N3T - NZ’s Transport Technology Testbed

Smart Roads, smarter Trucks

Self-driving and driver assisted trucks
Impacts for New Zealand

John Houlker

Commercial in confidence

REAAA Roadshow 2018
Agenda

1. Introduction
2. Facts & Trends
3. Technology
4. Commercials
5. Use Cases
6. N3T
7. Vision for Future Transport in NZ
8. Questions
Introduction
Autonomous Vehicle (AV) Revolution

AVs now under trial - enormous media attention on “Driverless Cars”

Image Sources: Waymo, Tesla, Uber, TNW, KVTU/AP
Less Media Attention to AV Trucks

Industry is responding to advantages for Commercial Vehicle Automation

Image Sources: Wymo, Tesla, Uber, HMI, Volvo
What drives the evolution?

Increased electronics and software content

Cost of electronics and software is <20% of the cost 10 years ago

Electronics systems contribute >90% of innovations and new features

Timeframe for new vehicle launches is 3–4 years, the cycle for new vehicle software is measured in months

Increasing regulatory requirements

Source: PWC (2014)
AV Progression

Source: Autoliv (2017)
AV Truck Progression

Stage 0
No Automation

Driver is fully engaged all the time, warning signals might be displayed

Stage 1
Driver Assistance

Automation of individual function, driver fully engaged – Driver may be "feet off" (when using ACC) or "hands off" (when using Lane Keep Assist)

Stage 2
Partial Automation

Automation of multiple functions, driver fully engaged – Driver may be both "feet-off" and "hands off", but eyes must stay on the road

Stage 3
Conditional Automation

Automation of multiple functions, driver responds to a request to intervene – Driver may be "feet-off", "hands off" and "eyes off", but must be able to resume control quickly

Stage 4
High Automation

Automated in certain conditions, driver not expected to monitor road – Driver has no responsibility during automated mode

Stage 5
Full Automation

Situation independent automated driving – Driver has no responsibility during driving

Source: SAE, Roland Berger (2017)
ADAS  Advanced Driver-Assistance Systems

Quiet technology integration revolution underway

Source: SAE, Roland Berger (2017)
FACTS & TRENDS
Key Facts & Trends

1. 1.3 million people die of **crashes** per year, in NZ one person/day
2. Over **28%** of transportation costs is in **last mile** delivery (B2B to B2C)
3. Globally every year 7 million people die from **air pollution**, with **27% of Greenhouse Gases** emitted by **trucks**
4. About **30%** of truck OPEX is **labour**, another **30%+ is fuel**
5. In NZ **75% Freight increase** forecasted (2006 to 2031)

# NZ Freight Mix

**Table 1 – Total New Zealand Freight Forecasts by Broad Commodity Group 2012 to 2042 (million tonnes)**

![Graph showing freight mix by commodity group from 2012 to 2042](image)

**Source:** HVTT - NZTA (2016)
NZ Freight Demand Growth

Freight increase of up to 75% from 2006 to 2031

Source: NZTA (2018)
Northland - Otaika Valley Road

- Over 10,000t of logs get handled at NorthPort/ day, 800 truck movements/day
- OVR 12km undulating at risk rural road
- 75% of all logging trucks travel daily on OVR
- 2017: 5 truck crashes, 1 fatal
- Social costs of accidents:
  - Fatal - 4.7m, Serious: 900k, Minor: 95k
  - Cost to put truck back on road: 80-600k
  - It is harder to find a driver, than replace the truck
  - Average cost per year > 1.5m
Crashes on Otaika Valley Road

Source: Opus/N3T from CAS data (2018)
Truck Rolling Crashes

Reasons
• Speed
• Shifting Load
• Sloshing of liquids
• Carelessness/ Drugs/ Fatigue
• Inexperience
• Other traffic events

Source: YouTube, Steve O'Brien (2016)

Prevention
• Driver Training
• Check load before start
• Drive to conditions
• Drive fresh (hours of service, breaks)
• Use of assistive technologies

8 x $500k trucks rolled May-July 2016 in Northland alone
Case for AV in NZ (2018-2030)

$5bn value add to the economy (another Fonterra)

32,000 net jobs created

2,500 serious crashes prevented

250 lives saved

TECHNOLOGY
How a vehicle sees/senses

Source: Parish (2016)
Smart Infrastructure - V2x

Illustration of V2X

V2I

V2V

V2P

Source: Chong (2018)

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The role of HD 3D Maps

Source: Google, HERE, Planet, Stanford, TomTom, DLR (2019)
Location Based Solutions (LBS)

Knowing to **centimetre accuracy** where you are in relation to your environment/infrastructure is a prerequisite for assisted and autonomous driving.

