6PANview: A network monitoring system for the “Internet of Things”

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Abstract: We present network monitoring architecture and the implementation of 6PANview, a network monitoring system which we developed to oversee the health of a 6LoWPAN based WSN from the Internet. At the core, 6PANview uses well known standard Internet monitoring and diagnostic tools such as ping, traceroute, SNMP. We implemented a memory efficient and power conscious snmp agent on the TinyOS platform and defined an enterprise MIB for WSN monitoring. 6PANview provides transparent snmp proxy model which incorporates snmp OID compression techniques. Other 6PANview features include, alert threshold definitions, reverse traceroute, time series online plots, and so on. 6PANview provides JAVA/WEB based administration console for configuring, displaying various monitoring statistics, and troubleshooting. The 6PANView prototype has been tested in a 6LoWPAN/RPL WSN lab setup. As per our knowledge 6PANview is one among the first open standards based network health monitoring systems for 6LoWPAN/RPL based WSNs.

Keywords: 6LoWPAN; RPL; WSN network monitoring; WSN SNMP; TinyOS

1. Introduction

Wireless Sensor Networks (WSNs) are deployed in various application environments such as agriculture, health-care, industry etc. These WSNs mostly work on battery-operated devices, and are expected to work autonomously for many months in harsh and unattended environments. Despite sophisticated algorithms & implementations, factors like isolated and mass node failures, unpredictable wireless channel outages, battery depletion, and software bugs can disrupt normal functioning of a WSN. WSN monitoring therefore becomes essential to ensure proper
functioning, improved performance and lifetime of the WSN. It should provide timely and accurate information, and scalable so that large network deployments can be monitored.

6PANview is a network monitoring and management system for 6LoWPAN/RPL [1, 2, 3, 4] based WSNs. For its operation, it makes use of well-known tools such as ping, traceroute, SNMP that a typical Internet network administrator is familiar with. 6PANview provides a generic framework which is applicable to a variety of WSN application scenarios. Its flexible architecture enables one to incorporate scenario specific customizations.

2. 6PANview System Design and Architecture

6PANview follows distributed software system architecture with the design objectives of modularity, flexibility, reliability and scalability. Due attention is paid to the overall system performance in the design phase with a view that node and network resources consumed by network monitoring should be within certain bounds, and at the same time meeting the desired performance levels of monitoring. Unlike conventional host based application software that uses large memory, the software that runs on the sensor nodes has to be aware of the memory and power constraints. Our architecture takes this specific constraint into account to come up with an appropriate design decisions at various stages of the software development.

The pictorial representation of 6PANview architecture is shown in figure 1. In this figure, WSN is accessed through a gateway which connects 6LoWPAN and IPv6 networks. PAN server performs middle-ware functionality for WSN and WSNMS. It runs a daemon which collects the monitoring parameters from WSN and updates the database server with the obtained statistics. It accepts high level instructions from the administrator and executes these instructions by converting them into corresponding low level network commands such as ping, traceroute, snmpget, and so on. The HTTP server shown in the figure maintains the WSN monitoring information which an end user can access it over the web.

3. 6PANview Features

- Memory efficient and power conscious SNMP agent has been built on the TinyOS
- Supports generic SNMP MIB by including various OIDs for monitoring
- A transparent proxy has been built for SNMP requests/response using the SNMP OID compression technique based on the Internet draft [5]. With this, we were able to achieve compression gain up to 30 percent
- 6PANview incorporates efficient caching mechanisms to improve WSN network performance
- Reverse traceroute feature displays the route taken by a packet originated from a node to reach the base station.
- An alert feature reports anomalies in the network caused by abnormal traffic surges
- An online time series plot utility based on a public domain RRDTool gives visual representation of WSN behaviour over time

4. 6PANview Testbed Ecosystem

The 6PANview testbed setup is shown in figure 2. As can be seen from the figure, a Linux based PAN server performs all the backend activities required for monitoring. It also provides the transparent proxy/caching functionality. Though much of the functionality has been realized on a single host in present setup, the architecture allows for implementing these functionalities in a distributed fashion. WSN monitoring station (WSNMS) and the 6LoWPAN based WSN to be monitored are all connected over the IPv6 network

5. 6PANview Screenshots of a WSN deployment at ECE department, IISc

The reachability of every node in the network is indicated by green and red colour in figure 3. The path chosen to a particular node from the base station and vice versa are shown in figure 4 and figure 5 respectively. The RRD graphs showing time series plots of monitoring parameters are shown in figure 6.
5. Conclusions and Ongoing Work

6PANview is an Internet framework for monitoring and managing of 6LoWPAN enabled network over the Internet. 6PANview will be incorporated with advanced caching, scheduling, and aggregation techniques to improve the performance and extend the lifetime of a network. The 6PANview code has been released on the SourceForge and can be downloaded from http://www.sourceforge.net/projects/sixpanview. To know more about 6PANview visit our website at http://www.ece.iisc.ernet.in/6panview.

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References


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