CELLULAR

Cellular

Bluetooth®

Wi-Fi

Proprietary

Combined

Mesh

Wireless M-Bus

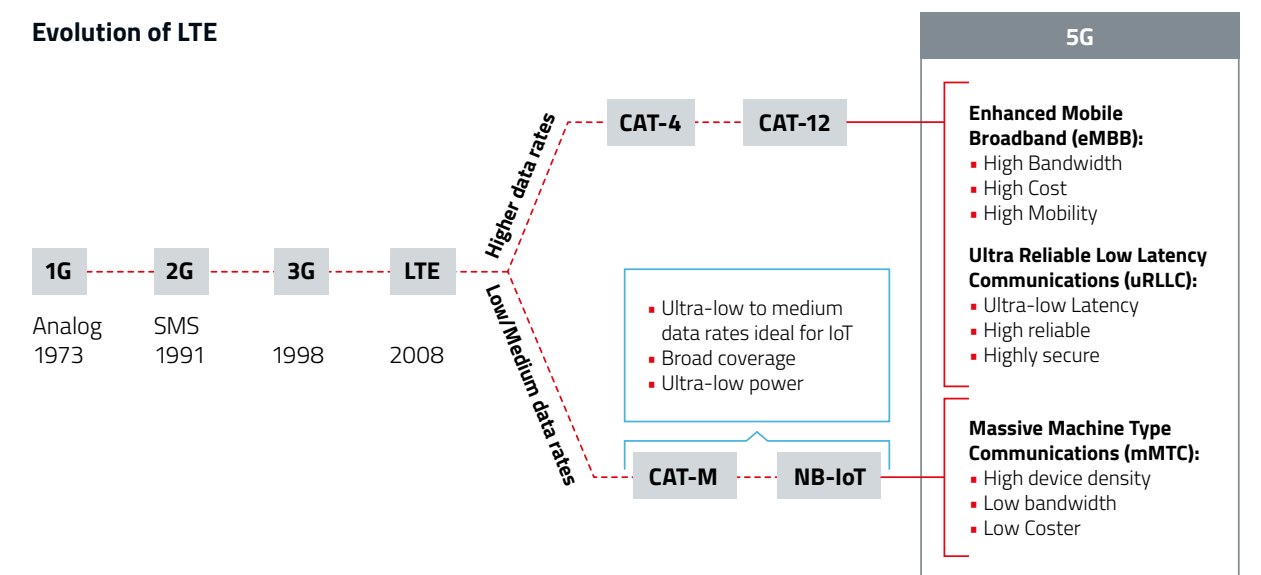Build Your Own Firmware

GNSS

Sensors

INTRODUCTION

Cellular - an Overview

LTE (Long Term Evolution) is a Cellular communication standard, which operates in licensed spectrum. LTE is also referred to as fourth generation ("4G") of cellular communication technology. The standards for LTE are defined by 3rd Generation Partnership Project (3GPP). 3GPP is a worldwide standards organization that develops protocols/standards for cellular telecommunications.
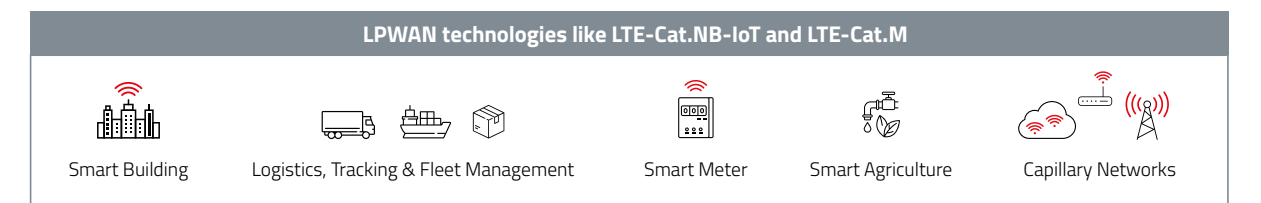LPWAN cellular technologies are for low-power, low transmitting speeds, low-cost module and devices, with low data usage per month, and wide area coverage. Existing cellular technologies were not designed to cater low power application, hence cellular LPWAN technologies covers scenarios for which existing mobile network technology is not suitable. These cellular LPWAN refers to low power wide area networks (LPWAN) in licensed spectrum.
3GPP specified LTE-M (LTE-MTC) and NB-IoT (Narrow-Band IoT) to address the fast-expanding market for low power wide area network (LPWAN) connectivity.
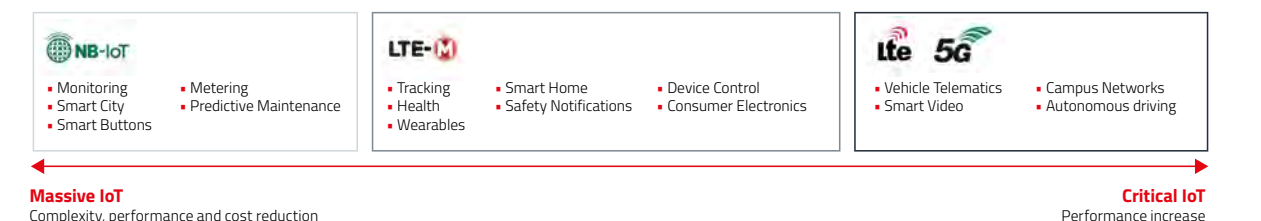
Evolution of LTE

