



HOW TO CHOOSE THE FITTING RADIO PROTOCOL

Michael Lang, Wireless Connectivity & Sensors
09.07.2024

BACKGROUND INFORMATION

Wireless Connectivity & Sensors Product Guide

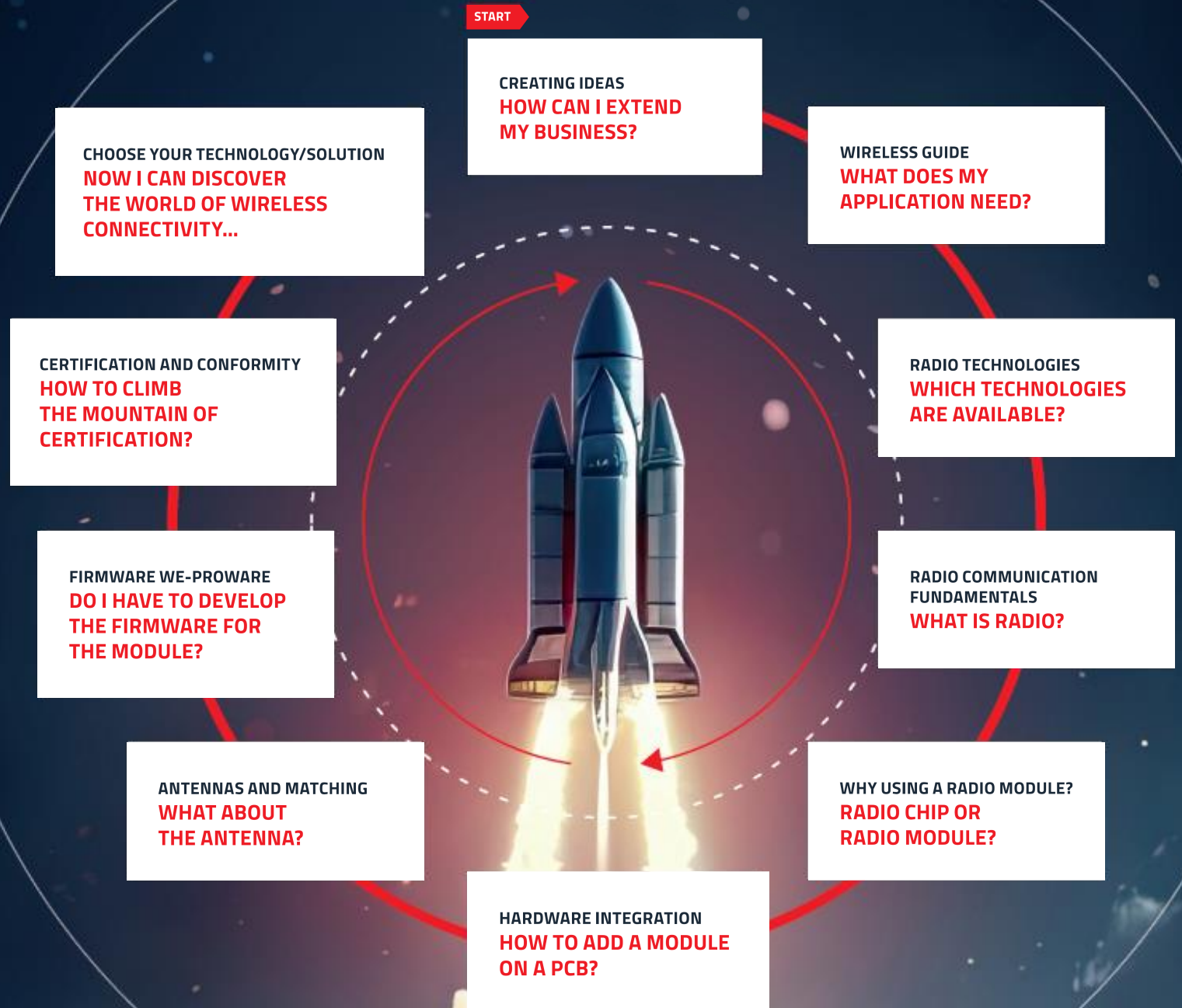


www.we-online.com/wcs-product-guide

HOW TO CHOOSE THE FITTING RADIO PROTOCOL



HOW TO CHOOSE THE FITTING RADIO PROTOCOL



START

CREATING IDEAS
HOW CAN I EXTEND
MY BUSINESS?

