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SENSEI 6lowapp Requirements
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Abstract

This draft examines the requirements created by the SENSEI project which are relevant to the 6LowApp interest group. The SENSEI project is a large-scale EU project dealing with the design and implementation of a framework for supporting applications wishing to use sensor information.

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1. Introduction

In order to fully realize the vision of intelligent machine-to-machine (M2M) communication, heterogeneous wireless sensor and actuator networks (WS&AN) have to be integrated into a common framework of global scale on the Internet. This framework will need to make the resources of the WS&ANs available to services and applications via a set of open service interfaces. The SENSEI project is a large European Union Framework 7 project started in 2008 with a consortium of 19 partners [SENSEI]. This project has created an open architecture that fundamentally addresses the scalability problems for a large number of globally distributed WS&AN devices. It provides necessary network and information management services to enable reliable and accurate context information retrieval and interaction with the physical environment. By adding mechanisms for accounting, security, privacy and trust it enables an open and secure environment for context-awareness and real world interaction.

The SENSEI Framework represents sensors and actuators as resources. A Resource is a conceptual representation, in the SENSEI domain, of any information source that enables real world sensing or has the ability to act upon the environment and entities within it. In addition to Resources that have direct access to the physical world, the concept covers also indirect information sources that acquire context information via aggregation, fusion or even inference from other SENSEI Resources. The SENSEI Framework has been designed using fundamental concepts of the World-Wide Web. In order to enable the SENSEI framework on even the most constrained devices (simple sensors) and networks (such as 6LoWPAN [RFC4944]), it makes use of a SENSEI embedded resource concept extending the web resource model to minimal IPv6 nodes with very little overhead.

SENSEI project has made the initial implementation of the designed global framework. It consists of the SENSEI core components: - Resource Directory: serving as a rendez-vous point for resources and resource users, it is storing descriptions of all available resources. XML is used to describe the resources. There are two types of description: basic and advanced. The basic descriptions contain simple text based tags identifying the resource. Advanced resource descriptions contain semantic descriptions with detailed information about the context of the resource including its location, available operations, inputs, outputs, etc. All resource descriptions are XML based. - Semantic Query Resolver: Responsible for analysis of high level user queries and discovery of suitable and available resources capable of providing information required to respond to the queries - Wireless sensor and actuator network islands that interact with the framework via their respective gateways. Implementation of a SENSEI resource end point wrapper is provided and

can be applied to any gateway to make it SENSEI compliant. Communication between all framework components is implemented using RESTful interfaces. POST, GET, UPDATE and DELETE messages are used to implement defined interfaces: RPI (Resource Publication Interface), RLI (Resource Lookup interface) and RAI (Resource Access Interface). WS&AN Gateways are responsible for compression of these messages for the end sensor nodes using EXI.

The SENSEI project has very similar goals to 6LowApp [I-D.bormann-6lowpan-6lowapp-problem], and has considered a wide range of M2M applications. This document introduces selected markets and scenarios that SENSEI is addressing and the requirements which have been derived from them for achieving the SENSEI resource architecture. We especially look at the SENSEI embedded resource concept, and the requirements related to that useful also in the scope of 6LowApp. Finally the document concludes with possible contributions to the 6LowApp effort.

2. Markets and Scenarios

A large effort has been made in SENSEI to identify and study relevant markets and application scenarios for this technology. In this section we look at a subset of these applications.

Transportation: Modern cars along with the roads are becoming more instrumented with sensors. Taking information from these different sources and presenting it to the driver and/or passengers of a car would allow better navigation and safety. Collision avoidance systems and monitoring of transportation of hazardous materials are two typical examples. Governmental authorities would also benefit from more accurate information about road traffic patterns for planning purposes. Enterprises, such as freight companies, would be able to perform more effective route optimization which allows energy savings.

Smart places: The major issues of the future have to be tackled in cities: environment, security and well-being. To meet these needs, sensors and actuators will thrive preferably there thanks to economies of scale. This will take the form of mapping the physical space into the Internet by allowing the public to interact, locally or remotely, with the physical environment through the Internet via the use of mobile devices.

Building automation: Every building (houses, offices etc.) will have wireless sensor and actuator networks in order to automate some processes, to support in users' activities, to make people more comfortable and to secure their environment through more efficient

energy consumption. There is a critical opportunity for deploying Sin's in every building. In addition to the standard WS&AN applications like the monitoring of temperature, humidity and other parameters in a certain area or room, applications improving energy management are of increasing importance.

Supply chain management: Whilst SENSEI examines passenger transport, supply chain management is an equally important area focusing on goods transport. As for passenger transport mobility is a key issue for future for goods transport as well, because supply chains are getting ever more global. In particular for cross border shipments, companies have to stick to regulations imposed by external authorities, environmental or social regulations.

