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CONVERGED WIRELESS TECHNOLOGY ARCHITECTURES: HYBRID NETWORKS CONSISTING OF LORA AND WI-SUN NODES

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ABSTRACT

The embodiments presented herein utilize class B LoRa to avoid conflicts with Wi-SUN traffic that is on the same band. In areas covered by a LoRa edge, portions of the time slots of specific channels may be aggregated into longer time slots to adapt to LoRa spreading factors. Edge mesh nodes may use class B to pull traffic from channels of LoRa devices at the appropriate time. LoRa may be configured to operate in the appropriate channels, and any interference with Wi-SUN can be minimalized.

DETAILED DESCRIPTION

The Wireless Smart Utility Networks (Wi-SUN) alliance promotes interoperable wireless standards-based solutions for the Internet of Things, such as smart grid Advanced Metering Infrastructure (AMI) and distribution automation. In a Wi-SUN network, the nodes may autonomously form a mesh network. Figure 1 illustrates a Wi-SUN network.Cisco ships a CG-Mesh which consists of a Connected Grid Router (CGR) and wireless powered mesh nodes, the IR500 acting as WPAN gateways or Range Extenders.

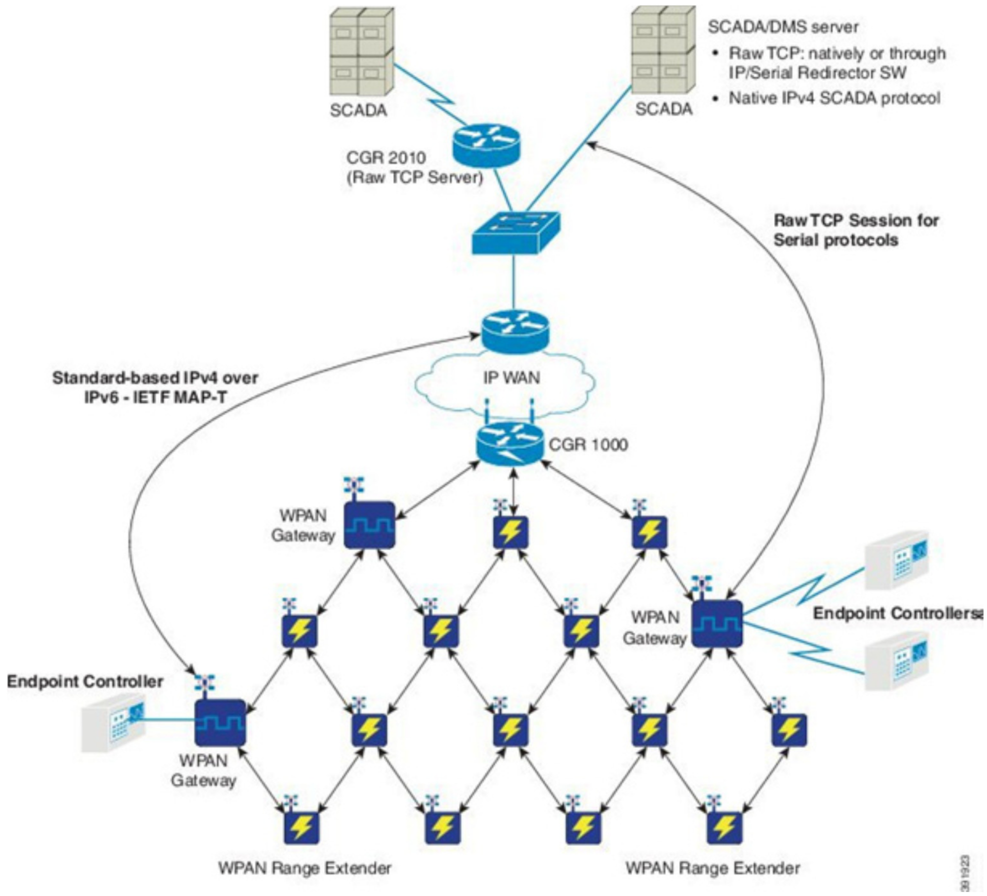

Figure 1

LoRa refers to a wireless data communication Internet of Things technology that can be used in a smartgrid for inexpensive and remote meters. A LoRa solution may include IXM LoRa gateways and partners with Actility for the Thingpark back-end. Figure 2 depicts an example of a LoRaWAN deployment.

