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Content

Executive Summary of Use case

This document describes the use cases targeted by the project GenerIoT[1]. The purpose of the use cases is to fuel the research and development within the project. For that reason, this document presents the motivation of the different use cases, scenarios, and their relation to GenerIoT objectives and innovations.

GenerIoT will provide new technologies and processing steps to simplify and speed up the handling of IoT software over the complete DevOps cycle. Consistent system models are the first core technology of the GenerIoT approach. These models can be interlinked and merged as demanded for the automation approaches in the development and operation phase. Additionally, the models can be checked for consistency, which improves the quality of the IoT software from the beginning and helps to overcome the cultural differences inherent in the various covered design domains. To speed up software design and implementation, all views required in the DevOps cycle shall be generated at least partially from the GenerIoT model, which forms the second core technology of GenerIoT. These views will include SW prototypes as well as productive SW. To guarantee quality, test automation and system analysis will also be generated. Views for operational handling, bring into/out of service and maintenance are likewise subject to generation. It is important to note that the generated views are not restricted to data and software, but can also be a matter of execution, i.e. contributing to the automation of processes. There are currently 21 use cases, ranging from specific product-like use cases to more general vertical-specific platforms, and even DevOps practices.

1 https://itea4.org/project/generiot.html

I Introduction

I.1 Role of this document

First, the role of Work Package 1 (WP1) is to give concrete, industrial use cases that, among other things, fuel the research and development in GenerIoT. Second, WP1 evaluates how the techniques, tools, and methods serve the use cases and use case providers. The use cases are provided by the GenerIoT WP1 participants. The organizations are called use case providers.

The purpose of this document specifically, is to present use cases uniformly so that other work packages, mainly WP2-4, can best benefit from them. This document sets a format for presenting the use cases and scenarios. Furthermore, this document shows the relation between the GenerIoT objectives and the use cases. The use case providers motivate how GenerIoT project is relevant, and how each use case is related to other work packages by relating the use case to FPP objectives. Evaluation concept for the techniques, tools, and methods is not in the scope of this document.

This document is the starting point for working with the use cases. By the following milestone of the project, use cases are refined so that they serve the project in all aspects, and during the last project year WP1 evaluates the techniques, methods, and tools in two rounds.

I.2 Intended audience

This document is meant for GenerIoT consortium members, and reviewers, to provide information of the use cases. This document is, as such, project public. The intention is to provide public versions of the case studies at later stages of the project.

II Overview of use cases and scenarios

This section describes first, for the readers convenience, the general format that each provider followed while presenting their use cases and scenarios. Second, there is an overview of the use case topics as in the form of a reference table.

II.1 General

Each use case provider section starts with a description of their use case. The context for each use case is presented by describing the industry sector and more specific problem area, which the use cases is related to. Furthermore, the section explains the motivation of how the GenerIoT project is expected to help the use case provider.

II.2 Use case description(s)

Use cases are more detailed descriptions of DevOps related cases and problems to be solved, and requirements for solutions. There might be one or several use cases within an associated partner. Since there are different types of use case providers, the use cases range from setups of specific products to wider technology and service frameworks. Consequently, the granularity of description differs, but nevertheless, each use case is described in the following fashion:

- Brief description of the use case and its relation to other work packages
- Description of current processes and practice works gives a baseline for development
- Detailed description of the use case answers to the following questions
    - How shall the product or service be improved?
    - What are the requirements that the use case provider can give at this stage? (Or at least the problems that should be solved)
    - Which stakeholders and actors are related to the use case?

    - Finally, the use case scenario described as step-by-step narrative, if applicable
- Research challenges are the use case provider's initial ideas for research partners to help understand valuable topics
- Risks are described and categorized as follows: Risk event, Triggers, Probability (High | Medium | Low), Impact (High | Medium | Low), Mitigation, Status (Identified | Problem | Under control | Mitigated | Materialized)
- "Relevance to GenerIoT" concludes each use case description. It aligns the use case with a GenerIoT objective mentioned in FPP, and thus, serves as the first validation for relevancy

The development of IoT devices is influenced by various factors, such as the need for a short time to market, the implementation of complex distributed algorithms, and the intricate interaction among interconnected devices, as seen in smart homes. Additionally, there is a growing demand for higher quality and robustness in the software and hardware used in IoT devices. To add value, study focuses on conducting early simulative evaluations of target software implementations, with a special emphasis on communicative aspects. One specific challenge is WLAN communication, which often encounters obstacles due to changing environmental conditions, sporadic transmission errors, and random channel arbitration.

