Technical Report: "Monitoring Industrial Wireless Sensor Networks"

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I. INTRODUCTION

Current WSN diagnostic tools have several drawbacks, as already pointed in our previous work [1]. In our opinion, some of these drawbacks are hampering the use of WSNs in industry because nowadays, to the best of our knowledge, there aren't multi-network, standard-compliant monitoring tools that support the IWSN technologies addressed in this technical report (ZigBee[2], ISA100.11a[3], WirelessHART[4], WIA-PA[5]). As a result, some questions arose: How can multiple networks, possibly comprising equipment compliant with different standards, be monitored in an integrated way? How to add management functionality at gateway level? How can firmware and hardware be monitored without extra costs in hardware, firmware, and network?

Thus, this technical report presents a new monitoring architecture that will be able to monitor all the four standards (ZigBee, ISA100.11a, WirelessHART, WIA-PA).

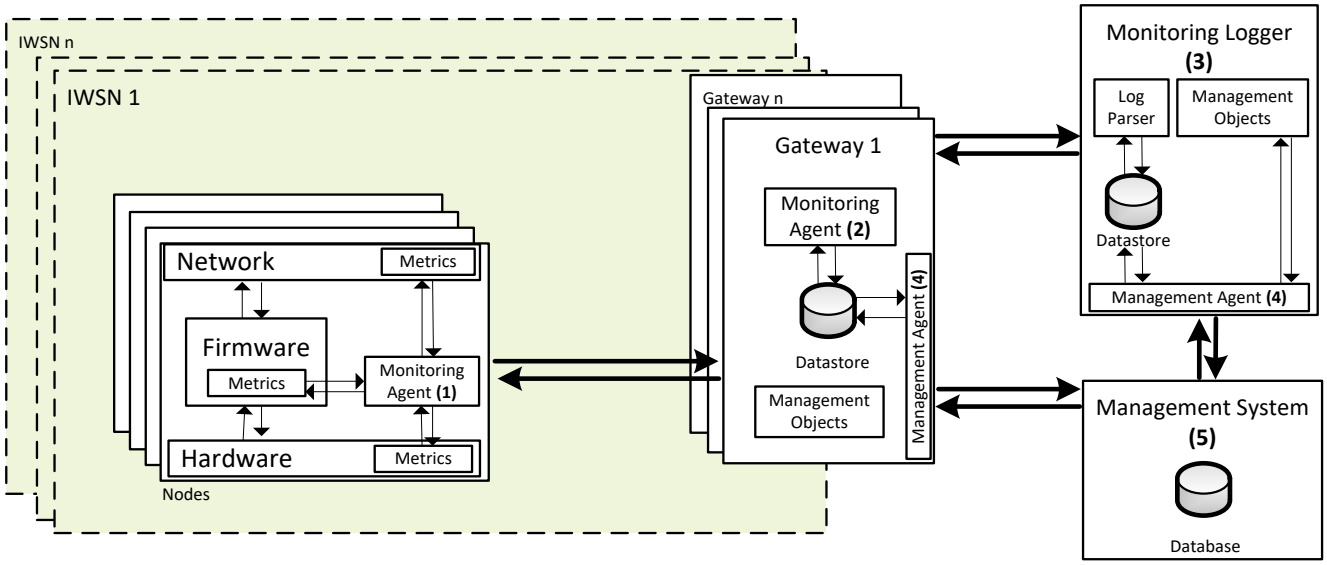
II. ARCHITECTURE

With the emergence of several IWSN standards and the increase in the number of IWSN deployments, it is crucial to define an architecture able to monitor multiple-network, standard-compliant technologies. The proposed architecture, presented in Figure 1, represents a flexible, scalable, energy-efficient, low-cost, and multi-standard solution that covers hardware, firmware, and network monitoring. In order to ease the adoption by IWSN vendors, OEM producers, and developers, the architecture was designed according to six main guidelines: i) it should support the monitoring of multiple IWSNs; ii) it should support multiple IWSN standards; iii) it should not lead to a significant increase in energy expenditure; iv) the collection of hardware metrics should not increase the cost of manufacturing; v) the acquisition of metrics should not have a significant impact on the main application size and delay, nor should it lead to a large traffic overhead; vi) the network metrics defined by each IWSN standard should be used; and lastly, vii) the collection of sensor-node metrics (hardware/firmware) and network metrics should be independent. The proposed architecture has five base modules: 1) sensor node monitoring agent; 2) gateway monitoring agent; 3) monitoring logger; 4) management agents; 5) and management system.

