
Piping Technology & Products, I
Wireless Asset Tracking Review

PT&P Construction Site Initiative

- PT&P has been told by its customers that costs at construction site for handling and installing its products are 2x the cost of the product
- PT&P has many customers that struggle with lost material
- PT&P has spent significant time at construction sites going through core processes and believes this environment can achieve cost savings via asset tracking and mobile
  - Construction site leaders have told us that SAP or Oracle systems that commonly used do not address the needs of EPCs well
  - EPC Vertical is small for the large ISVs
- PT&P has evaluated the wireless market to select the best options for construction site requirements

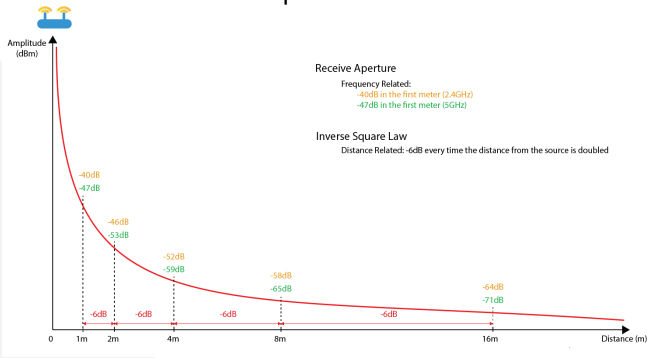
PTP has applied its engineering centric approach to asset tracking and construction site "automation"

Piping Technology & Products, Inc.

- Why do Wireless Protocols look like alphabet soup
  - 5G
  - WiFi
  - GPS
  - BLE
  - LORA
  - RFID
  - Bluetooth
  - Zigby
  - Z-Wave
  - NFC

Design Objective	Tradeoffs
Bandwidth	Options to improve include: increase power, add computing for higher bits per hz, increase spectrum, decrease distance, decrease number of devices
Distance	Options to Improve: increase power, decrease obstructions, decrease users, decrease bandwidth, increase spectrum, use private spectrum, add computing for more sophisticated signal processing, increase size of antennae
Battery Life	Options to Improve: Increase size, decrease bandwidth, decrease distance, decrease computing power
Cost	Options to Improve: Increase volumes of units, decrease bandwidth, decrease distance, decrease computing power, decrease device size/complexity, Integration with Mobile Devices
Number of Devices	Options to Improve: Decrease distance, add computing/complexity for collision management

Wireless Basics

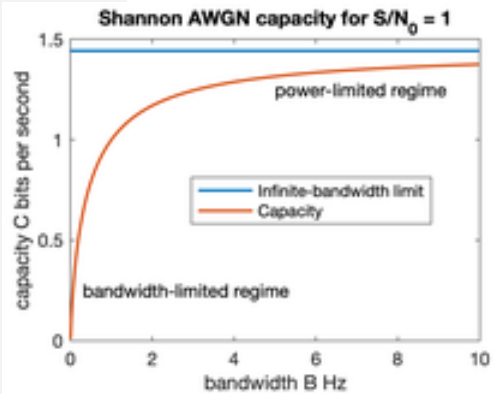


Distance	900 MHz free-space loss	2.4 GHz free-space loss
10 meters	72.5 dB	81 dB
100 meters	92.5 dB	101 dB
1000 meters	112.5 dB	121 dB

Table 1.

