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Design of embedded mixed-criticality CONTRol systems under consideration of EXtra-functional properties

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Standardization Report (final)

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History of Changes

ED.	REV.	DATE	PAGES	REASON FOR CHANGES
RG	0.1	2016-08-16	13	Initial version (based on D6.2.1)
JM	0.2	2016-09-01	14	Addition of activities performed at the OMG regarding MARTE.
SK	0.3	2016-09-06	15	Update of IEEE activities
SM	0.4	2016-09-10	15	Update SysML activities
PA	0.5	2016-09-16	16	Update MQTT section
RG	1.0	2016-09-16	16	Final Version

Contents

1 Introduction

This document summarizes all standardization activities that were undertaken by CONTREX project partners along the project execution. This includes standards proposals planned or under preparation and interactions with standardization committees. In addition to past activities, an outlook on ongoing and future activities within the CONTREX project is given.

2 Standardization Activities

2.1 OMG, SysML, UML/MARTE

2.1.1 UML/MARTE Profile

Some progress on providing UML capabilities for the modelling of mixed-criticality systems and system-of-systems has been done by UC. Specifically, the goal is to achieve a proposal of a synthetic and clearly necessary set of extensions to the MARTE profile [1].
The activity until M18 was oriented to find the required modelling elements (CONTREX metamodel reported in D2.1.1 [2]), and relying on such a metamodel to detect the lacks of MARTE. Once the lacks have been defined, the required extensions have been already defined. They cover modelling elements to capture:

- **Criticalities.** The proposal is sufficiently generic to cover the needs of current research work, and of the practices that can be derived from partners and from safety standards.

- **Network:** The proposal includes elements to model abstract communication channels and network nodes at different levels of abstraction. Additional novel concepts like zones, contiguity are also present.

- **Design Space Exploration:** The proposal includes minor extensions of VSL expressivity for describing the design space, and specific elements to model DSE rules.

As well as providing new and necessary concepts, there has been an important work to ensure that the proposed MARTE extension is synthetic and necessary. Specifically, for design space exploration (DSE) the CONTREX UML/MARTE modelling methodology (first report given in D2.2.1 [3]) improves the results of the most related background [6]. This work did not fully exploit all the expressiveness of MARTE for DSE. The development of the CONTREX modelling methodology makes a better use of MARTE and minimizes the profile extension requirements.

In order to tackle the actual implementation of the profile the following strategy is followed. In order to enable the production of models for former proof-of-concept, and as a convenient mechanism to separate the extension from the current standard, until the formal standardization proposal is delivered, the extension is being implemented as a separated profile: the CONTREX profile. In the longer term, the current MARTE profile will be extended with the elements of the CONTREX profile (upon success of the standardization proposal).
A first draft of the CONTREX profile for network modelling was reported in [4], and shown in Figure 1. As shown, novel concepts of the metamodel, like zones, contiguity, resistance, etc, have they direct expression in terms of new specific stereotypes.

