2016 MELBOURNE

23rd World Congress on Intelligent Transport Systems

ITS—ENHANCING LIVEABLE CITIES AND COMMUNITIES

Melbourne Convention and Exhibition Centre
10–14 October 2016

POST CONGRESS REPORT

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FOREWORD

ITS-ENHANCING LIVEABLE CITIES AND COMMUNITIES

BY BRIAN NEGUS, Chair ITS World Congress Board of Directors, President ITS Australia

The 2016 ITS World Congress was a significant event for the global ITS community, successfully raising the profile of Australian and international ITS industries, providing unprecedented business opportunities and connecting our industry with governments, organisations, academics and the community.

Hosted on behalf of ITS Asia Pacific, ITS Australia produced a Congress which benefited the national economy by $25 million (AUS) and was the second largest international association congress ever held in Melbourne.

The Congress was attended by 11,570 delegates from 73 countries – a significant increase on the 7,000 we anticipated and dismissing the notion that the long haul to Australia might be too far for many delegates.

In fact, more than 38 million kilometres was travelled by all delegates to attend.

ITS Australia was awarded the rights to host the 23rd World Congress at the Asia Pacific Board of Directors meeting in 2011. It was third time lucky after two unsuccessful bids. It was the second time the Congress came to Australia, following Sydney in 2001. We appreciated it is not expected here for many years to come so we were determined to maximise the opportunity.

After five years in the making, a tremendous amount of hard work from a vast number of organisations and individuals, we were honoured to welcome the global ITS community to Melbourne.

The traditional Cutting of the Ribbon to officially open ITSWC16

SPEAKER PROGRAM

The Congress was fittingly titled, *ITS Enhancing Liveable Cities and Communities,* because earlier in 2016, Melbourne was voted the World's most liveable city for a sixth successive year.

The program was split into eight themes namely: Challenges and Opportunities of Big Open Data, Smart Cities and New Urban Mobility, Automated Vehicles and Cooperative ITS, Mobile Applications, Vehicle and Network Safety, Future Freight including Aviation and Maritime, Environmental Sustainability, and Policy, Standards and Harmonisation.

There were four Plenary sessions, 12 Executive Sessions, 74 Special, 22 Scientific, 93 Technical, 8 Commercial and 4 Interactive sessions. In total, delegates could attend 236 speaker sessions featuring 663 speakers.

GOVERNMENT ENGAGEMENT

The Congress was officially opened by the Prime Minister of Australia, Malcolm Turnbull, Victorian Minister for Roads, Road Safety and Ports, Luke Donnellan and City of Melbourne Lord Mayor, Robert Doyle.

Government engagement was a feature of the 2016 World Congress with strong local and international support across the week. On behalf of the World Congress Board of Directors, I would like to thank the considerable contribution of the following Australian Ministers who attended various Congress activities across the week:

- **Malcolm Turnbull**, Prime Minister of Australian
- **Darren Chester**, Federal Minister for Infrastructure and Transport
- **Paul Fletcher**, Federal Minister for Urban Infrastructure
- **Jacinta Allan**, Victorian Minister for Public Transport and Major Projects
- **Luke Donnellan**, Victorian Minister for Roads, Road Safety and Ports
- **Tim Pallas**, Victorian Treasurer
- **Robin Scott**, Victorian Minister for Finance
- **Mark Bailey**, Queensland Minister for Main Roads, Road Safety and Ports
- **Stephen Mullighan**, South Australian Minister for Transport and Infrastructure
- **Simon Bridges**, New Zealand Minister for Transport.

HIGH LEVEL POLICY ROUNDTABLE

The number of international Ministers and Mayors in attendance was a feature of the Congress, with many extending their stay following the High Level Policy Roundtable, hosted by the Australian Federal Government.

The Roundtable was attended by 97 international guests, with 52 Ministers, Mayors, Department leads and representatives at the table, supported by 45 attendants. Australian Federal Minister for Infrastructure and Transport, Darren Chester chaired the meeting.

The Roundtable meeting was proceeded by a Civic Reception Luncheon, hosted by the Victorian Government at the Investment Centre in Melbourne CBD. With spectacular panoramic views of the city, the Luncheon was hosted by Minister Luke Donnellan, on behalf of Minister Jacinta Allan, and the Lord Mayor of Melbourne, Robert Doyle. Guests at this function were privileged as this facility is only made available for significant Victorian Government occasions.

The Australian Federal Government has provided a separate report on the High Level Policy Roundtable, which can be found in Part 3 of the Rapporteurs Report.

TECHNICAL TOURS

Another unique Melbourne experience was provided on the technical tours. Delegates had the opportunity to visit unique and public transport centres, rarely opened to the public.

It was one of the few occasions when visitors could view the control centre for the largest tram network in the world, while the Lindsay Fox owned Australian Automotive Research Centre is strictly off-limits to members of the public.

The Research centres also delivered unique experiences with visitors to the Swinburne University of Technology Factory of the Future, Smart Cities and Research-led Innovation tour witnessing the only Smart Structures Research facility in the Southern Hemisphere. The world renowned Wackett Aerospace Research Centre at RMIT showcased cutting edge facilities and Monash CAVE2 was the world's most advanced visualisation facility of its type.

The World Congress tour program involved another first with all major forms of transport covered. It was truly multi-modal, covering air, sea, road, freight, train, tram and public transport.

More than 650 tours were booked. The Tour program was supported by:

- **Australian Automotive Research Centre (AARC and Linfox)** - Heavy Vehicle Automation, new research and technologies for Road-Trains, B-Doubles and Prime Movers
- **EastLink** – Melbourne's newest and safest fully electronic tollway
- **Melbourne Airport** – Managing Traffic in an Airport Environment
- **Monash University** – Future Immersive Digital Environments for Transport and Collaboration
- **New South Wales Roads and Maritime Services (RMS)** – Electronic Lane Control Systems (ELCS) on Sydney Harbour Bridge
- **Port of Melbourne 1** – Melbourne Port System Tour: enhancing future freight productivity with container chain and 1-stop
- **Port of Melbourne 2** – Operations Control Centre and Hydrographic Survey Boat
- **Public Transport Victoria** – Public Transport Control Centres: Yarra Trams and Metro Trains
- **Queensland Department of Transport and Main Roads and Brisbane City Council, on behalf of the Queensland Pavilion consortium** – Multi Modal ITS in Metropolitan Brisbane
- **Royal Melbourne Institute of Technology (RMIT)** – Aerospace, Automotive and Manufacturing Laboratory Showcase
- **Swinburne University** – Factory of the Future: Smart Structures and Research-led Innovation
- **Telstra 1** – Customer Insight Centre: gain, share and develop insights
- **Telstra 2** – Global Operations Centre
- **Transurban** – CityLink: go behind the scenes at one of the world's first fully electronic toll roads
- **VicRoads 1** – Smart Work Zones and the Construction of Managed Motorways
- **VicRoads 2** – Managed Motorway Operations: Largest managed motorway network in Australia
- **VicRoads 3** – Traffic Management Centre and Using Smart Roads to achieve improved network performance

TECHNOLOGY DEMONSTRATIONS

The vehicle demonstrations were extremely popular with 3,618 experiences booked during the week.

An online booking process was introduced for the first time, allowing delegates to book their preferred time and date directly with the demonstration partner through the World Congress app. This enabled the demonstrator to engage directly with the delegate, improving business to business connections. There were four demonstration types and venues, with connectivity and interoperability the stand out features.

Remote parking, highly automated vehicles, including Australia's first Stage-Four automated car, shared driverless transportation and V2V and V2X communications were on display at Albert Park, home of the Australian Grand Prix.

Cooperative-ITS, open standards, real time emergency vehicle pre-emption, positioning and green light optimisation were displayed to delegates while being transported on the 'connected urban corridor' – created especially for the Congress - on a central Melbourne arterial to Albert Park.

GPS positioning, real time localisation and reference generation, emergency vehicle alerts and mobile tolling were displayed on public roads, based at the Melbourne Convention and Exhibition Centre.

Ubiquitous Bluetooth messaging transmitted to delegate smart phones was displayed at Melbourne Airport and key landmarks including Federation Square.

The technology demonstrations program was supported by:

- **Aldridge Traffic Controllers** – GPS Emergency Vehicle pre-emption
- **Aisin Group** – Remote Parking and Automatic Stop with Driver Monitor System
- **CO-GISTICS** – Open Roads Demonstration
- **Cohda Wireless** – GPSless Positioning for V2X
- **EasyMile** – Shared Driverless Transportation for the Last Mile
- **HMI Technologies Pty Ltd** – RouteTIP Bluetooth 12X ubiquitous demonstrations
- **Ibeo Automotive Systems GmbH** – Downtown Melbourne Challenge: real time localisation and reference generation in urban traffic

- **Intelematics** – Emergency Vehicle Alert
- **JUPITER-Galileo** – Ready for a Reliable Position for ITS
- **Kapsch TrafficCom Australia** – Enabling Mobility
- **NXP Semiconductors 1** – V2X Technology makes Melbourne's streets smarter (communicating car demonstration)
- **NXP Semiconductors 2** - V2X Technology makes Melbourne's streets smarter (bus demonstration).
- **Q-Free ASA** – ITS Station: Smart applications based on standard ITS messages
- **Robert Bosch Australia** – Highly Automated Driving Vehicle Demonstration

NETWORKING

The Exhibition Centre, housed 278 exhibiting organisations and witnessed many signings of Memorandum of Understanding, with new partnerships and initiatives announced. There was a constant buzz, with delegates participating in interactive and hands-on displays.

Significant networking events included the Welcome Reception and the traditional 3CEO's Toast, as guests moved from one stand to another, making introductions, swapping business cards and sharing information. The Exhibition Centre was also a focus for social functions and entertainment, with a cartoon wall, coffee, food and drink stations and even a chance to meet Australia's unique animals including a kangaroo, dingo and snakes.

The official Congress social program took delegates to iconic Melbourne venues and were well supported.

The VIP Dinner was attended by 300 guests and held in the Great Hall at the National Gallery of Victoria with the entertainment led by internationally renowned jazz musician James Morrison.

The Gala Dinner, at the Peninsula, in the Docklands, will long be remembered as the 'night of nights', with 1,200 guests treated to an evening of great company, fine food and dazzling entertainment. The three after party venues were packed with delegates dancing long into the night.

COMMUNITY ENGAGEMENT

With two key objectives - to ensure next generation ITS professionals had the opportunity to participate and to raise the profile of the industry to the community – we delivered on the most ambitious public engagement program seen yet at a World Congress.

The Smart Cities Hackathon saw 86 participants from 16 teams compete over two days to tackle three challenges, namely Green, Demand Management and Future City. The main prize of $10,000 was won by Team Geolicious for a concept offering motorists ways to optimise travel plans in upcoming regimes of congestion tax, help users find alternative routes, while rewarding them in the process.

Prior to the Congress school students were set a number of challenges with the incentive of attending the Congress to display their work. The challenges included the Autocar Programming Challenge: Smart City Project; Modal Solar Car Challenge; and Young Student, Design your Future Challenge. Not only was their work of the highest order, but they injected energy and youth into the event. Interstate winners of a national University essay competition received their awards at the Congress. Joining them at the Future Innovators Reception were 10 Asia Pacific student scholarship winners, sponsored by the ITS World Congress. The Reception not only recognised new talent, but was a networking forum for those starting in the industry.

Diversity in the work place was recognised with Transurban awarded as winners of the 2016 Award for Best Action for Supporting Diversity in the ITS Workforce.

More than 2,500 members of the community attended the student program and the two open for public days. Members of the public were invited into the exhibition centre, adding a new dynamic to the exhibitions and providing exhibitors with new opportunities to promote their products and brand.

Interest in the ITS space was heightened with the introduction of three Melbourne Conversations, in partnership with the City of Melbourne. These public discussions were held, on site, during the week and were well attended.

INDUSTRY PROFILE

The media also played their part in promoting the event and our industry. Partnerships with key industry publications and strong relations with local and stakeholder media ensured the Congress received good publicity.

To launch the Congress, a media event was held at Albert Park, the day before the official opening.

Speeches were made by Minister Luke Donnellan, Victoria Police Assistant Commissioner, Doug Fryer, Transport Certification Australia CEO Chris Koniditsiotis and ITS Australia CEO Susan Harris.

Media coverage included a live interview by Susan Harris on the national breakfast show and national news pieces. The Congress received more than 1,000 pieces of earned media and more than 100 media releases were pitched to relevant publications and journalists.

During the Congress, social media engagement, using the hashtag #ITSWC16, was immense with more than 4,000 followers and one hundred per cent of tweets retweeted. On Tuesday 11 October, the first full day of the Congress, Twitter was flooded with the ITS Australia account receiving 34,254 impressions.

The promotional World Congress video, on ITS Australia's YouTube channel, received more than 5,500 views and the Closing highlights video more than 600 views.

COLLABORATION AND PARTNERSHIP

The 2016 ITS World Congress was a great success for many reasons, with Melbourne proving to be a destination of choice and a perfect location.

Our success was generated from the extensive collaboration of governments, agencies, ITS organisations, academics and the ITS community.

We had wonderful support from many partners, with these relationships starting long before the final bidding process. It was a collective effort and we could not have done it without the support of our regional body, ITS Asia Pacific as well as global support from ITS Europe-ERTICO and ITS America.

The World Congress Globe passed to 2017 host city Montreal

Our Local Organising Committee and Program Committee were focused and dedicated and we owe them a huge debt of gratitude for overseeing a well-balanced program of events and activities.

In particular, I would like to recognise the significant contribution and strong leadership of the following:

- **Edward Chung** – Chair, International Program Committee and Co-Chair of the Local Program Committee
- **Brian Smith** – Co-Chair Local Program Committee
- **Dean Zabrieszach** – Program Director
- **Hany Eldaly** – Chair Technical Tours
- **Con Liosatos** – Chair Sponsorship
- **Chris Koniditsiotis** – Chair Demonstrations and Exhibition
- **Joanna Spanbroek** – Chair Media Marketing
- **Susan Harris** – CEO ITS Australia

I also thank the 140 people who participated on the local and international committees, making a valuable contribution.

FROM MELBOURNE TO MONTREAL

The final act of the 23rd World Congress on ITS in Melbourne was to the traditional Passing of the Globe to 2017 host city, Montreal. After five years in the making, and five fabulous days, it was with mixed emotions that I lifted and handed over the Globe.

It was a privilege to Chair the World Congress Board of Directors and to be part of a significant event for the Australian ITS industry, ITS Australia and the nation itself. We now look forward to the 24th World Congress, hosted by ITS America and the City of Montreal.

RAPPORTEURS REPORT

I would like to acknowledge the commitment of Eric Sampson and his team of Rapporteurs for producing this important Report. Eric and his team have invested considerable time and effort into providing a comprehensive summary of the Plenary and Executive Sessions. This Report is an accurate capture of the key discussions and messages. It provides not only a documented record of the event, but a reference point for the industry and future Congresses.

Yours sincerely

Brian Negus
Chair ITS World Congress Board of Directors 2016
President ITS Australia

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INTRODUCTION

The Congress headline was "ITS – Enhancing Liveable Cities and Communities". This wording aimed to reflect the remarkable range of ITS products that are being deployed now by cities and urban conurbations to support population increases, sustained growth in demand for mobility, and users' appetites for services that build on 24/7 connectivity. At the same time ITS can deliver improvements to network capacity, air quality and safety. The Congress was organised around eight key topics

- **TOPIC A** Challenges and opportunities of Big and Open Data
- **TOPIC B** Smart cities and new urban mobility
- **TOPIC C** Automated vehicles and Cooperative ITS
- **TOPIC D** Mobile applications
- **TOPIC E** Vehicle and network safety
- **TOPIC F** Future freight
- **TOPIC G** Environmental sustainability
- **TOPIC H** Policy, standards and harmonisation

The Congress Board of Directors, chaired by Brian Negus, appointed *rapporteurs* for each topic tasked with capturing the key messages and outcomes from the Congress, the exhibition and the demonstrations. The topics were addressed by a wide range of different types of sessions, over 220 in total – Plenary, Executive, Special Interest, Technical, Scientific, Interactive, and Commercial.

Around 450 papers were presented roughly divided as follows – Topic A: 65 papers; Topic B: 135 papers; Topic C: 110 papers; Topic D 25 papers, Topic E: 65 papers; Topic F 15 papers; Topic G 25 papers; and Topic H. 20 papers. In the four Plenary Sessions high-level industry executives, public officials and international experts shared their perspectives and extensive experience of ITS topics encompassing policy, strategic, economic, technical, organisational and societal aspects.

This Report summarises the Congress proceedings. The first part focuses mostly on the Technical and Scientific papers and the Special Interest Sessions; the second part reports on the Plenary and Executive Sessions and the third part is an account of the High Level Policy Roundtable. I give my profound thanks to the main team of *rapporteurs* who contributed so much to this document:

- **Fang Chen** TOPIC A
- **Carol Schweiger** TOPIC B
- **Catherine Morency** TOPIC B
- **Risto Kulmala** TOPIC C
- **Jana Sochor** TOPIC D
- **Max Gillard** TOPIC E
- **Gideon Mbiydzenyuy** TOPIC F
- **Paul Matthews** TOPIC G
- **Charles Karl** TOPIC H
- **Clarissa Han** TOPIC H

Additional support from: Krishna Desai and Nick Fisher with the documenting of Executive and Plenary sessions is gratefully acknowledged. I also thank Susan Harris and the ITS Australia team for their quick and cheerful handling of all enquiries and questions. Like many speakers I am pleased to acknowledge the Wurundjeri people as the traditional owners of the land on which we enjoyed many of the Congress activities.

Professor Eric Sampson, Chief Rapporteur

PART 1
TOPIC REPORTS

TOPIC A CHALLENGES AND OPPORTUNITIES OF BIG AND OPEN DATA

OVERALL SITUATION

Around the world a number of feasibilities studies and field trials are under way. An open and scalable platform entered the trial phase for smart mobility in the UK; a platform for real-time operational decision-support is being rolled out in New Zealand. Investigations in Japan have studied the use of ETC 2.0 data for freeway management and real-time image classification for analysing speed changes determined by congestion. Many studies have shown how sensor data can be used for infrastructure asset management as well as improving traveller experience. A real-time platform for integrating different data sources and predict the traffic state is currently being built in Netherlands.

Advanced techniques are increasingly coupled with the emerging ITS solutions. Machine learning techniques, with "deep learning" as a notable example, are central to transport data analytics. Open source tools such as Hadoop, Spark, Kafka and Cassandra are being used as building blocks to many emerging Big Data products and services in transport. Automatic detection of incidents and real-time road updates still remain a priority in the Big and Open Data in Transportation.

Overall, the traffic data collected from a variety of organisations is very similar among countries all over the world. These common datasets are driven by probes, loop detectors, crowd sourcing (including social media, mobile apps), real-time sensors, Bluetooth, CCTV, wireless, survey data and smart cards. The resulting big data resources are mainly being used in the following systems: real-time situation awareness, connected and automated vehicles, adaptive signal control, traffic network planning, traffic and driving simulation, smart city, mobility analyses and disaster planning. Among them, connected and automated vehicles can be considered as hot topic.

The trend for open data is becoming stronger in both public and private sector. Open data from government authorities includes Japan Open Data Charter, VicRoads and TfNSW. From private companies the HERE map provides a big open and collaboration platform for public use; and Arup introduced oneTRANSPORT as a smart mobility open and scalable platform.

NEW IDEAS

Rather than a variety of innovative thinking on utilising big data to address transport issues the 2016 technical presentations saw a continuous discovery and improvement from previous years. There were some new ideas on Machine Learning such as pedestrian detection using deep learning and disruption notifications

New ideas from technical paper sessions can be best summarised as:

- System integration, especially data platforms and the standardisation of data interfaces
- Industry standards, legislative principles and policy frameworks for data security
- Multiple data sources to improve urban mobility and behaviour discovery
- Decision fusion for convolutional neural networks
- Integration of Social Media in the traffic analysis process
- Automatic anomaly detection in road traffic
- Discussions in SISs looked at using in-car sensors and probe data for:
  - Service and repair suggestion.
  - Improving driver behaviour, alert for distracted, compare with other drivers
  - Auto insurance adjusted and auto claim validation
  - Predictive breakdown, battery failure
  - Hazard and weather warning from real-time sensor data.

Standardisation and integration coupled with an accommodating policy framework will ensure a smooth adoption of new technologies and a wider appeal to the participants.

FORWARDS vs CONSTRAINED

Big Data analytics was projected to make a substantial impact on urban mobility, transport operation, privacy and asset management and the potential is being realised at a fast pace. Standardisation and integration coupled with an accommodating policy framework will ensure a smooth adoption of new technologies and a wider appeal to the participants. In general we did not see many new approaches to processing big and open data, especially in predictive analytics. Most of the work presented focused on data fusion and visualisation for reporting and real-time situation awareness.

The session on Predictive Analytics discussed an interesting question on using neural networks (deep learning) for traffic incident classification. Deep learning is a new method in data mining research and can potentially applied to big data analytics in transportation. We can expect to see more applications of future Congresses; the only Melbourne presentation looked at pedestrian detection.

CHANGES FROM PREVIOUS CONGRESSES

An ecosystem for leveraging Big Data in transport is taking shape encompassing sensor data connection, data platforms, data sharing and communication protocols, and data security frameworks. Participants articulated the importance of the standardisation of data interfaces, establishment of legislative and legal frameworks to ensure data security, and a data platform for data integration and sharing. An important aspect raised this year was the need to use crowd-sourced data generated by citizens to improve congestion management and help improve situation awareness. More attention is being given to the fusion of heterogeneous and distributed data sources which need to be collected, stored and used for traffic monitoring and incident management.

Autonomous vehicles and C-ITS is a fast growing area but it did not receive a good number of data-related presentations this year. This area is likely to benefit most from the interface standardisation and system integration so participants in Montreal might be encouraged to discover and present ideas on this topic.

KEY THEMES FROM SESSIONS AND PRESENTATIONS

We had a lively session on mobile sensing, open data and data from probes to address mobility issues. This looked at technologies to monitor individual vehicles such as ANPR, C-ITS and the inferred traffic logger (TIRTL); use of Big Data to improve urban mobility and the idea of a System of systems; leveraging Big Data to identify and address mobility issues with emphasis on crowd-sourced data; refinement of probe data using GPS, acceleration, and gyroscope data from smartphones, compensation for movement orientation and machine learning for classification of transport modes. This session also addressed free open-source big data tools such as Apache Hadoop, Spark, Kafka and Cassandra with the idea of a common data gathering and processing architecture.

Data Sharing and Exchange featured prominently with a focus on platforms and the Cloud The "oneTRANSPORT" approach to smart mobility was presented; it offers an open and scalable platform enabling multi-modal and multi-system transport integration across geographic boundaries. This work is in its second phase (In-field trial) having successfully demonstrated the potential of the platform in a feasibility study. We also heard about a field operational test for data sharing and a Big Data-based platform for Hangzhou's urban traffic management and control with focus on public transport and commercial vehicles including taxis. A key topic addressed here was the road operator's view on Cloud-based ITS and the different data needs.

Safety and Security always feature at Congresses and there was discussion on the particular issues for Big Data. Data Encryption featured prominently with work on Symmetric and Asymmetric Cryptography, key exchange algorithms, different challenges of Implementation, good practice methodologies (*eg* ISO 27005) and risk evaluation models. Access to and use of ITS personal information was a hot topic with discussions on legislative control such as regulating access to licensing and registration data, regulating access to ANPR data and regulating access to C-ITS data

Different aspects of both safety and security emerged when considering how to identify passable routes after disasters. ETC2.0 probe data allows provision of road traffic information to vehicles equipped with ETC 2.0 OBU while supporting discovery of vehicle driving routes and the changes to routes after disaster

As expected we had much debate about the impact of Big Data on ETC and applications for network management. ETC data is being used for traffic flow analysis, understanding traveller resting behaviour on inter-urban expressways and extracting individuals' resting behaviour by tracking successive travel data on expressways. The Auckland Motorway Network has started real-time operational decision support using a Cell Transmission Model. This is a potential platform for an on-line decision support tool to take advantage of the extensive traffic detection infrastructure on the motorway mainline and adjoining ramps

A majority of sessions looked at techniques to support real world deployments. A very practical problem was how to use Big Data to assess an organisation's infrastructure and assets. This reviewed data collection and monitoring at remote intersections based on cloud base processes and cellular technologies; inspecting and planning repair of ITS-facilities using mobile devices; assessing the condition of signage by mobile LiDAR Imaging and digital photologs then applying a Random Forests model to analyse this data and rank all of the factors based on their importance to the sign visual condition.

One of the key practical issues is how to make big data meaningful. This was addressed by reference to applications derived from Big Data and a Connected Car. Topics discussed included in time service and repair; improving driver behaviour; generating a distraction alert by comparing an individual with other drivers; how to save time / money by better route and departure time selection; breakdown or battery failure prediction and using sensors for insurance claims validation.

A session on securing digital communities in a hostile cyber-world looked at the particular case of Cybersecurity at intersections, securing critical ITS infrastructure, and how to develop a security-aware culture.

Visualising data technologies on display at ITSWC16

Key points raised here were that so far hacks in transport have centred on vehicle security and not infrastructure breaching; remembering that dangerous attacks are possible and could cause significant impacts on the whole transportation system and there is no perfect protection method; and aiming to be better prepared with a good knowledge of cybersecurity issues.

Using data for predictive analytics has been developing steadily and we heard about road event learning from streaming telematics data the application of online clustering algorithm and analysis by grouping data into spatial clusters on a map. Other emerging topics were:

- Automatic classification of incident severity
- Using machine learning
- Visualising and classifying data using decision trees
- Predictions from incomplete data
- Using a neural network (or deep learning) for incident classification
- Predictive and dynamic distributed network management

TOPIC B SMART CITIES AND NEW URBAN MOBILITY

OVERALL SITUATION

The "Smart Cities and New Urban Mobility" topic was organised around 69 sessions and the presentation of 150+ papers covering a variety of sub-topics. Four Executive Sessions presented a broader perspective on the most relevant topics within the theme and, as in previous conferences, set the stage for the other sessions. They focused on key concepts such as the Internet of Things (IoT), Mobility as a Service (MaaS), and connected and automated vehicles (CAV).

Technical, scientific and commercial sessions included papers on more specific topics, issues or opportunities, and illustrated applications or possible approaches to address the issues. The presentation themes were not uniformly distributed across sub-topics: integrated transport systems (40); next generation traffic management (50); transport modelling (18); road user charging (15); travel demand management (10); integrated ticketing and payment (9); incident management (10). Several general messages came through strongly from the papers and presentations had some overall themes:

- Systems must be more traveller- and human-focused rather than driven by technology without regard for the traveller's role, needs or quality of life; or focused on the optimisation of infrastructure;
- Cooperation, whether it is among public agencies, or public and private service providers, is critical to bringing ITS to the next level;
- We can no longer develop and deploy systems that only react to a situation (*eg* traffic congestion) – rather we should, as far as possible, ensure that systems are predictive and proactive.

Overall, the most popular discussions within this topic were as follows:

Mobility as a Service (MaaS) featured in five sessions and one plenary nevertheless concrete examples of actual MaaS deployments were lacking. One of the only "real" deployments, in rural Finland, featured in one Special Interest Session (SIS). The objectives of this trial are:

- Provide the possibility to travel and move easily and cost-effectively without a car;
- Attract new users to public transport and taxi services;
- Create new mobility services and increase the demand on the existing services;
- Find a business model;
- Test different mobility service packages and pricing models;
- Define the applicable technology.

There were discussions in several sessions about UbiGo, a MaaS demonstration project in Gothenburg. Other applications that are a pre-cursors to MaaS were discussed including Go Denver in Denver, Colorado and Syndicat Mixte Intermodal Régional de Transports (SMIRT) Pass-Pass in the Lille area. Apart from the Finland trial discussion of how to develop and deploy MaaS for rural and small urban areas was lacking as most of MaaS pilot projects focus only on urban areas. Dwight Mengel in Ithaca, NY has developed a unique MaaS concept that envisions packages of services in rural and small urban areas.

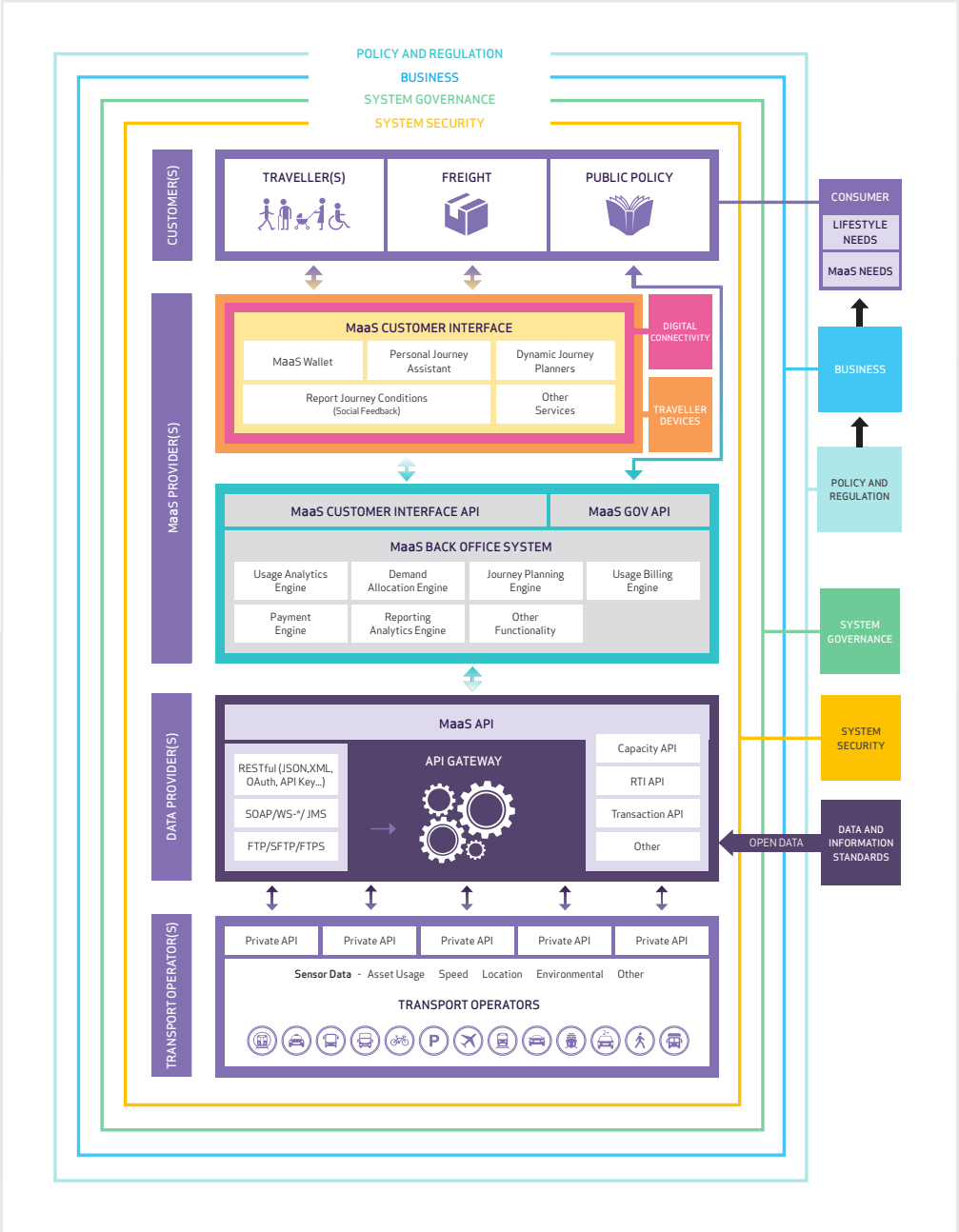
Two other key concepts were discussed in Melbourne: first, that MaaS can influence travellers' behaviours (at this point we do not necessarily know the extent to which this is true except for the results of the UbiGo project). It was suggested that gamification is thought to be a way to change driver behaviour. The second concept was the tool developed by Mobility as a Service Australia to assess MaaS market readiness which is driven by assessments of Customer Demand, Transport Service Availability, and the Government and Regulatory Environment.

