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CPS4EU

Cyber Physical Systems for Europe

D2.2 – Specification and architecture of the communication modules – v2

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Dissemination level: Public

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V1.0	30.12.19	J. Schmitt (VSORA) A. De Domenico (CEA LETI) N. di Pietro (CEA LETI) J.B. Doré (CEA LETI) V. Savin (CEA LETI) D. Demmer (CEA LETI) M. Maman (CEA LETI) S. Ben Hadj Said (CEA LIST) M. Boc (CEA LIST) D. Ansaldo (Leonardo) P. Azzoni (Eurotech) F. Greff (Thales) G. Vivier (Sequans)	First release
V2.0	30-11-20	J. Schmitt (VSORA) N. di Pietro (CEA LETI) J.B. Doré (CEA LETI) V. Savin (CEA LETI) D. Demmer (CEA LETI) M. Maman (CEA LETI) S. Ben Hadj Said (CEA LIST) M. Boc (CEA LIST) D. Ansaldo (Leonardo) P. Azzoni (Eurotech) F. Greff (Thales) G. Vivier (Sequans)	Updated release, capturing updated requirements from use case WPs.

EXECUTIVE SUMMARY

In recent years, Cyber Physical Systems (CPS) technologies have become a game changer in strategic sectors such as Automotive, Energy and Industry Automation, where Europe is a world leader. CPS4EU is an European project, aiming at developing enabling technologies for CPS, encompassing various vertical uses cases.

The Work-package 2 of CPS4EU deals with the communication aspects of the CPS: how a physical system can be connected efficiently and securely to a network, in the context of emerging technologies, as Internet of Things (IoT) and 5G.

This report is the second report of WP2, task 2.1, dealing with the specification and architecture of the communication modules. Part of these communications modules will be developed in WP2 and later integrated into WP6 into the pre-integrated communication platform. Ultimately, these communication modules may be used by verticals to fulfil their use cases. However, CPS communications may request tough characteristics that cannot be served with nowadays communications systems. As a result, the WP2 has also the mandate to studies innovative solutions to meet these tough requirements, in line with 5G development in 3GPP.

The first report D2.1 captured the requirements from “use cases” work package, at least the one available at the time of the first document. This report provides an update of the requirements, taking into account the complete description of the “use cases” available now. Then it summarizes what could be done with nowadays technologies (4G or early 5G solutions). While the initial report also introduced the initial ideas coming from the tasks 2.2 and 2.3, this report focuses on requirement and on the communication modules (task 2.1), because dedicated reports (namely D2.3 and D2.5) captured the work undergone in tasks 2.2 and 2.3.

The analysis of the complete use case descriptions coming from WP7, WP8 and WP9 confirmed the initial conclusion made in D2.1, at least from the communication standpoint: a single radio modem cannot meet all the requirements. For instance, depending on use cases, very low data rate could be good enough, while for others, high data rate is a must. This fact reinforces the interest into the notion of pre-integrated architecture board. Indeed, such board could be a way to ease the integration of one or multiple radio modem, with similar HW and SW interface.

The report performed a quick survey of existing technologies. It appears that 4G is a good starting point since it proposes a framework meeting most of the requirements, thanks to the various LTE categories. However, for most stringent requirements, such as low latency, time deterministic communication, 4G is somehow limited and WP2 has to work on building blocks, enabled by 5G to fulfil the complete set of requirements expressed by verticals. This report proposes three axis of research for WP2, investigating Time Sensitive Networking, URLLC, and a DSP framework and development flow that could combine communication and AI processing.

This report is the last report from WP2 about requirements and architecture of the communication module. Dedicated reports are now capturing the outcomes of tasks 2.2 and 2.3 about the building blocks toward 5G and more exploratory investigations to propose solutions to fill the gap with respect to some extreme requirements expressed by the vertical use cases.

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1 INTRODUCTION

1.1 PURPOSE

This report is the second report of WP2, task 2.1, dealing with the specification and architecture of the communication modules. It provides an update of the initial report, D2.1, published in Q4 2019, based on partial expression of communication requirements from the vertical work-package. Hence, refinements of the requirements are captured in this report, whereas the original sections in D2.1 about long-term studies and prototyping are now moved to dedicated reports: D2.3 and D2.5.