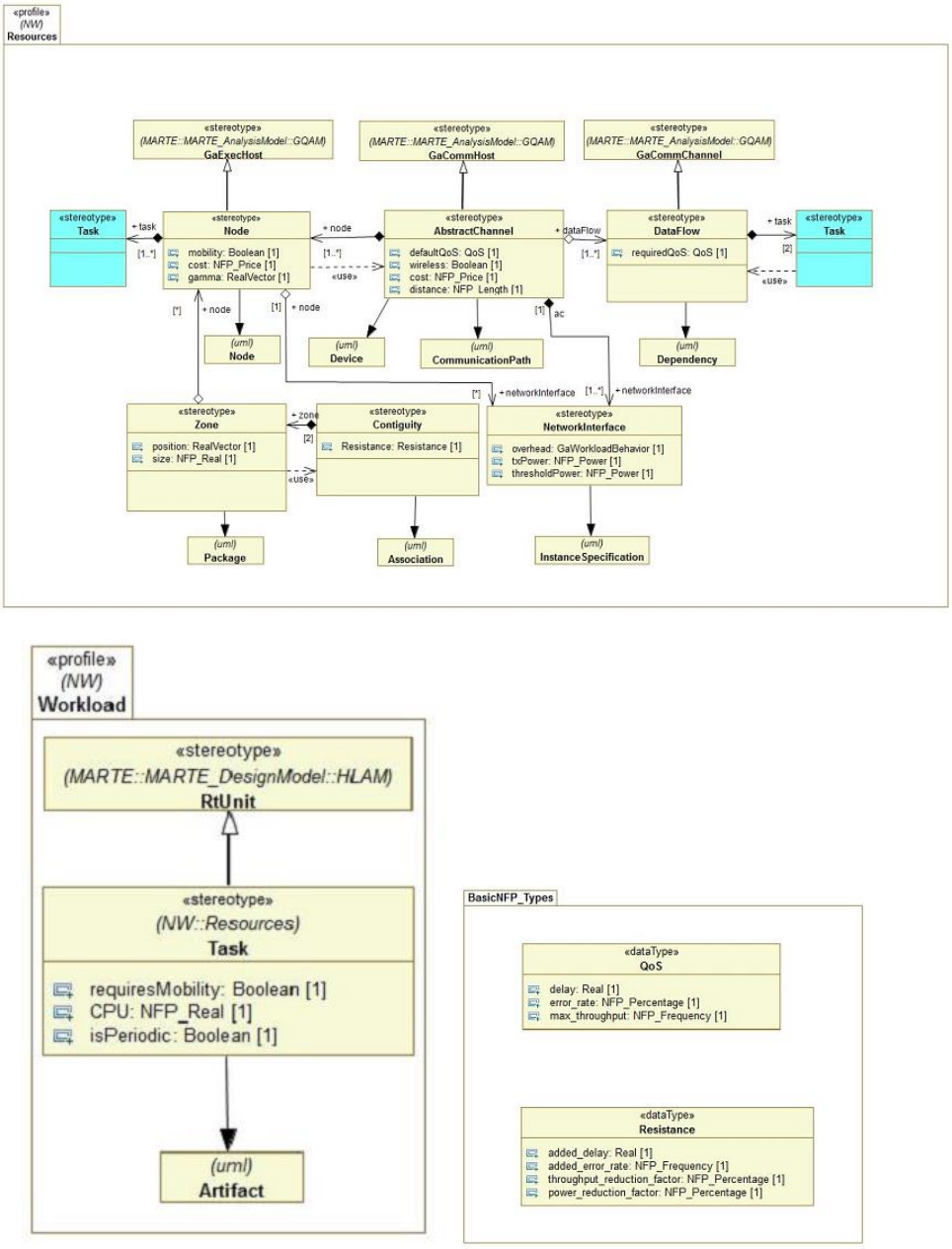


Figure 1. Profile for distributed embedded systems reported in [4].

Work on the production and completion of the network profile is on-going. The development of the modelling methodology (task T2.2) is providing additional feedback for the polishing of the profile and for enabling a more versatile network modelling. For instance, recent work on the network modelling methodology is posing the convenience of an extension to enable the capture of zones and contiguities through composite diagrams (the version in Figure 1 only supports to express them in deployment diagrams). Figure 2 shows the additional extension required.

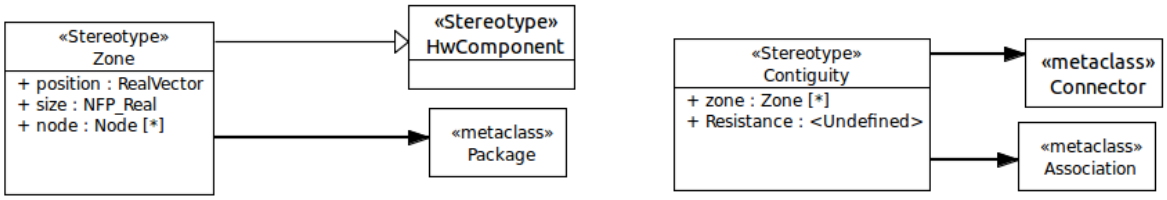
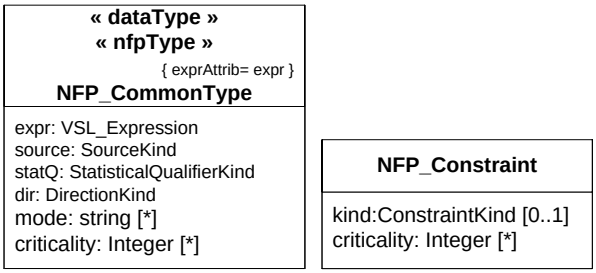


Figure 2. Extension of the profile to enable the description of Zones and Contiguities in composite diagrams.

