Bluetooth® LE vs 2.4GHz Proprietary wireless

WÜRTH ELEKTRONIK

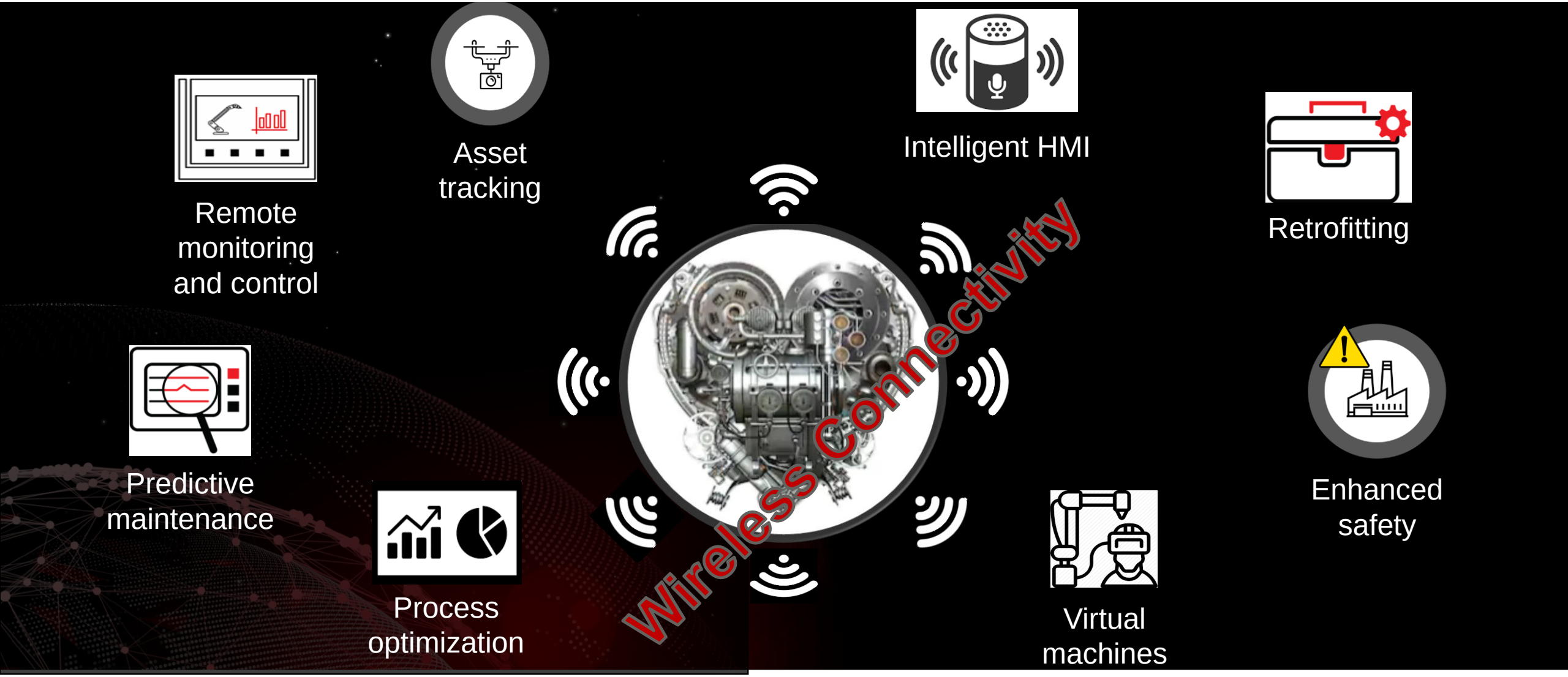
Choose the right connectivity for your industrial application

April 7th 2020

Overview

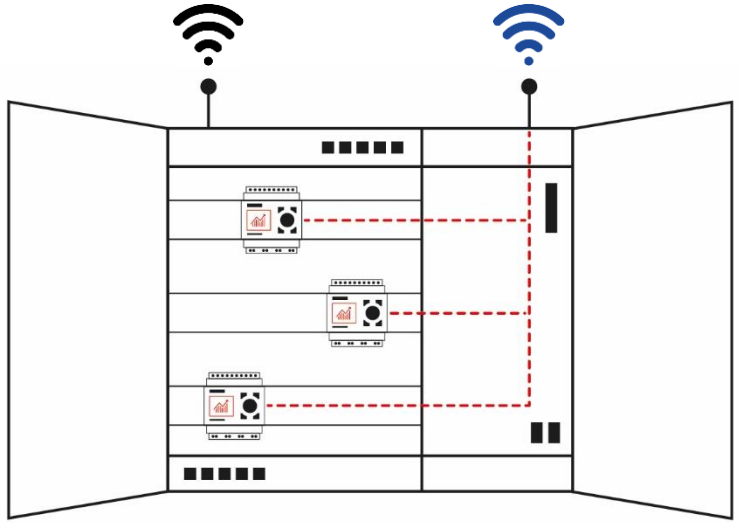
- Wireless connectivity for IIoT
- Design Considerations
- Application example
- Proprietary radio overview
- Bluetooth® overview
- Bluetooth® LE vs. Proprietary radio
- Our newest products

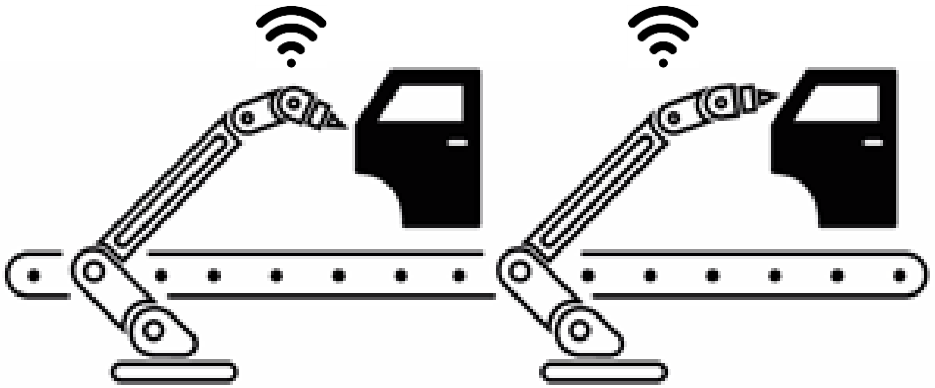
The Industrial IoT or Industry 4.0

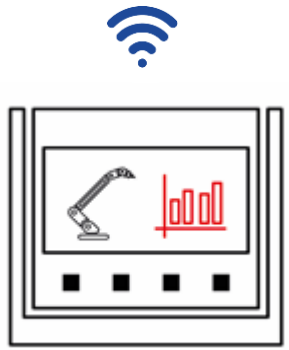


Typical applications

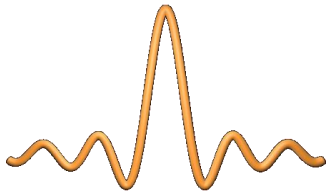
- Remote monitoring and control of machines
- Indoor and co-located machines (~100 m)
- Battery operated sensors
- Low to medium data throughput necessary
- Secure communication link







