C-ITS Deployment in Europe – Current Status and Outlook

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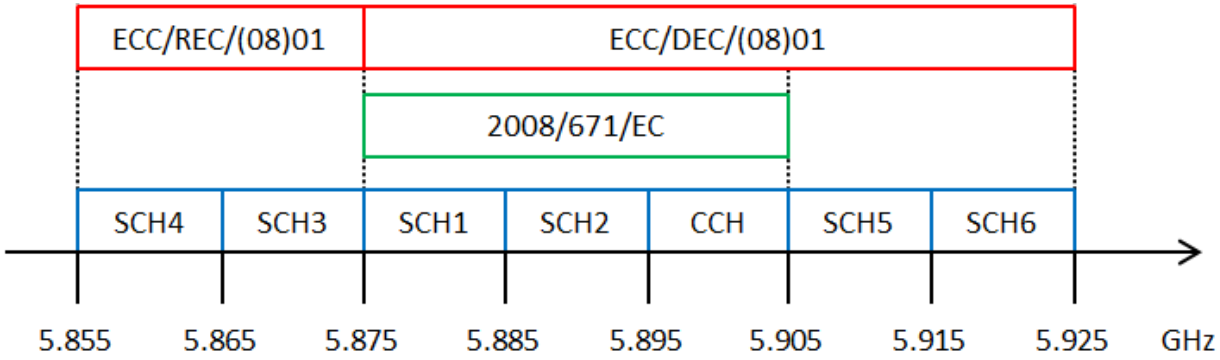
Quick Facts about the Volvo Group

- Founded in 1926 in Göteborg, Sweden
  - In 1927, the first car leaves the factory and in 1928, the first trucks and buses saw the day of light
- Volvo cars were sold to Ford in 1999, and since 2010 owned by Geely
- The Volvo Group has 6 truck brands (whereof 2 joint ventures), 5 bus brands (whereof 1 joint venture), 2 construction equipment brands (whereof 1 joint venture), and Volvo Penta
- The Volvo Group, which employs about 110 000 peple, has production in 18 countries and sell in more than 190 markets

Frequency band for C-ITS in Europe

- Standardization on vehicle-to-vehicle communication took off in Europe after the allocation of the frequency band 5.855-5.925 GHz in 2008
  - Commission Decision 2008/671/EC
  - ECC/DEC/08(01)
  - ECC/REC/08(01)



ECC = Electronics Communications Committee (ECC), one of three business units of CEPT

What is C-ITS and V2V today?

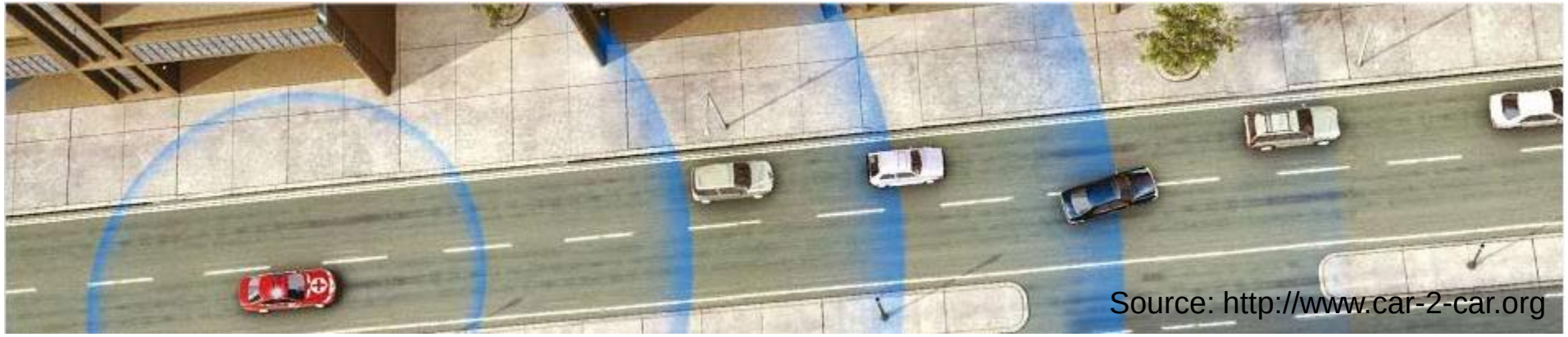
- C-ITS and V2V have recently be broadened in its definition and can mean any of the following ways to communicate between vehicles
  - *Stand-alone* V2V
    - Pure *ad hoc* communication between vehicles using IEEE 802.11p (oldest V2V definition)
  - *Cloud-supported* V2V
    - Vehicles communicate via clouds using cellular communication (connected to a base station)
  - *Cellular-assisted* V2V
    - Vehicles receive resources via a base station in order to communicate directly with each other

This presentation refers to standalone V2V.