TION

WI
W
AP

REPLACING LC DISPLAYS



DIGITAL DEVICES



Communication Smartphone - Tool - Peripheral Devices



BLE



BLE





WEIGHTING SYSTEM



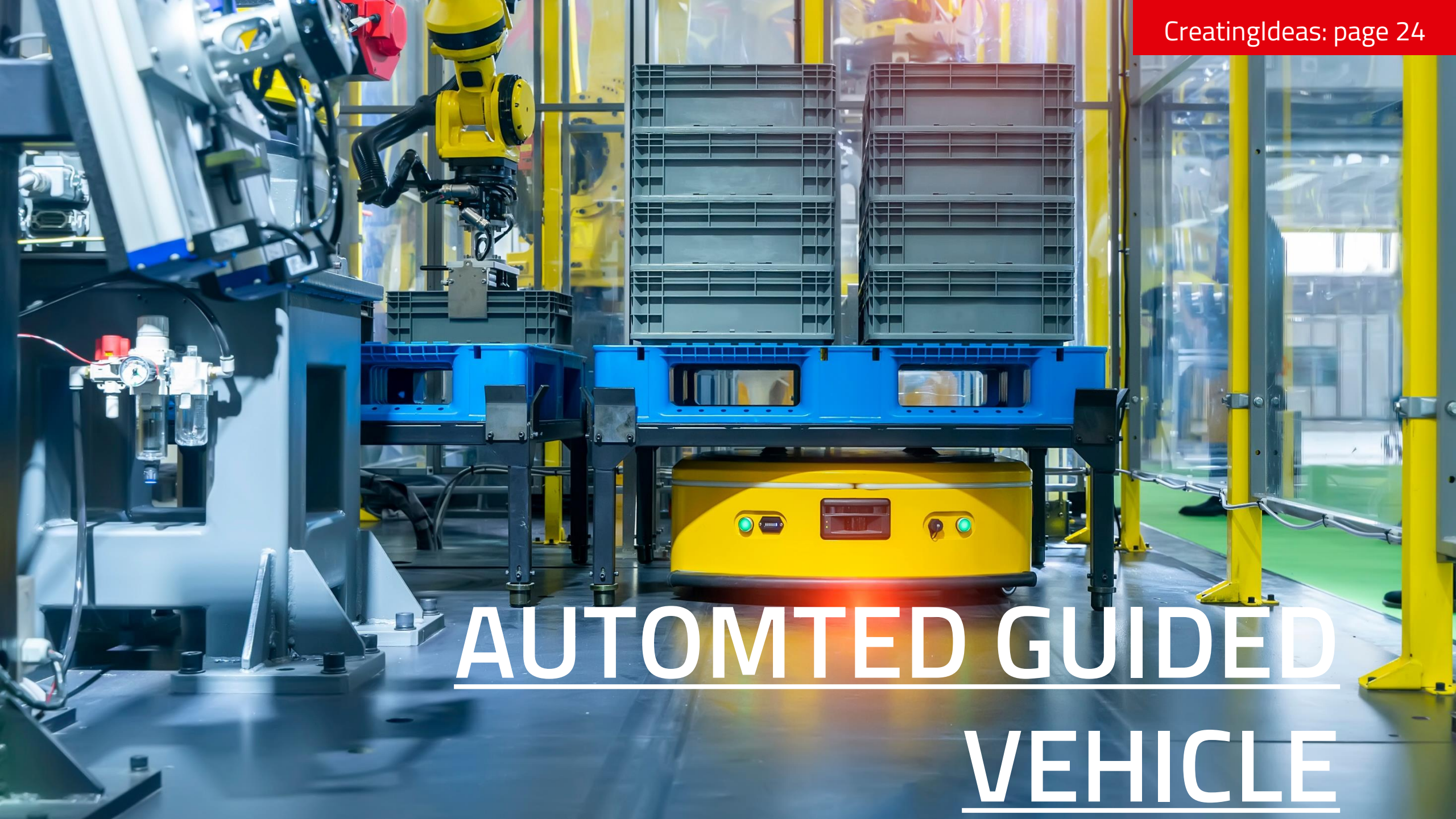
INTELLIGENT COFFEE MACHINE



LIFESTOCK MONITORING



CONTAINER TRACKING



AUTOMATED GUIDED VEHICLE

SMART METERING

2000 imp/kWh
SK C9 - 001 HD

M 13 1432

220V 0,25-5(60)A 50Hz

KI.B EN 50470-3

* Kodas 220.C100.V1

Nr. 01182017
4982.53.1A6Fv11
Pagaminta Lietuvoje 2013

G1A 152* 220.C100.V1 01182017

The image shows a close-up of a smart meter label. The label contains technical specifications such as '2000 imp/kWh', 'SK C9 - 001 HD', and '220V 0,25-5(60)A 50Hz'. It also features a meter identification number 'M 13 1432', a barcode, and a unique number 'Nr. 01182017'. The label is mounted on a white panel with a green display area visible in the background.

START

CREATING IDEAS
HOW CAN I EXTEND
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W
AP

WIRELESS GUIDE
WHAT DOES MY
APPLICATION NEED?

IMPORTANT QUESTIONS

Wireless Guide

1. Region



In which region will the application run or should be used in the future?

- Europe
- North America
- South America
- Asia
- worldwide
- other: _____

2. Range



What range do you need to cover in your application?

- 0 - 15 m
- 15 - 50 m
- 50 - 100 m
- 100 - 500 m
- 500 m - 2 km
- 2 km - 10 km
- >10 km

3. Environment



In which environment will your application be used?

- Indoor
- Outdoor
- Industrial
- Home Automation
- other: _____

IMPORTANT QUESTIONS

Wireless Guide

4. Data

001101
010100
101101

How much data has to be transmitted? Which data rate is required?

- Very low data rate (up to 1 kbps)
- Middle data rate (up to 100 kbps)
- High data rate (>100 kbps)
- Very high data rate (>500 kbps)

5. Energy



What about power consumption? How much energy is available? How long should a battery last?

- Long term battery powered
- Battery powered
- Main powered
- other: _____

6. Interface










































Communication to...?

- Smart Device (Mobile, Tablet)
- PC, Server, etc.
- Device of own development
- Special communication interface (Wirepas, wM-Bus, CAN-Bus, ...)
- Mesh (Wirepas, Bluetooth® Mesh, Closed Mesh)
- other: _____


WIRELESS GUIDE
WHAT DOES MY
APPLICATION NEED?

RADIO TECHNOLOGIES
WHICH TECHNOLOGIES
ARE AVAILABLE?



	LICENCE FREE ISM BANDS (INDUSTRIAL SCIENTIFIC MEDICAL)							LICENCED CELLULAR BANDS					
Frequency [MHz]	169	433	868	915	1500	2400	5000	700	900	1800	2100	2600	3500
Wavelength [cm]	178	69	35	33	20	13	6	43	33	17	14	12	9
Radio Protocol	 		  Long-Range     	  Long-Range    	   	 Bluetooth  zigbee matter THREAD Wirepas IEEE 802.15.4 		 	   				
Range	middle	middle	high	high	high	low	low	high	high				
Data Rate	low	low	middle	middle	low	high	high	high	low				
Würth Elektronik Antennas													
Typical Certification	CE	CE	CE	FCC, IC	worldwide	worldwide	worldwide	worldwide	worldwide				

RADIO PROTOCOLS



Cellular Systems




- Global System for Mobile Communications (GSM)
- Second-generation mobile communications standard (2G) after analog systems (1G)
- Used in 670 GSM mobile communications networks in around 200 countries and territories in the world
- GPRS and EDGE are part of GSM





- Universal Mobile Telecommunications System (UMTS)*
- Mobile communications standard of the 3rd generation (3G)
- HSDPA and HSPA+ are part of UMTS







* Will not be supported / disabled in the future









- Long Term Evolution (LTE)
- 3rd generation (3G) mobile communications standard
- Only part of 4G with LTE-Advanced




- 5th generation mobile communications standard (5G)
- Significantly higher frequencies used, but therefore also smaller wavelengths, which require more closely meshed networks












- Based on LTE
- High data rates possible
- Low energy consumption














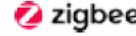

























- Narrowband-IoT (NB-IoT / also CAT-NB1/NB2)
- Based on LTE
- Low data rates, high ranges

Applications


-  Mesh
-  Tracking & Positioning
-  Agriculture
-  Measurement & Automation
-  Medical Devices
-  Smart Device Interface
-  Automated Meter Reading
-  e-Mobility
-  Cloud Connectivity/IoT
-  SensorSystems
-  Lighting

Legend  WE module available  USB radio stick available  Customized implementation possible on request


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RADIO PROTOCOLS

Well known standards


Bluetooth® 

- Bluetooth® classic, Basic Rate (BR), Enhanced Data Rate (EDR), High Speed (HS)
- Standardized connection to smart devices
- High data rates possible
- Esp. audio connections



Bluetooth® LE  



- Bluetooth® Low Energy
- Standardized, simple connection to smart devices
- Low energy requirements
- Low data rates, typically for parameterization, service interfaces, remote displays, etc.




Wi-Fi® CERTIFIED 

- Actually Wireless Local Area Network (WLAN)
- Wi-Fi is a marketing name
- Standard of IEEE-802.11
- High data rates possible
- Worldwide standardized in use









M-Bus®  

- Standardized interface for energy counters (electricity/gas/water/heat)
- According to EN13757-4, OMS
- SmartMeterGateway as defined remote station














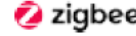



























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RADIO PROTOCOLS

2,4 GHz Systems


IEEE 802.15.4 


- Transmission protocol for Wireless Personal Area Networks (WPAN)
- Defines only PHY and MAC layer of the OSI model




zigbee 


- Low energy consumption and low data volume
- ZigBee Alliance consists of over 200 companies




ANT+ 

- Managed by ANT+ Alliance, belonging to Garmin
- Very low data rates, very low power consumption
- E.g. widespread in the fitness equipment market




THREAD 



- IPv6-based mesh networking technology
- Thread Group working group continues to develop
- Open Thread released by Google Nest




matter

- Connectivity Standards Alliance (CSA) with more than 250 members, including Apple, Google, Amazon, IKEA, and many others
- Smart home standard (scheduled for release in 2022)
- Uses Thread, Wi-Fi and BLE as protocols














Wirepas  

- Decentralized, intelligent routed mesh protocol
- High scalability even with a very large number of network nodes possible



Applications


- | | |
|--|---|
|  Mesh |  Automated Meter Reading |
|  Tracking & Positioning |  e-Mobility |
|  Agriculture |  Cloud Connectivity/IoT |
|  Measurement & Automation |  SensorSystems |
|  Medical Devices |  Lighting |
|  Smart Device Interface | |

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RADIO PROTOCOLS

Sub GHz Systems


sigfox 

- Own global radio network
- Low data rates, high ranges




ZWAVE


- Developed by Sigma Designs and the Z-Wave Alliance
- Low power consumption




enOcean


- Battery free wireless sensor technology (energy harvesting) with very low energy consumption
- EnOcean Alliance with 400 members




LoRa 

- Managed by LoRa Alliance
- LoRaWAN® widely deployed LPWAN (Low Power Wide Area Network)
- Low power consumption and high range
- Open networks can be shared if available














mioty 

- LPWAN Application
- High range, low data rate, low power consumption
- Managed by MIOTY Alliance
- Licensed by Fraunhofer