A new graphic describing MaaS was developed by the UK's Transport Systems Catapult and is shown in the figure on Page 12. Generally speaking there was strong interest shown by the Plenaries in the MaaS concept, as observed in Bordeaux, but the community is still awaiting clear demonstrations and measures of the role it can play in cities, who should operate and manage and what are the expected contributions at the individual and collective levels.

IoT, the Internet of Transportation (IoTr) and the "digital tsunami" were the subject of several presentations. In one presentation it was argued that the use of Bluetooth beacons can maximise the value of IoT; in another that the IoTr is "an eco-system of connected vehicles, infrastructure, pedestrians, data systems, security, and cloud to provide applications and services to improve the movement of people and goods and generate new business models and a component of the IoT

The role of **location tools and services** in Smart Cities was discussed in several sessions. Understanding location is vital and location links everything in Smart Cities. GIS is becoming an enterprise platform to open, integrate and simplify everything in Smart Cities. One example is integrating GIS and crowdsourcing, which was mentioned at the Congress when ESRI announced a new partnership with Waze. Cities need to start digitising all their assets, not only the connected objects or infrastructures.

Big data in Smart Cities was often discussed. In one session, it was suggested that there are five aspects of big data to be considered: (1) Business case – how do you pay for it? (2) Policy – What are the outcomes? (3) User Needs; (4) Key performance indicators; and (5) Governance. Big Data helps Smart Cities by providing greater accuracy, reduced costs; and deeper insights into transport reliability on a 24/7/365 basis. Another presentation suggested that "data silos are holding us all back".



MaaS Reference Architecture: Courtesy Andrew Everett

Overall challenges associated with **mobility in Smart Cities** were discussed and focused on the future role of government in mobility with questions such as

- How will transport infrastructure be funded?
- How can data be packaged for public release?
- How to balance privacy with a user-centered experience?
- How to send the right price signals while addressing equity of access?

Reducing congestion and improving reliability of travel times on network is still a key issue for urban areas and multiple approaches benefiting from the availability of a diversity of data are being tested. The concept of hyper-congestion is emerging in some megacities, bringing added complexity to the problem. It was regularly argued that we need to focus more on cooperative approaches that improve business planning, and system development and deployment, and that facilitate local and regional travel from a network and enterprise perspective. As one speaker put it: "It's not about competition. It's about co-operation."

Demand-responsive transport services (also known as Mobility on Demand) and microtransit facilitated by ITS were discussed, but not as much as expected. Via, a new Transportation Network Company (TNC), was described. It uses Israeli military scheduling algorithms to identify optimal pickup and drop-off locations to create significant efficiencies. Via is now operating in New York City, Chicago, Washington, DC and Orange County, CA where it has been a success despite its not being a dense, urban environment. A memorable quote from Sarah Reinhoff was "Let the Station Come to You." Via creates virtual bus stops and optimises seats across hundreds of vans in real time. There were a few mentions of other TNCs, such as Bridj, which is a point-to-point shuttle service that currently operates in Boston, Washington and Kansas City. Bridj was characterized as creating pop-up urban infrastructure. Simply Connect is a similar concept that provides door-to-door travel on demand for just above a bus fare. It is soon to be launched in Manchester, UK with seeding support from the Department for Transport.

Citizens need to be involved in the development and deployment of Smart City systems

While **citizen and traveller involvement** in the development of Smart Cities and related technologies was mentioned by several speakers throughout the Congress, no one described how citizen and traveller needs will be collected and integrated in Smart City development. Wietske Smith said that there are five core customer needs: safety, dependability, good value, confidence and personal relevance. While customer expectations and the mode of delivery will change over time, the core needs of a customer will hold true and consistent. In one of the few presentations to address customer expectations Joanna Robinson mentioned six core traveller expectations: seamless journeys, being informed before a trip and *en route*, reliability, efficiency, connectivity across modes, and safety.

Citizen involvement was mentioned in several presentations about big data. For example Carol Schweiger described multiple layers of transport big data. The top layer is the Transportation User Experience, followed by Transportation Services, Information Collection, Information Management and Control, and Transportation Company Coordination is the bottom layer. The bottom line is that citizens need to be involved in the development and deployment of Smart City systems. Without this cities will not be "smart" even though they have deployed numerous technologies. One of the sessions included this statement "A Smart City is not about technology – rather, it is about being a more livable city, which includes quality of life, health, economy, reliability, efficiency, accessibility, environment, mobility, inclusion and safety." Another key quote was Singapore's Prime Minister: "A nation where people live meaningful and fulfilled lives, enabled seamlessly by technology, offering exciting opportunities for all."

The contribution of **connected and autonomous vehicles** (CAV) to the possible reduction of congestion (by more efficient travel) was discussed in previous conferences and in Melbourne but we still lack insights into the other consequences, potentially negative, of such technology if it promotes the use of cars at the expense of active and alternative modes of travel. Implementation of autonomous cars needs to occur within a shared-modes conceptual framework. Hence, there are still some unresolved issues such as how we will go from 0% to 100% autonomous cars; how the mixed traffic will behave, how the interactions with other road users (pedestrian, cyclists) will be managed and how our current infrastructures should be adapted to be suited to these vehicles (or how we build our current infrastructure to future-proof them).

Data: big data, open data, cloud computing: There was a lot of discussion around data and how they fit in the smart city conceptual framework. There is still a need for a business case for open data even though some still question the benefits of sharing data. There are a lot of challenges to overcome before data become usable (up to 30-40% of the time is spent on data cleaning and validation). Hence, the amount of data available is rapidly increasing but it is still in silos and accessing the data is often the real issue. As one speaker said, we need to move from big data to big understanding and it is true that systematically processing big data and making sense of them is a key issue. Regarding cloud computing, we need to assess how such a service can facilitate / improve the sharing, storing, merging and processing of large-scale databases. Also we need to take advantage of third-party data and be aware of those sources when thinking about data standards and integration.

Parking is a key component of travel demand management – we have known this for many years. Still, we do not see enough interest into how ITS technology can assist in switching behaviours from the car to smarter and more sustainable modes of travel. Further, the ITS community often overlooks the need to include parking (*eg* in schemes like MaaS) and the parking community does not necessarily understand ITS. More demonstrations are needed and the full potential of technology to manage (from a planning point of view) and use (from the user point of view) parking is necessary. In addition, the way we design current infrastructure needs to account for the eventual introduction of autonomous cars.

The use of the **smartphone** to facilitate choice among a wide variety of transportation modes was not sufficiently discussed or demonstrated. We know that smartphones are used in many projects, but we are still awaiting confirmation and demonstrations of the one single app that can encourage smart mode choices and cover everything that is necessary for a traveller to make smart choices. Some papers discussed mobile payment for tolls but we expected to see more discussions about the opportunity of using mobile payment in an integrated sense (see below for an additional discussion about integrated payment). Instead of having one app to pay for each system, we need one app to access all possible services. This is something that has been conceptualised for quite some time but we are still waiting for actual demonstrations (case studies) and discussions about the challenges associated with implementation. This is directly related to the objective to move toward fully integrated multi-modal transportation systems.

ITS to facilitate the use of active modes was definitely lacking in this topic. It is difficult to imagine a smart city in which optimisation is done for the car without interaction with pedestrians and cyclists or any other road user / usage. Hence technologies to facilitate travelling by active modes (for all population segments) need to be discussed, developed and deployed. We saw some contributions regarding automatic recognition methods to account for their presence and movements at intersection but we need more focus on how ITS can facilitate an entire trip.

There were very limited discussions about the **role of government** in Smart Cities. One presentation mentioned that government's role is to (1) from a policy-perspective, allow for the transportation disruption and enable the transition to take place; (2) provide equity of access; and (3) provide essential infrastructure.

There are several **planning challenges** associated with modelling for the new mobility. Many of the current models were developed well before there were significant changes to our transport ecosystem such as the advent of transportation network companies (TNCs) and the reduction of car ownership primarily due to the millennial generation. Only one session addressed these challenges which included:

- Modal shift is based on two primary factors: the car ceasing to be the default mode and people understanding the real cost and benefit of current and new modes.
- Modelling has to reflect that there will be less use of your own car and more awareness of travel, including car as a service, crowd-sourced buses on demand, cycle or rideshare to transit, app-hailed taxis and more utility for non-car modes. It must incorporate an understanding of how people and things drive demand, including how people choose old and new modes; new tools for demand inputs, machine learning to determine new correlations, people's intent and data fusion; new urban usage patterns; and greater share of automated vehicles
- Technology affects travel behaviour; as one speaker said "The world became more complex when technology was invented." It created transport options and allows information about these options to be widely accessible.
- The 4 revolutions in intelligent mobility should be reflected in models: Automation Theme, Access Theme, Integration Theme (smart ticketing *etc*), and Demand and Supply Theme (load balancing – geo-shifting demand, time-shifting demand).

Integrated payment systems were not discussed as much in Melbourne as they were in Bordeaux where the many sessions suggested that integrated payment leads to improved mobility. One of the sessions revealed that not every situation reflects that integrated payment equals improved mobility. In the rural MaaS deployment in Seinajoki, Finland, integrated payment is NOT included because of implementation time, management challenges, the high cost and the limited number of participants in the current deployment.

It is important to realise the added value of integrated payment systems for users, transport operators, municipalities and other authorities compared to the costs. Payment systems are usually costly. All operators and other stakeholders own already well-functioning systems. Users have varying ability to adopt new services and systems. There is no need to get stuck in complex payment systems since there are many light choices available. A mobile payment solution + credit/debit cards = a good combination. It is also necessary to balance Operator Independence and Customer Experience when considering integrated payment systems. Xerox has proposed a device-less payment system in which there is a smart tag in the location where payment will take place and people use their phones to read the tag and make the payment). This is considered "fare collection as a service," which can be integrated within MaaS offering. There is no need to purchase a ticket in advance.

INNOVATIONS

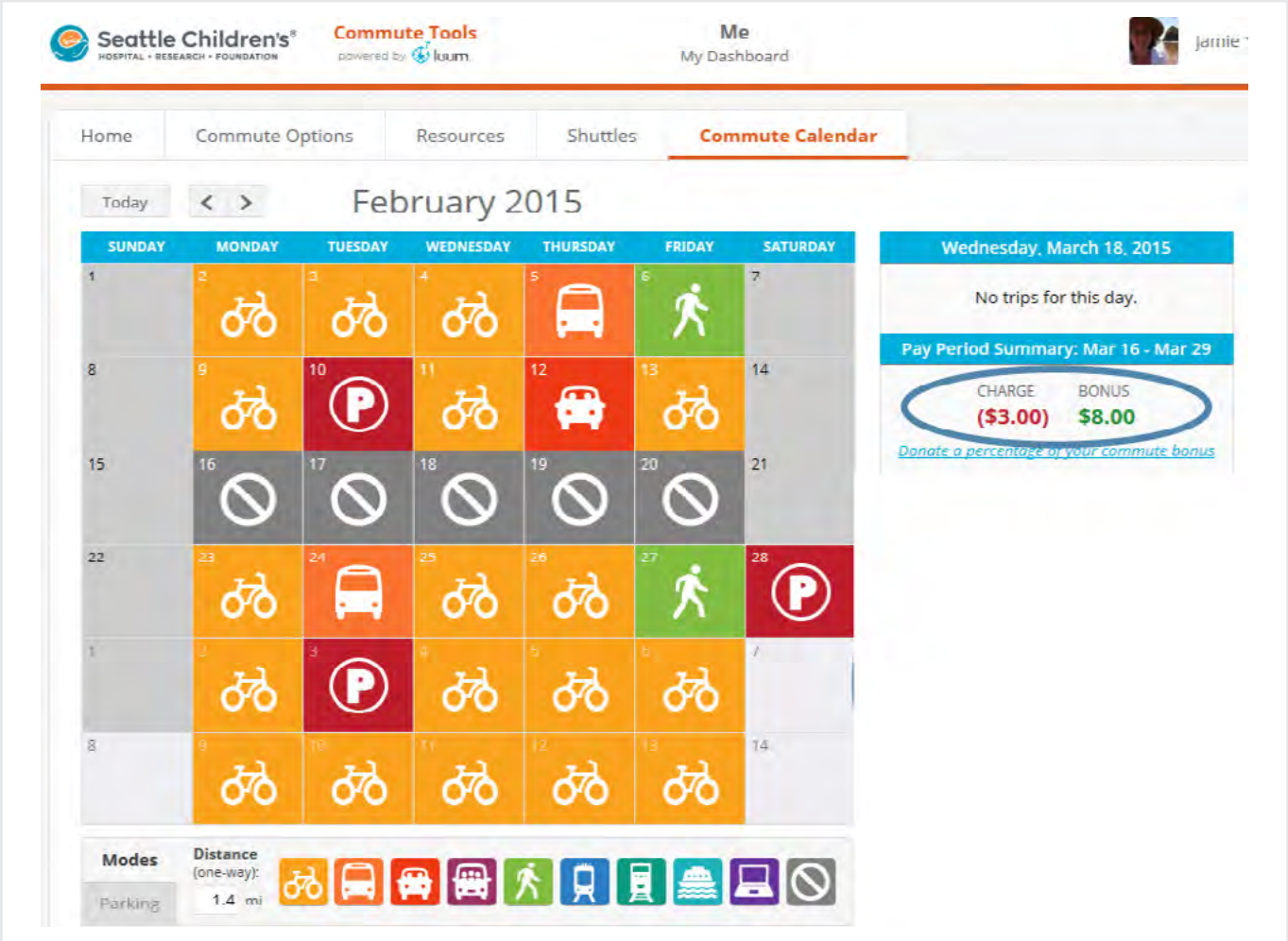
There were a number of new ideas and findings in this topic area for example:

- Low cost solution that integrates automatic vehicle location and control (AVLC) with Sydney Coordinated Adaptive Traffic System (SCATS). This solution utilises existing systems infrastructure to deliver significant public transport time savings with no additional on-street equipment being necessary.
- Traffic Intersection Market (TIM) applies economic design principles to traffic signal services to produce a competitive market that considers the trade-off of customers' time costs between conflicting movements.
- Protection for pedestrians from turning vehicles, with specific attention to the conflict with vehicles turning left through the pedestrian movements.
- The Smart Motorway is automating the implementation of Variable Mandatory Speed Limits (VMSL) to manage recurrent congestion on the Wellington, NZ motorway network. The VMSL regime will be controlled and implemented through a Model Predictive Control (MPC) framework approach, creating a predictive software module which will sit inside NZTA's Standard Sensor Data Format (SSDF) system.
- Transit services that share: passengers and goods deliveries. A conceptual model has been developed to explore the performance of such a service with two different optimisation algorithms.
- Proposed bus priority scheme at small and medium sized roundabouts without traffic signals. This approach will give higher priority for buses and less disadvantages for other traffic compared to most bus priority schemes at signal controlled intersections.
- A new approach to public transport planning from the timetable creation perspective. It is a lightweight simulation that helps validate how different parts of the service interact with each other.
- Next generation traffic management in which mobile applications, crowd sourcing and advanced analytics are used to engage the commuter and serve as a means to provide personalised and highly contextual information to the commuter. Here, connected-customers influence automated traffic signal control decision-making.
- Smart bus shelters that act as smart city hub and provide the opportunity to present real-time information to public transit users and that can also be used to inform on other activity location while creating potential revenue opportunity.
- Strategies to measure the contribution, at the system-wide level, of drivers having access to real-time information on traffic conditions. This may not actually bring the collective travel cost down and could actually increase the average travel time on the network – a paradox to think about.

TRENDS – NOT SO NEW IDEAS

There has been a fundamental shift in the definition of Smart Cities from a few years ago to now with recognition that a Smart City is not just a city with multiple technologies and smartphone applications; rather it is a city that has deployed integrated technology that meets the needs of citizens. Some of these thoughts were expressed at the Congress and we can expect more of a discussion in the future about how we engage citizens in the process of considering and deploying smart city technologies. Some speakers have argued that the ITS community has to help cities get smarter by showing where regulations are stopping progress so some adjustments are required.

In the last few years, we have moved from discussing individual travel modes to discussing mobility. We no longer focus on which mode(s) carry a traveller from point A to point B. Rather, we are concerned about presenting the traveller with a menu of available services, personalised to that particular traveller, and giving the traveller the capability to pay for the trip with one payment, not multiple payments to each service provider. Further, the last few years have seen a rapid increase in the development of Mobility as a Service (MaaS), which provides the traveller with a monthly subscription to mobility services that are tailored to that particular traveller. While many of the new European MaaS systems are being developed in major urban areas, the discussion and initial development of MaaS in the US focuses on all types of regions: urban, suburban and rural. The bottom line is that a person's mobility facilitated by technology contributes to that person's well-being in many ways (*eg* social inclusion, connection with health care services).



Mobility as a Service - Opportunities in the US: Courtesy Carol Schweiger

Key messages

Several key messages were captured from the presentations and discussions including:

- The ITS challenges: lack of a single solution, autonomy, or integrating ability.
- We are still waiting to see the full potential of ITS;
- While Mobility as a service is being discussed, identifying "what needs to be done to encourage a truly user-centric transport service ecosystem" is crucial;
- Interesting idea of customer-centric multimodal network and tailor-made travel services based on preferences;
- Connecting all of our nodes, people, vehicle, modes will create value that we cannot imagine now (as the internet did) – it will be limited only by one's creativity;
- Data networks and the cloud will be as critical tomorrow as roads are today;
- We need to start with the digitisation of all our assets – not just connected objects;
- Update cycles in the public sector are longer (slower) than in the private sector and this is an issue for the implementation of new technologies in our cities;
- Technological development cannot occur independently of economic, social and environmental developments;
- "New technologies will run on old infrastructure" – so how are we future-proofing the infrastructures we are currently building?
- With the changing set of mobility options, we need to redefine what transit is.

TOPIC C AUTOMATED VEHICLES AND COOPERATIVE ITS

OVERALL SITUATION

The move from stand-alone to connected and further to automated vehicles, systems and services was one of the most popular topics in the Melbourne Congress with over 100 papers and numerous dedicated sessions and many mentions under other topics. This move towards connectivity and automation is apparent in the areas of monitoring and sensing, data and content management, MaaS and shared mobility services, traffic management and information, and the development of smart cities and highways. A major change is currently under way, not only in vehicles but also in mobility and the whole transport system.

For many areas such as safety, security and transport as well as community planning, the move is regarded as disruptive requiring new approaches, and methods to cope with it. This includes new simulation, modeling and data management tools, legal, privacy, security and business model challenges as well as their solutions, and new planning and operational paradigms as well as some technology issues. Testing and evaluation aspects were increasingly and widely taken up.

Automated Vehicles were on display at ITSWC16

AUTOMATED VEHICLES

Automation is still in the preparatory and research phase with papers discussing ideas and concepts for the use of automation, sensing solutions, testing areas as well as the needs for the physical and digital infrastructure. One session specifically pointed out that with road vehicle automation, many authorities are like a “kangaroo caught in the headlights” not knowing what is expected of them as those developing automated vehicles are not sharing information on the operation of higher-level automation and the expected requirement of road and other authorities. The authorities were comforted up to a point by industry stakeholders reporting of cases where device and IT providers to automated vehicle manufacturers were similarly kept in the dark.

Many presenters and also sessions discussed how to make connected automation happen on a global scale utilising the plans and the experiences so far from the different regions. A legal framework is essential, for example for setting the liability scene, and for facilitating insurance for automated vehicles. It is evident that we need a compelling business case, acceptance by purchasers/drivers, robust technology solutions for the navigation, guidance, maneuvering and operation of automated vehicles. We also need solutions taking on board the needs of pedestrians and other vulnerable road users, elderly and handicapped riders, adverse weather conditions, and dynamically changing road environments.

Specific attention was given to high precision maps as well as local dynamic maps, and their further enhancement. There was also a lot of interest in providing reliable vehicle positioning via a combination of satellite positioning, vehicle sensors, location of adjacent vehicles and roadside ITS stations.

Some discussions centred on serious doubts about whether road vehicle automation really is a viable solution as today the higher-level automated vehicles being tested are not even up to the level of novice human drivers. If this proves to be the case then the best solution could be to keep an intelligent human driver in control of the vehicle, but prevent driver errors or at least their consequences with the help of advanced driver assistance and support systems accompanied by vehicle-to-vehicle and vehicle-to-infrastructure communications. This would clearly reduce road fatalities by more than 50%.

something everywhere and everything somewhere

COOPERATIVE ITS

Connectivity and Cooperative ITS (C-ITS) are moving to the deployment phase *via* C-ITS pilot deployments and regional coordination actions such as the European C-ITS Platform as a key driver. Specific use cases such as traffic signals, different warnings, maintaining optimal speeds and traffic management were discussed. An impressive number of different testing, inspection and certification tools and environments were presented.

Concerning the communication systems to be used there was a wide consensus that it is a hybrid one including both the short-range communications (DSRC or ITS-G5) and the longer-range cellular ones. Many papers compared the performance and viability of the different communication technologies, also including the upcoming 5G cellular solution. A number of solutions were proposed for dealing with varying degrees of communication network load, and especially with congestion, by also dynamically considering the situations of the vehicles involved. For basic vehicle connectivity and Internet of Things cellular communications are already in wide use, and will also be so in the future. Just as with road vehicle automation the concepts of "something everywhere" (cellular covering all road networks) and "everything somewhere" (DSRC in hot spots) seem to be applicable to C-ITS communications.

According to many of the presentations given we are still missing "off-the-shelf" ITS stations as well as standard equipment in new vehicles for dedicated short range communications, and some respected experts claimed that DSRC will never happen on a large scale. However, if DSRC is mandated in new vehicles in the USA during 2017 DSRC will most likely be rolled out widely also in other regions.

KEY THEMES

The following key themes can be identified:

It is all about accurate positioning. The safe operation of an automated vehicle builds on having accurate knowledge about where the vehicle itself is located, where the other vehicles and road users are relatively, the current and expected trajectories of the vehicle itself and the other road users, and how all of the above are related to the road and the environment in a so-called dynamic local map.

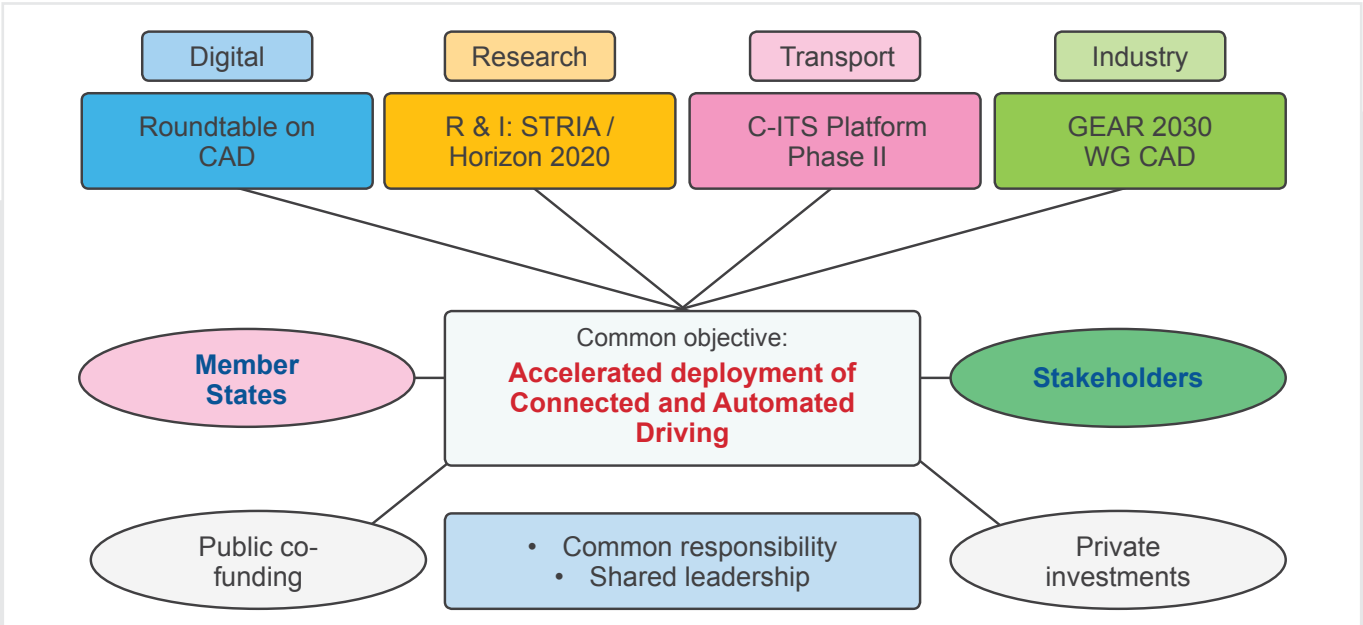
The Congress papers and presentations clearly indicated that a lot needs to be done even to ensure the accurate positioning of the vehicle itself, especially in cases where the conditions are not optimal for vehicle sensors or satellite positioning. High-definition maps are one important building block in generating the accurate position. The importance of landmarks, visible also in adverse conditions either 'manually' or electronically, was widely recognised.

Data as a fuel of smart transport. Data from a connected or automated car in combination with other data *eg* Big Data could be of huge value to a road operator in adjusting parameters to reduce congestion, identifying maintenance requirements, predicting travel times, and identifying unsafe drivers or other hazards. Big Data also has potential large economic value, and the value of data depends on the purpose to which the data is used. Ownership of, and right to use, data from connected vehicles remain unresolved issues so far – cloud-based solutions seem to be the choice of many stakeholders to govern "their" data.

Benefits include better safety, reduced air pollution, cheaper maintenance and operations, reduced need for new infrastructure due to maximum use of existing assets, and optimisation of city operation through a better understanding of people's movements. Presenters showed that current traffic management can be clearly enhanced and the effectiveness of traffic management improved by integrating cooperative vehicles in traffic management.

Data on technical performance, impacts, benefits and costs is important, and the more reliable the better - we need more and more data. For instance, some doubted whether automation really provides the required mobility and liveability to the cities, and whether the benefits from automation would really cover the massive investments due to highly or fully automated driving.

Infrastructure, vehicles and drivers are a system of mutual cooperation. Automated vehicles, smartphones, infrastructure sensors and network operation & management systems are increasingly behaving as a single system, mutually communicating and informing each other's behaviour – just like an ant colony as one speaker pointed out during the Congress. New frameworks and modelling and simulation approaches are analysing the total connected system, attempting also to incorporate existing non-intelligent vehicles and infrastructure. This point was well made in a European Commission presentation:



Innovations meets regulation: Courtesy Wolfgang Höfs

Smartphone applications and communications can be used to bring non-connected vehicles into connected automated transport and deliver benefits to existing vehicles. The digital road and communications infrastructures play a major role in the cooperation. Closer cooperation of the automotive, telecommunications, road network operation industries and stakeholders as well as the user communities is needed to accelerate such a development.

It was often emphasised that it is important to make – and keep – vehicle drivers conscious of being connected to others in transport and not to have this realisation occur only rarely when the driver is being warned about a hazard. One additional benefit from cooperative traffic signal applications that advise the current signal phase and timings is keeping the driver constantly reminded of being a part of a larger connected world.

Real-world trials and new testing tools are advancing technology maturity. The concept of learning by experience works very well for ITS. ITS technologies are being increasingly tested and trialled in real-world environments to establish best practice and identify barriers to wider implementation. Large scale trials have highlighted the need for innovative approaches to procurement and careful consideration of the legal and data management implications. A wide range of new test environments and locations across the world are facilitating technology development and accelerating deployment. "Learning by doing" is the catchphrase used now for connected and automated driving all over the world.

Meeting customer expectations is essential for acceptance and business case. The deployment of connected, cooperative and automated driving hinges on whether the customer will want to pay for the equipment, service or the app. The need to understand and meet the customers' expectations, wishes and also fears was brought up by many – especially when discussing large-scale deployment. If the user does not immediately grasp how to use the technology solution on offer, or if the benefits of it are not immediately evident, it is likely that the solution tried out will neither be taken into service nor purchased. Some presenters also reported examples of user confusion, which had prevented getting the benefits expected from the deployments. There is clearly a lot of catching up to be done regarding understanding traveller behaviours.

OLD vs NEW

There was a reasonable balance between bringing forward new ideas and reporting how the older ideas are performing. The most interesting related to new mobility and transport systems *via* connected automation:

- Various cooperative positioning solutions
- Automated cars as fun
- Use of visible light communication
- Novel mapping solutions
- Soft transport
- Autonomous or A-ITS – the ant colony analogy
- Distraction free HMI design for personal gadgets
- Moving sensor detectable code used in lane markings
- Simulation platforms for testing and validating ITS
- Comprehensive cloud-based connected AV services
- Bringing vulnerable road users into connectivity with motor vehicles

Deep learning was brought up by many presenters and discussions as a way forward to provide human-like intelligence and capabilities to automated vehicles.

New approaches for signal control, drowsiness detection, testing and certification as well as security were discussed. New aspects for ITS congresses were introduced with the People Flow concept for analysing mobility, utilisation of aerial images, and use of autonomous vehicles in the mining sector.

FORWARDS vs CONSTRAINED

Some areas were clearly moving forwards – cyber-security for connected automated vehicles, use of simulation tools in testing and evaluation but also in day-to-day operations, integration of mobile sensors and users into traffic management, sharing of issues related to test areas, technical and impact evaluation, and the utilisation of C-ITS messages for different purposes. Considerable more attention than before was given to human-technology interaction such as understanding disturbances in driving operation, ensuring system function understanding *via* HMI, vehicle control hand-over between human and machine, and the interaction of human- and machine-driven vehicles.

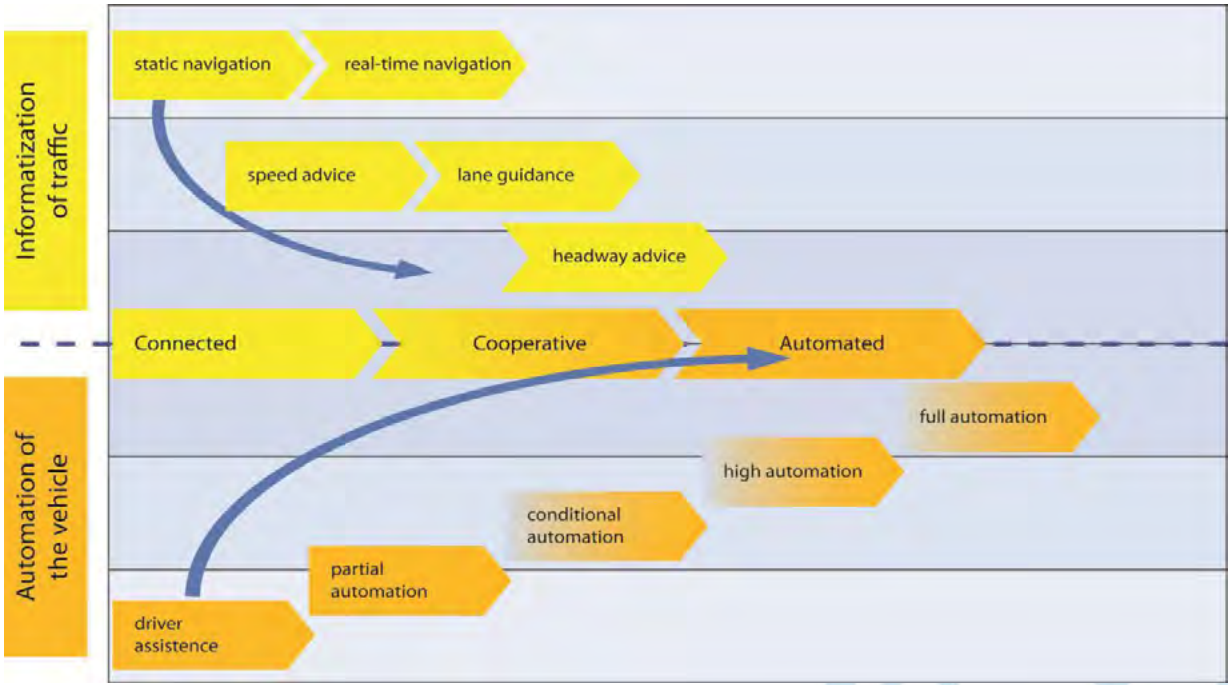
The word "trust" was heard everywhere in the Congress and in the Exhibition, in the context of data security, privacy, data and service quality, and deployment partnerships. The message was clear: "no trust means no business". Trust rests in the foundation of good customer relationships and strong partnerships in cooperative ITS and automated driving – as well as in all other areas of ITS.