Part of these communications modules will be developed in WP2 and later integrated into WP6 (or WP8) into the pre-integrated communication platform.

The report presents in the section 2 the requirements from vertical as captured from the "use-cases" work-package of CPS4EU project. Then section 3 describes nowadays technology (4G or early 5G systems) and propose internal architecture of typical communication module that could fit the requirements.

1.2 DEFINITIONS, ACRONYMS, AND ABBREVIATIONS

Acronym / abbreviation	Description
3GPP	3rd Generation Partnership Project
AI	Artificial Intelligence
API	Application Programming Interface
CPS	Cyber Physical System
DL	Downlink
DSP	Digital Signal Processor
IoT	Internet of Things
LTE	Long Term Evolution
LTE-M	Long Term Evolution – Machine Type Communication
PIARCH	Pre-Integrated Architectures
QoS	Quality of Service
SPI	Serial Peripheral Interface
UART	Universal Asynchronous Receiver-Transmitter
UE	User Equipment
URLLC	Ultra Reliable and Low Latency Communications
UL	Uplink
USB	Universal Serial Bus
V2I	Vehicle to Infrastructure
V2X	Vehicle to everything
TSN	Time Sensitive Networking

2 REQUIREMENTS FROM VERTICAL

This section captures the high-level requirements with respect to communication aspects coming from other WPs, mostly WP6, WP7, WP8 and WP9.

2.1 REQUIREMENTS FROM WP6 AND WP7

This section is based from a review of the following deliverables:

- D6.1 Pre-integrated Architectures Specification, April 2020
- D7.1 Specifications of automotive demonstrators v1, August 2020

2.1.1 High-level needs from the automotive use case (WP7)

WP7, the automotive use case, aims to demonstrate several features and technologies for next generation cars, mainly:

- Autonomous driving level 4 and the related technologies for perception, localization and human-machine interfacing,
- Added value of secure V2X communications,
- Digital twin simulation for validation.

This section will focus on the "secure V2X communications" part of this automotive use case. The objective is to demonstrate the added value provided by secure V2I (Vehicle to Infrastructure) communications, for functional chains such as Health and Usage Monitoring Systems, Over-the-Air updates and interaction with IoT objects. These demonstrations require a connectivity subsystem (Figure 1) providing the following features:

- Various LTE communication capabilities (LTE-M, NB-IoT, Cat. 4), for the communication between the vehicle and either the cloud or nearby IoT objects. 5G could also be considered during the second step of the project,
- Wi-Fi and Bluetooth connectivity, for multimedia applications,
- Access to the embedded network of the vehicle, in this case an Ethernet backbone,
- A secure gateway for the communications between the trusted embedded network and the non-trusted infrastructure.

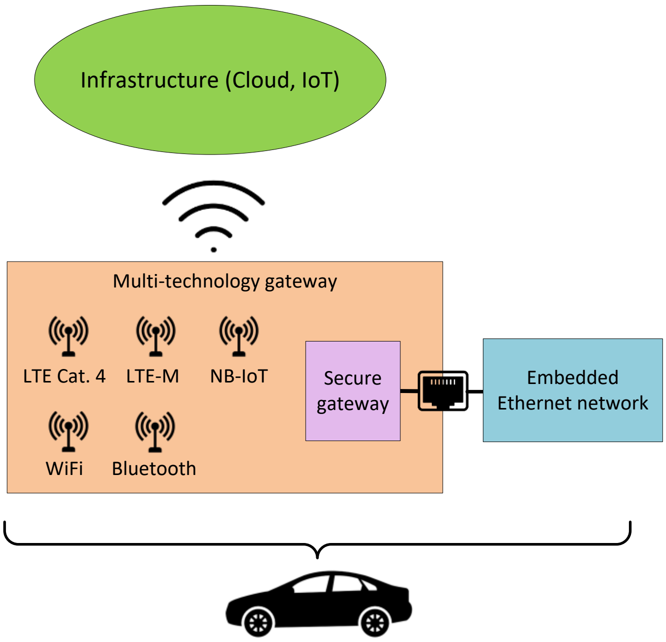

Figure 1. Connectivity subsystem of the automotive use case

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This connectivity subsystem will be integrated using the "Connectivity Pre-Integrated Architecture" developed in WP6.

