Agenda

9:00 – Welcoming remarks

9:05 – Near-Term Automation Issues: Use Cases and Standards Needs

9:40 – New Automation Initiative in Korea

9:55 – Infrastructure Requirements for Automated Driving Systems

10:10 – Automated Driving Systems: Roles of Digital Map Databases

10:40 – Discussion of New Actions for TC204

11:00 - Adjourn

Near-Term Automation Issues: Use Cases and Standards Needs

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Outline

- Diversity of automation concepts
- Near-term use cases
  - Cooperative ACC and platooning
  - Highway driving assistance
  - Automated valet parking
  - Low-speed urban shuttles
- Near-term standards needs
  - SAE J3018 example – testing guidelines

Diversity of Automation Concepts

Impediment to mutual understanding until we get specific about:

- **Goals to be served by the automation system**
- **Roles of driver and automation system**
- **Reliance on connectivity**
- **Complexity of operating environment**

Goals that Could be Served by an Automation System

- driving comfort and convenience,
- freeing up time heretofore consumed by driving
- reducing vehicle user costs
- improving vehicle user safety or broader traffic safety
- reducing user travel time
- enhancing and broadening mobility options
- reducing traffic congestion in general
- reducing energy use and pollutant emissions
- making more efficient use of existing road infrastructure
- reducing cost of future infrastructure and equipment

SAE J3016 Definitions – Levels of Automation

SAE Level	Name	Narrative Definition	Execution of Steering/ Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability (*Driving Modes*)
Human driver monitors the driving environment						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
Automated driving system ("system") monitors the driving environment						
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task* with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	High Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**

Example Systems at Each Automation Level

Level	Example Systems	Driver Roles
1	Adaptive Cruise Control OR Lane Keeping Assistance	Must drive other function and monitor driving environment
2	Adaptive Cruise Control AND Lane Keeping Assistance Traffic Jam Assist (Mercedes)	Must monitor driving environment (system nags driver to try to ensure it)
3	Traffic Jam Pilot Automated parking	May read a book, text, or web surf, but be prepared to intervene when needed
4	Highway driving pilot Closed campus driverless shuttle Driverless valet parking in garage	May sleep, and system can revert to minimum risk condition if needed
5	Automated taxi (even for children) Car-share repositioning system	No driver needed

Definitions
(per Oxford English Dictionary)