The concept of autonomous driving relying solely on the vehicle's own sensors was clearly giving way to connected automated driving, where the vehicle makes use of the more extended electronic horizon providing information of events and conditions further along and around the vehicle's route beyond the range of the vehicle's own sensors. As a result, more sessions and presentations than in previous Congresses dealt with multi-stakeholder cooperation.

There was a significant focus on ensuring that future technologies are mutually compatible and interoperable, and in establishing common frameworks and approaches which can be used across projects, systems and services. The aim was getting to national, regional and also global interoperability.

The number of papers dealing with traffic management, parking, legal and institutional issues for connected and automated driving seemed to be more constrained than in the recent congresses. This is likely largely due to other conferences focusing on these domains specifically.

The contribution of connected and autonomous vehicles (CAV) to the possible reduction of congestion (by more efficient travel) was discussed in previous Congresses and featured regularly in Melbourne but we still lack insights into the other consequences, potentially negative, of such technology if it promotes the use of cars at the expense of active and alternative modes of travel. Implementation of autonomous cars needs to occur within a shared-modes conceptual framework. Hence, there are still some unresolved issues such as how we will go from 0% to 100% autonomous cars; how the mixed traffic will behave, how the interactions with other road users (pedestrian, cyclists) will be managed and how our current infrastructures should be adapted to be suited to these vehicles (or how we build our current infrastructure to future-proof them). Solving these problems will almost certainly rest on the speed with which vehicles and the underpinning infrastructure "go digital". This was graphically illustrated by one speaker who showed how digital technologies sponsor a convergence path to future solutions (see Convergence of Connectivity and Automation image over page).



Convergence of Connectivity and Automation: Courtesy Wolfgang Höfs

TOPIC D MOBILE APPLICATIONS

OVERALL SITUATION

In this increasingly connected world, boundaries are becoming increasingly blurred in place and time, *eg* when and where one works. Information access and services are now not only in our workplaces, homes, and towns, but also in our pockets (smartphones and apps) and in vehicles. This has led to an expectation and demand for information anywhere and at any time. The Mobile Applications (MA) description in the Melbourne Call for Papers asked: "Do any boundaries remain?"; and "How can we provide improving customer experiences and proactively provide information?" The area's suggested subtopics focused on multimodal information and planning, real-time information including advisory information, demand-responsive transport, and booking services.

The MA sessions in Melbourne included one Executive Session – "Using smart nomadic devices safely to enhance personal mobility" –- and three Technical Paper Sessions, TP42, TP85, and TP93 on safe corridors, generating travel information and keeping drivers better informed, respectively. Nearly 25 papers were presented under this topic, the majority of which fell in these three TP sessions and their respective themes. However, 10 papers were presented in various other Commercial, Interactive, Technical, and Scientific sessions on Smart Cities, Future Freight, and Vehicle and Network Safety.

- The session on safer corridors (TP42) included MA papers on a proposed dynamic evacuation route planner for emergency situations such as wildfires; a proposed system architecture for using smartphones (instead of roadside infrastructure) to provide driver information; a driving simulator test of a smartphone-based audio warning message system for work zones and cross-traffic turns at intersections; and an ex-ante desktop CBA of the NEXT-ITS corridor.
- The MA session on generating travel information (TP85) focused on travel time estimation and using Bluetooth Low Energy (BLE). Travel time estimation included using ETC Electronic Toll Collection vehicle probes in order to use ETC-tagged cars as "floating cars"; using Bluetooth technology to gather travel time data, potentially increasing the information's reliability compared to floating car data; and using travel time data from GPS-enabled devices. Using BLE included how to transmit content in a way to reduce devices' power consumption and packet delivery time, as well as using BLE tags in or ahead of work zones to push in-vehicle messages to improve safety.
- The MA papers in the session on keeping drivers better informed (TP93) focused on providing traffic information to drivers and papers provided overviews of traffic information services from various regions (*eg* lessons learned); as well as a small study on the potential impact on tourists' behaviour of providing traffic information particularly related to popular tourist destinations.
- The MA papers not included in the above TP sessions covered a wide variety of subtopics and areas of application including:
  - an electronic system for requesting and granting rail track access
  - the use of mobile mapping technology to manage heavy vehicle access
  - an on-board weather sensor to detect different road conditions
  - an app-based platform to better manage/plan informal transportation operations
  - an algorithm to optimise (from a cost perspective) automated booking for on-demand transport in multimodal journeys

- a methodological approach for mode detection *via* smartphones
- using post-trip multimodal information provision to inform users about "what would have happened" had they used the other mode (train vs car)
- an educational development and professional support platform for ITS and CV technicians
- a framework for evaluating the social network concept within ICT-enabled mobility schemes
- integrating parking payment into an ETC system.

Based on the papers and TP sessions, travel/traffic information (particularly for drivers) stood out as a clear sub-topic, which has been of interest for years, as well as a focus on safety and/or efficiency, mostly in terms of systems/networks, with some focus on workers as well. Furthermore, although a few papers presented frameworks, methods, *etc* many papers focused on existing smaller scale trials, implementations, or simulations (or on concepts that hopefully will be trialled further) rather than on presenting completely new, innovative ideas or concepts. Of course the papers presented at the World Congress are not fully representative of what is happening in the topic of MA, but given that MAs are tools to achieve other goals, it would be of interest to see evidence from more full-scale and real-life pilots, including thorough evaluations of effects of MAs.

one can also view driving as the task that is distracting us from what we really want to do, ie use our devices

In general presenters within this area concentrated on the potential benefits of MAs (or nomadic devices) to provide tools and resources to collect and disseminate information and to improve network performance. This tended to be viewed in terms of congestion, safety, efficiency, and environmental sustainability, particularly during the transition period to fully autonomous vehicles, and in lieu of building physical infrastructure. Nomadic devices and MAs were generally viewed as one of if not the best tool we currently have at our disposal – the new wave of ITS – although these estimations of future benefits are most often based on assumptions of behavioural impact rather than evaluations of full-scale trials.

The main drawback under discussion was driver/user distraction as some observers have argued that nomadic devices are making an already unsafe transportation system even worse, and that the recent increase in accidents and fatalities is probably due to the use of nomadic devices. Some presenters pointed out that it is the task/application/design that is distracting rather than the device *per se* – that the devices/applications are currently designed to be distracting, and that one can also view driving as the task that is distracting us from what we really want to do, *ie* use our devices.

There is much concern over how to enhance mobility without compromising safety while recognising that it is human nature to undertake risky behaviour despite knowing better. Proposals for potential interventions varied from educating to punishing the device user (fines, confiscation *etc*.); to introducing new, less distracting designs; to technically blocking use *eg* in moving vehicles, even if this means potentially disabling some legitimate device uses. Other (potential) drawbacks such as privacy issues were sometimes mentioned but not discussed, at least within the MA sessions.

OLD vs NEW

Although the topic of Mobile Applications may not be directly included in the latest trending topics such as Mobility as a Service, connectivity, sharing or automation it is indirectly included as MAs are a result of or a building block for these other trending topics. However, discussion on these synergies was often lacking at the Melbourne World Congress. For example of high relevance for this area, although underrepresented in the MA papers and sessions, was the design and use of MAs to support non-private car modes (and non-drivers), multimodal trips, sharing, and new transport services *eg* Mobility as a Service, as well as the collaborations necessary to offer such services and applications.

User behaviour was often mentioned or assumed (*eg* in terms of future benefits of MAs) but content was missing, as has been the case with most Congresses since Vienna, directly addressing either understanding behaviour or how to influence or (dis)incentivise (un) welcome behaviour. Similarly we had little on evaluating (potential) behavioural impacts of MAs impacts. All of these topics are relevant for MAs as all of them can and should influence design, business models, and policy. One often wondered if the proposed mobile apps, tools, methods *etc* would be feasible under real world conditions and/or accepted and adopted by users.

Potential barriers for behavioural impact via MAs are many, including but not limited to:

- smartphone access and data plan affordability
- inadequate app design and/or service offer
- users actually downloading and running the relevant apps at the relevant times/places
- impacts of information and/or (dis)incentives
- users' willingness and intention to change behaviour.

Although work is being done in these areas, it could be of benefit to the ITS community to include and encourage more such work and evidence on behaviour under the umbrella of the ITS World Congress, as this could nuance the debate and understanding of how to leverage the various transportation tools such as technology, mobile applications, design, policy to reach their full potential in terms of influencing and reinforcing more sustainable travel behaviour.

TOPIC E VEHICLE AND NETWORK SAFETY

OVERALL SITUATION

The subject of "Vehicle and Network Safety" is quite broad and it was expected that the majority of the Papers would focus on recent developments associated with Vehicles, particularly Autonomous Vehicles, and the Networks and Infrastructures required to support them. However this was not the case and very few papers covered new, exciting or unique developments, concepts, ideas or put forward new thinking. In fact many focused on the adoption of existing technology to make something "better" or to protect Government or Semi Government assets, particularly roads and road networks. The table (below) gives a breakdown of the focus of the 74 technical or scientific papers to be presented on the Topic at the Congress which divided research: 44 (60%); trials: 18 (24%); in service 12 (16%).

Focus	Number (%)	New Thinking	Comment
Conventional Vehicles	5 (7)	No	Basically "improvements" only
Autonomous Vehicles	8 (11)	Some	Basically "improvements" only
Infrastructure	40 (54)	Some	11 papers on protection of road assets; good variety and good examples of adoption of new technology. Some innovative ways
Human involvement	15 (20)	Yes	Wide variety with good focus on pedestrian detection and avoidance (including bicycle)
Education / Regulation / Enforcement	6 (8)	No	3 papers relate to enforcement

A very common approach was utilising existing technology for "kaizen"-style improvement. In general there were no descriptions of key breakthroughs or unique developments particularly in vehicle related matters where there is much activity. Similarly it was a little disturbing that there appeared to be no attention paid to network protection, security or integrity (*eg* information theft, corruption, vulnerability to Third Party control).

It would be easy, and wrong, to infer that this topic was "stalled" with the exception of a few very interesting and exciting papers. It is highly likely that the real "breakthrough" development is being done by the large multinational automakers and Tier 1 suppliers where work is commercially confidential so cannot be shared at this time. Consequentially the papers at Melbourne are mostly coming from Academia or "adopters" rather than "originators" – just an opinion and with the deepest respect to the contributors at the Congress. Some papers that caught the *rapporteur's* eye included

- Congestion relief by a moving light guide system – by adjusting the speed of moving lights on the roadside the driver is subconsciously influenced to maintain speed when safe to do so, on a portion of road where he would normally slow, thereby reducing congestion.
- An Immune based dynamic evaluation model for traffic congestion in urban areas
- Human skeleton recognition using a 3D depth camera on a vehicle
- Evaluation of traffic safety using near IR spectroscopy
- Incident detection and virtual variable messaging using Bluetooth
- Analysis of rat-run traffic based on floating car data

Not all technology needs to be in-vehicle; there are new approaches to detection and identification of road marking and road signs to support automated driving

KEY POINTS BY TOPIC

Preventative and Active Safety Systems

There were discussions on the adoption of improved technology based on ITS systems to provide advanced warning of hazards – adverse/ dangerous weather conditions, unseen pedestrians, bicycles or motor cycles *etc*. The European Commission's Cooperative ITS (C-ITS) Platform stressed the good benefits/costs case for this approach. ITS can also be used to assess the potential for accidents and through automated driving take the appropriate emergency response to avoid an incident.

Not all technology needs to be in-vehicle; there are new approaches to detection and identification of road marking and road signs to support automated driving. Speed advice and monitoring comes into this topic. The Tokyo Police normally use data from roadside infrared beacons to impose speeding fines but have explored using the same data to modify infrastructure indicators and roadside signs to ease traffic congestion. A presentation from Norway demonstrated how C-ITS solutions for traffic light assistance can assist both drivers and authorities to reduce congestion and accidents at intersections. The introduction of C-ITS solutions appears to be superior to installing extensive roadside infrastructure.

Advanced driver assistance and support systems featured prominently with a variety of presentations from systems in service to testing service promotions to fundamental research activities. Pedestrian detection and recognition systems currently in service were showcased; they are technically very interesting and increasingly relevant. Progress with night-time PED recognition is more immature and still in the research phase but it is showing much promise with more work and refinement to be done.

The papers on "Cooperative vehicular surround sensory systems" and "In-vehicle object detection" were both at an early stage but showed the promise of the techniques, the latter in particular for Automated Vehicle application by being able to detect the location and position of occupants in the event of an unavoidable collision when in automated drive mode.

Collision Avoidance;

The paper on "Identifying hazardous road locations using GPS and accelerometers" was particularly interesting – it uses acceleration measurements to identify both deceleration and a significant drop in speed. When combined with the measurement of "jerks" this can distinguish between planned and unplanned decelerations which

occur when drivers react to hazardous situations. Using GPS data the location of this can be linked to specific locations and approaching drivers can be notified

Of equal interest and relevance was the presentation on using endpoint detection to evaluate a "loss of control" risk using the noise of acceleration signal as indicator – the higher the noise, the higher the risk of loss of control. This investigation was conducted on vehicles without VSC and confirmed by investigation of actual accidents on the same section of road used for the trials.

Vehicle sensing and cycle recognition:

A number of varied subjects were covered. Video surveillance system improvements based on convolutional neutral networks offer the possibility of strategies to detect and classify vehicles in the surveillance area by overcoming the occlusion issues of current systems. Early testing shows significant improvements but more work and refinement is required.

Infrastructure protection was also a focus in this sector, specifically road maintenance which is predicated on an understanding, not only on the number of vehicles using the roads but also on the type/ classification of those vehicles. A paper proposed dynamic time warping to classify the data from magnetic induction loops. Another study has trialled an over-height vehicle detection and warning system for the protection of over road bridges. The investigation revealed that human error or poor human judgement are the major cause of "Bridge Hits" which result in long term traffic chaos during the lengthy repair phase. An interesting paper proposed a multi detection and multi warning system solution

It is essential for automated driving that systems are not only able to detect bicycles but also can understand their behaviour. A paper proposed a multi-directional recognition system in which the movement direction of the bicycle is divided into sections linked to a method of feature extraction to cope with the bicycle in any direction. This is very much in an experimental phase but it has shown promise.

Safety of Vulnerable Road Users:

There was good coverage of the application of C-ITS systems for 2-wheeled vehicles although it seems that the development has a relatively low priority in the minds of companies. Eight services have been identified and proposed for Bike/Motor Bike to everything (B2X). Three of these are applicable in the near future but the others need more development in the areas of C-ITS infrastructure. The RACV presentation was an education knowledge transfer session regarding autonomous vehicles. A paper on semi-supervised learning for real time pedestrian detection and classification via the application of ITS technology was innovative and we can expect positive results to be reported at future congresses.

Many speakers stressed the value of simple "information sharing" between interested parties to warn/inform road users of hazards or changes ahead. An excellent example of this was given by a presentation on the lessons learnt as a result of the earthquakes in Kumamoto Prefecture in Japan in 2014. This clearly demonstrated what can be achieved with clear thinking and strategies as well as the appropriate application of ITS technologies.

Network Safety

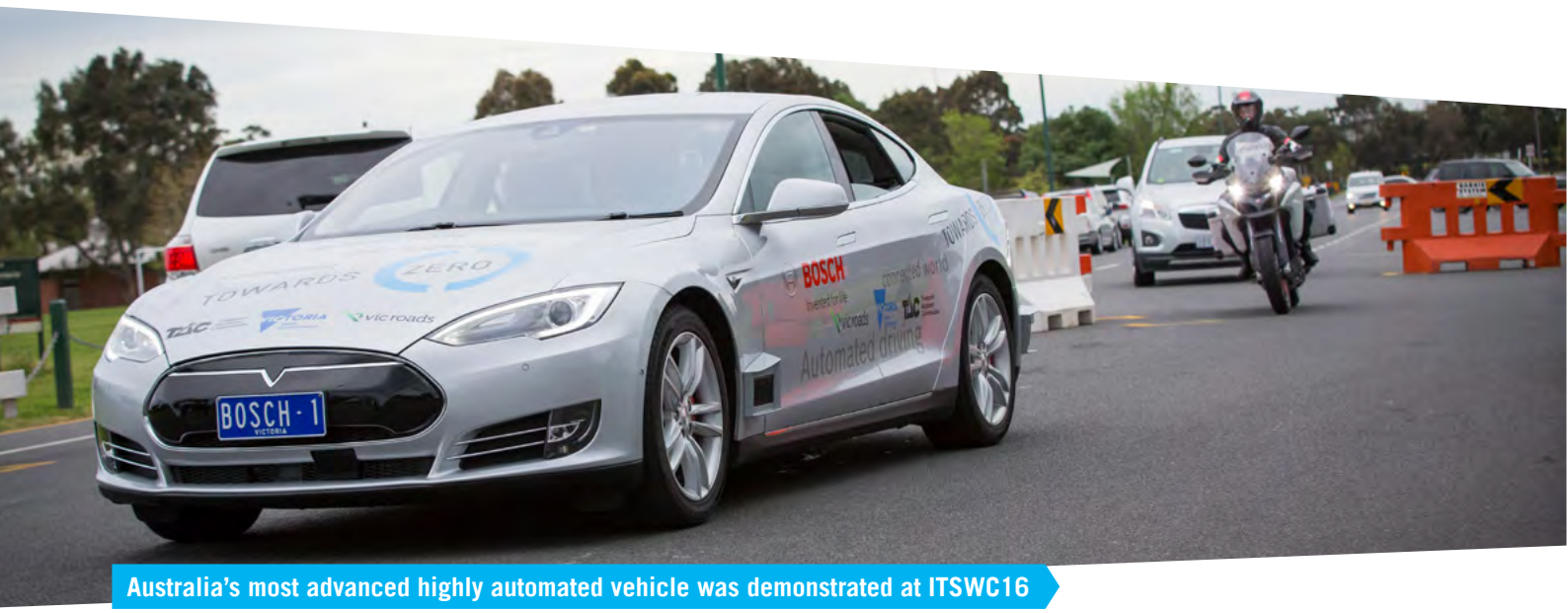
A highlight here was a presentation "Investigating the feasibility of using the Strategic Highway Research Program Naturalistic Driving Study to support decision making and its application in connected vehicle". This paper focused on using data gather by relatively "simple and conventional" current ITS means related to driving in bad weather, compared to good weather to determine the variable speed limit that should be applied depending on the conditions. This has demonstrated a very logical and accurate process that was well considered and applied, not least as the data gathered are very similar to those which will be available from connected vehicles and therefore can be used in preparation for automated driving scenarios

Road Safety:

It was proposed that freeway accidents between slow moving trucks on hills and faster vehicles can be reduced by determining when climbing lanes for trucks are opened or closed. This will be achieved by dynamic strategies considering the level of service, percentage of trucks *etc* using ITS technology to provide the data. The innovative use of ITS combined with analysis of previous traffic incidents is proposed to improve traffic incident management in the US. It is still in the early stages but appears to show promise for both small- and large-scale incidents.

Advanced Driving Assistance Systems (ADAS) are being gradually enhanced to facilitate fully automated driving however the current systems do not take into account the drivers driving preferences. The paper in this session from Australia computes on line optimal trajectories for given traffic conditions, whilst also considering the driver's preferences. With more development, this may assist in the further uptake of ADAS in current vehicles and assist in making Automated Drive more "understood/accepted/comfortable" by the user.

The actual effectiveness of the adoption of DRLs on road safety in the US is reviewed. The conclusion is that they have had little effect in reducing accidents during day-light hours. In addition, it is suggested that as the tail lights do not come on until the driver manually turns the low beam headlamps on, that the DRLs may actually increase the risk of accident in adverse weather conditions and at Dusk and Dawn if the driver places too much reliance on the fact that his vehicle is equipped with DRLs – an interesting hypothesis.



Australia's most advanced highly automated vehicle was demonstrated at ITSWC16

Human factors and driver behaviour

This topic has tended to have waves of popularity; Detroit and Bordeaux were down a bit, Melbourne was up a bit. Many presentations were very country-specific; it would be intriguing to test whether there are any significant national behaviour or HMI differences – and if so why. Driver behaviour in the context of both overload and underload has become of great interest relatively recently following concerns over the 'control handback' process of a Level 3 automated vehicle.

Two papers of particular interest were: "Human skeletal recognition using 3D depth camera in a vehicle". This technique can assess the driver situation by the position of the skeleton and then issue warnings to drivers *eg* mobile phone usage, drowsiness at the wheel and importantly to confirm that the driver is ready to take control when automated driving mode is handed back to the driver.

The other was "Extraction and analysis of rat-run traffic based on floating car data" which described the development of an extraction method of studying rat-run traffic using floating car data for a specific area. Lowering the extent of "rat-running" traffic – short cuts taken on community streets to avoid traffic congestion – is a challenge for improving the living environment and safety of local neighbourhoods and communities. The approach set out in this paper can be applied in similar regions so that traffic impediments to discourage use of the rat-run route can be put in place with knowledge of the subsequent effect.

An innovative paper described the application of near-infrared spectroscopy normally used for functional neuroimaging to measure the effect of environmental disturbances on the driver's brain activity. The measurements can then be extrapolated to the degree of driver distraction as well as the effect of that disturbance on the driver's control inputs. A very interesting analytic technique which although still in its early stages will provide valuable information.

TOPIC F FUTURE FREIGHT

OVERALL SITUATION

The sessions' contents pointed to a clear shift from connected and cooperative ITS towards automation that is expected to have a major impact on freight transport. The issue was more clearly articulated in Melbourne than in any previous ITS world Congresses. Some of the major signals included:

- There is consumer interest on connectivity features beyond safety features *ie* consumers are likely to pay a little more to stay connected than for an extra safety feature.
- There is a "political correctness" in improving traffic safety, decongesting urban areas and making cities smarter.
- There is no more "business as usual" for the automotive industry. Trials of automated and connected vehicles have created a new front in this open competitive market.
- Several functions for delivering automation are already available or about to be available in different forms although not necessarily integrated. For example technology is not the hindrance but opening, integrating and sharing data is a major stumbling block and unless this block is removed it will be difficult, if not impossible, to "close the loop".
- The ongoing wave of digital transformation such as the Internet of Things will shake up many functions in society including transport.

Broadly speaking the approaches of the three Congress Regions – Americas, Asia-Pacific and Europe differ to an extent:

- The approach taken by Japan and Singapore is along the lines of backcasting in which future scenarios are defined and impacts analysed with that information leading to the design of autonomous vehicles and related infrastructure to attain the desired impacts.
- The US is looking at a proof-based approach in which hard evidence is a key driving force for funding and regulations that will define the future of Connected and Autonomous Vehicles (CAVs).
- Europe is following the traditional European top-down approach in which determining the future of autonomous vehicles is coordinated by the European Commission and the strategies are then implemented at the level of each member state.
- For Australia concerns were raised concerning how to align with and adopt international approaches and standards in connection with automated vehicles. The standards relate to communication infrastructure, data collection tools and sensor technology. This is because the geographic location of Australia and the size of its market limit the ability to marshal its own path in the evolution toward autonomous vehicles. Thus Australia and New Zealand are instead focusing on initiatives in developing standards for autonomous vehicles *eg* New Zealand is in the forefront of regulatory programmes for Unmanned Aerial Vehicles (UAVs) establishing some of the early examples and looking as far ahead as 2045.

There is no more "business as usual" for the automotive industry

Some ITS professionals in the US believe that the "tipping point" for autonomous vehicles sits somewhere between 2025 and 2030. Many regions are already looking ahead and beyond autonomous vehicles. A system perspective with a focus on integration across modes is being considered *eg* in the case of smart cities where UAVs (Drones) promise to fortify the integration between aviation and land transport. Similarly Automated Delivery Vans (ADV) together with integrated distribution centres are being planned to fill the gaps between surface transport modes and marine transport. To realise these developments there will need to be a change in attitude or behavioural patterns. One speaker put the point rather nicely – *"a developed country is now a country where poor people own their own cars while rich people take public transport".*

SOME CHALLENGES ON THE WAY…

Giving data a voice

Data integration is fundamental to delivering the benefit of new technologies. In particular how can open freight data be used to:

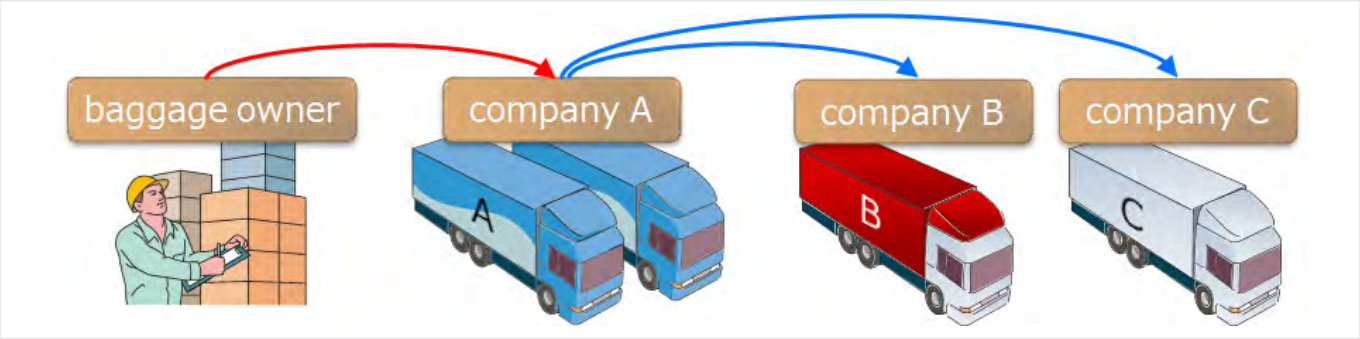
- mitigate risk and manage insurance premiums,
- help freight stakeholders to collaborate by uncovering benefits,
- manage slots in distribution centres during consolidation and reduce the cost of the last mile delivery,
- manage overweight vehicles,
- achieve "pay per use" services for transport resources,
- debunk political sensitivity on some areas such as road tolling,
- free up time (by making use of peak hours) and space (by making use of the flexibility of passenger transport compared to freight) in urban areas for improved freight deliveries,
- get a better balance between economy of scale (addressed with increasing truck sizes, platoons) and damage on the road

We saw much focus on making use of freight data with popular sessions on Big Data, Open Data as well as the session on the IoT. One clear challenge that resonated across several presentations is how to get stakeholders to share data with no business model. Data sharing is necessary to develop innovative and profitable applications yet stakeholders seem to be unwilling to share data when it is not clear who will benefit. Moreover, data sharing comes with cost and privacy concerns. Different incentives beside business models are needed to get stakeholders to share. Since data will be a key element for deploying critical ITS applications there need to be focus on showing what we are currently doing. For instance, data-driven policy decisions, data driven freight operations, open data, sharing etc.

Many simple solutions have yet to work for freight

Problems that appear to have been solved in passenger transport still remain key issues in freight, including:

i. Traceability – Transport and logistic chains involve multiple actors especially in the context of intercity freight transport. This creates a challenge in terms of traceability especially when the transport is outsourced to a third party (see image below). In order to help consignors or freight owners to trace the status of a transport, presentations highlighted the use of existing platforms such as the ETC platform in Japan.



Traceability problem in freight courtesy of Kazunori Inoue'

ii. Real time information – concerning delays and navigational services that take into consideration the requirements for freight transport. Basic requirements such as route choices and access points, optimisation approaches to manage trucks and trailers, etc., were all highlighted in different presentations and suggested the need for improvement in the context of freight transport. Where few solutions exist, they are hardly deployed on pervasive devices such as mobile phones.

iii. "Last mile" delivery – the main concern here relates to city distribution. Although it is obvious that off peak times can reduce congestion and improve freight and logistics operations in cities, using ITS to achieve such load balancing has not been exploited. However, this is beginning to change partly as a result of automated driving and digitalization.

iv. Collaboration to maximise the potential of ITS solutions, although there was an ITS application (MobileDock) presented to facilitate management of slots in a distribution area and yet another concept for integrating the freight flows between marine, rail and road –integrated distribution center. The major challenge identified in many of these remains at the level of organisational collaboration. Although freight transport actors have many incentives to collaborate, these solutions are helpless without inter-organizational collaboration.

v. Remote diagnostics – to detect faults within a road or train network, and dispatch the required staff to address the fault thereby minimising the use of staff to monitor such faults. An example of this was from the train network in Sweden but also in Australia.

The need for a systems approach

An important concern expressed in many presentations was how to focus on a systems approach where transport is perceived as integrating different pieces of technologies (*eg* GPS and aviation equipment) to offer mobility *ie* looking at mobility solutions regardless of mode and whether it is by air, sea or land. This is a clear reflection of current ideas echoing concepts such as Mobility as a Service (MaaS), Internet of Things, Big Data, *etc*. Approaches such as CONOPS – Concept of Operations, were highlighted as a way to capture needs and fulfillment in relation to existing systems in a "whole of system" transformation. A question prompted discussion on the possibility of an MaaS concept that includes air and related services elements as well as the usual land based transport. Navigation systems were seen as a key component to fortify the connection between all modes of transport.

Don't try to eat the elephant all at once, eat it bit by bit

Lessons from other autonomous technologies

One key distinction regarding Melbourne relative to previous congresses was the inclusion of aviation. There were comparatively few sessions but they attracted many delegates and the discussions suggest that there is lot to learn from automation in different areas. Aviation and maritime transport (*eg* Automated Guided Vehicles in sea ports), rail transport, (*eg* automated subway systems) are advanced in automation relative to road transport. There is great benefit to ITS and road transport from discussing experiences from other transport modes.

Sessions suggested that the advent of UAVs and the IoT could be a suitable blueprint for development and deployment of automated vehicles. Speakers from New Zealand and Australia reported major challenges in getting different government institutions to cooperate and collaborate since the traditional approaches to transport – single mode – does not capture the complexities resulting from integrated transport as waves of new ITS technologies sweep across transport. Experience from UAVs, the airline industry and other areas with automation suggests that performance based regulation will deliver more as opposed to the traditional reactive approaches. To put this in perspective a speaker with a life time of experience in aviation argued *"if we tried to develop motor bikes today they would never go on the roads because we would regard the risks as unbearable".* We have to recognise some level of risk in order to fully realise automation in road transport. He gave additional advice on how to approach regulation: *"Deliver what you can when you can; don't try to eat the elephant all at once, eat it bit by bit". A* complete regulatory structure will not, and may never be, developed before some of the new technologies in connection with autonomous vehicles are deployed.

Understanding urban freight distribution and service trips

There were lively sessions on the main challenges of urban freight delivery in cities. Much of the focus was on organisational and inter-organisational difficulties surrounding different communities in different cities across Europe. Challenges identified related to making available information about freight movement but also possible services to road users and other actors in urban areas. The need for a platform (*eg* ITS national organisations) to bring together local municipalities and governmental agencies to engage was highlighted as well as the role for coordinated policies in these challenges. Coordinated policies were highlighted in a cross-European platform where experiences are shared among different cities.

OLD vs NEW

Connected and automated vehicles and freight

The opportunities and challenges for connected and automated vehicles are emerging although empirical evidence based on experiments is not yet common knowledge. Some work presented in this category was not new but the interest from participants was intense. Success in automated and connected vehicle systems will require a combination of multiple components; vehicles, road networks, communication networks, people, shipments, cyclist, and other moving objects within the network. These different pieces need to be developed and adopted to fit the concept of automation in ITS. However there is much focus on the vehicle and less focus on all the other components. Perhaps, there is a need to be clear about what components will have to be modified, developed or remain unchanged. For example, are today's highway systems ready for autonomous vehicles, or do they need to be developed and adapted? There is a gap in addressing these issues. Future ITS world congresses must encourage researchers to present concrete challenges and opportunities based on evidence rather than speculative work as is seemingly the case now. For example, a session focusing on real world experiments on connected and automated vehicles would provide a good forum for such discussions.