However, when looking into the details of D7.1, the only reference to the connectivity device is to perform software upgrade other the air and connection to a cloud. The report mentions the use of a Sierra Wireless module: Airlink GX450, which is a kind of rugged mobile router device.

For the purpose of precise localization, the D7.1 report proposes as well to use a LTE modems to receive RTK correction to correct GPS measurements. The propose modem is from Sierra Wireless too: Airlink MP70, which is a more recent 4G modem, largely overdimensioned for the announced purpose.

It would make sense to replace the two LTE modems, the one used for other the air SW upgrade and the one used for precise localization, by a single one, to limit antenna placement issues on the roof, as well as routing (cabling) inside the car. Such integration is offered by the secure connectivity pre-integrated architecture proposed by WP6 and introduced below.

2.1.2 Secure Connectivity Pre-Integrated Architecture (WP6)

The purpose of Pre-Integrated Architectures (hereinafter PIARCH) proposed in CPS4EU is to facilitate the integration of CPS building blocks into final systems.

The first objective is to help technology providers having a better understanding of industrial integration contexts. To this end, PIARCHs will propose an abstraction of these contexts, such as required interfaces, security features, mechanical constraints, etc.

The second objective is to enable a reusability of the integration work, by separating the integration work specific to a building block, to the integration work specific to the final system or application. This intermediary integration work, which we call pre-integration, will be associated with tools for the integration, configuration, and validation of the PIARCH.

The Connectivity PIARCH led by Thales Research & Technology focuses on the integration of connectivity and security modules. It will address the needs of WP7 but is meant to be usable for other projects as well. It will be composed of:

- A central board with Wi-Fi and Bluetooth connectivity and a general-purpose OS
- A high-performance LTE module (Cat. 4) from WP2,
- A low-power LTE module (Cat. M1, Cat. NB1) from WP2, that would ideally make use of low-power processors such as ARM Cortex-M4,
- During the second step of the project, a 5G/URLLC module could be added,
- A secure OS (Trusted Execution Environment) for cyber-critical services, such as a gateway between an embedded Ethernet network and a non-trusted wireless environment,
- Tools for utilizing the PIARCH, e.g. a tool for configuring network parameters from a high-level model.

The integration work performed for each module can be used separately, or the PIARCH can be used as a pre-integrated subsystem.

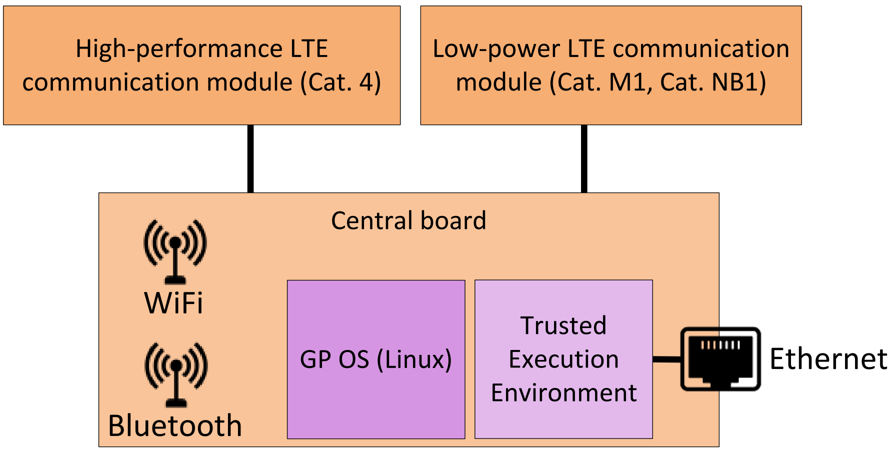

Figure 2. A representation of the connectivity PIARCH

2.1.3 Requirements for WP2

As was described above, there is a need in WP6 for two different communication modules, one for high-performance applications, and the other for low-power applications. Each has different interface requirements. In Figure 2, we represented them as two physically separated modules, but they could be aggregated into one communication module (one board), as long as they can be accessed separately. If no dedicated board is provided by WP2, we at least need an evaluation board for the pre-integration.

