

# Albrecht

## Beginning Europe's Infrastructure-to-Vehicle (I2V) Roll-Out

**Josef Kaltwasser**  
**AlbrechtConsult GmbH**  
**Aachen - Germany**



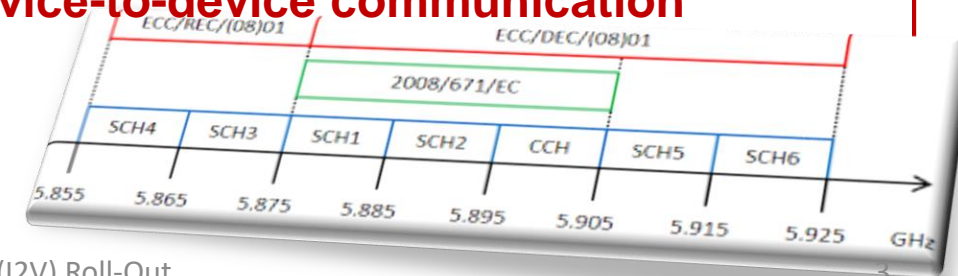
## Introduction – what does “Roll-Out” mean?

- ▶ “Cooperative Intelligent Transport Systems” (C-ITS) enable direct communication between vehicles and also between vehicles and infrastructure
- ▶ So far, vehicles have perceived the infrastructure as tarmac and concrete, infrastructure and vehicles have sensed (other) vehicles as moving chunks of metal → what a huge potential!
- ▶ R&D has been done up to 2010 in the scope of the 6<sup>th</sup> European Framework R&D Programme (e.g. Integrated Projects CVIS, SAFESPOT, COOPERS)
- ▶ Field Operational Tests have followed and validated the developed technology
- ▶ The European Commission has allocated the 5.875 to 5.905 GHz spectrum to “*safety-related applications of Intelligent Transport Systems (ITS)*” (2008/671/EC)
- ▶ So, we are ready for 2008/671/EC based C-ITS Roll-Out in day-to-day regular operation, aren't we?
  
- ▶ Well... let's look at some of the challenges faced to find out



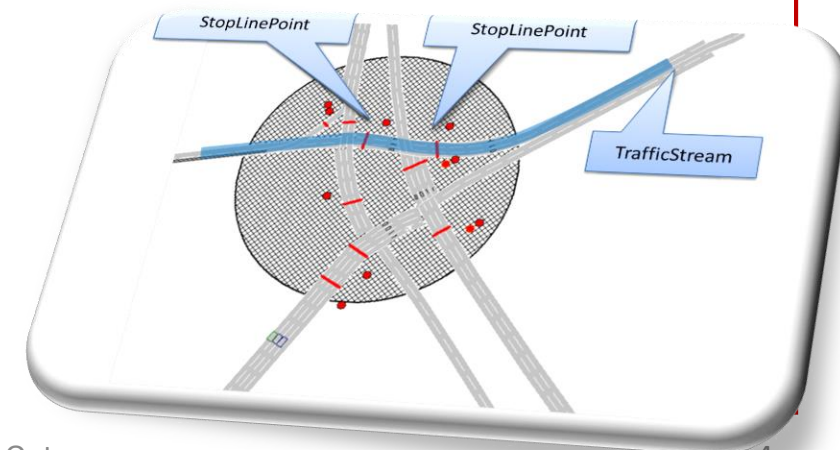
## Base technology choice for the radio channel

- ▶ **Basic design idea: two stations (vehicle, personal, infrastructure) are able to communicate, without any need for further communication infrastructure (“device-to-device”)**
- ▶ **Decision needed regarding the lower communication layers to use;**  
Note: spectrum allocation is purely functional and technology agnostic
- ▶ **The design decision in R&D years: use Wireless LAN technology based on IEEE 802.11 (802.11p amendment adopted in 2010)**
- ▶ **Standardisation on top at ETSI (mainly V2V) and ISO (mainly extension to I2V):**
  - full multi-layer protocol specification to use the radio channel
  - station model as a reference for C-ITS systems
  - → “ETSI ITS G5”
- ▶ **But... 3GPP’s Release 12 for HSPA+/LTE in 2015 contained device-to-device communication (‘sidelink’) – initially not invented for traffic, but soon applied to this → ‘LTE-V2X’ → Now we do have two contenders!**
- ▶ **The consequence? See ‘Policy / Lobbying’ slide**