Integrated transport and freight

Technology and new concepts are driving integrated transport solutions, for example MaaS continued to be a popular topic with respect to passenger transport. There is no equivalent focus on freight although the idea of the concept is not new to freight as freight forwarding and logistics are, to an extent, concepts based on MaaS. Some sessions pointed in this direction. Logistics and freight forwarding need to be addressed from a MaaS perspective in order to align freight with such new developments. Another area that has become more evident is integrated transport from the smart city perspective. Here freight is addressed through last mile delivery but also distribution centres. Future events should provide room for advancing MaaS not just for road transport but across all modes and including freight and in the same way smart cities should provide room for last mile logistics.

TOPIC G ENVIRONMENTAL SUSTAINABILITY

OVERALL SITUATION

While the majority of the Melbourne ITS conference focused on road and vehicle developments and treatments there was acknowledgement of other mobility solutions such as cycling, walking and public transport. There is a direct link between Intelligent Transport Systems (ITS) and prioritising public transport. Smart road and rail signalling can reduce journey times, increase punctuality and make alternative more sustainable transport options attractive for car users. Many speakers explained that green thinking is often a "feel good" tie breaker but not necessarily a deal breaker in ITS developments. If we are to truly realise sustainable benefits, green thinking with ITS needs to be a deal breaker. Sometimes the right solution may not be the easiest.

The way we choose to travel is an important contributor to the impact on the environment. Car pooling, public transport, cycling, walking and other transport modes are all important travel options. The more attractive an option is the more likely behavioural change will occur. The share of cycling and walking has declined over past decades in emerging Asian countries due to the lack of planning for non-motorised transport in favour of cars and motorbikes. Many citizens see good bicycle infrastructure as a priority. This was discussed in a paper evaluating the bicycle friendliness of Asian cities by the Republic of Korea.

The impact of traffic on air and noise pollution is an important indicator as we collectively look for better ways to move using more sustainable energy. It is difficult to improve what we can't measure. Several presentations examined ways where measurement can become part of future road management and movement technologies. Research presented suggested that traffic congestion is the main cause of urban traffic accidents. Several presenters discussed how ITS can help reduce traffic accidents which indirectly can result in lower CO_2 emissions. There is a role for ITS in improving air quality and delivering greener transport. Being proactive rather than reactive was a key point made by several speakers.

Green thinking with ITS needs to be a deal breaker

ELECTRIC VEHICLES

Most vehicles are parked 95 per cent of the time but when they are being used they need power. Several papers discussed the issue of electric vehicles needing to be charged either through charge points, wireless technology or both. As more electric vehicles come into operation there is expected to be disruption to the electricity distribution grid so the tracking and management of these vehicles is important. Many presenters have researched how best to do this.

Wireless charging technology for heavy-duty vehicles, such as electric buses, has been actively investigated with a view to accelerating deployment of eco-friendly transportation. But there are several concerns regarding conventional wireless charging systems, such as the need for a good alignment of the charging pad in the parking space and the on-board receive charging pad. In Japan the national and local governments are financially assisting the deployment of electric buses, and thus electric buses are being actively operated in many municipalities as well as by private-sector. There are several examples of field operation of wireless battery charging for electric buses at parking spaces.

In Vienna, electric taxi (E-Taxi) fleets were tested in urban areas. This poses a number of economic, organisational and technical challenges related to the nature of electric vehicles. The assessment of the trial supports the improvement and upgrade of the system such as using higher battery capacity or the expansion of stations with additional charging points to allow more than one E-Taxi to be charged at the same time. During one presentation on electric vehicles there was interesting audience discussion on the merit of electric cars being categorised as part of an Intelligent Transport System solution. While the debate did end in consensus it was acknowledged that through electric vehicles, technology plays a big role in how these vehicles interact with infrastructure and ITS.

FUEL, EMISSIONS, TARGETS AND DRIVING BEHAVIOUR

In relation to transport emissions, fuel quality, emission reduction technology and engine emission standards have all improved over the last decade. However progressively tougher emission standards are not delivering the predicted real-world benefits – especially for diesel vehicles. A mismatch between regulation and real-world emissions from diesel vehicles seems to be one of the key reasons why the anticipated reduction in roadside concentrations have not materialised

Oslo is part of a global move to reduce CO_2 emissions. The city has set out to investigate the potential for a considerable reduction in emissions and air pollution with the goal of zero emissions by 2030. It is proposed to do this in a number of ways including 100% emission free cars, 40% of freight moved from road to rail, reduction in traffic volume by 20%, public transport initiatives and even congestion charging systems.

In France, gamification has been used to test drivers' ability to conserve fuel. Game play affects not only a user's motivation to engage with the play elements, but subsequently the ability for the learning and behavioural objectives of the game to be achieved. The principle is to use a fuel consumption challenge, in virtual reality, where the drivers need to drive as far as possible with a limited quantity of fuel. This challenge was demonstrated in the Paris Motor Show in 2014 where more than 1200 participants drove on a virtual road.

In Japan driving tips on more economical driving behaviour are encouraged but appear to be followed more by professional drivers as there is a clear link to saving money through less fuel consumption and wear and tear on vehicles. Trials of platooning in Japan also revealed a positive impact on reducing CO_2 emissions with a 3.5% reduction due to the buffeting impact of heavy vehicles in the platoon (less wind resistance). Measurement of the trial suggested a 1.3 percent reduction in CO_2 emissions resulting from better traffic flow attributed directly to the platooning trial.

AIR QUALITY, NOISE, TRAFFIC AND ITS

Air quality limits are exceeded in many cities in the world mainly due to emissions from road traffic. Studies in Stockholm show that traffic pollution can lead to premature deaths of 470 persons / year – 10 times higher than the number of deaths due to road accidents. This is similar in other parts of Europe including the United Kingdom. Road transport emissions contribute significantly to poor air quality in urban areas. Modern ITS-based Environmental Incident Management Systems have a key role to play in addressing and mitigating the negative impacts of these emissions. The environmental impacts of urban freight traffic, especially in terms of greenhouse gases and other air pollution, are of increasing concern to the community. One paper examined the urban logistics related factors for greenhouse gas emissions through a multivariate linear regression model.

The ability to predict combined traffic and pollution levels over a short-term period has rarely been explored in the past. The potential to improve traffic and air quality management by allowing a proactive approach, rather than reactive, can lead to more effective decisions to changing conditions. Research presented from Sweden could lead to the development of a system that could help local authorities anticipate and predict extreme events related to pollution or traffic a few hours in advance. Emissions are not usually included in traffic signal control metrics. Since environmental performance measures are becoming more important in traffic signal control there is a need to include these metrics in the future.

Ride sharing

Low private car occupancy is one of the reasons for the large number of vehicles travelling. In Germany average car occupancies range from 1.9 for leisure trips to 1.1 for daily commuting trips. Similar figures are recorded in Australia. In the US, 9.2 percent of commuters carpool in peak hour with average car occupancy rates improving to around 1.2. Ride sharing is an effective way to utilise the available but often unused seat capacity in private vehicles. In long-distance ride-sharing, people offering rides at web-based platforms often find passengers in cities *en route*. To encourage carpooling Paul Czioska from Hannover Germany proposed a better way to pick up passengers at meeting points using a GIS approach *via* an app. Meeting point optimisation, a multi-modal routing network including driving, walking and public transport, are all necessary for making carpooling easier both for the driver and passenger. All this can be done through a mobile device.

THE FOLLOWING KEY THEMES CAN BE IDENTIFIED:

Electric battery life and charging

The increase in electric and autonomous vehicles is expected to have a positive impact on the environment. Current tests highlight some issues with battery life and charging opportunities which need careful consideration when planning for higher volumes of these types of vehicles. The congress papers and presentations clearly indicated that a lot needs to be done regarding the development and advancement of electric batteries. While further field tests are ongoing, the test done in Vienna highlighted a number of variables to be considered in such assessment. This includes driving times/distances to charging stations, remaining range before charging, the charging duration and energy consumption. There is interesting research on the impact of constant heating and cooling of the vehicle interior on the electric battery life. Making more use of climate control results in fewer kilometres available due to the drain on the battery.

Fuel consumption and emissions

The development of zero-emission fuel-cell electric vehicles is advancing globally at an impressive rate. One paper presented the performance and hydrogen consumption of a passenger fuel-cell vehicle under real-world conditions. Driving routes in urban, suburban and rural locations were chosen to determine the hydrogen consumption of the vehicle under summer and winter conditions. Real-time in-car measurement systems for vehicle performance and energy consumption combined with car-to-infrastructure communication gives an important insight to the real efficiency of vehicles equipped with different propulsion systems. This comparison is useful in a number of applications such as sensor requirements for autonomous vehicles that can assist in improving fuel economy.

Ride sharing and data

The growth of motorised traffic in and around city centres contributes to increasing congestion rates, which brings not only inconvenience and frustration but also financial and time costs for commuters. One way to reduce congestion on busy corridors is the introduction of managed lanes particularly for car poolers. Detecting the presence or absence of passengers in an image and being able to differentiate the vehicle class (car, utility, bus, motorcycle etc.) has always been an enforcement and data collection challenge. Until 2014 no road side control system was able to detect passengers in vehicles with the accuracy and reliability required for automatic control of high occupancy vehicle lanes. A system measuring vehicle occupancy, developed by Xerox was evaluated at the French Swiss border in 2015 and presented at the congress.

Real world tests can improve environmental outcomes

Connected and Automated Vehicles (CAVs) may drive more smoothly, stop less often, and move at faster speeds, thanks to overall improvements to traffic flow. These changes in driving patterns have an impact on energy consumption which was estimated on one trial using high-fidelity vehicle models. Simulations done by in the USA highlighted synergies between connected and electric vehicles which resulted in less energy consumption. Connectivity improves power demands with smoother driving. In analysing energy losses of vehicle components, fuel consumption was found to be reduced using connectivity because less power is demanded as a result of less energy lost in traction components. Connectivity also reduces aerodynamic drag and the energy lost in brakes.

ITS technologies that can improve environmental outcomes are being increasingly tested and trialled in real-world environments to establish best practice and identify barriers to wider implementation. The testing of electric vehicles, battery life, sensors for automated cars, fuel types, air quality monitoring around traffic hot spots and even smarter ways to manage waterways – it's all about learning and getting better.

The introduction of new collaborative partnering contracts by VicRoads in Melbourne is another example of developing community benefits under a shared responsibility scenario. The contractor is required to develop efficiency and improvement proposals using innovative solutions that can benefit road safety, travel times, the longevity of assets and network reliability. As advances in technology are realised, the impact on the environment will be minimised.

Transport generated noise in urban areas is a problem in many cities around the world because it affects human life and health. Preliminary results of wheel noise tests demonstrated situations where propulsion noise is eliminated by using electric vehicles with porous and large graded pavements that are much quieter than conventional asphalt and concrete. Accurate noise assessment and finding the correct noise generating media can contribute to creating the right solutions such as more aerodynamic vehicles, low noise pavements or sustainable noise blocking screens and walls.

Several speakers presented data about air quality improvements that can be gained through the improvement of traffic flow. This included many simulations and real world testing. An initiative such as the Green Wave does improve the predictability of journeys through vehicles maintaining a consistent speed. This results in fewer emissions when compared to the regular deceleration and acceleration of vehicles without the support of traffic priority.

In Scotland, IBI has provided the Highlands and Islands Transport Partnership with its Real Time Public Transport Information system using E paper technology. E-Paper is a display technology which has been designed to mimic the appearance of ordinary paper similar to the technology used within eBook readers such as Kindle. These tests have proved cost effective with very low use of power operating 24 hours a day on solar energy.

Support for lower emissions.

Norway has ambitious targets and initiatives. The introduction of environmental road charging will be strengthened as part of incentives for purchasing zero emission vehicles. There is great political support and will for achieving this, with the development of the national electric vehicle charging network, possible financial support for a network of hydrogen filling stations and the continued strengthening of public transport services. For cities to make a positive difference in environmental sustainability, it requires a collaborative approach and political support. Norway talks about Smart Cities – a Smart City is a city and region that through specific activities utilises technology to improve on quality, efficiency and interactivity. This means more efficient use of resources, reduced costs and improved coexistence between municipal authorities and the community.

Copenhagen aims for zero carbon emission by 2025; there is already reliance on cycling as a viable transport mode and the city's goal is to be the best bike city in the world. Currently 41% of trips to and from work are made on bikes and are not generally motivated by health or cost but the fact that the bike is quicker than the car. The key is prioritising. If you give to one mode, you take away from another. On any given road you can have five times more people on bikes rather than cars. ITS helps increase the traffic flow on roads for modes that can move the most amounts of people. When road space is reorganised to create more sustainable spaces, the cities livability prospers.

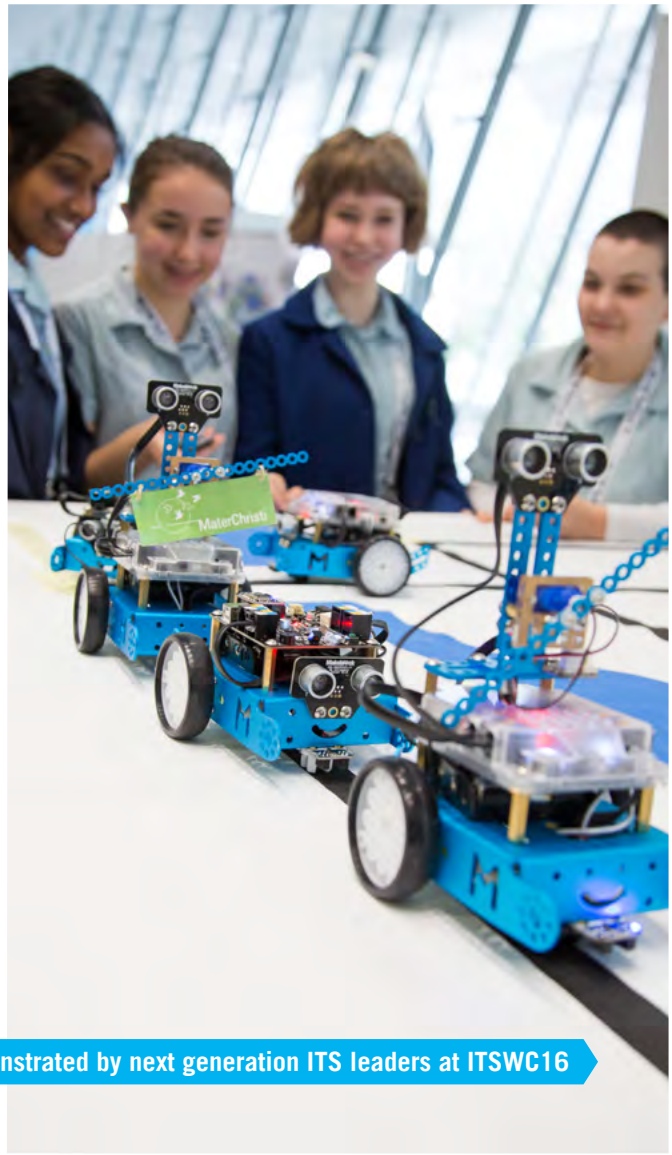
Encouraging people to move more by non-motorised transport such as walking and cycling has many benefits. One could argue that the future is not about private transport but more about shared or non- motorised transport. This could be through autonomous driving vehicles that drop off and go to the next pick up or through self-propelled vehicles. A paper presented an assisted human powered vehicle with innovative steering to promote sustainable urban mobility being tested in Japan with a full scale prototype. The advancement in assisted human powered vehicle development has the potential to encourage active transport and mode shift to create sustainable urban mobility. While this technology maybe a signpost for the future, it is still in its infancy with challenges such as increasing the vehicle's speed (currently 20kph) and improving passenger safety (capacity 4) still evolving.

MOVING FORWARD

We are the problem and also the possible solution when it comes to environmental sustainability. Dr Moon argued that transport systems need to be cheaper, simpler and easier. Transport services need to be safer, smarter and greener. Transurban presented case studies on the regeneration of Australian roadsides along its toll roads. The term *motorscapes* was introduced to congress participants. This includes native plant regeneration and iconic public art installations. Of particular environmental interest is the habitat filters being designed to provide greater ecological and social value by capturing carbon emissions. *"We would like to promote green infrastructure in an educational and playful way that gives back to the community. The highly sculptural forms also have a functional purpose of providing a habitat, acting as micro-climate filters and capturing the sun and rain for re-use on the site."*

It is clear that most car manufacturers are moving forward with electric hybrid vehicles and the development of autonomous vehicles. We know our fuel resources are not infinite. Developing more sustainable mobility options and energy sources is not simply a nice thing to do; it's something we have to do. It should no longer be acceptable that a private vehicle is active for only 5% of its life.

Several papers presented at the ITS Congress highlighted the need to think differently about how we approach moving people, freight, information and data. It does require a change of mindset in many instances. One paper references embracing culture by acknowledging basic common values. In Asian cities, there is a phrase *heerbutong* which means both "get along with others" and "harmony in being different". The more we research better ways to travel and invest in sustainable ITS solutions, the more chance we have of travelling happily and having a positive impact on the environment.



Future transport solutions demonstrated by next generation ITS leaders at ITSWC16

TOPIC H POLICY, STANDARDS AND HARMONISATION

OVERALL SITUATION

Policy, Standards and Harmonisation was one of eight top-level topics for the Melbourne Congress. There has never been a greater demand by cities and communities all over the world for global interoperability of mobility services and products enabled by big data, internet of things, automation and connectivity. In the face of this tidal wave of technological change, new concepts of operations are possible requiring attention to policy, regulatory frameworks, architectures and business models to truly maximise the full potential to deliver sustainability outcomes as cities get larger and larger.

A technical paper described the key challenges as (i) uncontrolled disparate growth, (ii) vendor driven evolution, (iii) aligning technology advances with government programs, (iv) business systems alignment with physical infrastructure and (v) human factors in ITS. Policy, Standards and Harmonisation content at the World Congress was both comprehensive in scope and depth with the key sessions grouped into sessions that provided the context and policies for the Topic and related architecture impacts.

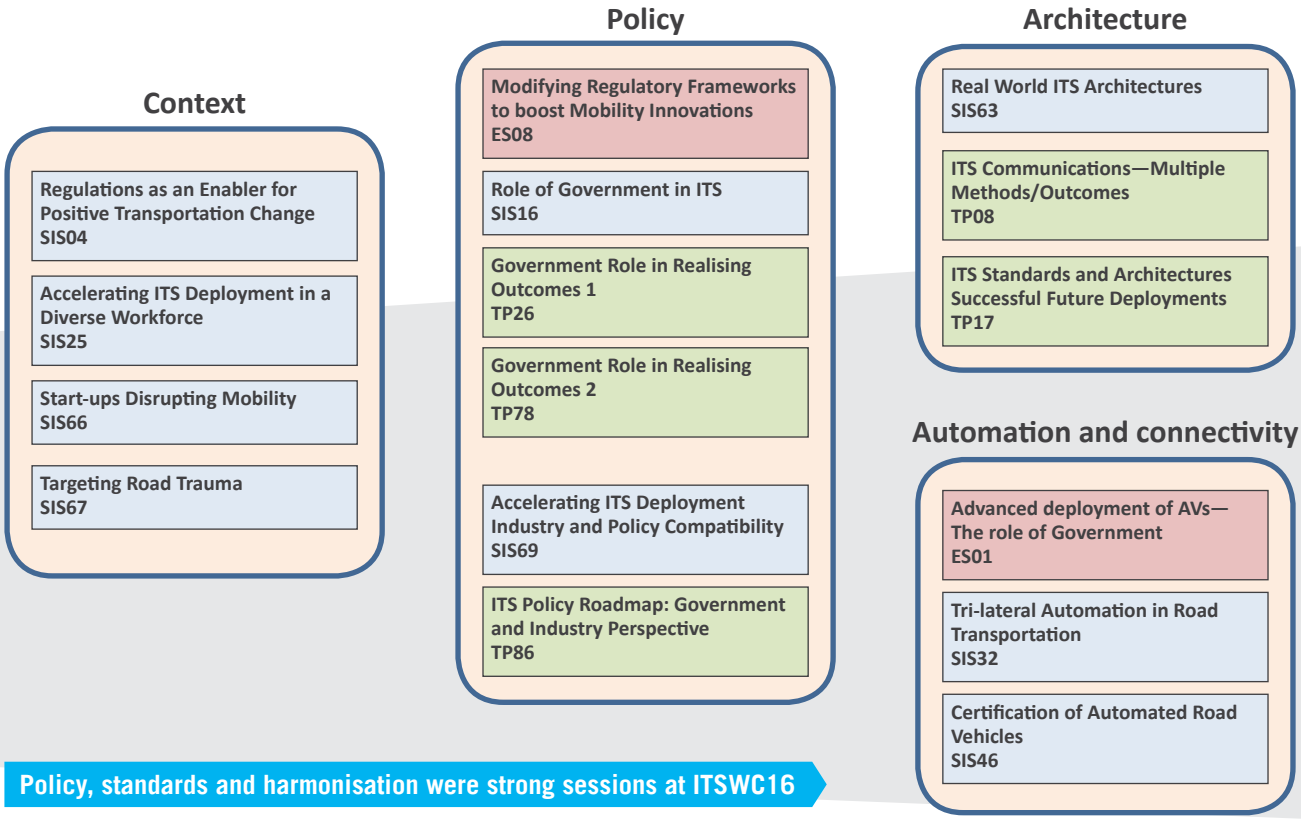
SPECIFIC POINTS

The selection of sessions in automation and connectivity indicates the need for policy and harmonisation in connected and automated driving that is demanded by industry, governments across the world.

Government's roles and solutions

Technology-enabled transport services such as smartphone-based innovative mobility services often do not fit into existing regulatory structures (*eg* Uber, Lyft *etc*). These services are expanding and have raised public policy issues such as:

- An uneven regulatory playing field
- inconsistent requirement for incumbent taxis and emerging transportation network services
- equity implications of taxi industry decline
- public security and employment status



Policy, standards and harmonisation were strong sessions at ITSWC16

Experts from US, the EU, UK, NZ and Japan had extensive and energetic discussion and debate on '*when innovation meets regulation*'. All agreed that regulations should not limit progress but support, encourage and enable new and innovative solutions. Many speakers considered that the biggest innovation in the mobility area could be happening in the regulations. Regulators and policy-makers should examine the growth and diversification of technology-enabled mobility services and explore the implications these services have for consumers and existing transportation services. The integration of the features of innovative shared mobility services into existing transportation systems and services would leverage the new services' strength and features.

Matthew Dorfman (D'Artagnan Consulting) offered six possible solutions for government regulators to adapt their business models and embrace the innovation and involvement from private sectors:

1. Use simple fast procurement
2. Establish an open market, allow multiple players to compete for users
3. Establish innovation centres
4. Establish a public-private forum (*eg* Roads Australia a successful example)
5. Provide employee flexibility and empowerment to encourage change
6. Simplify rules and regulations (the IT area is often over-regulated).

PUBLIC PRIVATE COOPERATION

Until recently the public sector has been the primary (and in many countries the only) transport provider. A range of transport services is emerging such as Big Data, MaaS, connected and automated driving (CAD), in which business models have shifted to embrace more involvement from the private sector. Mobility will be the biggest driver of economies in the next decade. Innovative mobility services are expanding travel choices and are being widely embraced by millions of users. Shared mobility services have the potential to change our long term travel patterns. However, providing mobility as a service is never easy for any single player as mobility needs to combine everything from public transport, car ownership, rental and sharing to payment flexibility, system interoperability, public security, disparity between access for users with disabilities and other travellers etc. Increasingly, players in the private sector are keen to work with governments and become more involved in policy, standards and regulation processes.

Connected and automated driving (CAD) could be another strong driver of the economy. Fraunhofer Institute research predicts that if German car manufacturers and suppliers maintain their current levels of market and location share, the value added for assisted and automated driving will amount to nearly €2.3Bn in 2020 and around €8.8Bn in 2025. This is 16 times the current German value added of advanced driver assistance systems (ADAS), which accounts for €546M, and is predicted to generate around 120,000 jobs in 2025.

The European Commission has published nine studies and identified infrastructure development needs representing approximately €700Bn of financial investment until 2030. There is an investment plan of €315Bn for projects to maximise the benefits from the Connecting Europe initiative. In addition the total cost of new EU infrastructure needed to match the demand for transport has been estimated at over €1.5Tn for 2010-2030 for all EU Member States. The reality is that the EU will never have the resources to address even its critical needs. It is unimaginable that increasing taxes and fees will ever bridge the gap to address the needs. The truth is that innovation is the only real solution to overcome the resource needs. Both public and private sectors have recognised the strong need for cooperation, common responsibility and shared leadership in the deployment of emerging technologies. It was argued that a systematic approach could be established to encourage collaborative business models.

Many of the government representatives present expressed a willingness and flexibility to work with industry in looking for new ways and approaches to accelerate innovation

TECHNOLOGIES

The presenters in all the policy, standards and harmonisation sessions were found to be paying close attention to current and over the horizon technologies which included safety features in new vehicles, V2V and V2I communications, electrical vehicle technologies, software-centric vehicles, Mobility as a Service (MaaS), Data as a Service (DaaS), drones, artificial intelligence, connected and automated driving (CAD), specialised expertise and reductions in the workforce.

Concerns were raised that legislation designed for different technical, commercial and social times was impeding the adoption of new products and services. As such, the challenge for regulators is finding the balance between a more open regime that encourages innovation while encouraging an open competitive marketplace and a sensible operating environment for domestic and international transport service providers. Many of the government representatives present expressed a willingness and flexibility to work with industry in looking for new ways and approaches to accelerate innovation.

PILOTS

There were many sessions on deployment, pilots and trials as well as announcements of further activities going forward. An EU representative asked the question - "are cities aware of what is coming up?", and noted that much research has already been undertaken and now is the time adopt a learning by doing approach. The US government representative highlighted that Connected and Automated Vehicle initiatives have since become the cornerstones of the US DOT's ITS Joint Program Office activities and gave an example of the very successful Smart City Competition in the US. Other speakers from Asia spoke about the Japanese Government's role in advancing the deployment of automated vehicles from both a domestic as well as international perspective, the Korean establishment of a significant C-ITS program involving 3000 vehicles, a Vision 2030 for Jeju Island when only electric vehicles will operate on its network, and the Chinese establishment of an intelligent vehicle and CITS testing and evaluation platform in Chongqing.

In summary remarks on what actions governments could take in deployments, Knut Evensen, CTO of Q-Free, advised; "*build competence, follow the scene directly and be smart in your investments as you think about your own deployments.*"

A clearer picture is emerging that the next 3-5 years will see considerable end-user testing occurring all over the world which will greatly inform the policies, standards and business models needed for user acceptance and take-up of smart mobility and services.

ITS ARCHITECTURE

In order to enable more effective strategic planning and business transformation initiatives for both public and private service providers it is necessary to adopt architecture models for better understanding and articulation of the organisation's ability to deliver its business services. An architectural framework provides a common language, concepts and methodology defining a repeatable, rigorous but flexible approach to solution delivery. At a national level, each ITS-related organisation can leverage national ITS architecture content to develop ITS solutions more quickly, while increasing the potential for collaborative development, consistency and re-use of existing ITS solutions.

Different architecture methodology and frameworks such as the European ITS framework architecture (FRAME) and the open group architecture framework (TOGAF) were discussed. Australian practitioners have developed a national ITS architecture framework which maps FRAME content with TOGAF concepts. This has demonstrated positive experience and benefits through the establishment of pilot projects in Queensland.

LAWS AND STANDARDS

Many countries have started to think of land transport regulations 20 to 30 years in the future (under different scenarios), in order to begin the conversations with stakeholders on the regulations of the future. For example, Australia announced a new study to consider Land Transport Regulation in 2040, following similar initiatives in New Zealand, Canada, Japan, the US and Europe.

In the shorter term a range of new laws and standards has been discussed at the US Congress. Work has been done in the US with the release of a much revised and refined SAE J3016 on the taxonomy and definitions of automation, the Federal Automated Vehicle Policy, an updated NHTSA 15 point "Safety Assessment" guidance and enhanced testing regulations. The EU has released the "Declaration of Amsterdam" where 28 European Member States agree to work together to have harmonised and coordinated rules and regulations and to cooperate on cross border testing in order to advance the deployment of automated vehicles. This follows the Cooperative ITS Platform Report published earlier in 2016.

Globally, work at the United Nations Working Party on Harmonisation of Vehicles Regulations (UN-ECE WP29) progresses with the addressing of Regulation 79 (steering wheel function) to allow for automated steering. Japan reported on the G7 Transport Ministers meeting in September, hosted in Nagano, which had a special focus on connected and automated vehicles and acknowledged the importance of co-operation between governments for technology deployments on roads and vehicles

ACCELERATING ITS DEPLOYMENT BY CREATING A MORE DIVERSE WORKFORCE

A panel of VIPs from both public and private sectors discussed the benefits of diversity in the ITS workforce and how to achieve it. Diversity in the driving community, diversity in the needs of road users and diversity in the mobility service itself have all emphasised the need to create a diverse workforce in ITS industry.

The discussion covered a broad range of issues including how to attract and support a diversified workforce in the engineering area, diversity in both current leader team and in the succession plan, specific training programs to avoid unconscious bias, increased opportunities and confidence for potential female, younger or non-English speaking background candidates. Some successful case studies suggested that organisations should support workforce diversity in gender, culture, language, country and skills background through corporate policies, recruitment, training and developing process, and even from school systems and value education for younger generations etc.

SOME KEY QUOTES AS POINTERS TO FUTURE TRENDS

On the transformation of transport to smart mobility:

"Today, transport is seen as a market, a service, a utility"

Paul Retter, Chief Executive, National Transport Commission, Australia

"Successful deployment of public ITS relies crucially on partnerships with the private sector"

Nick Brown, General Manager New Zealand Transport Agency

On the rise and rise of big data and the Internet of Things:

"if you think about automated vehicles, it is data that is the pilot of the car"

Paivi Antikainen, Finland Ministry of Transport and Communications.

"We need to focus on trials and deployment with real life cases to show the world what the benefits will be such as last mile stations, accessibility at airports, centres for handicapped people, smart grids"

Tomas de Laat, Ministry of Infrastructure and Environment, Netherlands

"It's happening all over the world and on all parts of the road network – there's something everywhere and everything somewhere"

Peter Sweatman.

PART 2
PLENARY AND EXECUTIVE SESSIONS

PLENARY 1 AUTOMATED AND CONNECTED VEHICLES

MODERATOR

Kim Thomas ITS leader, Aurecon Group Australia

SPEAKERS

Gavin Smith President Robert Bosch (Australia), Australia

Shin Morishita Counsellor for SIP, Bureau of Science, Technology and Innovation, Cabinet Office, Japan

Peter Sweatman CAVita USA

Wolfgang Hoefs Head of Sector, DG Connect, European Commission, Brussels

David Buttner President Federal Chamber of Automotive Industries and Toyota Australia, Australia.

Opening the session **Gavin Smith** discussed how people had been designing transport since the 15th century – from Leonardo da Vinci's early concepts of automobile to steam tractors and electric vehicles, and the early works of Karl Benz which included vehicles powered by gasoline burning, 4 cylinders, having 3 wheels and an internal combustion engine. Automobiles weren't liked initially as they were seen as being noisy and dirty and considered a risk to people and animals. There were strong lobbyists who made it hard for automobiles to be implemented in society, speed limits were 2 mph and there had to be a flag waver or bell ringer in front to announce its arrival. The objections were short lived, as in time the benefits and capabilities outweighed the reasons for dislike, and mass production made them cheaper for people to buy.

As time has gone on and as cars have become so necessary in today's society, new problems have arisen. 30% of people spend their time and money on parking. It has become apparent that people aren't good drivers but claim they are better than average. Comfort and luxury appeals to most people and so they spend more money on that and less on safety. It has been argued that more than 90% of crashes take place because of human error. By 2020 61 M vehicles will have smart connected capabilities while the prices of the batteries for electric cars which currently make up 80% of the cost of the car will have halved. Autonomous and connected vehicles will become a reality, just as the car in Knight Rider was once a fantasy – the likelihood of its becoming reality is growing.

