

Advanced Renesas Technology for Locationing 2.0

Enabling new possibilities by more accurately tracking people and objects in real time



Locationing 2.0: Advanced Wireless Products Unlock Value of New Tracking Technology

Recent developments in wireless technologies, specifically including Bluetooth® have made possible the implementation of more sophisticated and capable methods for tracking the locationing of people and objects in real time.

These advancements in accuracy, dependability and cost-efficiency (collectively 'Locationing 2.0') are presenting designers and end users with significant improvements to tracking and real-time locationing typically applied to security, safety, efficiency or convenience-related services.

The value of Locationing 2.0 features is applicable across many industries, from logistics and warehousing, factory automation, construction and mining, hospitality, transportation and leisure services to retail stores, offices and medical and nursing care. Locationing 2.0 solutions, supporting higher accuracy and dependability are well suited to tracking, examples including: staff or customers on a cruise ship, pallets, boxes, forklifts in a warehouse, and shared-use e-bikes in a city center.

The latest wireless chips and modules that implement Bluetooth connectivity may also include built-in features that support various methods for tracking objects, supporting the advanced capabilities of Locationing 2.0.

A broad portfolio of Renesas Bluetooth® products is available to support asset tracking and location finding, all benefiting from superior design features including ultra-low power consumption, small footprint, and high location accuracy.

These products are supplemented by advanced NFC chips which enable wireless battery charging and convenient authentication, and by Wi-Fi® networking modules which enable tracking and location-finding devices to connect directly to the cloud with ultra-low power consumption.

In addition, complete Renesas Asset Tracking and Locationing At Scale (ATLAS) and Wireless Ranging (WiRa™) locationing solutions provide a ready-made offering for implementing locationing as quickly and easily as possible. Renesas also offers a range of solutions supporting Crowd-sourced Locationing to quickly and cost-effectively enable your products to be found when lost, globally by leveraging Google Find My Device and Apple Find My™ Network services.

Locationing 2.0: Understanding Its Applications and Value

Advanced wireless technology is improving performance and creating new benefits for tracking people and objects in new ways. The increased accuracy of location finding for objects and devices of all kinds has given rise to a new industry term for real-time object tracking: Locationing 2.0.

By tracking objects indoors or outdoors with an accuracy down to just tens of centimeters, operators can gain many benefits from implementing a Locationing 2.0 system. The most valuable are:

- To improve security by making it more difficult for valuable assets to be removed without proper authorization, and allowing them to be found after they have been moved or lost. This helps to avoid the cost and distress caused when a valued or useful object is lost, stolen, or removed in error from its proper location
- To integrate real-time tracking of inventory and assets into organizations' operational and information technology (OT/IT) systems. This enables more streamlined and timely provision of assets to where they are needed, reducing the management time and effort expended by people in finding and accounting for the valuable tools and equipment that organizations use
- To streamline and improve organizations' monitoring of valuable equipment by automating asset tracking and management. For perishable assets in the cold chain such as food or pharmaceuticals, Locationing 2.0 also enables information about parameters such as temperature and exposure to shock and vibration to be continually uploaded alongside the asset's location.
- To add value to personal and care services by enabling service providers to quickly locate customers or service users, whether diners in a restaurant or residents in a care home for senior citizens

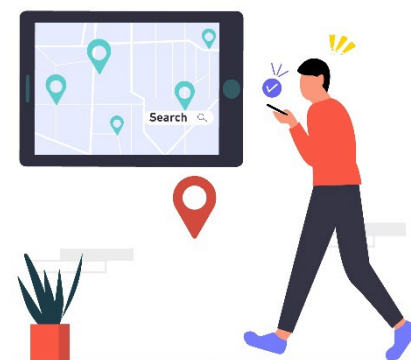
The use cases for Locationing 2.0 technology extend across consumer, commercial, industrial, medical, logistics and agricultural settings.

Crowd-sourced Locationing Applications

In the consumer world, Bluetooth Low Energy-based asset tracking helps people to find lost items quickly and to deter theft. Simple, small wireless tags attached to everyday items such as a purse or wallet, keys or

glasses, as well as larger items such as luggage, allow the owner to locate them after they have been lost or stolen.