In the following subsections, we give the current requirements for the connectivity PIARCH of WP6.

2.1.4 High-performance module

	Required	Preferable	Nice to have in addition
Supported technologies	Cat. 4		
Interfaces	At least UART interface	Ethernet interface	USB and UART interfaces in addition to Ethernet
Drivers	Linux drivers		

2.1.5 Low-power module

	Required	Preferable	Nice to have in addition
Supported technologies	Cat. M1, Cat. NB1		
Interfaces	At least UART interface	SPI interface	UART and USB interfaces in addition to SPI
Drivers	Linux drivers		Cortex-M4 drivers with C API

2.2 REQUIREMENTS FROM INDUSTRIAL MANUFACTURING

The requirements of this section come from CPS4EU WP8, mostly from D8.1, *Use case requirements V1*, Feb 2020 [D8.1] and D9.1, *Use case 10 and Use case 11 requirements*, March 2020 [D9.1].

It is interesting to see that WP9 does not raise any requirement for wireless communications: from the use case description, wired link are assumed. We could imagine backup solution relying on wireless systems in case the wired link is broken, at least to ensure a minimum level of operation.

2.2.1 Use Cases communication needs

Leonardo is a partner of major civil aircraft programs in Europe and in North America, manufactures for world players such as Boeing, Airbus, Bombardier, ATR, Lockheed Martin. As a Boeing strategic partner, Leonardo's Aerostructure Division develops and manufactures about 14% of the 787's airframe.

Three Use Cases will be developed in Leonardo's plant in Grottaglie (Italy), where we manufacture the largest composite "one piece barrel" fuselage, a large and complex carbon fiber structure built with unique and innovative technologies.

Leonardo will use its own ICT platform to support the development of use cases (i.e. for storing data collected from sensors/machines, dashboards, user interfaces, etc.). Through the CPS4EU project, such platform will be enriched and complemented by modules, tools and architectures coming from the CPS4EU project.

In those Industrial automation use cases we have communication scenarios:

- **Device-to device** (e.g. UC3: vacuum and drill need to exchange information on their position)

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- **Device to Data Center** (e.g UC5: monitoring of process parameters i.e Pressure, durations, temperatures, humidity, geometry of the product; data collection from field for later analysis; analysis of big amount of data and the statistical correlations between variables need to be performed in real time are to be monitored in order to take control decisions and correctly stamp form the part; UC4: feeding of sensor data into the prediction model (for the entire trimming duration)
- **Data Center to device** (e.g UC4: real time application of the quality prediction model and the setting of tool parameters, with the aim to reach the best final quality trimming;)

2.2.2 Communication requirements

To this extent, we envisage the need of a communication gateway to address the following needs:

- Monitoring
- Data collection
- Supervision and control.

The communication gateway should satisfy the following requirements:

- Security: support for mutual authentication (also for the communication device-to-device), data integrity and confidentiality, intrusion protection from cyber attacks, anti-tampering.
- Throughput/bandwidth: ability to support high rate transmission of large amount of data at for monitoring purposes (including images).
- Low latency: support for real-time control of production machines.
- Interoperability: ability to work with different infrastructure and devices supporting various protocols and interfaces providing an abstraction from the adopted device/infrastructure.
- Remote Management: possibility to configure the devices and gateways and to manage remote updates of firmware and business logic.
- Reliability: ensure delivery and quality of data transmission against interferences (e.g. noise, disturbances and/or frequency constraints on plant).

In order to meet these requirements, Eurotech, a cyber-physical systems manufacturer and an industrial IoT solution provider is developing a communication gateway devoted to edge computing, data collection, systems and enterprise software (e.g. cloud platform) integration. In addition, Eurotech is exposed to other industrial use cases whose requirements are summarized hereafter.