**Above Ground**
- GSM 100 metres (cellular phone triangulation)
- GPS 20 metres
- Satellite 3 metres
- Computer vision 20 centimetres (stereo camera, Lidar …)
- HD 3D Maps 10 centimetres (combination of multiple sensors)
- IPS 2 centimetres (IMU + HD stereo camera)

**Below Ground**
- GPR < 4 centimetres (works in adverse weather conditions, tunnels)

**Location accuracy**
- 100 metres (cellular phone triangulation)
- 20 metres
- 3 metres
- 20 centimetres (stereo camera, Lidar …)
- 10 centimetres (combination of multiple sensors)
- 2 centimetres (IMU + HD stereo camera)

Sources: DLR, MIT, N3T, TomTom (2017)
Automotive Complexity

A typical modern vehicle has over:
- 30 electronic control units (most with the power of an iPhone)
- 100 million lines of code

A “computer on wheels” (E. Musk)

Source: NHTSA, GAO (2017)
NZ USE CASES
Self-driving trucks

Waymo - Atlanta DC

Uber - Ot.to - Arizona

Mercedes - Nevada

Embark - CA to FL

Volvo - Sweden

Tesla

Source: Embark, Mercedes, Tesla, Uber, Volvo, Waymo (2018)
Einride’s T-Pod for forestry

Source: Einride (2018)
Smart Platooning

- Redirect freight aimed for North Shore to NorthPort
- Store at affordable NorthPort vs. most expensive NZ real estate (Ports of Auckland)
- Load freight on platooning EV/ AV trucks
- Platoon from NorthPort to Distribution Centre (DC) in Silverdale after 10pm
- Redistribute freight with EV vans next morning

Advantages

- First rural road platooning in the world
- Testing latest computer vision/ smart roading technology
- Solving real business case
- Reducing traffic over harbour bridge
- Cost savings
- Creating local jobs in Northland
Waste Management

- Use EV trucks for curbside rubbish collection
- Put rubbish on landfill
- Collect methane from landfill and convert to electricity (Silverdale: 12 MW)
- Charge EV trucks with landfill electricity

- Convert EV truck to AV truck and conduct automated rubbish collection at off peak times

Source: ZEV, WM (2018)
Last Mile Delivery - AV Nuro

Co-invented by Kiwi Innovator
David Ferguson

Source: Nuro (2018)
The 2025 Vision - no crashes

Vision Zero Whangarei

no crashes, no emissions, no hassle
COMMERCIALS
Operating a truck in NZ

- Key cost drivers: Fuel, Staff, Leasing, Repairs & maintenance
- On average 120,000km/a and 1.5m km lifetime VMT
- Repairs due to uneven roads > $2,500 truck/a (N3T Pothole Finder)
- Bigger NZ truck operators have over 500 trucks
- Trucks make up 2% of total vehicles in NZ, but generate over 28% of Greenhouse Gases
- If a truck crashes, it can cost between $80-600k
Truck vs. Car ADAS

- Growing freight need, shortage of drivers
- Operating times and range
- Capital & Operating expense of truck vs. car
- Truck safety & efficiency
- Different Physics than cars
- Relative ADAS retrofitting costs (~USD3K/truck, 2.5$k/car)

Making trucks safer and more (fuel) efficient makes a lot of business sense

“Self-Driving Trucks May Be Closer Than They Appear”

New Business Models

B2B:
Transport-as-a-Service - example: Einride
Logistics-as-a-Service - NetLogixs
Last-mile-as-a-Service - Nuro

B2C:
Mobility-as-a-Service - Vision-Zero.nz;
BlaBlaCar; Car2Go, i-drive; Didi, Uber