These wireless tags take advantage of Google Find My Device and Apple Find My™ Network or collectively referred to as crowd-sourced Locationing. Utilized either as an integrated function in an end product or as a wireless Bluetooth Low Energy tag, they emit a beacon signal which may be detected by any passing smartphones running either the Google Find My Device or Apple Find My™ Network software services. These services report the latest known location of the tag based on the reporting Smartphone's location, allowing the owner to recover their lost item and relieving the distress caused by loss or theft.

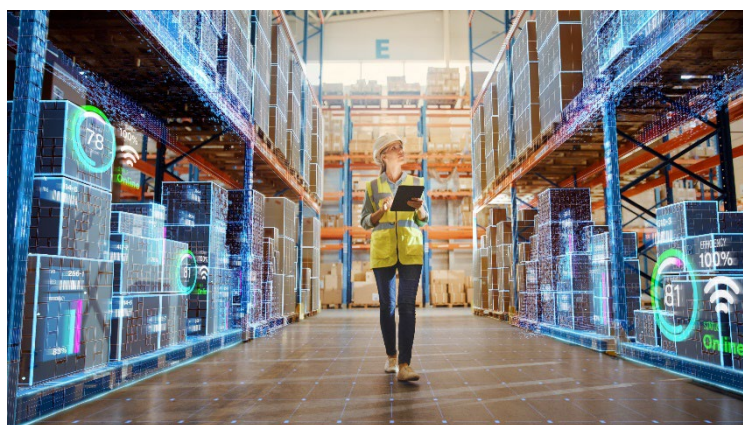


The principle of crowd-sourced locationing can be applied in many other use cases as well, for instance by e-bike manufacturers to allow users to locate both the e-bike and its battery. In metropolitan shared-use schemes, this tracking capability enables operators to automate the tracking and mapping of e-bikes, making it convenient for users to find available vehicles. Crowd-sourced locationing will also in future be deployed as a matter of course in car keys, and potentially also for loss and theft deterrence in automobiles.

Tracking Static or Mobile Assets with a Fixed Locationing Installation

While crowd-sourced locationing may be used to track assets anywhere in the world, the location of people and objects can be accurately tracked in confined spaces with fixed 'locators' (detectors), which receive pulsed beacon signals from tags inside or on assets.

This arrangement can track both static and moving assets. In a warehouse, for instance, a locationing system can maintain a real-time log of the position of static objects, such as pallets or stock-keeping units. In a warehouse, this system can also track moving assets such as materials handling equipment and staff, for instance to monitor compliance with safety protocols.



Deployed across an entire logistics system, locationing with fixed locators enables goods to be tracked from the warehouse, in transit in a truck or container, all the way to a destination in a retail outlet or other end point. This systematic location tracking enables operators to detect when goods go missing or are removed without authorization. Sophisticated locationing tags can also monitor an asset's exposure to shock or vibration and temperature, and report measurements in real time.

On a construction site, a locationing system can detect the position of equipment. This can save time when multiple teams share tools, allowing all users to quickly find the item that they need on site. Similarly, in a hospital, valuable items of shared medical equipment can be rapidly located anywhere on the site, relieving users of the need to continually fetch and return equipment from a central storage facility.

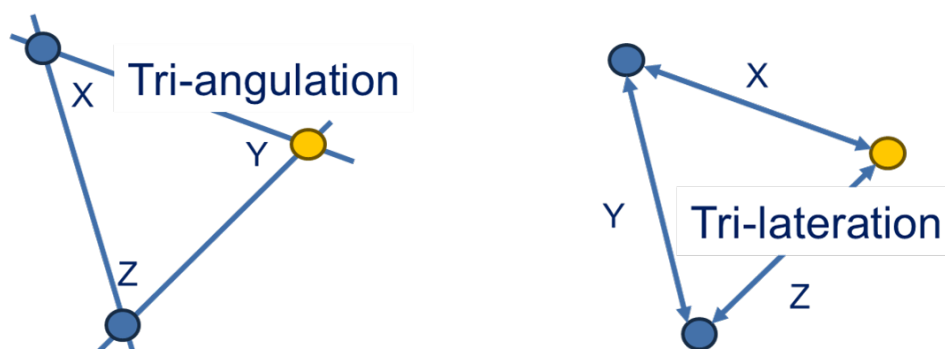
In a care or hospitality setting, Locationing 2.0 enables service providers to instantly locate service users. In a senior living facility, for instance, a locationing tag can allow care staff to continually monitor the location of vulnerable or mentally impaired residents, enhancing the home's ability to maintain a safe environment for service users.