Design considerations

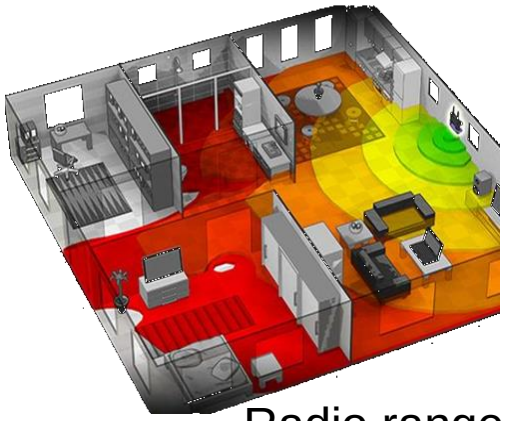


Frequency of operation

Energy budget

Protocol

Regulatory compliance

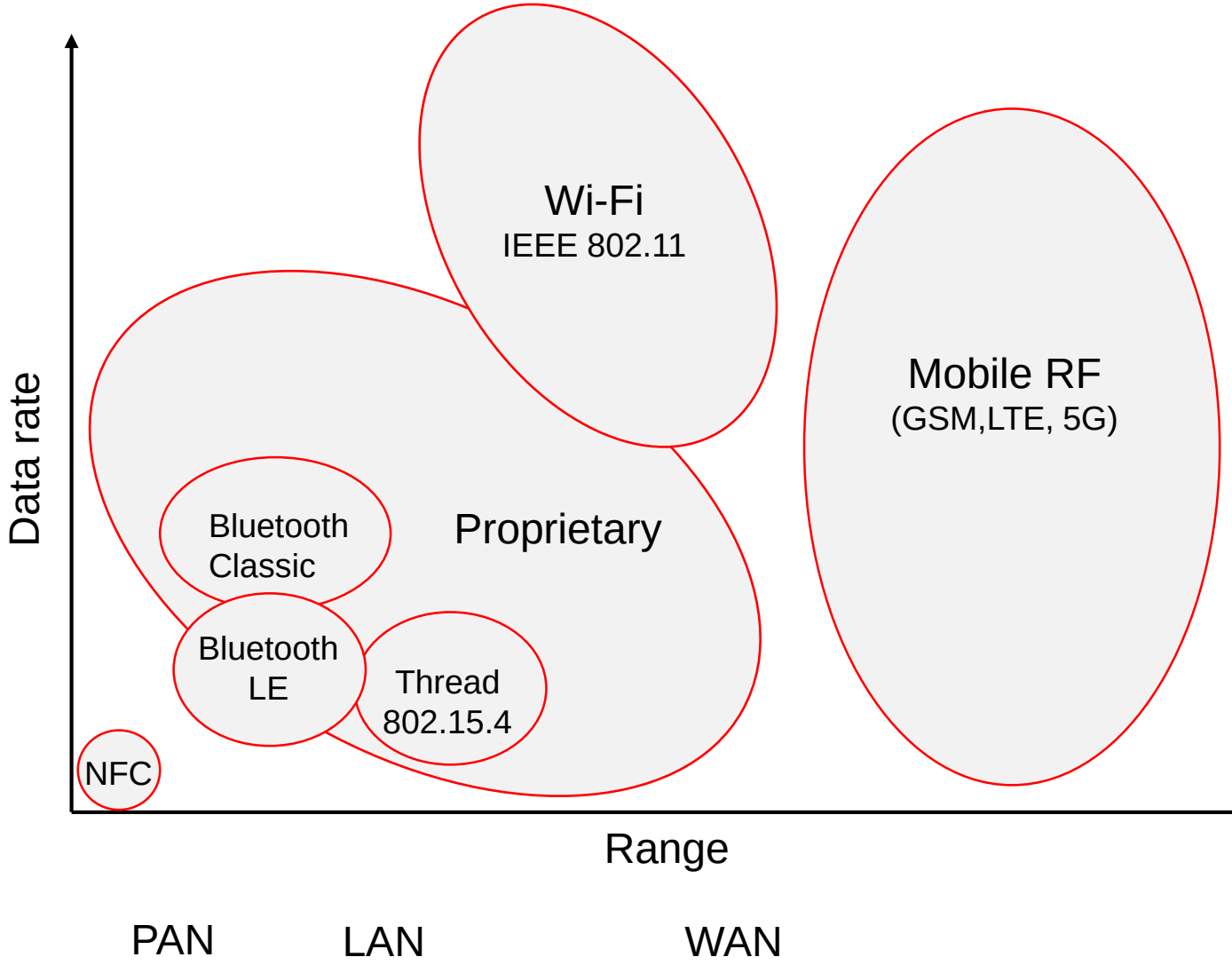


Radio range

Data throughput

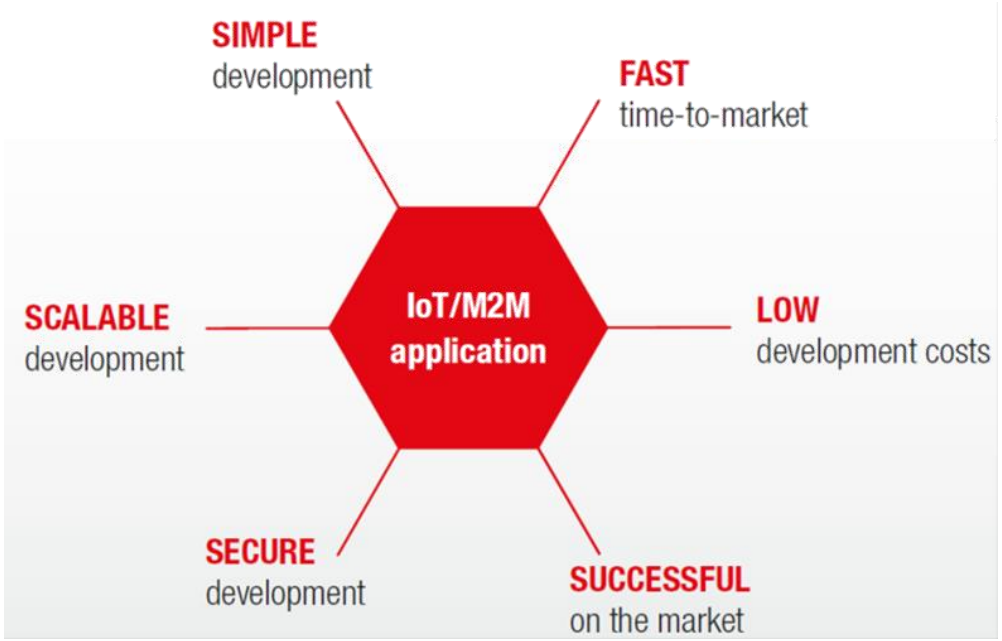
Security

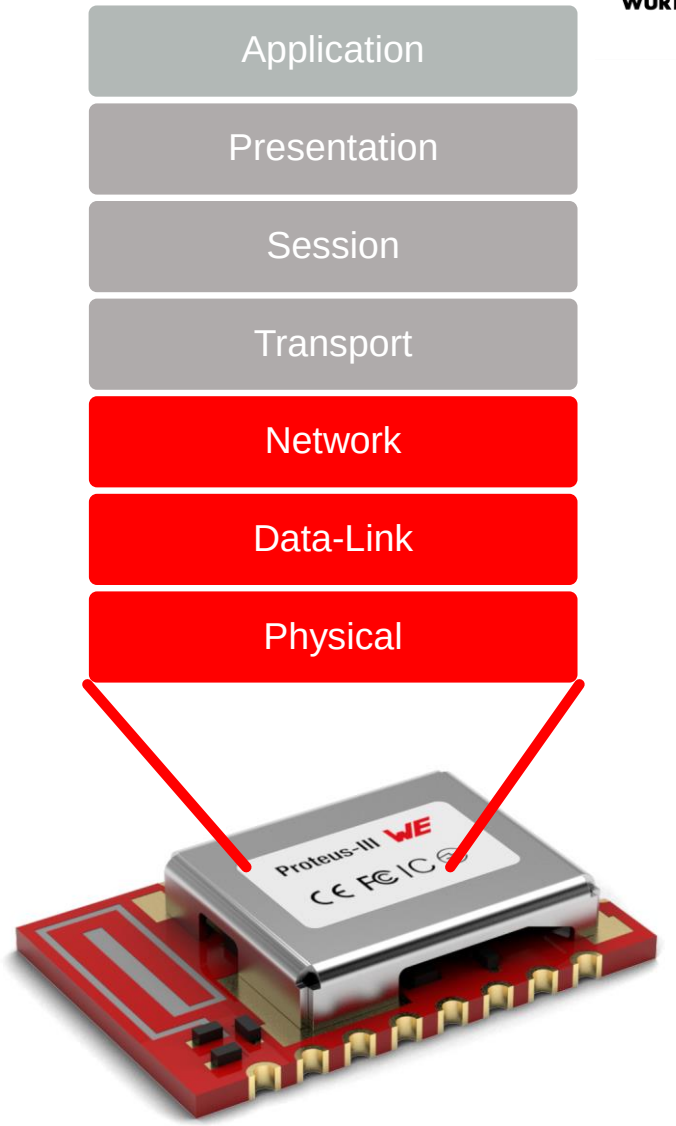
Radio standards - Overview



Wireless connectivity simplified!

- Radio system on modules from ***WE***
- Ready to use hardware
- Configurable firmware