Source: company information
## Latest Technology vs. Rail

<table>
<thead>
<tr>
<th></th>
<th>Platooning</th>
<th>Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Costs</strong></td>
<td>Several 100k, can be up and running in 3-6 months</td>
<td>1.5 -2 billion/ 10yr project</td>
</tr>
<tr>
<td><strong>Jobs</strong></td>
<td>100+ local jobs</td>
<td>unclear</td>
</tr>
<tr>
<td><strong>Economic impact</strong></td>
<td>Cheaper freight, Faster last mile delivery</td>
<td>Fonterra, CHH are only bigger commercial users of rail to / from Northland</td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td>Less crashes than now</td>
<td>Low speed, low crash rate</td>
</tr>
<tr>
<td><strong>Future Proving</strong></td>
<td>Flexible to re-configure routes</td>
<td>Technology from 1781, once built can't be changed (sunk cost)</td>
</tr>
<tr>
<td><strong>Global Leadership</strong></td>
<td>Leading edge - no one is doing rural road truck platooning anywhere globally, together with mobility-as-a-service potential for national and global leadership</td>
<td>Laggard position globally</td>
</tr>
<tr>
<td><strong>Environmental impact</strong></td>
<td>Up to 18% less emissions with ICE, zero emission if EV/HV/ AV</td>
<td>unclear</td>
</tr>
</tbody>
</table>
KEY PLAYERS
AV Players

**Selected investment and M&A activities**
- Bosch - ITK, ProSys, Seeo
- Daimler - Chauffeur Prive, Flinc
- Delphi - Nutonomy (US 0.45bn)
- Dyson - McLaren (US 2.5bn)
- Ford - Autonomic, LocStat
- GM - Cruise, Strobe Lidar (US 1bn)
- Google - Boston Dynamics, Deep Mind, Waze (US 2.5bn)
- Intel - MobilEye (US 5bn)
- “Lidar Solutions”: LeddarTech, Quanergy, VeloDyne, Waymo, ZF-IBEO (US: 3bn)
- NVIDIA - Continental (strategic partnering)
- Softbank - Didi, FlipCart, Uber (US 35bn)
- Tesla - Grohmann, PerBix
- Uber - Otto (US 0.7bn)
- ZF - IBEO Lidar, TRW (US 13bn)


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China - AV leader in 2025 ...

Vehicles in China
2017: 27 mio
2025: 37 mio

Source: Shi (2018)
N3T

NZ’s Transport Technology Testbed
N3T’s - Smart Road Conditions

Spiking Neural Network
(Edge Computing)

Source: Bahrami @/KEDRI (2018)
N3T’s - Road Condition Alerting App
N3T Road unevenness detection/ prediction

Prototype Features

- GUI
- Interactive mapping
- Linear referencing
- Time series analysis
- Output Formats
  - csv
  - kml
  - RAMM (coming soon)
N3T App - Crowd-Sensing Conditions

This smartphone app is used to manually detect, take a photo & position of road surface damage and report it to central GIS map. We use it to ‘ground truth’ our deep learning algorithms. And plan to make this available to general public.
NZ AV testing/trial sites

Source: HMI, N3T, SHPG (2017)
AUT/ German Aerospace - Digital Roads NZ Project

- Intelligent Positioning System
- UAV/Drone
- Satellite Imagery

Fig. 1: Left: Measurement vehicle. Middle: IPS headset with 45 cm baseline. Right: Oncoming truck traffic during m campaign.

Automated Large-scale 3D Roadside Modelling

Ines Ernst, Hongman Zhang, Sergey Zuev, Martin Knoche, Amita Dhiran, Hsiang-Jen Chien, and Reinhard Klette

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Data Fusion  Terrestrial, UAV & Satellite Remote Sensing

● Terrestrial Sensors
  ○ Truck platform based sensors/data logger: Cameras, IMU, CAN Bus for near real-time monitoring of road unevenness, edgebreak, road safety conditions, dropped objects, sign damage ...
  ○ Roadside beacons for weather sensors, visibility, sound, dust, landslip cameras
  ○ “Crowd sensing” inputs from user data

● UAV Sensors
  ○ UAV trial with DLR, trial safe UAV surveillance above live traffic
  ○ Ideally extend to BVLOS - Beyond Visual Line of Sight - autonomous survey
  ○ Potential future applications include rapid traffic/emergency surveillance, Police ...

● Satellite Remote Sensing
  ○ Complete area coverage, traffic & weather surveillance, landslip detection ...

