Standards for Cooperative ITS: A Proof of Concept

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ITS : Usages
ITS: Vision

- **Communicating ITS station**
  - ITS station diversity (vehicle, roadside, central, personal)
  - Communication scenario diversity (V2V, V2R, V2C, R2C, R2P, ...)
  - Communication media diversity (WiFi, DSRC, 3G, Satellite, ...)
  - Application diversity (road safety, traffic efficiency, comfort/mobility)
Cooperative ITS (C-ITS) are Intelligent Transport Systems (ITS) where vehicles, roadside equipment, traffic control centers, nomadic devices, etc. cooperate, based on a common communication architecture (the ITS Station Reference Architecture standardized by ISO, CEN & ETSI) to provide road users with better road safety, traffic efficiency, comfort, improved mobility & sustainability.

Cooperative ITS

Standard Communication Architecture (ISO/CEN/ETSI)

ISO 21217
Cooperative ITS: New paradigm

Current ITS solutions

- Traffic Mngt e.g. ETC
- Proprietary Protocol
- Dedicated Access Technology

- Safety e.g. V2V
- Access Technology Dependent Protocol
- Dedicated Access Technology

- Mobility e.g. navigation
- Proprietary Protocol
- Dedicated Access Technology

Cooperative ITS solutions

- Road Traffic Management
- Road Safety
- Mobility

Common communication services & protocols

- Short Range Radio
- Medium Range radio
- Long Range radio

Single box equipped with multiple radio technologies (11p, 11n, 3G/4G, 802.15.4)

=> Need for a **generic** communication system, **standardized** and adapted to all ITS usages.
Cooperative ITS: ITS Station Architecture

- **ITS Station Architecture** [ISO 21217] supporting a diversity of:
  - ITS stations (vehicle, roadside, central, personal)
  - Access technologies (802.11p, 2G/3G, 802.11n)
  - Applications / Use cases (road safety, traffic efficiency, mobility/comfort)
  - Communication protocols: Internet Protocol (IPv6) and non-IP (ETSI GeoNetworking / ISO FNTP)

- **EC ITS Directive & Standardization Mandate M/453**
  - 65+ standards developed by ETSI/CEN/ISO (2009-2014)
Cooperative ITS: Standards (ITS Station)

Standardization effort initiated within ISO TC204 WG16 (CALM) [2001], completed by European Projects (CVIS, SafeSpot, Coopers, GeoNet, COMeSafety, DriveC2X, FOTsis, ITSSv6, PRESERVE) [2006-2013], ETSI TC ITS / CEN TC 278 / ISO TC 204 (WGs 16, 17 & 18) [since 2010]

L’ISO TC 204 (International Standard Organisation) - ITS
- WG1: Architecture
- WG2: Quality and reliability requirements
- WG3: Database technology
- WG4: Automatic Vehicle and Equipment Identification (AVIAE)
- WG5: Electronic Fee Collection (EFC)
- WG6: Commercial Fleet Management
- WG8: Public Transport and Emergency services
- WG9: Integrated Transport Information, Management and Control
- WG10: Traveller Information Systems
- WG11: Vehicle Control Systems
- WG16: Wide Area Communications
- WG17: Nomadic Devices
- WG18: Cooperative Systems

L’ETSI (European Telecommunications Standard Institute) – TC ITS
- WG1: User and Application Requirements
- WG3: Architecture and Cross Layer
- WG5: Transport and Network
- WG4: Media
- WG5: Security

CEN TC 278 (Comité Européen de Normalisation)
- WG1: Electronic toll collection
- WG2: Freight and Fleet Management Systems
- WG3: Public Transport
- WG4: Traffic and Travel Information
- WG5: Traffic Control
- WG6: Parking Management
- WG7: Geographic Road Databases
- WG8: Road Traffic Data
- WG9: Dedicated Short-Range Communication (DSRC)
- WG10: Human-Machine Interfacing
- WG12: Automatic Vehicle Identification & Automatic Equipment Identification
- WG13: Architecture
- WG14: Intelligent Traffic Systems & Vehicle Recovery
- WG15: eSafety
- WG16: Co-operative systems

IEEE (Institute of Electrical and Electronics Engineers) WAVE standard
- IEEE 802.11p
- IEEE P1609

IETF (Internet Engineering Task Force)
- MIPv6 & Network Mobility
Facilities Communication Support Functions

Generic ITS-S facilities functions facilitating the exchange of data between ITS stations [ISO 17429]

- Communication profile selection
- Publication / subscription to the reception of a given content
- Time stamping of messages
- Security: encryption, authentication...

