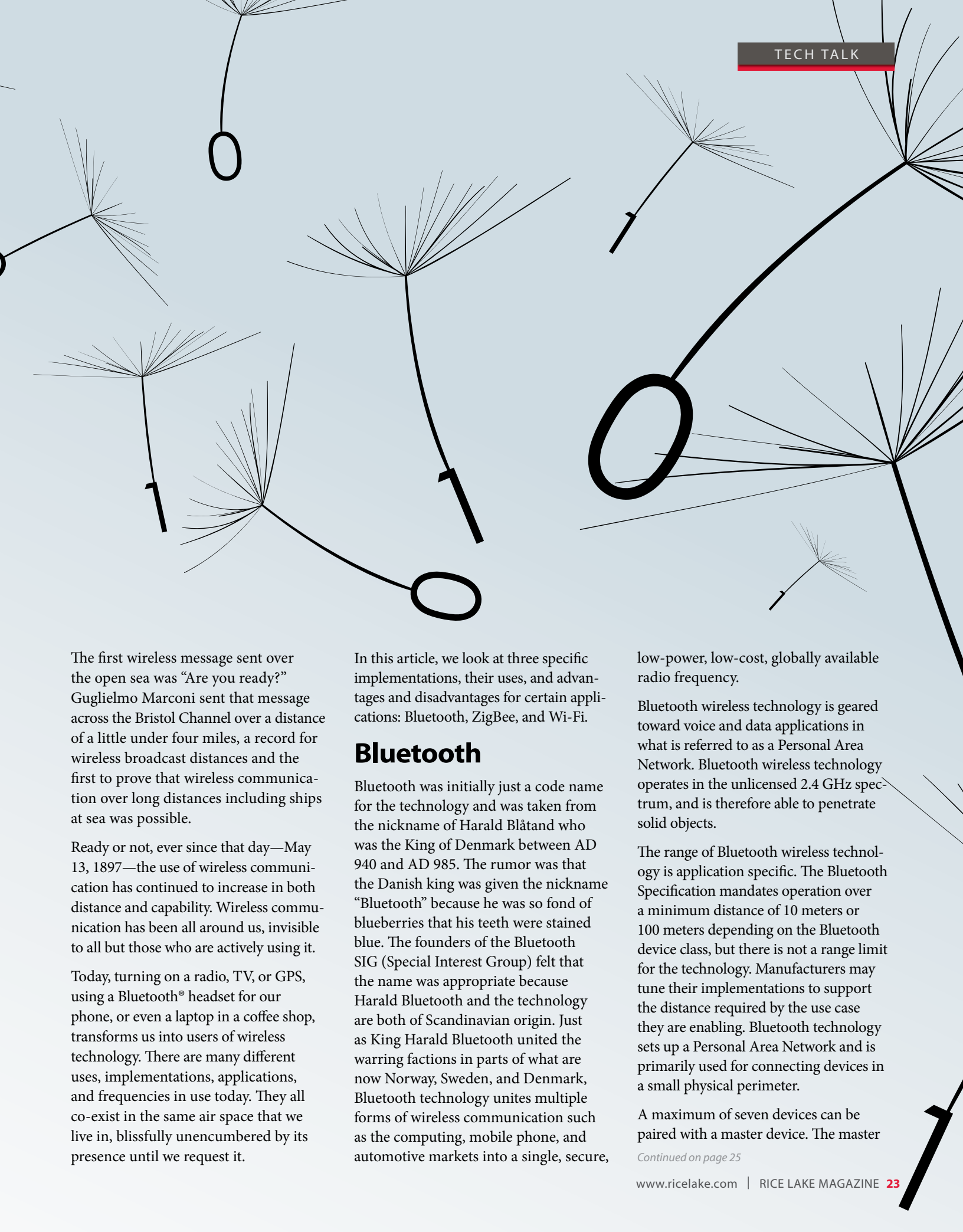


Blowin' in the Wind

Wireless technology made simple

by Jim Daggan, Rice Lake senior engineer, Emerging Technologies



The first wireless message sent over the open sea was “Are you ready?” Guglielmo Marconi sent that message across the Bristol Channel over a distance of a little under four miles, a record for wireless broadcast distances and the first to prove that wireless communication over long distances including ships at sea was possible.

Ready or not, ever since that day—May 13, 1897—the use of wireless communication has continued to increase in both distance and capability. Wireless communication has been all around us, invisible to all but those who are actively using it.

Today, turning on a radio, TV, or GPS, using a Bluetooth® headset for our phone, or even a laptop in a coffee shop, transforms us into users of wireless technology. There are many different uses, implementations, applications, and frequencies in use today. They all co-exist in the same air space that we live in, blissfully unencumbered by its presence until we request it.