The IoT based integration solution that should be adopted in the industrial use case requires a communication gateway capable to monitor the infrastructure, ensure continuous, secure and reliable data collection and to provide remote management functionalities. The communication gateway should satisfy the following hardware and software high-level requirements:

- Rich set of hardware interfaces to provide connectivity between local devices & sensors and the communication gateway.
- Several OT Communication Technology options, to ensure the interoperations of the two parts of the software framework, the one on the edge and the one on the enterprise side.
- M2M/IoT communication protocols support, to ensure unattended, geographically dispersed and mobile devices connectivity, with a message oriented, publish & subscribe, hierarchically structured and standardized model.
- Communication security, providing support for mutual authentication (also for the communication device-to-device), data integrity and confidentiality. Hardware support for security (e.g. TPM) might improve the adopted solution.
- For data collection and command/control activities, the communication gateway should support high transmission rate with low latency and near real-time capabilities.
- Provide a solution for command and control activities with a specific protocol capable to support the gateway remote management for its entire lifecycle.
- Ensure reliable communications in an industrial environment.

It has to be noted that part of the requirements expressed here are similar to the one seen in section 2.1 (requirements coming from the automotive sector)

2.3 SYNTHESIS OF REQUIREMENTS

One characteristic of the CPS4EU project is to combine many use cases from various vertical industries. Each vertical has its own set of requirements that may lead to completely different solutions. The previous sections illustrate somehow this variety. In this section we try to summarize – and synthetize – these requirements to define theoretically a unified communication solution that could suit all needs.

The Table 1 summarizes the requirements expressed previously.

Table 1. Summary of high level requirements

Requirement	**Exemple**	**Comments**
Long-range communication capability – low data rate	Cat-M or Nb-IoT	Low power is a key requirement here
Long range communication capability – high data rate	LTE Cat-4 or LTE Cat-6	Depending of the application, higher data rates (up to few Gbits) may be required. However, 150 to 300Mbits DL seems to be a nice sweet spot. UL to be addressed too, for new set of applications.
Short range communication capability	Wi-Fi, Bluetooth, Zigbee and alike	Could be interesting to have mesh capability too
Wired communication	Ethernet	To connect "old" non wireless objects; for transition purpose as well as future application (e.g. automotive embedded network).
Security	Capability to define a secure / non secure zones in the device	Private 4G or 5G deployment is also a mean to ensure end-to-end security to the vertical
Device Management capability	Example: LWM2M, OMA based Should enable secure over-the-air upgrade	
Unified Software environment	Ideally, applications should be able to interface with modems in a unified manner	The standard for M2M is to use AT command based interface. It would be better to get more modern interface such as an interface in C for more efficient programming.
Low latency, high reliability	The level of requirements directly depends on the use case.	4G may be limited here. 5G, with URLLC and TSN can fit the requirements. Requirement on latency is not only to get low latency, it is also to have deterministic latency
On-board processing capability	Ability to process data locally for faster analysis and limit communication burden	It is not directly a requirement for communication module, rather for the complete device

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The first conclusion is that a single solution to fit all needs is not realistic, at least from modem perspective! However, it seems possible to define a kind of pre-integrated platform, integrating multiple communication systems, but leveraging possibly unified interface to ease its final use. This is indeed the target of WP6 and of the already mentioned PIARCH.

Moreover, it seems feasible to meet most of the requirements expressed in this initial phase of CPS4EU project with 4G technology, except possibly the low latency / high reliability ones that have to wait for 5G. Indeed, the promise of 5G is to provide higher throughput, lower latencies, better efficiency etc. compared to 4G, as illustrated by the spider chart in Figure 3. IMT-2020 is the label of ITU for 5G, while IMT-Advanced is the one for 4G.

