Emerging Wireless Standards

IEEE 802.15.4 and ZigBee™ promise reliable, cost-effective wireless connectivity for appliances.

How are your products performing in the field? Are they in need of repair, or are they being abused? Until recently, appliance manufacturers looking to answer these questions have had to choose between proprietary approaches and systems based on open standards that were either inappropriate for the application or technically insufficient for the market.

Standards-based wireless, such as IEEE 802.11b and Bluetooth™, have been deployed in trials but are ill-suited for the simple communications needs of most appliances. Wide area wireless technologies, including GPRS and GSM, have also been trialed successfully but their high costs and inability to communicate with more than one appliance have limited their deployment. (See Table 1 for a summary of wireless standards.)

New standards

For any communications technology to be widely deployed it must be cost-effective and highly reliable. Two new global wireless standards, IEEE 802.15.4 and ZigBee™, promise to deliver the high reliability and low price points necessary to achieve volume deployment worldwide across a wide range of appliances in both residential and commercial markets.

IEEE 802.15.4, ratified in May 2003, is the first wireless standard designed specifically to address the unique needs of manufacturers for reliable and cost-effective remote monitoring and control. IEEE 802.15.4 is a simple but powerful packet data protocol that provides high reliability through acknowledgement, error checking, prioritized communications, direct sequence spread spectrum, the ability to change frequencies to avoid interference and user-selectable security levels. IEEE 802.15.4 specifies the physical (PHY) and media access control (MAC) layers, and defines three license-free frequency bands including 2.4GHz, 915MHz and 868MHz, making it a truly global standard.

The ZigBee Alliance (www.zigbee.org), a global non-profit consortium of over 50 industry leaders, is defining the Network, Security, and Application layers that reside above the IEEE 802.15.4 PHY and MAC layers. The result of this cooperative effort is a well-integrated, standards-based wireless network platform designed to meet the unique needs of wireless monitoring and control applications.

The ZigBee Alliance is defining multiple network layer topologies, including star, mesh, and hybrid architectures. Each has its own strengths for various applications. Star topologies work well for relatively simple or low-power applications. In a star topology, all wireless nodes are connected to a network coordinator or gateway. When physical obstructions or strong RF interference blocks communication, the normal fix is to move the effected node, which is not an acceptable solution for most appliance monitoring and control applications.

Mesh networks utilize a decentralized, multi-hop architecture in which each node is in direct communication with its immediate neighbors. Mesh topologies can provide an extended coverage area by relaying information from node to node. If a single node fails for any reason—including the introduction of strong RF interference messages can be automatically routed along alternate paths. Optimal path selection is usually set by measured signal strength between any two nodes, and the cumulative number of hops required to transmit a message from one node to another. Mesh topologies

<table>
<thead>
<tr>
<th>Application Focus</th>
<th>ZigBee™ 802.15.4</th>
<th>Bluetooth™ 802.15.1</th>
<th>Wi-Fi™ 802.11b</th>
<th>GPRS/GSM 1XRTT/CDMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Resource</td>
<td>Monitoring &amp; Control</td>
<td>Cable Replacement</td>
<td>Web, Video, Email</td>
<td>WAN Voice/Data</td>
</tr>
<tr>
<td>Battery Life (days)</td>
<td>100 - 1,000+</td>
<td>1 - 7</td>
<td>1 - 5</td>
<td>1 - 7</td>
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<tr>
<td>Nodes Per Network</td>
<td>255</td>
<td>7</td>
<td>30</td>
<td>1,000</td>
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<tr>
<td>Bandwidth (KB/s)</td>
<td>20 - 250</td>
<td>720</td>
<td>11,000+</td>
<td>64 - 128</td>
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<tr>
<td>Range (meters)</td>
<td>1 - 75+</td>
<td>1 - 10+</td>
<td>1 - 100</td>
<td>1,000+</td>
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<tr>
<td>Success Metrics</td>
<td>Reliable, Low Power, Cost Effective</td>
<td>Cost, Convenience</td>
<td>Speed, Flexibility</td>
<td>Reach, Quality</td>
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</tbody>
</table>

Table 1. Comparative summary of wireless standards. (Source: Helicomm.)

Topologies

The logical shape of a network—its topology—determines how different nodes in a network are logically connected to each other and how they communicate. Network topologies include star, mesh, and hybrid architectures. Each has its own strengths for various applications. Star topologies work well for relatively simple or low-power applications. In a star topology, all wireless nodes are connected to a network coordinator or gateway. When physical obstructions or strong RF interference blocks communication, the normal fix is to move the effected node, which is not an acceptable solution for most appliance monitoring and control applications.
SMART APPLIANCES, MICROCONTROLLERS & ICs

IEEE 802.15.4 & ZigBee Key Features
- 2.4GHz, 915MHz, 868MHz frequencies supported.
- High data reliability and network scalability.
- Data throughput of up to 250KB/s.
- 128-, 64- or 32-bit AES encryption.
- Star, mesh or hybrid network topologies.
- Interoperability via ZigBee Application Profiles.

can provide the industrial-strength reliability required by applications such as commercial appliance monitoring and control.

A hybrid cluster-tree configuration combines the power of a mesh topology with the simplicity of a star topology to form a reliable, scalable, and cost-effective wireless network. This is frequently the best solution for low-data-rate applications that require both long-battery life at the node and high-network reliability. Battery-powered sensors in a home or on a single floor of a commercial building could be linked in a star topology to line-powered wireless appliances on each floor or in each home, which could then be linked in a mesh topology.

Summary
The emergence of global wireless standards for appliance networking has fundamentally altered the industry landscape, accelerating the demand for wireless monitoring and control applications worldwide. Helicomm is working with the Haier Group, one of the world's largest appliance manufacturers, and others to integrate IEEE 802.15.4 and ZigBee wireless communications into products. These wireless standards will minimize customer risk, reduce total costs of ownership, improve product development and increase customer satisfaction.

— George Karayannis

George Karayannis is vice president of sales and marketing at Helicomm, Inc., Carlsbad, Calif.

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