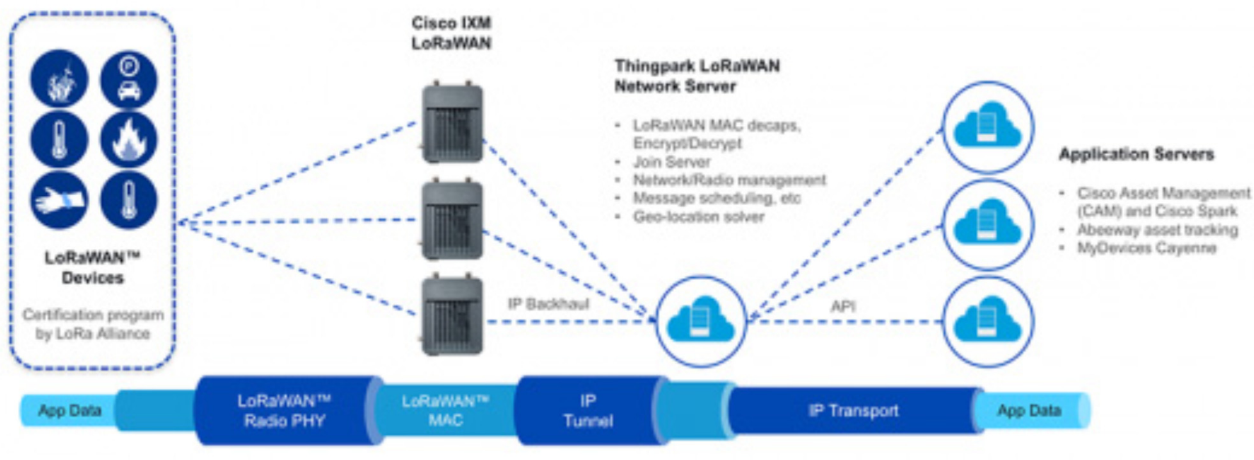

Figure 2

The embodiments presented herein relate to a hybrid network architecture for the co-existence of a Wi-SUN mesh that forms the back-haul network, and a LoRa access for the last mile. In this model, LoRa may only be used on last-hop communications, as opposed to having a parallel competing channel. Since LoRa and Wi-SUN operate in the same sub-gigahertz band, the combination may be problematic, as Wi-SUN activity near a gateway can prevent low-power LoRa reception.

However, a network architecture and communication pattern can be provided that enables LoRa nodes and Wi-SUN to co-exist in the same network while also optimizing network performance in terms of throughput, latency, and power consumption. A smartgrid network can be used to gather extended data in a way that enables a utility to resell a data access service (such as for gas or water metering). The smartgrid network can also be used to control appliances in order to smooth power consumption and avoids peaks, without having to directly connect appliances to the smartgrid.

In this model, LoRa Gateways (e.g., IXM) are collocated with mesh nodes (e.g., IR500) and enable a control interface between the two to share configuration information such as schedules. As illustrated in Figure 3, the Wi-SUN nodes form a mesh network and act as a back-haul, while LoRa nodes are responsible for the last-hop communications.