					5G
				CAT-4 — CAT-12	**Enhanced Mobile Broadband (eMBB):** • High Bandwidth • High Cost • High Mobility
1G	2G	3G	LTE	*Higher data rates*	**Ultra Reliable Low Latency Communications (uRLLC):** • Ultra-low Latency • High reliable • Highly secure
Analog 1973	SMS 1991	1998	2008	• Ultra-low to medium data rates ideal for IoT • Broad coverage • Ultra-low power	
				Low/Medium data rates CAT-M — NB-IoT	**Massive Machine Type Communications (mMTC):** • High device density • Low bandwidth • Low Coster

Application Areas and Use Cases

LPWAN technologies like LTE-Cat.NB-IoT and LTE-Cat.M				
Smart Building	Logistics, Tracking & Fleet Management	Smart Meter	Smart Agriculture	Capillary Networks

Customers using LPWAN Technologies require small data volumes, a low cost contractual obligation, low energy consumption and the possiblity for a massive number of devices.

From NB-IoT to 5G

NB-IoT	LTE-M	Lte 5G
• Monitoring • Metering • Smart City • Predictive Maintenance • Smart Buttons	• Tracking • Smart Home • Device Control • Health • Safety Notifications • Consumer Electronics • Wearables	• Vehicle Telematics • Campus Networks • Smart Video • Autonomous driving

Massive IoT
Complexity, performance and cost reduction
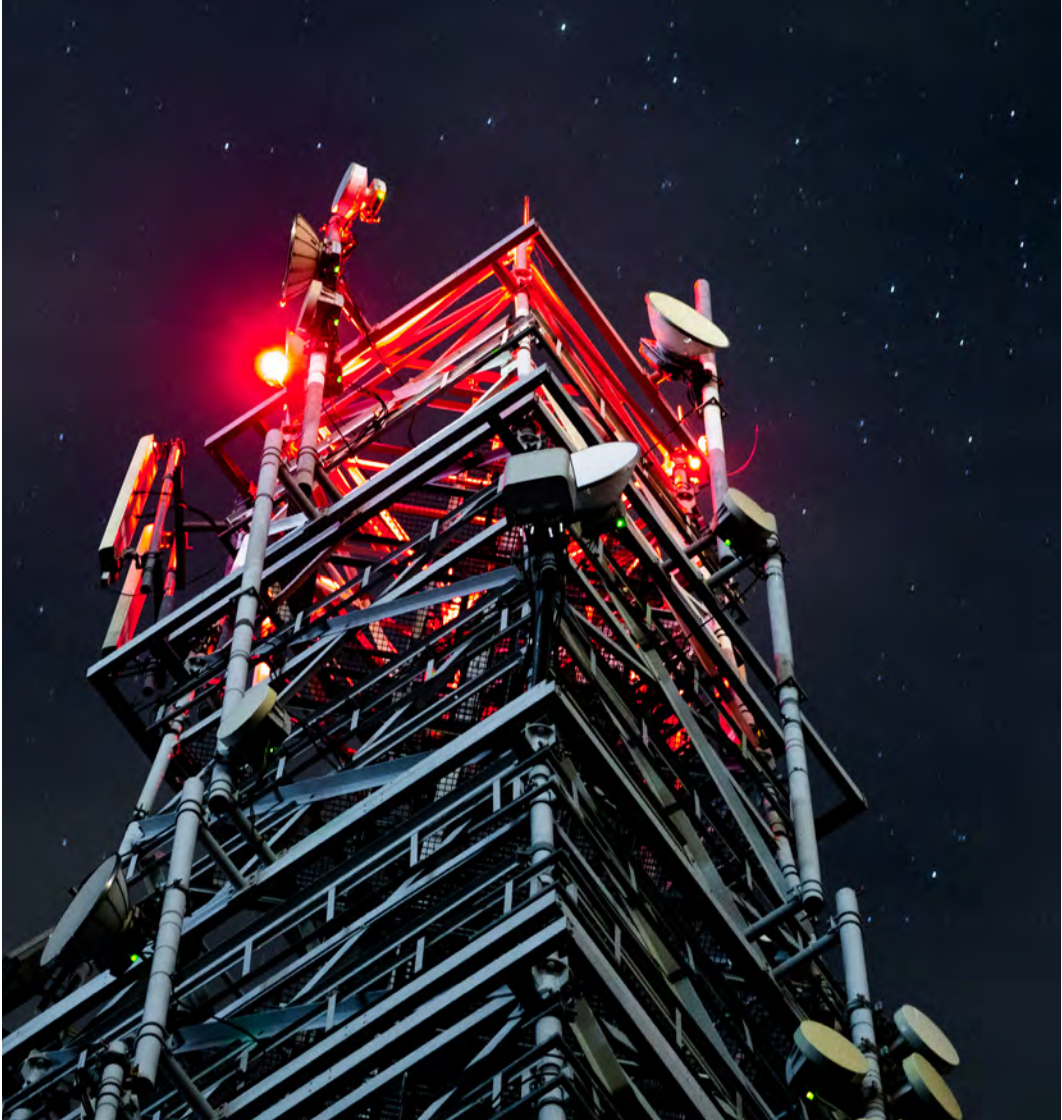
Critical IoT
Performance increase