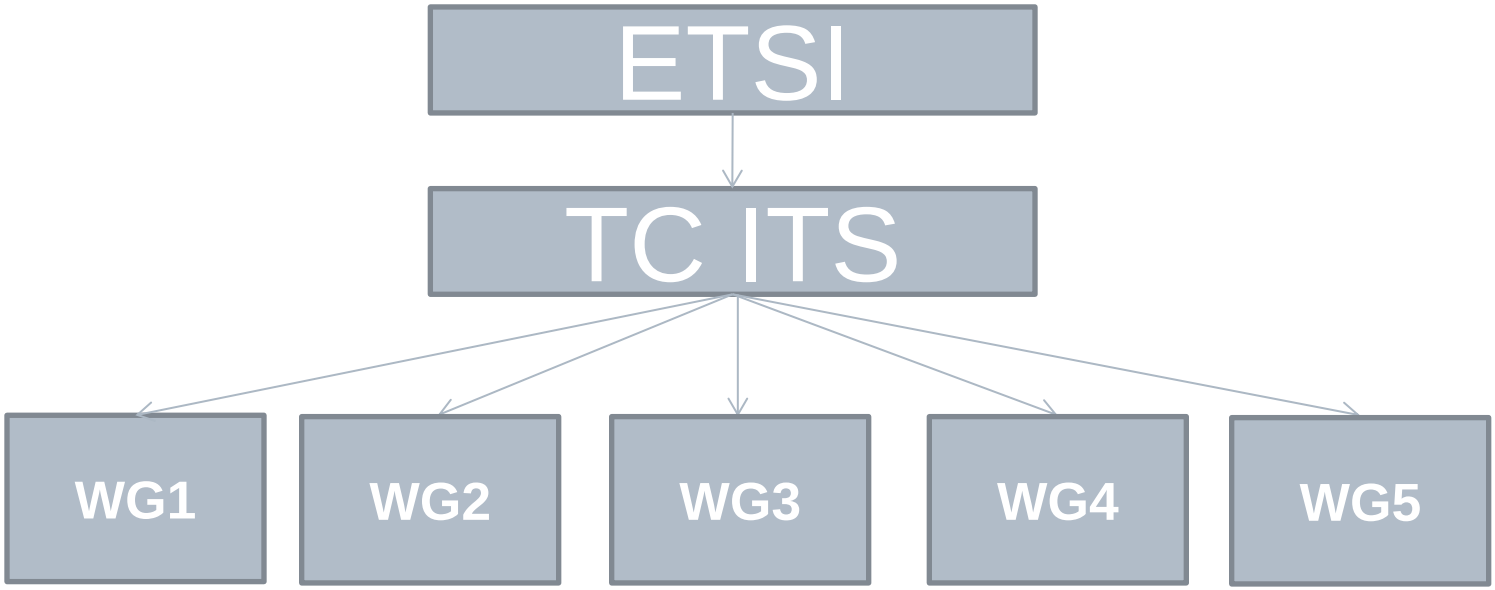
C-ITS applications day one

- Day one applications intend to increase the awareness horizon for the driver by detecting risky situations early, e.g.,
  - Emergency electronic brake light
  - Emergency vehicle approaching
  - Stationary vehicle warning
  - Slow vehicle warning
- Day one traffic efficiency applications, e.g.,
  - Green light optimal speed advisory (avoid unnecessary stops)
  - Real-time route guidance

The driver will get warned/adviced and must take appropriate action! These applications are a driver support.



