Technologies

For Urban-ITS

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European Context

ITS and C-ITS use cases

EU commission ITS.
Targets overall ITS services safety as well as none safety use cases have been identified. This list is complement:
- List of use cases:
  - Slow or stationary vehicle(s) & Traffic ah warning
  - Road works warning
  - Weather conditions
  - Emergency brake light
  - Emergency vehicle approaching
  - Other hazardous notifications
  - Static In-vehicle signage and In-vehicle sp limits
  - Dynamic In-vehicle signage and In-vehicle sp limits
  - Signal violation / Intersection Safety
  - Traffic signal priority request by designa vehicles
  - Green Light Optimal Speed Advisory (GLOS)
  - Probe vehicle data

General ITS oriented

C-ITS, safety oriented
Based on the applications roadmap C2C-CC driven CODECS maintains an Technology roadmap. This is a working roadmap providing an overview of the expected required technologies and must be seen as indication.
C-ITS Spectrum

C-ACC Information classes

1. Cooperative Awareness and Day 1 events
   - CAM, DENM, Basic MAP/SPAT, IVI, SAM (10 Mbit / 10-50ms)

2. Collective Perception
   - CPM, CLM, Extended CAM, Extended SPAT, (10 Mbit / 10-50ms)

3. Cooperative Automated Maneuver
   - Parking, Platooning extensions/management/control, (1 Mbit / 10ms)

4. Predictive and Intention Perception
   - Predictive trajectory, Electronic Horizon Message e.a, Urban rail (1 Mbit / 10ms)

5. Infrastructure Information
   - Safety services e.g. Dig. Inspection; Transport Logistics, Urban rail

6. Raw Data / Electronic Horizon
City Traffic Management

Objectives

- Improve the travels experience in reaching the destination predictably and maximize road efficiency
  - Fasted root, Multi Model Transport including parking
  - General Road congestion and flow
  - Accident management
  - Prioritized traffic

- Improve Road User safety
  - Vulnerable Road User (VRU) protection (example: Children crossing roads)
  - Improve clearness about traffic situations (e.g. hazard warning)

- Reduce CO₂ emission
  - Specific Road congestion and flow
  - Truck and Car limitations in cities
  - Specific traffic in specific lanes

- Improve Costs-Benefits ratio of Road Management systems
Currently these use cases are addressed in a general way from a community stand point of view with updates into the minutes! As traffic density, safety and CO₂ emission requirements increase, improvement has to come from personalization, detailing and instant info delivery down to 0.1 second!
Urban-ITS Technology

How to realize personalisation and detailing?

- Improve and increase the information availability as input to the traffic management processes
  - Direct Access to individual status and predictions
  - Increase knowledge at local (crossing(s)), at district, city and country levels.
  - In time for adequate response 0.1-1 sec, 1-5 sec, 5-60 sec, 60-600 sec.

- Improve and increase information to the road user
  Provide personalized & instant traffic flow & safety guidelines cost effectively
  - By Authorities themselves to general road-users
  - Via service providers to general road-users
  - By themselves to specific road-users
    - Emergencies
    - Public transport
    - Truck and special transport

The NEED

To PROVIDE
City relevant ITS use cases

To show use fullness of C-ITS

- Road User Information availability for traffic managers
- Traffic flow optimization
  - Green Light Optimization
- Road hazard warnings
- Vulnerable road users
  - Children crossing
  - Obstacles
- Emergency priority
- Environmental Corridors
- Public transportation
- Accident management
- Road construction
- Traffic Information availability for road users
  - Parking assist

The NEED
To PROVIDE
Urban-ITS Technology

The Hybrid Communication reference architecture

- No installation costs with standard Cellular services. When C-ITS requirements included are included in Cellular 5G. Introduction later then ITS-G5 and installation cost for coverage and/or back office function costs can be expected.
- An additional cellular radio at road user side will introduces additional technology costs as Cellular costs are about a factor of 10 compared to WiFi (ITS-G5).
- Communication Provider costs.
- With standard Cellular services no guarantied delivery.

- Installation costs as ownership by road operator
- Technology can be used for many ITS and none ITS use cases
- No communication costs
- Information links can be found automatically by users, and allows quality management by Traffic management.
**ITS use cases**

- **Information availability for traffic managers**

- From all road users you would like to know, what type they are, where they are at any given time and with what speed they are heading to, with a granularity to ensure safe traveling.

