The 'Autonomes' are Coming – This Will Fundamentally Change How We Do Road Transportation

ITS CANADA ACGM 2012

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Background

My belief (glass half full!):

We are on the cusp of two technological tidal waves that will result in a paradigm shift*
in how we do road transportation.

We need to
- Make ourselves aware
- Decide if we need to make a response
- Act on our convictions

 *a radical change in underlying beliefs or theory.

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Agenda

- The Problem
- The Technology 'waves'
- What autonomes are
- The Ultimate Autonome Vision
- Opportunities
- Challenges
- When might this all happen?
- Possible ITS Canada response

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Big Problems - need a Big Solution

- Every year approximately **1.2million people are killed** on the world's roads.
- It is estimated that in approximately **95% of collisions (accidents) human error is a significant factor**
- **Congestion / 'lost time'** is a major problem – average US commuter >50mins in the car/day
- Road vehicles are a significant contributor to **pollution** particularly in urban centers.
- The technology that will allow us to virtually **eliminate human error from the road system and significantly reduce road congestion and pollution** is already moving from 'science fiction' to 'science fact'.

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1st Wave - Connected Vehicles (CV)

Relies on electronic modules within the vehicle, roadside infrastructure and other vehicles. Typical functions include:
- Speed adaptation
- Collision avoidance
- Extended or revised traffic signal timing or phasing
- Emergency vehicle warnings
- Warning of red light runners
- Dynamic route selection or adjustment
- Platooning (SARTRE – Safe Road Trains for the Environment)

NHTSA (US) will make a decision on CV tech in 2012 for 2013 – **estimated to remove up to 48% of all collisions**

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2nd Wave - Autonomes

- Autonomous Vehicles ('Autonome' for ease)
- Nevada Law (1st Mar 2012)
  - "artificial intelligence" means the use of computers and related equipment to enable a machine to duplicate or mimic the behavior of human beings.
  - "autonomous vehicle" means a motor vehicle that uses artificial intelligence, sensors and global positioning system coordinates to drive itself without the active intervention of a human operator.
- DARPA Grand Challenge
- Google driverless car
- Continental, BMW, AutoNOMOS, GMC, Ford, Volvo etc.

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Examples
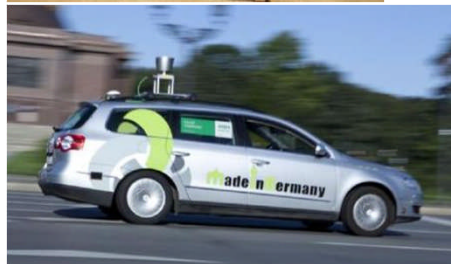
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The Google Car

- Based on information in the public domain probably the most advanced civil autonome
- Key: Software-to-Hardware (traditional vehicle manufacturers Hardware-to-Software)
- Aims:
  - 1 million miles without human intervention
  - Save 1 million lives
- Greater than 250,000 miles (16 April 2012) travelled in self-drive mode
- Passenger No.1, Steve Mahan, San Jose, CA – 95% blind

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Autonome Characteristics

- Sensors typically:
  - OPTICAL – includes stereo vision for 3D image
  - RADAR – sees better through rain, dust, snow, foliage
  - LIDAR – 360 degree 'point cloud' tracks movement
  - INFRARED CAMERAS – night driving
  - GPS / INERTIAL MEASUREMENT – macro view/location
  - WHEEL ENCODER – velocity during manoeuvers
- COMBINATION = 360 degree view, improved sensing even when visual obscuration. Monitors real time movements at approximately 10 to 20 times per second.

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Autonome Characteristics

DATA ANALYSIS / CONNECTIVITY
- Artificial Intelligence
- Develops it's own algorithms as to how to cope with new situations
- Connected – one 'learns', all 'learn', knowledge and experience dissemination
- Hive mind (connected vehicle) - platooning, intersections

CONCLUSION
- Combination of superior sensory information, real time hazard analysis, artificial intelligence and rapid reaction times = safest & most efficient road transportation today? (on **existing** infrastructure).

