ANT™
the power of less

ANT Q&A's

Q: What is ANT?

A: ANT™ is a demonstrably superior Wireless Sensor Network (WSN) RF protocol for almost all practical ultra-low power networking applications – from simple point-to-point to complex mesh networks. ANT is designed to run using low cost, low power microcontrollers (MCUs) and transceivers operating in the 2.4 GHz Industrial, Scientific and Medical (ISM) band. The ISM band is a globally available licence-free part of the RF spectrum. The worldwide adoption of the 2.4 GHz band lends itself to cost critical consumer applications such as sports and health products because a single product design can be shipped to a global customer base without modification.

The ANT WSN protocol has been intentionally engineered for simplicity and efficiency. In operation, this results in an ultra-low power consumption, maximised battery life, a minimal burden on system resources, simpler network designs and lower implementation costs.

ANT also features low latency, the ability to trade-off data rate against power consumption, and support for broadcast, burst and acknowledged transactions up to a net data rate of 20 kbit/s. (ANT's over the air data rate is 1 Mbit/s (for low duty cycle operation).) The protocol also features bi-directional communications and adaptive isochronous channels that support multiple frequencies and high density networking in practical peer-to-peer, star, tree and practical mesh networks.

ANT is a production-proven protocol - successfully used in over two million nodes in many applications worldwide - designed to give developers maximum flexibility, scalability and ease-of-use when constructing WSNs.

Q: Why is ANT required?

A: Before ANT™, wirelessly connecting devices was a big challenge. Existing RF protocols based on industry standards required a significant investment of time and technical resources to be adapted to the ultra-low power and highly restricted space requirements of the types of devices targeted by ANT. (For example, intelligent sports watches wirelessly communicating with associated sensors such as Heart Rate Monitors (HRMs) and Speed & Distance Monitors (SDMs)).

Standards-based protocols such as Bluetooth® and ZigBee® are compromised by additions made to the protocol in order to satisfy the wide application needs of all interested parties (namely SIG or Alliance members). The net result is a large protocol overhead, lower efficiency, increased power consumption and increased costs.

In contrast, designers can employ ANT safe in the knowledge that the protocol is the best available for ultra-low power operation.

Q: What are the applications for ANT?

A: ANT™ is a production-proven RF protocol solution that can already be found in a wide range of consumer products from companies such as Suunto, Garmin and Timex.

In addition, ANT's power efficiency makes it ideally suited to thousands of applications where previously wireless connectivity was impractical due to battery cell constraints. Prime examples include:

- Wrist-mounted instrumentation
- Heart Rate Monitoring (HRM)
- Speed and Distance Monitoring (SDM)

- Bike computers
- Medical instrumentation
- Industrial sensors
- Low data-rate communications
- Active RFID
- Location-based services
- Utilities wireless Automated Meter Reading (AMR)
- Smart toys
- Automotive instruments

ANT is also particularly suited to the unique demands of Wireless Sensor Networks (WSNs) that are poised to form the cornerstone of the next phase of the wireless revolution (see "What is a Wireless Sensor Network?" FAQ for further info).

The demands for WSNs differ significantly from less complex Personal Area Networks (PANs) and Wireless Local Area Networks (WLANs) serviced by Bluetooth and Wi-Fi®. To be competitive with traditional wired systems, WSNs must be very reliable, feature ultra-low power consumption (because many of the network nodes have to be battery-powered and often be hard to access) and above all, inexpensive to purchase, install and maintain. ANT is the ideal protocol to meet these constraints.

Q: What is SensRcore?

A: SensRcore™ is an extension of ANT that allows 2.4 GHz Wireless Sensor Network (WSN) developers to rapidly develop and configure low cost, ultra-low power sensors. Sensors designed with SensRcore can run autonomously using ANT and an inexpensive ultra-low power, ANT BBP and a 2.4 GHz radio chip. SensRcore enables the development of ultra-low power networks – allowing sensors to run for years on a coin cell battery – and cuts system costs by 30 percent.

In operation, SensRcore configures the sensor at start-up with a flash memory stored sensor profile and the relevant ANT sensor communication protocol. ANT chips and modules equipped with SensRcore do not require an application host MCU, eliminating the need for complex firmware development. This shortens design cycles and cuts system cost, power consumption and, battery and unit size.