● Data Fusion / Integration
  ○ Terrestrial sensors “ground truth” UAV & Satellite remote sensing
  ○ UAV & Satellite data used to verify and complement terrestrial sensors
  ○ Combined data with DEM & 3D survey provides complete continuously updated “Digital Road”
AV Simulator/ Digital Twining

Source: HVTT - NZTA (2016)

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Digital Road / Digital Twinning

R&D/Pilots contributing towards complete transport system “Digital Twinning”

- **Real World** IoT/Sensors/V2X communications for:
  - Vehicles, road surface, roadside, road infrastructure, road barriers ...
  - Potential UAV rapid traffic/emergency surveillance, Satellite Remote Sensing
  - “Crowd sensing”/“Floating Car Data” inputs from users

- **In Silico** Digital Model, Monitoring, Simulation & Visualisation of:
  - Vehicles, Platooning, Roads, Traffic/Congestion, Weather
  - Accidents, Hazards, Dropped objects, Road/Infrastructure damage, Weather, Landslips ......

- Linked with ITS, ICM

- Providing:
  - Proactive monitoring/preventative maintenance of vehicle condition, road surface/infrastructure
  - Proactive monitoring/emergency response for driver health, hazards, accidents
  - **Support for AV/ADAS systems, including road safety alerts & advice to drivers**
  - Congestion management, control of VMS/Signals

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Vision for Future Transport in NZ
What could this mean for NZ?

- Strong ADAS technology business case for trucks
- Increased road safety - Contribute to Vision Zero
- Address cost/ freight efficiency issues
- Be disrupted, or become a disrupter
- Possibility to be rural road, smart transport leader
- Potential lead for the wider AV/”Digital Road” transformation in NZ
Smart Freight Leader - Why NZ?

- Most lenient AV policy globally (4 pages!!!)
- Diverse terrain, weather conditions
- Best rural road test environment
- No automotive industry - no competitor to global automotive customers
- First world country with first world IP protection, legal system
- New Zealanders are early technology adopters - great country to test new technologies
- NZ functions as a bridge to Asia
- Globally leading Computer Vision research facilities
- Access to data analytics, AI, hardware/ software development talent
Questions?

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NEW ZEALAND TRANSPORT TECHNOLOGY TESTBED

SMART ROADS, SMARTER CARS, SMARTER TRUCKS

Private and public road testing for autonomous vehicles (AV) - driver assisted systems
- Testing infrastructure available to your specifications
- Vehicle-2-infrastructure, vehicle-2-cloud, vehicle-2-vehicle communication tested
- Focus on heavy vehicles and smart infrastructure
- We can retrofit your sensor technology to our vehicles - or you bring your own vehicles
- Testing with real life applications - up to 30 ton loads e.g. on specialty trucks - waste management, logging, fuel, freight delivery
- Field mileage accumulation >500km per truck/day (up to length of NZ)
- 24 hours, 7 days, 52 weeks
- SERVICES: Data analytics, cyber security audits & AV simulation
- Why NZ?
- Early technology adopters, great place to innovate
- Access to world class universities and engineers

N3T
Smart Roads, Smarter Cars, Smarter Trucks

Contact Southern Hemisphere Printing Grounds for all your vehicle testing requirements
Cardrona RDI, Wanaka, New Zealand
tel +64 3 443 0244
email admin@s3gco.net
www.shpg.co.nz

For your driver assisted technology testing contact N3T
8 Marsden Bay Drive
Whangarei, New Zealand
tel +64 9 839 4424
email bookings@n3t.co.nz

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**Terminology**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ADAS</td>
<td>advanced driver assistance systems</td>
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<tr>
<td>AV</td>
<td>autonomous vehicle</td>
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<tr>
<td>BPO</td>
<td>business process outsourcing</td>
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<tr>
<td>EV</td>
<td>electric vehicle like Tesla, Nissan Leaf, BMW i3,i8, Renault Zoe</td>
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<tr>
<td>HCV</td>
<td>heavy commercial vehicle (over 18 ton)</td>
</tr>
<tr>
<td>HW</td>
<td>hardware</td>
</tr>
<tr>
<td>N3T</td>
<td>NZ Transport Technology Testbed (= this business)</td>
</tr>
<tr>
<td>OEM</td>
<td>original equipment manufacturer or here: automotive manufacturers like Daimler, Tesla</td>
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<tr>
<td>QA</td>
<td>Quality Assurance (does it work as intended, does it meet required standards)</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>research and development</td>
</tr>
<tr>
<td>SW</td>
<td>software</td>
</tr>
<tr>
<td>TaaS</td>
<td>Testing as a Service (a BPO solution for automotive OEM/ tier 1/2)</td>
</tr>
<tr>
<td>Tier 1</td>
<td>suppliers to automotive manufacturers or OEM’s like Bosch, Conti, ZF</td>
</tr>
<tr>
<td>Tier 2</td>
<td>suppliers to the tier 1 suppliers like Infineon, Sony, Samsung</td>
</tr>
<tr>
<td>WM</td>
<td>waste management (rubbish collection)</td>
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</tbody>
</table>
On-vehicle smart sensors