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Google Car Video

- http://www.ted.com/talks/sebastian_thrun_google_s_driverless_car.html (excerpt 1min 20s to 2min 43s)
- Notes:
- Presented at TED conference March 2011
- Google car travelled 140k miles at time of video
- Estimates in April 2012 were in excess of 250k miles travelled by the Google car

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The Ultimate Autonome Vision

Opportunities:
- Reduction (virtual elimination?) in collisions as it removes the human factor (i.e. error!)
- Maximizes road capacity by reducing spaces and improving flows
- Driver is now a passenger - free to use travel time productively
- Environmental – reduced emissions, fewer vehicles
- Business efficiencies – improvements to logistics, time, fuel, insurances, etc.
- Revolutionizes public transport

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The Ultimate Autonome Vision

Additional Opportunities:

- Minimizes the road geometry and structures (narrow lanes, compact intersections, no grade separation etc.)
- Removes the need for lighting, signing/lining, furniture
- Roads cost less to construct and maintain
- Driver's licenses no longer required?
- Law enforcement no longer required?
- Vehicle Insurance eliminated?
- Environmental benefits – reclamation of excess paved areas (NY Times Jan 2012 – approx. 8 spaces/car in US, Houston approx. 30 spaces/car!)

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Quantifying Opportunities (long term)

- SAFETY – Canada societal cost of road collisions = ($62bn p.a.) 4.9% of GDP.   **Saving >4% GDP?**
- BUSINESS EFFICIENCY – improves logistics, 'lost time', fuel, insurances.   **Saving >1% GDP?**
- PUBLIC TRANSPORT – improves service, logistics, time, fuel, insurances.   **Saving >0.5% GDP?**
- ENVIRONMENTAL – reduced emissions, less vehicles yet better level of service.   **Saving >0.5% GDP?**
- SOCIETAL – Like the phone, landline cell to smart and the social media revolution….. The possibilities are immense.

» **TOTAL**   **Saving >6.0% GDP?**

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The Ultimate Autonome Vision

Challenges:

- SECURITY – 'missiles' in a malicious entities hands
- LEGAL / REGULATORY – law must make space for non-human driver. Policies, Rules and Standards must adapt
- INSURANCE – define responsibilities and liabilities
- USERS – overcome trust issues
- UNIONS / TEAMSTERS – jobs threatened: long haul drivers, taxi drivers, road safety, trauma surgeons etc.
- STANDARDIZATION – systems, protocols, inter-connectivity, cross-borders, integration etc.

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BUT………….

……………… this 'vision' assumes that virtually all vehicles on the road are autonomes.

- There will be a (probably decades long) **transition period**, where man, Connected Vehicles and autonomes share the road space and learn to get along.
- Will we share the roads harmoniously (drivers taking advantage)?
- Will/should drivers and autonomes be treated equally (Societal and legal viewpoint)?
- Can rules, regulations, standards and legislation be flexible enough to cope?

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When will Autonomes arrive?

- Under development now in at least 8 countries
- March 2011 (onwards) - State of Nevada passed laws permitting autonomous vehicles in certain circumstances
- Sept 2011 - German states of Berlin and Brandenberg licensed the *MadeInGermany* vehicle to test drive
- General Motors predict they could have autonomous vehicles on the road by **2018**, Volvo by **2020**.
- UK Royal Academy predicted driverless trucks on the road by 2019.
- Bruce Breslow (DMV, Nevada) '*… thinks autonomous vehicles will be operating on the state's roads in three to five years.*' (Bloomberg BusinessWeek, 1 March, 2012) – **2015 to 2017**

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When will Autonomes arrive?

Once Google have completed 1,000,000 miles, then:

*"Google could make an announcement **as early as next year** on when it might offer the self-driving technology, he [Levandowski] said."* Quote from SAE (Society of Automotive Engineers) World Congress 2012 dated 26 April 2012.

"*He [Levandowski] said the car and hardware cost about $100,000, but Google has just a handful of them. When they go into mass production, he estimated an ordinary car could be retrofitted for a couple of thousand dollars. Some cars already have many of the sensors the Google car uses, so the cost of retrofitting such cars would be much lower."* Cato@Liberty "Googling around DC", 17 May 2012.

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Possible ITS Canada Response

- Ensure we are prepared for this **paradigm shift** in how we do road transportation. **Disruptive tech does not work to a fixed program and is unpredictable!**
- Assist in research of technology that could see **>6% improvements to Canadian GDP.**
- Review current Connected Vehicle Technology policies, systems and projects in light of Autonome technology.
- Review existing and proposed public transport projects with the Client and determine if Autonome technology is a feasible replacement in a, say, five year timeframe.
- Educate public sector/clients on the possibilities of autonomes.

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**The Autonomes are Coming
SOON!!
This Will Fundamentally Change How We Do Road
Transportation**

Thank You!

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