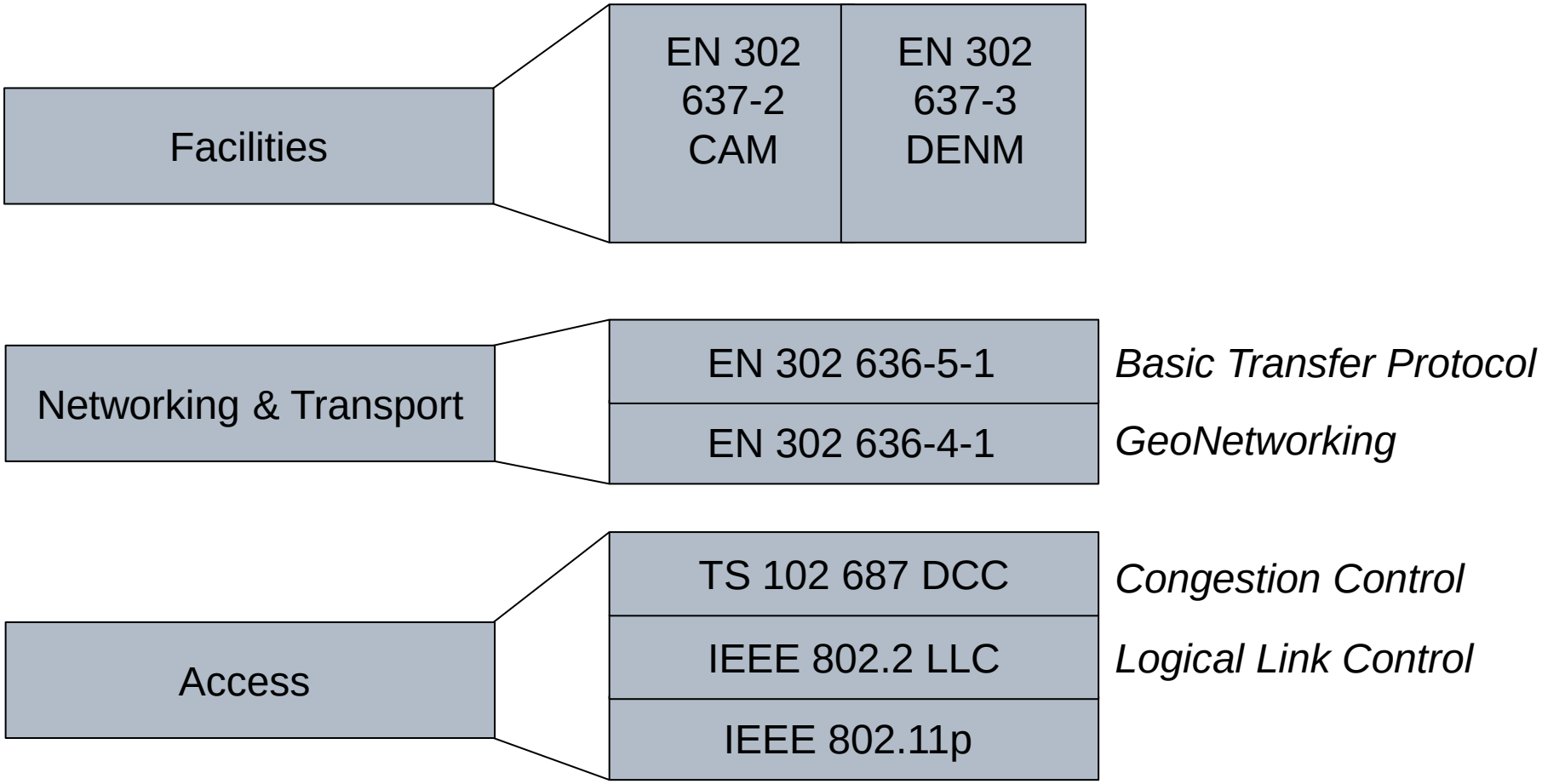
Standardization in Europe



- WG1 – Application requirements and services
- WG2 – Architecture, cross-layer, web services
- WG3 – Transport and network
- WG4 – Media and medium related issues
- WG5 – Security

ETSI = European Telecommunications Standards Institute
TC ITS = Technical Committee on Intelligent Transport Systems

Where are we now?



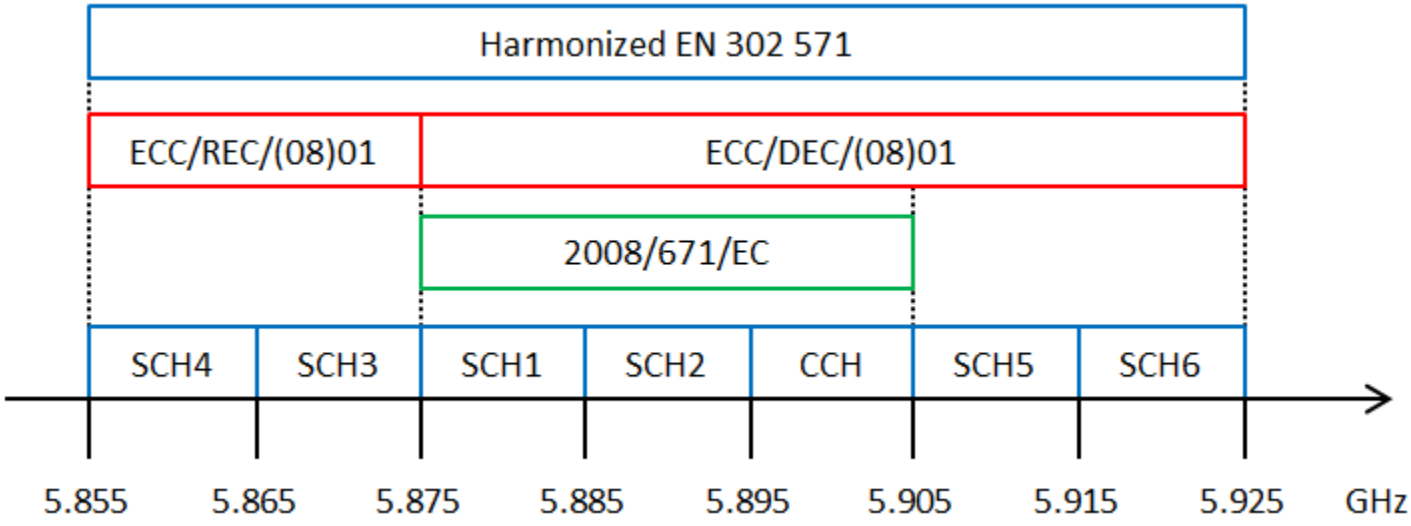
Protocol standards are in place for supporting Day One applications.

