STACKFORCE

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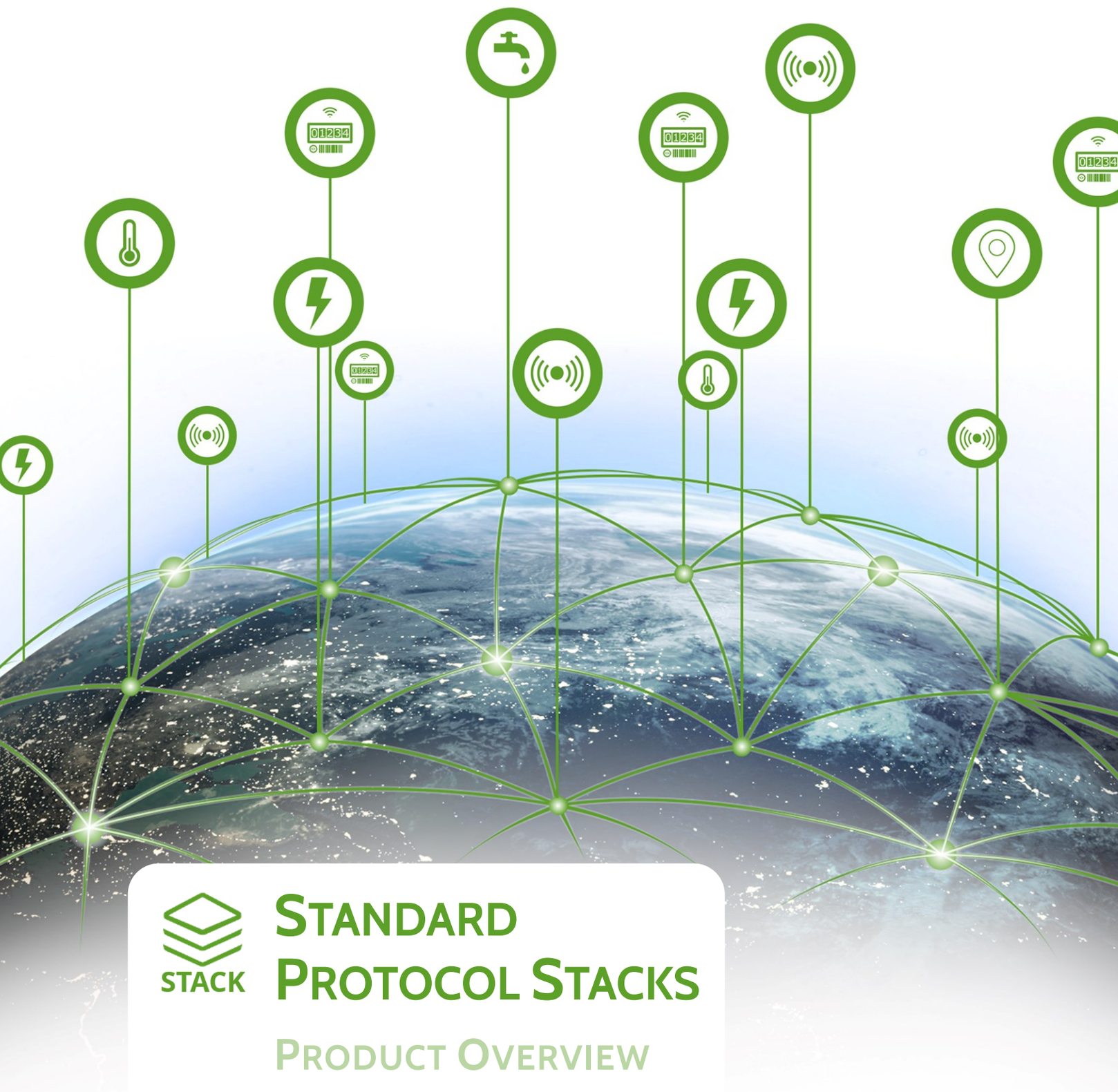

STACK

Standard Protocol Stacks

Product Overview

2023-10-31 | v3.0

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1 PROTOCOL STACKS INTRODUCTION

STACKFORCE's core business focuses on the development and implementation of Protocol Stacks for various IoT use cases. Our stacks support modern wireless communication technologies like the well-proven **M-Bus protocol** and the Low Power Wide Area Network (LPWAN) technologies **mioty®**, **LoRaWAN®** and **Sigfox**.

Our goal is to support the optimal connectivity of IoT networks.

Our stack solutions can be integrated directly into products or as components to already existing or new to establish wireless networks.

1.1 MAJOR USE OF PROTOCOL STACKS

Protocol Stacks allow devices like meters or sensors to communicate wirelessly and transmit data in combination with wireless networks such as LPWAN. So, it is possible to send data over several kilometers.