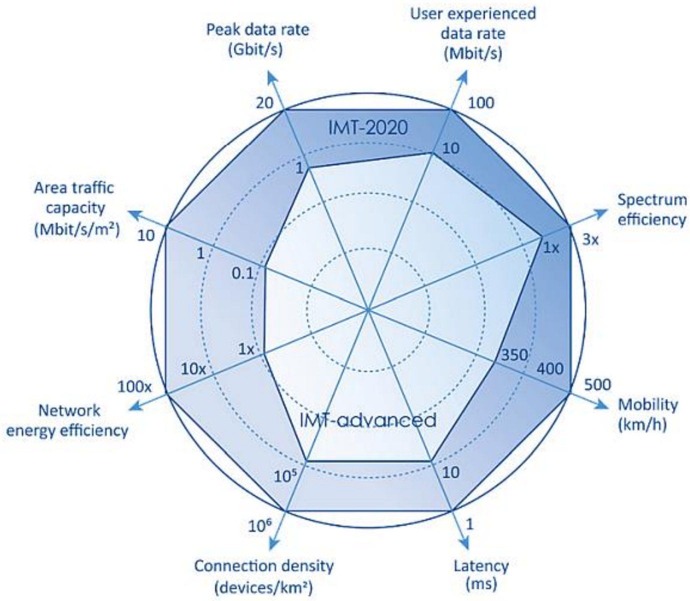

Figure 3. IMT-2020 vs. IMT-advanced spider chart (taken from ETSI: https://www.etsi.org/technologies/mobile/5g)

As a result, the next section proposes some building blocks for the communication module that could be considered into the WP6 PIARCH.

3 COMMUNICATION MODULES – LEGACY PART

3.1 4G-BASED SOLUTIONS

3GPP is the body of standardization of cellular technology since 3G. Although 3GPP did not change its name, it has standardized 4G (also known as LTE) and is now addressing 5G (the radio part is known as “NR” New Radio).

LTE was introduced with Rel. 8 of 3GPP, around year 2009. Rel. 13 was completed early 2013. In this release, LTE cat-M (also known as LTE-M) and NB-IoT were introduced as technologies for LPWA systems (Low Power Wide Area) as the answer of cellular systems camp to (semi) proprietary solutions such as LoRA or Sigfox.

Hence, LTE offer a complete set of solutions, from very low end to high-end, to connect devices of various capabilities and demands, with a unified network. 5G is completing this trend – single wireless system to cover all needs – bringing into the picture even higher data rates, lower latencies, higher reliability and techniques to support this flexibility, such as network slicing.

Table 2 represents the typical data rate that could be obtained with various LTE categories of devices and exemplifies some objects from day-to-day life that could be connected with a given categories. Definitely, in industrial context, similar split can be imagined and the table also position use cases from CPS4EU.

Table 2. Illustration of IoT that could be served with LTE based technologies

Throughput	Category	Applications
1Gbps	LTE Cat-4 (and higher)	Routers network bridges, High-res video, A/R devices Digital twin, collaborative lifting [D8.1],
100 Mbps		Video surveillance, In-car hotspot, Infotainment, Digital signage Over-the-air SW upgrade for car [D7.1]
10 Mbps	LTE Cat-1	Telematics, Predictive maintenance Automatic vacuum system [D8.1]
1 Mbps		Smart watches, Point of sales terminals E-call [D7.1]
100 kbps	LTE Cat-M	Patient monitor, Alarm panels, Wearables Distributed control for energy [D9.1]
10 kbps		Fitness devices, Trackers, Gas/water meters
1 kbps	NB-IoT	Waste management, Smoke detector
Few messages		Parking control, Smart agriculture

The next sections illustrate some of LTE modules designed by Sequans that could meet part of the requirements expressed in section 2.