In this article, we look at three specific implementations, their uses, and advantages and disadvantages for certain applications: Bluetooth, ZigBee, and Wi-Fi.

Bluetooth

Bluetooth was initially just a code name for the technology and was taken from the nickname of Harald Blåtand who was the King of Denmark between AD 940 and AD 985. The rumor was that the Danish king was given the nickname “Bluetooth” because he was so fond of blueberries that his teeth were stained blue. The founders of the Bluetooth SIG (Special Interest Group) felt that the name was appropriate because Harald Bluetooth and the technology are both of Scandinavian origin. Just as King Harald Bluetooth united the warring factions in parts of what are now Norway, Sweden, and Denmark, Bluetooth technology unites multiple forms of wireless communication such as the computing, mobile phone, and automotive markets into a single, secure,

low-power, low-cost, globally available radio frequency.

Bluetooth wireless technology is geared toward voice and data applications in what is referred to as a Personal Area Network. Bluetooth wireless technology operates in the unlicensed 2.4 GHz spectrum, and is therefore able to penetrate solid objects.

The range of Bluetooth wireless technology is application specific. The Bluetooth Specification mandates operation over a minimum distance of 10 meters or 100 meters depending on the Bluetooth device class, but there is not a range limit for the technology. Manufacturers may tune their implementations to support the distance required by the use case they are enabling. Bluetooth technology sets up a Personal Area Network and is primarily used for connecting devices in a small physical perimeter.

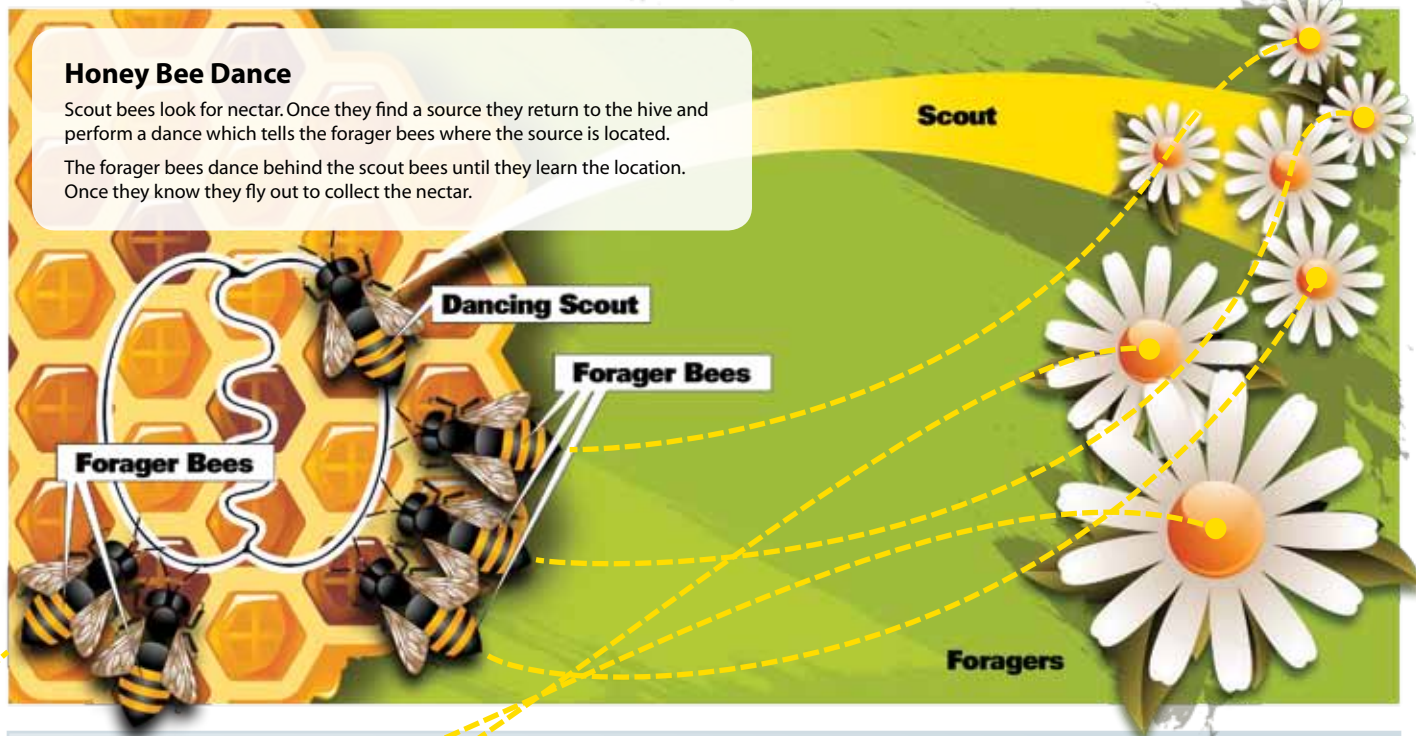
A maximum of seven devices can be paired with a master device. The master

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Honey Bee Dance

Scout bees look for nectar. Once they find a source they return to the hive and perform a dance which tells the forager bees where the source is located.