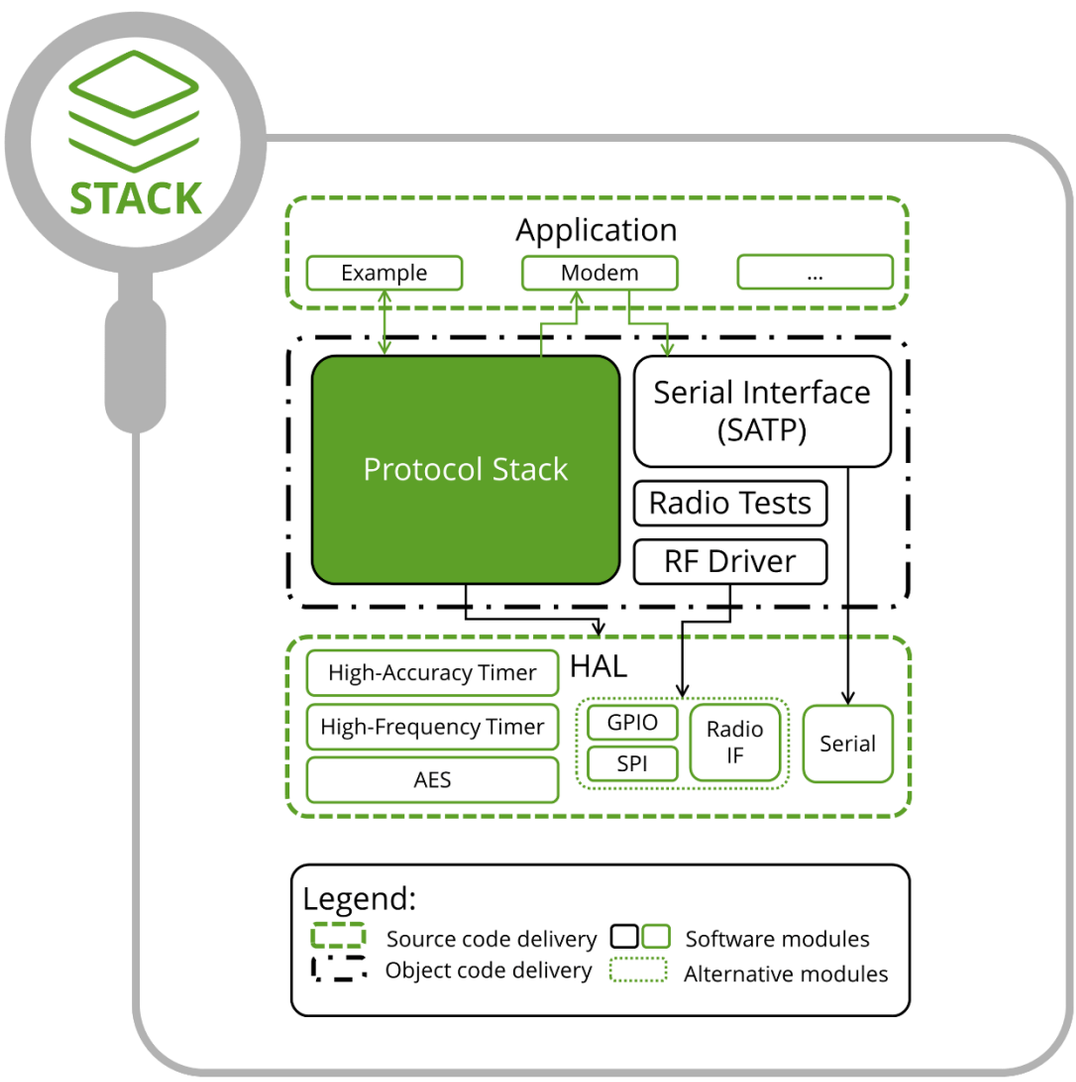
Software-based communication can be used in any area. The application scenario determines the appropriate software. With our standard products we enable a simple and convenient introduction to equip an IoT network with connectivity. The following application scenarios are conceivable in addition to many others:

- ✓ Meter remote readout (water, gas, electricity, heat, ...)
- ✓ Leakage detection and alarming
- ✓ Condition monitoring
- ✓ Predictive maintenance
- ✓ Machine monitoring
- ✓ Infrastructure surveillance

1.2 FUNCTION OF A PROTOCOL STACK

A Protocol Stack enables devices such as sensors or meters to transmit data via radio. The software is called Protocol Stack because it is divided into layers for better delimitation and maintainability. Each layer has a special function, depending on the respective technology-specific protocol: e. g. the correct channel access according to regulations, the addressing of recipients, the formatting of user data etc.

The Protocol Stack is located invisible to the eye on a microcontroller inside the respective device. Via a wireless chip or a wireless interface integrated in the microcontroller, it enables the wireless transmission (e. g. using LPWAN technologies) of the read-out device data to an IoT network. As a result, the data of a wide range of devices is available to the end user even over longer distances at usage-adapted intervals up to real-time.