In a large hospitality environment such as a hotel or cruise ship, locationing equipment enables serving staff to deliver orders directly to a customer who placed the order remotely online, giving a seamless and convenient customer experience.

Advanced Wireless Technologies: Technology Options for Implementing a Locationing 2.0 System

The emergence of the new capabilities in Locationing 2.0 systems owes much to the introduction of features in Bluetooth Low Energy specifications, which are defined by the Bluetooth Special Interest Group, an industry body.

Additionally, various radio frequency (RF) technologies may be used to perform wireless tracking of assets: each offers its own combination of advantages and disadvantages. An understanding of the different ways that these RF technologies operate will assist decision-makers in choosing the right one for their application. Schemes for estimating location include: RSSI (receive signal strength indication) based, time-of-flight and phase-based, proximity for 'tri-lateration' locationing and AoA/AoD (angle of arrival and angle of departure) for 'tri-angulation' based locationing.



Bluetooth Low Energy-based Locationing

Early implementations of Bluetooth-based locationing used the Received Signal Strength Indicator (RSSI) method for estimating distance. This method, while offering very low power consumption is vulnerable to

substantial error due to interference from neighbouring radio systems operating at the same 2.4GHz, and from signal blocking by solid objects in the line of sight between the transmitter and receiver.

One of the most important developments in Bluetooth technology is in the enabling of angle-of-arrival (AoA)-based locationing. **AoA-based locationing solutions** employ a fixed 'locator' (typically mounted on the ceiling) which contains an antenna array, a wireless system-on-chip (SoC) for signal reception and processing, and a communication link to back-end software, where raw location data are converted to useful information resources such as a tag map. Employing advanced algorithms beyond the basic, Bluetooth LE AoA/AoD schemes can lead to high accuracy and Locationing dependability typically offering less than $\pm 50\text{cm}$ accuracy.

Renesas provides a complete, customizable solution for AoA locationing. Called ATLAS (Asset Tracking and Locationing at Scale), the Renesas system (in partnership with IOSEA) includes tags, locators, signal processing software, and optional Real-Time Location System (RTLS) back-end software. It can also be easily integrated with a customer's own RTLS back-end.

The ATLAS system offers many advantages:

- The ATLAS Telemos locator is simultaneously compatible with various tag types, including tags supporting angle-of-arrival (AoA) and angle-of-departure (AoD) as well as the proprietary ATLAS and ATLASlite Locationing schemes
- High tag density – thousands of tags/locator, with 500 tags/locator/second for typical in-building applications
- Vertical, horizontal or angled locator placement with spacing up to 20m (10m typical) apart
- Simultaneous tracking of moving and stationary targets

Another application of Bluetooth radio signalling to range-finding is **phase-based ranging** (also implemented as part of the Bluetooth Channel Sounding feature). In this scheme, the Bluetooth transceiver utilizes tones at multiple frequencies: the relative phase difference measured between these tones being directly proportional to the distance they have travelled.

While consuming higher power than the RSSI method, phase-based ranging still consumes very little power when compared with UWB and, unlike RSSI its range measurements are far more tolerant to the attenuation of the signal caused by objects blocking the path between transmitter and receiver, offering significantly improved performance in non-line-of-sight when compared with UWB.

