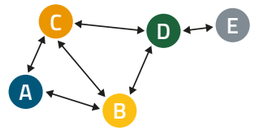
MESH

INTRODUCTION
MESH OVERVIEW

What's a Mesh?

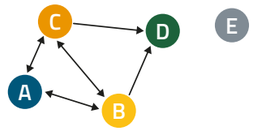
A Mesh is a network of multiple devices connecting to each other. The nodes connect directly to other nodes and there is no need of a master controlling the actions. In general there are more connection paths between the source and the target. The information is handed over from one node to the other.



EXAMPLE

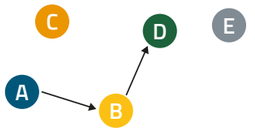
Sending a message from A to D

Flooding Technique
Each node just forwards the message



- ⊕ Easy to use:
  - No network organization (installation, change)
- ⊕ Size does not matter
- ⊖ Increased traffic:
  - Duty Cycle problems

Routing Technique
The network master or each node knows the path

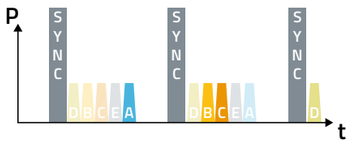


- ⊕ Shortest/Cheapest path
- ⊖ Extra network organization traffic
- ⊖ Size limitations (master handled)
- ⊖ Less robust on network changes:
  - Master has to know when adding/removing a node

Asynchronous
Messages can be transmitted at any times

- ⊕ Fast
- ⊕ No installation effort
- ⊕ No size limitations
- ⊖ Energy consuming (~100% RX)
- ⊖ High probability for radio packet collision

Synchronous
All nodes are synchronized and transmit/receive at determind slots



- ⊕ Energy efficient
- ⊕ Time and frquency hopping possible
- ⊖ Synchronization effort (master needed)
- ⊖ Size limitation
- ⊖ Low throuput/High latency

WIREPAS MASSIVE

What is Wirepas?

Wirepas is an international company with headquarters in Tampere, Finland.Wirepas is specialized in IoT opics and offers the Wirepas Mesh stack (firmware only) and support to high volume customers. Würth Elektronik is in cooperation with Wirepas to integrate the Wirepas mesh stack into radio chips as well as offering service to our customers to develop Wirepas mesh radio modules based on the existing Nordic Semiconductor nRF platform. Würth Elektronik is licensed to develop, support and sell standard and custom Wirepas mesh radio modules.

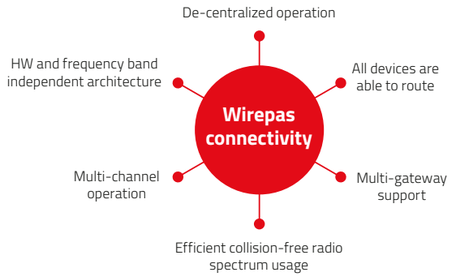
What is Wirepas Mesh?

Wirepas Mesh is a connectivity protocol for radio modules, optimized for large scale and energy efficient wireless mesh networks in the frequency 2.4 GHz. This innovative technology can be used to create large IoT networks, for example using battery-powered sensors, in which each node also functions as a router. On a single MCU solution, the application runs on the device itself. On a dual MCU solution, the application runs on a host microcontroller.

What are the strengths of Wirepas Mesh protocol?

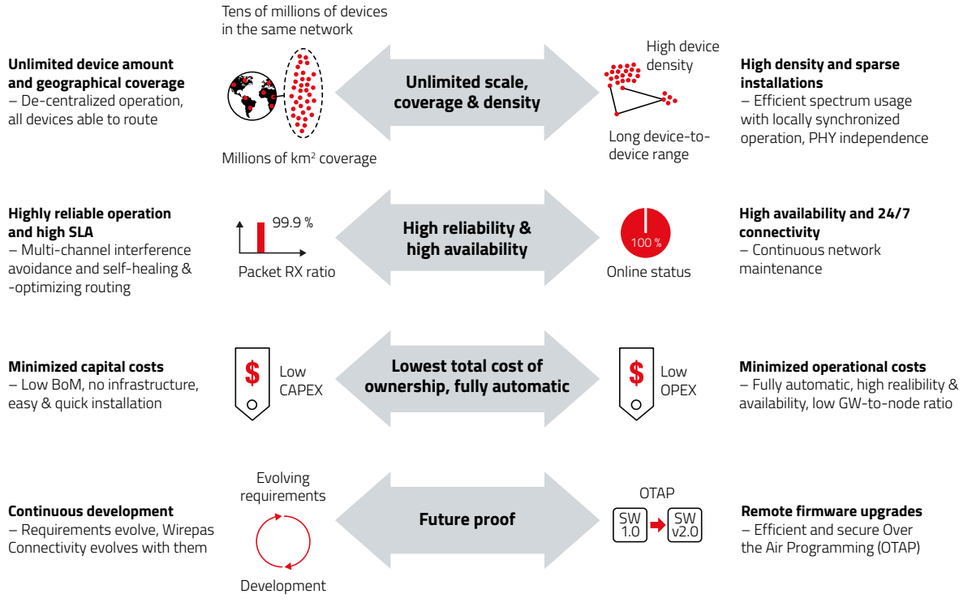
Traditional mesh networks suffer in large scale from complex networking tables, congestion and bandwidth issues. Wirepas overcomes these issues by removing network's infrastructures and decentralizing network's intelligence on the nodes. All networking decisions are done locally by the nodes. Every node:

- scans automatically the neighborhood and choose the best path to the sink
- adapts transmit power to neighbor proximity
- can act as sink, routing or non-routing node
- can work in low power or low latency mode
- chooses the best frequency to use locally
- has a high configurability, interference-tolerance, ultra-low energy consumption: Wirepas mesh software is ideal for large scale and battery-operated networks.



Wirepas

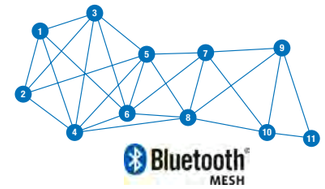
Main Benefits of Wirepas Mesh



BLUETOOTH® MESH

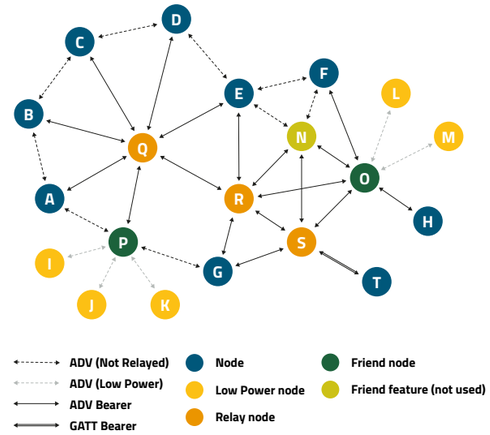
Bluetooth® Mesh

Bluetooth® released a Mesh Version in 2017. It is an own standard and strictly speaking not part of the Bluetooth standard. It uses Bluetooth® Low Energy link layer and radio and prefers Bluetooth® 5.0 or newer due to long advertising packets. As a flooding Mesh it includes time to live (TTL) in the messages. Security is approved by application key and network key.



How does it work?

The Network has nodes with different features. A node sends and receives data. Additionally there are relay nodes forwarding defined data. Special Low Power nodes are rarely active and only then send/receive data. The corresponding node is the Friend collecting data for the Low Power node. Only Low Power Nodes can be operated, since other nodes permanently receive and relay data. Bluetooth® Low Energy devices (i.e. smart phones) can connect temporarily to push/pull data to/ from the network. Nodes have to subscribe to groups to receive messages and publish to groups to transmit messages.



Mesh Models

Bluetooth® Mesh Models define basic functionality of nodes on a mesh network. Mesh Profile Specification defines foundation models used to configure and manage the network. Mesh Model Specification includes models defining functionality that is standard across device types. Those Models are: Generics (general functions), Timing, Lighting and Sensors.

Is a Bluetooth® Mesh the best Solution for my Scenario?

To sum it up, there are the following benefits and penalties in using Bluetooth® Mesh, which has to be considered:

⊕ Extending the range by repeating messages, a self-healing network as there is the possibily of different routes of the messages make the Bluetooth® Mesh very useful.

⊖ On the other hand it must be mentioned, that the performance of a Bluetooth® Mesh is quite poor. You could send 30 Bytes per 100 ms leading to a throughput of 2400 bps. Further, the Network must be installed by the end user himself, so technical knowhow is recommended. Furthermore each node has to be added to the network and provided with authentification and encryption keys which could make it time-consuming for the user.