Many common sensor profiles are preloaded and available through external pin configurations, and SensRcore includes support for almost any direct analogue or digital sensor sampling application.

Input sampling can be either interrupt driven (counter mode), poll-based according to the ANT message period, or periodically generated by an internal timer (when simple analogue-to-digital filtering is to be applied). Multiple data sources can be associated with a single ANT channel that will transmit data on every message period. Each data type has its own pre-defined payload format.

SensRcore is suitable for a wide range of WSN applications and products – particularly those that will benefit from eliminating unnecessary complexity common to other approaches. Application and product examples include: wireless intelligent sport instruments and sensors; and industrial and home automation sensing of parameters such as temperature, lighting and movement.

Q: What is a Wireless Sensor Network?

A: A Wireless Sensor Network (WSN) is a group or system of interconnected sensors and controllers, communicating via wireless links. A WSN can comprise two or three nodes, or several hundred. An example of a simple WSN is a sports watch connected to a Heart Rate Monitor (HRM) and pedometer. Examples that are more complicated include building temperature monitoring and control, and distributed meter monitoring.

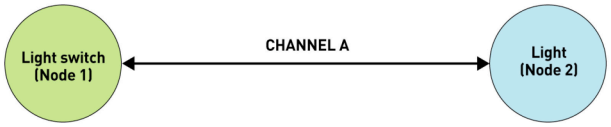
The main advantages of WSNs over their wired counterparts are the cost savings associated with the purchase

and installation of wiring and connectors and greater reliability. In addition, WSNs feature simple scalability because the network size can be increased with little or no additional design overhead.

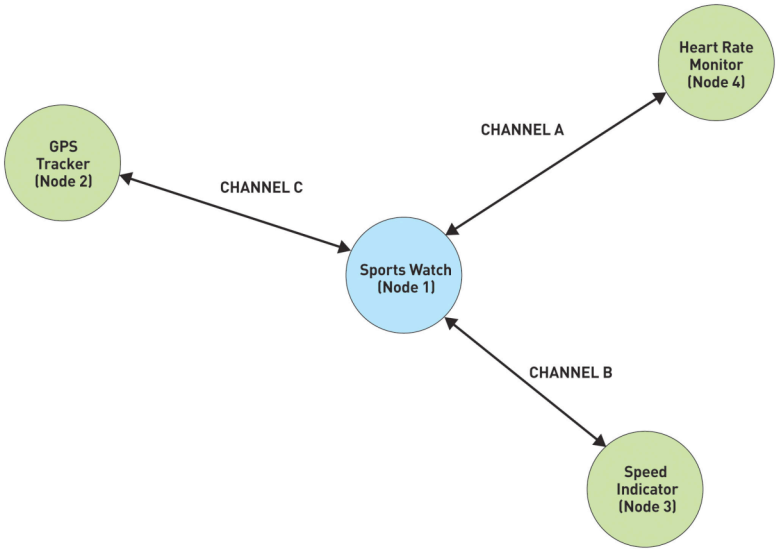
Q: What networking topologies does ANT support?

A: ANT™ is suited to all forms of practical Wireless Sensor Networks (WSNs) including peer-to-peer, star, tree and other types of mesh network. (Examples of all these networks are illustrated graphically below.)