There are some megatrends for connected, electrified and automated vehicles, such as demography. The over 65 age group is growing twice as fast as others and will rely on these technologies. There are 5 Bn people in the world 60% of whom live in cities – there must be smarter ways to use transportation more efficiently. By 2020 50 Bn things will be connected from which the logical conclusion would be to use the infrastructure with new types of automobiles. Gavin concluded by saying that in time the cost of the components of autonomous and connected vehicles such as automatic braking will decrease; but even so autonomous driving in urban areas is still a decade away. The benefits of autonomous driving are improved road safety, freed up spaces, decreased pollution, increased traffic efficiency, access to mobility and many others.

Shin Morishita focused on the SIP (Cross-Ministerial Strategic Innovation Promotion Programme) within Japan. SIP is backed by an intensive R&D programme which promotes 5 years' worth of R&D and enhances cross-ministerial cooperation. There are 11 research themes for the project from societal issues such as energy, next generation infrastructure and local resources which includes R&D for automated driving. The theme of automated driving systems sits within the issue of next generation infrastructure. It includes key technologies needed for vehicle control systems. The programme is trialling connectivity through cellular networks, satellites and V2X. In order to ensure success the project emphasises trying to balance a combination of cooperative and competitive approaches to the development and deployment stage process. Toyota are also working on SIP–ADUS (innovation on automated driving for universal services), which focuses on what AVs need to cooperate with including, digital maps, wireless communications, HMI and security. The success of the project is important for input to international standardisation and coordination. Security and other topics also need continuous discussion and dialogue by taking various opportunities.

Peter Sweatman started by saying we are at a technological tipping point brought about by connected vehicles and infrastructure to support these vehicles. Shared user services through SaaS and MaaS will ensure that by 2020 around 50% of our rides will be automated and the importance placed on smart cities will further drive the need for connected and automated vehicles (CAVs). Peter echoed Shin's views that the enablers for this will be sensors, software, cloud hosting, robotics, artificial intelligence and consumer electronics. Crash rates are declining but we see the same amount of fatalities as a decade ago because we travel a lot more now.

Peter spoke about the need to integrate different silos such as energy and emissions, traffic efficiency and safety. Some key transformational metrics are needed to measure the affects CAVs can have; Governments alone cannot make this happen, there has to be something exciting for the customers to want to make a change. CAVs do just that and the result of implementation should be a factor of 10 improvement on fatalities and injuries, delays in traffic, carbon emissions, energy consumption and customer satisfaction. The US DOT have issued statistics on today's transport challenges – around 37,000 highway deaths a year, 6.1M crashes in 2014, a $61 Bn cost of urban congestion coupled with 6.9 Bn hours of travel delay.

The process of deployment has been through creating artificial cities, such as MCity and Willow Run in Mission which is ten times the size of MCity. There are also CAV pilots such as the one with 10,000 connected vehicles in New York City by next year. The pilots test different scenarios such as whether a CAV can successfully detect a pedestrian crossing a road between 2 parked vehicles. The way forward is use cases, starting with deployment of small vehicles such as driverless shuttles, automated taxis, and platooning of trucks.

Wolfgang Hoefs echoed the view of Peter and said there would be a paradigm shift in mobility as CAV starts being embedded in the transport industry. Cooperative ITS is well established today, with vehicle to vehicle and vehicle to infrastructure communications based on dedicated short range communications. Day 1 applications will be on the market in Europe in 2019 delivering information services for drivers, traffic managers and other road user assistance based on an enhanced perception of surroundings One of the key questions is 'how can the technological advancements be matched by regulatory frameworks? Wolfgang argued that there is a C-ITS master strategy in preparation, which is at interservice consultation with the different Directors-General within the Commission and planned for publication by the end of 2016.

Wolfgang wanted to highlight the importance of digitalisation in tomorrow's world and its fast progress as it offers new opportunities for businesses and services. As disrupters enter the market, such as Google and Uber, digitalisation becomes more than just connectivity, it encompasses sensing, security, data and privacy. In order to help the development of CAV the European Commission are using instruments such as the Horizon 20-20 Research and Innovation Programme. There will be a scoping pilot of around €30K for testing automated passenger cars, as well as pilots for user acceptability and for road infrastructure able to support coexistence of traditional and automated cars.

In 2017 the Commission will issue Calls for proposals for full scale demonstration of urban road transport automation. They have launched GEAR-2030, a study programme to support the EU automotive industry to strengthen its competitiveness and to address the new challenges it is facing. The EU Commission see their role as facilitating a cross sectorial dialogue between automotive, IT and telecommunications industries, Member States as well as other stakeholders; for which they'll be hosting a round table discussion on. Wolfgang concluded by saying, automation and connectivity go hand in hand just like a horse and cart.

David Buttner noted that in Australia the adoption of CAV has been less than half the rate compared with the USA, China and Europe. This might reflect the need to adopt regulations from international standards but then adapt them to the Australian market. He compared the size of Australia to the rest of the world – Australia bought 1.15 M vehicles in a year which represents 1 month's sales in the USA. David highlighted how national road conditions need to be taken into consideration before creating the right framework policy to deploy CAV. When a policy framework is implemented it will need to address how best to serve the new fleet of cars as well has harness the safety and flow of the current automobiles.

The benefits of CAV are removing simple driver errors which cause the majority of accidents, which in turn should lift the load for roads, police and health services. It will allow for lower vehicle running costs and emissions and fully managed roads, which will inevitably help reduce congestion and in turn boost productivity. David went on to say that manufacturers such as Toyota are already integrating this system from autonomous, automatic braking and speed reduction capabilities. There are 5 ways to move forward. 1) Strive with consistency with other markets. 2) Learn from trials in other markets and adapt to the Australian market. 3) Update ITS policy framework ensuring all stakeholders are thought of. 4) Obtain support from government through grants and pilots. 5) Achieve national consistency.

POINTS ARISING FROM DISCUSSION OR QUESTIONS

- **Do you think governments should mandate automatic emergency braking, pedestrian detection and lane maintaining immediately?**

  As a driver and not a supplier I think anything to help ensure safety should be done and frameworks are a quick way to achieve that. This is already what happens in the US, for example the automatic braking had to be fitted within the cars by a certain time due to the policy framework which coincided with the safety timeline. Technology for pedestrian protection could be the next thing to have a framework.

PLENARY 2 SMART CITIES

MODERATOR

Neil Scales Director General, Queensland Department of Transport and Main Roads, Australia

SPEAKERS

Jack Dangermond Founder and President, Esri, USA

Men Leong Chew Chief Executive, Land Transport Authority, Singapore

Hamed Benouar Vice President of Business Development and Government Relations, Sensys Networks, USA

Leon van de Pas Senior Vice President, Head of IoT Business Group, HERE, The Netherlands

Mike Mrdak Secretary, Department of Infrastructure and Regional Development, Australian Government

We're wiring up the planet and have never been more capable of sharing knowledge, was the message from **Jack Dangermond**. He argued that a digital transformation was starting and virtually everything that moved could now be analysed and connected. Mapping was essential as it was like a fundamental language enabling content to be understood and applied. It was also a challenging time with issues of population growth, disasters (human and natural) and social conflicts. The future was not sustainable and everyone needed to contribute to turn it around. GIS provided a framework for enabling a smart future to emerge, where data could be integrated and understood, allowing analytics and modelling. GIS had enabled information gathering for many years, but it was now real time, enabling greater planning and decision making.

The definition of a smart city was an evolving one. However, smart cities were happening and growing, so while the definition might not be important component parts or features would be. Traffic monitoring enabled better appreciation of movements and behaviours, enabling cities and municipalities to future plan as well as adjust to changing situations. Smart cities also required a level of engagement, where people are connected. Social media enabled communication as well as data, plus instant feedback. Mobile apps based on geospatial infrastructure would help shape our future, with input from users.

Integrated systems – records, engagement and insights – were increasingly coming together in smart cities, to be found in one location. In addition to the practical components of a smart city there were smart approaches, for example open access and feedback. More jurisdictions were making their information transparent and sharing it so enabling greater learning and applications. One agency can assist another simply by making information accessible. ITS is creating the environment for shared information, with collaboration and trialling commonplace enabling innovative new approaches helping to meet challenges.

Men Leong Chew explained that Singapore is an island, city and state with a population of 5.6M and some 1M vehicles. In 1965, the population was 1.8M with only 160,000 vehicles. 12% of Singapore's land space is roads but this is not sustainable. More roads cannot be built so the challenge is to remove vehicles from the roads and make better use of that time and space on the road. To achieve improved transport, business productivity, home and environment, health and enabled ageing and public sector services, Singapore is increasing public transport, promoting first-mile-last-mile accessibility on its road network. A huge programme of public transport transformation has started looking to double the rail network from 180km to 360km by 2030. One new railway station will be built every 1.8 months for the next 15 years and the bus fleet will expand by 35%.

To support this ITS will be deployed to collect real time movements and apply analytics. Many signalised crossings, variable message signs, sets of adaptive traffic signals *etc* will be installed. Information will be shared with customers through apps – transport data is the most shared data in the city with 400M downloads of information every month. The city is testing four on-demand self-driving programs, and has expanded its cycling and walking networks to encourage alternatives for the last mile. This includes expanding the electric car sharing scheme with a fleet of 1,000 vehicles and 2,000 charge points to be introduced, in addition to more electric taxis and buses.

Hamed Benouar talked about Columbus, Ohio the winner from 78 applicant cities and 7 finalists of the US Smart Cities program. Columbus has received $40M prize money to work on its concepts. Hamed stressed that all participants had benefited from the competition as the engagement had resulted in more cities considering their future, and looking at ways to make life better for citizens. The program had assessed key factors such as transportation, energy, water and waste management, buildings and infrastructure, health services and emergency services, advanced wireless networks, sensor networks and cyber security.

Conversations had started with partners to review some, or all, of these areas which would bring long term benefits to a number of cities and communities. Smart cities need smart people who want to make improvements and the Smart Cities Project could have an energising effect. Different cities will have different requirements which is why defining a smart city is so hard – and not necessary. After all, no one claims they live in a 'dumb' city and so it is about using technology and better planning to make improvements. Each smart city often has the same perspectives and values which usually covers efficiency and safety, mobility options for all citizens, maximising infrastructure and information, with citizens having a contribution. Benchmarks for smart cities include living in the city, working in the city and city sustainability.

Leon van de Pas reminded that Australia was famous for its unique animals but he was not sure whether there was a specific kangaroo warning app for drivers. He had mentioned this to illustrate his point that vehicle connectivity must operate across platforms and not brands. In Finland, especially in Lapland, reindeer on the road are a huge problem; on a bad day 20-30 road accidents can be reindeer related. While cities and communities are becoming more connected, there are different levels of connectivity and different degrees of sharing. To ensure smart cities are fully integrated open systems must be encouraged. There are still too many fixed and closed ecosystems so having the right sharing platform is important.

A second example illustrated the perception of being connected. Leon said he has more than 30 road and vehicle user apps on his smart phone. Each one connects him with something; however they also present silos as many do not connect with one another. Citizens should be able to have one solution assisting travel from A to B, without conflict or competition. Most people are connected one way or another. They are connected to cities, cars, homes and infrastructure, but to make them fully connected, there needs to be more open data collected and better use of that data.

Data collection, be it real time or historical, should not be the end goa – it is how the data is used that will provide more information, optimisation and feedback for authorities and users.

Mike Mrdak noted that a Government can have a huge bearing on smart cities, if not as an instigator but as an enabler. It can accept and allow disruption, enabling those who oppose to be eased out, to open up markets. It can ensure accessible price points for all and regulate new markets when they are created to ensure safety and security. And it can establish essential infrastructure and the integrity of open data and research capabilities.

Mike argued that Australia is uniquely placed to benefit from technology to improve its cities and communities as it has specific challenges. It is the most urbanised country in the world with 85% of the population in cities and 80% of this total are in just 5 major cities which are due to double in size in the next 30-35 years. With fast urbanisation and economic growth come dislocation between homes and work areas. 2.5M people live in western Paramatta, outside Sydney and 35% commute each day from home to their work place. The cost of congestion to the Australia economy was estimated at $2.8 Bn in 2016. If nothing is done this is expected to increase to $30 Bn per annum by 2030. Because of Australia's size and the spread of its cities, it now has some of longest commutes in the world. The average is 29 minutes with some rail users in Sydney and Melbourne commuting 79-90 minutes each way to get to work. Growth is good but to make it sustainable, technology will have to be applied to change the shape of the urban community.

POINTS ARISING FROM DISCUSSIONS AND QUESTIONS

- **What is the most crucial information vehicle manufacturers will need?**

  There is practical as well as holistic information that manufacturers seek to meet the needs of consumers. Safety features are driving communications eg if an airbag were to be deployed messages should go to nearby vehicles warning them of an incident. The same information should be sent to authorities and manufacturers. Manufacturers should also be in a position to contact users to pre-empt engine or vehicle issues and should share real time user information to enrich traffic services, mapping and general information.

- **How do smart cities measure the right challenges as different people want different things?**

  The panel agreed that no one thing was a measure of a smart city. It could be argued that it is measured by change but the panel also thought that while disruption is driving change it is not always focused in the right areas. Ultimately if a city is considering what its citizens need, it is being smart. To be enticed away from cars to public transport commuters need to know when transport is available, if it is going to arrive on time and be reliable. Opening data was not enough; start-up communities and mash ups, and in some areas communities themselves, are exploring open services. Governments must also move beyond open data, and proactively design systems responses. If we really want to connect, we have to continue to march forward and not leave it to chance.

PLENARY 3 CONNECTIVITY AND BIG DATA: CHALLENGES IN CAPTURING, SECURING AND CONNECTING BIG DATA

MODERATOR

Chris Koniditsiotis Chief Executive, Transport Certification Australia, Australia

SPEAKERS

Michele Huey Group General Manager Strategy, Transurban, Australia

Hyoen Shik Baik Director, ITS and Road Safety Division, Ministry of Land, Infrastructure and Transport, Korea

Monali Shah Director Global Intelligent Transportation Solutions, HERE, USA

Claire Dupré Head of ITS Unit at the European Commission, DG MOVE, European Commission, Belgium

Adam Game Director Strategy, Intelematics Group, Australia

Michele Huey said that Big Data had been a hot topic for the past few years and was becoming increasing important as 90% of the data we have today has been created in the past 2 years. The real question was how is Big Data being used to solve long term transport problems. Transurban had created the world's first cashless, multi-lane, free-flow electronic tolling system on City Link and as well had trialled a dynamic toll pricing structure in Virginia. Michele described a survey for road user charging in which respondents had a plug-in GPS device in their vehicles to monitor how the driver was using the vehicle. The results revealed that participants were very open to trying a more direct and transparent way of paying for their road usage. 60% of the participants preferred a "user-pays" approach to the current system in Australia. When users were made more aware of how they were driving and the consequences of what they were doing they wanted to change the way they behaved on the roads in order to save time, fuel costs and the distance of their journeys. This was an interesting finding as only a small percentage change in the way people behave and drive on congested roads is needed to see a positive impact on the rest of the network.

Hyoen Shik Baik focused on transport Big Data and the policy within Korea. An exponential amount of data was being collected from both private and public sectors, from numerous sources and various modes of transport. Despite this the numbers did not portray a true reflection

on what was happening on the roads system. Around 80% of road accidents aren't reported and the Korean Road Safety Division have to rely on information from insurance companies to truly understand what is happening and explore how improvements might be made. Hyoen highlighted that the issues with utilisation of transport Big Data – it's difficult to form a collaboration system, difficult to accumulate Big Data and difficult to create a market for Big Data.

The Korean Transport Database conducts surveys every 5 years to try to aggregate data and then apply it to real-time situations such as prediction of traffic volumes by the origin and destination. Hyoen argued that it isn't enough to capture Big Data, there needs to be embedded policies to make use of it and implement the findings. He believed this could be achieved through developing policy supporting systems to solve current problems and generate new policies; providing Big Data integrated services to develop a national platform; encouraging the private sector to enter a Big Data service market; and establishing a virtuous circle of policy systems using Big Data so that the supporting analytic systems are connected to the final decision making processes.

Where Hyoen focused on policies, **Monali Shah** firmly believed that the future of connecting big data was transparency and sharing between agencies and suppliers. Location data is set to increase roughly 50-fold but is still siloed today. Collaboration is essential to break down these silos and could be done through two routes. The first is leveraging Government's position to help transport companies partner with leading transport agencies to harness Big Data for improved safety and mobility. HERE have launched a few pilots as test beds for this, an example being the automated vehicle and freight movement technologies used in Iowa.

As data generation is expensive it is imperative that both agencies and operators understand the nature of the problem to which they want to find a solution and tailor the data generation to solve it. The second example was automotive and vehicles where they were creating services from the integration of real-time sensor data from competing car brands. This showed that even in a congested marketplace competing companies can work together and collaborate to achieve wider benefits for all participants. Monali summarised: it all starts with a real understanding of the technical depth, an understanding of the scalability and an agreement to working collaboratively.

From her European Commission stance **Claire Dupré** emphasised that data is easy to get – what's more important is the governance behind it. At the forefront of the big data revolution is the IoT with digitalisation also leading the way. Digitalisation can help to make transport safer, more efficient and more sustainable which in turn makes our cities smarter. The Internet of Thing is a mechanism which will enable partnerships of public and private stakeholders and provide us with the opportunity to introduce a wave of new technologies that can make our industry, and the whole transport sector, much more competitive and much more responsive.

She described the concept of the European Digital Single Market which was promising to be a great platform for giving consumers and businesses better access to online goods and services across all the 28 Member States of the European Union and beyond. The EU's ITS Directive, which has been established for about six years now, sets out initiatives to help make better use of big data, such as it promoting data sharing mechanisms and data interoperability. The key priorities to address are data protection, data security and data interoperability.

Adam Game helped to further define the sorts of impact the Internet of Things was already demonstrating, and would continue to have, with Big Data. He explained that IoT is about everything being connected and Big Data is about those connected things leaving a trace as they interact. Both are happening but a key challenge in the IoT is accessing data as far too often data is to be found only in silos. He echoed Monali's thoughts that more dynamic data is collected than GPS but is unavailable as it's in a silo. Everything needs to connect together, everyone needs to work together. This can be achieved through security, robustness and latency, such as through diversity in sensors and systems. Security of individual systems is good, but robustness requires multiple, redundant sensing systems.

POINTS ARISING FROM DISCUSSIONS AND QUESTIONS

- **Should the Government mandate the compilation of Big Data?**

  The Government shouldn't mandate Big Data as it's complicated to do so and what is really needed is for Government to standardise data formats. But we need to remember that standards can't do much by themselves; in order to be effective they need to be implemented. It is also hard to get the data to a level of good quality in the first instance; pilots are therefore needed to create and then validate these standards, as has been shown by the automotive industry.

- **Everyone has been talking for years about the issues the panel raised, would it not be more practical to set targets and time tables to break the silos?**

  In different places the silos are breaking slowly, at different speeds. Pilots can help to create a standard. In the past 2-3 years this is increasingly being seen to happen. It will be aided by technology, 10 years ago, we didn't have the technology we have now, to start breaking the silos –such as, cars are now kitted with technology advancements to help collaborate and ensure consistency across the network.

- **Privacy and security – how does the panel see this not in terms of cyber-attacks but more so the privacy of the individuals?**

  People need to understand how their information will be used and stored. They need to understand the benefits derived from their data that is collected and see the bigger picture. So there have to be straightforward, honest, open explanations. There should be discussions on what is 'acceptable' because attitudes to and opinions on privacy and anonymity have changed and are not the same as they were 3 or so years ago. We now have checks in place so that when data is aggregated it doesn't collect personal data because it cannot; the data is anonymised at the personal level. There are established ways to design privacy into systems.

- **People showed that they were willing to change behaviour in the Transurban survey – were these people "early adopters" or did they really represent the typical people of Australia?**

  When people were asked to participate in this survey and the tests their awareness had changed. It wasn't so much that they thought of it as being something they were testing and adopting; they realised their behaviour was being monitored and as a result of the findings and the awareness of how they were driving in the car they changed their behaviour. When Transurban approached the community about a trial it was to get engagement and involve the people of Australia on what is happening in their cities, what are the problems, are they aware of the behaviour of other road users. Despite 80% originally being content with the way things were, after the trials were conducted and the awareness raised 60% preferred the Transurban solution. It's about working together and education.

PLENARY 4 MOBILITY AS A SERVICE

MODERATOR

Dean Zabrieszach Chief Executive Officer, HMI Technologies, Australia

SPEAKERS

Jeroen Weimar Chief Executive Officer, Public Transport Victoria, Australia

Xiaojing Wang Chair China ITS Industry Alliance, China

Boris Karsch Cubic Transportation Systems, USA

Richard Harris Director Communications and Marketing Transportation and Government International Public Sector, Xerox, United Kingdom

Martin Matthews Independent Consultant and former Secretary for Transport, New Zealand

Jeroen Weimar welcomed the audience to Melbourne. He explained that the public transport which they may have used to move around the city is undergoing transformation from a century old network to one which not only works today but uses new technologies and concepts to create inclusive and accessible travel for all. Victoria has one of the largest light rail tram systems in the world and a network of day and night buses offering affordable public transport. There is real-time passenger information for all metropolitan services being expanded into regional areas. The Victorian Transport Authority encourages a full open data ethos with release *via* APIs leading to innovations and delivery of new products to passengers. Extensive transformation up to the value of $20 Bn will take place as Melbourne sees the population doubling in 40 years' time so new mobility solutions are essential.

Melbourne is seen as one of the most liveable cities in the world but additional infrastructure alone is not the answer to getting passengers to work quickly and reducing their dwell time. There needs to be wider, better data to inform decision makers in transport. There needs to be a mobility network which is agnostic. Data can help us to understand and embrace transformation and influence how people can use their network. Releasing the timetable API into the open market has enabled the delivery of some great new transport products. A lot of companies are now opening their data to third parties for commercial and social products. Jeroen concluded by reminding that meaningful insight from data requires intelligent analytic tools.

Martin Matthews challenged governments, transport officials and civic leaders to think really differently about mobility and the role they play. He argued that Mobility as a Service will be a big game changer as people travel around in the future. Today we go to supermarkets to buy what we want when we want. We have more choice than in the past and it's cheaper and better quality. In the future we will purchase our transport in the same way – we will not buy cars; we will go to the equivalent of the transport supermarket and buy a service when we need it, which in turn will make it become much more convenient and cheaper. Cars will be shared/rented and when you share you change the way people drive.

The International Transport Forum's modelling of Lisbon is an excellent example – potentially under the best scenario a vehicle fleet of only 10% of the current size would be needed to meet the current demands of that city. Martin put this approach into a sharp focus for authorities thinking about the demand side of transport and wondering if some form of behaviour change incentives might help to avoid billions of pounds of investment. In developing the 30 year strategy for Auckland they had tested what would happen if vehicle occupancy went from 1.4 to 1.7 and this would represent adding 20% extra capacity within the road network.

Richard Harris confessed that in his time in ITS dating from 1994 the industry had failed to bring the different silos together and that Mobility as a Service was the way to break this barrier. His favourite city is Montreal which has 19 different operators who share a single back office platform where their sensitive data is kept and protected. Sharing the resource makes it cheaper for all operators and the data is in one compatible format making it far easier to analyse or process it to generate meaningful information. The key enabler for MaaS is having a single back office with multiple people using it. The OPTUS contactless card can be used on 3,000 buses, 5 train lines and 4 metro lines. Mobility as a Service starts with a single app and needs an account based system for passengers to be able to pay. The problem we face today is that there are so many different mobility forms being created, especially by the private sector with the likes of uber and lyft, which people are unaware of and this is causing confusion and fragmentation.

With the Go Denver system passengers know all of the transport options available and can put in their preferences, they are then advised on the options and they can then select the route. The key to the solution is 'the mobility market place' for the operator, one back office where details of all transport providers can be stored and searched with no emphasis on the bigger players. The region and city get regular data analytics through the compatible data stored. Another example Richard gave was the project Smirt in France where 14 transport authorities combined resources for a smarter procurement which included public transport, bike share and car share, to guide people towards more sustainable mobility. Richard concluded by sharing some powerful predictions – by 2025 around 51% of the population will decide where to work based on transport; 32% will use self driving cars; 41% will not use cash to pay for transport; 50% will be using one app for all their transport needs.

Xiaojing Wang said that in China MaaS isn't just a concept it's a reality. There are some challenges facing it, such as existing transport modes needing to change, harmonisation of systems, operators' roles being crucially important and the risks to enterprise investment. In order to make MaaS successful within cities the government played a vital role to create the right policies and legislation as well as giving support for the new commerce model. In Beijing more than 430M smart cards have been issued which people can use on public transport as well as taxis. Xiaojing_believes that the five key next steps for their ITS strategy are: (1) integrated transport systems (2) new types of infrastructure (3) promotion of low carbon and intelligent vehicles (4) shared and cooperative transport services and (5) intelligent decision making using Big Data. Within the next 5 years China will have 27 new pilot projects focusing on promoting multi modal transport services, new intelligent infrastructure and vehicles, and creating the ecosystem for ITS development.

Boris Karsch echoed the views stated above and said we need to focus on the outcomes we want to achieve – is it to reducing congestion to make cities more economically viable ? or greater social inclusion ? or perhaps making MaaS benefit the people and businesses in the cities that the transport networks service. He briefly mentioned other objectives such as more options for elderly and disabled people and personalised travel advice for millions of people. Technology has a role to implement and enforce policy. Boris went on to speak about payment policy choices and how they can range from being simple (example include pay per transaction and daily/weekly/monthly capping) to complex (*eg* a cell phone with a service plan where you have a certain amount of data you can use but calls are unlimited). This can be powered through multiple subsidies and possible third party incentives.

Addressing the question of how do you equitably deal with subsidies and funding he felt it was all about the single payment account. This has significant benefits for the data that is generated but it also to help create the right policies for incentivising people's travel which benefits the city. The second layer is about the technology which already exists to integrate public transport, taxi, bike share etc. In due course when cities add other charges for mobility such as road user or parking charges then they can also be collected using the same one account. Boris concluded by emphasising that the technology does exist today and that clever use of incremental investment is needed to get to the true benefit of MaaS.

POINTS ARISING FROM DISCUSSIONS AND QUESTIONS

- **MaaS needs to add the ability to buy a ticket or to buy access to public transport, just as easily as someone wanting to buy a uber trip– What are the panel's thoughts on how this might change?**

  A lot of public authorities such as Melbourne and London integrate public transport and also have a good pricing framework around it. There needs to be a policy debate around whether as a public authority you should introduce pricing incentives for mobility so that you are getting passengers to use different modes of transport to ease congestion as a lever through pricing. Another key point is 'what is the payment platform?' Richard highlighted the value of a single platform for many users where they can use it as a payment tool as well and which will start happening more. The telecommunications industry over the past 10 years has helped significantly for integrating payment.

- **What is the benefit for people to take the economically viable and green option of travel and smarter travel instead of driving and causing a high carbon footprint?**

  In the Denver user tool suppliers can put in a range of solutions and benefits and the passenger can put in all the information they want as well to get the best possible outcomes and better informed choices. Pricing is a key factor. MaaS isn't about people using public transport; it's about easing congestion and encouraging more efficient ways of travelling. In China for example, you can book car share on the app or you can share a car with 2 or 3 colleagues to work and make it greener.

- **How do you see markets evolving for MaaS – one operator or multiple operators?**

  We already have multiple operators; what customers want is a single access point. We are going to see high levels of competition and a paradigm shift.

- **What exactly is MaaS?**

  Where have you been all week?

EXECUTIVE SESSION ES01: ADVANCING THE DEPLOYMENT OF AUTOMATED VEHICLES – THE ROLES OF GOVERNMENT

MODERATOR

Steven Dellenback Vice President R&D, Southwest Research Institute, United States

SPEAKERS

Claire Depré Head of ITS Unit at the European Commission, DG MOVE, European Commission, Belgium

Ken Leonard Director of ITS Joint Program Office, USDOT, United States

Hidenobu Kubota Director for International Affairs Office, Engineering Policy Division, Road Transport Bureau, Ministry of Land, Infrastructure, Transport and Tourism, Japan

Thomas de Laat Director, Ministry of Infrastructure and Environment, The Netherlands

The moderator set the scene by reminding everyone that much was expected from automated vehicles and their connectivity to each other and to the roads on which they would be deployed. It was hoped that they would make driving easier, improve road safety, reduce emissions, ease congestion, allow people to be more productive and offer greater mobility to a wide range of people and goods. He hoped that the session would explore the opportunities and challenges associated with the adoption of highly automated connected vehicles with particular attention to the roles of government and its responsibility for ensuring that deployments meet the expectations and needs of all concerned. the adoption of highly automated connected vehicles.

Claire Depré set the perspective of the European Commission as looking for the best technology solutions for its problems; be it congestion, sustainability, environment, health and others. Traditional rule making models were being challenged by disruptive innovation and a right balance was needed between openness and necessary regulation. She asked the question "are cities aware of what is coming up?" in terms of the need for cities to understand the ways in which technology can solve their problems and therefore identified a key role of governments as building the bridges with the private sector for cooperation and laying the foundations upon which solutions can be provided. Claire noted that much research had already been undertaken and it was now time to pause on research and instead begin a "learning by doing" approach. For Europe this would be underscored by the EU Directives (*eg* Directive 2010/40/EU on ITS) and programmes in Cooperative Roads, The Cooperative ITS Platform, The Digital Single Market and a new European Electronic Communications Code.

Ken Leonard highlighted that Connected and Automated Vehicles initiatives had become the cornerstones of the US DOT's ITS Joint Program Office activities. He spoke about the recently released USDOT/NHTSA Federal Automated Vehicle Policy document, "Accelerating the Next Revolution in Roadway Safety" (Sept 2016) which covered four key components, (i) a 15 point 'safety assessment' for automated vehicles, (ii) a model state policy, and (iii) current and (iv) modern regulatory tools that can be used to facilitate the safe and efficient deployment of these technologies. This policy foundation in collaboration with supportive technical research by industry, state and local government stakeholders thus provided the enabling environment for all the US pilots' deployments.

He informed the session that the Government's Smart City Competition had been won by the City of Columbus, Ohio. This competition attracted 78 American cities as bidders, 7 finalists, funding of $40M from government and over $100M from industry. Many other bidders had since progressed independently with their own initiatives, funded elsewhere. Ken also mentioned the FAST (Fixing America's Surface Transportation) Act which became law in December 2015. This Act involved $350Bn over 5 years included funding of $60M/year for 5 years for advanced transportation technologies (FAST Act s6004).

Hidenobu Kubota spoke about the Japanese Government's role in advancing the deployment of automated vehicles from both a domestic as well as international perspective. Domestic activities had attracted cross ministerial support in the Strategic Innovation Program with industry working closely with several Ministries on the business strategy for automated driving. Domestic use cases included platooning, last mile, autonomous parking, aged/handicapped drivers and various advanced safety projects as well as car assessment (J-NCAP). International activities include co-chairing with Germany, the United Nations Working Party on Harmonisation of Vehicles Regulations (UN-ECE WP29). This Working Party is addressing Regulation 79 (steering wheel function) to allow for automated steering. Additionally, Japan hosted the G7 Transport Ministers meeting in September in Nagano which had a special focus on connected and automated vehicles and acknowledged the importance of co-operation between governments for technology deployments on roads and vehicles.

Tomas de Laat described the Netherlands collaborative efforts in automated deployment through activities such as the Declaration of Amsterdam, the European Truck Platooning Challenge and Smart Mobility. He stated that the Netherlands was ready to facilitate and cooperate with all governments and had been playing a lead role in

international liaison with other regions. He spoke about the efforts in bringing technologies and OEMs together in order to operate seamlessly across borders, as was the case with the six OEMs involved in the April 2016 truck platooning challenge. In support of Claire Depré he emphasised the need to focus on real-life cases to show the world what the benefits will be, especially in scenarios such as last mile solutions, accessibility of airports, centres for handicapped people and smart grids (around Helmond).

The moderator pointed out that at the April Transport Council in Amsterdam the 28 European Union Member States had agreed to work together to have harmonised and coordinated rules and regulations and to cooperate on cross border testing in order to advance the deployment. This action set a wonderful example for the much needed global approach.