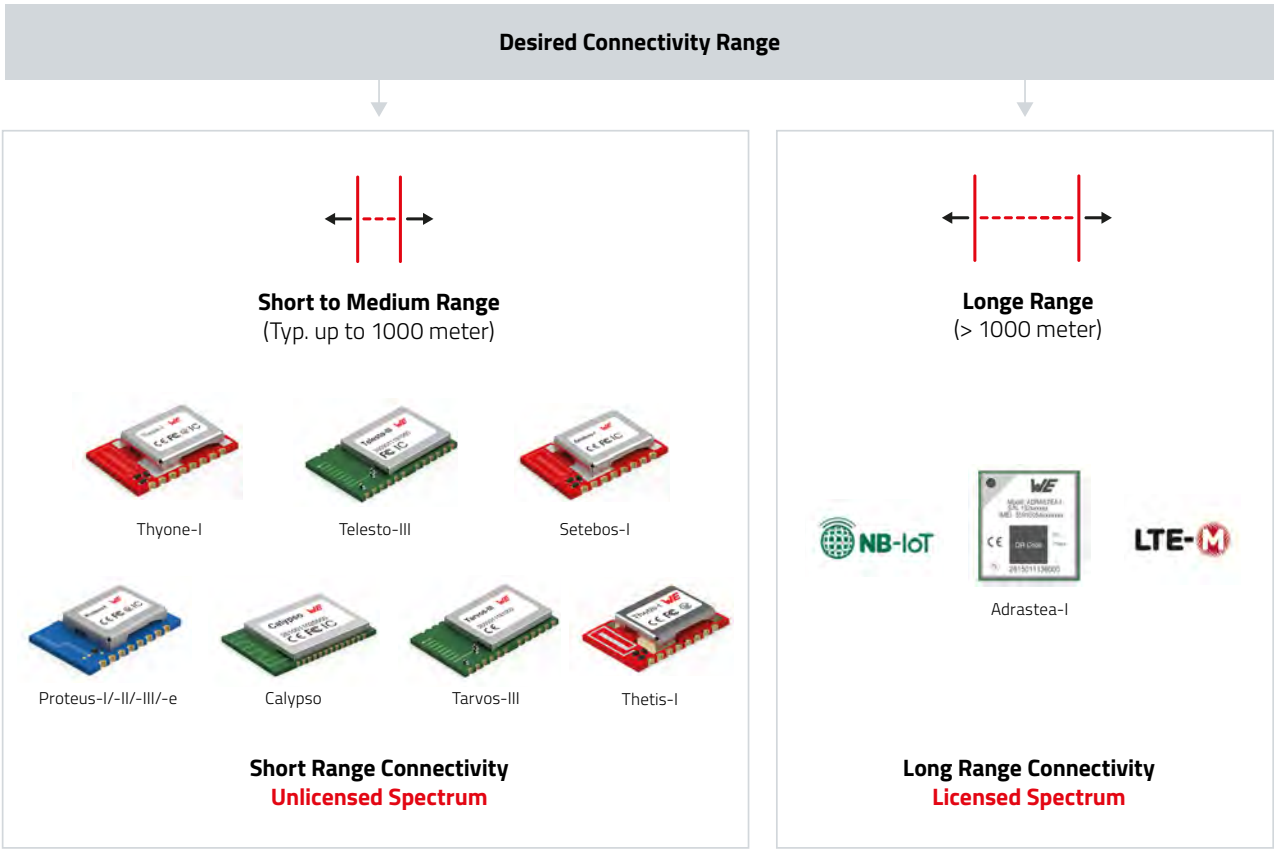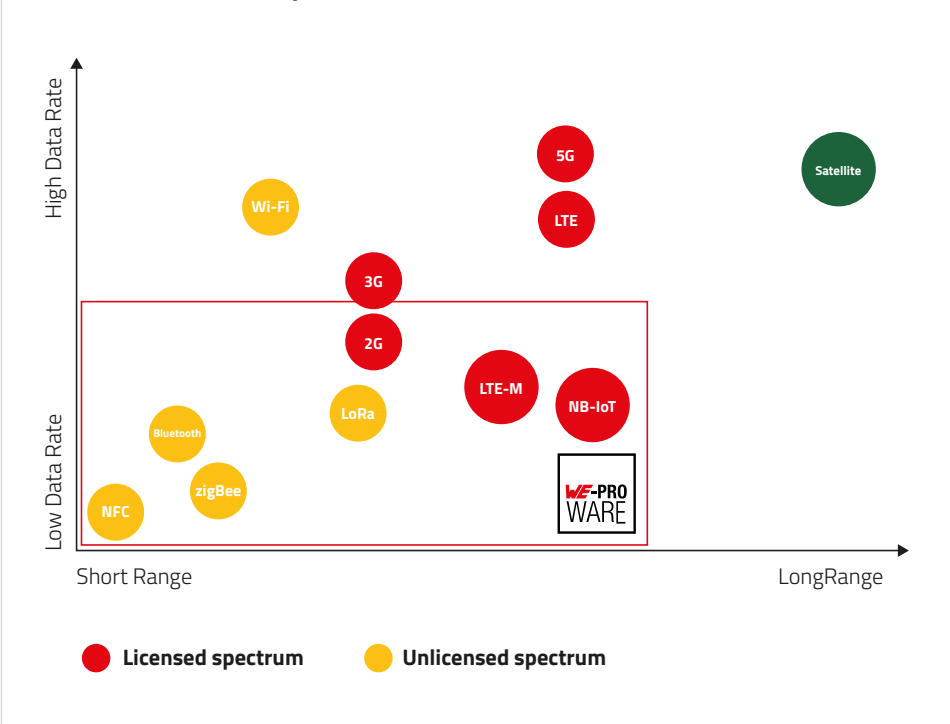# IOT CONNECTIVITY OPTIONS