- Example: The radio module 261101102xxxx of Würth Elektronik





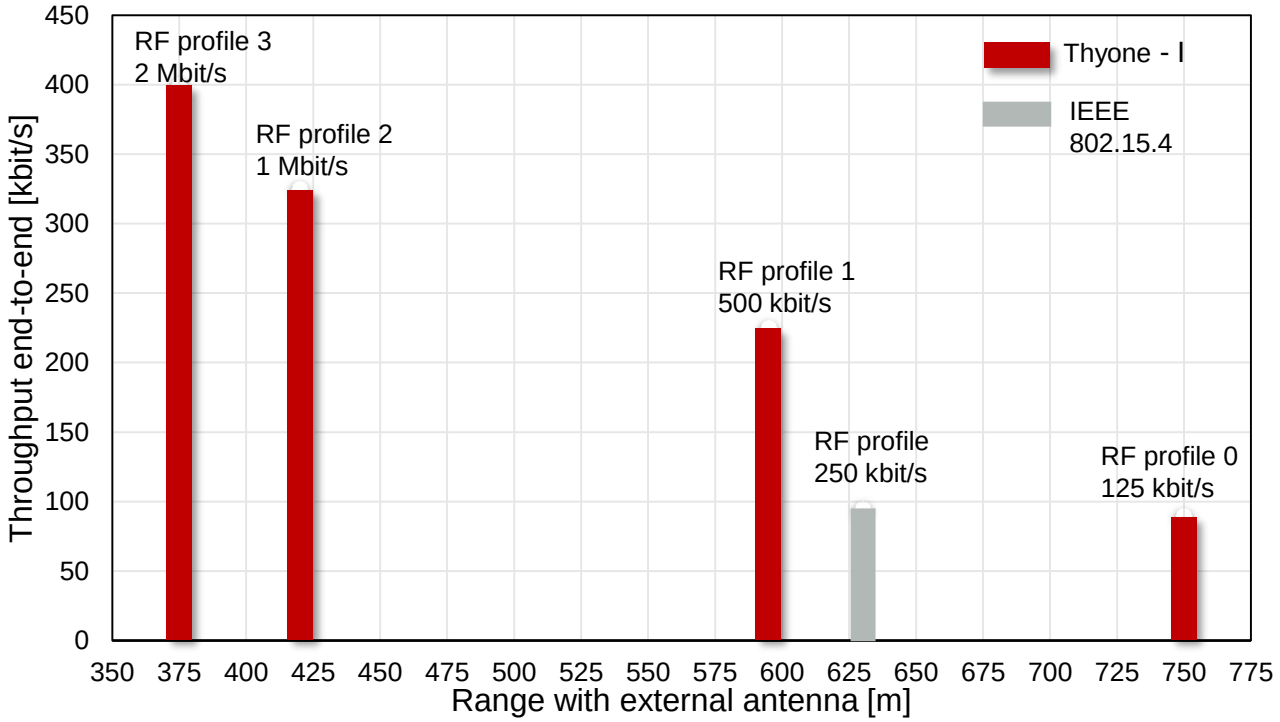
Proprietary radio – What is it?

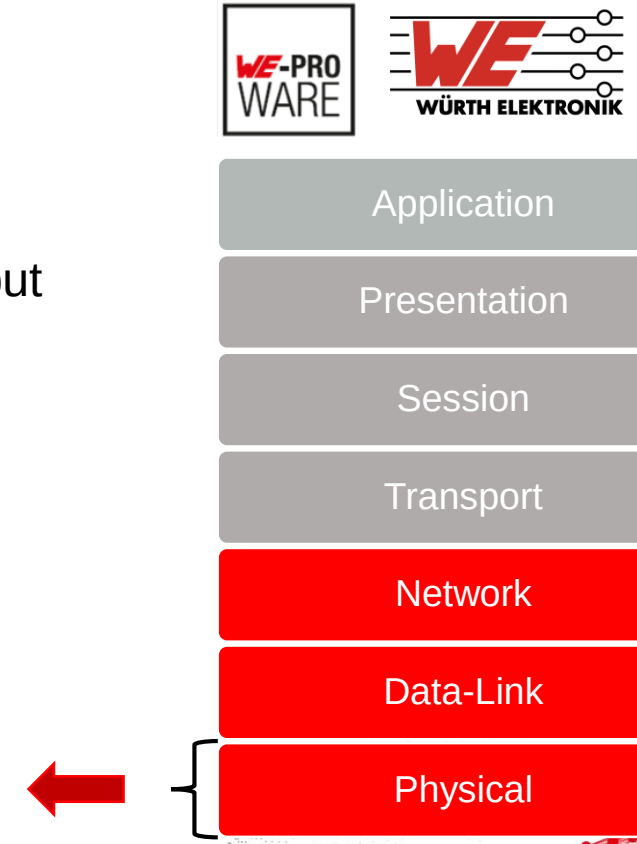
- Not conform to any standard
- Optimized for specific functionality
- Isolated operation

WE-PRO WARE

WE Pro-Ware – 2.4 GHz PHY

- Flexible PHY configuration – Choose between long range and high throughput
- Configurable transmit power
- Optimized for low power performance





