“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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AUTOmated driving Progressed by the Internet Of Things

Use **IoT technologies** to move **Automated Driving** 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€

Eindhoven, NL
Versailles, FR
Vigo, SP
Tampere, FI
Daejeon, KR
Livorno, IT
Overall concept
## Pilot Sites, Applications and Services

### IoT enabled Services

- **Vulnerable Road User sensing**
- **6\(^{th}\) sense driving**
- **Dynamic eHorizon**

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About Livorno Pilot Site

• 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.
  ✓ 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.

• Partners involved:

  Supported by:
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 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

AUTOPILOT in Italy – oneM2M enabling "Smart Roads" for AD cars

15/10/2018
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 https://icon-lab.tim.it.
- 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 into the ICON platform.
- The IoT devices used are used to enhance the autonomous driving function considering:
  - latency;
  - availability;
  - range (covered area).
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.

Values of attributes

oneM2M attributes: Name, ID, time, type of content, etc.

Identifier

A CAM message that is the content stored on ICON.
Final User Applications
IoT final user applications

• Enabling:
  • Port Monitoring by IoT functions for drivers and VRU safety

• Driving with 6th sense:
  • Connected-eHorizon

• Checking:
  • status of the IoT infrastructure by means of connected probe vehicles

• Validating:
  • IoT detections as (DATEX - formatted) events flowing through TCC

AUTOPilot in Italy – oneM2M enabling "Smart Roads" for AD cars
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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