SENSORS NETWORKS, SOA AND WEB BASED APPROACH FOR FRESH WATER ENVIRONEMNTAL MONITORING

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ABSTRACT

Sensor Networks are currently being considered for critical monitoring. For example, in this paper our main purpose is to provide continuous access to real-time and historical data as well as integration with model predictions/forecasts. The system includes network of sensors which is distributed and customizable based on sensor and communication requirements. This data includes water quality parameters like conductivity, temperature, salinity, and turbidity. Web based SDOA platform is used in this paper to manage, collect data, and monitor a fresh water area. Then our system consists in three layers. The first layer is the infrastructure layer of sensors. It includes sensor modules, sensors network control box with presentation layer functionalities to effect access, distribution and update of spatially attributed data via basic web services for devices. Then, the system takes advantage of Internet mapping and web-services technology to publish and compose data in the second layer of the system. In our application, it allows to create maps dynamically and enable the visualization of a diverse and growing collection of environmental data on fresh water and integrated catchment management initiative, in the third layer (user-center layer). The three described layers then allow users to search, query and visualize the data from network with distributed but also variable collection of sensors. This original architecture is detailed in this paper.

1.0 Introduction

Sensor Networks are currently being considered for critical monitoring. Then the main purpose is to provide continuous access to real-time and historical data as well as integration with model predictions/forecasts. The system includes network of sensors which is distributed and customizable based on sensor and communication requirements. This data includes water quality parameters like conductivity, temperature, salinity, and turbidity. In the next section we present the overall system we propose to manage, collect data, and monitor the fresh water environmental information and operational system. Freshwater systems integrate environmental factors such as hydrogeological and chemical cycling, geology and land-use within catchments and over larger landscape-scales as well as atmospheric, climatic and meteorological inputs [9]. In fact, all manner of aboitic factors combine with biological features and processes to determine water availability and quality. The system will illustrate i) how environmental, chemical and biological data can be integrated into a Geographical Information Systems (GIS) database and ii) how these data can be used for operational forecast. In such a system, Sensor Networks technologies are facing new challenges including heterogeneity, interoperability, failure detection, dynamic appearance and disappearance of sensors etc. Then, management and data processing of these distributed sensors has become equally important issues. In the second section of this paper we detail how we can solve such challenges in the infrastructure layer of sensors of environmental information and operational system. Finally we conclude with the limitations and perspectives of such a new approach.

2.0 Development of Fresh water Information and Operational System

The development of fresh water environmental information system is to effect access, distribution and update of spatially attributed data via web-based systems involving GIS and mapping technology. Interactive digital maps have also become the means by which users present their queries to databases and information stores. The system takes advantage of Internet mapping and web-services technology to publish data as maps. These maps are created dynamically and enable the visualization of a diverse and growing collection of environmental data on fresh water and integrated catchment management initiative.

The Information System designed to perform the following unique set of services:

a) ingest of data sets in different formats;
b) cataloging and search of data sets;
c) interactive visualization as graphics, tables, maps, or reports;
d) secured access to data access, visualization and dissemination
e) data export after conversion to other application formats
f) Networking with existing databases

The System is based on web based client-server architecture. The server side software components consist of several servers working in tandem, including Apache, web mapping server (ArcGIS), Database server (MSSQL) .NET application development. The web mapping server handles the linkage between spatial objects and non-spatial attribute data stored in a relational database. The web based system will allow the users to interactively query, visualize data and analyze spatially through decision support tools.