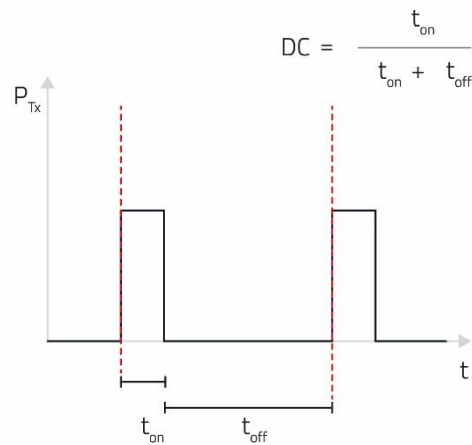


Applications

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DUTY CYCLE

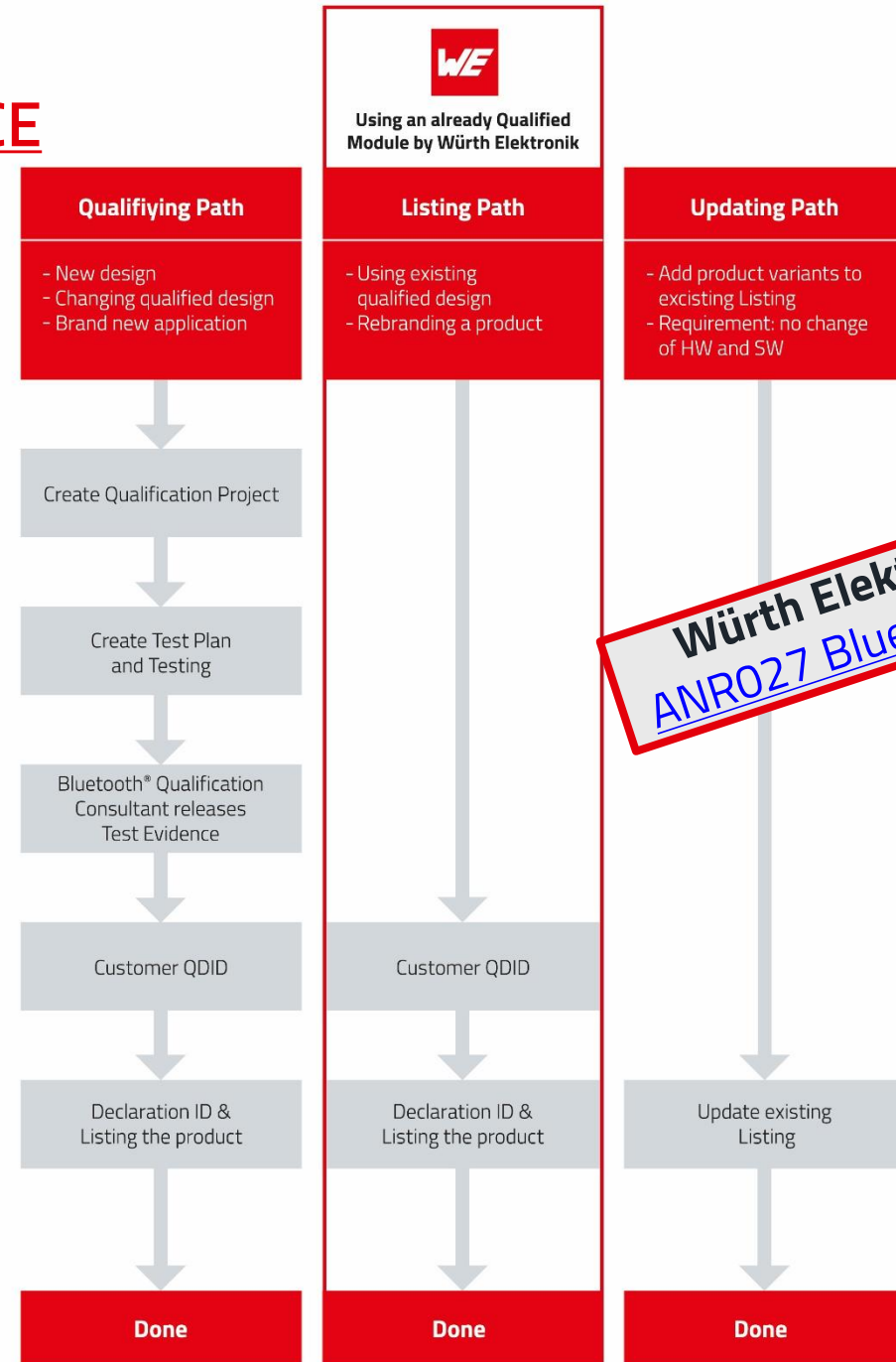


Frequency [MHz]	Band	TX Power [dBm]	TX Power [mW]	Duty cycle	max. occupied BW*	Notes
169.400 - 169.475	D	+ 27	500	≤ 1 %	50	For metering devices: 10 % DC;
169.400 - 169.4875	E	+ 10	10	≤ 0.1 %	whole band	
169.4875 - 169.5875	F	+ 10	10	≤ 0,001 %	whole band	0,1 % DC during 0:00 and 6:00 local time; Equipment that concentrates or multiplexes individual equipment is excluded.
169.5875 - 169.8125	G	+ 10	10	≤ 0,1 %	whole band	
433.050 - 434.790	H	+ 10	10	10 %	whole band	
433.050 - 434.790	I	0	1	no limits	whole band	-13 dBm / 10kHz PSD when bw > 250 kHz, audio/video applications are excluded
433.050 - 434.790	J	+ 10	10	no limits	25	audio/video applications are excluded
863.0 - 865.0	K	+ 14	25	≤ 0.1 % or psa**	whole band	OBW restrictions except audio & video limited to 300 kHz
865.0 - 868.0	L	+ 14	25	≤ 1 % or psa**	whole band	
868.0 - 868.6	M	+ 14	25	≤ 1 % or psa**	whole band	
868.7 - 869.2	N	+ 14	25	≤ 0.1 % or psa**	whole band	
869.4 - 869.65	P	+ 27	500	≤ 10 % or psa**	whole band	
869.7 - 870.0	Q	+ 7	5		whole band	audio / video applications are excluded
869.7 - 870.0	R	+ 14	25	≤ 1 % or psa**	whole band	analogue audio / video are excluded
2400.0 - 2483.5		+ 10	10	no limits	whole band	non specific short range devices
2400.0 - 2483.5		+ 14	25	no limits	whole band	radio determination devices (radar, rfid,...)
2446.0 - 2454.0			500 / 4000		whole band	RFID only