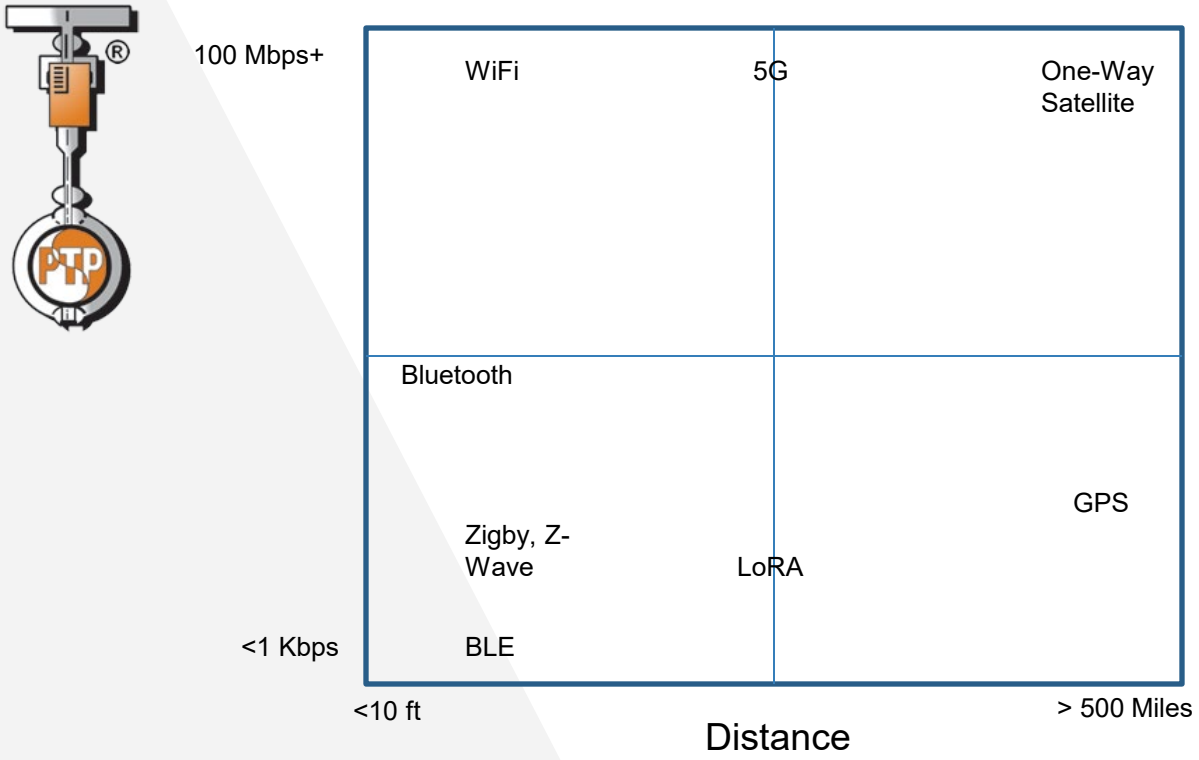
Material	Attenuation @ 900 MHz
Glass 0.25" (6 mm)	0.8 dB
Glass 0.5" (13 mm)	2 dB
Lumber 3" (76 mm)	2.8 dB
Brick 3.5" (89 mm)	3.5 dB
Brick 7" (178 mm)	5 dB
Brick 10.5" (267 mm)	7 dB
Concrete 4" (102 mm)	12 dB
Masonry Block 8" (203 mm)	12 dB
Brick faced concrete 7.5 " (192 mm)	14 dB
Masonry Block 16" (406 mm)	17 dB
Concrete 8" (203 mm)	23 dB
Reinforced Concrete 3.5" (203 mm)	27 dB
Masonry Block 24" (610 mm)	28 dB
Concrete 12" (305 mm)	35 dB

Table 2.



- Wireless signals attenuate at over distance exponentially based on frequency
- Lower frequency, private spectrum (e.g. greater power output allowed) yields best distance/bandwidth
- Maximum theoretical bandwidth per hz is driven by the signal to noise ratio based on Shannon's Law

Wireless Protocols



Different Protocols take tradeoffs to target different applications

5G Reality vs Hype

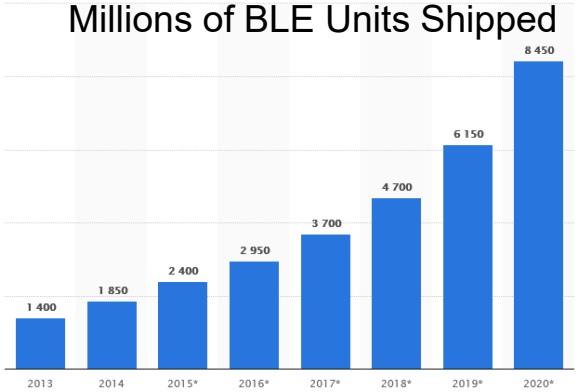
- Increase bandwidth
  - Bits per Hz optimization almost complete with 4G
  - 5G addresses amalgamation of disparate frequency bands and supports higher frequency bands
  - Wireless carriers starting to deploy small cell to reduce cell size and increase bandwidth per user
- Support for targeted signals
- Supports an increased number of devices to better enable IoT – 1M devices per sq KM vs 4K for 4G
- Improved latency