What's left before deployment in Europe can commence?

- Creating an interoperable system requires parameter setting
  - C2C-CC has parametrized the protocol stack developed within ETSI TC ITS
  - Basic System Profile (BSP)
- Nitty-gritty details about the security framework (PKI, public key infrastructure)
- Compliance assessment

Regulation – Harmonized EN 302 571

- Radio regulation
- Harmonized standard covering the frequency band at 5.9 GHz
- Outlines radio related parameters such as spectrum mask, output power etc.
- Requirements on co-existence with CEN DSRC at 5.8 GHz
- Duty cycle requirements



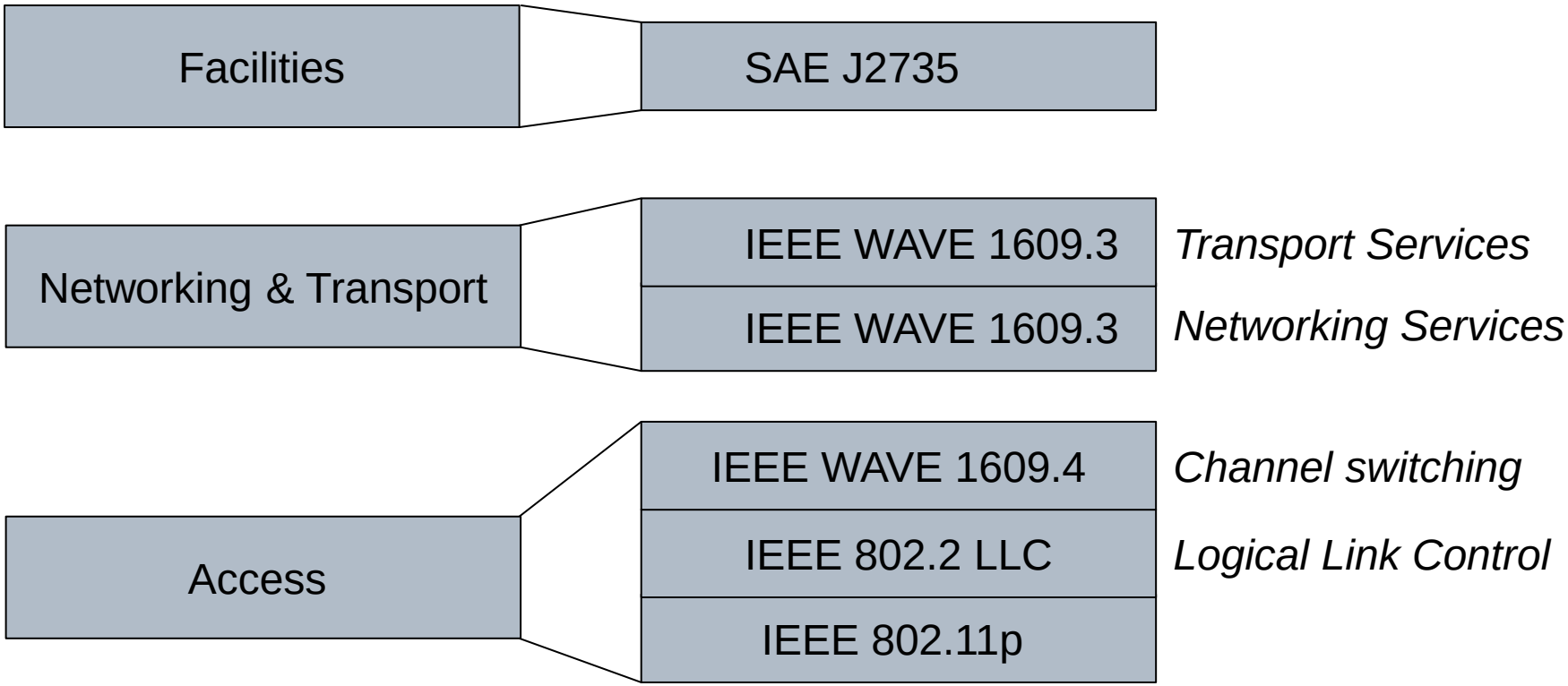
FCC decision on 5.9 GHz 1999

- The US frequency regulation authority FCC allocated a 75 MHz band for cooperative ITS (called connected vehicle technology in the US) in 1999
  - 5.850-5.925 GHz
  - “to improve traveller safety, decrease congestion, facilitate the reduction of air pollution, and help to conserve vital fossil fuels”
- Sparked today’s wave of cooperative ITS projects and deployment plans
- In 2003, ASTM released the precursor to IEEE 802.11p, specifying the whole protocol stack consisting of
  - Physical, data link and application layers
- In 2004, IEEE took over the work from ASTM
  - Developed 802.11p approved in 2010