MESH
IN WE RADIO MODULES

Asynchronous Flooding Mesh

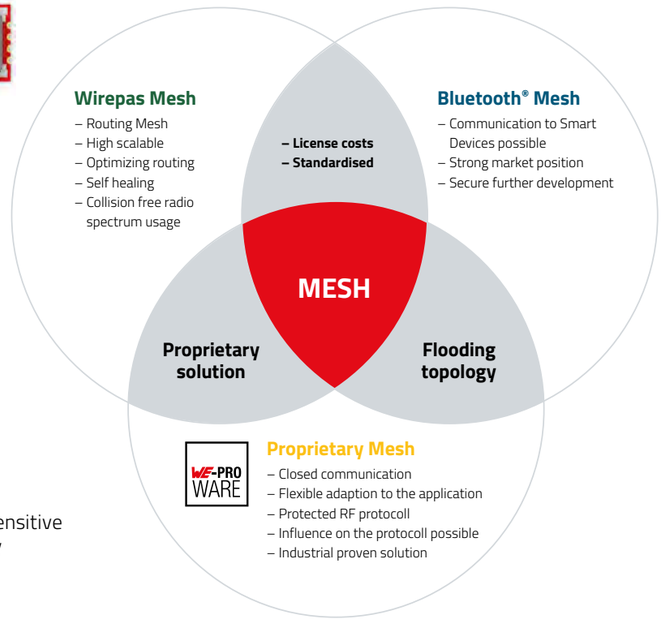
An asynchronous flooding mesh is integrated into Thyone-I, Tarvos-III, Thebe-II, Thelesto-III, Themisto-I & Setebos-I. Suited for applications:

- using small/medium size mesh networks (much traffic due to flooding technique)
- where current consumption does not play a role (always on RX or TX).

	WE Radio Module
Latency	😊
Current consumption	😠
Throughput	😐
Maximum number of nodes	😐
Installation effort	😊
Robustness	😊

Comparison Bluetooth® Mesh – Proprietary Mesh – Wirepas Mesh

	Nodes	Latency	Power
Bluetooth® Mesh	+	–	–
Wirepas Mesh	++	–	+
Proprietary Mesh	+	+	++



Comparison Asynchronous Flooding & (A)Synchronous Routing

We need a mesh solution that covers large power sensitive applications. Suited for applications that are battery operated, like sensor networks

Routing mesh integrated into Thetis-I.

	e.g. Thyone-I / Tarvos-III	Wirepas TDMA	Wirepas CSMA-CA
Latency	😊	😐	😊
Current consumption	😠	😊	😠
Throughput	😐	😞	😐
Maximum number of nodes	😐	😊	😊
Installation effort	😊	😊	😊
Robustness	😊	😊	😊
		Würth Elektronik Focus	**Additional capabilities**

we-online.com/mesh

OUR MESHED
WIREPAS 2.4 GHZ

Thetis-I

Radio Module 2,4 GHz with Wirepas Mesh protocol

What are the key points from customer's perspective?

- ✔ Throughput
- ✔ Maximum number of nodes
- ✔ Installation effort
- ✔ Robustness

Characteristics

Mesh | Security & Encryption | Long life battery driven application | Smart antenna selection

- Wirepas routing mesh
- Low energy and low latency mode
- Standalone (Single-MCU) or host-controlled (Dual-MCU) operation
- Standard or custom firmware solution available
- Nano SIM size - 8 x 12 x 2 mm
- ARM® Cortex®-M4 32-bit processor with FPU, 64 MHz
- ARM Cryptocell cryptographic unit
- Nordic Semiconductor SoC nRF52840
- 1 MB flash memory, 256 kB RAM
- Wirepas „Dual CPU" model, c-mesh api for hosts available through github (https://github.com/wirepas/c-mesh-api)
- +6 dBm TX power (ERP: 4 dBm)
- Encryption, Integrity & Authentication
- Smart antenna selection (2-in-1 Module)
- Also available as proprietary radio module (Thyone-I) or Bluetooth® LE radio module (Proteus-III)
- CE, FCC, IC certification

Grow your Industrial IoT endlessly

The possibilities to use an industrial IoT mesh network in production are endless. The Wirepas Mesh grows organically and has automated interference avoidance so one network can handle multiple use cases and thousands of assets.

Benefits of Industrial IoT

Battery Lifetime
No additional mains-powered routers are required. Only large-scale wireless mesh connectivity technology in the market enabling battery-operated routers with over 5 year lifetime with 4000 mAh battery (1,5 packets per second.

Security & Reliability
Includes self-healing routing, multi-channel operation with local channel white/blacklisting. Proven over 99.99% reliability in large-scale & high interference buildings. Secure connectivity with industry standard AES-128 encryption.