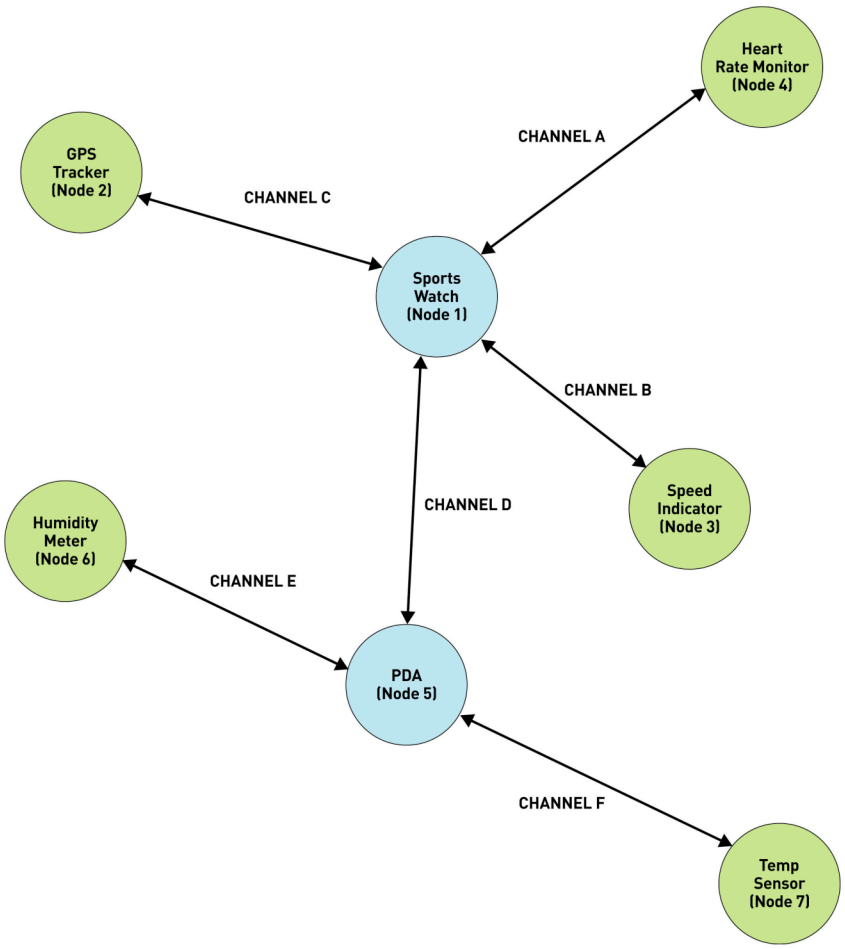
ANT has been designed with simplicity and efficiency uppermost; it is optimised for point-to-point, star and tree networks (with a capability of up to 65,536 slave nodes talking to one master over a time slot shared single channel). ANT requires minimal external resources significantly reducing the overall cost of a typical application. In addition, ANT is easily capable of having a mesh network built on top of it in the rare circumstances this increased complexity can be justified



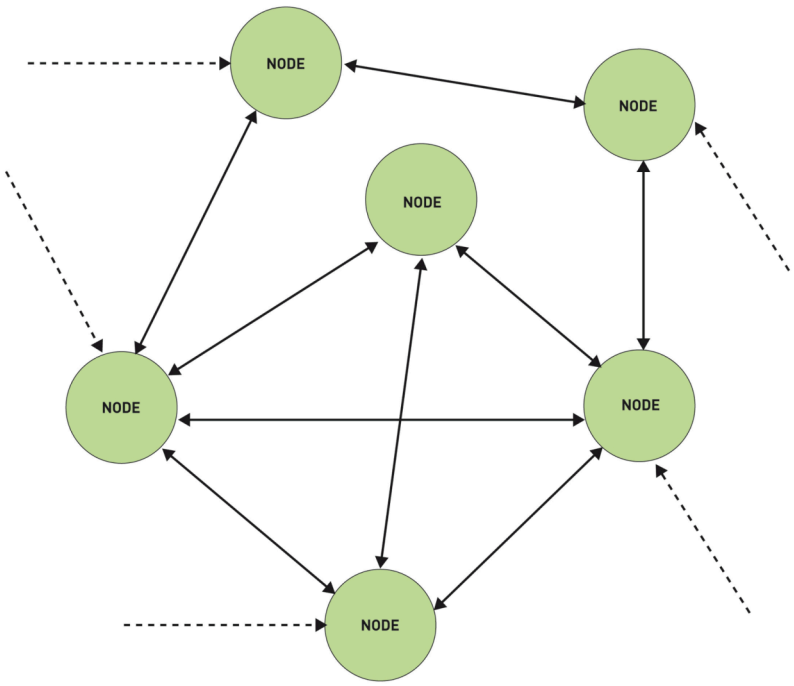
Peer-to-peer network (e.g. simple on/off switch or dimmer control)



Star network (e.g. sportswatch communicating with several peripherals)



Tree network (e.g. sportswatch and PDA communicating with each other and several connected peripherals)



Mesh networking allows a node to communicate directly with several other nodes, but introduces complexity, increased system resources and greater power consumption. Most practical applications can be resolved using pre-determined peer-to-peer, star or tree networks

Q: How does ANT simplify network construction?