ASTM = American Society for Testing and Materials, FCC = Federal Communications Commission

Protocol stack in the US

- SAE has developed message sets for C-ITS in J2735
- IEEE has developed all lower layer protocols



Deployment plans in the US

- Mandate driven in the US for traffic safety as opposed to Europe, which is market-driven
- A Notice of Proposed RuleMaking (NPRM) is expected any day
- SAE compiled J2945/1 ”On-Board System Requirements for V2V Safety Communications”
  - ”Basic System Profile” for Day One applications
  - Included in NPRM

C-ITS applications day two

- Connected automation
  - Marriage between automated vehicles and vehicle-to-vehicle communication
- Platoon (road trains)
- Cooperative Adaptive Cruise Control (CACC)

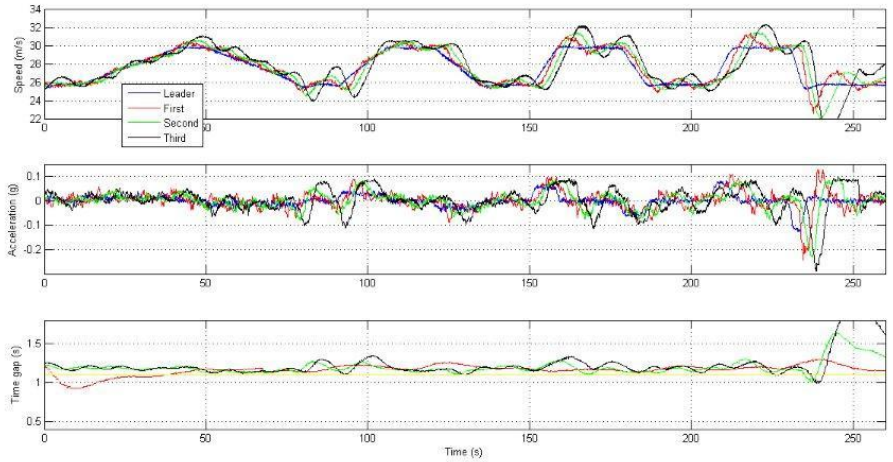
The vehicle is in control and will in certain situations hand over to the driver!

Cooperative Adaptive Cruise Control

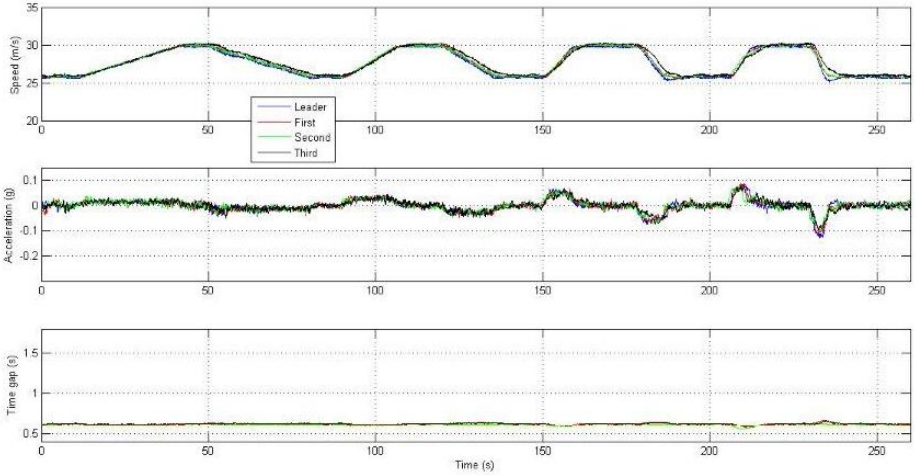
- Vehicles tag along to each other while driving after each other
- Better utilization of existing road infrastructure (less road traffic congestion)
  - ACC requires a time headway of at least 2.8 sec to be stable
  - Cooperative ACC using C-ITS can reduce this to at least 0.9 sec

A string of vehicles is said to be stable if any disturbances introduced into the string is absorbed!