The right choice

The main purpose of any IoT solution is to get data from the field to the cloud where analysis of the same generates the desired value proposition for the application. With a wide range of IoT connectivity options available, the connectivity decision is increasingly based on the cost, security, coverage, power usage and the potential throughput of the connectivity. Multiple IoT connectivity options are available and at the broader level these solutions can be categorized into two types:

a) Short Range wireless connectivity solutions and
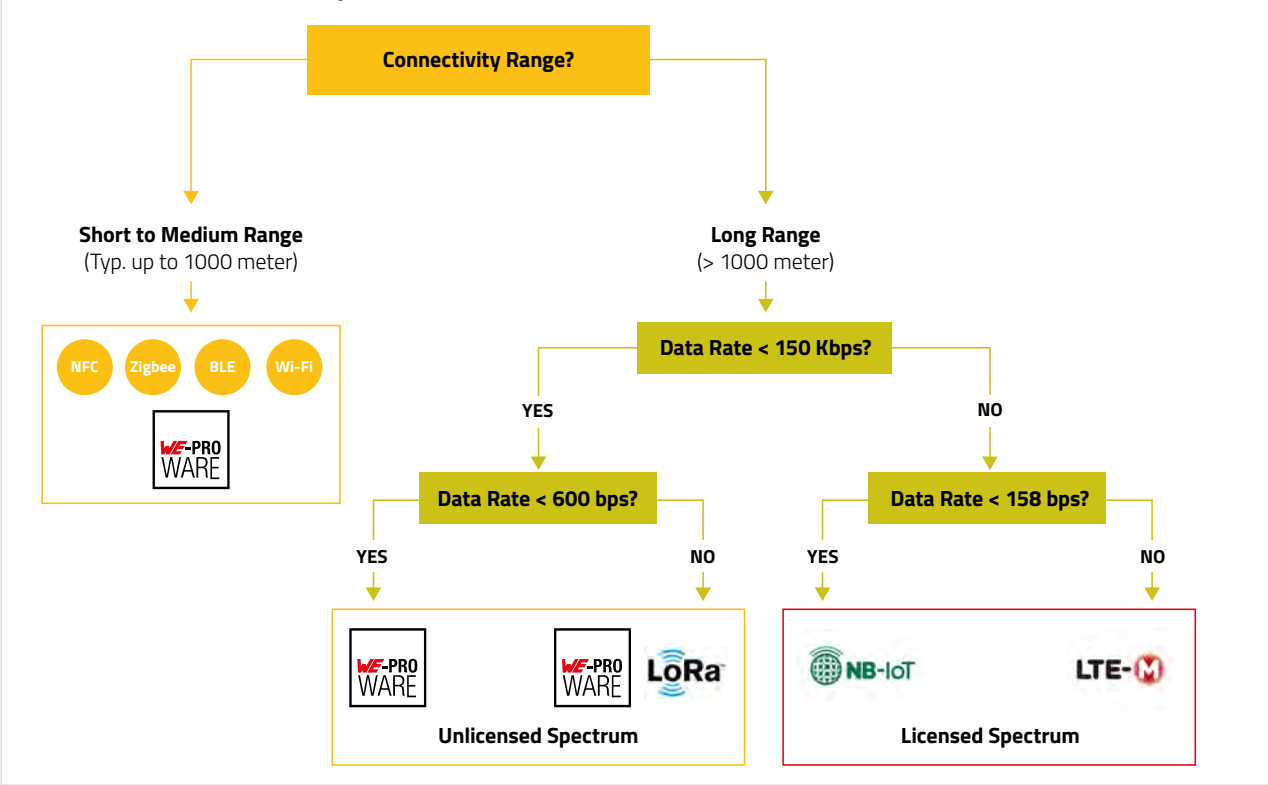**b) Long Range wireless connectivity solutions**

