Why Wi-Fi for the Internet of Things will move to 5 GHz

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More than a billion Wi-Fi devices were shipped over the past year and the market is growing fast. These devices are destined not just for laptops, tablet PCs and mobile phones, but for all the everyday equipment used in homes, offices, public spots, and literally everywhere. Equipment like washing machines, refrigerators, energy meters, surveillance cameras, industrial robots, point-of-sale terminals, photo frames – a really long list – all coming together as the Internet of Things.

Fortunately, the majority of these devices do not exchange large amounts of data, quite unlike in the case of handheld computing devices. Wireless LAN uses the unlicensed spectrum, where there is no control on how many users are sharing a channel, and on how much data they send out. A lot of us may have experienced first-hand the disruption to Wi-Fi connections in crowded environments. This is especially pronounced in applications where a reasonably high data transfer rate is required, or where packet latencies and packet drops have a noticeable effect like in voice or video communication. An immediate solution is to spread out the connections over a greater number of channels – unfortunately this is possible only with a move to the 5 GHz band which offers up to 24 distinct channels, as opposed to just 3 in the 2.4 GHz band.

In the case of embedded systems with Wi-Fi in them, a bigger problem arising from a crowded RF environment is the reduction of battery life. Many of these devices – for example, sensor nodes, locationing tags and control units – typically send or receive small amounts of data at long intervals. That is, their operational duty cycle is very low. These systems take advantage of provisions in the WLAN standard to go to a sleep state, waking up only when needing to transmit data or at the DTIM intervals as specified by the access point. In some cases the devices sleep for much longer periods, waking up to re-establish connection with the access point prior to exchanging data with another node or controller on the network. In all these cases, when they do wake up and happen to find the medium busy, they back off and wait until a transmit opportunity arises again – all in accordance with the CSMA/CA protocol defined in the standard. This backing off, or having to retransmit a packet due to loss because of collision, are ruinous to battery life. Power consumption

during active reception or transmission states is orders of magnitude higher than in a sleep state – a few hundred milliamps of current during transmission versus a few tens of microamps during sleep. If the battery life estimated at the time of design or deployment of the device were done assuming a fairly clear channel – and this is often the case – then during actual operation in a moderately busy channel where the device waits on average for a typical duration of one packet on air about 40% of the time would result in battery life reduction of over 45%. This is a significant hit and would well result in a particular application becoming unviable. Operation in the 5 GHz band with its choice of channels that can be chosen dynamically based on traffic conditions is an immediate solution to this potential hit in battery life.

The 5 GHz band however, throws up a few challenges. Operational range reduces because of increased signal attenuation; device cost and size is often higher – in part because most devices that support 5 GHz also support 2.4 GHz making them 'dual-band' devices; and available infrastructure may not support the band. These challenges are addressed by some Wi-Fi module vendors, enabling easier adoption of 5 GHz operation in all environments – which is crucial to the growth of Wi-Fi networks. Beyond just adopting the 5 GHz band, Wi-Fi devices also need to support newer standards that enable higher density of operation. Today, they all need to be 802.11n compliant, and by sometime in 2013 or 2014, be compliant with 802.11ac as well. These measures would pave the way for billions of embedded devices more to join the fold of the Internet of Things.

Author Bio:

N.Venkatesh is Vice President of Advanced Technologies at Redpine Signals, and has over 25 years of engineering and management experience wireless system design, semiconductor design, telecommunications, optical networking and avionics. With Redpine, Mr. Venkatesh is a key wireless technologist and champions the universal integration of wireless into embedded systems. His responsibilities include leading the development of wireless systems at Redpine's India center, and their application into diverse industry areas.

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