# A Publish/Subscribe Messaging System For Wireless Sensor Communication

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***Abstract*—We demonstrate the efficiency of using a publish/subscribe messaging system as communications means for Wireless Sensor Networks (WSNs). To this aim, we show how our protocol is able to provide seamless interconnection among WSNs based on different technologies without requiring nodes to be aware of where data is generated or consumed.**

## I. The MQTT-S Messaging System

A fundamental question when designing communication protocols for Wireless Sensor Networks (WSNs) is how to provide coordination among nodes. In particular, many applications require data generated at a given node to be quickly and efficiently forwarded to all the other sensors that are interested in the specific event. A first approach to tackle this issue may consist in having nodes that are aware of the identities of all their communication peers (e.g., by means of pre-programming), so that traffic can be delivered by means of multicast algorithms. However, such a method is prone to frequent failures in dynamic environments and thus has limited applicability. On the other hand, an approach that does not require any a-priori knowledge of peers is to have nodes broadcast their data to the entire network. Nevertheless, this strategy clearly does not scale with the number of nodes, which might represent an issue in WSNs, which are typically composed by a large set of nodes.

An effective solution to the aforementioned coordination problem is to provide nodes with a publish/subscribe messaging system, in which sensing nodes *publish* data they collect for a specific topic, whereas actuator nodes *subscribe* to certain topics and receive corresponding information as soon as available. The basic working principle of such approach is depicted in Fig. 1. Here, a node that senses data of interest sends a PUBLISH message to a broker, containing both the actual data and a description of the topic the acquired information belongs to. On the other hand, a node (e.g., the *subscriber* in Fig. 1) can send a SUBSCRIBE message to the central intelligence in order to signal interest on a certain topic. The broker, then, upon receiving newly published data on a specific topic takes care of informing all the nodes that subscribed to events of such kind. This strategy manages to timely deliver data to nodes interested in them without resorting to broadcast and without requiring nodes to have any knowledge on the overall network topology or structure. Indeed, as will be discussed later, publish/subscribe mechanism can be used to interconnect even nodes belonging to different subnetworks (e.g., networks based on different technologies that are not able to directly communicate with each other).

Starting from these remarks, we have developed MQTT-S [1] [2], a publish/subscribe messaging system that extends the well-established Message Queue Telemetry Transport (MQTT) protocol in order to cope with the specific constraints of WSNs, such as resource-limited and battery-operated devices, low network bandwidth and high link failures. Furthermore, our solution provides an intuitive application programming interface that hides completely the complexity of the underlying networking technologies. In fact, thanks to the publish/subscribe communication mechanism, applications are unaware of the identity of their communication partners and do not even know where or on which networks they reside. This makes MQTT-S particularly suitable to the development of applications for multiple platforms with a single communication paradigm.

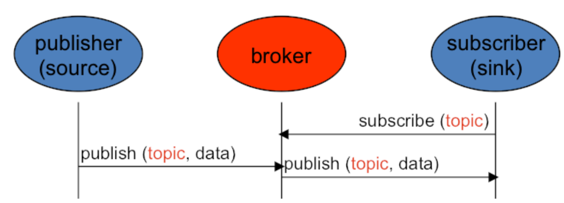


Fig. 1. Publish/subscribe communication paradigm

## II. Demonstration Description

In this demonstration, we concentrate on the network-interconnection capability of MQTT-S. In particular, we show how nodes located on a ZigBee[1]-based Wireless Sensor Network can use MQTT-S to send data to actuators located on a TinyOS-based network. Figs. 2 and 3 sketch the setup of our demonstration. The ZigBee-based WSN is composed by Jennic's motes [3], each equipped with the JN5139 microcontroller and with three sensors, one for temperature, one for humidity, and one for light intensity. The application running on these boards regularly reads the values measured by the sensors and publishes them to a broker running on a laptop.

Actuators are located in a second network which is based on TinyOS. Tmote Sky and MicaZ devices [4] are used as

[1]ZigBee is a trademark of ZigBee Alliance in the US, other countries or both. Other company, product or service names may be trademarks or service marks of others.

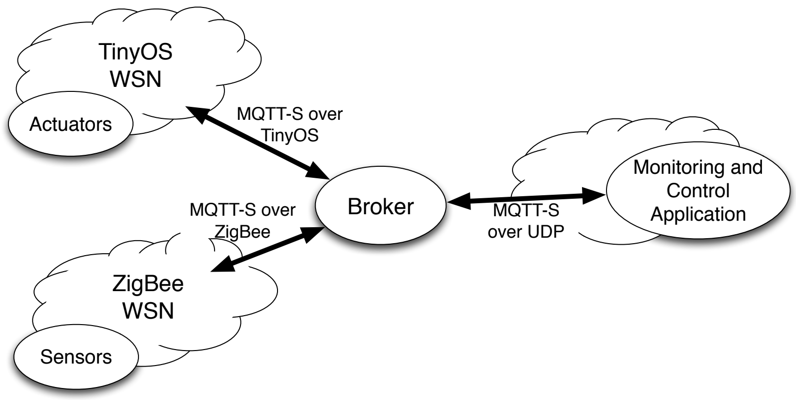


Fig. 2. Configuration of the MQTT-S demonstrator that shows the interconnection of multiple different wireless sensor networks

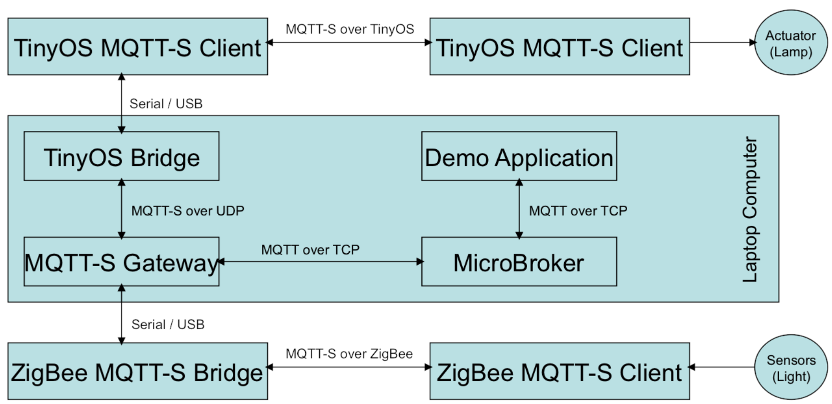


Fig. 3. Demonstration environment

hardware platform for this WSN. The actuators also connect to the broker for receiving the data published by the sensors.

In our demonstration, if the light intensity - measured by the ZigBee devices - is below a given threshold, then an actuator in the TinyOS network automatically switches on a light. In a similar fashion we control humidifiers and fans.

The laptop computer also hosts an application that communicates with the broker to monitor the data sent by the sensors and visualizes them in real-time. Control information can also be sent to the boards via the broker, e.g. to modify their reporting time periods.

We furthermore show how, with a few lines of code in the appropriate language for the target platform, the behavior of the network can be changed to suit one's particular needs. Participants are invited to create their own programs and test them on our demonstration network. Participants will learn how MQTT-S can support them in their own research efforts. They will be able to integrate MQTT-S in their own projects within minutes.

## References

[1] U. Hunkeler, H. Truong, and A.Stanford-Clark, "MQTT-S - A Publish/Subscribe Prptocol For Wireless Sensor Networks," in *IAMCOM'08*, Jan. 2008.
[2] "Mq telemetry transport," `http://mqtt.org`.
[3] "Jennic - wireless microcontrollers," `http://www.jennic.com`.
[4] "Crossbow technology," `http://www.xbow.com`.