  - **Overall management**
    - Only aggregated data to Regional centre
    - Strategic guided by Regional centre
  
  - **Information available down to seconds**
    - Indirect and guiding actions
    - Only aggregated data to city centre
    - Traffic light guided by city centre
  
  - **Information available down to <0.1s**
    - Direct action and change
  
  - **Huge data increase => bring intelligence and communication downwards in the chain to reduce communication overhead and costs.**
ITS use cases

Traffic Flow optimisation

Traffic lights can be static, dynamic and highly dynamic. The more actual (0.1 sec) knowledge about the state of any road user is known, the more dynamically, traffic flow efficient and more green environment becomes possible. The CAR broadcasts its status (CAMs and other messages). When received by Infrastructure a Local Dynamic Map (LDM) provide a means to predict traffic behaviour at the individual level and by that support high efficient traffic light management. As result no loops are required (10k Euro each).

- Actual aggregated information is received from lower levels.
- LDM information is received from more traffic systems and evaluated with possible adjustment of the timings.
- Provides routing information to lower systems and actual state received.
- Actual status of road users captured. LDM analyses used for highly dynamic traffic light settings.

Standardisation:
Pre-emption in SPAT/MAP, SAE 2735, ISO TS 19091, be used with ETSI TS 103 301 and the LDM norm EN 302 895 is available.
ITS use cases

- Traffic light optimization GLOSA
  - When knowing where vehicles are and what type they are this can be taken as an advantage as for instance the GLOSA use case has shown. In this case the existence of trucks is recognized and when traffic allows, priority green light flow is provided to all road users following the same traffic flow.
  - This results in less fuel consumption and less CO\textsuperscript{2} emissions.

Standardisation:
- Pre-emption in SPAT/MAP, SAE 2735, ISO TS 19091, be used with ETSI TS 103 301

General flow if provided to management
- Actual status of road analysed and based on LDM information decided to create Green light flows and corridors
**ITS use cases**

- **Road hazard warnings**
  - Not all road users can be seen. Roadside infrastructure could recognize other road users and obstacles and inform others.

*Standardisation:*
- The DENM Norm EN 302 637-3 and CAM Norm EN 302 637-2 are available

*Local information exchange*
- Statistics to centre(s)

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**To PROVIDE**
ITS use cases

Vulnerable road users
reference projects FRUITS and CODECS

There are many pedestrian, children, cyclist, disabled road user use cases here we take the bus stop as example, 2 possibilities

Scenario: Bus has front and rear cameras to have view around the bus, it stops at bus stop, it has ITS-communication with the information pall (possibly also equipped with a camera to see the business) at the via ITS-G5. A Car with ITS-G5 is approaching. Pedestrians are crossing the road and the Bus and/or the information pall detects these pedestrians by there camera sensors. And it sends out an Warning message for each of the possible vulnerable road users a warning. Also general bus station awareness can be shared.

This also allows the bus to exchange information with the bus stop. The bus stop could inform the bus at what stop (when there are more) to stop.

- Bus status to Central
- Local information exchange
- Detection of pedestrians

Standardisation:
Initial Technical Report currently created
ETSI TC ITS TR103 300
**ITS use cases**

**Emergency priority**

How to provide safe lane priority and at Crossings?
Based on the received locations of the road users (CAM’s) Identify and inform the road users which lane to keep free for approaching emergency vehicle via combination of MAP/SPAT/ DENM messages.

The emergency vehicle itself sends out DENMs to inform others about the lane really used and provides the real location.

- In case of Emergency is handled here
- When managed the Regional centre Provides routing information to lower systems and actual state received.
- Information available down to seconds
- Indirect and guiding actions
- Provides routing information to lower systems and actual state received.
- Actual status of road analysed based on LDM information decided to free-up a lane for Emergency vehicle <0.1s

**Standardisation:**
Pre-emption in SPAT/MAP, SAE 2735, ISO TS 19091, be used with ETIS TS 103 301
**ITS use cases**

- **Environmental corridors**

  - Currently Environmental corridors are static, provided to map suppliers and relevant stakeholder groups. As also changes may occur a process is in place to manage static change.

  - When at the city boarders these corridors could be directly provided to the road user these corridors could be manages locally and then also dynamically being updated in case of momentarily heavy pollution. This enables a simple local process with high flexibility. Local stations could even include some measurement equipment.

  - Decision making of pollution state and corridor size

  - Provides corridor information to lower systems and actual pollution state received.