Mobile weather station
Black Box
Stereo Camera
Radar
Tyre pressure
Mobile road skid resistance sensor
Ultrasound
Fleet management
Driver Monitoring

Source: N3T (2018)
Northland Trucks

**Mercedes Actros**
Weight: 40t with trailer
Load: 29t
Costs: ~500k

**Volvo FM**
Weight: 40t with trailer
Load: 29t
Costs: ~400k

Source: Daimler, Volvo (2017)
Roadside environmental live information

Live Weather/Visibility/Road Skid Resistance information to vehicle

Advantages of real-time weather/visibility/slipperiness monitoring

- Better planning of road maintenance activity (less down time)
- Input into fixing/re-sealing process
- Can be used on any rural road for road safety (best in conjunction with AWS and crowd-sourced weather data)

Source: N3T, MetService, SHPG (2017)
In-road smart sensors

- smart inductive powered sensors
- smart lights

Source: 3i Innovation (2017)
In-vehicle - Fleet Management

- CAN Bus data
- IMU – harsh braking, cornering
- Tyre pressure

Source: eroad, EK2 (2017)
Driver Monitoring

- Fatigue Management
- Driver Training

PHOTO: The technology uses sensors to detect when drivers are distracted or falling asleep. (www.seeingmachines.com)

Source: Autosense/Seeing Machines (2017)
AV Tech Side Effects

- Road Safety Trials - driving to the conditions
- Pothole Finder
Otaika Valley Road Safety Trial

Now

Source: Ruhdorfer (2017)
Hi Dave, fog in 400m after left bend. Slow down to under 31km/h. Have a safe journey.
3D Visualisation/ Simulation

Source: NRC, AtlaTec (2017)
Truck Simulator

Google is testing AV’s since 2009: 4mio miles on roads vs. 2.5bn miles in their Simulator.

The Physics of trucks is very different to cars!!!

To test trucks and supplier agnostic computer vision sensors, it needs a very different Simulator. The Simulator output will ultimately be used as CAN bus input for the truck control systems.
Why does unevenness matter?

1. Potholes are costly
   a) Crashes: indirectly (veering-off potholes) and directly (India: over 11,000 deaths/a)
   b) Higher vehicle maintenance costs (NZ: $2-5,000/a per truck)

2. Roads are getting unsafe

3. Spiralling road maintenance costs

Source: NZ Herald/ Northern Advocate/ FT (2018)
Sealed road unevenness

About 2,400 km sealed roads in Northland

Source: NZTA/ RAMM (2018)
Unsealed road unevenness

About 3,200 km Unsealed roads in Northland

Source: Councils (2018)
N3T Pothole Finder (PHF)

- near real-time WOF for road assets
- early-warning system for developing defects
- enabler to move to preventative road maintenance
Why N3T PHF Suite?

1. Tool Suite allows for cost effective monitoring of road assets and pinpoint where further diagnostics/attention is required
2. Working with internationally leading researchers
3. Over four years experience in finding unevenness with international partners
4. On-going product improvement
5. Installed base on key NZ truck operators: 3,000km/week and growing
6. Vehicle Miles Travelled (VMT): 150,000km/a per truck, up to 1.5 million km (with ten trucks) this year
7. Part of bigger smart transport vision
PHF Solution scope & deliverables

- High cadence monitoring to 10cm accuracy
- Timely identification of road defects and areas where more in-depth diagnostics is recommended (see Pukenui washout)
- Ability to assess road assets in almost real-time
- Better decision making based on this data
- Faster response times for customer complaints
- Seamless OPM metric reporting
- Early-warning system of road defects developing
- Data based solution for preventative road maintenance

OPM - output performance metrics (NZTA)
Technology designed to help Mars rover navigate could help make Northland roads and truck drivers safer

Imagine driving, and being warned when you’re too close to the edge of the road. That’s exactly what space technology developed by German researchers can do, and it could be in Northland roads in the next year.

