An IoT Framework for Intelligent Roadside Assistance System

Soumya Kanti Datta and Christian Bonnet
EURECOM
Sophia Antipolis, France
E-mails: {dattas, bonnet}@eurecom.fr

***Abstract*—The connected road infrastructure and roadside assistance services constitute an important consumer market segment in the Intelligent Transportation System (ITS) and Smart Cities. A closer look at available such services reveal the presence of data silos, heterogeneity and lack of interoperability. They affect the overall consumer experience and increase the cost of service development & maintenance. This paper proposes an IoT framework for next generation, intelligent roadside assistance system. A data centric architecture is presented along with solutions of the mentioned challenges.**

***Index Terms*—Consumer IoT; Data centric architecture; Intelligent Roadside system; Interoperability.**

I. Introduction

The Internet of Things (IoT) continues to expand its applicability to many consumer markets. The opportunities include basic scenario like connecting things to a cloud platform to complex scenario like connected roadside infrastructure, lane detection and tracking of vehicles from [7] self-driving cars. Greater availability of the IoT products, services and inexpensive connectivity are creating new business cases in multiple domains. In ITS market, roadside assistance[1] is an important consumer segment which assists in several operations including safety and emergency alerts. But the combined cost of deployment, maintenance and other resources is expensive[2]. In parallel, integration of mobile Internet, V2X communication and powerful On Board Unit (OBU) has significantly increased the demand for roadside assistance services like locating fuel station and emergency communication. Also the ongoing smart city waves promise to deploy IoT infrastructure for emergency situations [8], better road safety, cooperative mobility management and crowdsensing which in turn create more opportunities for roadside assistance services. Soon these legacy services have to be upgraded to offer next generation services including three main aspects - (i) support for ITS through V2X communication, (ii) unified and standard mechanism for vehicular data collection, processing, storage & decision making ability and (iii) seamless interoperability & information exchange among vehicles, computing platforms and consumer mobile devices.

This paper aims to investigate the design and development of next generation roadside assistance services for ITS and future smart cities. IoT and M2M communications are considered as two main pillars of smart cities [2]. Thus, we propose an IoT Framework for intelligent roadside assistance system that can provide wide range of assistance to drivers and passengers. We have identified research and engineering challenges related to the proposed IoT framework. Our research contributions in this paper are - (i) creating a co-existence of distributed data analysis (edge computing) and cloud computing, (ii) consumer centric [9] & horizontal IoT application development, (iii) seamless support of interoperability among building blocks, (iv) IoT and Web of Things (WoT) standards based implementation to break data silos and (v) open interfaces and APIs allowing third party developers to create inexpensive roadside assistance application.

[1]http://www.anythingresearch.com/industry/Automobile-Towing-Road-Service.htm

[2]http://www.finaccord.com/documents/series_prospectus_road_assistance_major_global_markets.pdf

II. Research and Engineering Challenges

This section identifies the main challenges for developing the proposed framework.

- **Infrastructure centric approach -** The current deployment is specific infrastructure centric which increases the cost of service development, deployment and maintenance. Apart from that, the inherent heterogeneity of the infrastructure promotes silo-based implementations and non-portable solutions.
- **Cloud based solutions -** Cloudification of such assistance services were done during a first wave of modernization of infrastructure. But in the vehicular and ITS contexts, real-time response to consumers is a key differentiator. Centralized treatment of data and requests at the cloud systems are not suitable and thus, the industry is looking at distributed analysis via edge computing [5]. The co-existence of edge and cloud computing is the key.
- **Consumer IoT approach -** As reported in [3], consumer centric and horizontal application development approaches are missing from the current roadside assistance systems.
- **Seamless interoperability -** Because of heterogeneous infrastructure and silo-based solutions, there is a lack of interoperability among software platforms and consumer devices. This is not a suitable scenarios for emergency solutions . As a result, the overall system becomes closed rather than an open API based system.

Therefore consumer experience become inferior which can be solved using the IoT and smart city technologies.

III. IoT Framework and Prototyping

It is evident from the previous discussion that the roadside assistance landscape should be upgraded to fit into a standard, consumer centric and open APIs based IoT framework. We describe solution to the four challenges presented above as

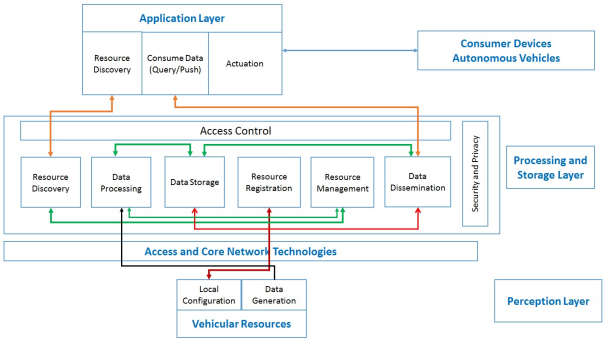

Fig. 1. Architecture of IoT framework for roadside assistance services.

well. Fig. 1 portrays the generic architecture of the proposed framework.

A. IoT Framework

The IoT Framework builds upon a data centric architecture called DataTweet [4] which decouples the dependency from the infrastructure. To settle heterogeneity of the building blocks, they should be uniformly described using CoRE Link Format [1]. The resulting description is lightweight and allows a computing platform and consumer device to understand the type of infrastructure. The heterogeneity of sensor types and their measurements used in the roadside assistance services can be overcome using SenML protocol [6] which is specifically defined for such purpose.

The framework considers the vehicular resources from which service request originates at the perception layer. The OBU of a vehicle contains a software module to initiate specific consumer requests. The processing and storage layer components are deployed in a Road Side Unit (RSU) which is connected to a cloud back-end for long term data storage and automatic service management. The communication link between the vehicle and RSU is ITS-G5. The RSU (edge computing platform) extracts the request from payload and forwards it the appropriate web service providing the assistance. The web service will obtain the payload, process it and reply.

The framework builds upon open standards recommended by oneM2M and W3C Web of Things Working Group[3]. This allows the framework to provide open and secure APIs for third party application development. The application development is extended from [3] which allows any developer to focus on the application logic of novel roadside application service. The software modules for resource discovery, data management, processing, security are provided by the DataTweet Framework. This facility makes the application development process more consumer centric and eases the process of development & maintenance. Finally, the framework is generic which allows the computational part to be deployed in a edge computing platform. The cloud systems provide long term storage, automatic management of services and their lifecycles. This corresponds to the co-existence of edge and cloud computing.

[3]https://www.w3.org/WoT/WG/

B. Prototype Development

A prototype of the system is being developed. A Least Mean Square based noise cancellation algorithm is developed to remove roadside noise when a consumer seeks verbal assistance through the assistance system. This algorithm together with the IoT components are running on an Road Side Unit (RSU) positioned next to the road forming the edge computing platform. For prototyping purpose a Raspberry Pi performs the computation and is attached to the RSU which receives the request via ITS-G5 communication link. For the IoT enabled assistance service, using DataTweet framework, handwritten codes can be reduced by almost 70% [3]. This allows the developers to focus more on consumer centric application logic.

IV. Conclusions

The paper focuses on the IoT based next generation roadside assistance services for ITS and smart cities. The currently deployed such services pose many challenges and must be upgraded to an open, secure and standard system. This will unleash the true consumer potential of such services. As for future work, we would evaluate the performance of the complete prototype and deploy it in a real test bed.

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