A: ANT™-powered nodes are equally capable of acting as "slaves" or "masters" within a network and swapping roles at any time. This means the nodes can act as transmitters, receivers or transceivers to route traffic to other nodes. In addition, every node is capable of determining the best time to transmit based on the activity of its neighbours, so no "coordinator" or "supervisory" node is required.

ANT is an ideal protocol for practical networks because of this inherent ability to support *ad hoc* interconnection of tens or hundreds of nodes. This ability to build a network on an *ad hoc* basis simplifies interconnection. Nodes can easily join and leave the network and fewer system resources are required. Devices can discover and track each other concurrently and communicate simultaneously.

Other technologies complicate network building by introducing "reduced function" (i.e. slaves), "full function" (i.e. masters) and coordinator nodes. These are distributed throughout the network to supervise subsets of nodes, adding complexity and increasing system resources. The coordinator first forms a subset cluster and then handles requests from neighbouring coordinator nodes wishing to attach their clusters to the mesh. Such networks can't be constructed on an *ad hoc* basis, because it is difficult for nodes to join and leave the network and computing overhead is increased

Q: How does ANT compare with other wireless protocols?

A: ANT™ is a proven, proprietary protocol unencumbered by features beyond those strictly necessary for creating and maintaining reliable, robust network communications in the 2.4 GHz band. As a result, it's highly efficient, features ultra-low power consumption and requires few system resources.

The Bluetooth protocol is designed for rapid file transfer between devices in a PAN such as PDA, cell-phone and portable computer. It is not designed for large WSNs. Consequently, Bluetooth's stack is 100 times larger than ANT, its average power consumption is 10 times greater and the hardware costs are 90 percent higher.

A more direct comparison can be drawn with ZigBee. Endorsed by an alliance of semiconductor companies, ZigBee – based on the IEEE 802.15.4 standard PHY and Media Access Control (MAC) layers, and supporting the alliance's own Network (NWK) and Application (APL) layers – is marketed as a solution when power consumption and cost are priorities.

Compared to Bluetooth, ZigBee is undoubtedly less expensive, simpler and more power efficient. ZigBee's protocol stack is less than a quarter the size of Bluetooth's. However, ANT is at least an order of magnitude smaller than ZigBee and forty times smaller than Bluetooth.

In addition, ZigBee's relatively complex protocol increases the external microcontroller burden compared with ANT, demanding microcontrollers that are more powerful and increasing system cost by 60 percent. ANT's requirement for external host resources is eliminated when using SensRcore™. (See table below.)

WSN parameter	**ANT (with SensRcore)**	**ZigBee**	**ANT's advantage**
Host resources required (kByte)	2 (0)	100	Smaller system resources results in lower sensor cost
Battery life (with coin-cell battery) §	3+ years	4 to 6 months*	Lower power requirements make coin cell operation practical, resulting in smaller size, lower costs and reduced maintenance

Over-the-air transmission rate (kbit/s)	1000	250	Short radio on time
Supported network topologies	Peer-to-peer, star, tree, mesh	Peer-to-peer, star, tree, mesh	Simple to complex network configurations

§ 8 byte data message, 2 second interval, 24hrs/day, 7 days/week.

*Peak current requirement for ZigBee exceeds coin cell battery capability so coin cell operation is impractical.

Q: Is ANT compatible with ZigBee?

A: No.

The ZigBee® specification is based on the IEEE 802.15.4 standard physical layer (PHY) and Media Access Control (MAC) layers, and supports the ZigBee Alliance's own Network (NWK) and Application (APL) through a tightly defined operating protocol. ANT™ is a different protocol and is thus not compatible with ZigBee.

Q: What is the advantage of ANT over standards-based protocols?