Researchers from the German Aerospace Agency have been in Whanganui with the Intelligent Positioning System, which has been designed to navigate the rover on Mars. Described as a ‘location sensor’ ‘sensor’ or ‘SPS’, which gives you an idea of where you are – 1% will know exactly where you are on the road.

NEW ZEALAND

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Fig. 1: *Left:* Measurement vehicle. *Middle:* IPS headset with 45 cm baseline. *Right:* Oncoming truck traffic during measurement campaign.
The Majority of freight is trucked

Transportation and the Economy
By 2045, the U.S. economy is forecast to grow by 115% to $36.7 trillion—and the transportation sector will represent about $1.6 trillion of total Gross Domestic Product.

Global Demand for U.S. Products
Global trade is one of the brightest spots in our economy.

The U.S. energy boom is placing unprecedented demand on our transportation system.

42x the 9,500 carloads of crude oil in 2008

Crude oil production is up 50% since 2008
Rail carried 400,000 carloads of crude oil in 2013

1 billion in exports = 5,000 U.S. jobs

By 2040, U.S. freight volume will grow to 29 billion tons—an increase of 45%.

Major gains in freight movement are predicted by 2040.

By 2040, the value of freight will grow to $39 trillion—an increase of 125%.

Freight Movement is Multimodal
Every mode of transportation moves freight, but trucking is the primary mode of freight travel.

2012 (in tons) 2040
Truck 13.2 billion 18.8 billion
Rail 2.0 billion 2.8 billion
Waterborne 975 million 1.1 billion
Air 15 million 53 million

System Performance and the Cost of Congestion
By 2040, nearly 30,000 miles of our busiest highways will be clogged on a daily basis.

Truck congestion wastes $27 billion in time and fuel annually.

Source: DOT – Beyond Traffic (2016)
Last mile delivery

28% of total transport cost is last mile delivery

Source: Council of SC Professionals(2017)
Some concepts - first/last mile delivery

Last Mile Delivery

Future of Transport

**Manual Driving**
- Decision making capabilities
- Memory
- Eyes
- Reflexes/coordination of movement

**Autonomous Driving**
- Machine learning algorithms
- Maps/environmental models
- Sensors
- Vehicle to X communication (not mandatory)
- Actuator control

Source: Roland Berger

AV advantages

Six ways that autonomous driving will improve your life

- Reclaim your time
- Save fuel
- Safer journeys
- Sit back and relax
- Always find a parking
- Lower insurance premiums

Source: Volvo (2017)
Deep Learning

Tinker With a Neural Network Right Here in Your Browser. Don't Worry, You Can't Break It. We Promise.

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## AV Levels

### The 5 levels of driving automation

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Human driver monitors the road</th>
<th>Automated driving system monitors the road</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>NO AUTOMATION</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>1</td>
<td>DRIVER ASSISTANCE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>PARTIAL AUTOMATION</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>5</td>
<td>FULL AUTOMATION</td>
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</table>

- **Steering and acceleration/deceleration**: The ability to steer, accelerate, and decelerate without human input.
- **Monitoring of driving environment**: The system monitors the driving environment while the human driver remains engaged.
- **Fallback when automation fails**: The human driver can take over in case of system failure.
- **Automated system is in control**: The system is in full control of the vehicle.

Source: SAE (2018)
Level 0 – No automation

1980s
- Navigation system

1990s
- Parking aid

2010s
- LDW Lane departure warning
- Night vision
- Driver monitoring
- Collision warning
- Traffic sign detection
- Blind spot warning
- Pedestrian detection system

Source: Bloomberg, Stanford (2018)
Level 1 – Driver Assistance

1970s
- ABS · Anti-lock braking system

1980s
- TCS · Traction control system

1990s
- ESC · Electronic stability control
- ACC · Adaptive cruise control
- BAS · Brake assist system

2000s
- Parallel parking assist
- Lane keep assistance
- Angled parking assist
- Automatic emergency braking

Source: Bloomberg, Stanford (2018)
AV Technology
Incremental Progress Toward Full Automation

Level 2 – Partial Automation

2010s
- Traffic jam assist
- Automatic lane change
- Automatic merge & exit

Level 3 – Conditional Automation

2010s
- Automated highway cruising
- Traffic jam chauffeur
- Highway platooning

2020s
- Foolproof autopilot disengagement

Source: Bloomberg, Stanford (2018)
Level 4 – High Automation

2010s
- Automated parking
- Automated valet parking

Level 5 – Complete Automation

2020s
- Fully automated on-demand mobility
- Fully automated personal vehicle

Source: Bloomberg, Stanford (2018)
NZ Road Safety

- Lane Keeping/Changing (Level 1/3)
- Adaptive Cruise Control (Level 3)
- Highway Pilot (Level 3)
- Rural Road Platooning (Level 4)
AV Technology