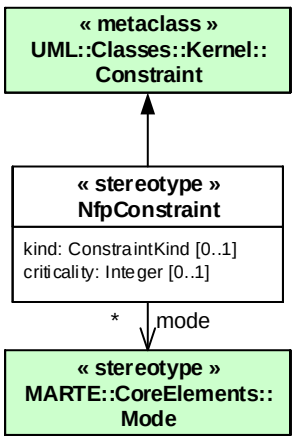
These extensions are under discussion though. In any case, they are incremental changes of the profile, and do not mean a significant variation of the metamodel.

There has been also a specific advance on the profile-based implementation of other key aspects of the metamodel reported in [3].

Figure 3 shows the extension for the support of criticalities, which corresponds to the domain view in [2], also showed in the figure for convenience. Notice that the NFP_CommonType extension refers to an extension of the capabilities of the value specification language (VSL) expressions used to annotate properties, e.g. a WCET, which can have associated a criticality now. However, it does not required a specific stereotype in the profile extension provided.



(a) Domain view extension (reported in D2.1.1)



(b) UML view extensions to be proposed to the OMG

Figure 3. Stereotypes provided for modelling of criticalities.

In the second half of the project, these two concrete proposals have been formalized, submitted, and accepted by the OMG as issues to take into account into the next version of the MARTE standard. UC will continue its efforts in the ongoing revision task force for the

MARTE 1.2 version of the standard so that these proposals get voted. The first OMG issue [10] is related to the annotation of criticalities for NFP values and as mentioned before it requires only the extension of the description of the model library for the VSL. The extension consists in enabling the annotation of a criticality value on a value annotation (see right hand side of Figure 3 (a)). The criticality value is expressed as an integer, denoting the criticality level.

The second extension [11] adds a criticality attribute to an NFP constraint (see left hand side of Figure 3 (a) and Figure 3(b)). Here again the criticality attribute is an integer type denoting its criticality level. The NFP constraint can be associated then directly to different types of modelling elements, e.g. UML components and UML constraints. Therefore, this extension enables the association of criticalities to components, e.g. application and platform components, and also to constraints, which in the proposed methodology are employed to capture performance requirements and contracts.

In order to explain these proposals to the standardization body, a comprehensive presentation of CONTREX contributions has been performed in the June 2016 technical meeting of the OMG [12].

Moreover, there are a number of aspects for which the methodology uses a set of stereotypes which are relevant and candidates for a final standardization proposal. Figure 4 shows the stereotypes which are used to enable the delimitation of the modelling views, referring to system modelling aspects and network modelling aspects.

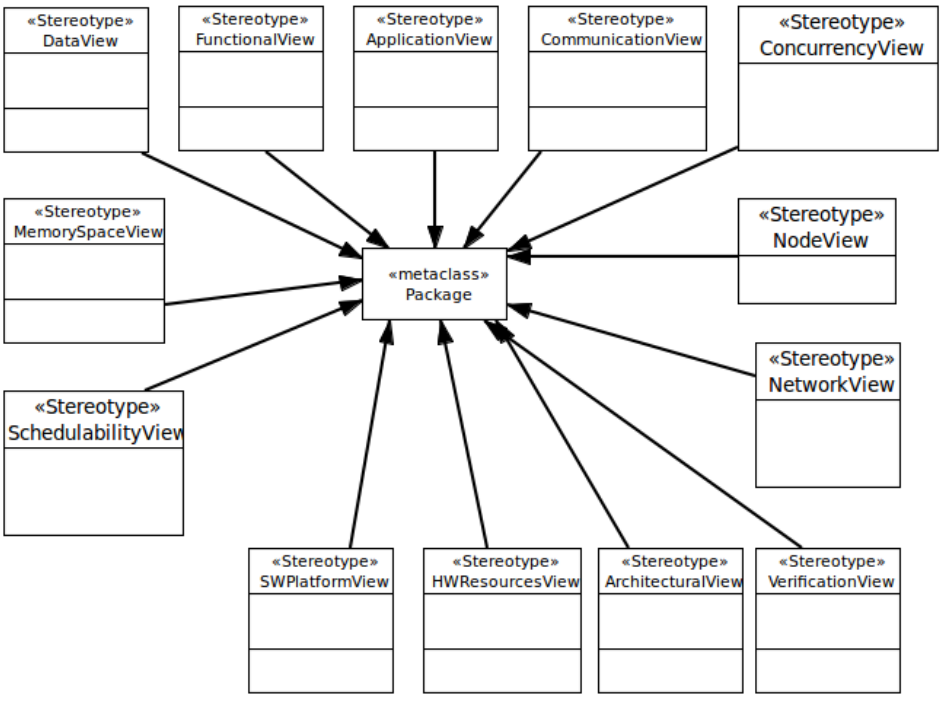


Figure 4. Stereotypes for supporting views for system and network modelling.