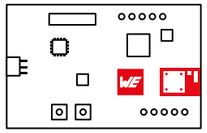
Easy Retrofit
Easy retrofit is required due to factory floor design, large number of unsensored machinery and large number of outdated sensors that need replacement. Easy battery-operated mesh network with our sensors can be installed by anyone and anywhere.

Future Proof
Enables not only lighting control, but environmental sensoring and asset tracking in the same wireless network. Any device in the network can be updated over the air. Interoperable with BLE devices.

Source: https://wirepas.com/applications/industrial-iot/

ADDED VALUES

Development Tools

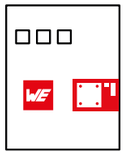


Eval Boards

- Easy testing
- Rapid prototyping
- FTDI integrated (UART to USB)
- Pins available on header
- Current measurement

we-online.com/EVAL-Mesh

More information on page 150

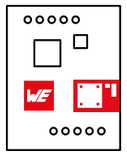


Sensor Node

- Easy testing
- Sensors onboard
- Rapid prototyping
- CR2032 battery powered
- setup Wirepas network immediately

we-online.com/Sensor-Node

More information on page 150



Mini Eval Boards

- Small and cheap
- USB connection with FTDI-cable possible (available as accessory)

we-online.com/EVAL-Mesh

More information on page 150

USB-Radio Stick

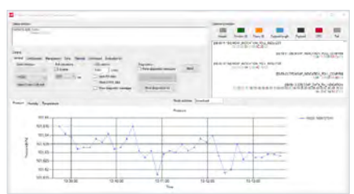
- USB-FTDI-RF-Module
- Radio connection for computer

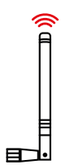
we-online.com/USB-Mesh

More information on page 150

Wirepas Commander

- Easy testing
- AT-Commands as buttons
- Monitoring UART-Communication
- Export Commands for easy integration in the former HOST-Controller





Antenna

- 2.4 GHz external Antenna Himalia

ACCESSING
WIREPAS MASSIVE TECHNOLOGY

Wirepas partner

Acting as Wirepas partner, Würth Elektronik delivers modules with Wirepas firmware pre-flashed on the well-proven Thyone-I/Proteus-x hardware platform. Through a unique cooperation model, Würth Elektronik makes the advantages of the Wirepas technology accessible to small and middle sized businesses.

Wirepas

No License agreement or monthly rate – ONLY Royalty per piece (2.50 €)

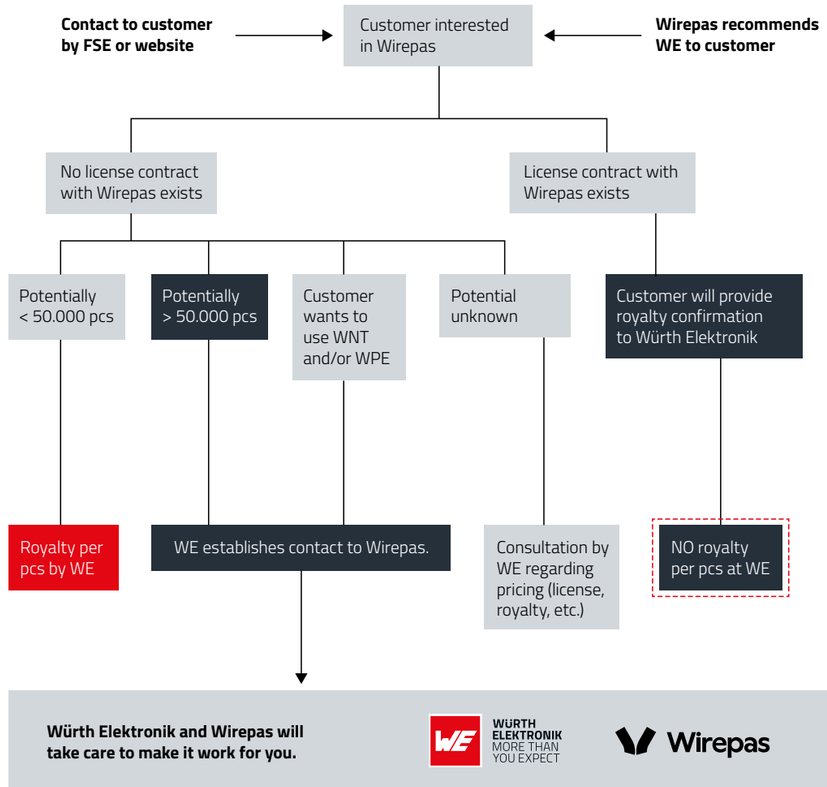
Paid from customer to WE, from WE to Wirepas. Focus on small- and medium-size customers with no MOQ.