**Autovot / Taxibot**
- Uber, GM, Lyft, nuTonomy
- 4
- 4,000–6,000 lbs
- 4–6 passengers
- 25–35 mph
- Pittsburgh, San Francisco, Singapore

**Driverless Shuttle**
- Navya, Local Motors, EasyMile, Auro Robotics
- 8
- 8,000–8,000 lbs
- 10–17 passengers
- 25–35 mph
- Lyon, Helsinki, Washington D.C.

**Deliverybot**
- Starship Technologies
- 18
- 40–55 lbs
- 10 passengers
- 4 mph
- Tel Aviv, London, Berlin, Redwood City, CA, Washington D.C.

**Software Train**
- Otto (Volvo), Scania
- 18
- 32,000 lbs
- 44,000 lbs cargo
- 55 mph
- Colorado, Rotterdam, EU (various)

**Autovot:** AV taxi providing sequential private rides
**Taxibot:** AV taxi shared simultaneously by several passengers

**Source:** Bloomberg, [Stanford](https://www.stanford.edu/) (2018)
Vehicle to anything (V2x)

- **V2V** - Vehicle-to-Vehicle. Alerts one vehicle to the presence of another. Cars “talk” using DSRC technology.
- **V2D** - Vehicle-to-Device. Vehicles communicate with cyclists’ V2D device and vice versa.
- **V2P** - Vehicle-to-Pedestrian. Car communication with pedestrian with approaching alerts and vice versa.
- **V2H** - Vehicle-to-Home. Vehicles will act as supplement power supplies to the home.
- **V2G** - Vehicle-to-Grid. Smart grid controls vehicle charging and return electricity to the grid.
- **V2I** - Vehicle-to-Infrastructure. Alerts vehicles to traffic lights, traffic congestion, road conditions, etc.
Automotive Tier 1 Suppliers

EQUIPMENT MAKERS AND ELECTRONIC PLAYERS – 2014 REVENUE

Equipment makers, but mostly electronic players are now big enough to become partners and technology providers instead of subcontractors for traditional carmakers.

Source: Yole (2015)
Automotive OEM’s

Source: Yole (2015)
AV Competitive Environment

Past: OEMs compete with one another

2030: OEMs compete in a complex market landscape

Established suppliers
Tier 1
Tier 1
Tier 1
OEM
OEM
Established OEMs

Tier 1
OEM
OEM
Established OEMs

e-hailing
Didi Kuaidi

Car sharing
Zipcar

Mobility providers

Chinese OEM
BYD

Specialty OEM
Tesla

Tech giants

Emerging OEMs

Consumer electronics
Apple

Software
Google

AV Promises

Launch timelines all over the board

Source: CB Insights (2018)
Einride’s T-Pod for forestry

/ The next generation transport provider

Einride is a **system creator** that uses electric batteries and self-driving technology to provide an environmentally sustainable transport service.

- Self-driving transport pods (T-pods)
- Charging infrastructure
- Remote control operators
- Order and fleet management system

Source: Einride (2018)
Legal/Ethics - The Trolley Problem

Who is responsible if an AV crashes?

Source: PM (2017)
Why N3T?

1. N3T has developed leading edge transport safety solutions
2. Working with internationally leading researchers
3. Tapping into decades of experience with national & international partners
4. Installed base on key NZ truck operators: 3,000km/week and growing
5. Vehicle Miles Travelled (VMT): 150,000km/a per truck, up to 1.5 million km (with ten trucks) this year
6. Part of bigger smart transport vision
7. International reputation - published with IEEE, presented in Singapore, Europe
8. Strong product roadmap and on-going product improvement
How does N3T process work?