II.3 Use case summary

The following table summarizes the use case topics. These topics range from specific product like use cases to more general vertical specific platforms, and furthermore to DevOps service practices. Involved partners are collaborating at the same use case.

Table 1 – Summary of use cases

Use case provider	Industry sector	Use case identifier	Use case description (incl. envisioned benefits achieved by GenerIoT)	Involved partners
Granlund (GRA)	Construction and real estate	GRA-UC-1	Structural Health Monitoring (SHM) for wind power stations	Loopshore (LOOP)
		GRA-UC-2	Structural Health Monitoring (SHM) for network base stations	Loopshore (LOOP)
		GRA-UC-3	Structural Health Monitoring (SHM) for indoor environment technology	Loopshore (LOOP)
Suomen Tekojää (STJ)	Industrial cooling and heating	STJ-UC-1	Virtual Power Plant in multiparty environment	Tietoevry (TIE)
		STJ-UC-2	IoT sensor cloud integration	Loopshore (LOOP)
		STJ-UC-3	Data security and secure software updates	Unikie (UNI), Tampere University (TAU)
		STJ-UC-4	Bidirectional cloud connectivity to legacy and closed automation systems	Valaa Technologies Oy / Nobody Engineering Oy (VAL), Tampere University (TAU)

Use case provider	Industry sector	Use case identifier	Use case description (incl. envisioned benefits achieved by GenerIoT)	Involved partners
University of Rostock (URO)	Industrial IoT	URO-UC-1	Development of IoT devices for multi-media-based wireless streaming with distributed edge computing capabilities	
		URO-UC-2	Development and automated integration testing of OTA firmware updating mechanisms for IoT devices	
Infineon Technologies (IFX)	Semiconductor based Solutions	IFX-UC-1	Architecture of Demonstrator SoC (includes modelling and meta-modelling)	
	Sensing and Acting for Industrial/ Automotive applications – may be also IoT or consumer (not clear yet)	IFX-UC-2	Virtual prototype of SoC	Technical University of Munich (TUM), Tampere University (TAU)
		IFX-UC-3	FPGA prototype of SoC	
		IFX-UC-4	Sensor specific Generation of Firmware Driver (includes modelling and meta-modelling)	FZI Forschungszentrum Informatik (FZI), SparxSystems Software GmbH (SSCE), Tampere University (TAU)
		IFX-UC-5	Actuator specific Generation of Firmware Driver (includes modelling and meta-modelling)	FZI Forschungszentrum Informatik (FZI), SparxSystems Software GmbH (SSCE), Tampere University (TAU)
		IFX-UC-6	Generation of specific Runtime System (includes modelling and meta-modelling)	FZI Forschungszentrum Informatik (FZI), SparxSystems Software GmbH (SSCE), Tampere University (TAU)
		IFX-UC-7	Protocol (probably SPI) specific Generation of Firmware Driver (includes modelling and meta-modelling)	FZI Forschungszentrum Informatik (FZI), SparxSystems Software GmbH (SSCE), Tampere University (TAU)
		Add-On and not related to GenerIoT enabled automation	Manually made additional SW, HW and Mechanics, making the prototype (Part of WP5)	

Use case provider	Industry sector	Use case identifier	Use case description (incl. envisioned benefits achieved by GenerIoT)	Involved partners
Loopshore (LOOP)		LOOP-UC-1	IoT-device OTA firmware upgrade	Granlund (GRA), Suomen Tekojää (STJ)
Razorcat (RAZ)	Industrial IoT Automotive Avionics	RAZ-UC-1	Coverage results from unit and system testing on IoT source code level	Embedded ocean (EMO), ScopeSET Technology Deutschland GmbH (SCS)
Embedded ocean (EMO)	Industrial IoT Automotive Avionics	EMO-UC-1	Generic IoT system testing platform demonstrator	Razorcat (RAZ), ScopeSET Technology Deutschland GmbH (SCS)
bee produced GmbH (BEE)	Electronics Design	BEE-UC-1	Modelling electronic components for providing equivalent/alternative components	Infineon Technologies (IFX), SparxSystems Software GmbH (SSCE)

II.4 Granlund (GRA)

GRA-UC-1: Structural Health Monitoring (SHM) for wind power stations

In predictive maintenance and repair actions of wind power stations, the goal is to detect anomalies in structural data and to observe malfunctions before they cause larger failures. Data from structural health monitoring is used in this analysis. Structural health monitoring data is used in service life forecasting. With forecasts it is possible to operate structures in a predictive manner and take into consideration aging management of structures. For example, if it is known that there is tendency for the increasing deterioration, the maintenance and repair actions can be adjusted to avoid damage.