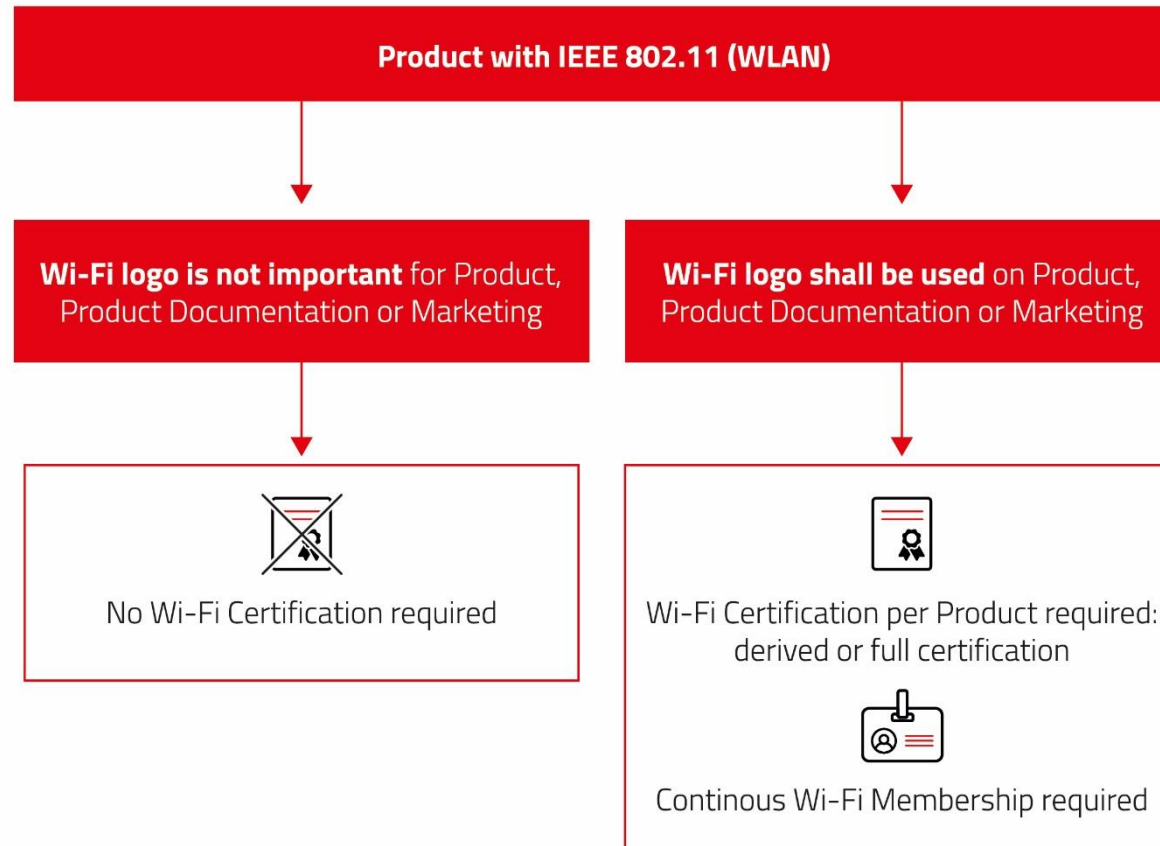
BLUETOOTH LISTING OF THE END DEVICE

BYOF & re-use of WE certification

- The Bluetooth listing of the standard module **can not be re-used**.
- A new Bluetooth listing for the end device must be done, using the listing of the **nRF Connect SDK and the radio chip** (not radio module).
- Nevertheless, the **testing part of listing** (measurement of the Bluetooth conformity) **can be saved**. Only the paper work for the declaration (declaration fee of 11.040\$) is still needed.



WI-FI „CERTIFICATION“



MATTER

Membership costs

- Minimum Adopter (7.000\$ p.a.)
- Certification 2.500\$ (derivative or Implement a Certified Product via the Certification Transfer Program)
- Certification 3.000 \$ for own development

In total:

7.000 \$ per year

2.500-3.000\$ for certification (one time)

Promoter *\$105,000 USD/yr	Participant *\$20,000 USD/yr	Adopter \$7,000 USD/yr	Associate \$0 USD/yr
<p style="background-color: #0070C0; color: white; padding: 5px; text-align: center;">Develop, Test, and Certify ▾</p> <ul style="list-style-type: none"> • Develop, test, and certify products \$2,000 USD per product • Certify own derivative product \$1,500 USD per product • Develop, test, and certify products that can be transferred to a 3rd party via the Certification Transfer Program • Implement a Certified Product via the Certification Transfer Program and use the Alliance Certification trademarks and logos \$1,500 USD per product • Certified Product listing on the Alliance website • Attend Alliance workshops, developer conferences, and test events 	<p style="background-color: #0070C0; color: white; padding: 5px; text-align: center;">Develop, Test, and Certify ▾</p> <ul style="list-style-type: none"> • Develop, test, and certify products \$2,000 USD per product • Certify own derivative product \$1,500 USD per product • Develop, test, and certify products that can be transferred to a 3rd party via the Certification Transfer Program • Implement a Certified Product via the Certification Transfer Program and use the Alliance Certification trademarks and logos \$1,500 USD per product • Certified Product listing on the Alliance website • Attend Alliance workshops, developer conferences, and test events 	<p style="background-color: #0070C0; color: white; padding: 5px; text-align: center;">Develop, Test, and Certify ▾</p> <ul style="list-style-type: none"> • Develop, test, and certify products \$3,000 USD per product • Certify own derivative product \$2,500 USD per product • Implement a Certified Product via the Certification Transfer Program and use the Alliance Certification trademarks and logos \$2,500 USD per product • Certified Product listing on the Alliance website • Attend Alliance workshops, developer conferences, and test events 	<p style="text-align: center;">White label or rebrand a Certified Product via the Certification Transfer Program and use the Alliance Certification trademarks \$2,500 USD per product + \$500 USD per year, per product (due annually on the anniversary date of the grant of certification)</p>
Go to Market >	Go to Market >	Go to Market >	
Participate and Lead >	Participate and Lead >	Participate and Lead >	

* Promoter membership also requires a one-time initiation fee
 * Membership Fees effective 16 July 2021.

[Become a Member | The Future of IOT - CSA-IOT](#)



THREAD

- Minimum Implementer (7.500 \$ p.a.)

In total:














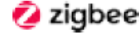





























7.500 \$ per year

MEMBERSHIP BENEFITS	ACADEMIC	AFFILIATE*	IMPLEMENTER	CONTRIBUTOR	SPONSOR
Receive Member Communications	✓	✓	✓	✓	✓
Access to Members-only Website	✓	✓	✓	✓	✓
Use of Alliance Member Logo	✓	✓	✓	✓	✓
Participation in Press Articles & Interviews	✓	✓	✓	✓	✓
Access Draft Specification / Documents	✓	✓	✓	✓	✓
Access Final Specification / Documents	✓	✓	✓	✓	✓
Participation in General or Annual Meetings			✓	✓	✓
Access to IP - Gain Intellectual Property Rights (IPR) for Thread Technology, Typically with No Royalty Payments			✓	✓	✓
Certify by Inheritance Compliant Components and Products and Utilize Alliance Certification Logo			✓	✓	✓
Certify at ATL Compliant Components and Products and Utilize Alliance Certification Logo				✓	✓
Ability to Purchase Thread Test Bed			✓	✓	✓
Option to Purchase Thread Test Harness			✓		
Free Access to Thread Test Harness				✓	✓
Access to Thread Reference Commissioning App				✓	✓
Participate and Vote in Work Groups and Committees				✓	✓
Chair Work Groups and Committees				✓	✓
Initiate Work Groups or Committees					✓
Approve Operating Budget					✓
Approve Final Deliverables					✓
Automatic Seat on Board of Directors					✓
Annual Fee	\$-	\$750	\$7,500	\$15,000	\$65,000
One-time Initiation Fee					\$35,000

*Open to organizations with fewer than 50 employees.




<https://www.threadgroup.org/thread-group>








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RADIO PROTOCOLS

Special: Proprietary Protocol

- Proprietary (non-standard) radio protocol
- Great flexibility and adaptability
- Communication closed to the outside, security factor