A: The ANT™ protocol is intentionally engineered to be simple and highly efficient. It demands minimal system resources to simplify network design and minimises implementation costs. This simplicity and efficiency further ensures ultra-low power consumption, dramatically extending battery life. Moreover, as a proprietary technology, ANT doesn't have to be ratified to meet a standard (although it must meet relevant local rules such as US FCC and European ETSI regulations.)

Some argue that a big drawback of proprietary technology is lack of interoperability. However, that's not a problem for ANT because of the introduction of the ANT+ managed networks. An example is ANT+ Sport. This hybrid model offers the benefits of the ANT protocol combined with an open, interoperable managed network (featuring pre-defined device types and data formats) while preventing ANT from becoming entrenched by the standards setting process and allowing the manufacturers to continue optimising ANT's ultra-low power attributes.

This is not to say that standards-based protocols such as Bluetooth® and ZigBee® don't operate satisfactorily in the defined sectors for which each was originally conceived and designed. However, attempts by the ratification bodies to ensure the standards satisfy all interested parties (rather than meeting the specific needs of the end applications) invariably mean that the product is compromised by the attempt to develop a solution that pleases everybody. In the case of the Bluetooth and ZigBee, the net result is an increased overhead, lower efficiency, increased power consumption and increased costs.

Bluetooth and ZigBee protocols are loaded with extra features – for example to support mesh networking, encryption and higher applications – that tend to creep into consortia specs in order to keep all contributing parties happy. As a result, a designer selecting these protocols is forced to accept these compromises even though he may not require many of the features. With ANT, the designer gets a protocol that's perfectly optimised for its defined purpose.

Q: How is ANT supplied?

A: ANT™ is available in three formats: As an integrated RF transceiver with embedded ANT protocol, as a scalable two-chip set and as an FCC-ready drop-in module. The single-chip integrated solution allows drop-in connectivity in a 5 by 5 mm package. The two-chip set solution enables an RF + protocol solution in approximately 180 mm^2.

A radio from Nordic Semiconductor is the preferred physical layer (PHY). Like ANT, this radio has been purpose-designed to meet the design constraints and low cost, ultra low power characteristics demanded by Wireless Sensor Networks (WSNs). The radio operates in the 2.4 GHz spectrum, is highly efficient and features ultra-low power consumption.

As a complete RF and protocol solution, ANT products eliminate protocol development or the requirement for third party protocol integration and Special Interest Group (SIG) certification testing.

Q: Why is power consumption for Wireless Sensor Network applications so important?

A: The potential of Wireless Sensor Networks (WSNs) is huge, but to realise this potential and make a commercially compelling business proposition, these systems must not simply match, but be superior to traditional wired networks. Consequently, WSNs must be very reliable, cheap to purchase, install and maintain, and offer a functionality, flexibility and ease-of-use not achievable with a wired link.

Furthermore, in a practical WSN, there could be tens or even hundreds of these nodes, and often they will be in difficult-to-reach places. It is a huge advantage if the system features batteries that can last years rather than months. The lower the power consumption of the individual nodes, the longer the battery life.

Q: How does the power consumption of ANT compare to other protocols?

A: ANT™ features ultra-low power consumption, much lower than ZigBee® and Bluetooth®. It is difficult to draw direct comparisons with Bluetooth, because the application areas barely overlap. But for illustration purposes, if Bluetooth was used in a coin cell-powered application transmitting every two seconds continuously, the batteries would last no more than a week.

ZigBee features much lower power consumption and in the same application, the batteries could last up to four months. However, ANT is an ultra-low power consumption protocol, and, in the same application, a user might reasonably expect a battery life of between one and four years.

Q: How does ANT™ achieve its ultra-low power consumption?

A: ANT™ is a highly efficient protocol that allows a system to be engineered to spend most of its time in an ultra-low power sleep mode (consuming just microamps), wake up quickly, transmit for the shortest possible time (because consumption rises to tens of milliamps during transmission) and quickly return back to an ultra-low power sleep mode.

Each data packet features a small overhead (see "How does the protocol affect the wireless link's efficiency?" FAQ for further info). When combined with a 1 Mbit/s over the air data rate, for instance, this efficient packet scheme minimises the radio's transmission time, extending battery life.