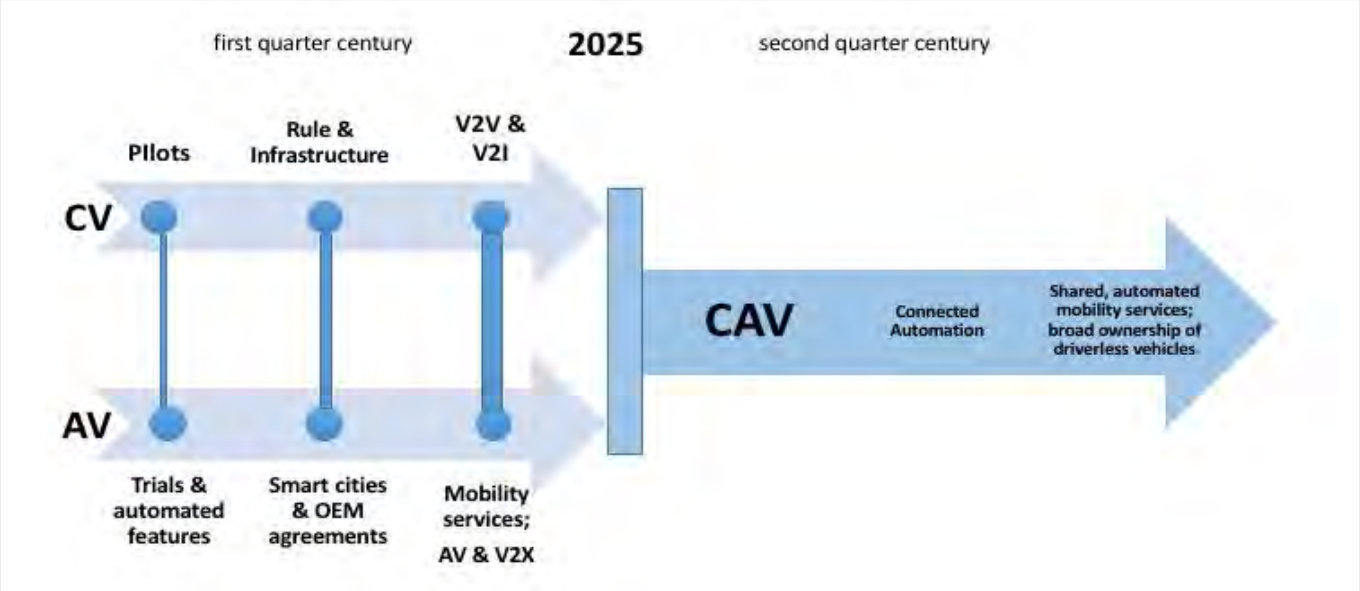
POINTS ARISING FROM DISCUSSIONS AND QUESTIONS

- **Why not legislate for Automatic Emergency Braking (AEB)?**

  The speakers responded that a number of different approaches had been adopted. In the US a market based approach saw a voluntary agreement proposed by 10 OEMS to NHTSA to deploy this technology. In Japan AEB is required for trucks while an assessment-based approached is favoured for light vehicles. In the EU not just AEB but rather a whole range of Day 1 services were currently under consideration as part of the C-ITS Platform Programme.

- **With all the technological developments, it appears possible that Governments might not be controlling things as much in the future?**

  It was argued that Governments needed to work with private companies and a broad spectrum of partnership arrangements is possible. While the role of governments in road traffic management might decrease, it was noted that to explore all the synergies between the transport modes a higher level of community led outcomes were required to guide. There was discussion on public perceptions and consumer acceptance and the key role governments play in managing equity for everyone.



The path to Avs: Courtesy Peter Sweatman

EXECUTIVE SESSION ES02: ADVANCING THE DEPLOYMENT OF AUTOMATED VEHICLES – THE ROLES OF INDUSTRY

MODERATOR

Andrew Somers Director, Transoptim Consulting, Australia

SPEAKERS

Christian Rousseau Executive Expert Leader, Renault Group, France

T.Russell Shields, Chair, Ygomi LLC, United States

Bernhard Morys Manager, Mercedes-Benz Daimler Cars, China

Frank Fosterling Head of Advanced Development and Innovations, Continental, Germany

Andrew Somers opened the proceedings and set the scene with a commentary on the changes since preceding congresses. It was clear that work on both connected and highly automated vehicles was advancing rapidly and the technology had evolved to the point where many driver support services were readily available. The session would hear from international leaders about the opportunities and challenges associated with deployment of automated vehicles from the Industry perspective; this was the second half of a programme with ES01 which dealt with the role of Government. If Government's role was 'enabling" then industry's role was "everything else".

Andrew noted that Christian Rousseau had volunteered not to speak to a presentation but contribute to a Panel discussion so the first speaker was **Russell Shields** who focused on "Maps". He explained that this was not maps in the traditional meaning as we know them but images that represent the real world which confirm and define the layout of every road which must be available in full detail and with great accuracy. Russell drew attention to the complicated liability world of a

Level 3 vehicles and argued that a better route forward was deploying Leve 4 where the local conditions matched (around 2020/2021) and then Level 5 in due course.

What did this imply for support technologies? Many sensors were well understood as a part of a control system but they could not 'read' a map and so additional inputs were needed – different aspects of road information such as speed limits, network topology, looking ahead for obstructions, lane marking *etc* to enable the real world situation to be pictured. This data would be collected using probe data from production vehicles as an automated process without the need for human judgement or intervention. It would have to be supported by continuous updates with guaranteed product reliability and this could only be provided by sophisticated software which had been developed and thoroughly validated and tested, which in itself provided many challenges for traditional digital mapping when applied to highly automated driving.

Data needed to be thought of as "dynamic" and "static" to ensure that the vehicle understood its positioned correctly within the static environment with a high degree of accuracy – typically better than 10cm within a lane. A huge issue that seemed not to be addressed was the high fixed cost for the development, validation and testing of this software. Every road needed to be digitised meaning that extensive coverage was required. Vehicle and personal privacy and security were essential; it wasn't clear how car companies planned to have this software installed and maintained but to allow frequent updating data communication costs would have to be minimised. Moreover both the system and its software would need to work reliably for as long as the vehicle was in service and work every time – not just for the first owner, but for all subsequent owners until the vehicle itself is scrapped.

In conclusion he wanted to stress three points:

- Even near term vehicle control functions leading to autonomous driving can benefit from improved road data and
- Traditional digital maps are not suitable for vehicle control highly autonomous driving.
- Road data developed from multi-vehicle probe data offers the way to coverage of a wide area with frequent updating.

Bernhard Morys argued that autonomous driving requires new ITS technologies. The 'old' world permitted a car to be manufactured anywhere in the world then deployed anywhere. The highly automated / autonomous world demands much tighter integration of vehicle and locality. It's essential to think of the motives for highly automated driving:

- Creeping mobility – travelling slowly in a perpetual jam
- Parking problems – as demand exceeds supply we need to make best use of space
- Aging population – more support is needed on complex routes, in poor weather *etc*
- Digital natives – More interest in social activities when at the wheel

In the past we had two dominant "places" in daily life: at home or at work / at the Office. Today and for the foreseeable future we need to recognise there's a third place – In the car moving between at home and at work. We need to make better use of that time and right now it's not that easy to think of all the options. We should not worry. In the early days of smart phones we thought of their uses as making calls, writing mails or texts and then their possible uses took off. Smart phones have changed our lives remarkably and offer huge benefits. Once we release time wasted in a vehicle it will be the same story and the benefits will be endless.

Bernhard explained that many current vehicles are quite close to being autonomous already with many active safety systems; the robustness of these technologies is being refined in these vehicles in preparation for their introduction and integration into an autonomous driving scenario. Going further demands some new or more developed ITS Technology. The vehicle needs to be aware of or have information on:

- Its own location and planned path ahead
- Bad weather
- Irregularities on the network such as construction or maintenance sites
- Tunnels and night driving situation

and all of this requires highly precise positioning which in turn relies on data and its communication to the vehicle as discussed by Russel Shields. Bernhard argued that from the different pieces of evidence it should be clear that much cross-country collaborative work by both Industry and Governments is needed to introduce automated driving including:

- Technology
- Laws and Regulation
- Liability
- Data Security
- Customer Acceptance
- Infrastructure and Driving Behaviour.

Frank Försterling said that he would like to begin with a look at the policy reasons behind the trend towards automated driving. The congestion, fatality and pollution arguments were well known but other 'pull' factors were increasing urbanisation and an ageing population. Vehicles were rapidly moving to becoming a part of the Internet of Things and the huge number of potential connections this would bring was a strong economic driver as it would open paths to many more services targeting safety, efficiency, comfort and vehicle maintenance.

Digitalisation was changing both the vehicle and the infrastructure markets with the result that automotive manufacturers were coming to terms with a need to move from a proven market based on selling products to a new market supplying mobility services designed for both people and goods. It required a move from key values of reliability, technical excellence and ownership to flexibility, sharing, ease of use and effectiveness. Highly automated / autonomous vehicles were undoubtedly a part of this trend. He expected to see a steady increase in the standard fitting of partial automation systems to vehicles such as automated stop-and-go for use in very slow traffic with a driver always monitoring performance. From about 2020 he expected to see high levels of automation with driver monitoring not required but the driver ready to take control after a reasonable warning. This would support stop-and-go for use at higher speeds outside cities. From 2025 we could expect full automation with a conventional driver not needed at speeds up to 130kph on highways, to be followed in later years by deployment in more difficult cases such as urban areas.

Frank said that a key commercial application area for autonomous vehicles was freight. On the 2025 timescale he expected to see highly automated long distance truck platooning, extensively automated logistics hubs and distribution centres, and all-electric automated inner city delivery. Looking at the underpinning functionality of Levels 4 and 5 the vehicle would need a sensing system, a planning system and then an acting/implementation system in order to close the loop of the vehicle, the driver and the environment. The range of on-vehicle sensing systems was almost certainly too short so external connectivity would be essential for the 'over the horizon' information input the "dynamic electronic horizon".

Implementing the dynamic electronic horizon required the automotive Industry to get closer to the telecommunications Industry to understand its infrastructure and ensure is applicability and reliability. The likely solution would be a hybrid of ITS G5 (DSRC) and LTE or/and 5G cellular communications.

POINTS ARISING FROM DISCUSSIONS AND QUESTIONS

- **We have heard comments about the ongoing costs associated with data streams for dynamic mapping: does this impact business cases? Will consumers accept a follow-on cost?**

  The supply company has to be clear on the value it is offering

the customer and at what price; that's not really different for a transport service as opposed to the sale of a vehicle for personal ownership. It's a question of understanding societal needs so the business model is meeting the customer's expectations. (CR)

- **Why does an autonomous car need a horizon longer than its braking distance?**

  Knowing what's around the corner or beyond 'line of sight vision' helps the development of the driving strategy and makes for an overall smoother ride (FF). It's also unwise to assume you can always achieve the optimal performance. Weather will influence, ambient light will very, the extent to which a road is straight also affects real world performance (BM). It's not enough to look forward: in many cases the safe movement involves getting a clear picture of what is going on behind the vehicle (RS).

- **What will be the equivalent test of roadworthiness for an autonomous vehicle bearing in mind the very different link of vehicle and infrastructure?**

  It's a bit early for this question as the UNECE Working Group 29 is still considering the required regulatory regimes for Levels 2 and above. Once we have a target regulation we can test compliance. We also have to have tests for functionality, for example if one brand of vehicle reacts to a situation in a certain time and a vehicle behind it responds to the same situation with a longer time then there would be potential for a complicated situation (CR).

- **Current traffic management is built on giving instructions to human drivers. Does the arrival of autonomous vehicles mean that the whole of network management has to change or be re-regulated?**

  A little too early again; another UNECE Working group is looking at road network management in close collaboration with WP 29 (RS).

- **Will autonomous vehicles be of value to people living in rural areas?**

  We expect AVs to prompt the development of new demand responsive services but the mapping and data problems associated with these areas

EXECUTIVE SESSION ES03: REALISING THE SAFETY AND MOBILITY BENEFITS OF AUTOMATED VEHICLES AND COOPERATIVE ITS SYSTEMS

MODERATOR

Ryan Lamm Director R&D, Southwest Research Institute, United States

SPEAKERS

Samantha Cockfield Senior Manager of Road Safety, Transport Accident Commission, Australia

Christopher Mentzer Manager R&D, Southwest Research Institute, United States

Doug Fryer Assistant Commissioner, Road Policing Command, Victoria Police, Australia

Wolfgang Hoefs Head of Sector, DG Connect, European Commission, Belgium

Takashi Nishio Director ITS Policy and Program Office, Road Bureau, Ministry of Land, Infrastructure, Transport and Tourism, Japan

The Moderator opened proceedings by sharing his thoughts of and experiences with the development of automated driving since automated vehicles were demonstrated for the first time on the streets of New York City during the 2008 New York Congress. Since then many significant advances had been made. Although the deployment of these technologies posed multiple challenges the expected safety benefits were being identified and quantified so that both governments and businesses can plan the necessary investments to realise the benefits. He had asked the Panel to provide just a short verbal introduction to the Topic so that there could then be a "Round Table" discussion and interaction with the audience.

Samantha Cockfield spoke as a road safety practitioner who manages across behavioural programmes through to vehicle technologies and infrastructure. Her organisation is the government's third party insurer for all people injured or killed in Victoria. An important feature of the Commission is that it's a "no fault" organisation, representing anyone who is hurt of Victorian roads. With the advent on new technologies TAC is working to find a balance between investments today that provide real and tangible benefits versus future possibilities and how they might be accelerated to be real possibilities.

One of the challenges with automated and connected vehicles is that while Level 2 technologies are on the market today and have been proven to save lives they are not mandated in Australia. TAC has a $A1.4Bn program to improve infrastructure but would like to know how to better integrate automated vehicles with infrastructure investments. Speed and speed management remain a challenge, with improved vehicles technologies offering an opportunity for better data quality on speed impacts and the potential for automated enforcement. Finally, motorcycles and safety don't seem to be covered adequately in most discussions yet in places like Victoria riders are overrepresented statistically in crashes.

Christopher Mentzer oversees automated ground vehicle developments as a member of an independent non-profit organisation. He has been working on connected vehicles technologies and was involved heavily in the 2008 deployment testing during the World Congress in New York City. There was a lot of military funding in the earlier years but more recently investments have come from the commercial sector with a strong focus on safety and cost efficiencies. Chris noted that with over 90% of crashes in the USA involving human error technologies to address this are of the utmost importance.

Referring to the five levels of automation documented by the by SAE he argued that we have a good sense for what is good, bad and ugly with each of these systems across the five levels. It's interesting that in California the issue of licences for autonomous vehicle "drivers" is conditional on the driver's agreeing to provide reports on vehicle issues including safety and "takeover" occurrences during certain events, to better capture data and further improve these technologies. Having vehicles able to assess and judge hazards or knowing how best to respond from a fair distance away is still proving to be a problem.

Doug Fryer believes that technology innovation is the key to saving lives. Last year there were 252 lives lost in Victoria's population from road incidents. This is a massive improvement since the 1061 fatalities of 1970 especially as the State's population and motorisation have both risen considerably but most of the 'low hanging fruit' in road safety has been picked. Victoria was the first place to introduce compulsory seat belts, random alcohol and drug testing, and bike helmets. Victoria practices four road safety pillars of the safe system; safer roads, safer drivers and education, safer speeds, and safer vehicles. Doug believes that automated vehicles offer the greatest big change to reaching a zero deaths target.

He said that it was important to ensure that the local community understands the big improvements that automated vehicles offer beyond today's vehicle safety. Doug believed that there is a tricky space between vehicle ownership and control, with road rules today identifying a human driver as being responsible for the vehicle. He also touched on data and security concerns potentially hindering progress.

Wolfgang Hoefs agreed that safety was an obvious benefit from automated vehicles and cooperative ITS, however deployment would also extend to societal, personal and productivity benefits. Similarly, about 95% of accidents were caused by human error. Across Europe

there had been around 50,000 fatalities in 2000. The Commission had set a target to reduce fatalities by half within the decade and had achieved 27,000 in 2010. Innovations in advanced driver systems had played major part in these improvements and he agreed with Doug Fryer that it would be the evolution of machine-controlled automation that would address the human factors issue prevalent in so many accidents.

From a Societal point of view it is necessary to justify both private and public investments in CAD solutions. Personal benefits offer an opportunity to lead towards a real Mobility as a Service solution. And business opportunities allow improved access to data and how it is better used. Europe has recently introduced a General Data Protection Regulation, to ensure better harmonisation of data handling, and a communications code protocol for automated vehicles.

Takashi Nishio gave a wide-ranging technical presentation that demonstrated some of the practical steps that Japan has realised from its use of vehicle-to- infrastructure technologies. Over 3,500 road side units and over 1M in-vehicle units now provide road operators with live and dynamic probe data at about 200 metre intervals on major freeways. An interesting initiative that the data capture has brought is Smart Tolls – vehicles taking a shorter and cheap toll route through a congested Tokyo centre can now be encouraged with toll cost incentives to take an alternative route around the city, which was longer but also quicker, thereby significantly reducing congestion in the city centre.

Freight seems to have been a major contributor and beneficiary of the change, with oversized and overweight vehicles now cooperating with authorities through the use of probe data to circumvent considerable approvals requirements.

POINTS ARISING IN QUESTIONS AND DISCUSSION

- Panellists were unanimous in their belief that safer vehicles which compensate for human error or indiscretion are the key to reducing fatalities and that this will come with Automated Driving
- Because of the current fatality levels from motor accidents and the social and political pressure to reduce them as much and as soon as possible, there is a strong incentive to invest in "prevention" now. However this must be resisted/tempered to ensure that investment is made for the future or organisations will be unprepared for the significant changes that will follow the roll out of automated driving.
- It was also recognised that the Industry needs to develop and improve vehicle systems to make vehicles safer across the range and not just the higher grade models.
- Some of the worst fatalities occur on country roads which don't offer the infrastructure provision found in cities. Can automated vehicle technologies address this? Some technologies rely on a minimum infrastructure such as white line marking, which isn't always feasible in rural areas.
- Japan is fortunate that its small size but large population allows deployment of new technologies to happen more quickly with benefits realised earlier. Takashi is keen to see consistency in standards rollout across all areas including the USA and Europe.
- Ryan made the interesting comment that automated driving has been marketed so widely that it may have reached its "peak of expectation", which may lead to future disillusionment.
- A quick poll of those in the room revealed that most believe that Level 4 vehicles will be commercially on the market by about 2025 onwards, while for Level 5 the room felt from 2030 onwards.
- On the issue of data, Chris believe that naturally more data allows more to be done, while Samantha was more interested to know how data could be used to better tell the story around speeds and how this can tell a more compelling story to communities.
- Ryan raised an interesting view that early regulation can potentially encourage and speed up innovation. Samantha agreed that a good framework is required to support and encourage changes, but also believe there's value in improved partnerships and further discussions across both the public and private sector. Wolfgang believes greater openness through a fairer sharing of data and information, noting that the innovation we're discussing is disruptive.
- **On a question of the next technological revolution?**

  Chris – improved energy density meaning EVs that are environmentally friendly and able to deal with longer distance travel. Doug – moving away from rubber and rail and hitting the air for everyone in a more practical way. Takashi – for Japan, high density automated driving in environments where pedestrian and bicycles also use the roads. Sam – personal mobility overall, including recreational mobility which doesn't have a commercial value.

EXECUTIVE SESSION ES04: REALISING THE PROMISE OF BIG AND OPEN DATA – PRACTICAL TRADE-OFFS BETWEEN BENEFITS, COSTS, SECURITY AND PRIVACY

MODERATOR

Leon Daniels Managing Director Surface Transport, Transport for London, United Kingdom

SPEAKERS

Nick Cohn Big Data Senior Expert, TOM TOM, The Netherlands

Malcolm Dougherty Director CalTrans, United States

Tagui Ichikawa Counsellor, National Strategy Office of ICT, Cabinet Secretariat, Japan

Peter Sweatman Principal, CAVita, United States

Nick Cohn pointed out that his company was a user of Big Data but that data came from many millions of individual suppliers all trusting TomTom for anonymity, privacy and security. And 'Big' was big – collecting 14 Tn location fixes ("GPS breadcrumbs") at around 11 Bn a day from 450M devices representing over 11 Bn trips a year occupying 400+ Tb of storage. Protecting suppliers' privacy was seen as a total priority and potentially challenging.

They first looked at privacy definitions and legislation across the world then devised internal handling rules designed to stop what he termed reindentification: combining two apparently anonymous data items in such a way as to focus sharply on just a small number of qualifying individuals. Their rules are: specifying the only purposes for which the data archive can be used, never releasing any raw data, doing all processing themselves, and aggregating data to increase the anonymity.

Their process was more stringent than the most aggressive national legislation in order to counter any possible legal challenges and sustain high trust levels. To prevent tracking data is split in intervals of less than a day and customers opt in – and can opt out very easily. Data supply was only to aggregated levels and never about an individual. Limiting what was done took away some business opportunities but it was felt that being trusted outweighed any losses. This was indeed a trade-off between benefits and (reputational) costs. The company was now working with automotive manufacturers to explore what could be collected from connected and automated cars

Malcolm Dougherty wanted to concentrate on data use: the problems that Big Data can help to resolve. He looked first at road accident data where traditionally wide-ranging records had been kept of accidents by type, involved parties, location *etc*. Because the database had started as automobile accidents it had not been realised that

a different analysis could yield new information on cyclist and pedestrian incidents. Another example of reusing what was already available came from pavement surveys where for many years there had been automated collection of condition. It was now possible to use new analytic tools that identified deterioration patterns and that in turn enabled future condition prediction maps allowing far better targetted maintenance and prediction of the places for 'just in time' rehabilitation.

Malcolm said that the Caltrans' own vehicle fleet had been fitted with GPS trackers that countered theft, enabled more efficient fleet allocation and maintenance and also collected data on network conditions. There were also a number of terrestrial laser scanner units that were used for asset condition surveys. These were more accurate and faster than traditional survey techniques but generated many petabytes (1000 Gb) of data. They were immensely useful in asset management once the data handling challenges had been overcome. An exciting potential data source was the pilot project on road user charging as an alternative to the gas tax. The pilot had involved many issues of data security, privacy and anonymity, charging policy and social equity.

California operated an Open Data policy so that in principle anything held that was not personal should be available through the web site. This sometimes caused concern, for example road accidents data showed where there were 'dangerous' roads and citizens were persistent in demands for rapid improvement. Looking forward Caltrans wanted to develop enterprise business intelligence so that there was a greater awareness of what was available, do more to show transparency and test new forms of public performance reports.

Tagui Ichikawa talked about the Japan national strategy for Big and Open data and its link to wider ITS and IT strategies. The Cabinet Office coordinates the policies and programmes of all national Ministries and has a high level Strategic Innovation Policy team. Three very high priorities are ensuring that data issues are included in work on highly automated vehicles, making good use of data and ensuring privacy/security. A new Personal Information Protection Law was passed last year and there is an outline national policy for Open Data and data sharing that specifies priority areas for release and gives guidance to local governments.

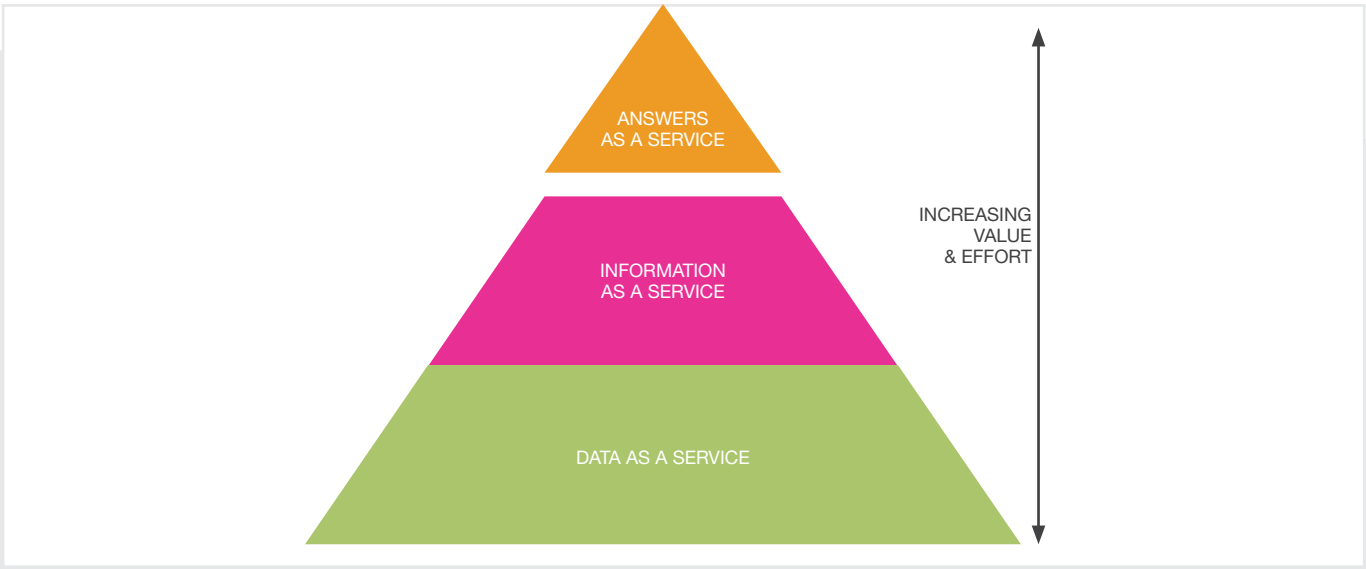
There is much potential social benefit from the use of Big Data but extreme care must be taken to sustain high levels of privacy; this can be helped if only 'horizontally', rather than 'vertically', aggregated data is released. The Japanese Road Traffic Information Centre handles very large quantities of data and processes it to supply information to media outlets, individual travellers and commercial customers. Two excellent examples of social benefit and sharing between public and private sectors were disaster recovery and road condition.

In the case of both the Great Eastern Earthquake (2011) and the Kumamoto Earthquake (2016) public data was merged with that from automotive companies to issue bulletins on road conditions as early as possible based on the widest available information. Vehicles fitted with toll collection technology can be seen as probe vehicles supplying real time information including the consequences of incidents. Manufacturers' technology can also register hard braking and link to location. Combining all these elements gives managers warnings of short-term or longer-established high risk areas for traffic on networks.

In concluding Tagui argued that sharing of data was a key to efficiency and effectiveness for both the public and private sectors; and that users must always be shown what was planned and the underlying merit.

Peter Sweatman explained that data streams from connected vehicles can be considerably larger than those from conventional vehicles with a higher volume, denser transmission and much more variety with probe data for monitoring the vehicle's and the network's condition, and new types of static and dynamic safety-linked data. The business models are starting to change too as the value shifts from raw data to data processed into information and ultimately answers to questions.

Transport data and in particular Big Data was of value to business services – vehicle diagnostics, infotainment, freight fleet management, truck fleet fuel economy monitoring *etc* – but also the basis of new information services such as mapping, congestion avoidance by re-routeing, multi-mode trip planning, taxi booking, food and fuel location, EV charging spots.



Big Data Business Value: Courtesy Peter Sweatman

Peter reviewed the data wisdom emerging from the Michigan 3000-vehicle trial of connectivity. The data sets here were huge, reflecting the constant operation of the vehicles for almost 4 years but the analysis had been relatively straightforward. Data had been collected separately on vehicle and infrastructure activity thereby enabling the interaction between them to be examined. Vehicle data gave information on driver behaviour, HMI and the performance of the safety support tools. The infrastructure data illustrated system behaviour and the two combined showed traffic behaviour at a high level in a connected system.

POINTS ARISING FROM DISCUSSION OR QUESTIONS

- **How should concerns about the protection and security of personal information be managed?**

  Solutions discussed involved demonstrating use of advanced technologies to protect data that were stricter than what regulations required although public perception plays a more powerful role than technological guarantees. Necessary measures discussed included no access to individual measurements, no external processing of individual measurements, aggregating information to avoid re-identification, and a prevailing attitude of "privacy by design".

- **What are the trade-offs that can be achieved in sharing Big Data among competing service providers?**

  There was no single answer as each case is different. Key factors are users' benefits, seeing public bodies as data custodians and not monopolist owners, getting across a message that a small concession by one party can lead to benefit for everyone. There is also making use of portals to achieve cost savings in open data sharing.

- **How do we enable the public to understand that "Big Data" does not mean "Big Brother"?**

  The main points highlighted include transparency and trust. Although this depends on the nature and type of data, as Big Data could vary in volume, velocity, and variety, it is crucial to understand the data first or as Peter Sweatman put it citing Peter Drucker: "you can't manage what you don't measure".

- **If people were aware how much data is already being shared and the associated value would they be more willing to share ? what can be done to increase awareness of value?**

  It's difficult to say. People's responses vary; some are altruistic, some are not but it's always worth focusing on transparency and openness and describing what is proposed in return for what gain. Remember "when in doubt about what people think, ask the people what they are thinking".

EXECUTIVE SESSION ES05: THE ROLE OF ITS IN MITIGATING CLIMATE CHANGE AND DELIVERING GREEN TRANSPORT

MODERATOR

Susan Harris Chief Executive Officer, ITS Australia

SPEAKERS

Morten Kabell Mayor of Technical and Environmental Affairs, City of Copenhagen, Denmark

Jennifer Cohen Secretary, Delaware Department of Transportation, United States

Shuji Okuda Director Electric Vehicle Advanced Technology and ITS promotion office, Ministry of Economy, Trade and Industry, Japan

Young-Jun Moon Chief Director, The Korea Transport Institute, Korea

Opening the Session the moderator said it was apt that the mitigating climate change and delivering green transport session was hosted in the Melbourne Convention and Exhibition Centre. It was one of the most sustainable venues in Australia with food sourced from within Victoria or within 100 km of the Centre, to reduce food-miles and to support the local community. Seating in the centre was made from recycled tyres and any left over food was redistributed to those in need. Numerous projects from eco-driving to multimodality for both passengers and freight have revealed the great potential of ITS to mitigate climate change and deliver environmentally transport services. New data sources were helping us understand travel patterns of existing behaviour and determine how to increase public transport, electro-mobility and other alternative modes share. Speakers in the session would share experience, outline future plans to increase greener transport modes and describe how to evaluate the benefits of ITS strategies from the climate change perspective.

Morten Kabell reported that cities are currently responsible for 70% of Green House Gas (GHG) emissions and with 70% of the world's population due to live in cities by 2050 it puts responsibility on cities and inhabitants to address this as they are the problem as well as the solution. Copenhagen aims to be the first carbon neutral city in the world by 2025 which is a challenge especially with a growing population of 2% per annum or 1000 people ever month. The city is tackling this through two concepts.

- Eco-driving, an app for trucks with GPS beacons telling drivers optimal driving speeds and green waves around the city to avoid costly stopping and starting.
- Compass4D which provides priority for buses at certain intersections.

Perhaps more ambitious than being the world's first carbon neutral city Copenhagen has also set out to be the world's best bicycle city. Residents are not necessarily fitness fanatics or cycling enthusiasts, but they are discovering the benefits of a system which makes travel fast and easy. Bike infrastructure includes safer crossings, dedicated and interactive signs and highlighted bike routes. Copenhagen has set up a Street Lab on its busiest roads with several trails up and running, including smart parking and waste management. Remaining mindful of data privacy, they are collecting data with the goal of sharing it so they can learn from other municipalities around the world.

Jennifer Cohen is from Delaware where the impact of climate change is obvious. Delaware is the lowest state in the US so is vulnerable to climate change. There's 381 miles of coastline and 18% of its area is wetlands and sea-level changes have resulted in roads being abandoned. With impact by hurricanes including Irene (2011) and Super Storm Sandy (2012) residents are very aware of environmental impacts. State agencies have prepared emergency plans for adaption, flood avoidance and mitigation. The GHG target is to reduce emissions by 2030 and as it cannot afford to raise all the road infrastructure it has had to abandon some and upgrade others. Delaware manages 98% of all transit including bus and rail networks. ITS enables 24 hour monitoring and system control if emergency evacuations are required. DelDOT is provided with real time information, plus user input, enabling 'boots on the ground' information from users that provides an instant picture of traffic behaviour.