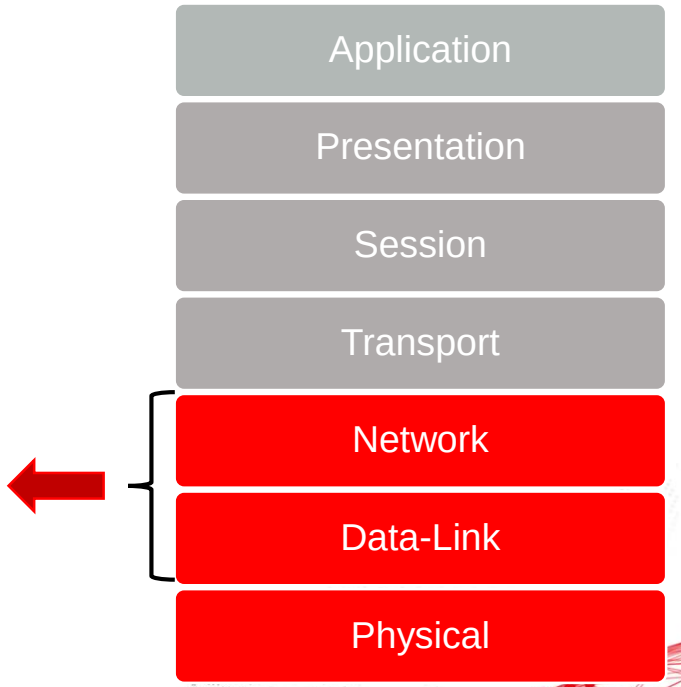
WE Pro-Ware – Network & Data-Link

- Industry tested **proprietary** wireless stack from Würth Electronic
- CSMA-CA based Clear Channel Assessment (CCA)
- 128 bit end-to-end encryption
- ACK and retry mechanism by default
- 4 byte addressing with Unicast, multicast and broadcast capabilities
- Repeater functionality for range extension
- Flooding mesh – Minimal configuration

Collison Avoidance

Encryption

Flooding Mesh



Bluetooth® – What is it?

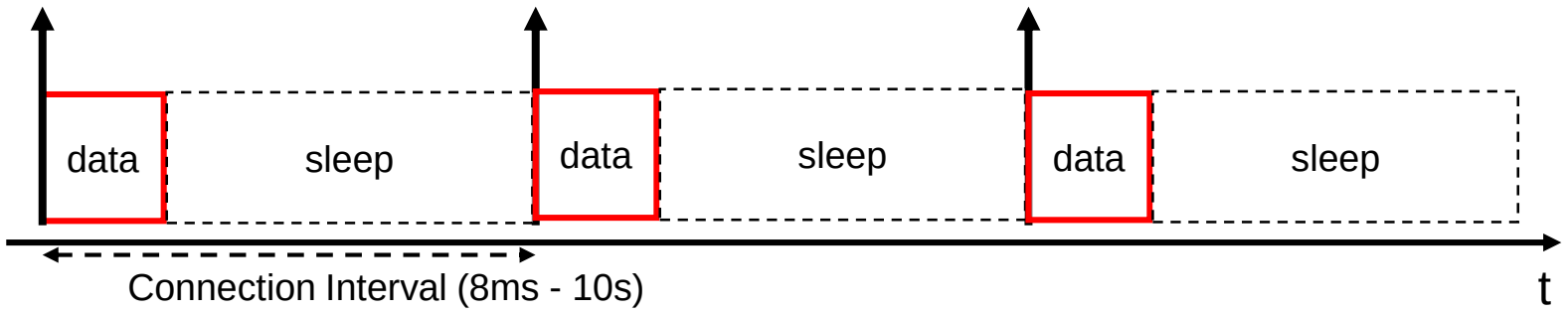
- Global wireless standard for simple, secure connectivity
- 2.4 GHz ISM Band – worldwide free of license
- Substitution of cables between devices (mobiles, PC, etc.)
- Connection oriented and robust data transmission
- Introduced by the Bluetooth SIG in 1998
- Bluetooth license cost (once per product type)

Bluetooth® – What is it?

- Current version is Bluetooth® 5.2
- Consists of the sub standards
  - Bluetooth® Classic
    - Developed until version 3.0 (2009)
    - Example profiles are Serial Port Profile (SPP) and audio
  - Bluetooth® LE
    - Introduced in version 4.0 (2010) and still under development
    - Designed for IoT and battery operated applications
  - Bluetooth® Mesh using non-connection-oriented Bluetooth® LE radio
- Available in all smart phones and modern computers

Bluetooth® LE

- Bluetooth® LE versions are backward compatible
- 40 channels with 2 MHz bandwidth (2.402 – 2.480 GHz)
- Radio data rate 1MBit/s (legacy), 2Mbit/s (BT 5.0) or 125kBit/s (LE coded, BT 5.0)
- Advertising on 3 channels, connection oriented data transmission on 37 channels
- Uses frequency hopping and TDMA (time division multiple access) to avoid radio packet collision and save power
- One data packet per connection interval
- Thus low energy and low throughput



Bluetooth® LE roles

Peripheral

- Offers connections and services
- Defines the security level of its services and data
- Acts as slave
- Example: Most applications, Door control, Service interface, Light, Roller Shutter, Heart rate monitor

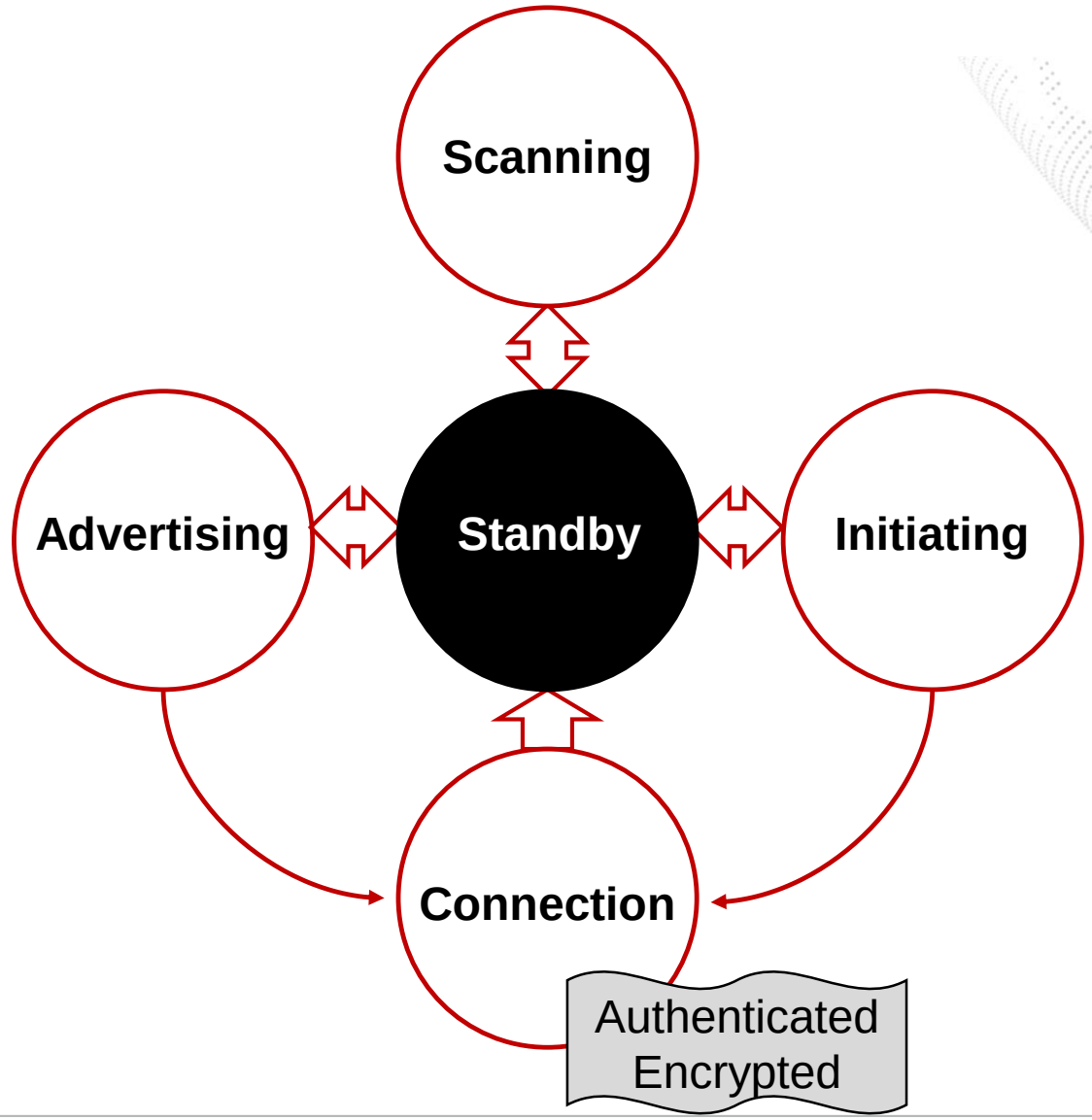
Central

- Initiator for all connections with peripherals
- Always as master in a connection with a peripheral
- Example: mobile phone at service interface, remote controller

Broadcaster

Observer

Bluetooth® LE states



Too much information?