For few applications both short range and long range solutions can fit but application's requirements and environments determines which connectivity solution shall be used.
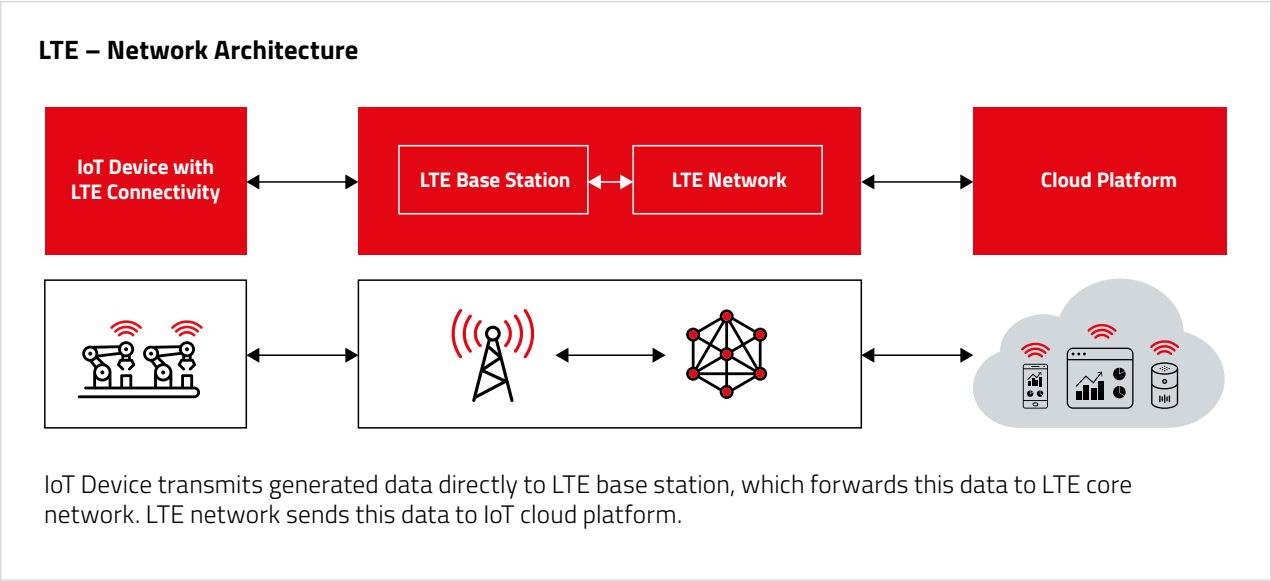
Overview of different protocols and standards

- High Data Rate / Low Data Rate (vertical axis)
- Short Range / LongRange (horizontal axis)
- 5G, Satellite, Wi-Fi, LTE, 3G, 2G, LTE-M, NB-IoT, LoRa, Bluetooth, zigBee, NFC, WE-PRO WARE

● Licensed spectrum   ● Unlicensed spectrum

Desired Connectivity Range

Short to Medium Range
(Typ. up to 1000 meter)

Thyone-I   Telesto-III   Setebos-I

Proteus-I/-II/-III/-e   Calypso   Tarvos-III   Thetis-I

Short Range Connectivity
Unlicensed Spectrum

Longe Range
(> 1000 meter)

NB-IoT   Adrastea-I   LTE-M

Long Range Connectivity
Licensed Spectrum

Choice between different protocols and standards

Connectivity Range?

Short to Medium Range
(Typ. up to 1000 meter)
NFC Zigbee BLE Wi-Fi
WE-PRO WARE

Long Range
(> 1000 meter)
Data Rate < 150 Kbps?
YES — **Data Rate < 600 bps?**   NO — **Data Rate < 158 bps?**

Data Rate < 600 bps?
YES — WE-PRO WARE   NO — WE-PRO WARE LoRa
Unlicensed Spectrum

Data Rate < 158 bps?
YES — NB-IoT   NO — LTE-M
Licensed Spectrum

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LTE – Network Architecture

IoT Device with LTE Connectivity → LTE Base Station ↔ LTE Network ↔ Cloud Platform

IoT Device transmits generated data directly to LTE base station, which forwards this data to LTE core network. LTE network sends this data to IoT cloud platform.

Example:

An industrial machine equipped with sensors, which collects the data on a wide range of parameters that determines its health and performance, for example, temperature, pressure, vibration frequency. This collected data is transmitted to LTE base station. LTE base station forwards this data to LTE core network. LTE network passes over this data to the cloud platform.
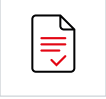
Advantages of Cellular Networks

Global Coverage and Roaming: Cellular networks are available globally, global coverage of cellular technologies makes companies to deploy their IoT devices globally. In-addition global presence of cellular networks enables roaming and mobility.

Secure and Reliable Transmission: Cellular technologies have default security procedures enabled, this procedure make sure only certified, subscribed and authenticated devices can access mobile network for data, SMS and voice services.

Standardized: 3rd Generation Partnership Project (3GPP) develops standards for cellular communication. These standards are internationally agreed standards. The device manufactures and network service providers follows cellular communication standards.

Network Quality of Service: Licensed spectrum is assigned exclusively to network service providers for independent usage. In this licensed spectrum service provider deploys his network. IoT devices has to subscribe for data or SMS services to network service provider, they are contractually bound to provide quality of Service for subscribers.

Certified Device Access: Certified devices access the cellular network this enables efficient utilization of licensed spectrum and minimizes the risk. Secured connectivity and strong authentication of IoT devices.