Shuji Okuda proposed that sustainability should be recognised as the third element of transport, with convenience and safety being the traditional first two elements. Japan aims to reduce cost, accidents and emissions caused by travel, critical considerations when planning, building and managing transport networks. The best way to reduce GHG is to leave the car at home. It would be better if people took public transport, but if this is not a good choice for commuters and travellers then car sharing should be encouraged. Japan aims to reduce 30% of emissions by 2030 through improved fuel efficiency and electric vehicles – 200,000 electric vehicles are expected to be sold in 2020. Truck Platooning will be a key strategy with the adoption of automated systems to address driver shortages and CO_2 emissions. They have already trialled a single vehicle driving four connected vehicles on a test course.

Young-Jun Moon reminded that Korea held the Olympics in 2012 and will host the Winter Olympics in 2018. Lessons were learned from 2012 where vast numbers of cars congregated in certain areas so it

is intended to make the Winter Games a low carbon zone in general and in some areas, a carbon free zone. The concept of Green Mileage Points will be considered to encourage cycling, public transport and low emission vehicles. Drivers can build up green credits and if they have enough credits they can drive in the main centres; if they don't have the required credits, they won't be allowed to.

Japan is also looking at emission reductions li9nked to smarter parking. Much focus is being placed on Automated Valet Parking as 30% of car accidents happen when parking. Even though parking usually takes place at low speeds, accidents happen because of unique and unfamiliar situations, misjudgements when drivers are in a hurry and under pressure. Considerable time is also lost looking for parking spaces so automated parking will also reduce emissions as well as accidents. Drivers who can go straight to a destination get out of the car, and leave the car to park itself in a designated area, are going to be safer. Valet parking requires three elements, namely automated vehicles, control systems and valet parking infrastructure. A study is examining the best combinations and looking into international standards development which may contribute to the acceleration of system implementation.

POINTS ARISING FROM DISCUSSIONS AND QUESTIONS

Questions from the floor continued to probe transport safety and efficiency however there was a strong consensus that the perception of the importance of sustainable ITS needs to be improved. For some any "green" benefits are seen as a bonus as customers are more focused on cost, reliability and safety. Copenhagen's bike uptake is driven by productivity and appreciation of the considerable infrastructure rather than a desire to be "green". However, in Delaware, climate impact was only too apparent, with consumers fully cognisant of the challenges, but ultimately practical and emergency transport underscored a desire to address transport options.

It was accepted that "sustainability" is not especially attractive in itself and that perceptions and the associated image must be changed. Politics can cloud the issue and often it is only when people experience the issues at first hand that they accept them.

A questioner reported that Dr Helen Murphy, Director Environmental Strategy, VicRoads and Rob Hannaby, Environmental and Urban Design Manager, NZ Transport agency (NZTA) are developing a report on world best practice on mitigating air pollution and noise. The study is also interested in particulates and NOx – in 2014 the OECD reported 3M people around the world die prematurely because of air pollution of which 50% is associated with transport. Organisations, researchers and individuals operating in the area of air quality and noise pollution are encouraged to make contact to assist with this programme.

EXECUTIVE SESSION ES06: THE USE OF CONNECTED VEHICLES AND DATA EXCHANGE IN FREIGHT AND LOGISTICS, INCLUDING AVIATION AND MARITIME

MODERATOR

David Silvester National Planning Manager, New Zealand Transport Agency, New Zealand

SPEAKERS

Sascha Westermann Head of ITS and Intermodal Traffic Management, Hamburg Port Authority, Germany

Paul Trombino Director, Iowa Department of Transportation, United States

Patrick Cheng Chief Executive Officer, Navinfo, China

Claire Depré Head of Unit, DG MOVE, European Commission, Belgium

Nick Brown General Manager Aviation and Maritime, Ministry of Transport, New Zealand

Opening the session the moderator suggested that for most of the public freight movement was unseen and unappreciated. When it was seen it was usually critical comments on large trucks in front of us. However the industry was undergoing considerable change with efficiency increasing and costs reducing. Freight movements were set to double over the next decade raising many questions on networks' capacity to absorb them. Ships were continuing to increase in size so ports were facing more complex and more numerous road vehicle movements linked to loading or unloading. Optimisation software was having to cope with new inland ports, larger distribution centres and the need to link to just-in-time delivery.

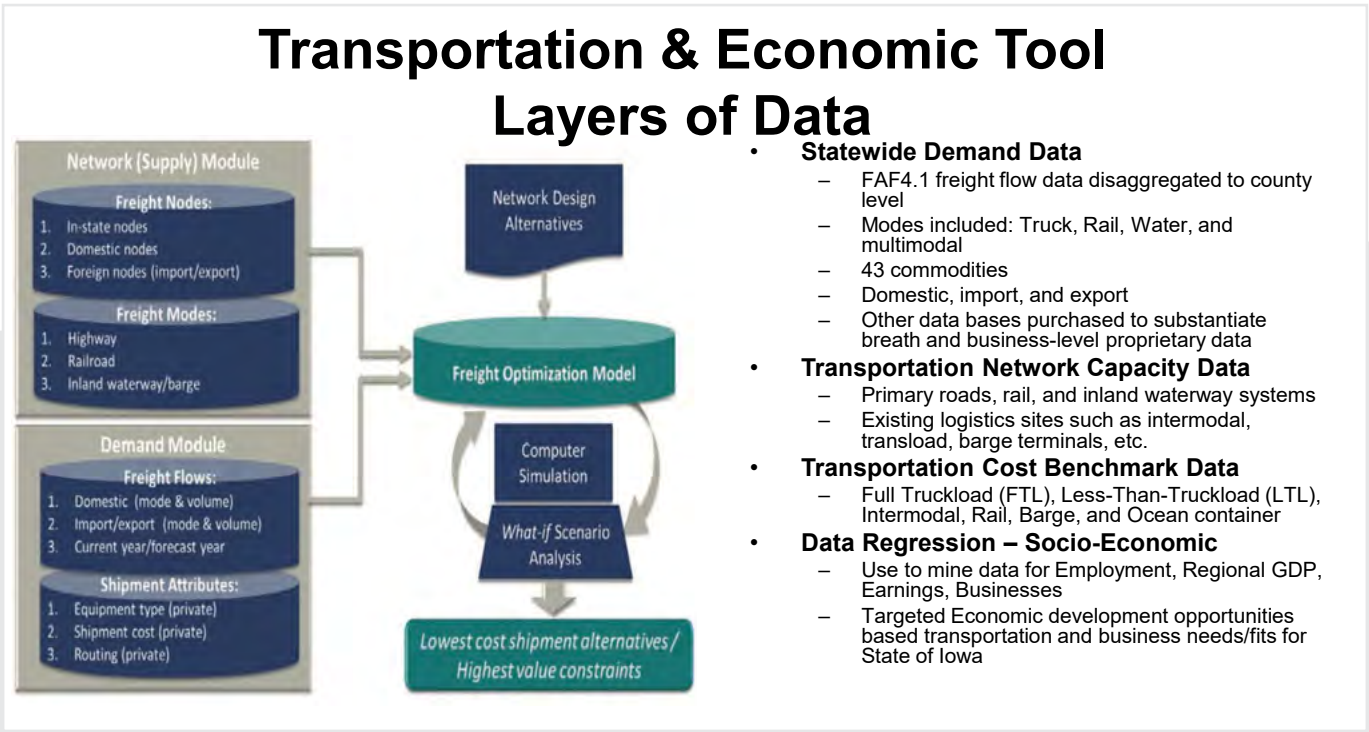
Sascha Westermann said that Hamburg was a port in the middle of the city with very little space to expand so growth had to be accommodated by being smarter. There were three key activities: connecting stakeholders through shared data, crowd-sourced data, and connecting to infrastructure and the Internet of Things. Stakeholders communicate are through a cloud-based platform driving apps on mobile devices and web-web-based services for offices.

The platform holds every item of data on ship movements in, transport movements in and out and the status of goods. Virtually all data is shared between the different parties. The crowd-sourcing activity uses the accelerometers and other sensor technology in smartphones and tablets to calculate where users are located and from this it's possible to track truck parking space availability. The connectivity work was designed to link to rail, waterways and road to infrastructure in order to get traffic management more tightly linked to freight vehicle movements.

Paul Trombino explained how Iowa had adopted a commercial sector technique of modelling supply chain design to try to get a better understanding of what was needed to handle freight movements in the State – rail, water and road. The model was built up from many layers of data and the key activity was sorting out what level of aggregation was best suited to a particular objective. For example a study on an area of congested roads showed that more or redesigned infrastructure was not the main issue: it was a pressing need for more load consolidation. The US DOT part-funded a project to create a load consolidation centre with equipment for mode transfers and the results have been reduced traffic, reduced emissions and for the hauliers reduced costs.

Attention is now turning to connected vehicles in order to enhance safety and reduce congestion through better information supply. This is being done as a public-private partnership with the State acting more as a convener helping the commercial partners to work together. The connected project is naturally leading to discussions to explore what can be gained for the freight world from automated vehicles such as improved safety, greater capacity, and increased efficiency as well as a general economic benefit for the State. The first objectives are identifying incident-related hazards such as obstacles on the road, work zones, slow or stationary vehicles, unprotected accident sites, and weather-related incidents such as poor visibility, slippery surfaces or extreme conditions.

For freight the long-term objectives include real-time truck management including parking, connected truck driving, truck platooning and weather-related re-routeing



Layers of Data: Courtesy Paul Trombino

Patrick Cheng Opened with some stark numbers about growth in lengths of highways, vehicle ownership and use in China. Eleven cities now hold more than 2M cars. Despite a massive construction programme there is still extensive congestion. Each day about 16M vehicles supply probe data and devices from about 30M active users also feed information. He illustrated many examples of the use of Big Data for practical day-to-day management, public service information and also vehicle administration tasks. Some of the main uses for data were in-car navigation for passenger vehicles, traffic flow information, navigation and route information for professional logistics organisations. Traffic indices were prepared for a number of cities to guide travellers' choice of routes and trip timing.

Claire Depré explained that Europe was looking to establish a Digital Single Market that incorporated extensive digitalisation, electronic data handling, efficient transport logistics and paperless multimodal freight movement. There has been a lot of work on reporting formalities especially in the maritime sector, and the adoption of established road ITS tools in maritime and rail. There have been many challenges – developing standards; removing silos and interconnecting systems; getting recognition for eTransport documentation; countering concerns about data security, ownership, access, confidentiality and re-use; extending trust both within and between market sectors.

She stressed that many of the challenges did not reflect inadequate technology but the need to change behaviour and trust others. Information and data sharing requires trust and cooperation; cooperation needs interoperability; interoperability needs standard solutions and business interfaces. The Commission had established a Digital Transport and Logistics Forum to bring the key stakeholders together more frequently. The Forum is looking at short-, medium- and long-term measures to eliminate barriers to movement along the high level European corridors. One of the key tasks has been standardising collection, sharing and distribution of traffic information as this is an activity of immediate benefit to the freight industry. A separate fund for logistics research projects has also been created.

Nick Brown began with a picture showing New Zealand as a small island of not many people (4.3M) a long way from most other countries and therefore markets so the freight issues of the country tended to be external as well as internal. 99% of freight moves by ship; 99% of people arrive and leave by air so international links are vital for economic survival. Technology is seen as essential to sustaining the freight industry with benefits expected from reduced fuel consumption, energy usage and emissions and increased safety, productivity and reliability.

In most cases New Zealand deployed solutions from elsewhere but there were two interesting innovative projects. On the roads trucks paid a road use charge that varies by distance and the vehicle mass (to the fourth power) as a clear case of "the user pays" principle. Distance is measured by both odometer and GPS position fixes. Operators have found that the information collected for charging purposes is immediately usable for their fleet and freight management. The information has had an unexpected application in asset management.

The Auckland Harbour Bridge has had its capacity extended but is still subject to heavy demand. There were concerns that if traffic flows were to be slowed or stopped with a high concentration of heavy trucks on the bridge then there would be risk if cracking and metal fatigue. The second innovative example is unmanned aerial vehicles ('drones'). These have proved to be extremely valuable as a complement to the country's sparse population and severe geography. The existing ICAO standards for drones were intended for model aircraft and so were out of date. New Zealand has introduced a two-part regulatory regime for drones used for crop spraying, surveys and freight delivery.

POINTS ARISING FROM DISCUSSION AND QUESTIONS

- **Knowing what freight customers want is key; how do speakers get direct input from their users?**

  Sometimes you can only convince people by getting them to try something, perhaps in a group demonstration, and then they realise that their concerns or fears were baseless (SW). We as suppliers need to be aware of the potential for using key data for enforcement as well as the main business. The truck charging data in New Zealand could be used for checking overloading *etc* but as Claire mentioned trust is key. This has been a key message all week: partnership requires trust (NB). The users can tell us all about inefficiencies in the transport system and some of them are because of us so if we can get an exchange at arms' length to keep some anonymity we will get the message clearly (PT)

- **How is the Iowa trial working and how can you convince commercial**

partners that you will not cheat with key data and equally their proprietary information is safe?

We can show companies that their data acquires extra value when incorporated in the bigger data set we can bring to the discussion.

We deal with confidentiality by having sensitive work done by a third party consultant approved by both sides with tight non-disclosure agreements (PT).

EXECUTIVE SESSION ES07: USING SMART NOMADIC DEVICES SAFELY TO ENHANCE PERSONAL MOBILITY

MODERATOR

Martin Matthews Martin Matthews Consulting, New Zealand

SPEAKERS

Mika Rytkonen Head of Business Development, HERE, Germany

Shailen Bhatt Executive Director, Colorado Department of Transportation, United States

Young-Jun Moon Chief Director Korea Transport Institute, Korea

T. Russell Shields Chair Ygomi, United States

Anthony Ferguson Deputy Director, Traffic, Department for Transport, United Kingdom

After his request to people to silence their mobile phones the moderator reflected that devices which have been banned for use in cars around the world because of driver distraction were also one of the leading tools for assisting travellers with navigation and information. The session was essentially exploring the balance between benefiting from the services that nomadic devices can deliver and avoiding the unintended outcomes or safety compromises.

Mika Rytkonen defined a nomadic device as any portable device that can be brought into a vehicle for use. He noted that in Europe an average citizen spends 100 hours a years in congestion, while globally there around 1.25M road deaths annually. Europe itself has 26,000 road deaths annually, a figure which has been increasing in recent years, with a 2025 target to get below 20,000. Mika believes that the best way to improve road safety outcomes is to leverage existing technologies and solutions, a role in which smart phones will play a major part.

Some motoring innovations such as seat belts and ABS have actually increased speeds, while smart phones will now provide better information and reporting about the roads ahead. His company's research has shown in a number of jurisdictions including Finland and USA (Colorado) that good real-time information prompts drivers to reduce speed as needed when they are notified that conditions such as hazards require it.

Mika was emphatic that phones *per* se aren't the distraction; rather it is how the application in use has been designed. Applications can be designed to be fully compliant and safe and extremely useful to drivers. To demonstrate this he showed a short video on the NEAR warning system in the Lapland area. In congestion terms alone there is over $4 billion in potential savings to the consumer through automated information and HERE is today working on a creating an ecosystem known as the HERE Open Location Platform to assist with improved data sharing.

Shailen Bhatt believes that people today are so in love with their mobiles that they are compelled to grab it when it flashes driven by our need to know that somewhere out there has something to tell us that confirms our social belonging more broadly. US Roadways currently lose over 35,000 people a year and this is clearly a big problem. In his state of Colorado fatalities increased from 480 in 2015 to 546 in 2016. US has had has Vehicle Miles Travelled coming down consistently, while fatalities across the US have increased about 10%. Nobody seems sure why this has happened; Shailen believes that nomadic devices and distracted driving have been a major contributor to this increase.

Colorado is currently running a Road X vision to deploy technologically advanced transport systems including nomadic devices as they represent our best tool right now given just about everybody has a phone. The State also has a strategy to overcome traditionally expensive infrastructure investment to deal with short period peak congestion and safety by providing better real time information through smart phones, and have termed it "roadways on steroids". As an example when there are frozen roads and traction control issues it's possible to use mobile devices to deploy salt trucks in real time. Colorado have partnered with HERE to assist with its strategy through probe data, and will be hiring a Chief Data Officer shortly in recognition of the need to better operate the network rather than being just traditional road builders.

Young-Jun Moon said that one of the emerging challenges being experienced today in Korea is that as ITS systems are rolled out the cost of these investments, particularly in maintenance, is becoming quite high. He made the important point that in many developed countries an ageing population is the growing trend, for example 20% of Korea's population is forecast to be over 65 by 2025. This requires the new technology systems to be able to support ease of use as well and the changing decision making capabilities of people. To cater for this Young-Jun's work across transport is focussing on the key areas covering convenience, safety, efficiency (which he termed the "Green" issues), and travel behaviours (the "Smart" issues), where mobile devices offer a great opportunity for trip choices.

As a consequence of Big Data transport will see better connectivity between trip makers, service provides and the vehicle, through the use of nomadic devices. Some real examples has been rolled in Korea including across its Taxi Services in Kakao, with 5M users on the system and more than 40% of taxi drivers participating, and in Seoul where late night revellers can request one of three specialised demand responsive bus dispatches through the early morning hours, using mobile location data on a personal mobile phone.

Russell Shields started by expressing his embarrassment that his panel colleagues where advocating for ways to allow nomadic devices to continue to be used in vehicles when in reality these devices were killing people. Using some crash data of those using nomadic and smart phone devices he argued that using these devices in the future when fully autonomous vehicles are on the market will be fine but they can't be used now. Drivers using them kill not only themselves but also third parties, innocent pedestrians and bystanders

The solutions are not difficult: app developers should ensure they don't actually work while driving, and are only used when it can be done so safely. He noted that he has been pushing this message to most American road authorities noting that mobile devices kill more people than the publicised concerns around Ebola and Zika viruses.

Anthony Ferguson said that road traffic in the UK is at the highest it's ever been. He owns two VWs, one modern and one old Beetle van, which reminded him of the unwanted downside of policy making and its relationship to public opinion. It's clear from public surveys that people generally accept technology and do embrace it and this includes transport. Use of mobile phones in vehicles has also proven to increase the likelihood of crashes by fourfold. As a cyclist, he often sees distracted pedestrians making poor decisions and stepping onto roads. We need to accept that deep down we are all risk takers – *eg* like doctors who smoke – and despite the fact that we know we shouldn't be doing it, we do so anyway.

In the UK the government introduced penalties however crashes due to distraction have continued to increase. When the Government was seeking public opinion on the matter the media publicised the worsening record and stressed loudly that the public was calling for even tougher penalties. The government followed through on this with heavier fines. However Anthony noted that this was a clear case of what psychologists term "cognitive dissonance"– the idea of having two competing thoughts. In this case people were absolutely clear that mobile phone use while driving was wrong and should be punished – but they continue to do it. Public opinion is clearly an important area when exploring successful next steps. Technology is available to block the use of mobile calls while driving or reduced risk installations could be made mandatory but this issue emphasises the importance of managing the deployment of new technology in ways that carry broad public support.

POINTS ARISING FROM DISCUSSION AND QUESTIONS

- Mika suggested one way to encourage phone and software developers to make their devices safer by making the user interface integrated with the vehicle, using a technology called middle link.
- Russell made the point that phones in most countries are sold with the carrier contract. If the carriers could oblige phone developers by only packaging phones that have nomadic recognition features and disabling distracting features, this would go some way to help. Young-Jun agreed, and suggested learning from the airplane mode to have one that disables car distractions would be worth exploring.
- Anthony indicated that young provisional drivers in the UK will likely have their licences suspended; such was the strength of public opinion on this issue.
- Shailen indicated that introducing bans in an effective way across so many jurisdictions can be complex and slow, by which time, vehicle and autonomy will have progressed.
- Russell and Martin both agreed that older vehicle fleets, being purchased particularly by inexperienced young drivers due to their lower cost, makes addressing the safety imperative associated with distractions from nomadic devices a fairly urgent issue.

EXECUTIVE SESSION ES08: MODIFYING REGULATORY FRAMEWORKS TO BOOST MOBILITY INNOVATIONS

MODERATOR

Anthony Ferguson Deputy Director Traffic, Department for Transport, United Kingdom

SPEAKERS

Wolfgang Hoefs Head of Sector, DG, European Commission

Leslie Richards Director, Pennsylvania Department of Transportation, United States

Yuko Sano Chief Superintendent, National Policy Agency, Japan

Paul Retter Chief Executive and Commissioner, National Transport Commission, Australia

The moderator welcomed the audience to the session and commented that transport legislation had been compared to forestry: the product tends to take a long time to create, lasts a long time, and changes equally slowly. We are in a period of unprecedented change for example connected and increasingly automated vehicles, Big and Open Data, Social Media, 24/7 connectivity. There are understandable concerns that legislation designed for different technical, commercial and social times is impeding the adoption of new products and services. The challenge for regulators is balancing an open regime that encourages innovation against a more specific approach to create a marketplace that encourages competition, inhibits monopolies and presents a sensible operating environment for transport service providers. The session speakers would explore what governments can do to remove barriers, harmonise standards to enable interoperability, balance privacy and the public interest, and maintain an emphasis on outputs rather than a focus on the means by which they are delivered.

Wolfgang Hoefs spoke about the need to align regulation with the pace of innovation as recent developments have seen new players (for example, Uber) introduce new business models not covered by regulations. He referred to the EU ITS Directive (2010/40/EU) which led to the introduction of eCall, Travel Information, Information services for safe and secure parking and real-time traffic information. The key issue is finding the right balance between openness and a light regulatory touch on the one hand and the necessary minimum framework to ensure an open market, consumer protection and in the special case of the European Union a common accord between the very different philosophies of the 28 member States.

It was important to keep in mind that regulations are invariably devised with a particular activity or technology in mind and it was important to be open to the arrival of a new sector actor whose business model or/and technology was seen as disruptive just because it was not the same as accepted practice. Regulation is not always needed for a physical situation: the obvious case was data where it was necessary to agree on a framework for ownership, location and access permissions and restrictions, usability and liability, privacy and anonymity. Regulation was also needed to support provision and secure use of wide area data networks.

Leslie Richards described the background leading to the Uber autonomous taxis in Pittsburgh. In planning for deployment of autonomous vehicles in the State of Pennsylvania attention had been given to all the major components of testing guidance and policy, following on from the US DOT/NHTSA lead. An important part of the plan included the education of the State's legislators through a Safety Symposium and opportunities for the legislators to experience demonstration rides in AVs. A long distance connected and automated vehicle corridor through Pennsylvania, Ohio and Michigan had been announced to support testing and deployment.

Yuko Sano from the Japanese National Police Agency outlined the Japanese efforts in sorting out the legal and operational issues associated with automated driving; liability, obligations for inspections and service adjustments and the need for regulatory changes for traffic control. Guidelines for public road testing were released in May 2016 enabling multiple entities to commence testing on public roads in Japan. Three difficult use cases for automated driving on highways had been investigated. First, the AVs comply with speed limits but often a busy road will be travelling above the limit. Second, the speed limits on motorway joining lanes are lower than those on the main road. Finally, where there is difficulty leaving a motorway traffic often queues on the hard should before the leaving lane: should the AV do this as well?

She noted that it was likely that law abiding automated vehicles would go against normal traffic flows, which could be dangerous but this issue already exists but has been ignored to some extent or not controlled strictly for various reasons. There was a strong wish to support and promote automated vehicles in Japan but understanding how to bridge the gap between the customary driving of Japanese people and the highly compliant approach of automated vehicles needed to be investigated further. She commented that 'people and their behaviour matter a lot when you are regulating.'

Regulators observed real time, real world demonstrations at ITSWC16

Paul Retter announced the release of two discussion papers in Australia relating to a programme of work 'Land Transport Regulation 2040' being launched today charged with giving Australia's governments a better understanding of the likely environments and requirements for future transport regulations. He stated that automation; data availability and sharing; shared mobility; and consumer demand for convenience and new services would be key drivers of change over the next 20-25 years. He considered that governments need to be guided by the view that in future, "mobility" will be seen very differently. "It will probably be seen as a market, a service and a utility. Technology will drive new and more responsive business models, and governments should encourage this innovation, while ensuring our transport systems and associated infrastructure are safe and sustainable".

These changes would potentially result in fewer accidents, congestion and supply chain issues, redundant licensing and registration systems, reduced fuel and fine-based revenue and shift enforcement from roadside to back office. In response in the short term governments would remove barriers but consider replacing them with something different, while in the medium term a safety assurance system would be required. He concluded that a responsive regulatory environment would have national consistency, more performance based regulations, flexibility and regular reviews with identified barriers removed or replaced with 'fit-for-purpose' regulatory tools.

POINTS ARISING FROM DISCUSSIONS AND QUESTIONS

Why not compare with the regulatory framework of the rail industry? All speakers agreed that a safe system approach in maritime, rail and aviation was a medium term consideration for road transport and that the end-user testing and deployments just begun will further inform governments on the development of such modern approaches.

How to address the current problems if automated vehicles interact with other vehicles and road users? Once again, there was much agreement on the need for more modelling, simulation, testing, development and refinement of the systems in the context of trials and pilots which would provide opportunities for more road users to both experience these technologies and have their feedback incorporated into future systems.

EXECUTIVE SESSION ES09: CAPITALISING ON THE INTERNET OF THINGS

MODERATOR

Stan Caldwell Executive Director, Traffic21, Carnegie Mellon University, United States

SPEAKERS

Ollie Isaakson, Ericsson, Sweden

John Maddox President and Chief Executive Officer, Michigan Transformation Center (MTC), United States

Yuji Nakamura Director, Ministry of Internal Affairs and Communications, Japan

Barry Einsig Chief Technology Officer, Cisco Australia and New Zealand, United States

Opening the session the moderator commented that people often speculated why developments in autonomous vehicles were happening now. In his view there were many contributing factors, some the availability of technology others the affordability but a key element must be the development of the Internet of Things. The rapid spread of digitalisation was driving many innovations related to IoT and the speakers would give four different perspectives.

Ollie Isaksson began by asking if within the room there would be an agreed definition of the Internet of Things – in his view not one but very many. He proposed characterising the IoT as a pathway to the monetising of services + applications & analytics + cloud computing and connectivity + devices and sensors. A perspective discussed was to consider every product as a (digital) service waiting to happen: perhaps building new services on existing devices but also building new services on existing services. The key value from IoT was its cutting across traditional boundaries such as 'transport', 'health' and thereby opening up our thinking. It was driving a move from a product-focused market to a services-focused one.

Capitalising on the IOT: Courtesy Olle Isaksson

Benefiting from IoT requires much more than technologies: we have to think about unfamiliar types of stakeholders, business models, value chains, sales channels, user behaviour, and the eco-system we intend to be a part of. It helps to start by thinking of a digital representation of the part of the real world we are dealing with as the new business activity will depend on a data supply and that takes us back to the 'things' that generate it. Exploring how the different elements can be joined will lead to a very wide range of requirements. Some services (*eg* smart farming) have low costs, low power use, reasonable data volumes, low communication requirements with high latency. Others (*eg* real-time traffic management) involve high reliability, high data volumes, low latency, high availability.

The digital representation of a possible IoT-based service would most likely depict many more, and more varied, stakeholders than a traditional transport function as it would no longer be necessary to involve some parties as subordinate actors to the 'first tier'. Similarly when thinking about monetising and income generation there would be a much wider range of potential sources. Although using the term 'monetisation' Ollie was keen to remind us that a contribution to the national targets for greenhouse gas emissions was also a worthwhile payback and Ericsson research had shown that carefully deployed ITS could cut emissions by 15%.

John Maddox agreed with Ollie regarding interpretations of "Internet of Things"; he preferred to think about Internet of Transportation (IoTr). If we stand back from transport we see a small number of familiar core elements: vehicles, roads/infrastructure, people, refuelling / recharging, traffic management. This current transport system has served us well for the hundred or so years over which it has evolved but we are now on the edge of a major transformation as it becomes extended through data, analytics and the cloud. If we reflect on what the 'conventional' Internet has done for social and business life then we will have some idea of the sorts of changes that will become common.

The key is connectivity – connecting all vehicles, all nodes on networks, all people, all networks, all retail outlets. The physical delivery is straightforward but two major challenges still need to be fully resolved:

cybersecurity and validation/verification. We are all aware of the difficulty of resisting attacks on networked services made for financial reasons. As we move towards connected and automated travel services the risks become physical safety and loss of life rather than financial loss so the security has to be correspondingly higher and very reliable. Regarding validation and verification the situation for transport is not as liberal as, for example, apps on a smart phone where we can tolerate a loss of service without too many problems.

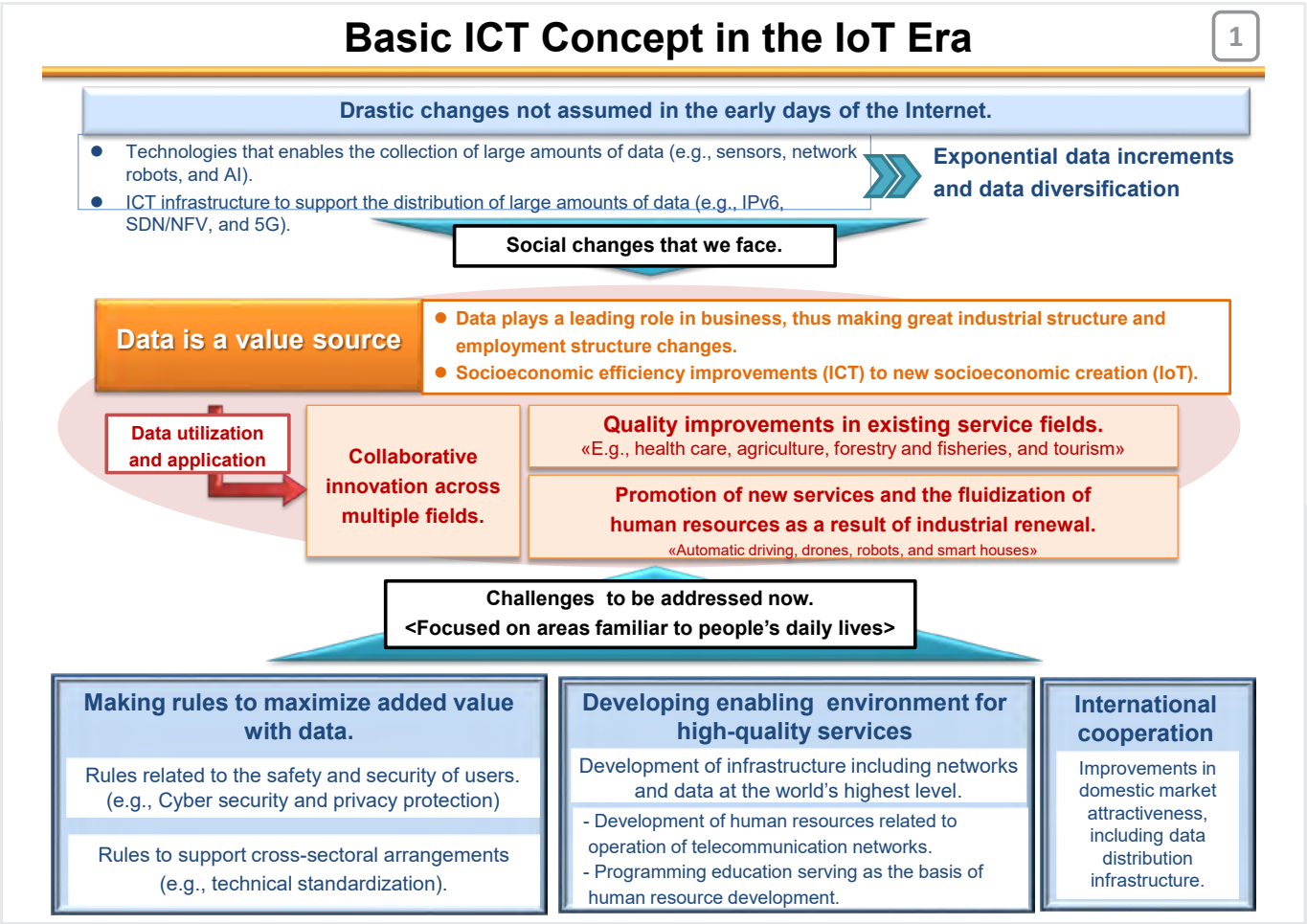
Solutions to both types of problem will depend on some swift standardisation work for the IoT and related technologies. The standards must not be transport-specific – they are needed in every sector where there is an IoT activity. This work needs to be done quickly but should not be too difficult: most technologies required to fully exploit the potential offered by IoT are here as things get connected every day; it's a question of addressing the whole system rather than the components. A promising way to take this forward is the creation of an IoT transport proving ground for accelerating cooperation between government and industry. This would be a neutral space to evaluate competing technologies and services to see how readily they can be connected to work seamlessly and securely together.