Benefits

- Transmit messages using any available protocol stack (agnostic to access technologies and network protocol)
- Future proof / inter-operability between existing systems and C-ITS
ITS station entities (non exhaustive)

**LDM**: Local Dynamic Map
- Database recording various information (map, position of various objects, ...)

**GMDH**: Generic Message Distribution Handler
- Publication / Subscribe mechanism

**CPH**: Communication Profile Handler
- In charge of selection of the protocol stack
Information flow between entities
Information flow between entities

Application → CPH: publish ADU

CPH → SME: get Flow Information

SME: Flow information

SME → Networking & Transport: send Facilities layer PDU

Networking & Transport → send packets
Proof of concept implementation

- Developed distributed middleware and API
  - Client on smart phone: user interface (Android)
  - Server on in-vehicle router (communication box)
- Developed example use case: detection of pedestrians on the road
  - Road maintenance employees working on the road equipped with smart phone
  - Smart phone connected to in-vehicle router (WiFi direct)
  - In-vehicle router broadcast position of employees (vehicular WiFi i.e. 802.11p)
  - Approaching vehicles detect employees on the road
Proof of concept implementation

Application user interface on Android
Proof of concept: Public demo

The vehicle (V-ITSS) requests the ITS control center (C-ITSS) to provide safety information directly (point-to-point, low frequency) based on the vehicle’s position. It is useful when the vehicle is outside the radio coverage of a roadside ITS station.

Pedestrians (P-ITSS) send their position to the ITS control centre (C-ITSS)

The ITS control centre (C-ITSS) notifies hazard information to relevant roadside ITS stations (R-ITSS) for local broadcasting by the roadside infrastructure.

Roadside ITS stations (R-ITSS) periodically broadcast hazard information to passing by vehicles (V-ITSS)

Personal ITS Station (P-ITSS)

Central ITS Station (C-ITSS)

Roadside ITS Station (R-ITSS)

Wi-Fi/11p

3G

The screen in the vehicle (V-ITSS) displays hazard information (either accurate & geolocalized information broadcast by roadside ITS stations at high frequency or last known information transmitted directly at low frequency from the ITS control center. The screen also displays the map and various information received from the CAN bus (speed, etc.).
Cooperative ITS Standards: Conclusions

- Deployment of cooperative ITS based on the ITS station reference architecture [ISO 21217] and related standards [ISO 17423] [ISO 17419] [ISO 17429] [ISO 24102.6]

- Middleware (ITS station facilities layer)
  - To develop media-agnostic applications
  - To provide common services to applications
  - To ensure interoperability
  - To decrease complexity of application

- Proof of concept implementation
  - Position sharing use case on Android
  - Any other use case can be contemplated
Cooperative ITS: Key standards

- ISO 21217 / EN 302 665: ITS Station Architecture published
- ISO 21210 IPv6 networking published
- ISO 24102.6 Flow and Path Management work in progress
- ISO 17429: Profiles for exchange between ITS stations work in progress
- ISO 17423: ITS application requirements and objectives for selection of communication profiles under ballot
Cooperative ITS : Links


EU-US ITS harmonization

- [http://its-standards.eu](http://its-standards.eu) Cooperative ITS Standards
- [http://www.scoref.fr](http://www.scoref.fr) SCORE@F : Système COopératif Routier Expérimental Français
- [http://www.fotsis.com](http://www.fotsis.com) FOTsis European Project (road operators)
- [http://www.cvisproject.org](http://www.cvisproject.org) CVIS : Cooperative Vehicle-Infrastructure Systems
- [http://www.amsterdamgroup.eu](http://www.amsterdamgroup.eu) Amsterdam Group
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