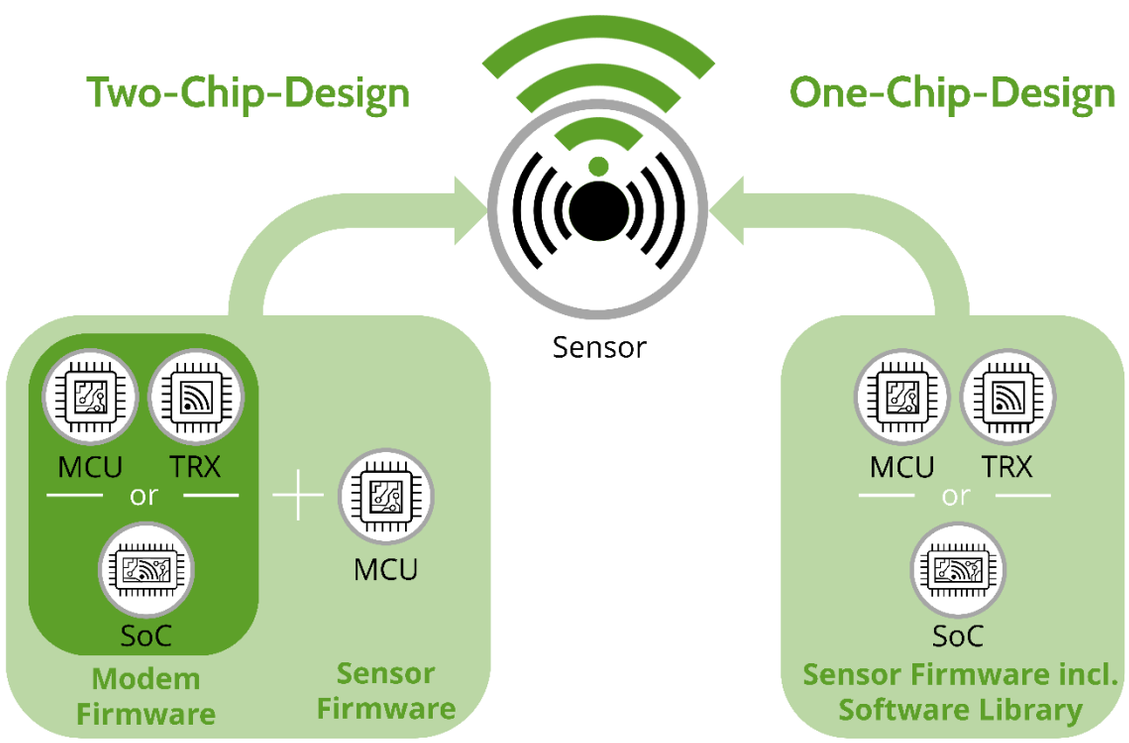


2 INTEGRATION OF A PROTOCOL STACK

2.1 ONE-CHIP VS. TWO-CHIP-DESIGN

In order to equip a device with a radio technology, it is important to pay attention to the details depending on the application. For example, if the device application is used on the same microcontroller as the communication software, the resources of the microcontroller and its periphery must also be shared among each other. This may be a disadvantage for very time-critical sensor applications. In general, there are three ways to run the application:

- with a communication module,
- with the One-Chip-Design or
- with the Two-Chip-Design.



MCU: Microcontroller
TRX: Transceiver
Soc: System-on-a-Chip

Communication module

The communication module takes over the communication with the network of the chosen technology. So, it is possible to equip an existing sensor circuit with a radio interface without major modifications if there is sufficient space available in the enclosure. The communication module is then connected to the sensor circuit via various interfaces, such as UART or SPI. If the communication module is selected, there are three options:

- ✓ use of a pre-programmed radio module,
- ✓ using the Protocol Stack as firmware in the modem version and
- ✓ using the Protocol Stack as a software library and developing custom firmware for the radio module.

The main advantage of this approach is the low development effort and the low risk of surprises when the device is certified.

Two-Chip-Design

An alternative to the communication module is the integration of a dedicated microcontroller together with a radio transceiver IC or a System-on-a-Chip, which is used specifically for communication.

In terms of architecture, the two-chip approach is the same as the communication module, but this variant is more space- and cost-saving. On the software side, the two-chip approach is equally simple compared to using one communication module. However, the effort regarding the circuit is somewhat higher since a corresponding circuit board must be developed and thus the effort for product certification also increases.

One-Chip-Design

The most integrated approach is a technology compliant circuit on which the sensor application runs. This requires only one module for the application and the communication software. A software library will be integrated into the own sensor firmware. With this library, the developer uses a complete implementation of the transmission protocol and controls the wireless transceiver IC or the wireless transceiver on the radio part of a System-on-a-Chip (SoC).

The advantage of this approach are obviously the savings in hardware costs as well as in the minimal space requirement of the various options. However, the one-off costs for the development of this approach are significantly higher as a separate and often product-specific hardware design has to be developed.