Phase-based ranging and RSSI schemes are however still vulnerable to distortion from multipath effects, caused when ranging signals bounce off solid objects such as masonry or metallic surfaces, leading to unpredictable fluctuations in distance measurements, and reducing the ranging system's reliability.

A comprehensive solution which supports phase-based ranging and RSSI has been developed and field-deployed by Renesas. [WiRa™ Gen 2](#) is a ready-made option for implementing this low-power and low-cost approach to locationing.

As well as being easy to implement, the WiRa Gen 2 solution offers the added benefit of a proprietary multipath cancellation feature, which maintains measurement accuracy even in structures prone to multipath effects such as inside a warehouse constructed from sheet metal.

NFC wireless charging

One more wireless technology of interest for locationing systems is not actually a range-finding method but provides an important function for locationing tags: wireless battery charging.

The advantage of embedding a rechargeable battery in locationing tags is that they can be maintained continuously in a ready state. By contrast, locationing tags with a primary (disposable) battery will fail periodically when the battery becomes fully discharged and will then require the user to replace the battery correctly.

Wireless charging eliminates the need for a mechanical connector to a power adaptor, and so allows the tag to have a fully sealed enclosure, resistant to spills, moisture and immersion in liquid.

The standard technology used in smartphones – Qi wireless charging – provides a high-power input but requires a large antenna and precise antenna alignment between the charger and the charged device. This makes it unsuitable for small, low-cost locationing tags.

NFC wireless charging, on the other hand, operates via an ultra-small antenna, and is highly tolerant of misalignment between the poller's (charger's) and listener's (tag's) antennas.

Complete system solutions for the NFC poller (PTX130W) and NFC listener (PTX30W) available from Renesas provide a compact and ready-made solution for NFC wireless charging in locationing tags and many other applications.

Power, Size and Performance: The Critical Factors in Locationing System Components

When implemented at scale, Locationing 2.0 systems have certain critical requirements which directly affect the system integrator's choice of wireless components, such as Bluetooth Low Energy chips or modules.

These requirements can be viewed from the perspective of the operator of the Locationing 2.0 system, or of its manufacturer: for the operator, the key parameters are those that affect the user experience, as well as the cost and convenience of installing, integrating and running the system.

For the manufacturer, the key parameters affect the cost, performance and scalability of the system. So, what are these parameters?

From the **operator's point of view**, components for locationing should offer:

- **Adequate accuracy** – the accuracy requirement differs from one application to another. For an e-bike located through Google Find My Device or Apple Find My™ network services, accuracy within a few meters is sufficient, because an e-bike is a large object which is easy to spot. On the other hand, for

locating people in a crowded environment such as a restaurant or stadium, accuracy down to as little as $\pm 50\text{cm}$ may be required.

- **High reliability** – in most consumer, commercial and industrial applications, the user would ideally like to achieve the specified accuracy at all times and in all conditions.

Many locationing systems will operate in environments that are hostile to RF transmission: the RF signals might be subject to multipath effects indoors, or to attenuation both caused by masonry, metal or other blocking or reflective objects. Bluetooth-based locationing systems will also often be exposed to interference from other radio systems operating in the same 2.4GHz frequency band.

Renesas locationing solutions such as the WiRa™ technology include algorithms for high-resolution location finding which mitigate the impact of multipath effects and interference.

- **Low cost** – every object to be tracked requires a tag. When tracking thousands of objects, the cost of the tag forms a substantial proportion of total system cost. This means that bill-of-materials cost and battery replacement cost must both be minimized.
- **Easy to implement** – for many operators, the installation of a new Locationing 2.0 system will be their first experience of implementing a Real-time Location System (RTLS). They want an easy-to-implement system which integrates smoothly with their existing OT and IT systems, and which provides intuitive location data out-of-the-box, without requiring complex computation and specialist software development.
- **Ability to scale up in dense deployments** – a key decision factor in the choice of locationing components is their support for the application's required density, which varies from application to application. Some wireless components for Locationing 2.0 handle interference from neighboring RF devices better than others. In the same way, some locationing technologies are better suited to dense deployments than others.
- **Ability to track fast-moving objects** – again, this requirement varies from application to application. Dynamic locationing, tracking moving objects, is a feature of warehouse deployments and construction sites among others. The chosen locationing technology and components must be able to maintain location measurement accuracy when the tracked object is moving.