## The special challenge of the infrastructure - technical

- ▶ **Why is the integration of infrastructure stations wanted for C-ITS?**
  - For information genuinely stemming from road authorities (→ digital traffic regulations)
  - To keep information in a relevance area even with low flow of equipped vehicles
  - To provide information from sources other than V-ITS-S (and P-ITS-S) – e.g. stationary sensors
- ▶ **But... Roll-Out of stations approx. every kilometre means huge initial investment and continued maintenance costs**
- ▶ **Important to note: costs are not only incurred by putting systems on the roadside – a large part of the required investment is needed for**
  - creating backbone services
  - training / recruiting staff
  - changing existing or creating new work processes
- ▶ **Example: the data needed to fill a MAPEM message for GLOSA today simply doesn't exist in urban traffic management systems!**



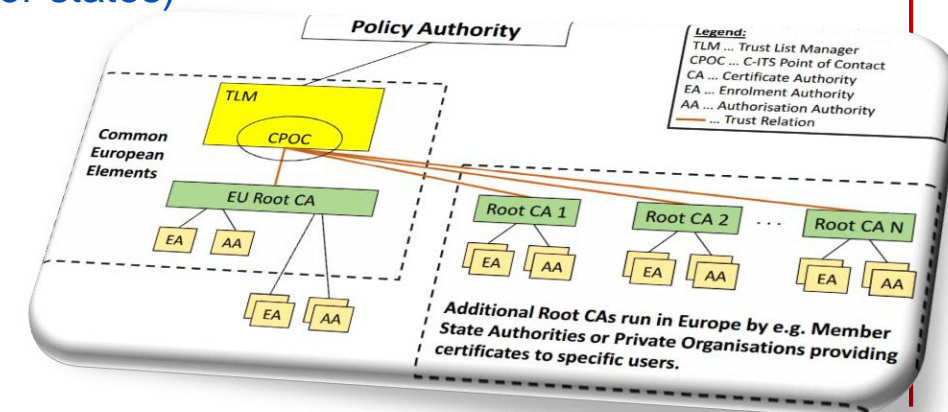
## The special challenge of the infrastructure - organisational

- ▶ Road infrastructure – in the broadest sense, including ‘digital infrastructure’ – is not standardised in the European Union
- ▶ The reality is: different road codes, different road signs (incl. VMS), different languages, different traffic management services, ...
- ▶ But... C-ITS Roll-Out requires one European (at least) interoperability interface between vehicle and infrastructure
- ▶ There was no ‘canonical host’ to develop and maintain the required specifications
- ▶ C-ROADS, as a Pan-European cooperation of Member States and the European Commission
  - developed an ‘Roadside System Profile’ to complement the CAR 2 CAR Communication Consortium’s Basic System Profile for V2V
  - Agreed cooperation with C2C-CC for shared evolution and maintenance of both profiles
  - Contributed to the European Commission’s Delegated Act on C-ITS
- ▶ But... still only 16 core members and 4 European associated members (EU has 28[27] members; Europe ~45+ countries)



## The C-ITS security challenge

- ▶ It was immediately apparent that it wouldn't be easy to create a common trust domain shared by the automotive sector and all European Member States
- ▶ The EC took the lead to create the required specifications (CP, SP...), but some MS had higher security requirements, so it could not be a single CA solutions
- ▶ The current Delegated Regulation contains a complex trust domain specification with federated Root CAs and a common Trust List Management
- ▶ But...
  - Certificate Policy untested
  - Protection Profiles not finished (also due to lack of expertise in the member states)
  - No supplier of PKI is currently willing to agree to the SLAs and OLAs
  - Unclear responsibilities within the PKI system (Which parts of the PKI need to be implemented nationally? What will the EU provide?)
  - C-ITS implementations were almost all developed without or only with rudimentary test C-ITS security
  - Effects of security on the performance of C-ITS is still under test





## The 'Hybrid Communication' challenge

- ▶ The new short range radio channel shall complement the existing links into vehicle via mobile Internet → potential new developments on the 'long leg' are denoted as 'hybrid C-ITS'
- ▶ But what makes a mobile Internet link into a vehicle a 'hybrid C-ITS' one?
- ▶ Basically the design principles other than those specific to radio channel transmission need to be complied with, in particular this holds for the Shared Trust Domain
- ▶ Essentially this means to simply carry the (binary) messages encoded in a C-ITS station via another channel into the vehicle
- ▶ Architectures for this have been created and tried out (e.g. in the InterCor project)
- ▶ Essentially you can simply use a message broker to spread messages on topics representing geographical tiles; mobile stations subscribe to tiles relevant for their current position; depending on the way you place one or more message brokers, the brokers may have to interact accordingly



