"Smart Roads" progressed by oneM2M: the experience of an EU Large Scale Pilot

AUTOmated driving Progressed by the Internet Of Things

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AUTO mated driving Progressed by the Internet Of Things

Use <u>IoT technologies</u> to move <u>Automated</u> <u>Driving</u> towards a new dimension

- Enhance driving environment perception with "IoT enabled" sensors
- Integrate IoT platforms in the vehicles
- Use IoT Platforms on the Cloud to
 - ✓ «Store & Share» IoT sensor data
 - Create new Mobility Services with fully automated vehicles





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Large Scale Pilot Sites and Partner Consortium

5 Large Scale Pilots on IoT funded by DG CONNECT unit

+ 1 extra EU Self Funded by South Korea

3 Years Innovation Action: 01/01/2017 – 31/12/2019 44 beneficiaries – coordinator: François Fischer, ERTICO Project costs: 25 m€ - EU contribution: 20 m€





Overall concept





Pilot Sites, Applications and Services







- Specific features:
 - ✓ The testbed encompasses the area of the Port of Livorno and the Florence Livorno highway.
 - ✓ IoT devices are deployed in the car and along the roads in both the Highway and the Urban Area.
 - ✓ 7 JEEP Renegade prototype vehicles are used: 2 connected and AD cars, 5 connected cars.
 - \checkmark A **connected bicycle prototype** is also used in the urban tests.
 - ✓ The MONI.C.A.[™] Port Monitoring Centre, Traffic Control Centre with DATEX-II node are integrated into the PS ICT infrastructure.

• Use cases:



- **Highway Pilot**: road hazard events announced by IoT devices enable speed adaptation and lane change functions on the AD cars.
- **Urban driving**: vulnerable road user are detected at traffic light intersection and trigger brakes on the AD cars.











Network Map of Livorno PS



- Large Scale Heterogeneous
 Network Infrastructure:
 - Tier 0:
 - Urban and Highway test sites.
 - Tier-1 service providers:
 - CNIT lab (Livorno);
 - AVR TCC (Empoli);
 - TIM IoT OpenLab (Turin).
 - Tier-2 remote labs:
 - Continental (Toulouse);
 - Thales (Florence);
 - FCA-CRF (Trento);
 - ISMB (Turin).
 - VPN for remote access to

devices during piloting.



Use cases and services





Highway pilot: IoT assisted Speed Adaptation

- In case of puddles an alert triggered by IoT ٠ sensors is published to the oneM2M platform
- RSU broadcasts this information to vehicles • (DENM) and to the OneM2M platform.
- TCC consumes the info validates the alert and set the advisory limit on the oneM2M.
- RSUs updates the DENMS with highest • information quality
- C-eHorizon is subscribed to the oneM2M, it • updates the maps with alert signals and advisory speed
- AD car adapts speed using information obtained from both oneM2M and DENM.





Highway pilot: IoT assisted Speed Adaptation and Lane Change

- TCC publish on the OneM2M platform the information about road works (DATEX-II -> DENM).
- The RSUs is subscribed to the oneM2M and broadcast the DENM message to the vehicles;
- At the same time the C-eHorizon is subscribed • to the oneM2M, it updates the maps with temporary signals and speed limits.
- The in-vehicle application fusing the information from the OBU, the C-eHorizon and on-board sensors, performs speed adaptation and lane change maneuvers;
- The IoT-assisted maneuver is safe and the • driving style is smooth.





Urban driving: IoT enabled traffic light crossroads and VRU protection

• Scenario:

- Port of Livorno maritime terminal
- IoT assisted manoeuvre:
 - AD Speed adaptation

• Tackling with:

- urban-like typical events:
 - traffic light phase
 - pedestrian traffic light violation
 - fallen cyclist in the intersection
 - pavement deformation





OneM2M platform enabling UCs and applications





IoT components of the Italian PS



• Devices

- Puddle IoT sensors (based on 6LowPAN and NB-IoT technologies),
- Pothole detector,
- Smart Trailer (announcing roadway works),
- Road Side Units,
- On Board Units (cars and bicycle),
- Smart traffic light,
- Smart camera.
- Networks
 - 4G cellular network,
 - Port Wireless Backbone,
 - Highway Backbone (Tuscan Institutional Cabled Network),
 - ETSI G5,
 - NB-IoT/6LoWPAN,
- Platforms
 - Infrastructure OneM2M platform,
 - In-vehicle IoT platform.





TIM ICON platform

- TIM provides the oneM2M platform as Platform as a Service (PaaS) that is a cloud model that provides all the infrastructure required to create and manage custom cloud applications
- ICON is installed in a TIM Self Data Center, a commercial platform for hosting, managed by TIM
- The platform is exposed on public Internet at <u>https://icon-lab.tim.it</u>
- It is based on Ocean platform, an open source product developed by a worldwide consortium promoted by Korea





Platform high-level architecture



- Compliance with the oneM2M standard
- Southbound and northbound Rest APIs for data storage and sharing
- Data sharing by means of pull/push (subscription/notification)
- URIs for identifying resources
- Web console for resource management and provisioning
- Web console for administrators
- Service independent, interworking with legacy platforms and non-OneM2M platforms by means of Adapters/Proxies
- Multi-tenancy: each tenant has credentials for access to its data



IoT Devices

- All IoT devices are integrated in into the ICON platform.
- The IoT devices used are used to enhance the autonomous driving function considering:
 - latency;
 - availability;
 - range (covered area).



AVR 6LoWPAN Water Level Sensor



ISMB "Virtual" Pothole Sensor



ISMB Connected bicycle



CNIT NB-IoT Water Level Sensor



ISMB IoT In-Vehicle Platform



CNIT IoT G5 RSU



ISMB Smart Traffic Light with Pedestrian detection





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Data Model and Resource tree



Data model

- The Data Model has five different packages:
 - Vehicle package
 - Based on Sensoris with plain JSON (Protobuf binary supported but not used)
 - Collects generic vehicles data coming from CAN bus
 - For data that cannot be directly mapped with Sensoris specifications, the ProprietaryInfo structure defined in Sensoris is used
 - NB-IoT package
 - RSU package
 - Traffic Control Center Package
 - DENMS
 - Validtions
 - DATEX II
 - Events
 - Status



Resource tree



- The resource tree for the Autopilot tenant.
- For each RSU there is a container for CAM messages received from the vehicle passing nearby



Example of a message

An example of a CAM message received from the RSU and published on ICON platform





Final User Applications



IoT final user applications



• Enabling:

Port Monitoring by IoT functions ٠ for drivers and VRU safety





On-board sensors

"Fog" information

Cmit corsorato nazionale interuniversitario

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Pedestrian Red Light Violation event







VIDEO: Puddle hazard on the highway





Conclusions

- Livorno experience shows that OneM2M compliant platforms and devices are valuable bricks of the digital infrastructure for accommodating the usage of AD cars in EU roads.
- The ICON oneM2M platform has been extended in order to manage the demanding IoT environment for AD cars.
- Starting from the use cases and based on ETSI C-ITS, Sensoris and DATEX2 legacy data models, a new data model supporting IoT services for AD cars has been proposed.
- Besides IoT sensors, also DATEX2 node and C-ITS devices have been integrated as oneM2M resources.
- Further work is need to achieve seamless interfaces between C-ITS and DATEX2 events.



Thank you for your attention

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