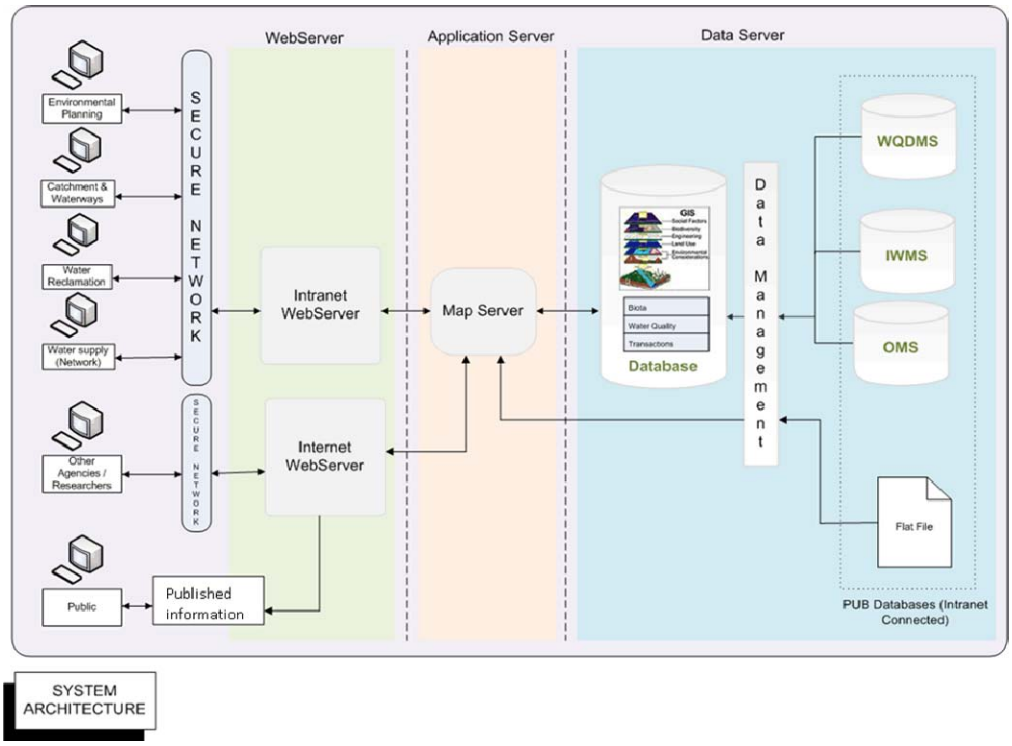

Figure 1: Information System Architecture

The system consists of three tier security system enable to allow users to access the system online and access to appropriate data. The first tier will have permissions to access all the information for day to operational use and decision making purposes. The second level will allow restricted data access for research institutions. The third tier will be access to general public on the fresh water information. The Operations System includes network of sensors and computer system to manage, collect data, and monitor a fresh water area. It consists in three layers.

The first layer is the infrastructure layer of sensors. It includes sensor modules, sensors network control box with presentation layer functionalities to effect access, distribution and update of spatially attributed data. Then, the system takes advantage of Internet mapping and web-services technology to publish and compose data in the second layer of the system. In our application, it allows to create maps dynamically and enable the visualization of a diverse and growing collection of environmental data on fresh water and integrated catchment management initiative, in the third layer (user-center layer).

For example, portal will be developing to show status of data quality. Portal will trigger alerts if quality of data falls below specified value (e.g. in terms of age of data). An issue resolution feature will be provided in the Portal for use during the project cycle to track project issues which subsequently can also be used for operational issues resolution.

The three described layers then allow users to search, query and visualize the data from network with distributed but also variable collection of sensors.

3.0 Infrastructure layer improvements

Sensor Networks technologies are facing challenges including heterogeneity, interoperability, failure detection, and especially dynamic appearance and disappearance of sensors. Then, management of these distributed sensors in the infrastructure has become equally important issues as data processing. Thus services oriented approaches [2][5], well-adapted to implement operational data acquisition and processing workflow, need to be extended to address multi-device systems, appearing and disappearing at runtime like sensors networks. Using services to create applications based on devices proved its worth for almost ten years, with Jini (1999) [3][6] and UPnP (1999) [4][7] but haven't met web standards.