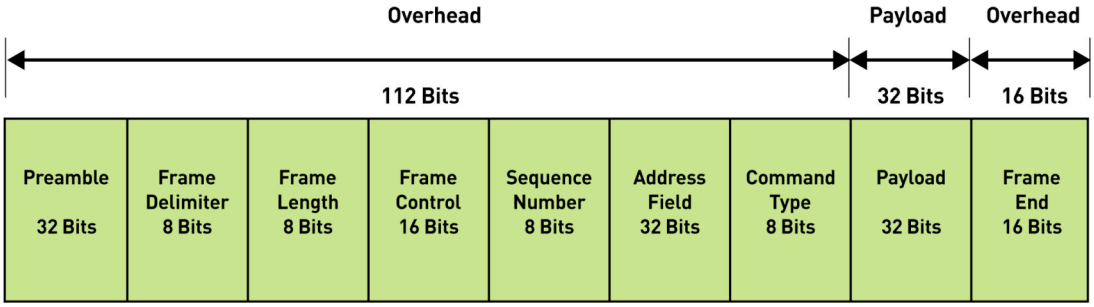
In comparison, ZigBee® features a less efficient packet scheme and a 250 kbit/s raw data rate. This means to send the same amount of useful information as ANT, a ZigBee® radio has to transmit for much longer, significantly reducing battery life.

Q: How does the protocol affect the wireless link's efficiency?

A: In a Wireless Sensor Network (WSN – see "What is a Wireless Sensor Network?" FAQ for further info) data is sent across a wireless link in packets of a predetermined size. Each packet comprises an 'overhead' (required to set-up the communication with a specific node and to determine how the information will be reliably sent) in order to deliver a 'payload' (the actual useful data). Information that is too large to be sent using a single packet is broken down into a number of standard packets and re-assembled at the receiver.

In ANT's case, the bits required to set-up communications are minimised so that a packet is much shorter for a given payload. The efficiency of a protocol is measured by the ratio of overhead to payload. For example, one generic protocol competing with ANT features a packet of 160 bits comprising 128 bits of overhead and 32 bits

of data yielding an efficiency of 20 percent. (See figure below). In comparison, ANT's efficiency is 47 percent.



Example of packet structure with an efficiency of 20 percent

The efficiency of the protocol – combined with the radio's bandwidth (a measure of the amount of data it can transmit or receive per unit time) – largely determines the battery life of the transceiver.

Q: Can designers start experimenting with ANT on a trial basis?

A: The ANT™ general purpose Development Kit provides all the resources necessary to perform an application development evaluation and to start developing applications using ANT.

The ANT Development Kit comprises:

- 2x USB/battery-powered ANT development boards
- 2x ANT battery powered boards
- 4x ANT RF transceiver modules with embedded protocol
- 4x coin cell batteries
- 2x USB cables
- 1x CD with documentation, software and libraries
- 1x PC-based demonstration application showing the channel set-up and communication modes
- 1x Emulation demonstration of a simple Input/Output sensor mode of operation
- 1x Documentation
- 1x ANT PC library files

Q: Is ANT affected by interference from other 2.4 GHz RF technologies such as Bluetooth?