Applications



Mesh



Tracking & Positioning



Agriculture



Measurement & Automation



Medical Devices



Smart Device Interface



Automated Meter Reading



e-Mobility



Cloud Connectivity/IoT



Sensor Systems



Lighting

Legend
















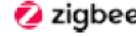





























WE module available



USB radio stick available



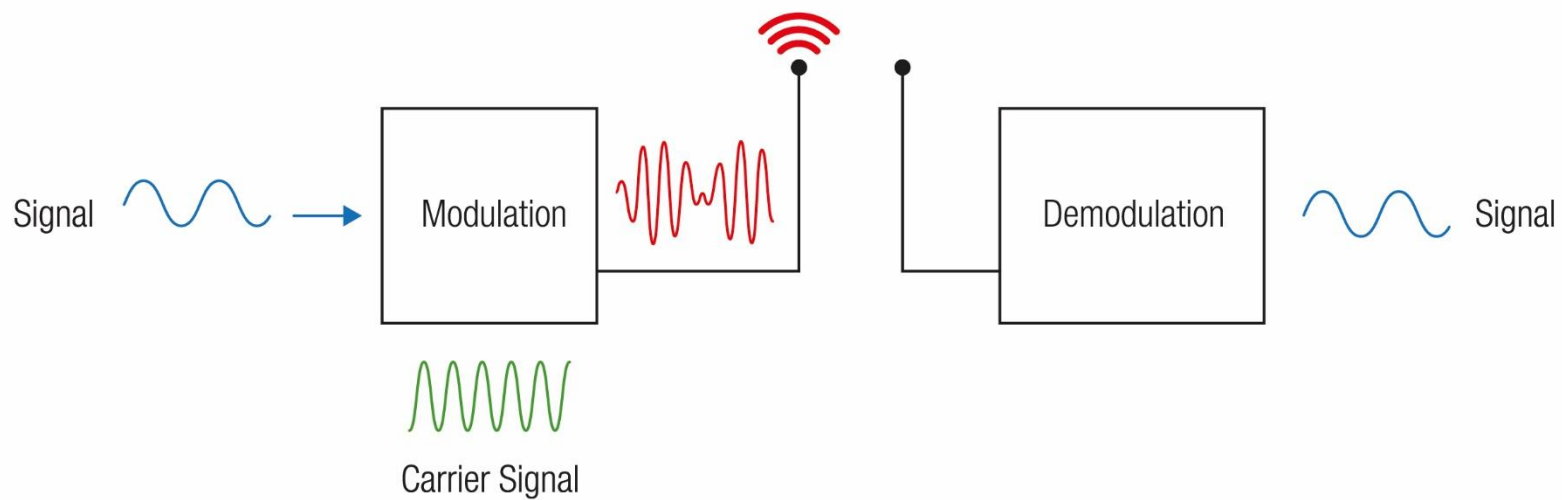
Customized implementation possible on request

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RADIO TECHNOLOGIES
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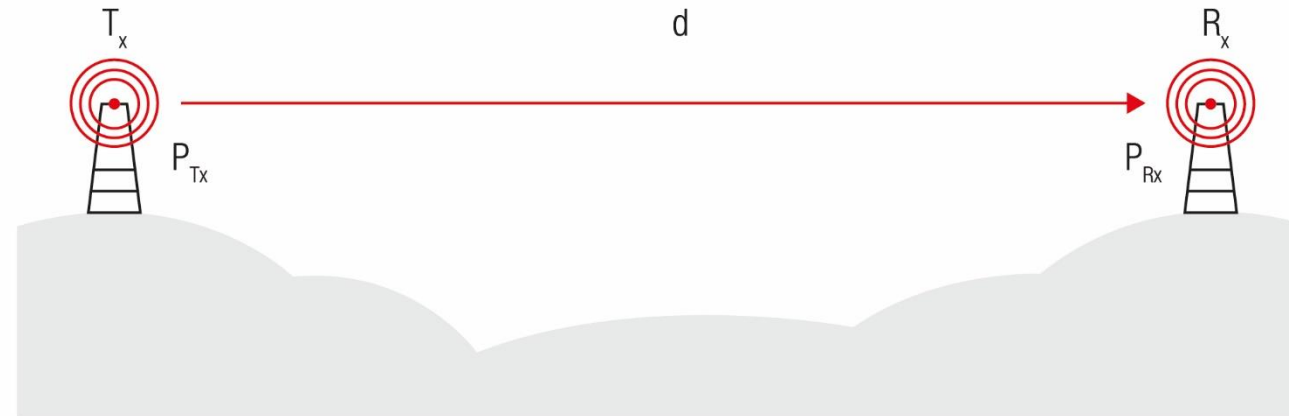
**RADIO COMMUNICATION
FUNDAMENTALS**
WHAT IS RADIO?