LTE-M and NB-IoT

Both LTE-M and NB-IoT are two new standards of Radio Access Technology designed for Low Power Wide Area Networks (LPWAN), which are very energy-efficient radio transmission technologies. LTE-M and NB-IoT features low power consumption, wide coverage, massive connectivity and lower cost. LTE-M and NB-IoT enable a wide range of IoT applications where low cost, low power consumption and good building penetration are important.

Generally, NB-IoT is suitable for applications that only need to transmit small data volumes. NB-IoT offers maximum uplink data rate 158 Kbps. This data rate is adequate for transmitting the sensor generated data such as Temperature, pressure, filling levels etc.

LTE-M fills the gaps where NB-IoT is no longer sufficient or where NB-IoT is not available. For example, LTE-M has a higher uplink data rate of up to 1 Mbit/s and can thus transmit a large amount of data in less time. LTE-M is suitable for asset tracking type of applications where higher data rate with mobility support is required.

Difference between LTE-M and NB-IoT

	NB-IoT	LTE-M
Bandwidth	180 KHz	1.08 MHz
Max Uplink Peak data rate	158 Kbps	1 Mbps
Max Donwlink Peak data rate	127 Kbps	588 Kbps
Power Consumption	Best for sending small data	Best for sending large messages
Voice Support (VoLTE)	No	Yes
Latency	High	Low
Mobility	No connected mobility – for stationary devices	Full mobility support – for asset tracking applications
Deployment Type	In-band LTE, LTE guard bands, Stand-alone	In-band LTE

	Firmware updates	Indoor coverage	Remote control devices	Suitability for moving devices	Possibility to grow with new use cases
LTE-M	●●●	●●●	●●●	●●●	●●●
NB-IoT	●	●●●	●●	●	●

	Low latency	Indoor coverage	Data rate	Battery lifetime	Suitability for moving devices
LTE	●●●	●	●●●	●	●●●
LTE-M	●●	●●	●●	●●	●●
NB-IoT	●	●●●	●	●●●	●

CELLULAR MODULE

Adrastea-I

LTE-M / NB-IoT Cellular Module

Characteristics

	Small form factor		Security & Encryption		Long range		Multi-band Support

- Flexible mode selection as LTE Cat M/NB-IoT
- LTE-Cat.M supported bands: B2/B3/B4/B5/B8/B12/B20/B25/B26/B28
- NB-IoT supported bands: B3/B5/B8/B20/B28
- 3GPP Release 13 compliant, Upgradable to Release 14
- Small form factor: 13.4 x 14.6 x 1.85 mm
- Integrates GNSS (Supports GPS, GLONASS)
- Integrated user MCU exclusively for customer application development (ARM Cortex-M4,1MB Flash, 256 KB RAM)

- Output Power class 3 (23 dBm)
- Supports 3GPP TS27.005, 27.007 and Würth Elektronik enhanced AT commands
- Protocols: IPv4/IPv6, TCP/UDP, HTTP/HTTPS, TLS/DTLS, MQTT, LWM2M
- Low Power consumption and longer battery life
- Adrastea Commander Tool (Evaluation tool for Cellular modules)

Key Features

Interfaces
- ✔ USM
- ✔ UART
- ✔ I²C
- ✔ SPI
- ✔ GPIO
- ✔ ADC
- ✔ JTAG

Protocols
- ✔ IPV4/IPV6
- ✔ TCP/UDP
- ✔ TLS/DTLS
- ✔ COAP
- ✔ HTTP/HTTPS
- ✔ MQTT
- ✔ LwM2M

Other Features

- Maxium Data Rate (LTE-Cat.M1):
  – Downloadlink: 300 Kbps
  – Uplink: 375 Kbps
- Maximum Data Rate (LTE-Cat.NB1):
  – Downlink: 127 Kbps
  – Uplink 158 Kbps
- Firmware upgrade over USB interface
- Firmware upgrade over air

Comparing Adrastea-I with GNSS Modules

Feature	Adrastea-I	Elara-I	Elara-II	Erinome-I	Erinome-II
Dimensions	13.4 x 14.6 mm	10 x 10 mm	4 x 4 mm	18 x 18 mm	7 x 7 mm
GNSS Constellations Supported	GPS, GLONASS	GPS, GLONASS	GPS, GLONASS	GPS, GLONASS, Galileo, BeiDou	GPS, GLONASS, Galileo, BeiDou
Maximum number of Concurrent GNSS	2	2	2	3	3
Antenna Type	External Antenna	Integrated Antenna	External Antenna	Integrated Antenna	External Antenna
Time To First Fix (Cold Start)	36 sec	28 sec	28 sec	28 sec	28 sec
Time To First Fix (Hot Start)	1 sec	1 sec	1 sec	1 sec	1 sec
Rx Sensitivity (Cold Start)	-145 dBm	-148 dBm	-148 dBm	-148 dBm	-147 dBm
Power Supply	3.6	1.8	1.8	1.8	1.8
Current Consumption (Acquisition)	54 mA	55 mA	52 mA	55 mA	55 mA
Accuracy (Tracking mode)	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m
Default Module Operation	LTE (GNSS activated with AT command)	GNSS	GNSS	GNSS	GNSS
External Connectivity Module Required	NO	YES	YES	YES	YES

