Demo: Spanning an Underlay over a Host WPAN Cluster

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ABSTRACT

A prototype for WPAN slicing and virtualization is showcased in this demo, where we form a contiguous wireless PAN underlay spanned over two neighboring IEEE 802.15.4 mote networks.

1. OVERVIEW AND MOTIVATION

Coverage of macro-programmed embedded sensor-actuator networks are often limited by inherently static nature of underlying IEEE 802.15.4 wireless PANs. The target area may span over heterogeneous mote hardware or ownership domains, where an untethered virtual sensor network abstraction is often sought.

Even two homogeneous WPANs, while operating on the same channel, can use distinct PAN-ids in frame headers to maintain isolation in case of overlapped radio coverage. Thus, a mote is traditionally programmed with a MAC address composed of a <PAN-id, node-id> pair (16 bits each) that remains unchanged until reprogrammed.

Multithreading along with MAC-layer bridging of a mote's MAC addresses associated with those threads, can be leveraged to make the same physical mote have multiple incarnations for different sensor networks. We have built a middleware on top of TinyOS 2.1.x using TOSThreads [1] and TinyLD [2] to include the multiple incarnation support for motes. When programmed with this support, motes can form a network substrate capable of on-demand hosting of a virtual WPAN underlay composed of newly incarnated virtual motes. However, the supported underlay need not be contained within a single host substrate, but can assume a cross-domain span over neighboring networks with a little co-ordination between host network gateways.

2. DEMO CONTENT AND USER INPUT

The setup involves two neighboring small multi-hop sensor WPANS, each with five TelosB motes with the middleware support for host substrates. Transmission power is adjusted to ensure multi-hop mesh connectivity without single hop reachability. Host networks have IP gateways with user control as in Figure 1. Once user parameters are chosen, the two host networks identify themselves by blinking the assigned LEDs with chosen frequency and get ready for the thread pertaining to the virtual underlay network.

The virtual underlay network client runs remotely to connect to the host gateways over IP network, presenting an interface as in Figure 1. The remaining LED color and the assignable node-ids for the virtual motes are chosen by the user along with one of the two candidate gateways, and the underlay network is initialized. Subsequently, users can change the blinking frequency to exert visible control over the underlay network, just as they could do so from the host network interface at their individual gateways.

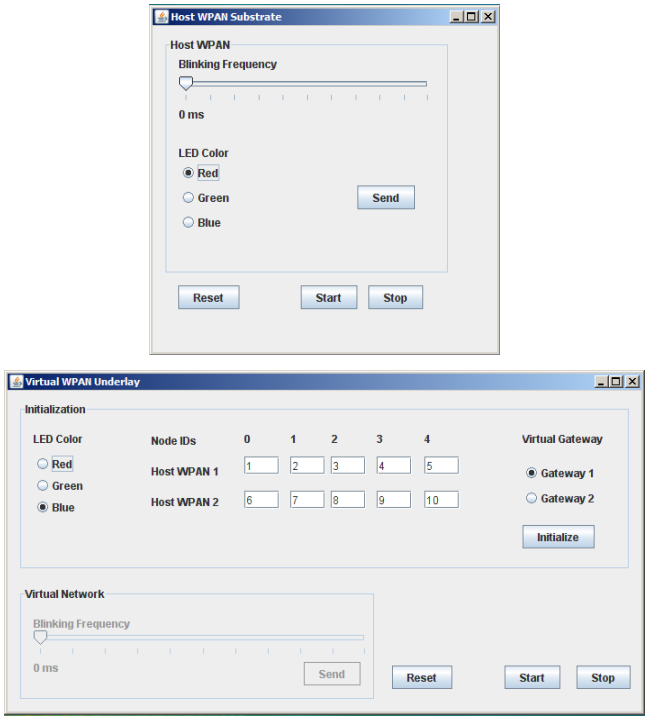

Figure 1: User Interfaces for Host and Virtual WPANs

3. ACKNOWLEDGMENTS

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4. REFERENCES

[1] Klues, K., et al., 2009. TOSThreads: Thread-safe and non-evasive preemption in TinyOS. In Proc. 7th ACM Conference on Embedded Networked Sensor Systems (SenSys 2009), Berkeley, California, USA, (November 2009).

[2] Musăloiu-E, R., Liang, C. M., and Terzis, A., 2008. A modular approach for WSN applications. HiNRG Technical Report 21-09-2008, Johns Hopkins University (2008).

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