Wirepas + Competitor

License agreement with Wirepas needed. Including monthly rate: Royalty per piece (2.50 €)

Wirepas cannot follow and support customers requiring small quantities.

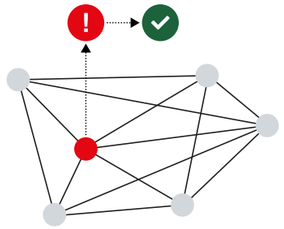
The process



USER APPLICATION
INDUSTRIAL IOT

Wirepas Mesh is the perfect fit for Industrial IoT

The manufacturing industry has started seeing a growing need for monitoring the condition of their assets and to perform predictive maintenance if needed. The challenge is that smart industries require an industrial IoT connectivity solution, a self-healing mesh network that can handle a demanding radio environment.

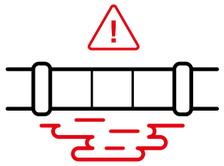


Predictive Maintenance

Machines, devices and equipment in production are lasting investments and keeping them operative is key. The sensors measure the condition data for the machines, devices and equipment and trigger predictive maintenance if needed. This reduces the need for multiple days of production halt to a few hours of maintenance.

Leakage Control

Pipes, ducts and vents carry and control many gas and liquid in production and from production plants to use. Monitoring and controlling valves and levers with sensors to ensure there are no leakages saves both money and the environment. The high number of sensors require a robust IoT connectivity to operate securely.

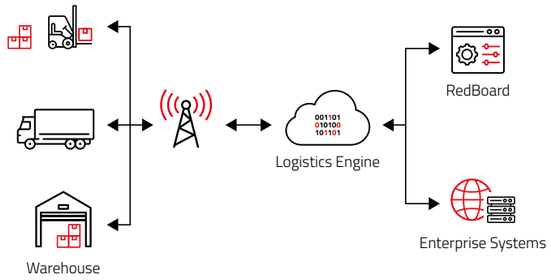


Monitoring and Measuring of Material Levels and Condition

Tanks, containers, vessels and sewage systems may carry dangerous liquids, gasses or material and the use levels need to be ensured to make sure safety and productivity is in check. Sensors may also keep tabs on for example safe temperature or ambient light levels to prevent accidents from happening.

RedLore – Container Tracking

RedLore Smart Sensors can be used in a large range of applications thanks to the wide variety of built-in sensors.



The Smart Sensors have the Wirepas Mesh Network Communication protocol inside: Every device is a wireless router and can act as a repeater for other nodes. As a result very large physical networks with 1000's of nodes can be built as long as every node can connect to a node which is closer to the gateway. At the same time every node remains low power and can work uninterruptedly for years on a small battery.

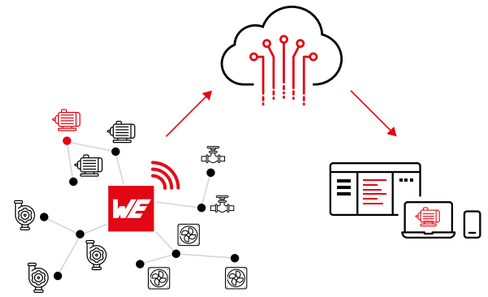
Different variants are available, each with different sensor sets and a long-life industrial LiSOCl2 battery for up to 10 years of battery life. The sensing parameters (e.g. update rate) can be changed to suit the application needs.

The Smart Sensors send their data to a gateway. The accompanying Mobile App connects through the built-in NFC 'tap'- interface, allowing configuration and diagnostics of a device. The same functions are available from the gateway using the Remote Functions API.

Condition Monitoring

Condition monitoring can be expensive - which is why up to 95 percent of all aggregates in a production plant aren't monitored or are monitored sporadically, which leads to high risks for unplanned downtimes.

With a condition monitoring system you can monitor hundreds of aggregates within a few hours. Thus monitoring is simple, fast and cost-efficient.



The expandable system works for almost all aggregates and detects potential damage, imbalances and misalignments already weeks in advance.

The final end solution can consist of:

- Wireless sensors to monitor machine and equipment data
- A gateway that receives the sensor data and transmits it into the cloud
- A digital service that evaluates this data and provides professional error analyses - comfortably via smartphone or desktop application