## The co-operation challenge

- ▶ After the successful development and test of C-ITS technology, the CAR 2 CAR Communication Consortium (C2C-CC) has actively pushed the required standardisation at ETSI
- ▶ The initial focus was clearly von V2V, but with an also clearly stated strive to extend this to V2X
- ▶ But the integration of road infrastructure is not a simple and straightforward task
- ▶ Example: The first generation of standards chose elliptic-curve cryptography with NIST P-256, a curve that can be implemented for high speed processing with relatively low performance requirements
- ▶ Unfortunately, it became apparent during the integration of I2V communication that some European Member State prohibit the use of this curve for public authorities (including road operators) → the whole spec. had to be re-worked to also open up for Brainpool P-256
- ▶ Lesson learned: Rolling out C-ITS vehicles and infrastructure in every day real-world operation requires system operation processes shared by vehicle industry and infrastructure operators (C-ROADS and C2C-CC are currently discussing options; institutionalisation may be required)





## The Policy / Lobbying challenge

- ▶ **C-ITS Roll-Out – in particular where infrastructure is involved – requires a stable regulatory framework**
- ▶ **In Europe, this implies an EU-level activity (European Commission) that is supported by the EU Parliament and the Member States in the European Council**
- ▶ **During the process of discussing this framework, a new dimension of EU activity has been entered with the European Commission taking an active, even operational role in the establishment of this framework (e.g. in the Trust Model)**
- ▶ **The Result: A Delegated Regulation for C-ITS (~250 pages), covering (i.e. prescribing) all technical design decisions**
- ▶ **But... there is the pending issue on ETSI ITS G5 vs LTE-V2X**
- ▶ **The LTE-V2X promoters strongly lobbied against a prescription of ETSI ITS G5**
  - The Committee on Transport and Tourism of the EU parliament made an intervention to object the Delegated Regulation, but failed in the parliamentary vote
  - Now the only institution that can stop the DR is the European Council, they have asked for an extension of the deadline for their decision until July...



## Lessons learned

- ▶ **When technology has been developed and tested, you are still years away from large-scale, operational roll-out on the road in every-day traffic**
  - It has to be understood and actively addressed that R&D, pilots and even field operational tests do not operate under real-world, day-to-day operational conditions
  - The amount of work that needs to be done – and the partly disruptive changes that this implies in your own organisation – are often underestimated
- ▶ **It is of utmost importance to identify and address domains early where stakeholder cooperation is pivotal for the system to work but not existing yet, in particular for public-private-partnership**
  - Connecting vehicles and infrastructure creates a single system in terms of functional safety assessment
  - All stations – vehicles, personal and infrastructure – belong to a single trust domain; roles, responsibilities and policies for creating and running the required security infrastructure have to be agreed by all stakeholders
  - Since the communication interface between vehicle/personal station and infrastructure is pivotal for the system, the operational processes to maintain and evolve the underlying specification have to be cooperative as well
- ▶ **But at the end: it is possible and there is an expectation that first V2V and I2V interaction in real life can be expected by the end of this or early next year!**

## Conclusions

- ▶ **So, where are we now?**
- ▶ **We do have a specification for C-ITS Roll-Out for V2V as well as I2V (in Europe):  
Two profiles – C2C-CC's Basic System Profile and C-ROADS' Roadside System Profile –  
cover the V2V and I2V use cases for Day 1**
- ▶ **We do have two initial organisations to carry the required cooperation of the vehicle and  
infrastructure stakeholders: C2C-CC and C-ROADS, and they have established a liaison for the  
topics that require cooperation**
- ▶ **We have stated plans to pursue C-ITS Roll-Out in regular vehicle fleets, in particular by  
Volkswagen (→ Golf 8)**
- ▶ **We have C-ITS infrastructure deployments on pilot stage already operational in some  
European Member States**
- ▶ **We have large-scale deployment initiatives started, with call-for-tender procedures already  
started (e.g. Austria) or at least being in preparation (e.g. Germany)**
- ▶ **We also have a clearly stated commitment to complement this with a 'long leg',  
i.e. mobile Internet communication via cellular 4G/5G networks**