2.2 MICROCONTROLLER AND SYSTEM-ON-CHIP

Standard Protocol Stacks are available for multiple hardware platforms, consisting of either:

- a microcontroller (MCU) in conjunction with a single-chip radio resp. transceiver (TRX), or
- a System-on-a-Chip silicon.

For our reference hardware, the Protocol Stacks have been tested and optimized. In general, almost any hardware can be used. If the hardware is not the reference hardware, an additional effort is necessary to ensure the compatibility of the protocol stacks with the selected hardware. In this case, porting to the customer-specific hardware has to be performed.

Depending on the radio technology, bidirectional as well as unidirectional communication is possible, but not all radio modules currently available on the market support both communication variants. Please note that not every microcontroller or radio transceiver is compatible with every Protocol Stack we offer. The following list provides information about which hardware can basically be used.

Microcontroller

STMicroelectronics
STM2L0 family, STM32L4 family, STM32WL (M0 and M4 core), STM32U5

Texas Instruments
CC1310, CC1311, CC1350, CC1312, CC1352

Silicon Laboratories
EFM32 Gecko family, EFR32FG14, EFR32FG23

Radio Transceiver

STMicroelectronics
S2 LP

Semtech
SX1272, SX1276, SX1261, SX1262, SX1268

Silicon Laboratories
Si4461, Si4462, Si4463

3 PROTOCOL STACK PACKAGE

The Protocol Stack Package is delivered with a pre-compiled stack library, hardware-specific drivers, a serial command interface, a power management and two apps:

- Example ***"exampleMain.c"***
- Modem ***"exampleMainSerial.c"***

While Example includes a suggestion of creating your own firmware, which shows how to integrate the stack library into your own application software, the app Modem allows you to create your own modem firmware using the supplied serial interface (e. g. UART, SPI, I2C, ...) and power management.

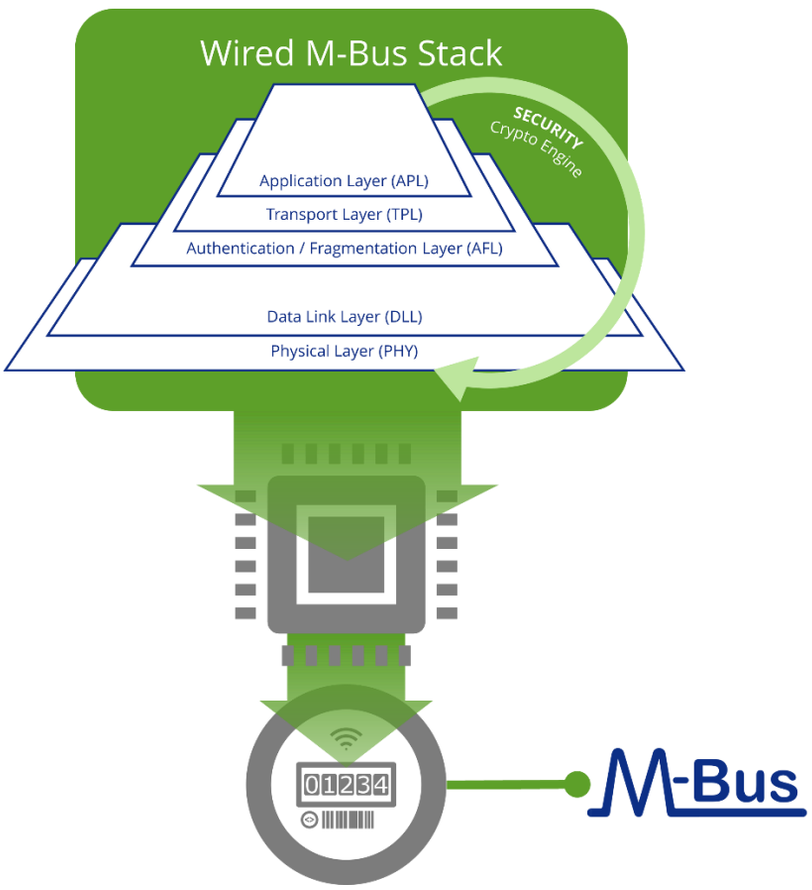
Therefore, it is possible to implement both chip architectures with the supplied Protocol Stack Package:

- ✓ To use the Protocol Stack within a One-Chip-Design (the Protocol Stack runs on the same microcontroller as the application), the app Example is required, and thus only the stack library.
- ✓ If you follow a Two-Chip-Design (the Protocol Stack is to run on a communication controller and the application is to run on a host controller), the app Modem can be accessed. This makes it possible to create your own firmware for the communication controller using the supplied serial interface and the power management. The Protocol Stack is then accessed via the host controller.

4 PROTOCOL STACKS PRODUCT RANGE

4.1 WIRED M-BUS STACK

STACKFORCE's Wired M-Bus Protocol Stack is the latest Protocol Stack in the product range and complements the Wireless M-Bus offering with a high-performance wired solution. The stack enables remote reading of meters in a wired M-Bus network and results in competitive products that are easy to install and maintain. The stack implements all protocol elements required for M-Bus compliance. Professional support guarantees smooth operation during commissioning and beyond.