Supported Cellular Technologies

Benefits of Dual Mode:

Enable international multi-regional coverage (In some country (region) LTE-M is not available then Module will select NB-IoT and vice versa)

Integrated MCU (Exclusively for Customer Application's Firmware)

Benefits of Integrated MCU:

- ✔ Cost (External micro controller is not required)
- ✔ Size
- ✔ Power Consumption

ARM® Cortex® M4	1 MB Flash	256 KB RAM

Positioning

Benefits of Integrated MCU:

Adrastea-I supports GPS and GLONASS satellite systems. This allows GNSS positioning for asset management applications where infrequent position updates are required.
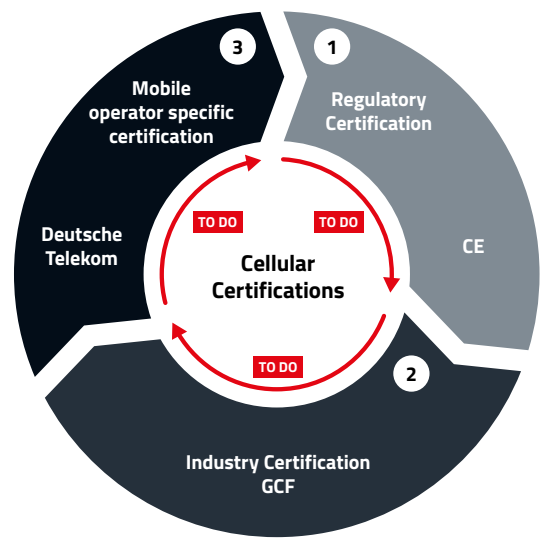
Embedded GNSS

GPS	GLONASS

Cellular

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CERTIFICATION

Normal Cellular Certification Procedure

+ ᛏ · · Certification

Regulatory Certification: Country specific to comply with country's regulations. Testing covers Safety aspects, RF emissions do not interfere with other wireless equipment's (e.g. RF transmitter and receiver tests, EMC, Electrical safety and environmental).

Industry Certification: The Global Certification Forum (GCF) is a certification organization in which manufacturers, operators and test laboratories deal with the compliance of devices in mobile networks with 3GPP standards and specifications.

Mobile operator specific certification: Testing specific to their network configuration and network parameter settings. This testing is focusing on field performance of the devices, such as radio sensitivity, data throughput.
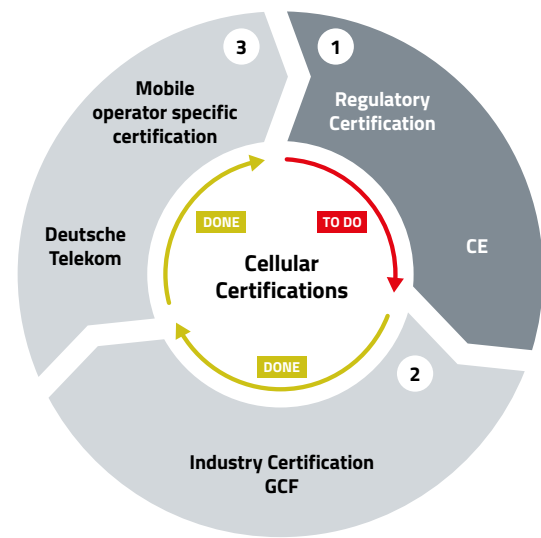
Normal Cellular Certification Procedure

2 Types of Certification are mandatory for End Product:

1. Regulatory Certification: CE
2. Network Operator Certification: Vodafone, Deutsche Telekom etc.

End Product with Cellular Module

WE - Deutsche Telekom Certification

Certification is mandatory for End Product:

1. Regulatory Certification: CE

End Product with WE-DTAG Certified Module

Benefits of WE - Deutsche Telekom Certified Module

Be smart and ensure that your product does not require certification again.

Optain assurance – Pre-certified module reduces final test effort.

Save time and money – the end product does not require to go through complex cellular certification process again

DTAG Coverage: Europe

Country	Operator	LTE-M	NB-IoT
Germany	Deutsche Telekom	✔	✔
	Vodafone	✔	✔
	Telefonica	✔	✔
Netherlands	T-Mobile	✔	✔
	KPN	✔	
	Vodafone Libertel	✔	✔
Belgium	Orange	✔	✔
	Telenet		✔
Austria	Magenta Telekom	✔	✔
Slovenia	A1 Slovenija		✔
Luxembourg	Post Luxembourg	✔	
Switzerland	Swisscom	✔	✔
Czech Republic	T-Mobile Czech		✔
Slovakia	Slovak Telekom		✔
Poland	T-Mobile Poland		✔
Italy	Vodafone		✔
	TIM		✔