But what is the difference?

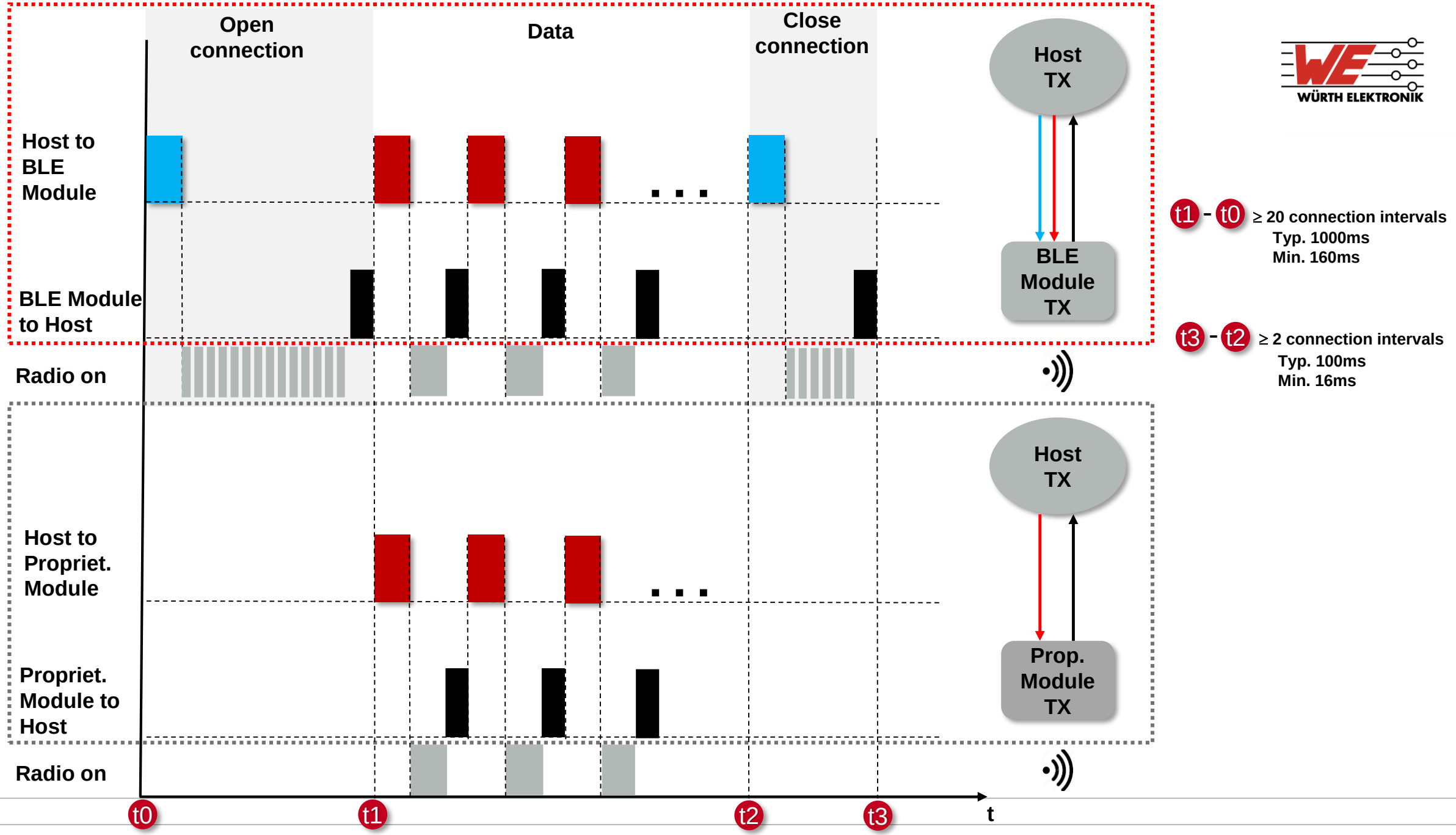
And how can I make a choice?

Bluetooth® LE

Proprietary Radio

Bluetooth® LE vs. Proprietary radio

	Bluetooth® LE	Proprietary
Connection	Setup/Termination needs time and power	Not needed
Authentication	Supported	Not supported
Encryption	Several encryption modes supported	AES128
Throughput	Medium (restricted by standard)	Maximum (not restricted)
Power consumption • Transmit a byte • Wait for data state • Sleep	 • Medium • Low (due to TDMA) • Very low	 • Medium • Medium • Very low
Mesh	Not supported	Supported
Robustness	ACK, FHSS	CCA, ACK
Number of compatible devices	High, billions of Bluetooth® LE enabled devices worldwide	Low, devices of same provider
Licensing costs	Once per product type (8000$)	None



