IPv6-based end-to-end communications in Cooperative ITS
from Field Operational Tests to Deployment

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ITSSv6: IPv6 ITS Station Stack for Cooperative ITS FOTs
http://www.itssv6.eu

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ITS: Usages diversity
Cooperative 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: 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

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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: Hybrid Communications

Internet IPv6

Control Center to vehicles in GeoArea

Roadside Unit to vehicles in GeoArea

Internet IPv6

Vehicle A to Control Center

RSU 1

RSU 2

V2V GeoBroadcast
Cooperative ITS: Architecture

- **ETSI/ISO Reference Architecture** 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 (WG 16, 17 & 18) [since 2010]
Cooperative ITS: IP Convergence

• IP-based communications are essential
  • Develop technology-agnostic applications  IP is designed to exploit a diversity of access technologies
  • Internet-based e.g. remote diagnostic, map update, roadside infrastructure
  • e2e communications between ITS stations e.g. vehicle ITSS – central ITSS
  • Maintaining information flow over any available media e.g. 11p, 11n, cellular, satellite, digital broadcast
  • Interoperability with various ITS & non-ITS sectors
Cooperative ITS: IP Convergence - IPv6

- **IPv4** is the most widely deployed version of IP (in ITS and in all other sectors)
  - Address space depleted
- **IPv4** cannot meet ITS requirements
  - 1200 millions vehicles by 2030 at current trend
  - Only $2^{32} = 4\ 294\ 967\ 296$ addresses for all usages
  - Currently being replaced by new IP version: **IPv6**
- **IPv6** provides:
  - IPv6 $2^{128} = 3\ 911\ 873\ 538\ 269\ 506\ 102$ addresses
  - New features required for scalable ITS deployment
  - Natural convergence (ITS sectors and non-ITS sectors)
ITSSv6: Fact sheet

- **IPv6 ITS Station Stack for Cooperative ITS FOTs**
  - FP7 STREP – Grant n° 270519
  - Call 2009-6: ICT for Mobility, Environmental Sustainability and Energy Efficiency
  - Budget / EC funding: 2.5 M€ / 1.8 M€ - 218 PMs
  - Partners: Inria & Mines ParisTech, Institut Telecom, Universidad de Murcia, lesswire, SZTAKI, Bluetechnix, IPTE

- **Objective:** Provide C-ITS FOTs with a robust, performant and secure implementation of ISO/ETSI ITS station IPv6 networking

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**Consortium Partners**

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http://www.itssv6.eu
ITSSv6: Objectives

- Develop a reference IPv6 ITS station stack
  - Provide proof implementation of IPv6 networking
  - Provide a playground to academic labs
  - Provide a framework to the industry
- Assist third parties
  - Develop IPv6 awareness & know-how in ITS
  - IPv6 training material focused to ITS
  - Guidelines for porting to various hardware platforms
  - Assist in deployment / Provide IPv6 services
  - Enhance Cooperative ITS standards
ITSSv6: ISO 21210 / 16788 / 16789
SCOREF: French C-ITS FOT

- **SCORE@F**: Système COopératif Routier Expérimental Français (Sep. 2010 – Jun. 2013)
  - FUI - total budget: 5.6 M€ / 19 partners

- **Objective**: Prepare the deployment of Cooperative ITS standards
  - Tests performed on test tracks and open roads (urban, semi-urban and highway environments)
  - 50 vehicles
  - Applications: road safety, traffic efficiency, comfort
  - Facilities: CAM, DENM, SAM, LDM
  - IPv6, GeoNetworking, multiple access techno (11p, 3G, 11n)
IPv6 solutions in SCORE@F

- **Roadside ITS stations**
  - IPv6 deployed at roadside infrastructure not originally connected to IPv6
    - IPv6 provided to roadside ITS-S over IPv4/3G|Ethernet
    - IPv6 provided to vehicle ITS-S over GeoNetworking/11p

- **Vehicle ITS stations**
  - Selected vehicles equipped with 802.11p (ETSI ITS G5), 2G/3G and 802.11n
  - End2end communications using IPv6
  - Most appropriate radio technology selected dynamically
  - Smooth handover between radio technologies
Cooperative ITS & IPv6: Conclusions

- Deployment of cooperative ITS based on the ISO/ETSI ITS station reference architecture
  - Non-IP communications for time-critical V2V safety applications and IP for all other applications
  - IP-based communications are essential for
    - Internet-based services and e2e services between ITS stations
    - Maintaining information flow over any available media (11p, 11n, cellular, satellite, digital broadcast, ...)
    - Interoperability with various ITS & non-ITS sectors
- IPv6 necessary & ready for deployment
  - Commercial solutions on the market
Key standards

- ISO 21217 / EN 302 665: ITS Station Architecture published
- ISO 21210 IPv6 networking published
- ETSI TR 103 068 ITS-S MNGT Procedures work in progress
- 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 Cooperative ITS Standards
- http://www.scoref.fr SCORE@F : Système COopératif Routier Expérimental Français
- http://www.fotsis.com FOTsis European Project (road operators)
- http://www.amsterdamgroup.eu Amsterdam Group
Don't hesitate to contact me for more information about Cooperative ITS standards and IPv6

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end-to-end communication solutions adapted to ITS

15 years R&D on Internet technologies (IPv6, mobility, security) applied to mobility & transports [Mines ParisTech / Telecom Bretagne / Inria]
YoGoKo Communication Solutions

- YoGoKo provides
  - Engineering: integration of our communication solutions in your hardware / legacy communication system
  - Software: License to use or to integrate in new products
  - Cloud services: connectivity, security
  - Communication box: to be installed in vehicles or roadside infrastructure
  - Counseling: Communication system, Cooperative ITS standards

- References

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