The **manufacturer of a locationing 2.0 system** has a related but different set of requirements for the components from which the system is built.

- **Low power consumption** – mirroring the operator's desire to avoid battery failure or replacement, or to extend the intervals between battery charges, the manufacturer wants to minimize system power consumption. In locationing tags, the biggest portion of total power consumption can normally be attributed to the radio transceiver. So, a low-power Bluetooth component helps the manufacturer to extend battery run-time, or reduce the size of the battery – or both.
- **Small size and robust package** – linked to the above point, the manufacturer wants to design locationing equipment that is as small as possible. Locationing tags for staff for instance, are wearable devices. The smaller and lighter they are, the more comfortable and unobtrusive. Bluetooth chips or modules that have a small board footprint and low profile help the manufacturer to minimize the size of the system's enclosure.
- Tags will often be exposed to liquids, moisture or other contaminants which are damaging to electronic circuitry. The provision of NFC wireless charging enables a tag with a fully sealed enclosure and a high ingress protection (IP) rating to recharge its battery.

- **Competitive cost** – the value of a locationing equipment manufacturer's product is strongly affected by its price, so bill-of-materials cost of the wireless components has an impact. But equally, the manufacturer can provide value to the operator by making a locationing product which is, for instance, easier and therefore cheaper to install, which costs less to run because it requires less frequent battery replacement, or which requires less infrastructure and fewer locators.
- **Ease of system integration** – operators generally want to avoid a long and difficult integration effort to link a new RTLS system to their existing operational software.

The manufacturer can add value to their product offering by providing a complete solution including intuitive RTLS location outputs and optional telematics information such as environmental sensor data and time stamps. A ready-made RTLS back-end can also be valuable for the many operators which are implementing a Locationing 2.0 system for the first time.

The table below summarizes the performance characteristics and attributes of the main range-finding technologies in use today in Locationing 2.0 systems.

Locationing 2.0 Technology	Accuracy	Advantages	Drawbacks
Bluetooth Low Energy RSSI	Median between 2m and 10m	▪ Low cost ▪ Low power (typically <0.367mW) ▪ Easy to deploy ▪ Good data-transfer capability	▪ Accuracy impaired by interference and multipath effects
Bluetooth Low Energy AoA	Median less than 50cm	▪ Low cost ▪ Low power ▪ Higher reliability than RSSI	▪ Limited to fewer than 50 tags per locator
Bluetooth Low Energy Phase-based ranging (Renesas WiRa™)	Median less than 50cm	▪ Low cost ▪ Low power ▪ Includes advanced Multipath cancellation ▪ Includes in-band noise resilience	▪ Connection based, peer-to-peer limits number of measurements per second ▪ Proprietary (non-BT SIG) scheme
ATLAS (Bluetooth-based)	Median less than 50cm	▪ Very low power consumption (as low as 0.12mW) ▪ High accuracy in most operating environments ▪ Works well in-non-line-of-sight ▪ Scalable up to thousands of tags per locator ▪ Fast 100Hz refresh rate enables use with fast-moving targets ▪ Requires fewer locators ▪ No tag synchronization required ▪ Easy to install and commission	▪ A proprietary Renesas technology – the other technologies can be sourced from multiple suppliers

Renesas: The Superior Choice for Connectivity in Locationing 2.0 Applications

The list of parameters above suggests that the choice of system components and solutions for Locationing 2.0 applications rewards careful engineering and commercial evaluation.

Having invested over a long period of time in technology and solution development, Renesas has best-in-class, 'Locationing 2.0' solutions. Our WiRa™ (phase-based ranging with multi-path cancellation) and, developed in conjunction with IOSEA, our [ATLAS AoA solutions](#) are both deployed and field-proven. These offerings, along with Google Find My Device, Apple Find My™ Network ([Crowd-sourced Locationing](#)) and NFC are available for demonstration/evaluation/product development, today.