Country	Operator	LTE-M	NB-IoT
Denmark	Telia	✔	✔
	Telenor	✔	
Finland	DNA	✔	
	Telia	✔	✔
Norway	Telenor	✔	
	Telia	✔	✔
Sweden	Telia	✔	✔
	Tele2	✔	
	Telenor	✔	
Spain	Orange	✔	
	Vodafone		✔
Croatia	Hrvatski Telekom		✔
Hungary	Magyar Telekom		✔
Greece	Cosmote		✔
Liechtenstein	Swisscom	✔	
Denmark	Telia	✔	✔
Latvia	LMT	✔	
Malta	Melita LTD		✔

DTAG Coverage: Non - Europe

Country	Operator	LTE-M	NB-IoT
USA	T-Mobile US	✔	✔
	AT&T	✔	
Canada	Bell Mobility	✔	
South Korea	KT Corporation	✔	
Japan	NTT DoCoMo	✔	
New Zealand	Spark	✔	
Taiwan	Chunghwa Telecom	✔	✔
Russia	MTS Mobile TeleSystems		✔
UK	Vodafone		✔
	JT (Jersey) Limited	✔	

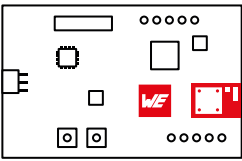## WE Cellular Solution

Adrastea-I: LTE-Cat.M and NB-IoT Module

Connectivity: IoT SIM Cards

IoT Platform: Any public cloud

aws Google Cloud
Azure ThingsBoard

iotcreators.com/wuerth/

ADDED VALUES

Eval Boards

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

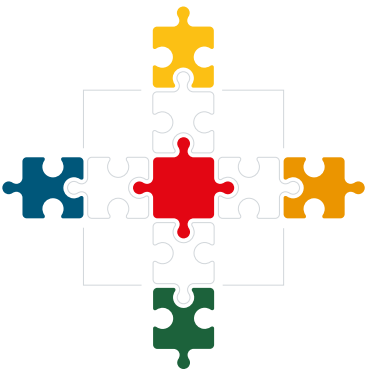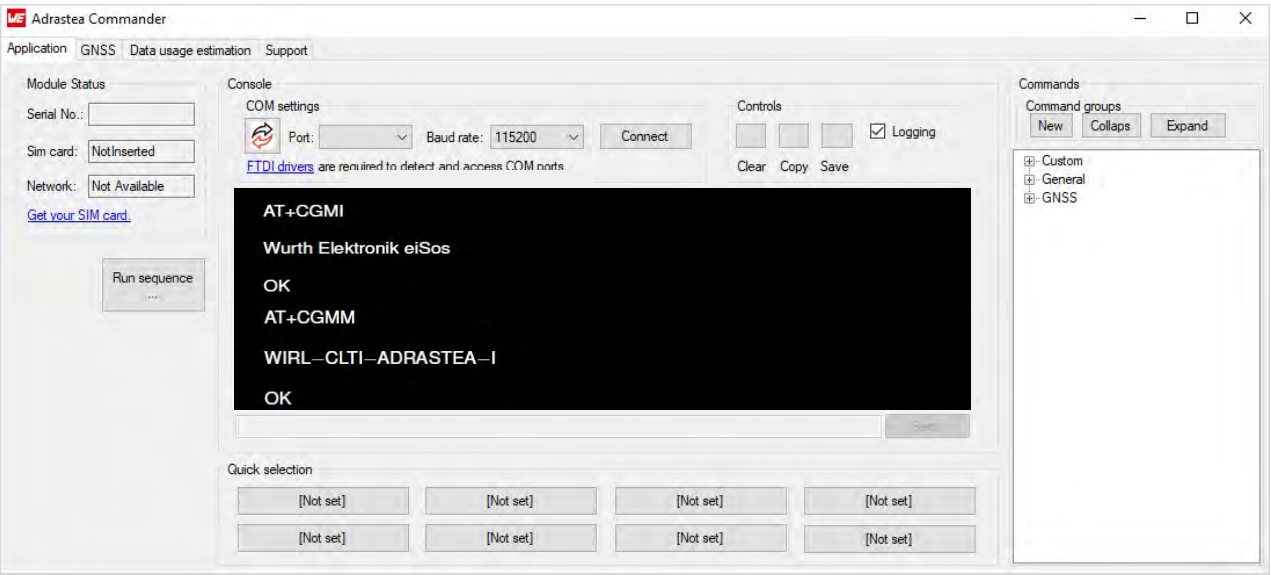🌐 we-online.com/EVAL-Cellular

ⓘ More information on page 150

Adrastea Commander

- Complete control of module over UART
- Evaluate GNSS functionality of module
- URL to access the WE-DTAG connectivity portal
- Approximate data consumption calculator
- Save and execute AT commands
- Run sequence of AT commands

🌐 we-online.com/Adrastea-Commander

Software Development Kit

Adrastea-I cellular module has integrated ARM Cortex M4 MCU exclusive for end product applications. The MCU SDK from Sony allows software developers to write their own applications directly onto the Adrastea-I internal application MCU. SDK have several examples on how to develop your own application. These examples can be used as a reference code or as a starting point for a customer to develop his own application. Each example is a simple application that demonstrates the usage of a specific interface.

- Detailed documentation from Sony for easy Development Environment
- Reference examples
- Typically C-Language Files

🌐 we-online.com/WCO-SDK