The forager bees dance behind the scout bees until they learn the location. Once they know they fly out to collect the nectar.



Why Bluetooth?

If you are in your car, it is convenient to set up your cell phone, your car's GPS, and your hands-free headset to "talk" to each other. That way, if you have your headset with you, as you get in the car, your headset can talk to the phone. If you forgot your headset, the GPS can be paired with the phone to allow you to talk on the phone via the microphone in the GPS. Since they are close to each other and need to be paired up differently each time you use them, it is convenient to pair them once, and when they are in range, have them connect automatically.

In a scale application, you could use Bluetooth for a master device that occasionally has to travel around to different scales and get the readings from them when the operator is close by.



Why ZigBee®?

The main advantage to ZigBee is its ability to self-form a "mesh" network to get the message through. A good example of this would be in a building where you wanted to collect the temperature in every office on multiple floors, to balance the heat or air conditioning. If someone rearranged his or her office and unknowingly placed a big steel file cabinet in front of a node, it might be cut off from the rest of the network. However, only the messages from that node would be lost. The rest of the messages that used that node as a routing device would simply form a new route around it by using another path. It would also make it very obvious where the problem was, rather than a whole section of the network going down and having the old "Christmas tree light" problem of locating the fault or faults.

A load cell (and its associated A/D circuitry) could be connected to a ZigBee end device and transmit weight on a regular basis to an indicator that was within range of either the load cell or a coordinator node to extend the distance.



Why Wi-Fi?

Wi-Fi is rapidly growing in use. The advantages are the ability to handle large amounts of data with a long range (see chart on page 27) between devices. PCs use this regularly to communicate on the Internet, at home, or in coffee houses and other establishments that offer free Wi-Fi. Hotels use this since it is much easier to equip an existing hotel with Wi-Fi than it is to hard wire Ethernet® to every room.

A scale indicator can be equipped with Wi-Fi to communicate wirelessly to either an existing Ethernet network or the Internet.



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device is placed in a discovery mode, and the slave device is also placed in a pairing mode. When the master detects the slave device, a confirmation is usually required. Once this is acknowledged, the master can be placed in a mode that will always acknowledge the slave with or without a manual confirmation. Manual confirmation is slower but more secure. Also, master units can be set to non-discoverable mode to prevent them from sending out discovery packets.

Technical Specs

Bluetooth uses adaptive frequency-hopping spread spectrum modulation (AFHSS), which uses 79 channels or frequencies at 1 MHz intervals between 2.4 and 2.485 GHz. It is unlicensed in most countries. Because of this, it can easily co-exist with other technologies and modulation schemes even in the same frequency.

The peak data rate of Bluetooth technology depends on the version and power, which ranges from 2.5 microwatts (low

energy) and 1-3 Mbps to 2.5 milliwatts with a data rate of up to 24 Mbps.

Bluetooth technology is omnidirectional and does not require line-of-sight positioning of connected devices.

Security has always been and continues to be a priority in the development of the Bluetooth specification, which allows for three modes of security.

The cost of Bluetooth chips is under \$3.

ZigBee®

The ZigBee technology was initially designed to make a mesh network of sensors for use in building automation for lighting and temperature control. The name of the brand is a reference to the behavior of worker honey bees after they return to the beehive.

When food is discovered by scout workers, they return to the hive. Shortly after their return, many foragers leave the hive and fly directly to the food. The remarkable thing about this is that the foragers do not follow the scouts back (the scouts may remain in the hive for hours). So the

scout bees have communicated to the foragers the necessary information for them to find the food on their own by a dance. The scouts zig and zag back and forth in a certain manner and number of repetitions to convey to the foragers information about the odor of the food, its direction from the hive, and its distance from the hive.

In the same manner, ZigBee wireless devices have the ability to create ad hoc networks dynamically, so that messages can get through even if the environment or the different nodes in the network are changing or adversely affected in some way.

There are three different types of ZigBee devices:

ZigBee coordinator (ZC): The most capable device, the coordinator forms the root of the network tree and might bridge to other networks. There is exactly one ZigBee coordinator in each network since it is the device that started the network originally. It is able to store information about the network, including

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Top Access

SURVIVORS® bolt-free covers permit easy access to load cells and electronic components through the scale deck. Side access can be difficult depending on the scale location to buildings. Harsh weather and age also cause bolts to seize up or break off.