Asset Tracking and Wireless Protocols

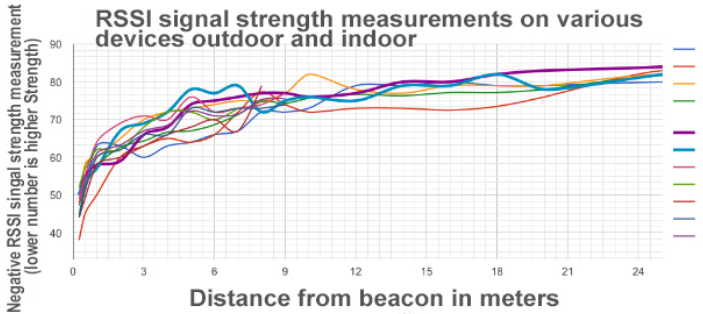
Element	Asset Tracking Requirement	BLE Technology
Bandwidth	Very Low	< 1Kbps
Distance	Local Area – up to 1 sq mile	100 ft – local area network with gateways, and mobile devices
Battery Life	6-24 Months	6 – 24 months
Cost	Very Low - <$10	Most Cost Optimized active wireless solution
Update Frequency	Infrequent – hourly	User programmable update frequency
Number of Devices	High	High
Size	Small preferable	Small devices

BLE History

- Development on BLE commenced in 2001 by Nokia as an offshoot from Bluetooth standard
  - Nokia targeted a lower bandwidth, lower cost protocol
  - Design was influenced by Logitech and European MIMOSA project
  - Utilizes the same 2.4 GHz frequency as Bluetooth
- Technology was released to public in 2006 under name Wibree
- BLE 4.0 published in 2010 with support for smart phone integration
- iPhone 4S integrated BLE 4.0 in October 2011 with many others following in 2012
- BLE 5.0 released on June 2016
- BLE Mesh Profile released in 2017



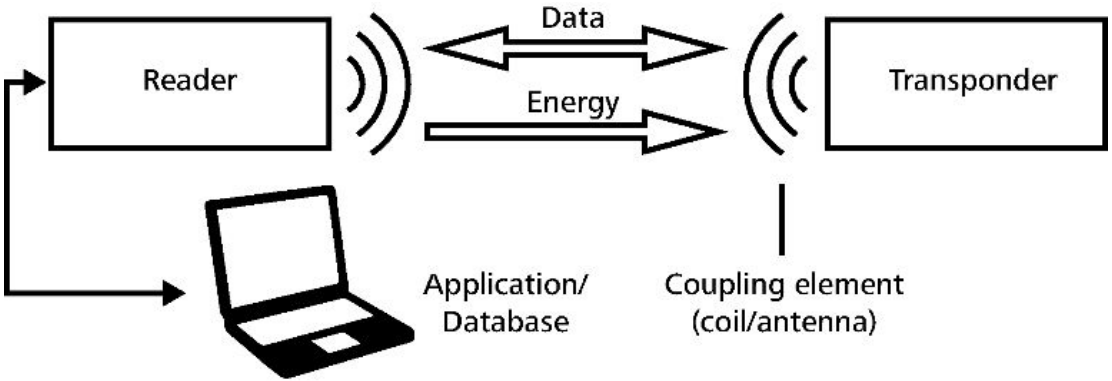
BLE Technology



BLE vs RFID

- Why BLEvs Active RFID?
  - Lower cost
  - Built-in support in Android and iOS
  - Manufacturing scale from consumer applications
- Why BLEvs Passive RFID?
  - Passive RFID requires energy to beamed onto tag and reflected in order to be read– similar to bar code
  - BLE is easier to setup with lower setup costs
  - No risk of poor orientation of tag for reflecting signal
  - Built-in support in Android and iOS
  - Scale from Consumer

RFID System



Requirements for Laydown Yard

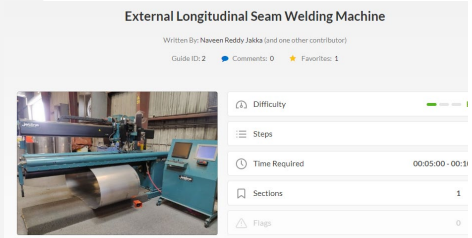
- Low cost gateways are placed with solar power and LoRa backhaul
- Require centralized internet access onsite
- Require workers using system to have mobile device
- Requires admin to associate items and files with individual beacons