RADIO SYSTEM



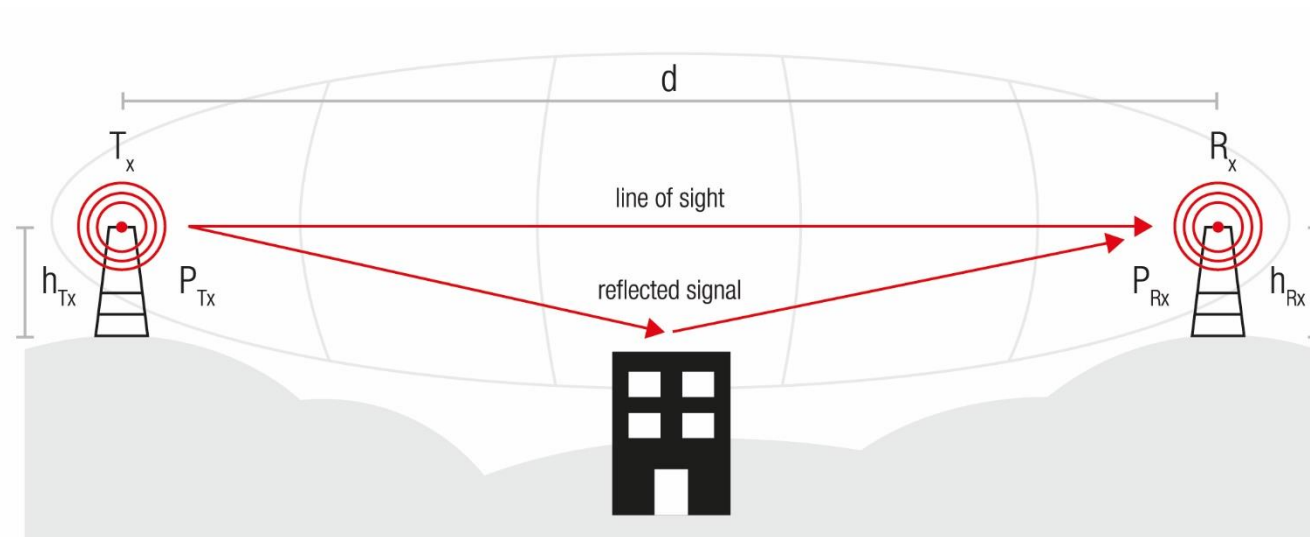
RANGE ESTIMATION

Model 1: Friis Transmission for Free Space



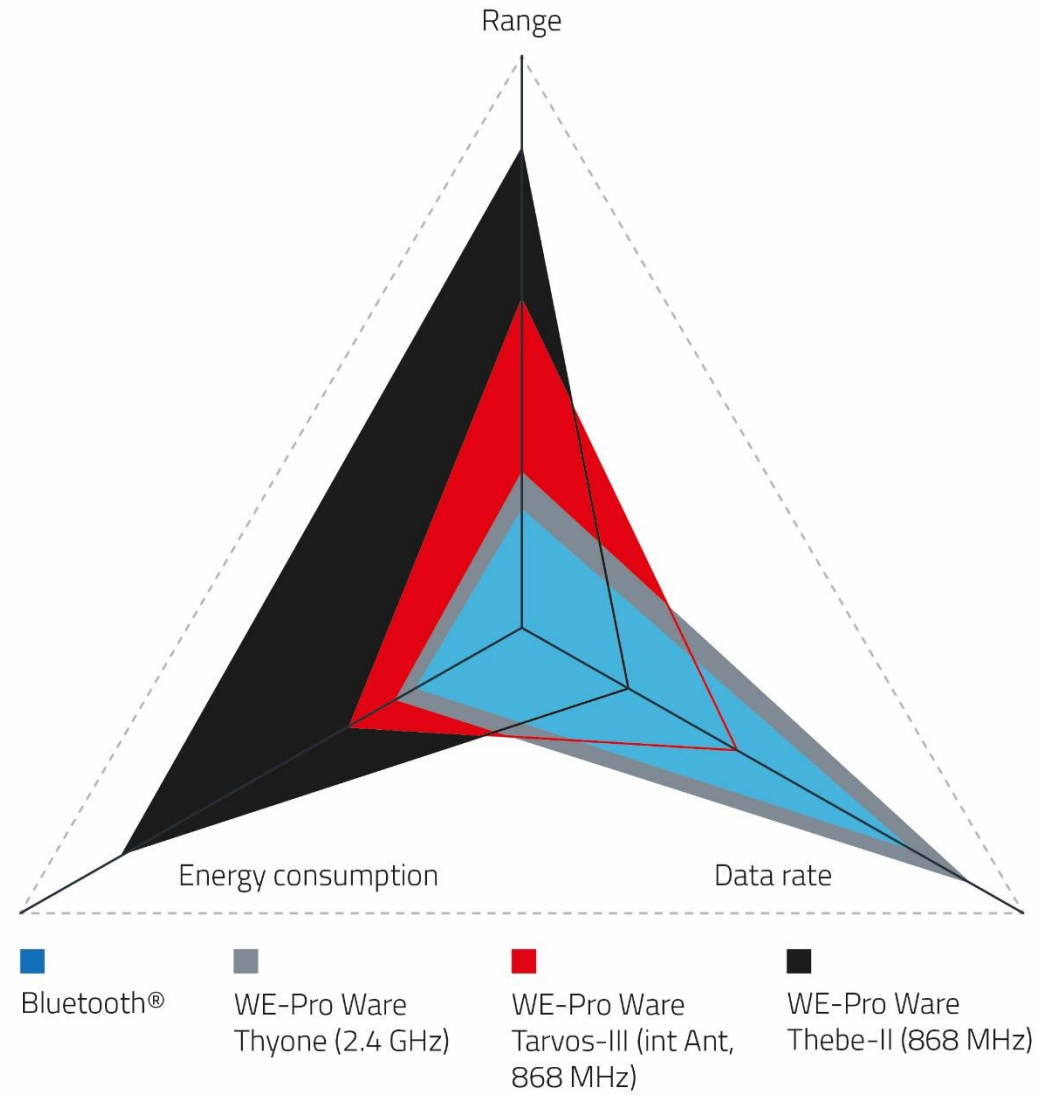
RANGE ESTIMATION

Model 2: Two-ray Ground Reflection

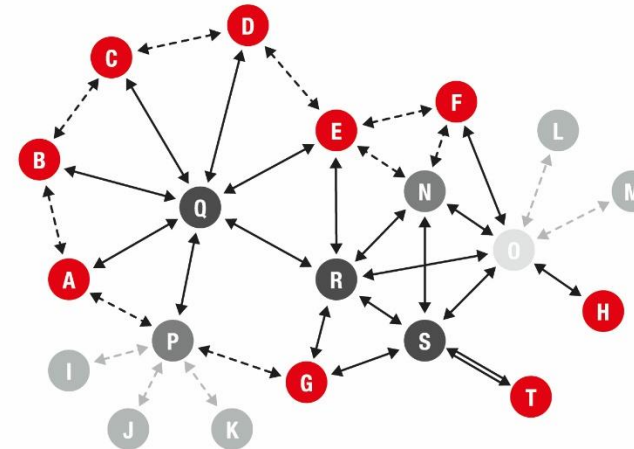
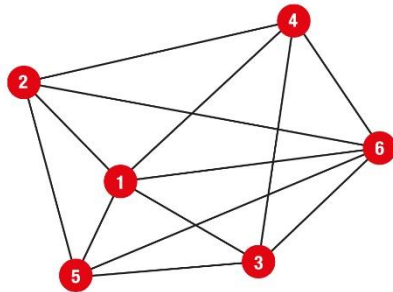
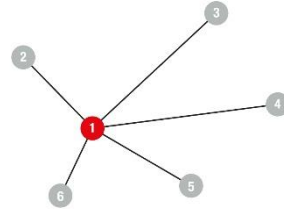


RANGE – DATA RATE – ENERGY CONSUMPTION

A compromise



NETWORK TOPOLOGIES

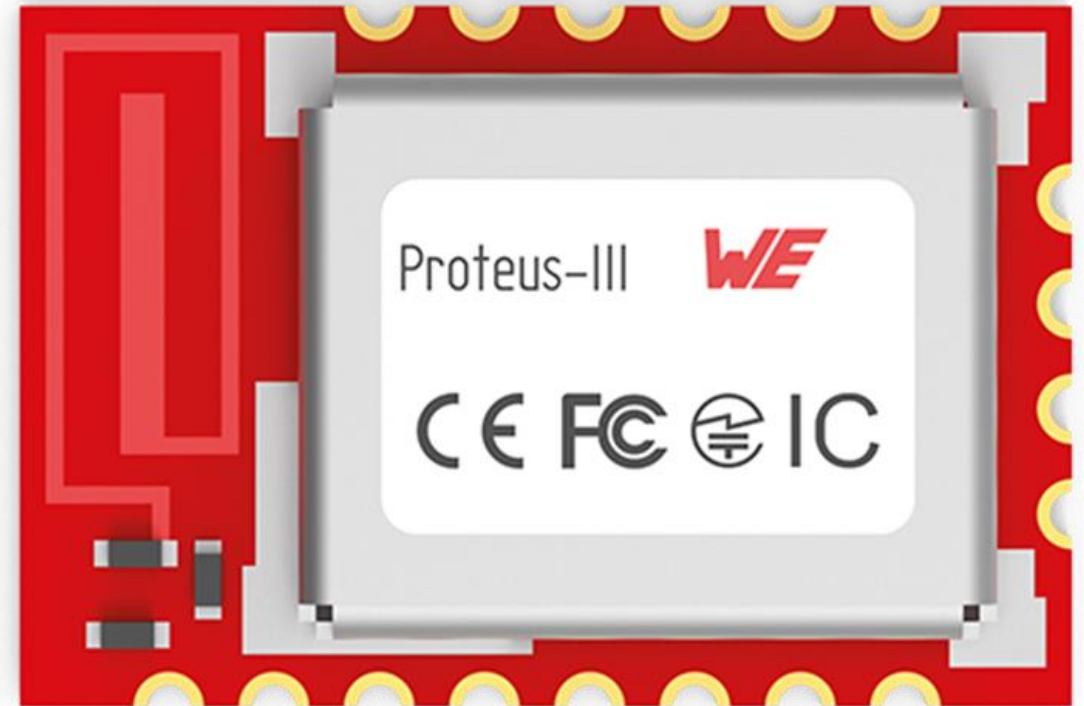
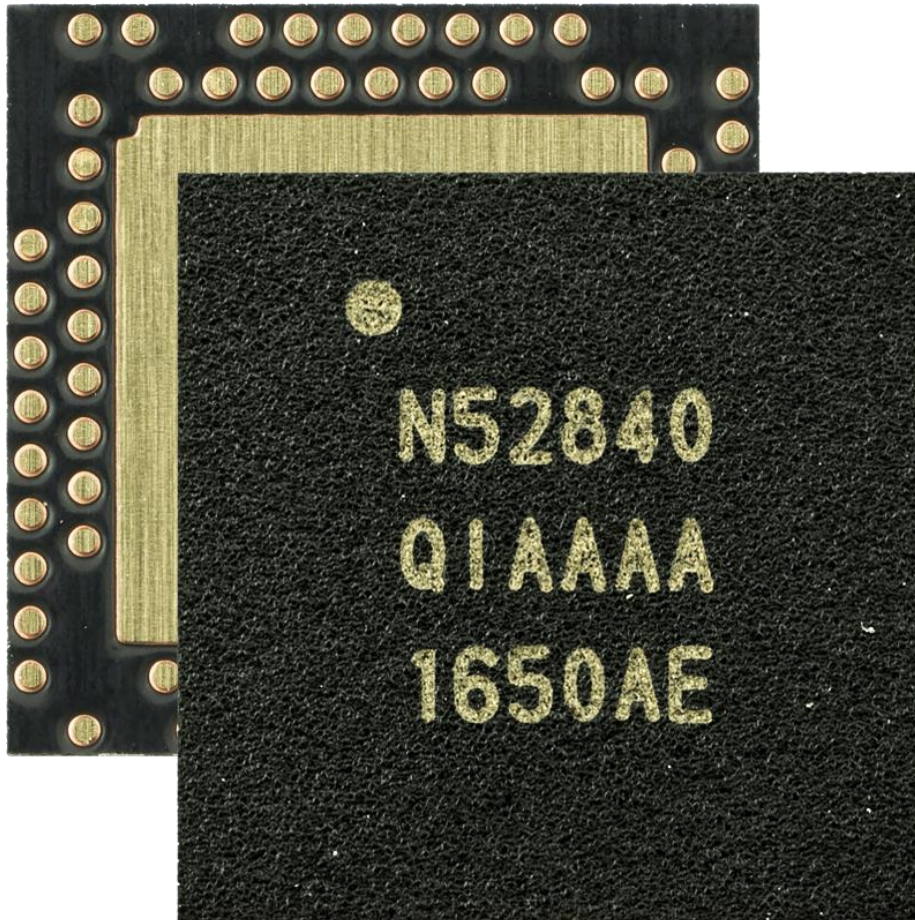