Owner benefits: fast throughput, low maintenance

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acting as the trust center and repository for security keys.

ZigBee Router (ZR): As well as running an application function, a router can act as an intermediate router, passing on data from other devices.

ZigBee End Device (ZED): Contains just enough functionality to talk to the parent node (either the coordinator or a router); it cannot relay data from other devices. This relationship allows the node to be asleep a significant amount of the time, thereby extending battery life. A ZED requires the least amount of memory, and therefore can be less expensive to manufacture than a ZR or ZC.

Technical Specs

ZigBee is also referred to as the IEEE 802.15.4.

Low Power—Individual devices must have a two-year battery life to pass ZigBee certification.

ZigBee operates in the 2.4 GHz region also, in most of the world, with an ad-

ditional spectrum at 915 MHz and 868 MHz in Europe. It uses direct-sequence spread spectrum (DSSS) modulation and a very powerful 128-bit AES encryption scheme. The ZigBee network can have as many as 65,000 nodes, all of which can be with routers, or end users, but only one coordinator! With all the traffic going along its network, collisions are avoided and corrected when they do occur using CSMA/CA—Carrier Sense Multiple Access/Collision Avoidance. This means that whenever a device has a need to transmit, it listens for a free carrier, and then transmits. This method

avoids collisions, rather than trying to sort them out later.

One advantage of the low power (multiyear) specification is that it includes a very fast “wake-up time” for end devices.

Wi-Fi

The term Wi-Fi is almost always associated with the IEEE 802.11x standard. The term Wi-Fi was originally coined as a twist on Hi-Fi, and references to Wireless Fidelity appear in some early documents from the Wi-Fi alliance. The Wi-Fi alliance serves a purpose similar

Potential Wireless LAN Uses

802.11	A	B	G	N
Data Rate	6-54 mBPS	1-11 Mbps	1-54 Mbps	7.2-72.2
MIMO	1	1	1	4
Modulation	OFDM	DSSS	OFDM,DSSS	OFDM
Indoor Range	115	125	125	230
Outdoor Range	390	460	460	820

Patented Mounts

SURVIVORS' exclusive G-Force mount system also eliminates excess movement and troublesome check rods and bumper bolts. Bumper bolts often cause binding and end up loose if they are not properly tightened when set.

Open Bottom

SURVIVORS' open-bottom design eliminates enclosed areas where moisture builds up and causes rust. Rice Lake's unique asphalt emulsion coating is applied to non-visible steel surfaces and undersides before pouring concrete decks.

nce, long service, and bragging rights—you own t

Comparison Chart

	Mode	Power	Data Rate (Max Bps)	Cost	Minimum Range	Nodes	Determinism	Ease of Setup	Security
Bluetooth	Pairing	1mW-100mW	24M	Low	10 Meters	7	High	Very easy	Fair
ZigBee	ZigBee	1mW and lower	250K	Low	75 Meters	65,000	Little or none	Simple	Good
Wi-Fi	TCP/IP	100mW	54M	Med	95 Meters	4 million +	Little or none	Moderate	Very good

to both the Bluetooth SIG and the ZigBee alliance—to provide testing and assurance of conformity to the standard. It is almost synonymous with computer wireless communications.

Wi-Fi is used for a Local Area Network of PCs. These can be connected in an ad hoc network or as a more static method using either MAC addresses or fixed IP addresses.

Technical Specs

There are 14 channels designated in the 2.4 GHz range spaced 5 MHz apart

(with the exception of a 12 MHz spacing before Channel 14). Because the protocol requires 25 MHz of channel separation, adjacent channels overlap and will interfere with each other. Consequently, using only channels 1, 6, 11, and 14 is recommended to avoid interference.

Potential Wireless LAN uses of this range are documented by IEEE 802.11a, b, g and n. Countries apply their own regulations to the allowable channels, allowed users, and maximum power levels within the frequency range. (See Potential Wireless LAN Uses chart.)

So, which is best? It depends on the application. (See Comparison Chart).

Need an easy-to-set-up, on-the-fly network with a limited number of nodes that you can simply pair up? Use Bluetooth.

Need a very low-power network to reliably send small amounts of data over a wide range regardless of network conditions? Use ZigBee.

Need a fast network that can be expanded, can send large amounts of data quickly, can be scaled quickly, and is future-proof? Use Wi-Fi. ■

Rodent Barrier

SURVIVORS' flexible steel conduit at the connection point to the load cell and steel conduit throughout are the ultimate protection against rodents chewing through to wires. They can chew through braided or sheathed cable causing scales to malfunction or fail.

Stone Crusher

SURVIVORS' exclusive rock guard crushes stones before they find a spot to bind the scale.

the toughest truck scale on earth

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