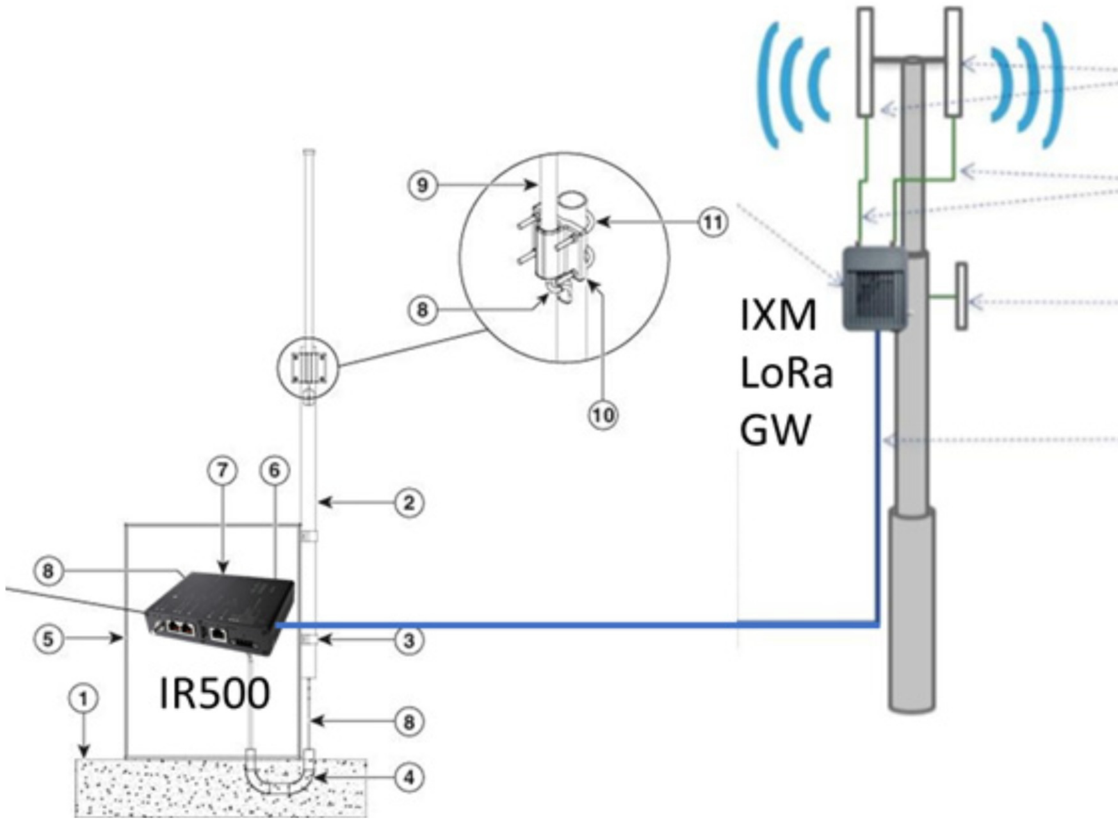

Figure 3

Wi-SUN can use time-division multiplexing (TDM) with time slots of 128 ms, which can be combined with LoRa's class B mode whereby nodes wake up and listen periodically so they could be polled to speak. Periodic windows in the Wi-SUN domain can be scheduled where Wi-SUN edge nodes may not transmit on 802.15.4g, as illustrated in Figure 4.

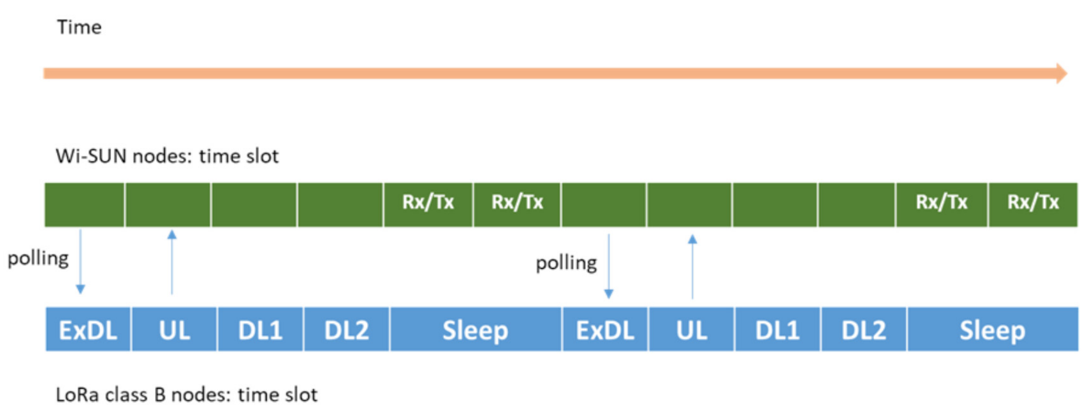

Figure 4

Windows may consist in one to ten contiguous 128ms slots in the EU, and one to five in the US. This is done in order to accommodate various LoRa speeds (also known as spreading factors) and the maximum dwell time, which is regulated. Figure 4 illustrates in more details how the invention generates inactivity periods on the Wi-SUN side in green, thus enabling LoRa operation in blue. As a result, LoRa nodes and Wi-SUN nodes perform in a time-multiplexed manner, with uplink (UL) communications from the LoRa nodes to the Wi-SUN nodes, and downlink (DL) communications from the Wi-SUN nodes to the LoRa nodes. Extra downlink (ExDL) may be reserved for polling from Wi-SUN nodes, and Receive/transmit (Rx/Tx) can be reserved for communications between Wi-SUN nodes.

The LoRa class B operation may be synchronized to mesh time slots so that LoRa devices listen at the beginning of a 802.15.4 time slot. The first octet of a message from the CG mesh acts as a tick, and the message may contain the offset of that tick from the beginning of the 128 ms window, thereby enabling the LoRa device may resync.

Novel: When the LoRa window occurs, one hybrid LoRa / Wi-SUN "node" uses class B to poll the LoRa meters for data.

Polling may indicate a list of one or more device(s) from which reading is required (e.g., gas or water meters), or on which device a control action is required (e.g., starting a washing machine, changing a heating mode to night). In response, the polled LoRa device(s) send their data out in a LoRa fashion, and one or more gateways (combined with mesh nodes) receive and forward the data up the mesh. This data is sequence and timed, and is considered a flood. If a parent node sees multiple copies, then it will eliminate the duplicates. In this way, the communications of Wi-SUN nodes will not interfere with LoRa nodes, and the mesh network can be used beyond gathering only power metering.

The ratio of time slots allocated to Wi-SUN nodes and LoRa nodes can be pre-configured based on the performance requirements, or dynamically optimized based on real-time traffic patterns. In either case, the smartgrid uses polling and can control the amount of data that is pulled. At the global level of the mesh, rules can be applied as to which times are dedicated to which protocols in which areas. For example, if half of the packets originate from LoRa, and the LoRa spreading factor (SF) makes it so that a packet dwells at most 512 ms, and if the average number of hops is four, then half of the bandwidth may be dedicated to LoRa near the access edges.