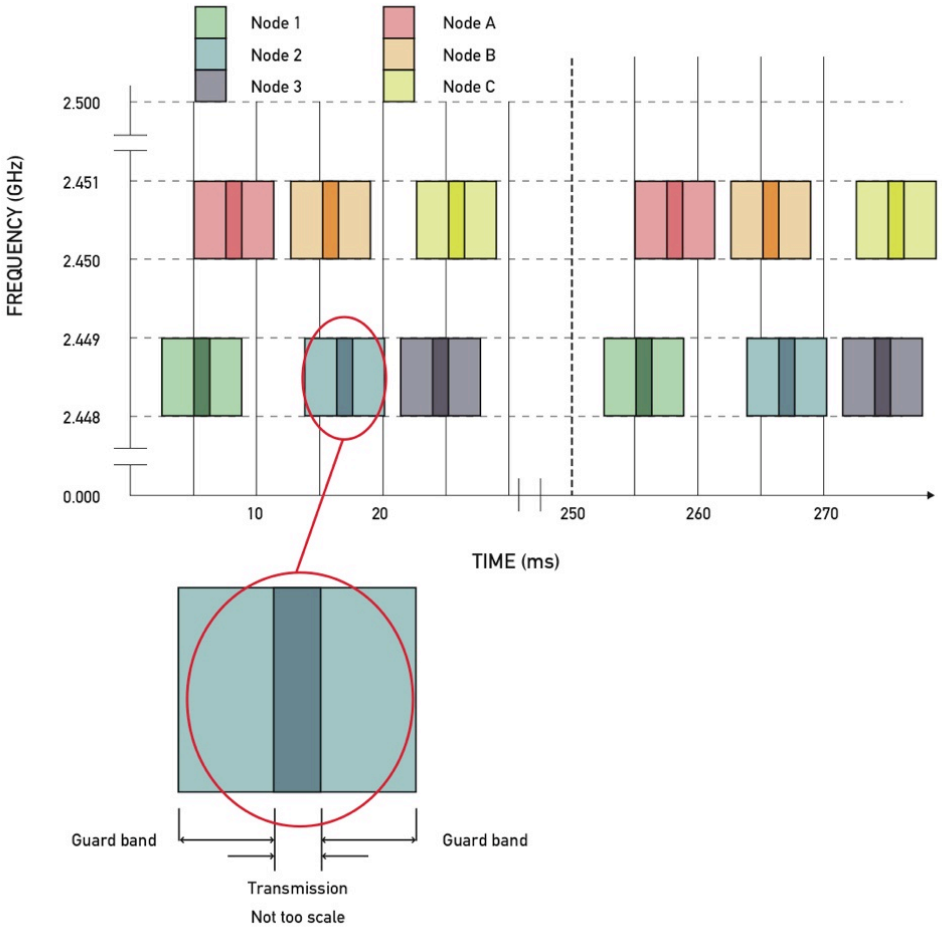
A: All radio links are prone to interference from other devices operating on the same frequency. Any company that tells you otherwise is not telling the whole story. Interference is particularly a problem in the 2.4 GHz band because of its status as the global licence-free band and booming popularity. ANT™ addresses these challenges directly by employing an adaptive isochronous scheme that effectively eliminates the vast majority of interference issues.

ANT's adaptive isochronous co-existence scheme relies on each transceiver transmitting in a clear timeslot within the defined frequency band. This is a good technique for low duty cycle applications because each radio only has to transmit for a very short period (less than 150 μs per message), allowing a single channel to be divided into hundreds of timeslots.

A master clock isn't needed for ANT's adaptive isochronous scheme. Transmitters start broadcasting at regular intervals but then modify the transmission scheme if interference from a neighbour is detected on a particular timeslot. This flexibility allows ANT to adapt to hostile wireless operating conditions. For example, if there are a number of discrete ANT-based systems working side-by-side – such as a row of wirelessly communicating rowing machines lined up next to each other in a gym – then by "listening" for drifting transmission sources on its frequency an individual wireless node can determine if there is approaching interference and re-time its

transmissions accordingly.

If the radio environment is even more crowded – for example, other 2.4 GHz sources such as Bluetooth and Wi-Fi are present – ANT can 'hop' to a different 1 MHz slot within the 2.4 GHz band. The graphic below illustrates ANT's adaptive isochronous co-existence and frequency hopping schemes.



ANT adaptive isochronous scheme subdivides a single 1 MHz frequency band into timeslots. These timeslots are repeated depending on the messaging period (this example shows a 250 ms messaging period). A single timeslot comprises a guard band, followed by a short transmission, followed by another guard band. Nodes 1, 2 and 3 adapt transmissions so that no clashes occur. If required, the system can switch frequencies to accommodate additional timeslots (Nodes A, B and C). In practical use tens or even hundreds of nodes can be accommodated in a single 1 MHz frequency band (depending on the messaging period)

Q: Is ANT expensive?

A: See our website at www.thisisant.com for budgetary pricing on modules and chips.

Q: ANT sounds interesting, how do designers find out more?

A: See our website at www.thisisant.com for budgetary pricing on modules and chips.

For further information go to www.thisisant.com or call Catherine Aylesworth, Marketing Coordinator, ANT on catherine.aylesworth@thisisant.com (tel: +1 403 932 9292 ext 226)

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