



Automated Vehicles, Connected Vehicles and 5G: the Synergies between them

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Agenda

- Autonomous Vehicles (AVs)
- Connected Vehicles (CVs)
- 5G
- Combined benefits and synergies between the above



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AV Status

- Semi-autonomous cars, e.g. the Mercedes S-Class, are already commercially available
- Advanced development and testing of fully-autonomous cars has already started
- Virtually all the major car manufacturers are working in this space



AV Status #2

- Ontario:
 - MTO was developing regulations for testing AVs on public roads in Ontario
 - Stopped by Ontario election
 - CVAV Research Program announced
 - Partnership between Ontario Centres of Excellence, MTO, Ministry of Research and Innovation
- Google's cars have already logged over 1 million Km
 - Now focusing on city driving

AV Trends



- Trial of fully-automated taxis planned for Milton Keynes, UK, in 2015



AV Trends #2

- First commercial fully-autonomous cars are expected by 2020
- 2020-2030 will see a major penetration of AVs in Canada and around the world based on their numerous benefits.



AV Trends #3





Google's Expectations

From the Florida AV Summit in November 2013:

- Tech will deploy incrementally
- Tech will not be 100% effective
 - There will continue to be crashes
- Tech will perform better than human drivers from the start
 - System wide fixes to lessons learned
 - Tech will constantly get better over time



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CV Status

- Two broad use cases
 - Safety / collision-avoidance applications
 - Infotainment and telematics applications
 - Both known as connected vehicles
- Safety / collision-avoidance applications:
 - Dedicated Short Range Communications (DSRC)
 - Use vehicle-to-vehicle (V2V) or vehicle-to-infrastructure (V2I)
 - Custom equipment embedded in vehicles
 - 5.9 GHz band



CV Status #2

- Safety / collision-avoidance apps (cont'd):
 - Large pilot project in Ann Arbor MI
 - Canadian test-beds being developed
 - Key benefits:
 - Reduced number of accidents, fatalities and injuries
 - Improved real-time traffic management / traffic flow
 - Improved utilization of highways and roads
 - Reduced environmental footprint



CV Status #3

- Infotainment, telematics applications:
 - Mobile phone technology, Wi-Fi, WiMAX, etc.
 - Use cases: map updates; traveller information; vehicle health monitoring; usage-based insurance; updating vehicle software / firmware; toll payments; streaming music, TV and videos; on-line games; web surfing; many others



CV Status #4

- Key trend is closer integration of smart-phones and cars
- Some CV applications now available:
 - Traffic updates; insurance telematics; web access; over-the-air software updates; links to smart-phones, etc.



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5G

- Next generation of cell-phone technology
 - After 3G, 4G, LTE
- Now: basic research, definition of features.
- Then development
- Commercially available about 2020



5G (cont'd)

- Likely features:
 - Low-latency, device-to-device connectivity (D2D)
 - Also, traditional device-to-tower connectivity
 - Operating in 60 GHz band
 - GB/s data rates
 - Low cost may support wireless connectivity between devices within a vehicle



5G (cont'd)

- Benefits:
 - Very high data rates to/from vehicles for infotainment and other apps
 - Technological competitor to DSRC for collision avoidance
 - Will be a driver for enhanced AV and CV software and apps



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- **Combined benefits and synergies between the above**



AVs + CVs + 5G

- AVs and CVs both lead to fewer collisions
 - Combined, even fewer
- AVs will have cameras / radar sensors
 - 5G will enable uploading of huge volumes of data in real-time
 - Every vehicle could be a probe
 - Improved collection and distribution of traveller information
 - Could reduce the need for traffic cameras, road weather terminals, variable message signs, etc.



AVs + CVs + 5G (cont'd)

- Wideband connectivity for updating operating systems, driving software, map data
 - AVs will need the latest map updates
- 5G will support next-generation CV apps
 - AV occupants will want improved connectivity while the computer does the driving
 - Cloud-based apps will need enhanced connectivity
 - Other apps we have not yet thought of



Conclusions

- AVs will be commercially available by the end of the decade
 - Significant increase in penetration in 2020s
- Wide range of CV infotainment features already commercially available
- CV / DSRC systems now being tested
- 5G under development; vehicle apps key part of vision



Conclusions (cont'd)

- AV + CV + 5G will lead to:
 - Vastly improved safety and fewer collisions
 - Improved production and dissemination of traveller information
 - Richer experience for occupants of AVs while the computer does the driving



Questions?