Smart data analysis, which learns from analyzing huge amounts of unevenness data => ground truthing

Crowd sensing of unevenness events

- Car
- Truck
- Smart Infrastructure
- Modelling
- Deep Learning
- Categorization

Pothole Map & Alert

Commercial in confidence
2020+: New players are threatening previously ‘secure’ margins and market size of incumbents

Market size - today

Incumbent truck manufacturers & Tier 1 suppliers

The Perfect Storm: “Our industry is going to change more deeply in the coming 10 years than in the 100 years before” CEO of VW, the globally biggest automotive manufacturer

EV new retail channels
new service models
new players
connectivity
new materials & manufacturing methods
mobility-as-a-service
## AV car vs. truck testing (VMT)

**Different Physics than cars**  
**Very little AV Truck experience on public roads vs. cars**

<table>
<thead>
<tr>
<th>AV Car Mileage Accumulation Leaders</th>
<th>AV Truck Mileage Accumulation Leaders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tesla: ~1 billion (Autopilot - SAE Level 2)</td>
<td>Embark: &gt;2,500km (SAE level 2/3)</td>
</tr>
<tr>
<td>Mercedes: &gt;100m (Drive Pilot - Level 2)</td>
<td>Uber: &lt;1,000km (SAE level 3)</td>
</tr>
<tr>
<td>Waymo: 4m (SAE Level 4)</td>
<td>Mercedes: &lt; 500km (SAE level 3)</td>
</tr>
<tr>
<td>Uber: 2m (SAE Level 4)</td>
<td>Volvo Trucks: &lt; 500km (SAE level 3)</td>
</tr>
<tr>
<td>GM’s Cruise: ~0.5m (SAE Level 4)</td>
<td></td>
</tr>
</tbody>
</table>

=> significant opportunity for ADAS/ AV truck testing on public roads (Level 3+)
The testing/ QA Bottleneck

With growing disruption and the need to develop AV tech faster, companies can’t do all AV R&D in-house*

=> outsource parts of QA (to N3T)

*Note: over 17% of AV R&D effort is QA/Verification (Fraunhofer, 2016)
The N3T Solution

N3T Vision: Become The Leader in testing computer vision technology for heavy commercial vehicles on rural roads - starting in the Southern Hemisphere

IaaS

Proof of concept sites/ Infrastructure-as-a-Service (IaaS)
- Otaika Valley Road - The most digitised rural road on the planet by Q1Y18
- Marsden City - AV calibration and ITS V2x testing
- Town Basin - V2x testing

TaaS

Valued adding, outsourced Testing-as-a-Service (TaaS)
- Mileage accumulation
- Sensor calibration
- BPO QA

Testing Tools

Testing Tools for QA outsourcing/ licensing
- Data Collection - Multi Box
- Data Analytics
- Location Based Services
- Rural Road Truck Simulator
- Cyber Security Assessments
- Testing Frameworks

Increasing value add
# N3T Tool Roadmap

<table>
<thead>
<tr>
<th>Tools for Rural Road Safety</th>
<th>Tools for both</th>
<th>Tools for AV testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Box</td>
<td>Environmental Monitoring</td>
<td>Multibox</td>
</tr>
<tr>
<td>Pothole Detection</td>
<td>crowdsourced Environmental Monitoring &amp; Forecasting</td>
<td>Location Based Solutions (&lt; 10cm)</td>
</tr>
<tr>
<td>Pothole Mapping</td>
<td>Environmental Alerting</td>
<td>AR/VR Simulator*</td>
</tr>
<tr>
<td>Collision Avoidance (10cm)</td>
<td>Real-time Visualizer*</td>
<td></td>
</tr>
</tbody>
</table>

## Timeframe
- Deployed now
- Under development
- Available within 6m

* co-development with [ARL](https://www.arl.org.nz), Dunedin, [Waikato University](https://www.waikato.ac.nz) and [TERNZ](https://www.ternz.org)
Phased plan for Whangarei

- Phase I - EV sharing
- Phase II - car free City Centre with AV/EV shuttle
- Phase III - widen AV/EV Zone
- Phase IV - 15 km around CBD full AV/EV pod public transport
EV Sharing - Vehicles

- BMW i3
- IONIQ EV Elite

$12/hr for corporate customers
$14/hr for general public
120 km range
Round trips to start with
Free Fuel/ Electricity
No hidden costs

Source: YooGo Share, Hyundai (2018)
Other AV Options

Source: 2getThere, OHMIO, Ierospace (2018)
Whangarei built AV/ EV Pods

Source: Ruhdorfer (2018)
AV/ EV Pod - artists impression

Source: Ruhdorfer (2018)
Self-driving and driver assisted trucks
Impacts for New Zealand

John Houlker

REAAA 2018

Source: Mercedes (2018)