Potential Impact on Core Processes

Process	Pain Points	Potential Benefits
Material Receipt	•Time to identify and record what has been received	•Asset tracking could “auto-record” receipt of items
Material Verification – Did We Get Everything	•Packing slip often lost by this point •No drawings readily available to verify items • Getting information to right person to manage escalation with vendor	•Beacons can be used to tie to “virtual” packing slip •Beacons can be tied to drawings for the item and pictures
Installation	•Finding material • Training and proper installation with inexperienced workers – particularly in current economy	•Beacons have tracking information so they can be easily located •Full work instructions and training can be tied to beacons •Workers can record installation for review by expert
Walkdown	• Proving to owner that individual items were installed correctly	•Pictures of installation could be used to demonstrate proper install
Maintenance after Turnover to Owner	• Inventory of items is not well kept for the many smaller items in a new build	•Database with Beacons could be used to establish inventory of smaller items that are not well tracked

PTP Mobile Enabled Work Instructions Platform

PTP Internal Work Instructions for Long Seam Welding



Step 1 Machine Selection

- Check for the thickness of material that is measured and written on the job
- Thickness from 0.012 inch to 0.048 inch is on Jetline #1 and Thickness from 0.048 inch to 0.125 inch is carried out on Jetline #2

Step 3 Check Latch and Gas

- Latch at the end of mandrel must be closed before welding
- Check for the Argon Gas cylinder for a minimum level of 200 psi. Change the cylinder if it goes below that value.
- Dial shows the reading with units. Arrow shows the place to remove the cylinder if needed.

PTP Customer Work Instructions for Installation of Variable Spring Supports

Step 1 Procedure for Spring Support type

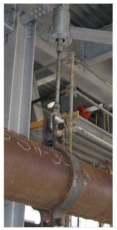
⚠ If the type of spring support to be installed is Type A-C continue with the next step.

- For Type D & E: https://pipingtech.dozuki.com/Guide/embe...
- For Type F: https://pipingtech.dozuki.com/Guide/embe...
- For Type G: https://pipingtech.dozuki.com/Guide/embe...

Step 7 Remove shipping bands

- Cut the shipping bands off and remove the lower travel stops.
- Responsibility for this would be Technician.

Step 10 Inspection of setup



Upload a picture for each of the following steps to ensure proper installation:

- Check that the structural attachment is properly secured.
- Check that the connection from the structural attachment to the spring support is properly secured.
- Check that the connection from the spring support to the pipe clamp or other hardware is properly secured.
- Check that the shipping bands and lower travel stop have been removed.
- Check that the upper travel stop has been removed.
- Check that the pressure plate is at the cold load mark.

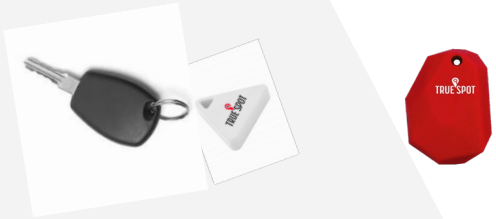
PTP BLE Platform

Multi-Modal Real Time Location Services Platform

Delivers simple, cost effective and low overhead real-time visibility of all assets

TT103 – Optimized for smaller assets

TT400 – For larger assets and outdoor environments



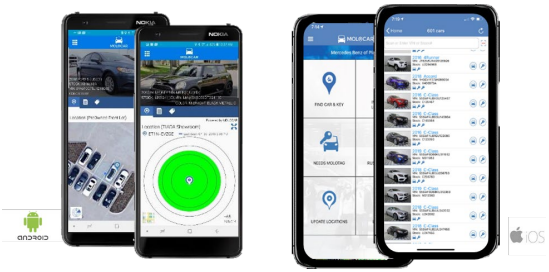
TrueTags pair in 30 seconds or less (digitally and physical), ensuring ease of integration and ramp up.

Campus Low Power Network & Gateways

Up to 5 KM range

Built from ground up to cover campus environments and be highly flexible and adaptable to each unique use case, easy to deploy and maintain

Apps - iOS and Android



Apps and cellular devices provide additional tracking

PTP BLE Platform