Compliant to EN 13757 and OMS Specification

Available for meter and collector

Interference-free data transmission via cable

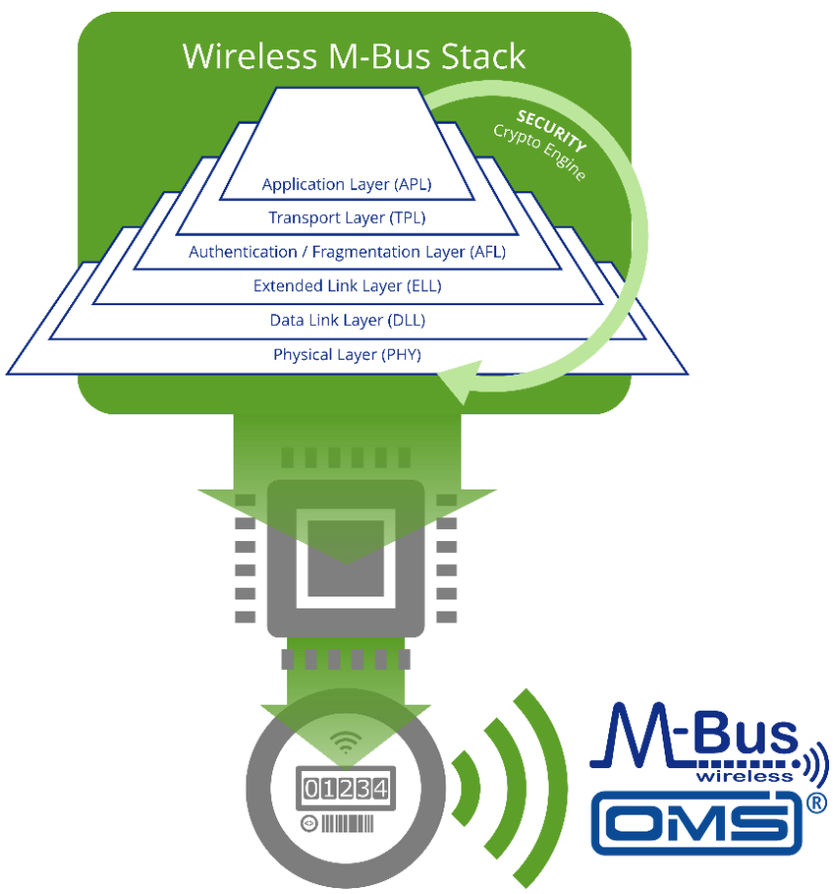
Interoperability ensured via intensive cross-testing

4.2 WIRELESS M-BUS STACK

The Wireless M-Bus Stack is not just available as standard version, **compliant to EN 13757 or OMS specification as meter or collector**, but also as derivatives in combination:

- with **mioty®** (M-Bus-over-mioty® Stack),
- or **LoRaWAN®** (M-Bus-over-LoRaWAN® Stack).

Therefore, you do not only benefit from the well-proven and popular wireless M-Bus protocol, but also from the advantages of the modern LPWAN (Low-Power Wide Area Network) technologies. They enable larger transmission ranges, which is especially of interest for applications like Smart Metering and Smart City.



Compliant to EN 13757 and OMS Specification

Available for meter and collector

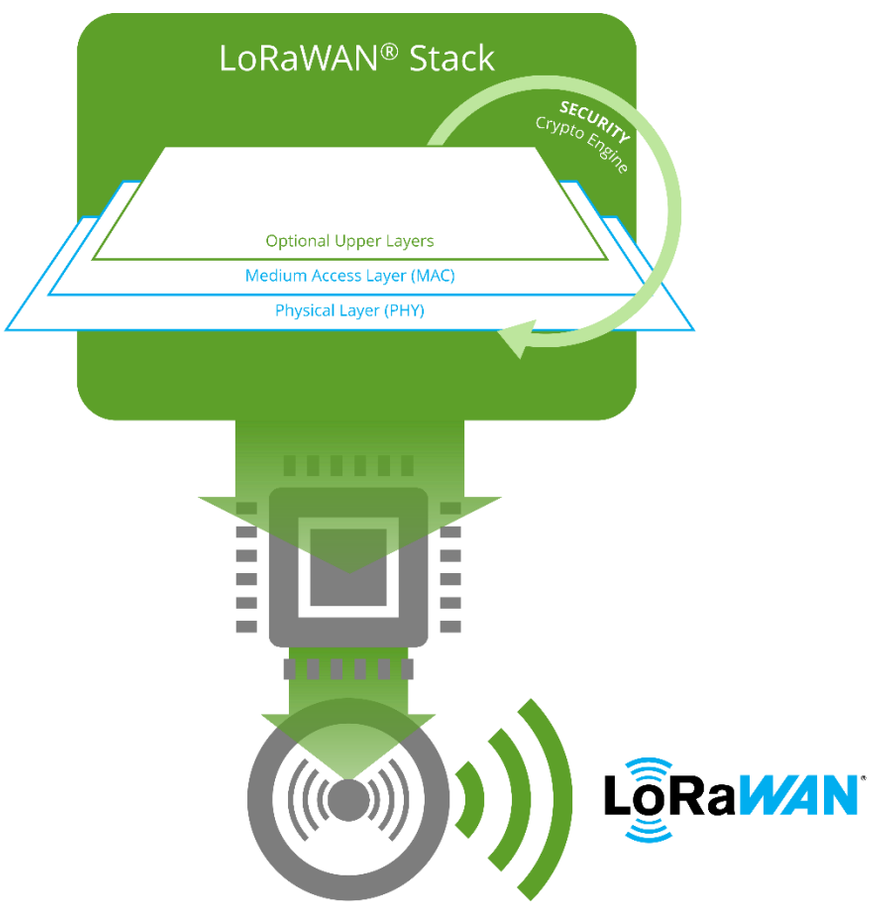
More network coverage in combination with LoRaWAN® or mioty®