Adaptive Cruise Control compared to Cooperative ACC



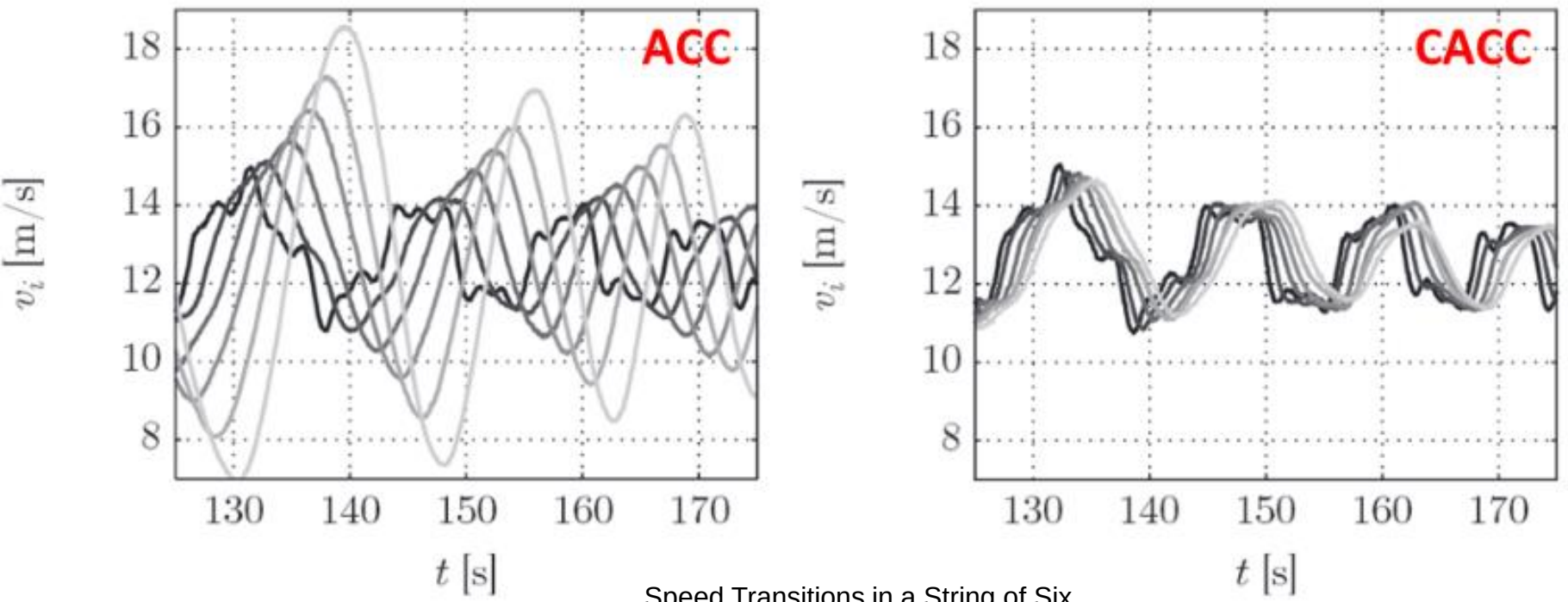
ACC – Forward sensor only



CACC – Forward sensor + V2V data

Courtesy: Steve Shladover, PATH

ACC vs CACC cont'd



Speed Transitions in a String of Six
Vehicles with ACC and CACC Systems

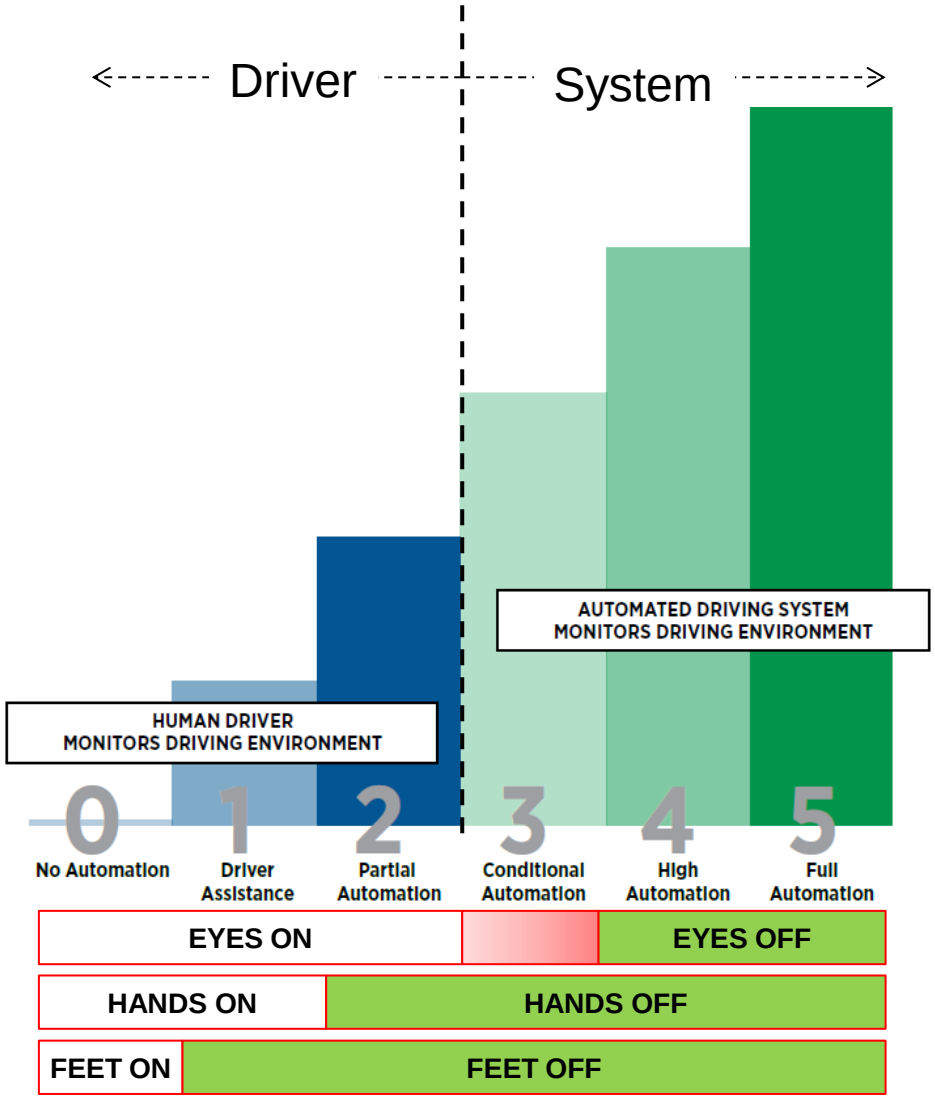
Source: http://www.mate.tue.nl/mate/pdfs/11998.pdf

How does platooning work?

- The first truck is manually driven by certified driver
- Electronic platoon is created by lead truck (communicating using 802.11p/ITS-G5)
- All platoon members follow breadcrumb trail created by the leader
- Platoons can be regarded as an electronic tow bar
- Centralized architecture where the platoon leader grants access to the platoon

Automation levels

- SAE J3016 ”Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems”
  - Released January 2014
- A major difference between level 2 and level 3
  - Driver monitoring to system monitoring



SAE = Society of Automotive Engineers

Standardization on CACC and platooning

- ETSI TC ITS
  - TR 103 299 ”Intelligent Transport Systems (ITS); Cooperative Adaptive Cruise Control (CACC); Pre-standardization study”
  - TR 103 298 ”Intelligent Transport Systems (ITS); Platooning; Pre-standardization study”
- Scope of Technical Reports (TR)
  - Describe relevant use cases
  - Identify and review existing standards
  - Identify and describe features needed in the studied application and at the facilities layer
  - Identify standardization needs