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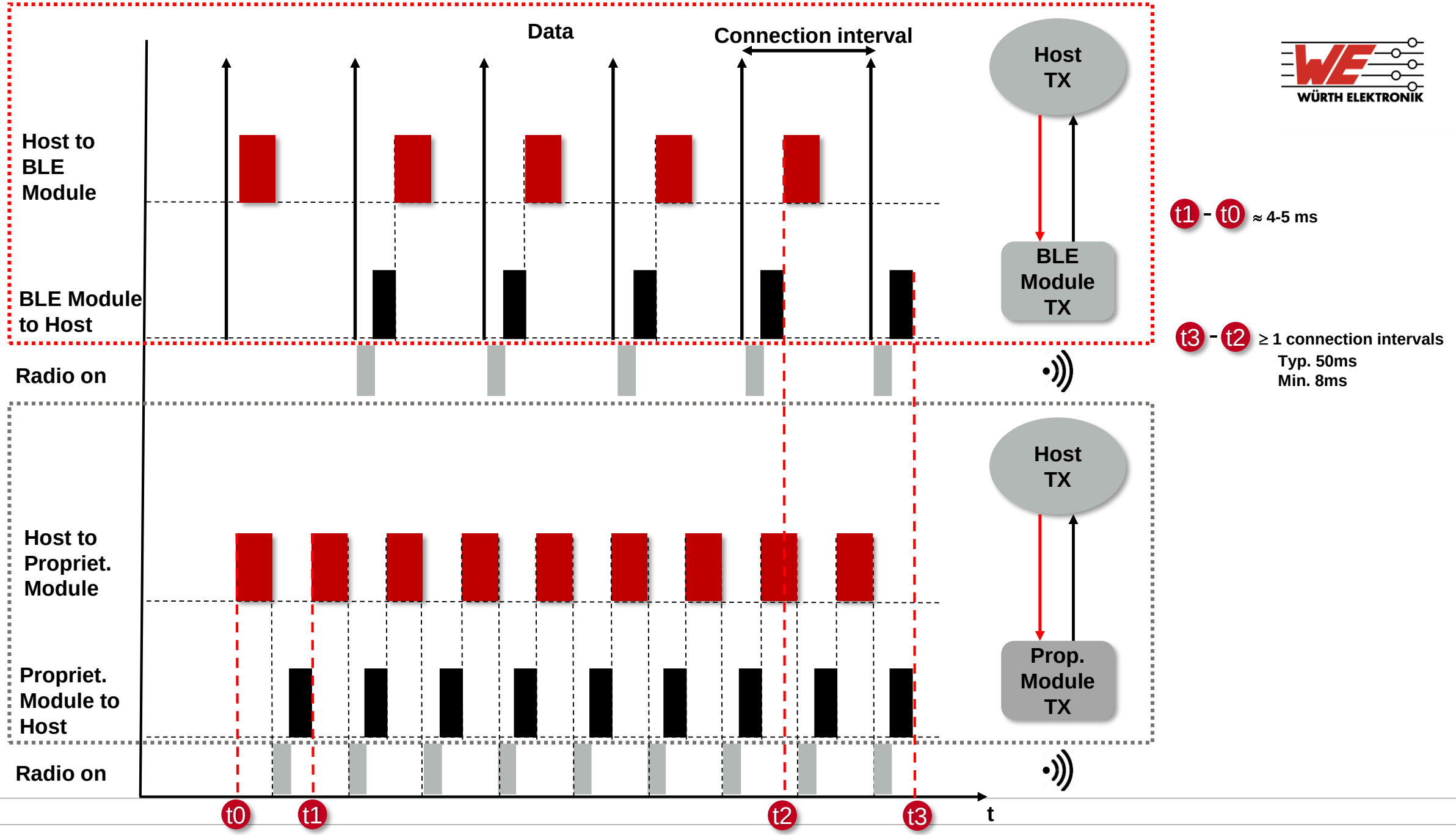
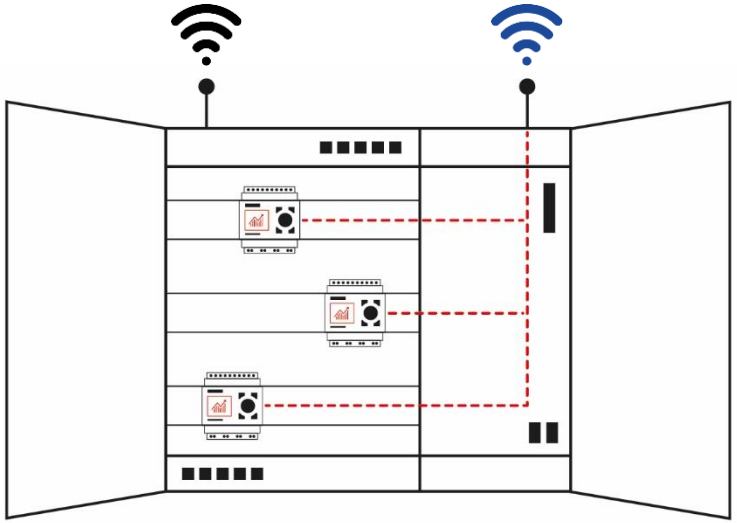
t1 - t0 ≥ 20 connection intervals
Typ. 1000ms
Min. 160ms

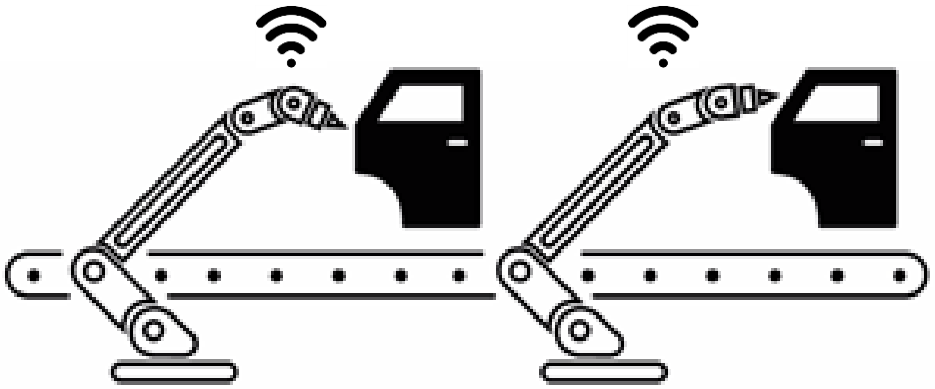
t3 - t2 ≥ 2 connection intervals
Typ. 100ms
Min. 16ms


Data
Connection interval
Host to BLE Module
BLE Module to Host
Radio on
Host TX
BLE Module TX
t1 - t0 ≈ 4-5 ms
t3 - t2 ≥ 1 connection intervals
Typ. 50ms
Min. 8ms
Host to Propriet. Module
Propriet. Module to Host
Radio on
Host TX
Prop. Module TX
t0
t1
t2
t3
t

Choose the right solution for your application

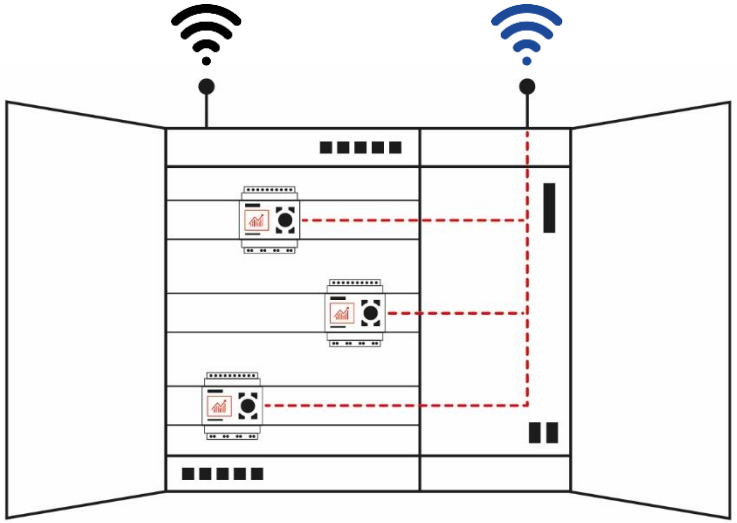
- Choose proprietary radio if
  - mesh is needed to achieve higher ranges
  - the device can sleep, when not transmitting/receiving data
  - a higher throughput is needed
  - network topology needed (subnets, star, mesh)
  - a isolated network is needed
  - **Compatibility with standard devices is not necessary**