Broad product portfolio gives wide choice of implementation options

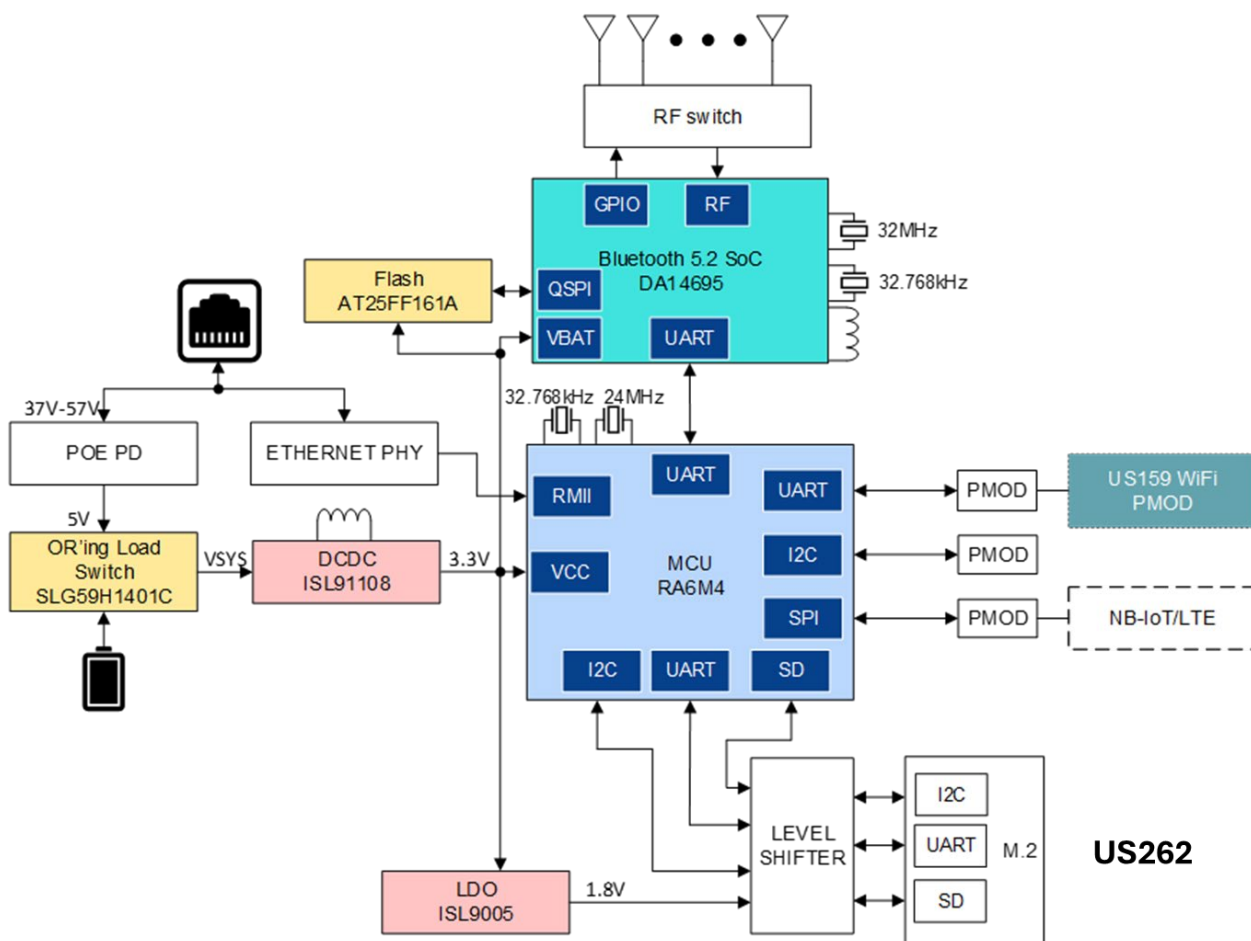
Renesas Connectivity Solutions offers one of the industry's widest selections of chips and modules for Bluetooth, and [NFC](#) wireless connectivity. The breadth of the portfolio gives customers freedom to make appropriate technology choices. This is in part because Renesas is a technology-neutral supplier: Renesas engineers can help the customer to choose the most appropriate way to implement Locationing 2.0, whichever method the application requires.