3. Requirements

Using the application scenarios identified for the project, requirements were extracted for achieving the global resource architecture of the project. In this section the general project requirements are first summarized. This is followed by an analysis of technical requirements related to realizing the SENSEI embedded resource concept that will be of interest to 6LowApp.

3.1. General

General requirements that have been derived from the SENSEI scope and problem statement are as follows:

(1) Horizontalisation: Facilitate the horizontal reuse of sensing, actuation and processing resources for a large number of applications. This is similar to the idea of software reuse in software engineering. Rather than having to recreate custom bespoke solutions from scratch, it would be more efficient to reuse the existing infrastructure.

(2) Heterogeneity: Accommodate a variety of different (technology, administrative domains) sensor and actuator networks at its edges. Whilst there will undeniably be an enormous variety of sensors and actuators in the future, it is essential to use a common method for interacting with them.

(3) Reduced Complexity: Reduce the complexity of accessing sensing and actuation resources for applications. Since many sensors & actuators and even gateways will have limited hardware resources, keeping the complexity to an absolute minimum will be crucial for the successful operation of the system.

(4) Simplicity: Reduce the barrier of participation for WS&ANs and thus facilitate deployment by ease of integration. Related to the previous point, it is important that it is simple and straightforward for new WS&ANs to be connected to a SENSEI system and for these resources to be easily accessible.

(5) Evolvability: The architecture must be evolvable to withstand technological change forced upon by tussles carried out by actors in the eco-system. For reasons of sustainability we wish to maximize the lifetime of the deployed system by allowing it to be retasked to support new sensors and also new applications.

3.2. Application Protocols

The SENSEI project has designed and implemented an embedded web resource protocol with similar goals to that of 6LowApp. In this section we have extracted the key requirements used for this design. In the realization of SENSEI resources and components, their interfaces have been designed using RESTful principles.

Application protocol requirements from SENSEI:

(1) Push & Pull methods of interaction need to be supported. Additionally, both one-time and periodic versions of these interaction methods need to be supported to support as wide a range of interactions as possible. As sensor nodes are often available with a small duty cycle, a subscription-based PUSH feature is critical to the application protocol. It should be noted here that push interaction without any optimization is quite resource-intensive as it requires soft-state to be kept at the resource as to who the subscribers are.

(2) URL identifiers for resources, with the ability to compress URLs with out-of-band identifiers.

(3) Caching and the ability to deal with sleeping nodes at the edge of IP sensor network (e.g. 6LoWPAN) islands.

(4) Support for REST methods (GET, POST, PUT, DELETE) allowing for easy interoperability with HTTP through a proxy.

(5) Support for UDP as a transport. Wireless mesh networks suffer from packet losses and SENSEI transactions are often just a single packet exchange. TCP is not suitable in such situations due to its sensitivity to large variations in latency which are typical of wireless cellular networks and also keeping a TCP connection up in the presence of mobility is a challenging task.

(6) Internet media type and transfer encoding type support. The project uses RDF/XML and XML payloads which are encoded using EXI.

(7) A compact protocol header which is easy to parse.

3.3. Application Commissioning

SENSEI performs application commissioning using what is called the Resource Publication Interface (RPI). This interface is realized with the same embedded web resource protocol on a well-known URL on the proxy (usually on the Edge Router of the WS&AN) supporting REST methods. Embedded resources advertise themselves by sending an EXI encoded XML resource description, describing its resources available, the interfaces to access them and meta-data.

Once resources have been published, they can subsequently be looked up by using the corresponding Resource Lookup Interface (RLI). The RLI supports both one-shot lookups and longer-lasting lookup subscriptions. Similar to the RPI above, it uses an embedded web resource protocol to provide this functionality.

The only requirement this kind of application commissioning requires is for the embedded web protocol to support URLs and standard content and encoding types. For more general use multicast support may also be required.

4. Conclusions

The SENSEI project has developed an architecture for globally scalable web resources for machines, sensors and actuators - The Internet of Things. Part of this architecture includes an embedded resource concept enabling web resources on very constrained devices and networks while maintaining end-to-end IP principles and easy interoperability with existing web protocols.

Potential contributions of this consortium to the 6LowApp effort may include:

(1) Input to the problem statement, objectives and requirements

(2) Participation in the design of an embedded web resource protocol

(3) Participation in the requirements and design of application commissioning

(4) Possible input on security, web architecture integration, scalability and resource mobility.

5. Security Considerations

No security issues have been identified in this draft.

6. IANA Considerations

This draft requires no IANA consideration.

7. Acknowledgments

We wish to thank our fellow members of the SENSEI consortium for many fruitful discussions.

8. References

8.1. Normative References

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