’s largest shareholder bases</td>
</tr>
<tr>
<td>$53.0 Billion</td>
<td>Australia’s 6th largest listed company. World’s 10th largest telco by market cap</td>
</tr>
<tr>
<td>4G</td>
<td>Australia’s largest mobile service reaching 98% of the Australian population</td>
</tr>
<tr>
<td>17.2M</td>
<td>Domestic retail mobile services</td>
</tr>
<tr>
<td>5.7M</td>
<td>Fixed voice retail services</td>
</tr>
<tr>
<td>3.4M</td>
<td>Fixed data retail services</td>
</tr>
<tr>
<td>95%</td>
<td>Of Australia’s businesses covered by Australia’s largest fully integrated IP network</td>
</tr>
<tr>
<td>1.1M</td>
<td>Home broadband and mobile customers activated to use Telstra Air Australia’s largest Wi-Fi network</td>
</tr>
<tr>
<td>2.9M</td>
<td>Foxtel Pay TV Subscribers. Joint owner of Australia’s Leading Pay TV Operator</td>
</tr>
</tbody>
</table>

1. Number of employees and span of countries as at 30 June 2016. 2. Market capitalisation as at 12 October 2016. Share price $5.10, 11,943m shares on issue. 3. As at 30 June 2016 4. Telstra is a 50% owner of Foxtel.
Connected & Autonomous Vehicles
Motor vehicles have been able to ‘connect’ via telecommunications systems since the 1960’s when the first military G.P.S. satellites were launched.

The term ‘Telematics’ was first coined in the late 1970’s in France. Since then, Vehicle Telematics has expanded to provide a wide range of functionality including:

• Tracking individual vehicles, trailers & containers – location, performance, condition, emergency alerting, remote access
• Fleet management – integrated scheduling, monitoring of drivers, regulatory compliance
• Satellite navigation – journey planning, route compliance, etc.
• Usage based insurance – based on Telematics data

Telematics systems have been developed by mobile carriers and vehicle manufacturers, but generally do not integrate with road network intelligent transport systems.
Intelligent Transport Systems (ITS)

ITS has traditionally involved equipping and connecting the fixed ‘Road’ infrastructure and includes traffic signals, variable message / speed signs, detectors, CCTV, etc.

Motorway ITS systems include Tunnel safety systems, Tolling systems, etc.

Government Road Agencies and Toll-road operators have typically driven the development of ITS.

The traditional ITS ‘interface’ between roadside equipment and the vehicle has been via the human driver’s eyes, ears, hands and feet.
Cooperative ITS (C-ITS)

C-ITS involves electronically connecting two or more vehicles (V2V), a vehicle to roadside ITS infrastructure (V2I) and a vehicle to others – cyclists, pedestrians, etc. (V2X).

Primarily C-ITS (V2V) aims to implement wireless communications between moving vehicles for safety functionality such as collision avoidance, lane and speed control, etc.

- Why? - Because current Road Safety strategies of engineering, education and enforcement are failing to prevent over 1,200 deaths and 50,000 injuries on Australian roads each year!

C-ITS (V2I) primarily aims to optimise traffic flow & reduce congestion through integrated journey planning services, travel time advisory, traffic signal timing optimisation, etc.
Connected Vehicles for C-ITS
Cooperative ITS (V2X) use cases

V2X enables a broad and growing set of use cases

- Forward collision warning
- Do Not Pass Warning (DNPW)
- Queue warning
- Curve speed warning
- Blind intersection
- Cooperative adaptive cruise control & platooning
- Vulnerable Road User (VRU) alerts
- Discover parking and charging
- Traffic signal priority and optimal speed advisory
- Emergency vehicle alert
Autonomous vehicles
Autonomous Vehicles are equipped with sensing technology such as radar, lidar, optics and low-latency wireless communications connectivity, as well as intelligent driving control systems that enable all or part of a journey to be successfully executed without the need for a human driver to be in control for some or all of the time.