Partnered with IOSEA, Renesas' ATLAS 'Telemos' Locators and a growing range of asset tracking tags are being made available for private labelling, accelerating customer time-to-market and reducing project development costs. For customers looking for a 'turnkey' solution, IOSEA also offers a scalable, best-in-class RTLS Back-end and expert technical support is available during evaluation and product development phases. To learn more or to arrange for a demonstration, please contact Renesas Sales.

World-wide certified modules for the Google Find My Device and Apple Find My™ services also speed the implementation of systems for crowd-sourced locationing as stand-alone tags or integrated into customer's end-products.

Renesas' portfolio includes a complete set of NFC components for communication and wireless charging. Renesas solutions are backed by Renesas Winning Combinations, vetted configurations of components for specific applications. Examples related to Locationing 2.0 include:

- Locator for Asset Tracking and Locationing
- Bluetooth Low Energy tag based on DA1453x that can be used as sensor tag or tag for ATLAS lite



Market-leading performance optimized for Locationing 2.0

Products available from Renesas Connectivity Solutions provide superior performance and characteristics when deployed in Locationing 2.0 applications.

The following selection highlights products with particularly attractive attributes for Locationing 2.0 applications.

DA1453x TINY™ Bluetooth system-on-chip

The industry's smallest, lowest-power Bluetooth Low Energy SoC. Low unit cost makes it particularly suitable for disposable locationing tags and also offers the lowest cost and longest battery life.

Key features:

- Arm® Cortex®-M0+ core operating at 16MHz, backed by 64kB of SRAM and 160kB of ROM
- Integrated buck/boost DC-DC converter. Enables operation from a battery supply as low as 1.2V
- High-performance radio: +4dBm maximum TX power, -94.5dBm RX sensitivity
- Very low power consumption:
 - 1µA deep sleep current with no RAM retention
 - Typical TX current 3.1 mA, RX current 2.5 mA

- Extended operating temperature range of –40°C to 105°C

[DA14592](#) dual-core Bluetooth system-on-chip

Ideal for applications with high tag density. Low cost, low power and small size make this SoC ideal for Crowd-sourced Locationing (ie Google Find My Device and Apple Find My™ network).

Key features:

- Dual-core architecture: Arm Cortex-M33F operating at 64MHz as the application core, Cortex-M0+ core operating at 64MHz as a configurable wireless media access controller
- High link budget: RX sensitivity -96dBm, maximum TX power +6dBm
- Lowest radio current: Rx 1.2mA, Tx 2.3mA (radio only)
- Hibernation current: 75nA
- 8-channel sigma-delta ADC
- Small board footprint – only requires six external components
- Key storage and secure boot for high application security

DA1469x dual-core Bluetooth system-on-chip with battery charger

This compact Bluetooth SoC includes an integrated USB charger with software fuel gauge feature to provide built-in support for rechargeable batteries. This makes it ideal for rechargeable tags, such as staff badges, etc.

Key features:

- Multi-core architecture: Arm Cortex-M33F core operating at 96MHz as the application core, Cortex-M0+ core operating at 96MHz as a configurable wireless media access controller; sensor node controller
- Integrated USB charger offers charging current of 560mA at 5V (with JEITA compliant fuel-gauge)
- High link budget: RX sensitivity -96dBm, maximum TX power +6dBm
- 8-channel, 14-bit sigma-delta ADC
- Integrated: LCD controller, haptics support, white LED driver

Bluetooth Low Energy modules

Renesas modules provide ready-made, world-wide regulatory certified system implementations using Renesas, Bluetooth SoCs including: [DA14531MOD](#), [DA14592MOD](#) and [DA14695MOD](#). These modules provide for faster development time and lower development cost, while also reducing regulatory and Bluetooth certification costs.