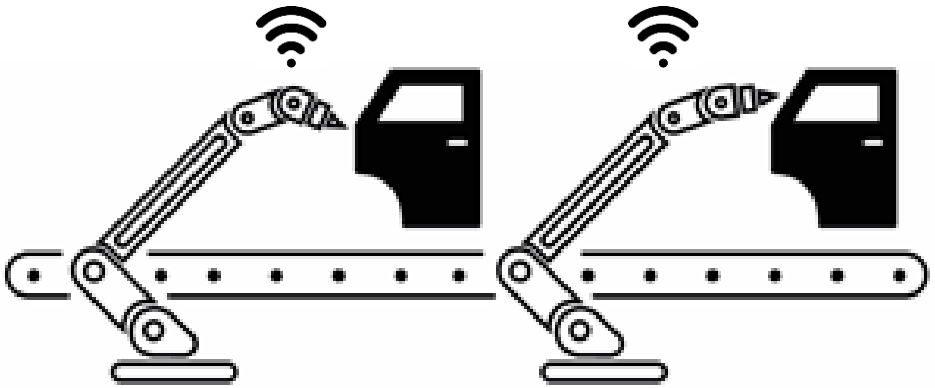


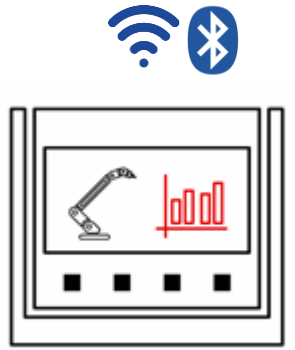


Choose the right solution for your application

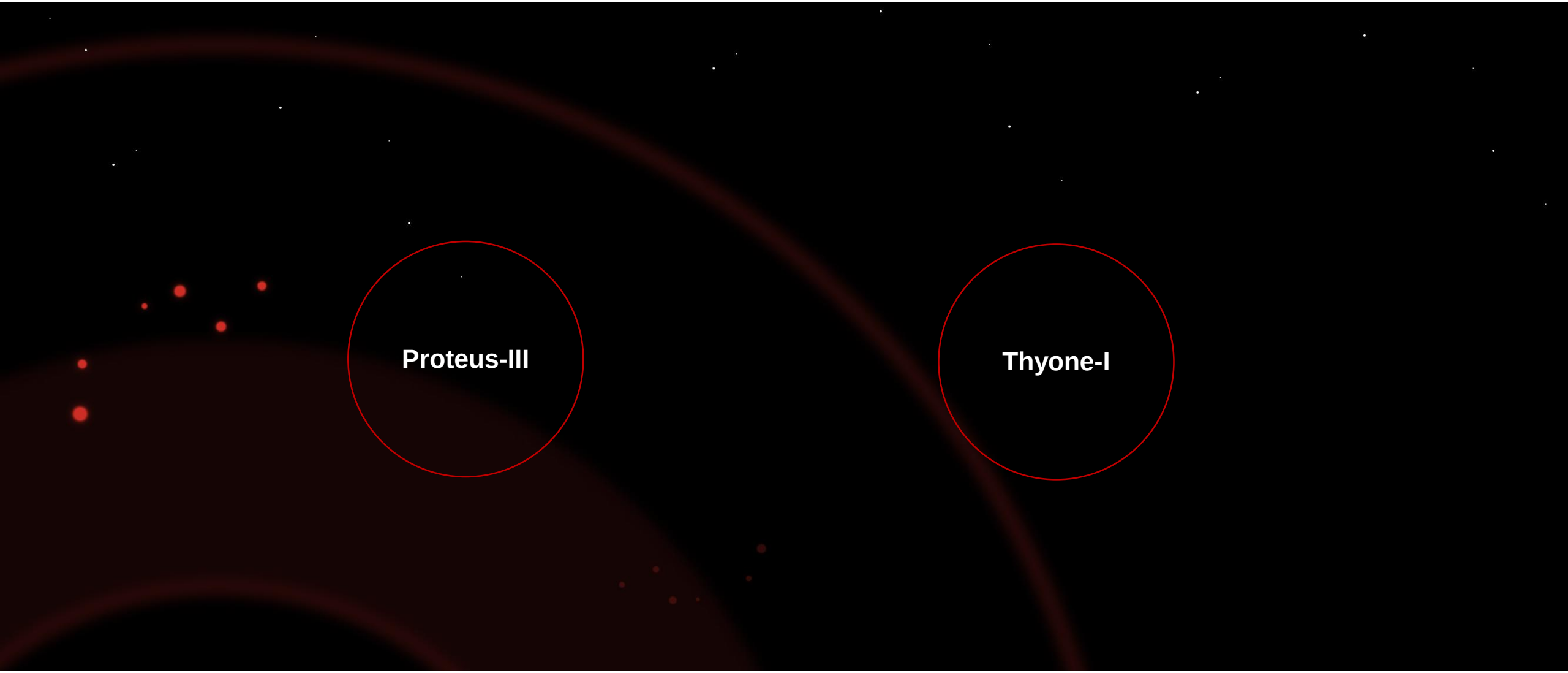
- Choose Bluetooth® LE if
  - **interconnectivity to BLE enabled devices (i.e. smart phones / tablets) is needed**
  - the device is mainly waiting for incoming data and current consumption plays a role
  - advanced authentication and data encryption





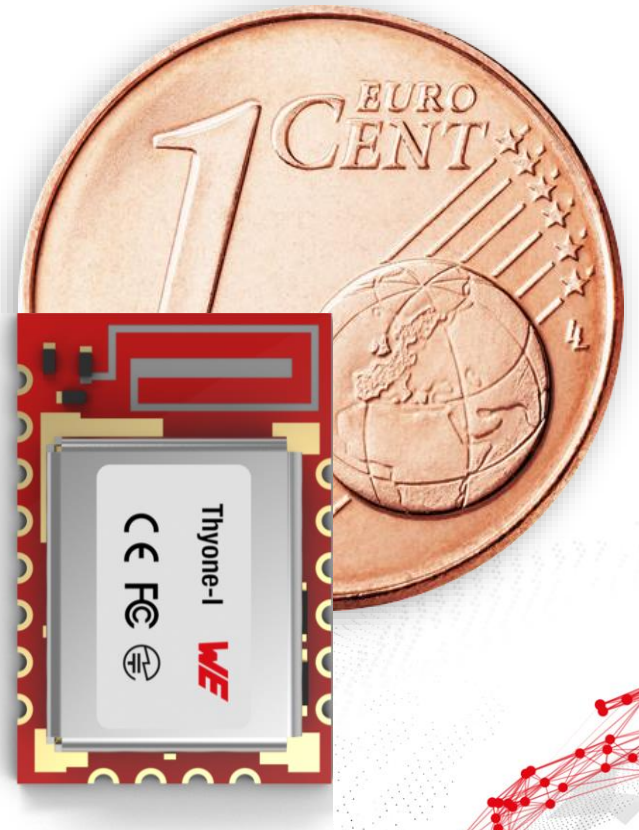


Our newest products



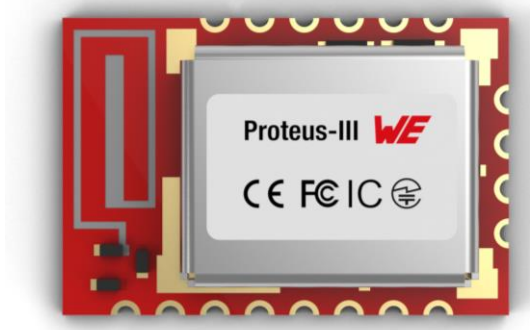
Thyone-I: 2.4GHz proprietary radio

- Extremely small size of 12 x 8 x 2 mm
- Smart antenna selection (external or integrated antenna)
- Radio includes all 1 MBit/s, 2 MBit/s, 500kBit/s and 125 kBit/s long range mode
- Repeater for flooding mesh networks
- Encrypted data transmission of up to 414 kBit/s
- CCA, acknowledgements, different network topologies (point to point, flooding mesh, sub nets, broadcast)
- Sniffer included
- Remote GPIO control
- Simple command based UART or transparent UART interface
- Highly configurable and customizable via user settings
- Certification
  - CE (Europe), FCC (US), IC (Canada), ARIB (Japan)
- Development tools, evaluation boards and USB radio dongles available