Yuji Nakamura reported on the Japan Government policy approach to the IoT which was seen as a vital element of an overall ITS strategy. The key element was data; this was now becoming a reliable and abundant resource so the priority was applying the appropriate analytics and interpreting the results for maximum business or social benefit. As the previous speaker had said the IoT enabled collaborative services across multiple fields but this rested on standards and willingness to cooperate especially with regard to data sharing.

The IoT relied on a small group of core operating technologies: Big Data analytics, 5G and similar telecomms, network function virtualisation, software-defined networks, artificial intelligence. In combination these functions could support a wide range of specific applications for all sectors including transport. Access to the applications would depend heavily on the capabilities of smart phones and their telecomms. In Japan the number of smart phones was around 1.6 for every member of the population. Smart phone data traffic continued to rise and was manageable only because the telecomms technologies tended to advance by a new generation every 10 years.

Japan was eagerly awaiting the wide scale release of 5G telephony which promised ultra high data speeds, ultra low latency, multiple simultaneous connectivity for sensors and other devices – all key components of automated driving systems. The multiple simultaneous connectivity was a vital factor as the integration of the IoT with current transport networks would increase the number of connected devices some hundreds of times. Three projects had been commissioned to reinforce the move to 5G – wireless IoT, next generation ITS, and an ultra high speed broadband study. The projects involved nine different application areas: transport, sports, medical, entertainment, smart cities, smart houses, smart offices, retail, agriculture. New markets or/ and new businesses were expected in all nine areas.

Yuji talked about the importance for 5G within plans for ITS developments. He also described the Cabinet Office's SIP (Cross-Ministerial Strategic Innovation Promotion Programme). SIP is backed by an intensive 5 years R&D programme which promotes R&D and enhances cross-ministerial cooperation. There are 11 research themes for the project from societal issues such as energy, next generation infrastructure and local resources which includes R&D for automated driving. One theme of automated driving systems and next generation infrastructure. It includes key technologies needed for vehicle control systems with connectivity through cellular networks, satellites and V2X. There is also work on SIP–ADUS (innovation on automated driving for universal services), which focuses on what AVs need to cooperate with including, digital maps, wireless communications, HMI and security.



Basic ICT concept of the IoT era: Courtesy Yuji Nakamura

Barry Einsig wanted to talk about the origins of the IoT. For CISCO the concept started around eight years ago with smart cities and energy grids and then acquired a name. Today we think of Cooperative ITS as a backbone for IoT developments in transport. By linking to other sectors new data combinations are emerging and new services are becoming possible. The big challenges are how to integrate such technologies with existing transportation infrastructure to provide information services that will benefit travellers, service providers and other transportation businesses.

There have been many attempts to measure the size of the IoT usually as part of an exercise to assess the overall potential added value. These studies tended to start with the numbers of potential device connections then an analysis of potential application areas – "use cases" – and then classify as business process, end-user service *etc.* It was now understood that to be of maximum benefit the studies had to drill down to an actual transport mode-specific activity and focus on better customer service delivery first rather than work on how to introduce a new type pf service.

Barry was concerned that in the language of the Gartner Hype Cycle both the IoT and the idea of autonomous vehicles hit a peak of "inflated expectations" – in other words "everybody's talking about it but nobody quite knows what it means". Reverting to numbers of connections it was predicted that cellphone numbers would reach around 6 Bn in 2020 which is close to the global population of 7 Bn and there would be about 2 Bn vehicles. These 8 Bn initial nodes were already connecting with each other to form networks of value to them. There were many examples of C-ITS systems with roadside devices – sensors, cameras, transceivers – connected to in-vehicle processors to create new information for travellers. The IoT was already a reality with real customers doing real things using what is already available technically. There is real value possible for suppliers and for users.

POINTS ARISING FROM DISCUSSION AND QUESTIONS

- **Thinking about deploying the IoT what aspects are likely to present the major challenges – data collection, data analysis, integration?**

  A big challenge will be getting organisations to cooperate and

that might rest on getting agreement on the standards that we don't yet have. There are many different industry groups all keen to maintain their current approach. The big problems will emerge when we cross sectors because consumer-centric IT isn't the same as industry-centric IT so that has to be resolved which means improving trust and getting agreement on business rules. Most of the expressed concerns really translate as a fear of the unknown and a wish to cling to sovereignty which we have to overcome by showing a trustable secure alternative.

- **The range of devices that we use to connect with computers today is essentially not very varied whereas the candidate devices for IoT differ hugely. What's likely to be the preferred route to connectivity: some sort of wrapper around the device or a set of standard interfaces?**

  A number of alliances have formed in this area and they have different approaches. The interface solution seems to be preferred and it enables easier decisions for example on data such as who owns what, what can I use, who can do what with it *etc*. You need to remember that although you may opt for *a* particular solution the typical user will need time to convert legacy systems or decide whether they can be abandoned.

EXECUTIVE SESSION ES10: MOBILITY AS A SERVICE

MODERATOR

Sampo Hietanen Chief Executive Officer and Founder, MaaS Global, Finland

SPEAKERS

Andrew Everett Chief Strategy Officer, Transport Systems Catapult, United Kingdom

Kirk Steudle Director, Michigan Department of Transportation, United States

Jianping Wu Professor, Tsinghua University, China

Michael Brown Regional General Manager, Uber, United States

Andrew Somers Director, Transoptim Consulting, Australia

Sampo Hietanen opened the session reminding delegates that Mobility as a Service is a concept that can change transport from a focus on ownership and management of separate systems to a user service promise. MaaS has the potential to contribute to solving many mobility problems and to offer an attractive alternative to car ownership thereby giving users more choice and the possibility to influence the development of new services. However MaaS will only happen through a systematic change to the ways in which we operate our transport systems.

Andrew Everett said MaaS presented a great opportunity but we have to solve how to move from theory to deployment. One aspect is to better understand travellers' needs. A UK study identified a "hierarchy of challenges" from improving experience (removing pain points) to improving choice (enhancing end-to-end journeys) to improving mobility fit (enhancing lifestyles). He outlined four themes for developing intelligent (seamless) mobility: automation, supply & demand, integration and access, which can merge to give a MaaS ecosystem including transport operators, data providers, service operators and customers. This showed the complex dependencies needed to provide seamless mobility, each of which needed to be addressed. He felt there were two main areas of innovation in MaaS – aggregators of different transport operator services as well as within the individual transport operators and regulation which is flexible enough to allow for innovation but rigid enough to guarantee quality for the customer.

Kirk Steudle provided a US state government perspective on MaaS and brought to the fore many challenges related to regulation and service impact and the government's role. He first asked "do you regulate it or not?" eg for safety so citizens can be assured of some basic level of safety, or do you leave it up to citizens to become self-informed? He next asked "is it coordinated or not? *eg* is it a completely private initiative or is it linked to government services. What is the impact to underserved or poor communities? Third, "what support comes from the government such as money or incentives?", and why would the government incentivise MaaS instead of transit or some other mode? Fourth, "what communications are needed and from whom, and how does one ensure equitable access?" He went on to discuss the United States' vision for smart cities, including urban automation, connected vehicles and intelligent, sensor-based infrastructure. Kirk noted the robust conversations happening in the USA between local governments (cities) and state governments. He sees a great opportunity for MaaS, as a transformational technology, to save time, create value and change society. Sampo Hietanen asked which US city is most ready for MaaS? – a highly urbanised city dependent on a lot of non-traditional movements (eg New York, Chicago, San Francisco, Washington, DC and with a culture of transit that makes it easier to move towards shared mobility.

Jianping Wu described an electric vehicle (EV) car sharing push in China with collaboration between government, industry, and academia. EV sharing provides a low-carbon transport mode for society, an innovative way to stimulate EV promotion for cities, and convenient self-service for individuals. The government views car sharing as a complementary transport mode with large potential to provide benefits such as energy savings and air quality improvement while encouraging investment, constructing charging infrastructure, and involving EV manufacturers. However, challenges include providing sufficient charging facilities, investigating barriers, configuring better business models/operations, and promoting the idea. Future work includes policy support in terms of subsidies, research funding, regulations (government), and innovation, partnership and operation (industry).

Michael Brown opened with the potential for MaaS to incorporate more individual preferences in metropolitan transport (similar to air transport) such as time, cost savings, or trip chaining. He emphasized that Uber, as one option in the transport system, needed to partner with public transit and possibly other private providers and government to improve mobility in cities and with third party technology companies that can use data (via APIs) to improve customer experience. He discussed one test partnership with a local government to subsidise trips to/from public transit terminals instead of expanding parking infrastructure, and another idea in which dynamic road pricing could be enabled in Singapore via every car running the company's app. He closed by emphasizing the possibility to connect places that do not have public transit. Sampo asked if Uber would open up to MaaS operators? – "Uber's API is publicly available …so I think my answer is 'yes'".

Andrew Somers gave an overview of what is shaping the future of mobility: automation, electrification, and connectivity which go beyond ownership and will come together to offer a customer experience known as Mobility as a Service – hassle-free, on-demand, the best choices for moving you from A to B and beyond. However the situation today is quite different from the envisioned future and it will take a lot of private sector and commercial innovation to achieve the goal. He presented a tool developed to help assess MaaS readiness and emphasised its market potential. He closed by emphasising that access is key, to alternatives in terms of moving away from ownership but also in terms of service availability, booking and payment. The market is going to change dramatically so now is the time to move. Sampo asked him: What is the biggest barrier to creating MaaS? – access to public transport ticketing because it is a monopoly.

POINTS ARISING FROM DISCUSSIONS AND QUESTIONS

What are the biggest barriers to creating MaaS.

- ensuring greater convenience than private car ownership but also equity across the community
- the public's perception of the benefits
- consumer behaviour and understanding it
- people's understanding the true cost of the car.

How can we encourage everyone [providers] to join a single, unified marketplace for transport?

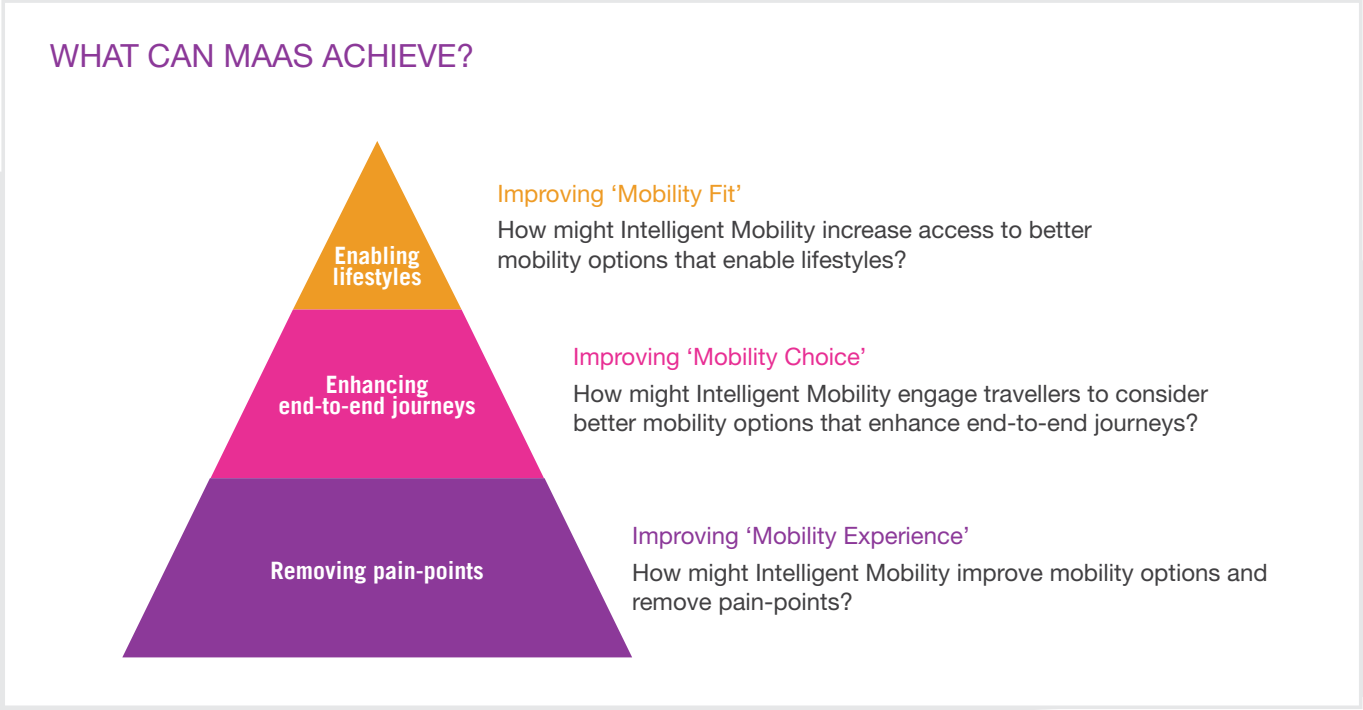
- the marketplace needs to decide that competition is good for everyone; communication is an important piece of the puzzle as well as incentives by government, ultimately the customer should decide.
- people need choice and it will probably be private entities providing consumer services, but who should own the vision: government/ cities or the private sector?
- is this a private or public or public-private model and how does it serve all of the public? Focus on the public and the customer and not the shareholder.
- the government has a role as a market regulator but what that looks like is yet to be determined. It makes it much easier if one can get the market to innovate in the interests of the consumer. It's also unclear what is the market to be regulated.

What is the measure of success in terms of geographic service coverage?

- approximately 20% of the population could be served in Sydney or Melbourne but there are many questions to be resolved in terms of subsidies, equity and inclusion, access for mobility-impaired persons, etc. But from a commercial operator's perspective one needs to chase opportunity and that is where public transit is already strong.
- You need to avoid having commercial services cherry-picking customers where transit service is strong and leaving government with the leftover, non-profitable areas, which will ultimately kill off public transit. complimentary first-mile-last-mile services could on the other hand increase the demand for public transit, and MaaS was about increasing options rather than eliminating options and taking transit customers.

When will more people rely on a mobility subscription than car ownership?

- Andrew Everett thought at least 5-10 years as a car is still a status symbol. Kirk agreed, but said that Ford expects to sell fewer cars in the future, so it could get here sooner with increased customer acceptance. Jinping said it depends on government policy, but maybe 4-5 years in Beijing, as people are already using online delivery services. Michael identified Singapore as the government is really forward thinking so possibly within the next 5 years aided by the fact that car ownership is extremely expensive in Singapore. Andrew S added that servicing the Australian urban sprawl will depend on automation, so 5-10 years after such service becomes commercially available, partly also because of lag in fleet turnover.



What can MaaS achieve: Courtesy Andrew Everett

EXECUTIVE SESSION ES11: INTEGRATING PHYSICAL AND DIGITAL TRANSPORT INFRASTRUCTURE TO CREATE SMART CITIES

MODERATOR

Pat Elizondo Senior Vice President, Global Sales & Marketing, Xerox Service, United States

SPEAKERS

Klaas Rozema CTO Dynniq, The Netherlands

Scott Sedik General Manager and Vice President, INRIX, United States

John Merritt Chief Executive, VicRoads, Australia

YC Chang Managing Director, Far Eastern Electronic Toll Collection Co, Ltd., Chinese-Taipei

Pat Elizondo opened with her view that most citizens have a good concept of what they want from a Smart City – a variety of modern services linked together, available seamlessly through a range of simple interfaces and of course personally configured, reliable and affordable. The theory is easy but delivery is much more difficult. We have a legacy infrastructure, much of it physical, and integrating it with digital infrastructure has had its challenges. But we also have great opportunities for communities. This still raises questions around data and who actually owns it and determines how it used or shared? How private is data on me?

Klaas Rozema acknowledged that Smart Cities means different things to different people to some extent depending on your industry. Setting aside the largely data-related approach to identify how things might be able to be done faster and more efficiently, it still remains quite vague. In his line of work Klaas defines it as integrating physical and digital transport infrastructure to create smart cities. He further delved into the why questions, as to why we'd want to do create smart cities, and came up with our growing challenges around urbanisation, safety, demographic change, climate change and resource scarcity, and behavioural change. ITS deployment has already proven its ability to substantially change the numbers in each of these areas.

Klaas discussed the traditional physical infrastructure challenges (*eg* line marking) and how this can be better integrated digitally. However to integrate fully in a way that is useful for customer some form of application needs to sit above all this, a point which prompted Klaas to wonder if transport authorities love personal navigation devices because its ready availability reduces the need for them to be able to convey traveller information to customers. Not getting involved means that authorities cannot always see the best information to issue and may leave key areas exposed during calamities.

Dynniq has been working in this challenging space in public private partnerships, allowing Traffic Management Centres and navigation device operators to share and inject information to customers as needed. Klaas ran through some early stage trials that Dynniq is working through in Europe, including the Xcycle project where he is assisting with cycling initiatives such as introduced green waves and similar integration solutions. This has been important to Copenhagen, which has experienced a dramatic cycling mode shift of 45%!

Scott Sedlik identified eight emerging megatrends driving the development of connected vehicles and smart cities [urbanisation; big data and the Cloud; congestion; connected cars; connected devices; cooperative road networks; safety; urban mobility]. Today there are over 25 Bn mobile devices, with the number expected to double by 2020. The trend sees two way connected cars in the market by 2020 also, and fully autonomous vehicles on our roads by 2030. Globally there are 28 megacities (over 10M population) today expected to increase to 41 cities by 2030. None of these cities will have enough room for infrastructure expansion and will rely on digital communications and data to improve and extend the way that the cities are run.

Scott sees connected cars occupying an inflection point spread across the four areas of autonomous, connectivity, electric and shared. Smart Cities are all about using all of these elements to provide a network based approach and solution to transport. It's interesting that over 30% of urban traffic is caused by drivers looking for parking – we each do this for around 55 hours per year. Scott described a number of projects that Inrix have been working on, using GPS and digital probe vehicle data to provide transport authorities with dynamic and live origin and destination as well as congestion information across networks. He offered six 'hot tips':

- Smart Cities are the journey not the destination
- Explore hybrid solutions using mixes of approaches
- Accept different business models
- Get out of the traditional silos
- Engage with suppliers to ensure privacy
- Move beyond traditional client/supplier procurement to 'ecosystem teams'

John Merritt was impressed by the number of solutions being offered by organisations attending the congress, but felt it was important for governments and transport authorities to articulate more clearly the problems that need to be fixed. There is otherwise a tendency for solution developers to cherry pick the problems and choose those that best fit their commercially available answers. He showed a video of Melbourne with Victorian streetscapes in the background. Victoria's economy is largely one of consumption with incredible amounts of freight and white vans congesting the network. The challenges that John would like see addressed through forums such as the congress include growth, with Melbourne alone growing 2,000 people per week in a largely low density environment, road safety, particularly in rural areas, and social equity, with growth largely based on immigration and integrating newcomers into our very vibrant democracy.

Ultimately, the challenge for the public sector is that there are no problems for which there is a single consensus on a solution. The approach locally has been to see initially if behaviours can be changed, and then explore how the asset can be used differently or "sweated". There are many opportunities for greater mode shift in Melbourne to see similar public transport and bicycle use such as has been experienced in Europe. What we build has also been a challenge, with some spectacular failures in major infrastructure investments evidenced across Australia. He closed by commenting that every problem he hears about seems to be described in terms of how bad it is and how it is only going to get worse, but from participating in the Congress he's been encouraged to see that while it is indeed bad with the selection and help of technology, it can only get better.

YC Chang talked about Taiwan as a real life case study and outlined how the main components of a Smart City were digitalisation, personalisation, and mobility. However these factors in turn relied on infrastructure, penetration and integration. Using all of this, Taiwan has introduced its "5S" transport framework – seamless, sharing, safe, smooth, sustainable. The basis is Infrastructure to Vehicle connection using RFID technology in the licence plate (Etag) for almost 7M vehicles and at the roadside, and tolling with almost 100% accuracy.

Interestingly, the level of data accuracy means that in Taiwan, transportation is less of a statistic and more an approach in accounting. With I-2-V technology now in place one MaaS application sees parking in parts of Taiwan now allocated through the vehicle's Etag information. In YC's view, the MaaS opportunities are so great that he believes its evolution is a journey and not any single project.

YC emphasised the need to work together as a successful business model for dealing with transport technologies, and encouraged people to look to Taiwan and its excited PPP wins. The infrastructure and ITS investments in Taiwan have been partnerships between government, private sector and the community, with end to end solutions having already being delivered with KPIs and performance measures still being set by the government.

POINTS ARISING FROM DISCUSSIONS AND QUESTIONS

- Scott advised that the UN is currently using Dubai as a test case for likely future KPIs in Smart Cities. John suggested that measuring and acknowledging health and wellbeing would also be an important consideration.
- In Taiwan, data is so rich that every movement can now be aggregated into a cost and benefit.
- Klaas believes that Smart Cities and MaaS isn't only about Smart Phone and users, rather a system that generally benefits everyone.
- Can someone be a member of a Smart City if they don't have a smart phone and are not '24/7 connected? "Yes but they have to recognise that information to them and from them will be slower and more expensive. Inclusion is always difficult to ensure and for many non-car ownership is a major exclusion point."
- John made the point that technology ultimately is not a substitute for community, when car dependency has spread in communities it has reduced people's connectivity.
- Klaas emphasised the importance of an integrated system being driven by a dynamic and highly accurate relationship between digital and physical infrastructure. YC agreed, noting that there are also considerable changes and the introduction of new digital infrastructure also happening.
- On the issue of good and smart data to better plan, John believes that it's delusional to think you can rely with great confidence on future planning. Ultimately as organisations, it's important to be responsive to changes in economy and public sentiment, particularly as the emotions of the community do change.

EXECUTIVE SESSION ES12: SMART AND AUTOMATED PUBLIC TRANSPORT ENABLING LIVEABLE CITIES AND IMPROVED MOBILITY

MODERATOR

Hermann Meyer Chief Executive Officer, ERTICO - ITS Europe

SPEAKERS

Mikkel Balskilde Hansen Chief of Traffic Unit, City of Copenhagen, Denmark

Andrew Chow President, ITS Singapore, Singapore

Martin Howell Director of External Affairs, Cubic, United Kingdom

The moderator opened by noting that around the world cities are coming under unprecedented pressures. There is strong population growth but expanding cities to cope is frequently constrained by geography. Meeting the mobility demands of people, and enabling the freight traffic that supplies goods, services and food to an urban network, is becoming increasingly difficult. In addition to these strains on existing infrastructure tighter financial constraints require cities to make difficult choices about their future priorities. Consequently all cities have enormous challenges in mobility concerning safety, efficiency and environmental performance but at the same time we know that ITS presents a great opportunity to tackle the provided we can address the associated technical, organisational and legislative issues.

Mikkel Balskilde Hansen said he was not an expert in transport technologies; rather he and his team focused on knowing and understanding the needs of the citizens and government and converting them into infrastructure and technological solutions. Accordingly, he looked more at the key drivers and barriers in these areas. Copenhagen has a very clear political agenda to decongest the city's streets, with targets including being CO_2 neutral by 2025 including across transport, and a powerful way to achieve that is mode shift from private car to public transport.

Introducing a high quality high frequency metro system has allowed Copenhagen to open up spaces across the city to people. City Hall's agenda is to automate public transport and integrate it with all other modes as an improved network through changes in road space prioritisation. Existing infrastructure also plays an important role and may represent a precondition to implementation of any large scale deployments, and technological developments need to consider existing city ecosystems.

Barriers for deployment in Mikkel's experience have included a lack of standards, technological changes always tending to be ahead of legislation and regulation (with authorities often slowing things down), and unclear relationship to safety, which is the only way to gaining government and public acceptance of smart and automated technologies. He believes that automated and smart technologies have and will continue to have enormous opportunities in helping us overcome our transport challenges. On the other hand achieving large scale deployment using legacy infrastructure, standards and regulations and approaches to safety will continue to present ongoing challenges, emphasising safety as the greatest challenge.

Andrew Chow gave us a snapshot of Singapore, a city state with 5.4M people and 1M vehicles, but more than 7M public transport trips per day. About 12% of the land mass is roads and quite simply there is no further space for roads. Singapore published its Land Master Plan in 2013, noting five key challenges that included land constraints, increased travel demand, changing expectation norms, an ageing population, and a labour shortage (especially not enough public transport vehicle drivers). Its 2030 ITS Strategic Plan separately focuses on how the systems can be informative, interactive, assistive, and provide green mobility.

Andrew demonstrated Singapore's "layered township designs" that are taking place now as the basis for balancing the different demands for space and the different demands for transport services. The usual surface level provides community open spaces. Roads are placed underground and matched with shopping services also below ground and the metro system sits even further below. Under the holistic umbrella of Autonomous Road Transport there are groups split into visioning autonomous vehicle deployment, and regulations and implementation, with the objective of making Singapore a sustainable and liveable city.

The key activities being covered are how to provide fixed route and scheduled mass transport services, point-to-point mobility on demand, freight transport, and utility operations such as automated street sweepers and waste management. A great example of early implementation is in Gardens by the Bay which has fully operational self-driving vehicles, while projects and trials are being scoped or are occurring covering most of the other key track areas.

Singapore concept of self driving cars: Courtesy Andrew Chow

As a part of Project SAVI (Singapore Autonomous Vehicle Initiative) Singapore has established an autonomous vehicle testbed in a real road environment with technological infrastructure in place including a control centre, a place where the market place is invited to test its vehicles. One such trial underway is for driverless taxis. Importantly, Andrew emphasised the need to raise awareness in the public through education and a robust publicity plan, and excite the community about these technological opportunities to then gain acceptance in the mainstream.

Martin Howell wanted to start with the drivers leading us towards autonomous vehicles and it comes down to road accidents, congestion and the large growth and movement towards urban centres. Inevitably the costs associated with all of these areas are projected to continue to balloon. Conversely, a fully autonomous United States has been estimated to be able to generate productivity gains of around $1.2Tr annually. He agreed with Mikkel on the types of challenges ahead of us including liability issues and who is responsible for decisions. He also feared that in the early days there might be a spike in errors and crashes as was the case with the initial deployment of earlier technologies such as Automatic Pilots for aircraft. The social impacts could also be significant – would America be ready for 1.3M unemployed former truck drivers in less than 10 years?

Martin was convinced that simply adding autonomous vehicles to a city would do little to improve its public transport. The key was to plan a holistic approach through a strategy that also incorporated data analytics, tolling, parking, traffic management, real time passenger information, and revenue management, as well as the benefits that come with these.

Martin concluded by emphasising the massive financial and environmental benefits that autonomous vehicles offer, with a need for action now planning for a holistic mobility management solution.

POINTS ARISING FROM DISCUSSIONS AND QUESTIONS

- Andrew's explained that the pilots are big in Singapore because the city's problems are immediate and there is a need to develop the right overarching framework now.
- Mikkel agreed with Singapore's approach but also felt that getting the legislative framework is important and tricky, particularly when proven technologies in one jurisdiction are later deployed around a different set of regulations in another.
- Martin warned of the difference between connected versus autonomous vehicles, particularly in the world of insurance. There had been a tendency at this year's congress to use the terms interchangeably.
- Mikkel agreed that deployments of automated transport offered great opportunities for changed land uses in a constrained city.
- In term of Singapore's continued dependence on cars Andrew drew the comparison with Coke, Coke light and Coke Zero. In a similar vein Singapore also aims to move towards a Car light and Car zero future. The car population is growing at 0.25%, however car ownership is being discouraged and is projected to reduce through car sharing initiatives and improved mode choices.
- Copenhagen is starting to explore subsidising certain parts of its public transport system, similar to some of the free services in Melbourne.
- Martin saw a huge opportunity to get this delivered in the right way which then provides social equity solutions able to support all users. We must remember that solutions are ultimately about people.

PART 3
THE HIGH LEVEL POLICY ROUND TABLE

The Hon Darren Chester MP, Australia's Minister for Infrastructure and Transport, hosted the ITS World Congress High Level Policy Roundtable on 10 October 2016, which provided an opportunity to discuss the challenges of enhancing the liveability of cities and communities, and initiatives being undertaken to address these challenges.

The High Level Policy Roundtable is a traditional component of the World Congress which provides international ministers, mayors and dignitaries with an opportunity to discuss significant issues prior to the commencement of the Congress. It was held at the Melbourne Convention and Exhibition Centre and open to delegates, with only official Congress media invited to attend.

Participants at the Roundtable gathered from:

- Australia
- New Zealand
- Austria
- Netherlands
- Belgium
- Norway
- Canada
- People's Republic of China
- Denmark
- Republic of Korea
- Finland
- Republic of Singapore
- France
- Romania
- Germany
- Taiwan
- Greece
- Turkey
- India
- United Kingdom
- Japan
- United States of America
- Malaysia

Minister Darren Chester chairs the High Level Policy Roundtable

The United Nations estimates that, in 2016, 54% of the world's population live in urban areas, a proportion that is expected to grow to 66% by 2050. This rapid urbanisation raises significant challenges for governments in ensuring their cities and communities are 'liveable', that is, offering a sustainable quality of life to inhabitants which provide for their social, economic and environmental needs. As the ability to move around the community underpins all aspects of life for all people, efficient transport networks are essential. They enable a competitive, productive and growing economy, facilitate connections between people, and ensure the amenity and liveability of cities and communities.

In this context, transport technology can help achieve these important outcomes by improving transport safety, efficiency, sustainability and accessibility. For example:

- The use of managed motorways, such as ramp metering or variable speed limits, can significantly improve traffic flows at relatively low cost, while allowing better management and maintenance of transport assets.
- Real-time information can help transport system operators and users better plan efficient journeys and facilitate more convenient access to transport.
- Automated vehicles could bring a step change improvement in mobility, especially for those unable to move around their communities themselves.

- Connected vehicles and Advanced Driver Assistance Systems can reduce the number and severity of vehicle crashes by providing warnings to drivers, or by reducing the need for human decision-making.
- The data generated by smart infrastructure and new vehicle technologies can be analysed to improve planning, investment decision-making, and transport operations, such as by adding new public transport services during anticipated peak periods.
- Shorter trips and free flowing traffic generated by many of these technologies can lead to fuel savings and emission reductions.

The High Level Policy Roundtable on Monday 10 October, chaired by the Hon Darren Chester MP, Minister for Infrastructure and Transport and Mr Brian Negus, President of ITS Australia, drew 100 participants, representing over 20 countries. Discussions centred on the Congress theme 'ITS – Enhancing Liveable Cities and Communities'. Participants shared the particular ITS challenges their cities and communities are facing, and exchanged experiences and strategies on how they are leveraging and applying transport technology to address these challenges.

The Roundtable highlighted common challenges faced by cities and communities around the world including:

- increasing congestion and impacts on economic productivity;
- the issue of climate change and environmental sustainability, especially emissions produced by the transport sector; and
- road safety and the regulatory challenges related to connected and automated vehicles.

Key themes in relation to the initiatives governments are undertaking when adopting and applying ITS to enhance the liveability of cities included:

- national policies and approaches to developing and deploying ITS;
- the importance of legal and regulatory frameworks for automated vehicles;
- continued development of capabilities in big data analytics, data-sharing and the Internet of Things as they relate to transport systems;
- the facilitation and support of innovative business models in the transport sector, such as Mobility-as-a-Service and multi-modal integration; and
- effective community engagement when deploying ITS solutions and infrastructure.

Overall, participants agreed that the effective integration of technology, data and people is what will drive the greatest benefits when trying to enhance the liveability of cities and communities. The sharing of experiences and lessons across international borders will also continue to be crucial in the future.

High Level Policy Roundtable ITSWC16

23rd World Congress on Intelligent Transport Systems

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