3.1.1 Examples of Sequans solutions

The GM01Q EZLinkLTE module is the first, all-in-one, single-mode LTE category M1 (Cat M1) module with worldwide deployment and roaming capability. GM01Q is based on Sequans’ Monarch LTE Cat M1/NB1 platform, a member of Sequans’ StreamliteLTE™ family of LTE chip products for the Internet of Things. GM01Q comprises Sequans’ Monarch LTE Platform and all other elements necessary for a complete LTE modem system. These include an LTE-optimized transceiver, a complete Single SKU™ RF front-end to support LTE bands worldwide, and key interfaces, all in a single compact LGA package. GM01Q also includes Sequans’ carrier-proven LTE protocol stack and a comprehensive software package for over-the-air device management and packet routing. GM01Q is compatible with any host running Linux, Windows and a wide range of embedded and real-time operating systems. It is an ultra-compact, high performance solution, delivering a perfect blend of LTE features and ultra-

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low power consumption ideal for the design of cellular devices including sensors, meters, buttons, and trackers of all kinds.

Obviously, Sequans is not the only LTE module vendor. Similar modules can be purchased from Gemalto (Thales), Sierra Wireless, Telit, Quectel, Simcom etc. Sequans offer is optimized for 4G systems and provides most often lower cost, lower power consumption and lower size than its competitor. Moreover, it can allow more customization to fit very specific needs of end customers, thanks e.g. to an advanced debug and monitoring tool providing deep information on the modem and the system.

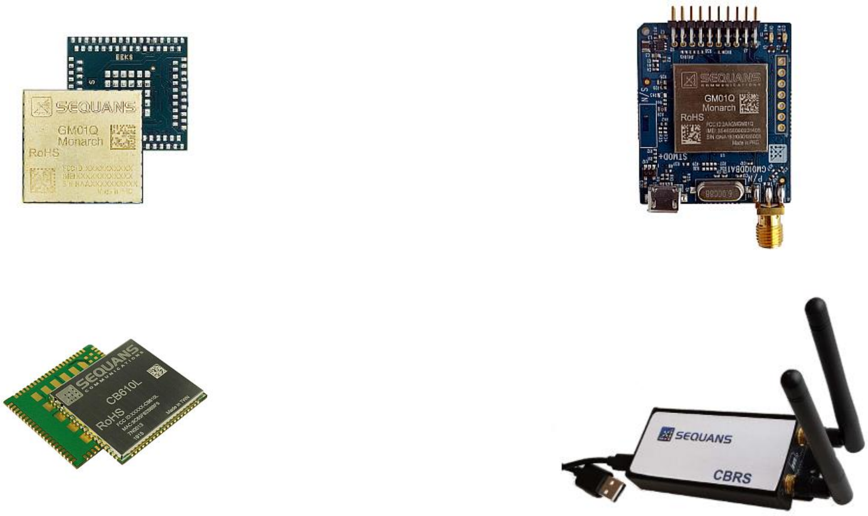

Figure 4. Examples of Sequans modules and EVK

Though these modules address different market, they present similar software interface: an user application can be quickly adapted from one module to the other, though in practice it is unlikely that the same application is defined for either low-end or high-end communications modules.

The solution presented above is providing a solution for cat-M and Nb-IoT system, required to meet some of the requirements expressed by the CPS4EU verticals, typically the one related to the collection of data from sensors, or low rate / un-frequent communications (sensors, trackers, actuators, etc..), and having a long life on battery.

The next section introduces an IoT gateway from Eurotech, being developed in context of CPS4EU, based on a new hardware platform leveraging legacy communication components.

3.2 AN IOT GATEWAY FOR INDUSTRIAL CONNECTIVITY

Eurotech is developing a solution to support IoT communications in industrial context.

The IoT-based infrastructure is composed of a hardware platform conceived for edge computing and a software framework for hardware abstraction, data collection, edge processing, devices remote control, fleet management and systems integration. The gateway will provide not only communication support (WP2) but also all these latter functions in relation with WP1, WP6, and WP8. It also provides a complete and developers-friendly environment for the implementation of the business logic, that is, the use case specific application that partially runs on the edge and partially on the enterprise side.

Both components of the infrastructure, that conceptually compose a communication gateway, are application independent and could become Pre-Integrated Architectures.