While concepts for autonomous vehicles have been around nearly as long as vehicles have, global vehicle industry standards have recently been defined to categorise a vehicle’s level of autonomy.
Autonomous vehicle control systems

KEY: Si MEMS, magnetic, light sensors

Cam/crankshaft position, engine speed, throttle by wire, engine oil, brake fluid level, airbag accelerometer, roll detection, passenger occupation, in-cylinder pressure, active suspension accelerometer

Various brushless DC motors, cooling fan, coolant level, ABS, pedestrian detection, crash sensing (ultrasound)

Throttle, EGR valve position, manifold air pressure, altitude, mass air flow, DPF, common fuel rail, oil, start-stop, EGR, continuous transmission

Compass, HVAC position, sunroof, wipers, HVAC solar sensor, head-up display brightness, rain, auto dimming mirror, automatic lights, steering angle

Electronic parking brake, suspension pressure, alarm, E-call, Electronic stability control

Battery management sensor, wing mirror position, steering wheel angle, torque

Trunk/door lock switches, electric windows, HVAC, HUD, air quality, temp, anti-fog, in-dash navigation gyroscope, night vision

Wheel speed sensing, fuel level, seat position, belt presence, TPMS, fuel vapor

Starter/alternator, stop - start systems

Transmission gear position, speed, accelerator pedal position
The 5 levels of driving automation

For on-road vehicles

<table>
<thead>
<tr>
<th>Level</th>
<th>NO AUTOMATION</th>
<th>DRIVER ASSISTANCE</th>
<th>PARTIAL AUTOMATION</th>
<th>CONDITIONAL AUTOMATION</th>
<th>HIGH AUTOMATION</th>
<th>FULL AUTOMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human driver</td>
<td>N/A</td>
<td>SOME DRIVING MODES</td>
<td>SOME DRIVING MODES</td>
<td>SOME DRIVING MODES</td>
<td>SOME DRIVING MODES</td>
<td>N/A</td>
</tr>
<tr>
<td>Automated system</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

- Steering and acceleration/deceleration
- Monitoring of driving environment
- Fallback when automation fails
- Automated system is in control

Source: SAE International
Driverless Vehicle
Connected & Autonomous vehicles
**Level of Automation**

**Level 5** – Full automation (no human driver required)

**Level 4** – High automation (driver can intervene when required, but does not have to)

**Level 3** – Conditional automation (driver can focus elsewhere but must be able to intervene when required)

**Level 2** – Partial automation (automated acceleration, steering and braking but driver must intervene often)

**Level 1** – Driver assisted (adaptive cruise control, park assist, lane keeping)

**Level 0** – No automation

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**Connected & Autonomous Vehicles**

**Level and method of Connectedness**

- **UNCONNECTED** – GPS satellite maybe?
- **CONNECTED** – ODB2 port for Telematics via 3G / 4G LTE comms
- **CONNECTED** – only V2V via 5.9GHz for Safety applications
- **CONNECTED** – V2V & V2I via 5.9GHz & 4G LTE / 5G for safety & traffic control
C-ITS (V2I) integrated Traffic Management
RUSH HOUR
Adoption of connected & autonomous vehicles
Considerations for adoption

Retro-fitting existing vehicles to enable autonomous operation is highly infeasible – cost, certification, regulation, etc. Numbers would be very minimal for trials.

Fully autonomous (driverless) vehicles need to come ex-factory and be type certified to operate lawfully on Australian roads.

Some manufacturers may begin to supply some forms of autonomous vehicles by 2020, but Government regulation may not ‘allow’ operation – subject to penalty, not covered by insurance, etc.

Average vehicle turnover is > 10 years, so Australia’s 18Million existing registered vehicles will still be operating for a number of years.
How many autonomous Vehicles will be on the roads?

1. Conditionally autonomous: the driver may take occasional control.
2. Fully autonomous: the vehicle is in full control.
3. OEM: Original Equipment Manufacturers.

Factors in disruption scenarios
- High disruption: Fast, Comprehensive, Enthusiastic
- Low disruption: Gradual, Incomplete, Limited

Source: McKinsey
Thank you

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