Renesas modules are supplied pre-certified for compatibility with the Google Find My Device and Apple Find My™ locationing services.

Integrated NFC wireless charging

The [PTX130W](#) poller SoC and [PTX30W](#) listener system-in-package provide a complete solution for NFC wireless charging, to enable the realization of a robust, sealed design with a high IP rating.

The solution has an ultra-small footprint including small antenna and high tolerance of antenna misalignment

[PTX130W](#) poller IC key features:

- DiRAC® direct antenna connection technology
- Simple antenna matching
- Flexible placement of the charger's antenna relative to the tag's
- 2W maximum charge power at the antenna

[PTX30W](#) SiP key features:

- NFC tag, active rectifier, limiter, battery charger circuit, and dedicated core in a 1.78mm x 1.78mm WLCSP package
- Wireless charging protocol implemented on-chip
- Harvests up to 1W from the charger
- Data exchange capability
- Superior RF performance via a small antenna

Locationing 2.0 in Practice: Successful Implementations of Renesas Connectivity Solutions Products

Princess Cruises®: tracking thousands of people and in a metal-bound indoor environment

The SUN Princess, a cruise ship operated by Princess Cruises® and part of the Carnival Cruises fleet, is the site for what is believed to be the world's largest deployment of a Bluetooth-derived, angle-of-arrival locationing technology. Built with steel walls, floors and ceilings, this highly reflective, RF-hostile environment presented a particularly challenging project with the



resulting, successful deployment only being made possible by the use of Renesas' (in partnership with IOSEA) ATLAS Locationing 2.0 solution. The SUN Princess cruise ship is equipped with a complete

locationing solution, including ATLAS locators, ATLAS tags (Princess Medallion-class™ Medallions) and IOSEA RTLS back-end.

This successful deployment of the ATLAS system shows that it offers a highly robust and reliable method for providing high accuracy locationing data, with very high tag density (thousands of tags) performing in an RF-hostile environment.

John Padgett, CEO of Princess Cruise Lines, said: *“Renesas’ technology has given us the precision and confidence to deliver services like never before. In the cruise industry, personalization at scale is essential, and Renesas has been a crucial partner in helping us achieve this”.*

Feasycom: Bluetooth Low Energy modules provide ready-made RF system for use in locationing tags



Feasycom, a developer and manufacturer of Bluetooth, Wi-Fi and IoT modules and solutions, has based its most advanced Bluetooth Low Energy modules, beacons, and sensors on the [DA14531](#) system-on-chip (SoC).

Feasycom chose Renesas mainly because of the [DA14531](#) SoC's superior features, including its very low power consumption, small size, and high ratio of value to cost. These characteristics are crucial for developing competitive IoT solutions that require efficient energy use and compact form factors.

The [DA14531](#) chip's power consumption is half that of competing solutions, doubling battery standby time. This substantial improvement enhances the competitiveness of Feasycom's products by extending battery life and reducing operational costs. Furthermore, the low power consumption allows for the use of smaller batteries, contributing to cost savings and reduced product dimensions. These advantages have enabled Feasycom to increase its market share and maintain a leading position in the industry.

Howard Wu, VP of Feasycom (US), emphasized the importance of Renesas' support in its success: *“Feasycom keeps making great innovations to solve hard problems and challenges in IoT. All the great work is only possible thanks to the support of our great partners, such as Renesas.”*

Conclusion

In essence, the advancements in wireless technologies, particularly Bluetooth, have revolutionized the way we track and locate people and objects in real-time. Significant improvements in accuracy, dependability, and cost-efficiency, make it a valuable solution across various industries and offers higher accuracy with consistency and at attractive Capex and Opex costs. The integration of crowd-sourced locationing and fixed locationing installations further enhances the capabilities of Locationing 2.0, providing a seamless and efficient tracking solution. Additionally, the inclusion of NFC wireless charging ensures the longevity and

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reliability of locationing tags. Overall, Locationing 2.0 represents a significant leap forward in tracking technology, unlocking new possibilities and benefits for businesses and consumers alike.

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