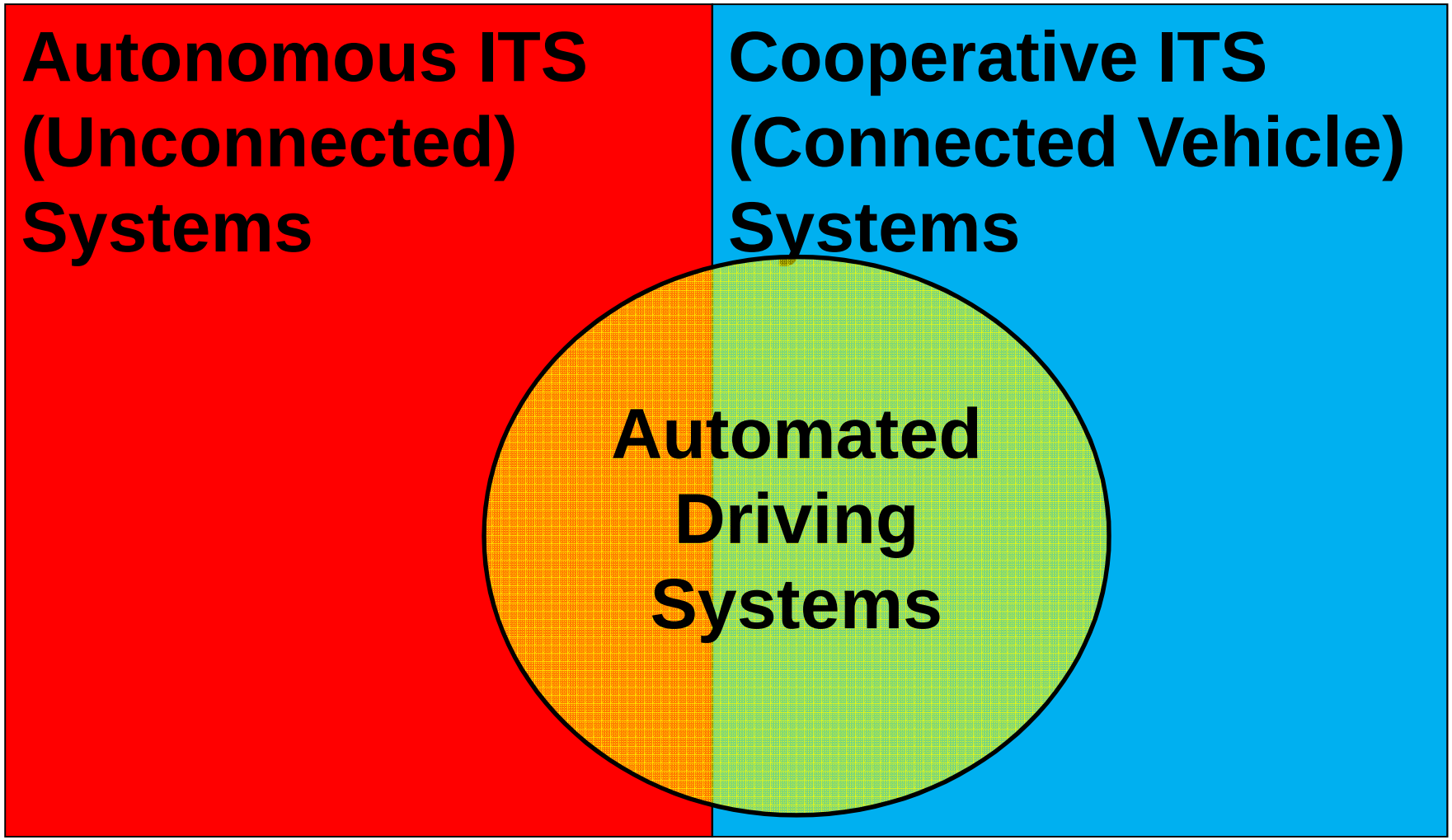
- **autonomy:**
  1. *(of a state, institution, etc.)* the right of self-government, of making its own laws and administering its own affairs
  2. *(biological)* (a) the condition of being controlled only by its own laws, and not subject to any higher one; (b) organic independence
  3. a self-governing community.

  autonomous:
  1. of or pertaining to an autonomy
  2. possessed of autonomy, self governing, independent
  3. *(biological)* (a) conforming to its own laws only, and not subject to higher ones; (b) independent, i.e., not a mere form or state of some other organism.

- **automate: to apply automation to; to convert to largely automatic operation**

  automation: automatic control of the manufacture of a product through a number of successive stages; the application of automatic control to any branch of industry or science; by extension, the use of electronic or mechanical devices to replace human labour

Autonomous and Cooperative ITS



Complexity of Operating Environment

- **Degree of segregation from other road users**
  - **Exclusive guideways**
  - **Dedicated highway lanes**
  - **Limited-access highways in general**
  - **Protected campus/special-purpose pathways**
  - **Pedestrian zones**
  - **Urban streets**
- **Traffic complexity (speed, density, mix of users)**
- **Weather and lighting conditions**
- ***Availability of I2V, V2V data***
- ***Availability of dynamic digital map data***
- ***Standardization of signage and pavement markings***

Near-Term Use Cases

- **Cooperative adaptive cruise control (CACC) – L1**
- **Platooning – L1**
- **Highway driving assistance – L2 - L4**
- **Automated valet parking – L2 - L4**
- **Low-speed urban shuttles – L4**