Today, emerging Web services software technology appears with the potential to address these challenges [8][13]. Web services is a Web standard-based, XML-centric realization of Service-Oriented Architecture, which enables heterogeneous systems to describe, discover, and invoke services anywhere, anytime, irrespective of the network and platforms. Some additional standards like WS-Eventing in Device Profile for Web Service (DPWS [5][8]), allows sensors to emit spontaneous information, as events, from the environment through the sensor network, to the computing system. Introducing the notion of SDOA (Service for Device Oriented Architecture) to sensors (as Web Services for Device) thus provides management capacity for modeling sensors that can be discovered and composed via the Internet.

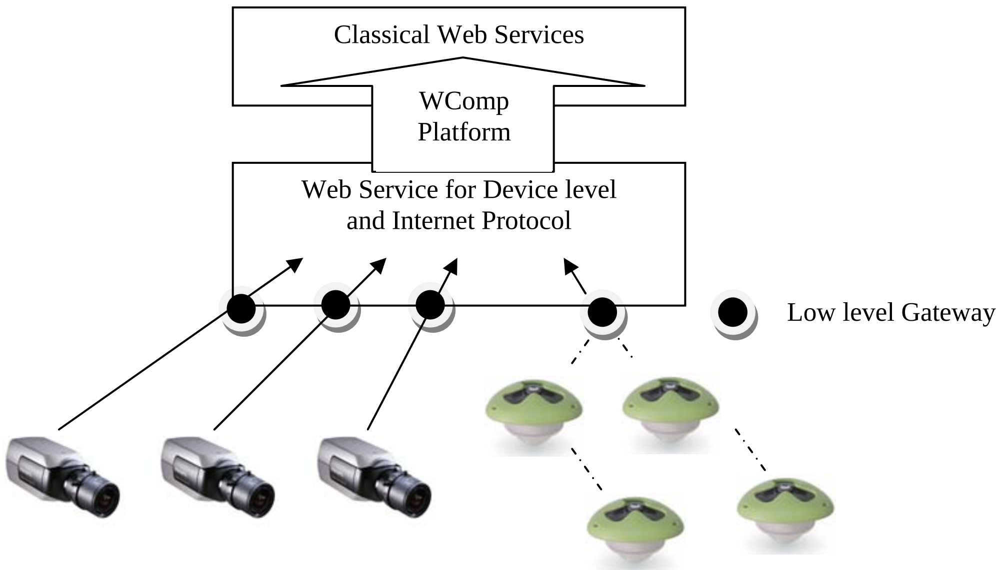

Figure 2: Operational System Infrastructure layer

In such evolution, two new principles and features appeared to fit new infrastructure requirements. Firstly, one of the main evolutions is probably the full discoverability. In fact services are classically discoverable using repositories and service brokers. Now, we can discover new device like sensors on the fly thanks to a peer to peer discovery mechanism. Secondly, a new kind of eventing interaction between services is providing to allow spontaneous messages to be sent from the real world through sensors to software clients in Operational System.

The Infrastructure of Operational System is then managed using two levels of communications (see figure 2). The first one consists in gateways attached to sensors and enabling communication between specific network technologies and an IP based network. Every gateway gets specific data from its sensors and exposes them using a web service for device DPWS. At the second level, our Web service for device composition platform, named WComp [1][3] [6][9], allows to produce new classical web services for the upper layer of the Operational System, in spite of the dynamic appearance and disappearance of sensors.

4.0 Conclusion

We presented in this paper the Operations System including network of sensors and computer system to manage, collect data, and monitor a fresh water area. In such a system, Sensor Networks technologies are facing new challenges including heterogeneity, interoperability, failure detection, dynamic appearance and disappearance of sensors etc. Then, management and data processing of these distributed sensors has become equally important issues. To address such new challenges we introduce Web service extended technologies with two new principles and features:

- the management of the dynamic appearance and disappearance of services for device and
- a new kind of interaction, event based, in order to send spontaneous information from the environment to the system through the service for device.

The limitations of this approach lies in the necessity of having to equip each device or set of devices with gateways to reach extended standards of web services. Each gateway design is coupled to the local protocol used by specific devices and sensors.

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