**RADIO COMMUNICATION
FUNDAMENTALS**
WHAT IS RADIO?

**WHY USING A RADIO MODULE?
RADIO CHIP OR
RADIO MODULE?**

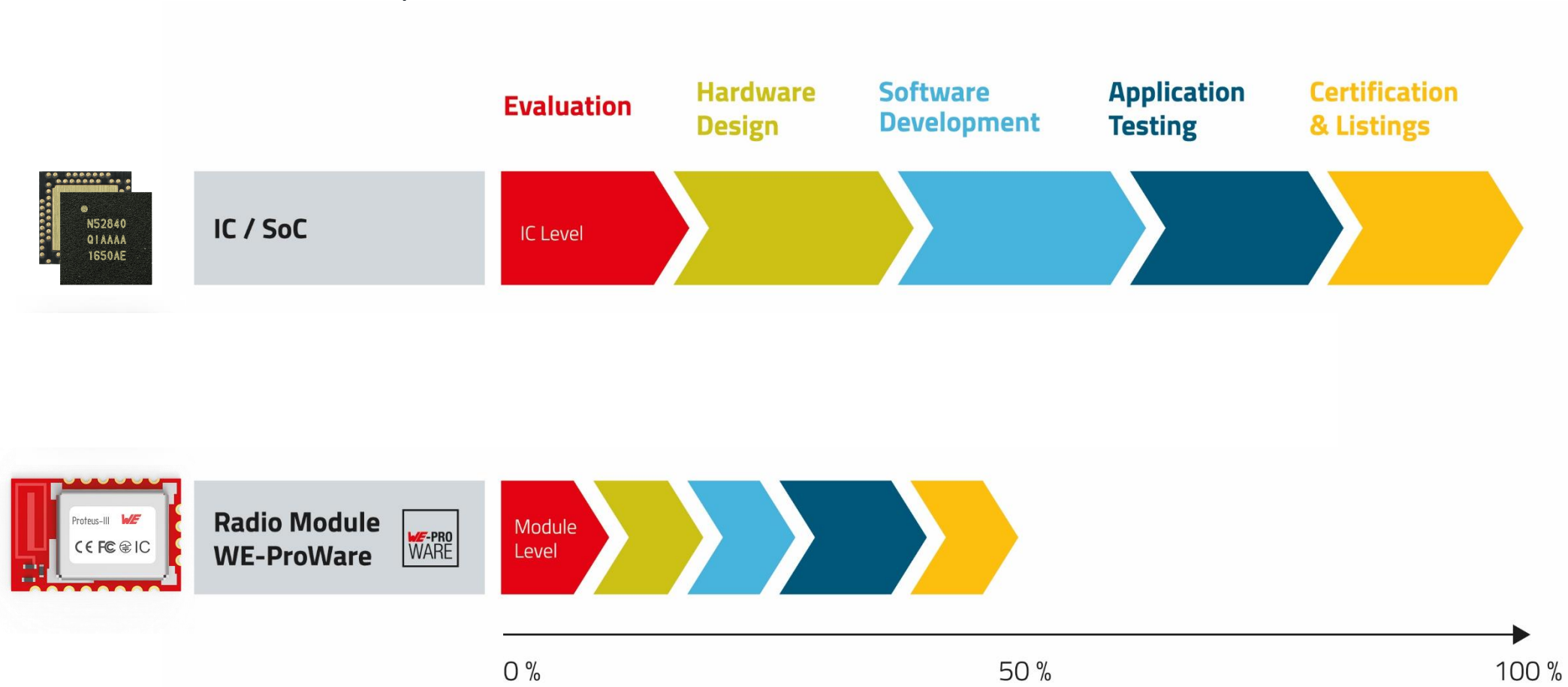
FUNK-CHIP VS. FUNK-MODUL

2 Möglichkeiten

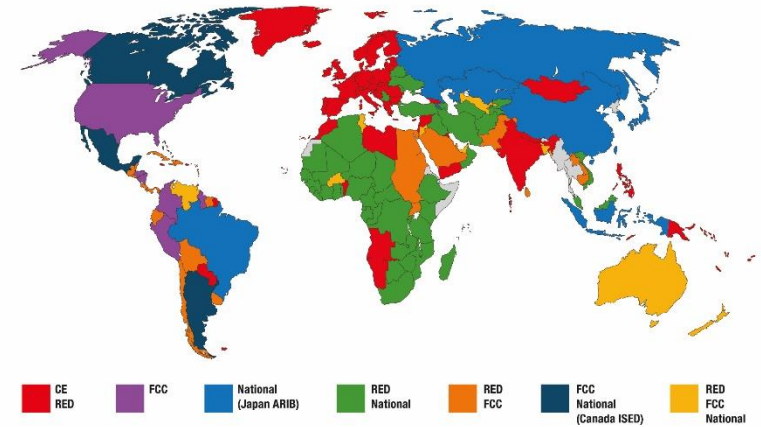
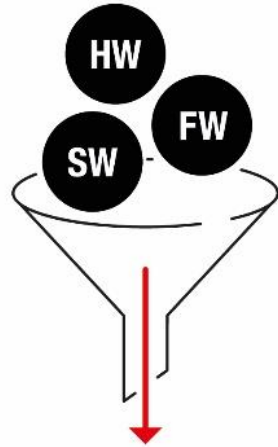


HARDWARE

Funkmodul oder Funkchip



WAS IST EIGENTLICH EIN FUNKMODUL?



Radio module



Certification




Hardware



Firmware



Software



EU DECLARATION OF CONFORMITY

Radio equipment: 2011011024000

The manufacturer: Würth Elektronik eSOS GmbH & Co. KG
Max-Eyth-Strasse 1
74638 Waldenburg

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Object of the declaration: 2011011024000



The object of the declaration described above is in conformity with the relevant Union harmonization legislation: Directive 2014/53/EU and 2011/65/EU.
Following harmonized norms or technical specifications have been applied:

EN 300 328 V2.1.1 (2016-11)
EN 301 489-1 V2.1.1 (2017-02)
EN 301 489-17 V3.1.1 (2017-02)
EN 62366-1:2014 + AC:2015 + A11:2019

Japanese Radio Law Compliance.
This device is granted permission to the Japanese Radio Law. This device should not be modified (otherwise the granted designation number will become invalid).

The MAC address of the radio device maintains the format 00:18:DA:xx:xx:xx. The latter part (xx:xx:xx) of the MAC address coincides with the serial number of the device.

Due to the size of the Proteus-III label, the certification label of the Proteus-III is not placed onto the module label.


2011011024000:  201-190950



**WHY USING A RADIO MODULE?
RADIO CHIP OR
RADIO MODULE?**

HARDWARE INTEGRATION
HOW TO ADD A MODULE
ON A PCB?

ANTENNAS AND MATCHING

WHAT ABOUT THE ANTENNA?

FIRMWARE WE-PROWARE
DO I HAVE TO DEVELOP
THE FIRMWARE FOR
THE MODULE?