Pre-certification of the stack for reference hardware platforms

4.3 LORAWAN® STACK

The LoRaWAN® Protocol Stack is a more advanced development of the Open Source Long Range Wide Area Network (LoRaWAN®) Stack, coming along with all commercial features like support and maintenance.

The LoRaWAN® Protocol Stack is designed for productive industrial use with high demands on safety and maximum performance – it is a guarantee of success for complex environments.



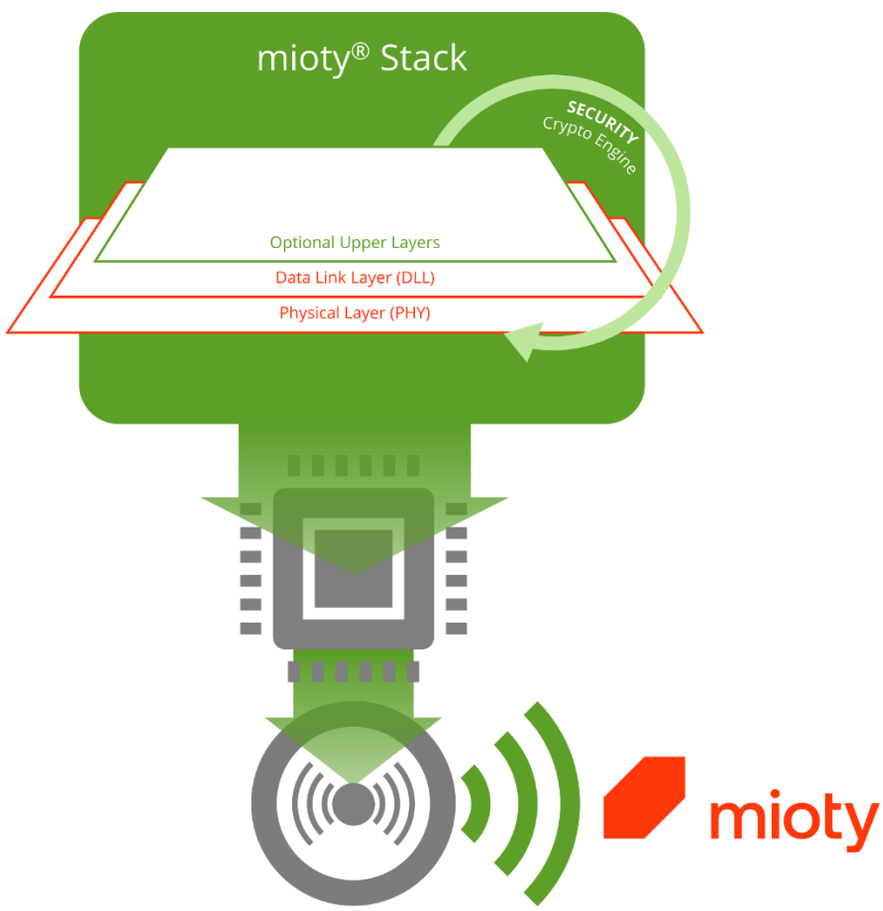
- Compliant to LoRaWAN® Specification v1.0.4 and associated Regional Parameters
- Comprehensive support and maintenance from our professional team
- Designed for high-performance industrial use in complex environments
- Pre-certification of the stack for reference hardware platforms

4.4 MIOTY® STACK

The mioty® Protocol Stack is an extremely efficient and robust solution for both, common Low Power Wide Area Networks (LPWAN) and specialized industrial networks. It implements the Internet of Things (IoT) system mioty®, developed by Fraunhofer IIS.

With the innovative technology of telegram splitting, it sets new standards to the field of wireless data transmission and is highly flexible in application areas.

The mioty® Protocol Stack is an implementation of ETSI Standard TS 103357, designed for operation of end points according to this standard.