Figure 5 shows some additional useful stereotypes. The <<System>> stereotype is recurrently used for delimiting and distinguishing the system parts from the environment (or test) components (standard UTP profile [7] is used for the latter). Figure 6 shows an extension required for the detailed modelling of communication services of the SW platform. Figure 7

illustrates the DSE rule stereotype, which enables a flexible mechanisms for modelling a constrained design space.

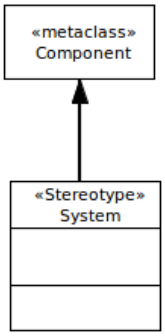


Figure 5. Stereotypes for supporting system component specification, and OS specific attributes.

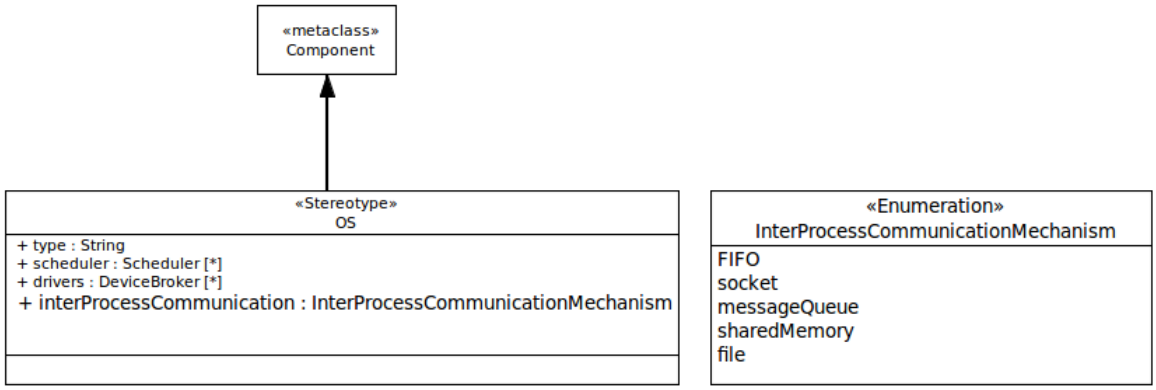


Figure 6. Stereotypes extending the modelling of the SW platform.

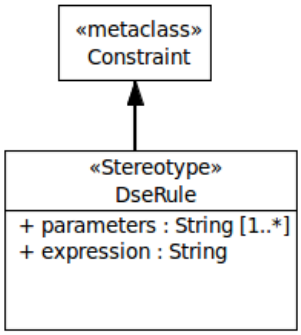


Figure 7. Stereotypes for supporting a flexible constraining of the design space.

2.1.2 Extrafunctional Properties in SysML

Intecs has applied part of the CONTREX meta-modelling solutions for system modelling with SysML, and derived some extensions to SysML for the modeling of extra-functional properties, quantities and units beyond time (e. g. temperature, power) and for the definition of contracts. These extensions could be submitted to OMG in the next period.

CHESS (FoReVer) Contract-Based Modelling and AnalysisSupportCHESS has improved the use of MARTE as proposed by CONTREX (see above) and CHESS/FoReVer support for contract modelling and support for analysis with OCRA was delivered the under the PolarSys working group of Eclipse (https://www.polarsys.org/chess/).

PolarSys is an Eclipse Industry Working Group created by large industry players and by tools providers to collaborate on the creation and support of Open Source tools for the development of embedded systems. PolarSys is a candidate to become an open source industrial reference standard platform for embedded systems development.

2.2 IEEE 2415, IEEE 1801 SLP

Docea Power SAS/Intel Corporation SAS participate in the IEEE 2415 and IEEE 1801 SLP standardization initiatives. Following Docea's acquisition by Intel in August 2015, the Docea team is also a member of Intel's ESUG (EDA Standardization User Group).

2.2.1 Software Access to Power Management – IEEE 2415

The IEEE 2415 initiative targets a better cooperation between hardware and software in order to design more power and energy efficient electronic systems. This especially consists in abstracting hardware design attributes in order to adequately present the low power capabilities implemented in hardware to the power management (and thermal throttling) software. The work conducted in the group thus relates to system design at high levels of abstraction and to consideration of power and energy (and temperature) from the software runtime perspective.