The hardware platform provides all the functionalities of an edge controller/multiservice gateway in a small and rugged format factor, specifically conceived for industrial application. The platform will provide the computing power and the hardware resources required to host the IoT software framework and the business logic of the industrial use cases (e.g. intel Atom or AMD processor starting from 1GHz, 8 GB eMMC and several storage media). It will also provide a rich set of communication interfaces, in order to guarantee a high level of connectivity, both on the field for the integration with the manufacturing plant and with the enterprise IT infrastructure (e.g. cloud platforms, data centers, etc.). Typically, the communication interfaces include multiple Ethernet, USB, RS-232/RS-422/RS-485, digital I/O ports, a CAN bus port, a mini display port, an LTE internal cellular and several internal interfaces for further expansions.

The software framework will be based on Eclipse Kura and Kapua, the open source community version of Eurotech ESF and EC. From the connectivity perspective, the framework is responsible for:

- Communication channel abstraction: developing and maintaining the business logic on the field is a challenging task, specifically when the integration with legacy systems is required. The complexity of the communication protocols represents an obstacle both for the development of the business logic and for its maintenance. The framework offers an abstraction layer that hides the technological details of the communication protocols, with a unified and service-oriented interface that simplifies and speeds-up the development process. The interface provides specific services for field communication, for the interaction with sensors/actuators and more complex devices, but also for the interaction with cloud platforms or enterprise software.
- Field communications (e.g. Zigbee / 802.14, Serial, Bluetooth, Ethernet, Wi-Fi, RFID, but also Field Bus technology like ModBus, CAN, etc.):
    - with low level support for wireless and wired interaction with sensors/actuator;
    - with low level support for machine to machine communications (e.g. industrial use case UC3: vacuum and drill need to exchange information on their position).
- LAN and WAN communications and Internet connectivity (OSI Model Layer 1 & 2), including Cellular Networks, Satellite, Ethernet, Wi-Fi, xDSL, etc., and M2M/IoT Communication (OSI Model Layer 5) through MQTT layered on top of TCP/IP (e.g. data collection in industrial use cases).
- Command and control communications required to manage the fleet of edge controller/multiservice gateways deployed in the manufacturing plants (e.g. industrial use case UC3 and UC4).

3.3 SYNTHESIS OF EXISTING COMMUNICATION SOLUTIONS

From the review of existing communication modules or more advanced solutions from Eurotech, it appears that most of the requirement expressed in section 2 can be fulfilled with existing solutions. However, some of the requirements, especially on latency cannot be met with 4G technologies and it is important to work on future building blocks to enable communication modules able to support the more demanding use cases from industry.

In practice, WP2 will deliver for short term:

- Communication modules to be integrated into the PIARCH (WP6)
- Field protocols to interface the industrial gateway with the manufacturing infrastructure (WP8)
- Wide area network support for the integration of the industrial gateway with the existing IT infrastructure (enterprise level as defined in WP8)

In addition, WP2 will work on linger term deliveries, to propose innovative solutions towards meeting the more stringent requirements expressed by the vertical use cases, especially related to low latency and critical communications. These exploratory ideas are captured in deliverable D2.3, while deliverable D2.5 introduces in more details the activity related to the development of a DSP solution adapted both for communication and AI processing. This later report also presents the prototyping activity undergone in context of WP2.

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4 CONCLUSION

From the requirements expressed by the verticals or coming from other work-packages, we derived the high-level requirements of the communication modules to serve a maximum of use cases. It appears that a single radio modem cannot meet all the requirements. For instance, depending on use cases, a very low data rate could be good enough, while for others, a high data rate is a must. As a result, WP2 has to address multiple modems that could be then integrated into a pre-integrated architecture board, which is the objective of WP6.

We performed a survey of existing technologies. It appears that 4G is a good starting point since it proposes a framework meeting most of the requirements, thanks to the various LTE categories. However, for most stringent requirements, such as low latency, time deterministic communication, 4G is somehow limited and WP2 has to work on building blocks, enabled by 5G to fulfil the complete set of requirements expressed by verticals.

This second report of WP2, addressing requirements, confirms the initial landscape of communication needs for CPS. Our original choices on the first hand to start from a 4G solution and adapt it for CPS needs (whenever specific) towards an integration into the pre-integrated architecture and on the other hand to explore innovative solutions enabling true URLLC and TSN communications.

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