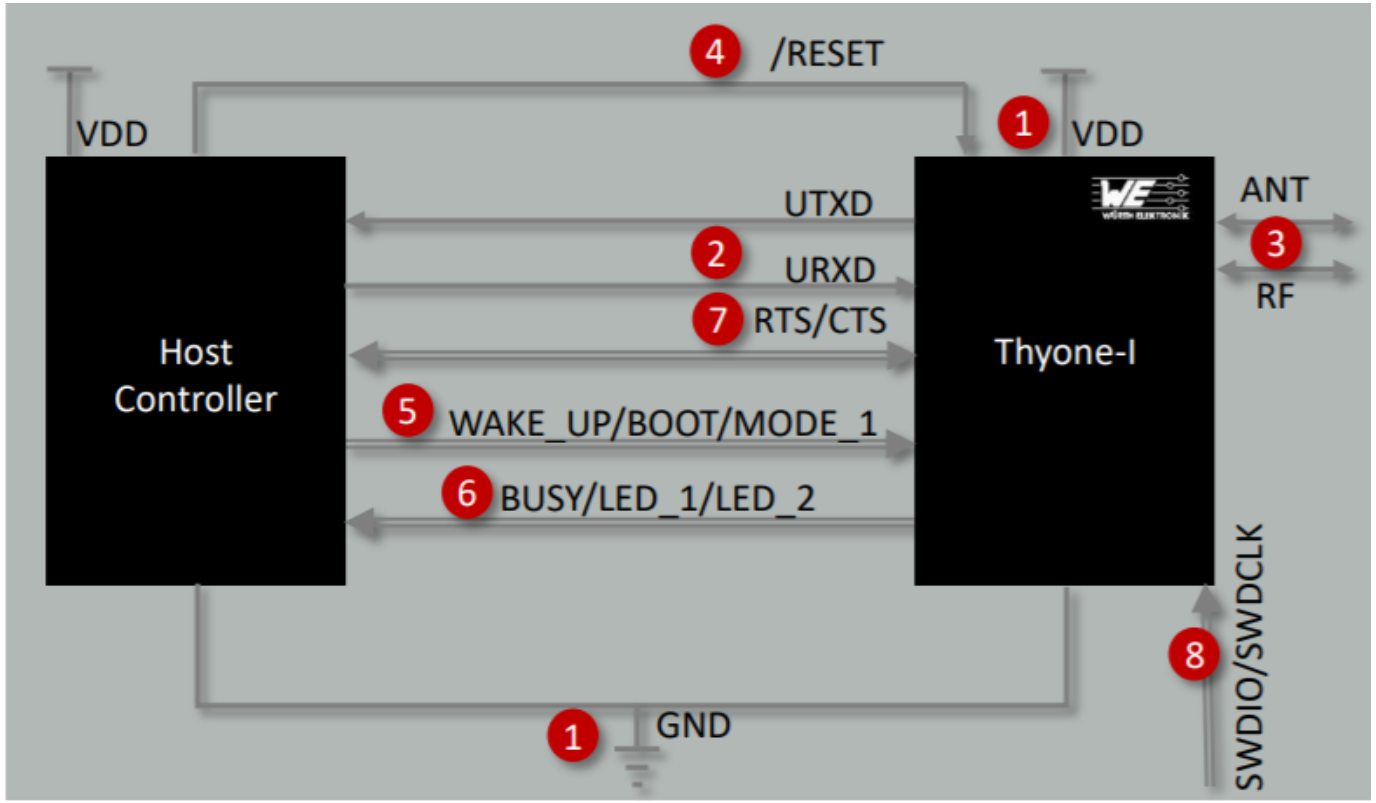
Proteus-III: Bluetooth® LE 5.1

- Extremely small size of 12 x 8 x 2 mm
- Smart antenna selection (external or integrated antenna)
- Peripheral and central function included
  - Initiate AND accept connections
- Several pairing modes plus bonding
- Radio includes all 1MBit/s, 2Mbit/s and 125kBit/s long range mode
- High throughput mode (transmit 4 packets per connection interval to increase the throughput to 340kbit/s)
- Remote GPIO control
- Simple command based UART or transparent UART interface
- Highly configurable and customizable via user settings
- FOTA (firmware update over the air) via smart phone
- Certification
  - CE (Europe), FCC (US), IC (Canada), ARIB (Japan)
  - Bluetooth SIG qualified and listed
- Development tools, evaluation boards and USB radio dongles available



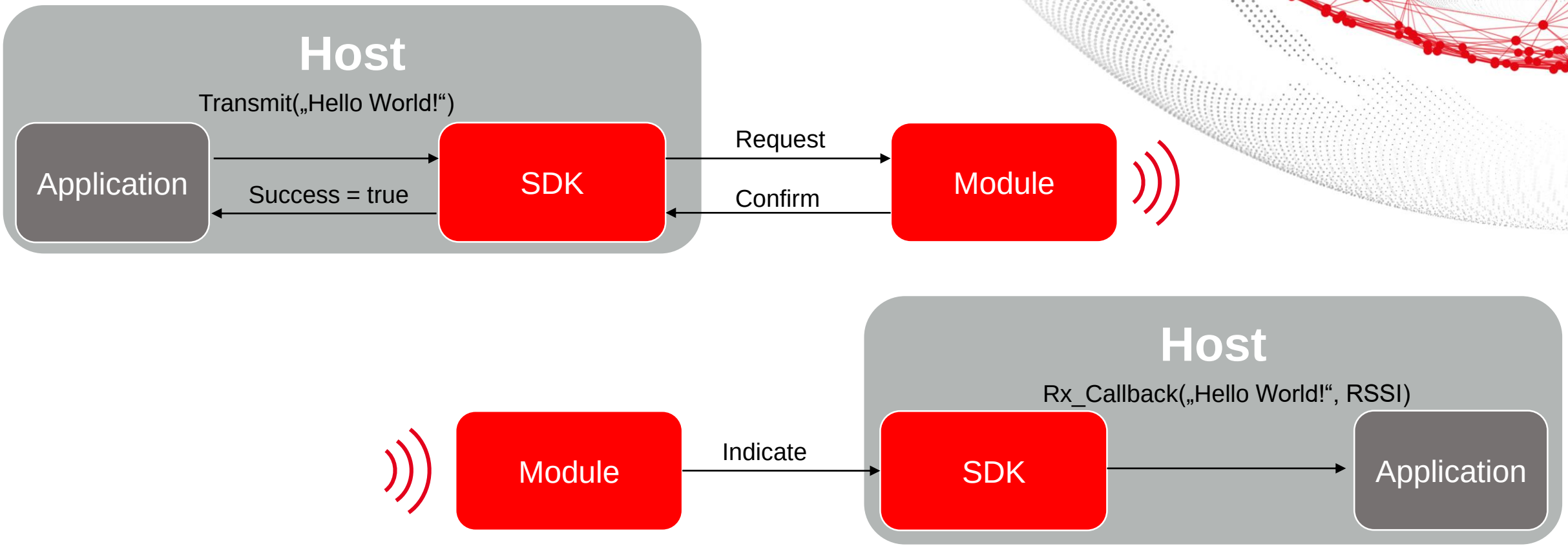
Radio module: Design-in

- How to connect a radio module to a host controller?
- Example Thyone-I:
  - Mandatory
    1. Power supply
    2. UART
    3. Antenna
    4. Reset
  - Optional (5. – 8.)



Radio module: Design-in

Wireless Connectivity SDK in C source code for all our modules as well as USB sticks



Thank you for the attention!

Questions & Answers

We are here for you now ! Ask us directly in the chat!

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