The group formed mid-2014 [13] and several technical subgroups were defined (namely, the Requirements, Power States, Device Enumeration, Clock Intent subgroups). Intel drives the Requirements subgroup and as such delivered a requirements document. The Docea team besides works with several Intel's stakeholders to align on general Intel BUs' interest and strategy.

2.2.2 Enablement of System Level Power Estimation – IEEE 1801 SLP

The IEEE 1801 SLP (System Low Power) initiative, which the IEEE 1801 (a.k.a. UPF, which stands for Unified Power Format) working group initiated, aims to augment behavioral, functional and implementation representations of electronic system designs with power models, so simulating the system representations generates power consumption estimates. A typical targeted application is to turn SystemC-TLM platforms into power-aware platforms able to perform power estimation. Several prototypes using the proposed 1801 SLP format were developed and demonstrated by the standard group members, including a prototype developed by Docea. The prototypes were used to validate the format and showcase its interest. The format was then submitted for ballot end of 2015 and approved in the 1801-2015 release (a.k.a. UPF 3.0) [14]. Moving to a new standard release always takes time so the effort put in developing the 1801 SLP extension will likely prove a valuable contribution to the industry only in some years yet.

2.3 Accellera Systems Initiative – SystemC

CONTREX provides inputs to the standardization of SystemC/TLM. OFFIS has directly participated in relevant Accellera Systems Initiative SystemC working groups, namely the SystemC Language Working Group (LWG), the SystemC Transaction-Level Modelling Working Group (TLMWG), and the SystemC Control Configuration and Introspection Working Group (CCIWG).
More information available at: http://www.accellera.org/
Until end of 2015, the position of the LWG chair was held by an OFFIS employee. Since he left OFFIS, the opportunities to influence the SystemC standardization process are reduced. But OFFIS still participates actively in the Accellera Working Groups and relevant conferences like DVCon or SystemC User Group Meetings.

2.3.1 SystemC Tracing and Introspection

The tracing capabilities of SystemC are very limited when it comes to extra-functional properties. Therefore, OFFIS developed a concept and framework for stream-based simulation and tracing, supporting

- Hierarchical tracing of extra-functional properties,
- Flexible adaption of granularity,
- Strongly typed physical unit support (C++) to avoid composition errors.

A detailed description is given in D3.4.1, Section 3.2 [8].
The general idea of the stream-based tracing has been presented at the Indian SystemC Users Group Meeting 2013. More details of the framework have been presented and discussed in the Accellera SystemC Language Working Group. Furthermore, the concept and framework has been presented in the IEEE Low Power Study Group, the predecessor of IEEE 2415 and IEEE 2416 working groups.

2.3.2 SystemC Simulation Phase Callbacks

The integration of advanced introspection and tracing facilities into SystemC requires a more fine grained control over the simulation and time advance. The already standardized `sc_trace` functionality is integrated in the simulation cycle after the update phase. But the integration of custom introspection code is not possible in standard SystemC without changing the implementation of the simulation kernel. To overcome this limitation, an extended simulation callback mechanism has been proposed by OFFIS to the Accellera working group (Figure 8).Figure 8). The proposed mechanism adds callbacks similar to existing callbacks like `end_of_elaboration()` after the evaluate phase (1), after the update phase (2), when the simulation time is increased (3), and when `sc_pause` is called(4).

