Enabling Layered Interoperability for Internet of Things Through LISA

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I. Introduction

The Internet of Things (IoT) is growing fast and promising various benefits. A wide range of devices, communication technologies and standards are introduced. However, these heterogeneous collection of entites are challenged by the lack of interoperability. Due to a different set of requirements by IoT and resource constraints of the majority of the devices, existing methods of solving interoperability challenges are not feasible. To enable these heterogeneous technologies work together, standardization activities and various researches are going on. There are many efforts to solve interoperability challenges using middleware. The majority of these middlewares are not designed for resource constrained devices. Our middleware, a Lightweight IoT Service bus Architecture (LISA), is inspired by Network on Terminal Architecture (NoTA) from Nokia Research Center. The focus of this work is on the demonstration of LISA. In the following section an overview of the middleware is presented with highlights of the demonstration and results.

II. LISA: the middleware

LISA is designed with resource constraints of IoT devices in mind. These constraints are in battery life, memory and computing power. To work with these constraints a range of operating systems, communication protocols and applications are proposed. LISA is designed to be easily portable to these various platforms and support a range of protocols. This enables the interoperability of devices at technical and syntactic interoperability layers. Figure 1 shows how LISA works in a typical three tier IoT deployment architecture. The general architecture enabled through LISA is service oriented (SOA). At the base of the architecture a lightweight middleware is used to write application (AN) and service nodes (SN). These are resource constrained nodes that form a small portion of a subsystem that compose to form a bigger system. The layers above this base layer (cloud and fog layers) support in fulfilling the requirements of AN's and SN's, such as mobility and interoperability. Along with LISA, a node centric networking (NCN) is also proposed to compose semantic information along with the data collected from AN's and SN's. NCN is a variant of Information Centric networking paradigm where by communication packets are routed based on the name of nodes (LISA addresses) instead of network address specific for each protocol.

An intermediate computing layer, Fog layer, is composed of gateways with fewer resource constraints running manager node (MN) of LISA. Service nodes register to a nearby manager node for application nodes (client) to discover a service. For cross-protocol communication the manager node serves in translating one format to the other. Nodes use domain specific ontology names to discover each other from user applications, which are appended to a URI to uniquely identify a node at the Fog layer. These unique node names are used as appendices to a predefined resource identifier that comes from domain specific ontologies.

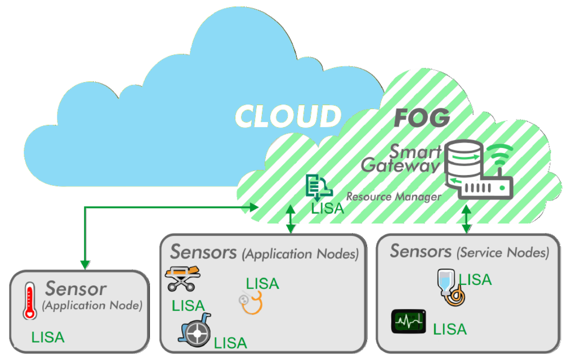

Fig. 1. LISA in a three tier IoT architecture

III. Demonstration

To demonstrate LISA, the first target real-time operating system (RTOS) used is RIOT with 6LoWPAN at the base (sensor) layer and Linux is used in the gateway. A uniform socket like API is exposed to user application, which passes requests to the core of LISA. The core component interacts with the communication infrastructure and the operating system with standard interfaces that help to swap different choices, such as Contiki or TinyOs. Manager nodes communicate with each other to discover a service node registered in one manager by a client from a different subnetwork that belong to a different manager. The message is routed based on internal LISA names at the data plane of LISA. To see the performance characteristics of LISA, the memory footprint and timing measurement has been done and the results are published in [1]. As part of the future plan, LISA will include various platform and protocol support modules that enable it to be portable in multiple configurations.

References

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