Compliant to ETSI Standard TS 103 357

High scalability with up to 1.5 million messages per day using a single mioty® base station

Very robust through innovative telegram splitting technology

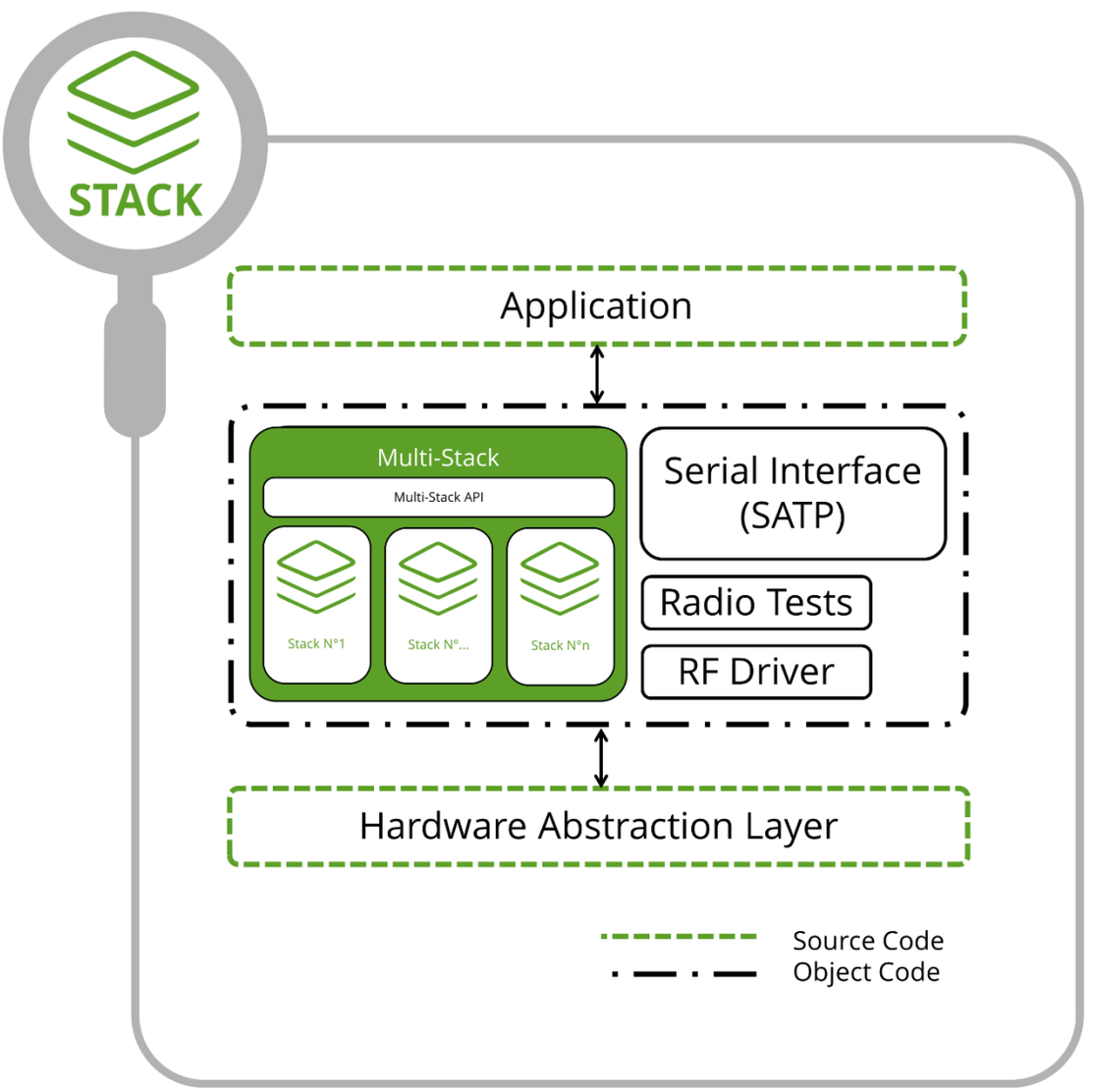
Pre-certification of the stack for reference hardware platforms