CACC and Platooning

- **Both involve cooperative vehicle following control (based on V2V communication + forward ranging sensor data about dynamics of preceding vehicles)**
  - **Faster responding, more accurate vehicle following**
  - **Shorter gaps**
  - **Enhanced string stability**
- **Both may involve ad-hoc grouping of vehicles or local or global coordination to find each other**
- **All decisions are made on the individual vehicle being controlled, but CACC may also use I2V communication to provide local speed limit and gap settings**
- **Platooning may be combined with automatic steering ("electronic towbar" relative to predecessor or absolute relative to lane reference)**

CACC vs. Platooning

CACC	Platooning
Vehicles may be coupled pairwise or may use data from all predecessors	Vehicles must respond to predecessor and platoon leader, possibly other predecessors too
No special responsibilities for leader vehicle	Leader vehicle negotiates joins and alerts followers to forward hazards
Drivers always control steering, and maintain large enough gaps to see lane markings ahead	Drivers may control steering or it may be automatic if the gaps are too short to permit adequate forward visibility
Constant-time-gap vehicle following	Constant-clearance-gap vehicle following
Any vehicle may split at any time	Any vehicle may split at any time

*** Platooning imposes tougher requirements on V2V communication and control**

Highway Driving Assistance

- **Combined lateral and longitudinal control in highway driving, with varying levels of possible driver involvement:**
  - **Driver continuously monitoring for driving hazards (L2 – available now)**
  - **Driver prepared to intervene with a few seconds' warning (L3 – uncertain)**
  - **No need for driver intervention within the specified operating domain (L4)**

Intentional Mis-Uses of Level 2

Mercedes S-Class

Infiniti Q50

Automated Valet Parking

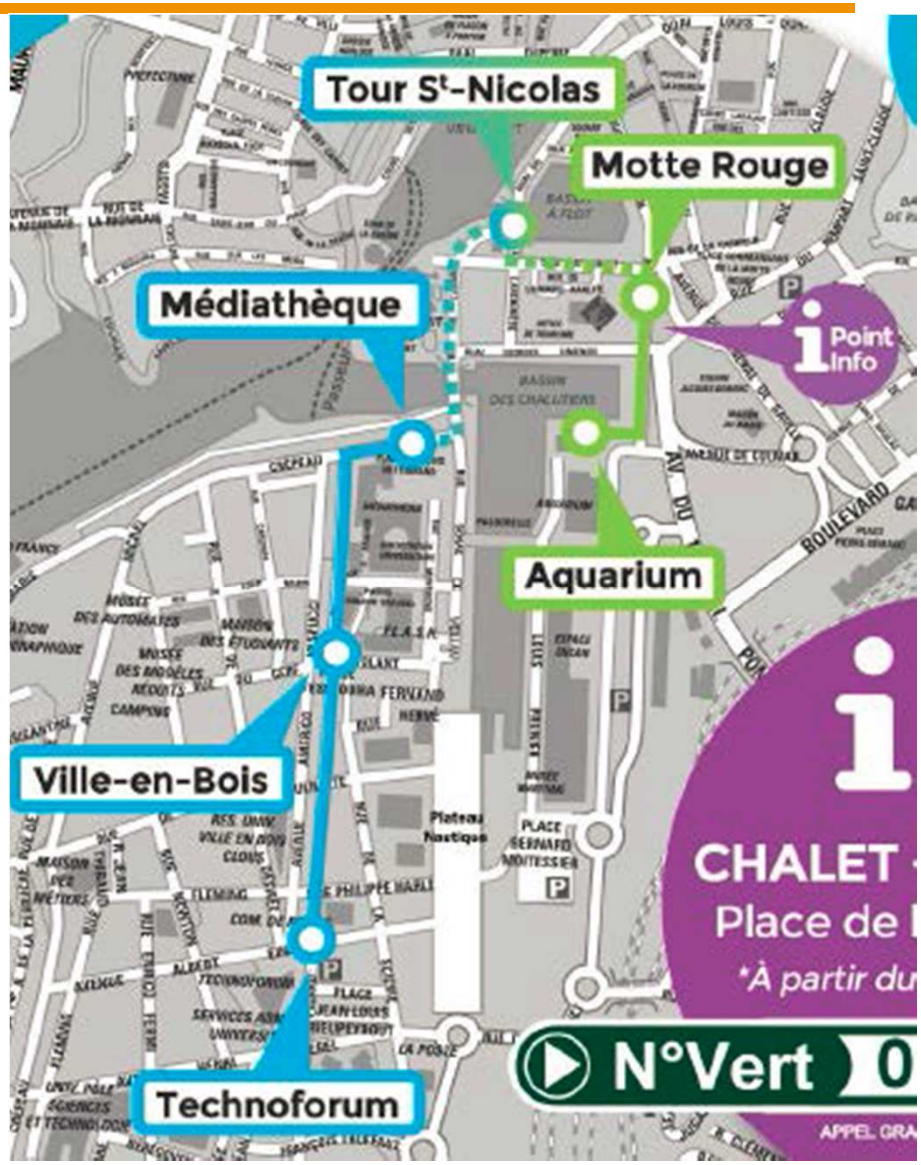
- **Multiple impending product introductions**
- **Driver leaves the vehicle before it parks itself**
- **Different levels of driver/operator supervision**
  - **Continuous monitoring, with continuous press of button to authorize motion (L2)**
  - **General oversight, with press of button to stop vehicle to avoid hazards (L3)**
  - **No supervision, vehicle out of operator's sight in a restricted parking facility (L4)**

