Poster Abstract: An Open Smart City IoT Test Bed

Street Light Poles as Smart City Spines

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ABSTRACT

Street light poles will be a key enabler for a smart city's hardware infrastructure, thanks to their ubiquity throughout the city as well as access to power. We propose an IoT test bed around light poles for the city, with a modular hardware and software architecture to enable experimentation with various technologies.

CCS CONCEPTS

•Information systems →Information integration;

KEYWORDS

IoT Middleware, Streetlight Poles, GPON, LoRa, Smart City Test Bed, Semantic Interoperability, Distributed Analytics

ACM Reference format:
Bharadwaj Amrutur, Vasanth Rajaraman, Srikrishna Acharya, Rakshit Ramesh, Ashish Joglekar, Abhay Sharma, Yogesh Simmhan, Abhijit Lele, and Ashwin Mahesh, Sathya Sankaran. 2017. Poster Abstract: An Open Smart City IoT Test Bed. In *Proceedings of The 2nd ACM/IEEE International Conference on Internet-of-Things Design and Implementation, Pittsburgh, PA USA, April 2017 (IoTDI 2017),* 2 pages.
DOI: http://dx.doi.org/10.1145/3054977.3057303

1 INTRODUCTION

Cities, with their complex web of interacting sub-systems, offer a rich platform for the application of cyber physical systems (CPS) concepts. Advances in sensing, communications, web, cloud, GIS and smart-phone technologies, provide a diverse menu of affordable technology options to bring in the ficyberfi component for city operations. However, there is a need for a test bed, which can enable exploration and experimentation and hence we propose a test bed around light poles.

DOI: http://dx.doi.org/10.1145/3054977.3057303

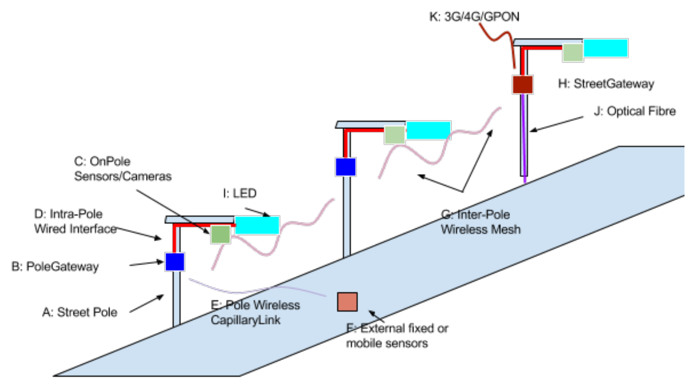

Figure 1: Streetlight Pole Test Bed Concept

2 HARDWARE ARCHITECTURE

The streetlight pole offers a basic mechanical structure and provides a single phase 230V AC supply. As the cities are already contemplating replacing existing halogen based street lamps with more energy efficient LEDs, it is possible to enhance it to incorporate support for more sensors as well as support IoT communications to enable a more general smart city solution (Figure 1). Analysis of the sensors required for the various components for intelligent traffic solutions, crowd surveillance, air quality etc. indicate that many of these can be hosted on the Streetlight Poles. Low bandwidth sensors like air quality, ambient noise, weather, illuminance etc. and actuators like street lights, can be connected via a low bandwidth, wide area, wireless network like LoRa [1] or NB-IoT. However, video cameras are challenging in terms of networking, compute and storage requirements. With optical fiber becoming quite common in city streets, it becomes convenient to use fiber backbone for cameras. We believe that a judicious mix of high bandwidth local wireless mesh in combination with a long haul high bandwidth fiber backbone will provide a cost optimal solution. Our proposed network architecture is shown in Figure 2, where our test bed spans about 50 light poles, with inter pole separation of by about 30m. We group the poles into clusters of 5 poles each. The center pole is connected to the GPON network to an OLT (Optical Line Termination). The pole with the GPON gateway also has a wireless access point and the 2 poles on each side of the GPON pole are connected wirelessly to this central pole. We surmise that an

