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ZigBee and Wireless Industrial Automation

Feature / Benefits

The most frequently cited characteristics of ZigBee are low power consumption, long battery life, low product cost and published, open standards. While these are all positive attributes, ZigBee offers another characteristic that can be still more attractive in wireless industrial automation: mesh networking. ZigBee networks feature a "self healing" mesh topology. If data cannot reach its destination through an intended link, the network dynamically routes that data to make delivery through an alternate path. While this capability existed previously in proprietary technologies, ZigBee delivers it in low-cost devices, catching the attention of design engineers in fast-growing numbers. What these developers often find is that, while battery life is seldom an issue in industrial environments as devices are typically mainspowered, ZigBee is so inherently good at addressing the challenges of harsh industrial environments that it merits thoughtful consideration.

Addressing Industrial Challenges

Most wireless networks feature a star topology, in which a base station manages communications with remote nodes in a point-to-multipoint fashion. This topology is simple to deploy, maintain and expand, and has long been the de facto wireless standard. However, industrial settings pose a challenge: If the link between a node and the base station fails, that node no longer participates in the application. A number of solutions can provide correction, including spread spectrum techniques, higher RF power and the deployment of repeaters, which can also extend network reach.

ZigBee addresses the challenge at the topology level, with full function devices (FFDs) at remote nodes doubling as repeaters and creating a mesh network. If two network points are unable to communicate as intended, transmission is dynamically routed from the blocked FFD to another FFD with a clear path to the data's destination. This happens automatically, so that communications continue even when a link fails unexpectedly. Dynamic routing can also extend the network's effective reach; when the distance between the base station and a remote node exceeds the devices' range, an intermediate node or nodes can relay transmission, eliminating the need for separate repeaters.

THE POTENTIAL ISSUE OF LATENCY

In any dynamic routing, each node-to-node "hop" introduces latency. With ZigBee, that latency is typically several milliseconds per hop, so that a multi-hop path can introduce tens of milliseconds of latency as data travels to its destination. Routing algorithms are typically designed to optimize the data path, but dynamic routing always introduces latency.

For many applications, this is not an issue. A sensing application that monitors slowly changing temperatures or pressure levels, for example, would likely exhibit no effects. For applications in which precision is critical, however, even latency measured in tens of milliseconds can be highly problematic.

MATCHING TOPOLOGY AND APPLICATION

In industrial wireless applications, a star topology is often the best choice, as long as it delivers data where and when it's needed – simple to deploy and maintain, with no routing-related latency.

If, however, communications barriers are significant, latency is not an issue, and the network nodes are close enough to realize the benefits of dynamic routing, ZigBee's mesh topology may prove to be the best solution.