Low-Speed Urban Shuttles

- **Aiming for operation without driver in restricted environment, certified for safety**
  - **Low speed**
  - **Some segregation from other vehicle traffic**
  - **Infrastructure modifications to ensure visibility of potential hazards and deter intrusions into vehicle path**
- **Examples:**
  - **Google “pod” cars**
  - **UK experiments recently announced**
  - **EC CityMobil2 project**

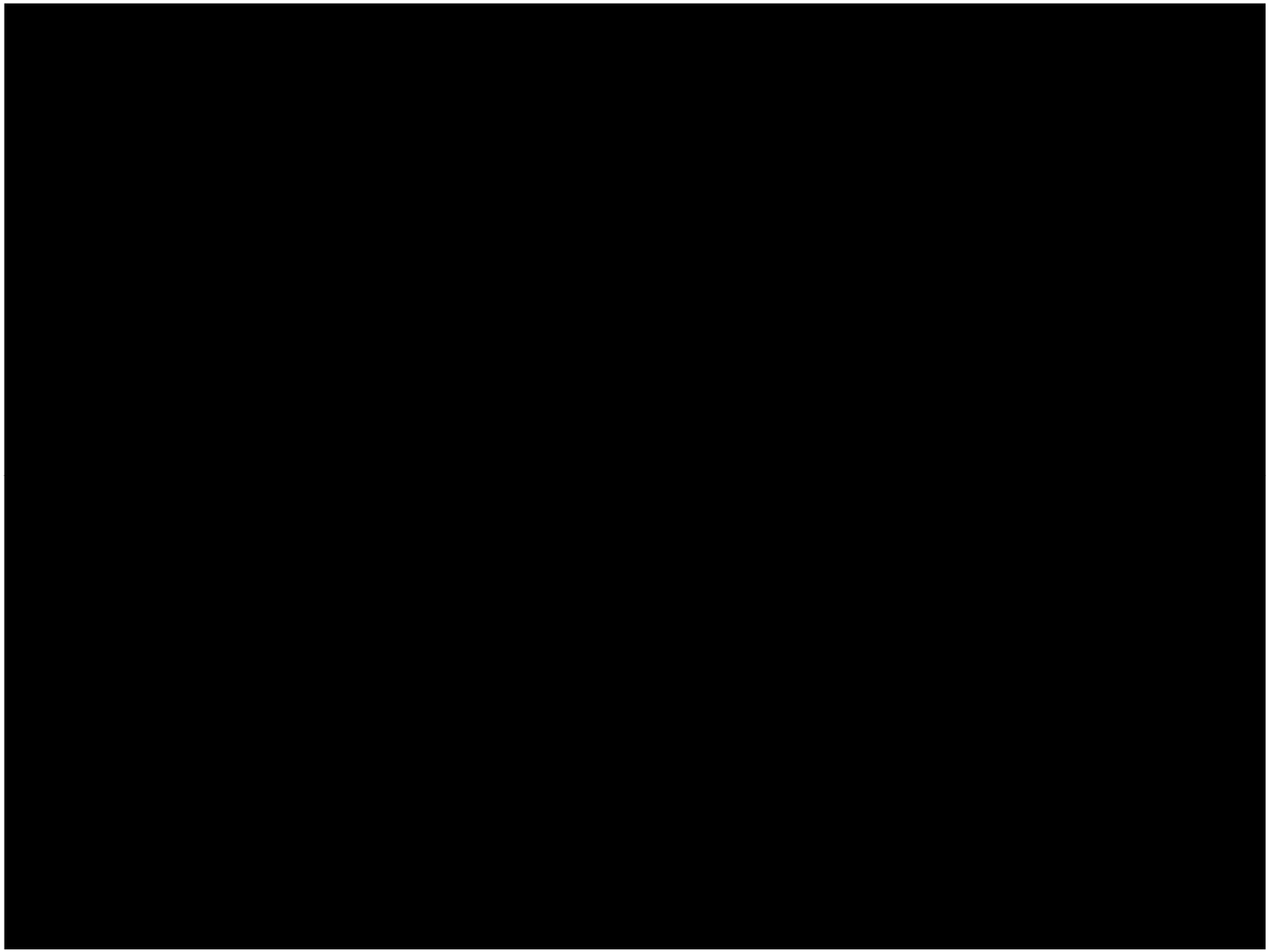
Low-Speed Shuttle Example – La Rochelle

- **Public demo this spring – up to 6 vehicles, 2.5 km route**
- **Limited to 7 km/h**
- **Operator onboard vehicle for:**
  - **Legal requirement**
  - **Passenger service**
  - **Anomalous conditions**
  - **Safety backup**



La Rochelle – Vehicle and Infrastructure

Vehicle-Infrastructure Protection



Vehicle - Ped/Bike Interactions

Near-Term Standards Needs

- **Definitions of terminology and classifications, to facilitate professional communication**
- **Definitions of functionality (user expectations)**
- **Performance requirements (especially related to safety)**
- **Testing procedures**
- **Interoperability (V2V and V2I/I2V messaging)**

Recent Example – SAE J3018

Guidelines for Safe On-Road Testing of SAE Level 3, 4 and 5 Prototype Automated Driving Systems:

- **Published March 2015 (13 pp.)**
- **Test driver levels – novice, trained, expert**
- **Test driver training, workload and management**
- **Test data capture – DAS and driver reports**
- **Test route selection criteria**
- **Safety provisions – overrides, graduated testing, safety development, software development and modifications**

TC22/SC39 – Vehicle Ergonomics

- **AV Human Factors Workshop – June 15 – Vancouver**
  - **International research and definition updates**
  - **Survey of research methods**
  - **Discussion of automation levels**
  - **Action items**
- **Road Vehicles – Operational Definitions for Measures of Human Performance and State within the Context of Automated Vehicle Systems**
  - **Support test methods development**
  - **AV HMI development and evaluation**
  - **Common language for developers and researchers**
  - **Level 2 and 3 automation**