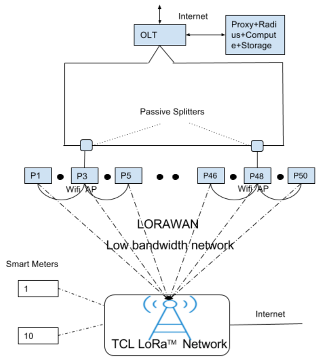

Figure 2: Test Bed Network Architecture

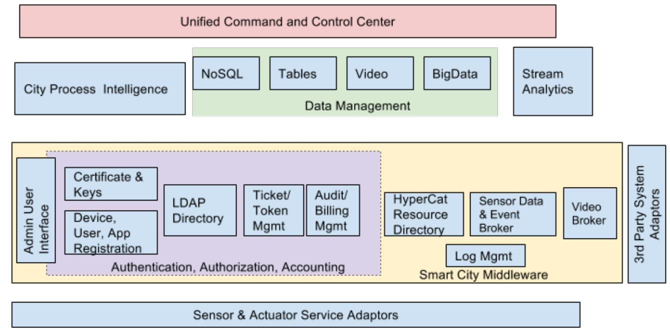

Figure 3: Test Bed Software Architecture

aggregate wireless bandwidth of 40Mbps for the wireless gateway should suffice to cover the video transmission requirements from each of the four poles. The PON itself provides for 1.25Gbps aggregate uplink bandwidth and can support upto 25 such clusters. One of the goals of this test bed is to understand the performance of the network architecture and its optimization under real-world usage scenarios.

3 COMPUTE ARCHITECTURE

The compute platform on a pole consists of a linux gateway which is connected via an 8-port Ethernet switch to the GPON interface (or the wireless access point based on the pole type). One or more IP cameras are connected to the switch and optionally an analytics processor is attached. Since these are deployed in public places, security becomes a paramount issue and is something we are exploring. We propose to use a managed switch with 802.1x port authentication and TPM for establishing root of trust. The array of computers on the pole along with the server attached with the OLT becomes a distributed compute cluster, on which we plan to explore edge/fog analytics [7] for video data.

4 SOFTWARE ARCHITECTURE

The Core sensor data broker platform (Figure 3) acts as the intermediary between the data sources and the data consumers. Data sources can be real or virtual sensors (either from light poles or from other sensors), citizen generated data, data from existing departments/IT infrastructure or other virtual sensors from applications. Data consumers can be applications, citizen, software processes (including edge analytics based sensors) or actuators (like displays, LED lights etc.). Each data producer and consumer registers with the platform, gets authenticated, obtains security credentials and has secure access to allowed resources.

The core platform also hosts a catalogue of information resources [2], with their semantic annotations and the means of accessing them. The catalogue supports search and discovery of resources. The platform also hosts brokers for low bandwidth sensor data, real time data and video streams.

The test bed allows multiple application layers, from different vendors to operate simultaneously. A typical application layer will have a unified command and control centre, a big data management platform, a stream analytics platform and a business intelligence platform. A typical city process, like garbage collection, could be expressed in Business Process Execution Language (BPEL) and executed by a workflow engine, which then reports the health of the process as a virtual sensor into the core data broker platform.

5 STATUS AND DISCUSSIONS

The preliminary version of our middleware platform is currently based on Sentilo [3]. In-order to support a broad range of sensors we integrated the support for SenML [4] in Sentilo. Our semantic data models consist of a semi-static portion and a dynamic portion and are based on an amalgamation of existing models from Fiware [5] and Saref [6]. Semi-static/Static portions of the data are stored in the catalogue, while the dynamic data is sent via SenML to the data broker. End to end security, semantic interoperability and edge/fog analytics for video are the key research questions we are exploring with our experimental test bed.

ACKNOWLEDGMENTS

We thank Electronic City, Bangalore and the Ministry of Electronics and Information Technology, Govt of India, for support.

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