GRA-UC-2: Structural Health Monitoring (SHM) for network base stations

In the future, not so many mobile network masts will be built, so the role of early detection of faults and maintenance during the life cycle of current masts will be emphasized. In the GenerIoT project, IoT devices are developed to implement maintenance and predictive maintenance of mast structures, for example a method based on leakage current measurement. The project examines the possibility of developing IoT devices as well as preventive maintenance of key equipment failures, such as the capacity of batteries.

GRA-UC-3: Structural Health Monitoring (SHM) for indoor environment technology

SHM for indoor environment technology is a generic area at which real-time indoor environment quality assessment can be evaluated, e.g., at sports facilities. Furthermore, structural details such as moving joints can be implemented. By utilizing SHM the condition-based strategy and estimations for the right actions at time can be achieved.

II.5 Suomen Tekojää (STJ)

STJ-UC-1: Virtual Power Plant in multiclient environment

Virtual powerplant in multiparty environment use case aim to develop collaboration model and related process to manage energy resources, like industrial cooling devices, owned by multiple parties in different geographical regions. Energy resources aimed to be aggregated as virtual powerplant towards energy reserve markets. There are three main scenario studies in GenerIoT:

1. feasible business models to reach benefits of multi-party operating model,
2. reach technical trustworthy and response times towards energy reserve markets,
3. capabilities to operate with/without connection to telecommunication network.

STJ-UC-2: IoT sensor cloud integration

Development of cloud-to-cloud capabilities. This use case focuses on connecting third-party IoT sensors natively and seamlessly to client automation via cloud:

1. Environmental data to existing system,
2. Improve control of automation with cloud connected sensors,
3. reduced installation costs and times.

STJ-UC-3: Data security and secure software updates

Development of secure end-to-end OTA software update infrastructure for connected devices. GenerIoT benefit; Secure SW update including:

1. Secure communication,
2. automatic recovery of failed updates,
3. update integrity,
4. reinforced security in connected device.

STJ-UC-4: Bidirectional cloud connectivity to legacy and closed automation systems

Development of cloud connectivity for old automation systems. Generation of common interface to unique cooling system.

II.6 University of Rostock (URO)

URO-UC-1: Multimedia Data Streaming over WLAN Connections

This use case involves the development of applications that stream multimedia data over WLAN connections. These applications require high-quality service to ensure a seamless user experience. Furthermore, the use of pre-processed or cached data within the framework of edge computing adds complexity to the scenario. URO aims to investigate and analyse the implementation of such applications, with a particular focus on communication aspects and the challenges posed by varying environmental conditions, sporadic transmission errors, and random channel arbitration.

URO-UC-2: OTA Update Strategies for IoT Components

In this use case, URO examines automated Over-The-Air (OTA) update strategies for IoT components. The objective is to ensure successful updates under a wide range of operating conditions. To achieve this, URO will explore how OTA update strategies can be assessed and evaluated for their extra-functional properties, allowing for informed decisions regarding their execution, particularly in worst-case scenarios. By conducting reproducible and automated analyses, the outcome of GenerIoT would be the enhancement of the reliability and robustness of IoT devices during the update process.

II.7 Infineon Technologies (IFX)

IFX-UC-1 ... IFX-UC-7

The Infineon use cases (IFX-UC-1 till IFX-UC-7) cover the development of the complete software for a (multi)sensor/(multi) actuator system, which interfaces with a communication hub via a simple wire-based interface, e.g., an SPI interface. The use cases are typical of industrial but also automotive applications. The specific problem is to speed up the design of the software by automatically generate most of the software parts including hardware abstraction layer, (physical) device driver, (logical) device driver, and runtime system including memory management and overall control.

The concept is general, thus a use case from industrial, IoT or consumer may be feasible as well. Key is automated construction of drivers and the runtime system.

The demonstrator shall be realized as both VP and FPGA.