Standardization on CACC and Platooning Cont'd

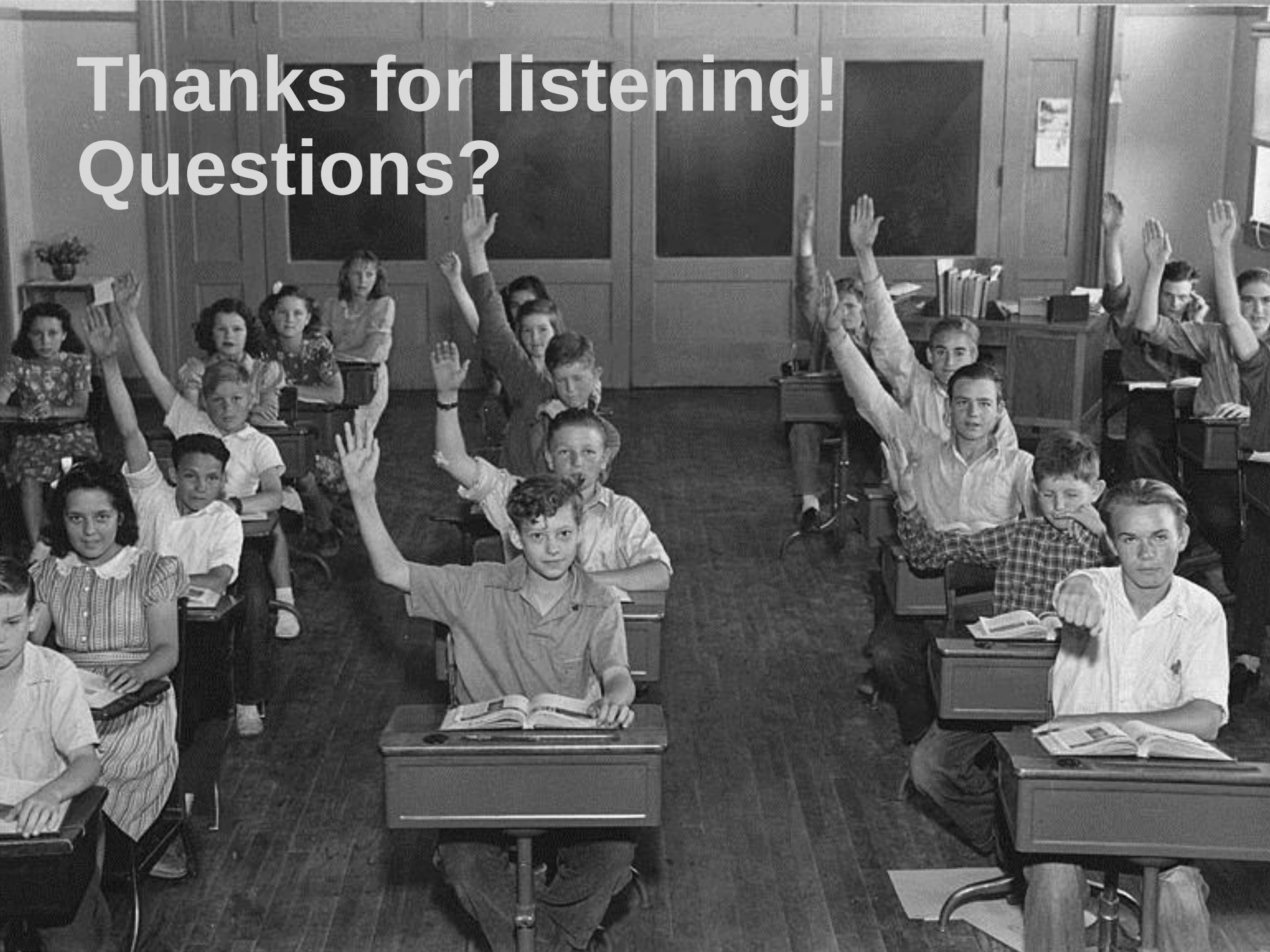
- ISO TC204 WG14
  - ISO/AWI 20035 "Intelligent Transport Systems – Cooperative Adaptive Cruise Control (CACC) – Performance Requirements and Test Procedures
  - No focus on V2V communication itself
- SAE DSRC Tech Cmte has established "V2V Cooperative Automation Task Force"
  - Develop message sets for CACC and platooning

Other ETSI standardization activities

- Draft TS 103 324 ”Intelligent Transport Systems (ITS); Collective Perception Service”
  - The collective perception service (CPS) specifies how an ITS station (e.g., vehicle) can inform others about position, dynamics and attributes of detected neighbouring road users and other objects
- Study on how to include vulnerable road users (VRU) in the V2V environment
  - Technical Report (TR) is currently being compiled
  - Draft TR 103 300 ”Intelligent Transport Systems (ITS); Vulnerable Road Users (VRU); Study of use cases and standardization perspectives”

Wrap up

- Protocols for supporting Day One applications are in place
  - Day One applications will support the driver
- Deployment of C-ITS for Day One applications is around the corner in both US and Europe
- Standardization on Day Two applications have started
  - V2V will be used for controlling the vehicle directly
  - New requirements on hazard analysis and data integrity
- Standardization on including vulnerable road users and more general object detection have been initiated


Thanks for listening!
Questions?