4.5 MULTI-STACKS – ONE INTEGRATION FOR MORE FLEXIBILITY

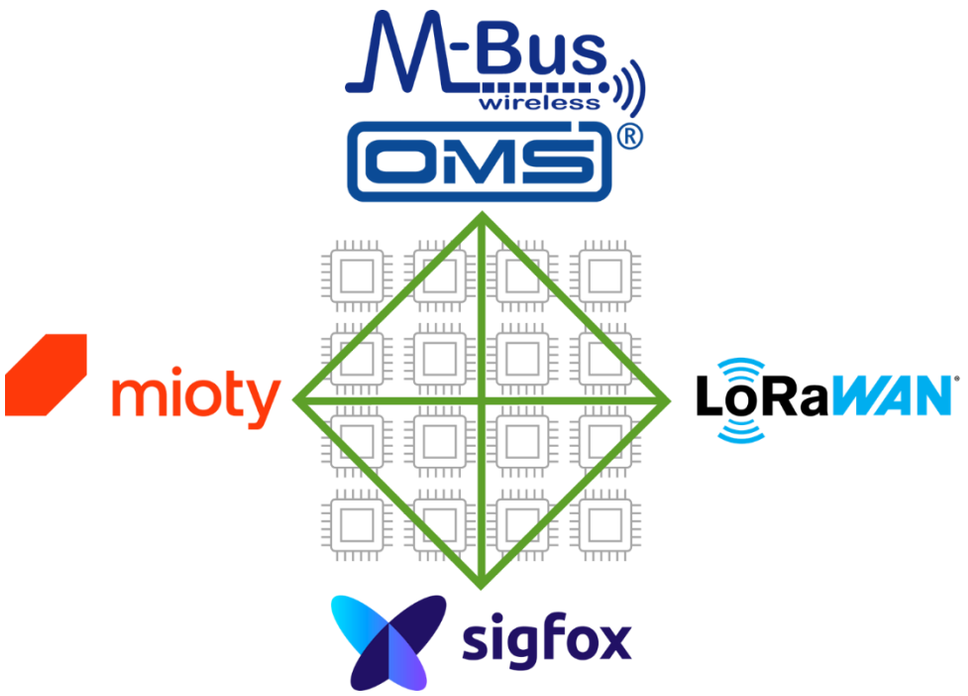
Flexibility and quick reaction are key elements for modern and efficient IoT networks. With our Multi Stacks, we provide an innovative solution for combining several communication technologies for wireless data transmission in just one stack. Switch between Wireless M-Bus and / or LPWAN technologies like mioty®, LoRaWAN® and Sigfox during runtime.

Perfectly adjusted to your requirements and done quite easily via our well-established Multi Stack API.

Therefore, you can not only benefit from the different advantages and features of the relevant technology, but also save development costs when only one stack integration is needed.



4.5.1 ADVANTAGES OF THE MULTI STACKS



More network coverage

Not every radio network is available at every operation site. With the Multi Stack you can easily choose between several wireless networks. Therefore, the network coverage can be enhanced.

More features

The advantages of different technologies are summed up, for example remote meter readout via the popular wM-Bus protocol and further data transmission over large distances via LPWAN technology.

More efficiency

If data should be transmitted via several radio technologies in the same network, you can do this by using different controllers – or you can save resources by using just one Multi Stack.

5 AVAILABILITY OF STANDARD STACKS

Type	Wired M-Bus slave EN 13757	Wired M-Bus master EN 13757	Wireless M-Bus meter EN 13757 & OMS v4	Wireless M-Bus collector EN 13757 & OMS v4	mioty® for end points	LoRaWAN®
Single	✓					
Single		✓				
Single			✓ [unidir]			
Single			✓ [bidir]			
Single				✓ [unidir]		
Single				✓ [bidir]		
Single					✓ [unidir]	
Single					✓ [bidir]	
Dual			✓ [unidir]			✓ [bidir]
Dual			✓ [bidir]			✓ [bidir]

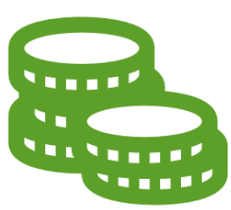
6 BENEFITS OF STANDARD STACKS

Software development is a broad field. Even when a product is fully developed, it requires constant further development and intensive maintenance to ensure that everything runs smoothly. As a specialist in developing Protocol Stacks, we support you exactly at this point with our standard products. For us, standard is "off-the-shelf". By this we mean that our standard stack solutions can be integrated directly into products and used as components for existing or new networks. They offer a quick and easy way to equip your devices with wireless connectivity. Off-the-shelf, the software is directly available, versatile, and due to continuous further developments, not very error prone.

The different Standard Protocol Stacks are available directly or as variants at very short notice and are ready for immediate use.

Due to a variety of applications and customers, our Standard Protocol Stacks are extensively tested and easy to integrate.

We offer professional support and additional services to the product, which saves your resources and improves predictability.



With different license packages, software purchase is financially easy to plan and affordable even for smaller companies.

7 FURTHER INFORMATION

Your IoT project is very special, because you need another combination of technologies, or your desired stack is not yet available for the platform you want? Just tell us your needs and we can also develop your personal Custom Protocol Stack fitting to your requirements and ideas. On request we offer for example:

- ✓ additional hardware drivers and porting to further hardware platforms
- ✓ adaptations and optimizations to hardware, e. g. application specific low-power operation
- ✓ customization and extensions of interfaces
- ✓ customization and extensions of protocol(s) itself
- ✓ support for additional protocols / specifications
- ✓ ...

For further information about our Standard and Custom Protocol Stacks, please contact STACKFORCE GmbH at info@stackforce.de.

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