II.8 Loopshore (LOOP)

LOOP-UC-1: IoT-device OTA firmware upgrade

Our plan as Loopshore is to implement an Over-the-Air (OTA) firmware upgrade for our IoT device, which consists of manufacturing of these use case-specific demonstrators. These demonstrators will be delivered to the testing site, where we will conduct further evaluations and tests. The purpose of the OTA firmware upgrade is to update the business case-specific functionality of these devices remotely, without the need for physical intervention.

Drawing on our expertise in OTA implementation, we will ensure a seamless and efficient upgrade process. By leveraging OTA technology, we can remotely update the firmware of the devices, allowing us to enhance and modify the specific features and capabilities that align with the intended use cases.

Once the OTA firmware upgrade is successfully completed, the updated functionality will be available on the devices, enabling us to validate and assess their performance and suitability for the targeted business cases. We will also gather valuable insights and data from these devices to further refine and optimize the solution.

Moreover, as active members of the GenerIoT consortium, we will share our experiences and lessons learned in implementing OTA firmware upgrades for these use case-specific demonstrators. This collaborative approach will contribute to the overall advancement and knowledge sharing within the consortium, fostering innovation and growth for all members involved.

II.9 Razorcat (RAZ)

RAZ-UC-1: Coverage results from unit and system testing on IoT source code level

With RAZ-UC-1 we would like to implement a CI based platform to automatically collect coverage information from unit, integration and system testing levels and provide immediate coverage result reports for each CI job.

Based on our unit testing product TESSY, we will enhance the coverage measurement import and export possibilities to public domain formats like LCOV in order to exchange coverage information with third party products (e.g. Accemic CEDARtools or Verifysoft CTC++) that are publicly available on the market. Our own technology of source code level coverage analysis will be merged with the results of these third-party products.

The use case shall demonstrate the planned ability of extensions to the unit testing product TESSY of RAZ to cumulate coverage results on source code level and to provide the results in commonly usable form to users of CI systems.

As active member of the GenerIoT consortium, we will provide the use case solution as well as experiences and lessons learned to the consortium members to contribute to the overall knowledge sharing. The use case results will provide innovative technology enhancements being integrated into the TESSY product of RAZ.

II.10 Embedded ocean (EMO)

EMO-UC-1: Generic IoT system testing platform demonstrator

The EMO-UC-1 use case will be a joint activity of RAZ and EMO to demonstrate the system testing approach on the generic IoT platform Xentara of EMO combined with the test specification language CCDL of RAZ. The example embedded system to be tested will be an elevator hardware model with a control unit that will be connected to the Xentara platform using COTS I/O interfaces.

The generic approach of this use case shall show that Xentara can serve as a runtime platform for machine controls and with the CCDL on the same platform as support for development, qualification, production tests or for maintenance purposes. New in this context is the point, that the runtime platform becomes the test platform at the same time.

During development, the machine or the corresponding I/O interfaces are not yet available. Here a simulation model takes over the stimulation of the application software. In parallel, the CCDL injects corresponding test cases and checks the functionality of the application software. In simpler environments, the CCDL can also take over the function of the simulation.

In production testing, the focus is on automating the completion tests that are currently mostly performed manually. The focus here is on the automated start-up of various machine functions and the non-destructive testing of the program logic and the wiring in conjunction with the machine.

Both RAZ and EMO will provide the use case solution insights and results to the GenerIoT consortium as base for HIL testing systems. The use case results will provide innovative technology enhancements being integrated into the products of RAZ and EMO. The final solution shall be adopted into a flexible IoT system testing platform as a joint product of RAZ and EMO.

II.11 bee produced GmbH (BEE)

BEE-UC-1: Modelling electronic components for providing equivalent/alternative components

The understanding of the electronic component specification and consideration of product manufacturability aspects during the design phase is of vital importance. A lack of such knowledge insights can potentially lead to expensive design modifications and result in costly product introduction delays. Besides, during operation or maintenance it could happen that a component is broken or obsolete and quickly requires replacement. In all these cases there is a strong possibility that components are simply out of stock and an equivalent (with the same or nearly the same electrical specifications) or alternative component (with different specifications, but able to perform the required functions) must be introduced.

A service developed in the GenerIoT project should enable the user to easily extract the requirements and consider specifications (e.g. footprints, package sizes or tolerances) to find fitting equivalent or alternative components. Besides, changes at the mechanical level (due to a replacement with an alternative component) must be communicated with other engineering domains to update their models accordingly.