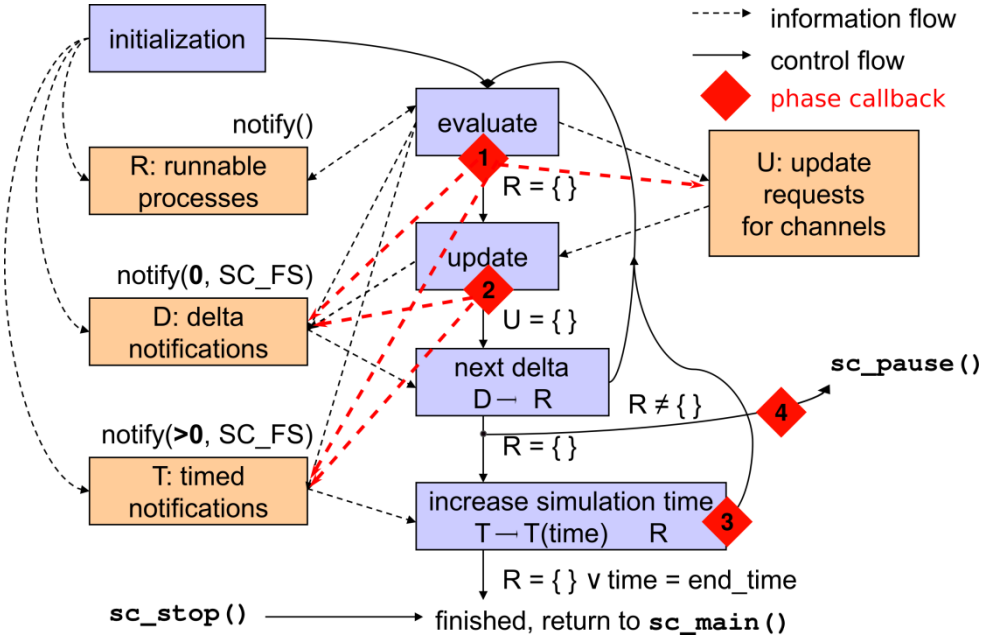


Figure 8: Extended SystemC simulation cycle

A proof-of-concept implementation of this extension has been provided to the Accellera and is already integrated in the current release of the Accellera Proof-of-Concept simulator. The proposed extension a very good candidate to be integrated into the SystemC standard (IEEE 1666) with the next revision.

2.3.3 SystemC Configuration

The CCIWG is currently working on an initial draft standard to define a standard configuration API for SystemC. OFFIS contributes to this by actively participating in discussions in the working group, especially regarding the configuration of extra-functional property models, e.g. support for physical units. Furthermore, OFFIS contributed to the proof-of-concept implementation, e.g. by providing a new concept and implementation for the serialization of configuration values.

2.4 MQTT M2M Telemetry Protocol

MQTT (http://mqtt.org) is a protocol originally designed by Eurotech and IBM from the ground up for M2M applications and is currently in the process of standardization by the OASIS standards body under the supervision of IBM, Eurotech, Cisco, VMWare, RedHat, and others. Its main benefits can be summarized as follows:

- Optimized for M2M applications: only 2 bytes of overhead per packet and integrated management of "quality of service". Through a session-oriented connection to the broker, the communication latency is only limited by the available bandwidth.
- Firewall friendly: the installation of devices within corporate intranets doesn’t require opening additional incoming network ports since the device initiates the connection.

- Publish/Subscribe messaging: the message pattern to provide one-to-many message distribution and decoupling of message producers (Devices) from consumers (Applications).
- Session awareness: the system automatically generates events when a device disconnects abnormally and provides the ability to fully re-establish the session upon reconnection.
- Security: the connection is protected by SSL and authenticated with username and password.
- Data Agnostic: the independence from data enables transmission of any type or content of data, in any user-defined form.
- Open standard protocol, based on TCP/IP.
- Quality of Service (QoS) levels determines how messages will be delivered and are used to assure of delivery of messages.
- Built-in mechanism for connection monitoring.

The MQTT protocol has been selected for data communication in the automotive use case (UC2), it represents the link between the vehicle, with the Kura IoT framework, and the data broker of the cloud platform.

During the first part of CONTREX project, Eurotech has been involved in the OASIS Consortium standardisation activities related to MQTT.

The OASIS Message Queuing Telemetry Transport (MQTT) Technical Committee members have recently approved a Committee Specification Draft (CSD) and submitted this specification for 30-day public review: MQTT Version 3.1.1, Committee Specification Draft 01 / Public Review Draft 01, 12 December 2013.

The related press release can be found at the following address [9]:

https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=mqtt

The MQTT Version 3.1.1 OASIS Standard has been ratified on 29 October 2014 and is available at the address:

http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/mqtt-v3.1.1.html

Recently, the protocol has been approved for release by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). Version 3.1.1 of MQTT was balloted through the Joint Technical Committee on Information Technology (JTC1) of ISO and IEC and given the designation 'ISO/IEC 20922'.

As ISO/IEC 20922, this International Standard will continue to be maintained and advanced by the OASIS MQTT Technical Committee.

The Joint Technical Committee (JTC 1) [15], Information technology, of International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC), is a consensus-based, globally relevant, voluntary international standards group. Its main role is the specification of worldwide Information and Communication Technology (ICT)

Standards in the context of business and consumer applications. Since 1987, ISO/IEC JTC 1 has brought about a number of very successful and relevant information and communication technologies (ICT) Standards in many fields: IC cards (smart cards), automatic identification and data capture (AIDC) technologies, information security, biometrics, cloud computing, multimedia (MPEG), database query and programming languages as well as character sets, to name just a few.

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