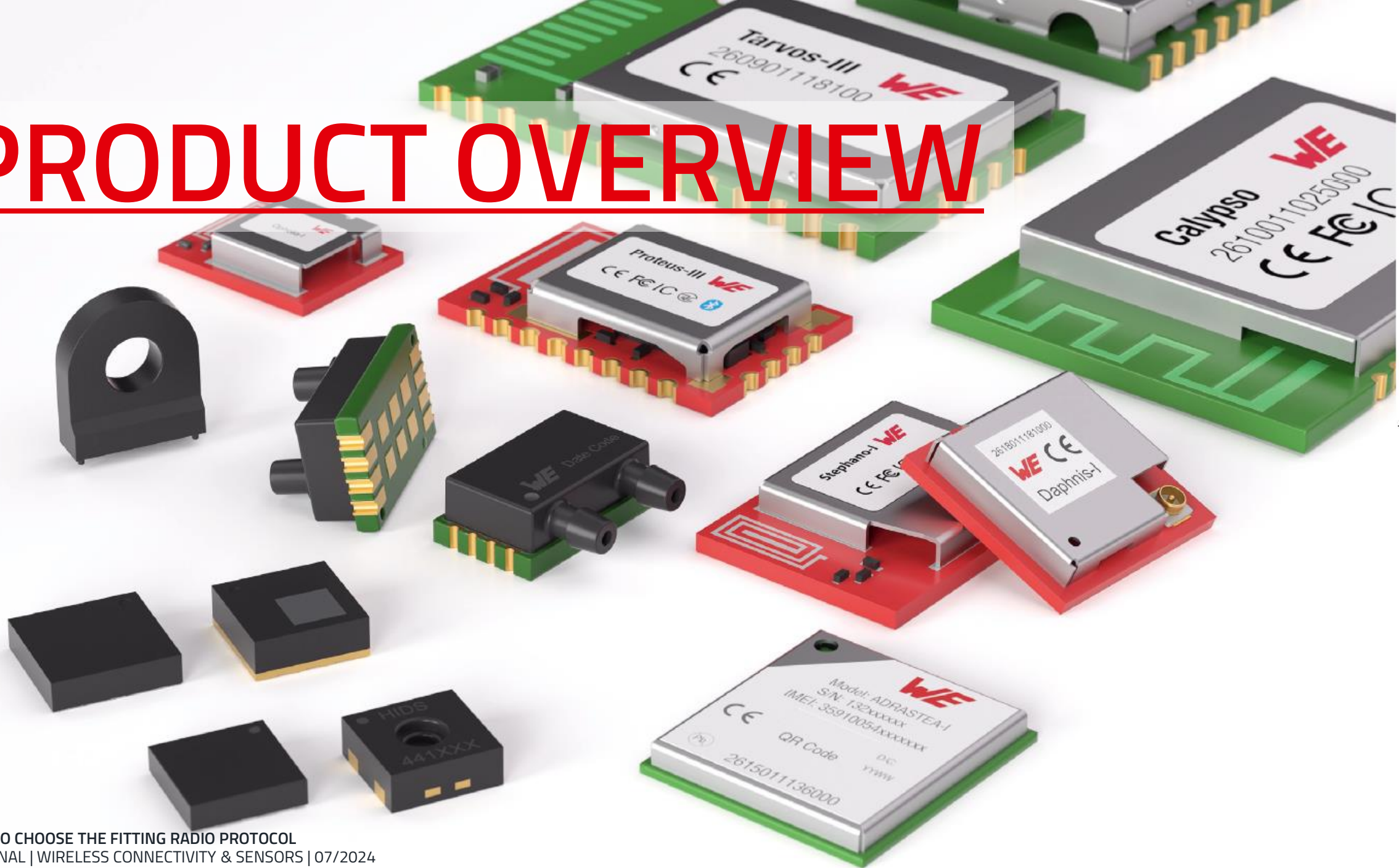
CERTIFICATION AND CONFORMITY
HOW TO CLIMB
THE MOUNTAIN OF
CERTIFICATION?

CHOOSE YOUR TECHNOLOGY/SOLUTION
NOW I CAN DISCOVER
THE WORLD OF WIRELESS
CONNECTIVITY...

HOW TO CHOOSE THE FITTING RADIO PROTOCOL













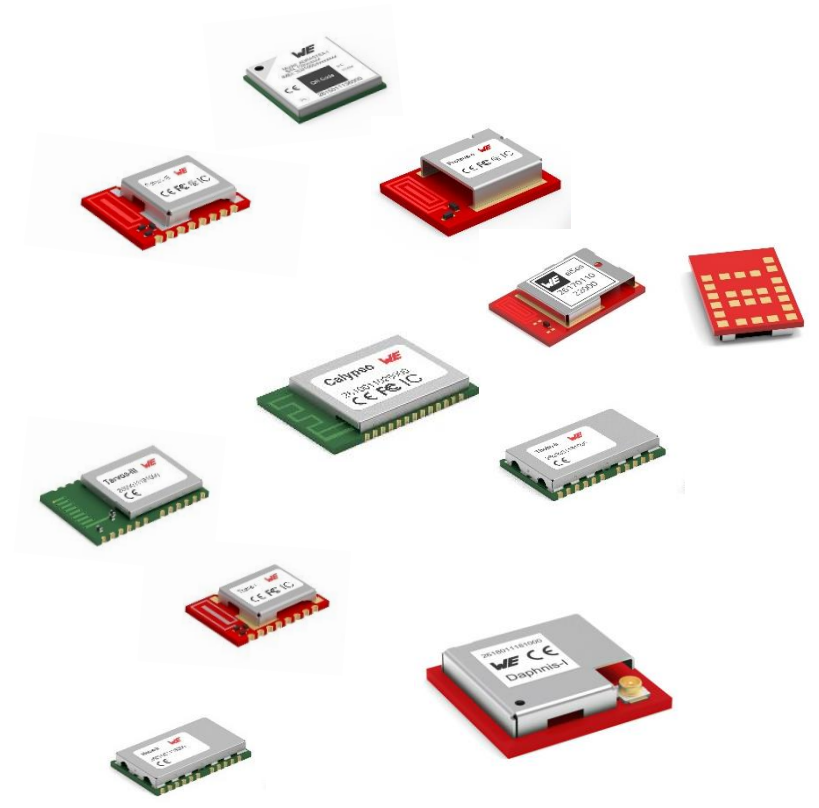
PRODUCT OVERVIEW



PRODUKTÜBERSICHT

WIRELESS CONNECTIVITY

	Connect Machine Globally	Cellular
	Connect Machine to Mobile Device	Bluetooth®
	Connect Machine to Internet	WiFi
Long-Range	Connect Device to Gateway	Long-Range-WAN
	Connect Machine to Machine	Proprietary
  WiFi	Connect M2M & Mobile Device	Combined
 	Connect all together	Mesh
	Connect Smart Meter	Wireless M-Bus
	Open Module/No Firmware	Build Your Own Firmware

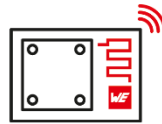


MORE THAN YOU EXPECT

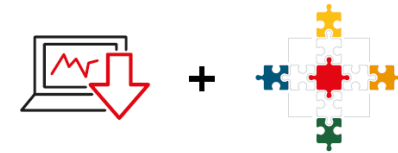
Full Service Products Hardware + Firmware



Proven High Frequency PCB-Design & Proven Antenna Characteristics



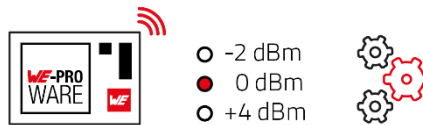
Software Toolkit: APIs and Software Development Kits (SDKs)



Certification and Conformity – CE, UKCA, FCC, IC, Telec , SRRC, NCC & ETA-WPC



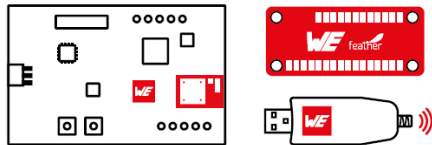
Configurable User Settings with our Firmware WE-ProWare



Free of Charge PC-Software and Mobile Apps



Evaluation Tools



Technical Support – Talk from Engineer to Engineer



Long Term Availability



FURTHER INFORMATION HERE:

WWW.WE-ONLINE.DE/KATALOG/WCO

WWW.WE-ONLINE.COM/WCS-PRODUCT-GUIDE

HINTERGRUNDINFORMATIONEN

Wireless Connectivity & Sensors Product Guide



www.we-online.com/wcs-product-guide

THANK YOU!

QUESTIONS?