  - Current agreed corridor information provided to road users. Real status of air quality measures (optional)

**Standardisation:**
Service Announcement Service: ETSI TS 102 890-2 currently in development
Service Announcement

Advantage of direct contact

Standardisation:
Service Announcement Service: ETSI
TS 102 890-2 currently in development

PROVIDE LINK AUTOMATICALLY AND DYNAMICALLY
DEPENDING ON EVALABLITY! FULLY UNDER CONTROL OF
AUTHORITIES POSSIBLE
**ITS use cases**

- **Information available for Road Users**

An ITS stations placed at the side of the road or at a first crossing when driving into the city is an excellent opportunity to inform road users about all kinds of information, e.g. road construction, environmental regulations, parking possibilities, events, updates of local maps. The Service Announcement Service (SAS) is like a digital advertisement. ETSI TS 102 890-2

- **Setup of specific SASs.**
- SAM information for ITS station or traffic light controller
- SAM information for ITS station or traffic light controller
- Station sends SAM’s to indicate where specific information can be found.

**A Service Announcement Message may advertise:**
- For a service on another radio channel
- For a service on a web link or radio station
- For security certificates

Stop looking for a link, you get this automatically. It provides the cities to manage traffic services.
ITS use cases

Geolocation Improvement

Internal view: (Information Mobility (Map/Navigation))

Where am I?

- **Absolute** Positioning (standard GPSS)
- 2-7 meters precision, at 95% availability
- >1 min <-> 0.1-3 s

External view: Safe Mobility & Automated)

Where am I compared to others?

- **Relative** Positioning (Lidar, Cam)
- Down to < 10 cm precision
- 0.1-3 s <-> < 0.1 s
**ITS use cases**

**Geolocation Improvement**

Geolocation improvement for safety related can be realized by sharing data among ITS stations, with the road side unit being an important element.

- Roadside provides Covariance Matrix to other ITS stations via the Collective Geolocation Service (CGS)
- Roadside provides RTK (differential mode GNNS) info to other ITS stations
- Roadside Traffic Systems provide already MAP message with accurate location of stop line this can be used by Cars with there relative camera and Lidar systems to improve the location precision.
- Roadside systems could know and recognize other objects precisely and inform Car about this in similar way as previous use case via the Collective Perception Service (CPS)

RTK is now successfully used in Platooning project AutoNet (EU project).

- Own GNSS covariance matrix data and RTK (differential GNNS) Via CGS
- Normal MAP message
- Normal Collective Perception Message (CPM)

*Standardisation:
To be supported by CGS being specified in ETSI TS 102 890-3 & CPM in ETSI TS 103 324*
Urban-ITS Technology

Can’t be handled by ONE COMMUNICATION TECHNOLOGY!

What we known today:

- All services can’t be handled by one channel. At least 2 Cellular radios are needed to realize full C-ITS safety via Cellular (Orange).
- Broadcasted CAM’s are seen as spam when deployed via Cellular (Ericsson).
- Waiting for Cellular 5G to be ready will delay the deployment of C-ITS (roadmap 3GPP).
- Due to limited amount of additional data transfer the additional ITS requirement for Cellular 5G are a big question for operators. Investment unclear.
- Bill of Material costs between WiFi/ITS-G5 and Cellular implementations will be about 1:10 while WiFi/ITS-G5 has maintenance cost but no Communication Operator costs.
- Business models of Cellular are more complex than ITS-G5 business models.
- Letter From the city of New York: Expressing that they will do traffic information and traffic safety related services through WiFi technologies and for this reason the appropriate technologies in 5G and at spectrum regulation must be recognized.

Hybrid Communication Approach

Initially indicated:

- Cellular 3-4-5G for none safety
- WiFi for none safety
- ITS-G5 for traffic safety and traffic efficiency
- DAB+ for bulk data and others
Thank you

For any questions

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Urban ITS

Some other aspects to recognize

- The need for personalized information is increasing and at a none safety related level can be provided as aggregated data with a delay. More critical such as safety related use cases can gain improvements by use of Urban-ITS as shown by European projects.
- The use of the Service Announcement Service as means to provide knowledge to road users where to get the correct information is a powerful tool for Traffic managers and City representatives to manage local aspects and ensure qualitative access to Traffic information for there citizens.
- The increase of the amount of localized and personalized Transport information requires at least an update but may be a new system architectural approach. It needs to be considered how to migrate from the existing Infrastructure systems to an ITS compliant system which also ensures European Interoperability.
- Recognized already for a long time, a single ITS use case does not justify the realisation of an ITS system. This needs to be done taking the full infrastructure in account. A consideration is that loops can be replaced by ITS radio’s on the long run which should bring a significant cost reduction.
- It is recognized that a single communication will not be sufficient and therefore an ITS Hybrid Communication architecture is envisioned. It is recognized that that Cellular can’t be the only technology. Combinations of 3-5G cellular with ITS-G5 and WiFi must be envisioned. Specifically for safety, ITS-G5 is ready, tested, standardized and cheaper.