The sensor node monitoring agent (Figure 2) is responsible for the collection of node monitoring data (hardware and firmware metrics), and the sending of this metrics to the network gateway. The latter will forward the metrics to the monitoring logger, where they will be parsed and stored. The monitoring agent will use the most appropriate service in each industrial standard for forwarding the metrics. These metrics are encapsulated in a specific application format. During its operation (either when collecting information or when sending it), the monitoring agent should minimise the impact on the available resources.

Each industrial gateway has a pair of agents (one monitoring agent and one management agent). The gateway monitoring agent is the component that collects the network metrics and the gateway state (globally called management objects) and stores them in a local database (the datastore). These are then accessed in a standardized way by management systems, through the services delivered by the gateway management agent. In order to support the

Figure 1 – Proposed monitoring architecture



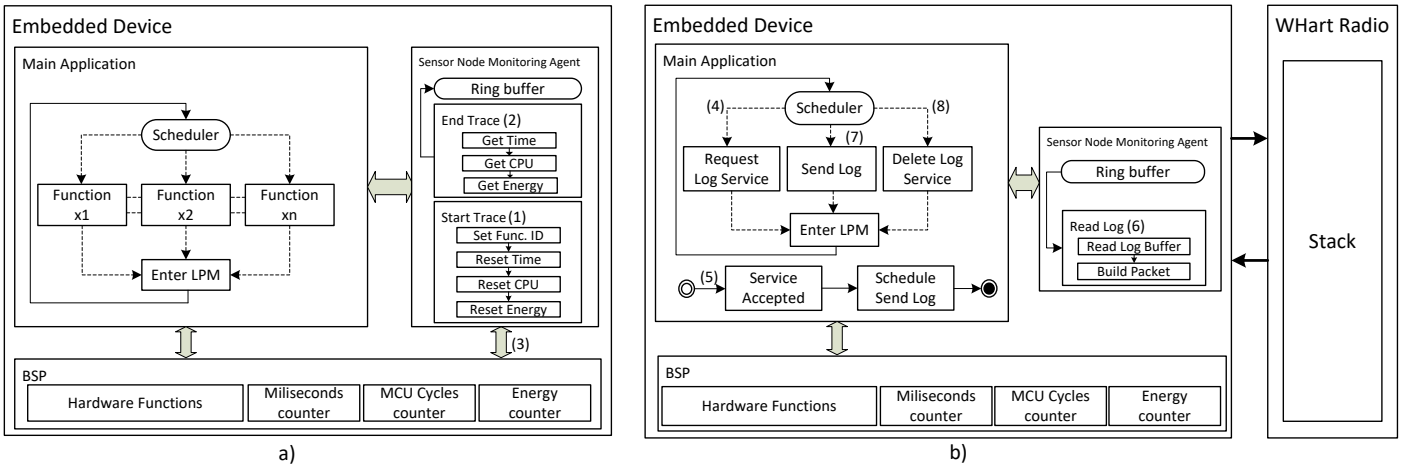


Figure 2- On the left, (a) the application architecture and the sensor node monitoring agent acquiring the state information. On the right, (b) the request of the WirelessHART publish service

interoperability with management systems, the gateway also stores the representation of the management objects (i.e., IWSN standard metrics, and gateway state).

On the other hand, the handling of the collected sensor node monitoring data is carried out by a monitoring logger component, which parses the log messages and stores them in its datastore. The monitoring logger is a software component with two main sub-components: log parser and management agent. The log parser is the component that receives the log messages from the gateway, parses them, and stores them in the local datastore. Like the gateway, the monitoring logger locally stores a representation of the management objects. This representation enables the management agent to share the sensor node metrics with the management system in a standardized way (i.e. by using description languages such as SMIv2, XML e YANG). It should be noted that the monitoring logger is a logical component that can be deployed either on the gateway (if the manufacturer supports it) or on the management system. The management system receives network monitoring data from the gateway management agent, and sensor node data (hardware and firmware metrics) from the monitoring logger management agent. Besides the traditional functions of configuring the çmonitoring capabilities of IWSN devices, the management system can include, for instance, a diagnostic tool that alerts operators or developers of critical events in the network, hardware, or firmware. Thus, the management system is capable of monitoring sensor nodes and network behaviour of multiple IWSNs using the standards addressed in this paper.

This technical report outlined a proposal for a monitoring architecture for IWSNs that: does not require any modification to IWSN standardized technologies, benefits from the management information provided by each IWSN standard, and communicates with management systems in a standardized way.

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III. REFERENCES

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