**O**pen
**S**ource
**A**utomation
**D**evelopment
**L**ab eG

OSADL eG · Im Neuenheimer Feld 583 · D-69120 Heidelberg

# Building an Open Source OPC UA over TSN Ecosystem
# Project phase #4: “open62541 improvements”
# Letter of Intent (V05, July 6, 2022)

This Letter of Intent is signed between

_____

hereafter Open Source OPC UA over TSN Ecosystem participant or participant

and the

Open Source Automation Development Lab (OSADL) eG, Heidelberg, Germany

hereafter OSADL.

## *Introduction and overview about previous project phases*

The following information on page 1 to 4 is given here only in order to understand the history and the context of the current project phase, but has no contractual significance.

A rapidly growing number of companies and organizations is fostering the development of a standardized method for real-time network communication based on OPC UA as platform protocol and Time Sensitive Networking (TSN) as link layer. This broad interest has led to the open62541 project (https://open62541.org/). It was founded to provide an OPC UA implementation that can be freely copied and distributed under the Mozilla 2.0 Open Source license.

The next important evolution of OPC UA after having implemented the base technology were the Publish/Subscribe (PubSub) components to allow for a connection-less and, thus, resource saving communication suitable for the low-power devices that are expected to be used throughout the future Internet of Things. For this purpose, Fraunhofer IOSB in Karlsruhe, Germany, Kalycito Infotech Private Limited, India and the Open Source Automation Development Lab (OSADL) founded a joint interest working group. This group launched a community project and distributed a call for contributions in form of a Letter of Intent of project phase #1. This Letter of Intent was signed by the working group participants

a) Heidelberger Druckmaschinen AG
b) Kontron AG
c) Linutronix GmbH
d) Pilz GmbH & Co. KG
e) SICK AG
f) TQ-Systems GmbH

which resulted in sufficient funding to execute the project in addition to the contributions made by Fraunhofer IOSB, Kalycito Infotech and OSADL.

The software that was created during the project phase #1 from January to March 2018 was merged gradually into the existing open62541 repository in April 2018. The implemented features are

a) brokerless OPC UA PubSub via IP multicast and the binary message encoding format according to the draft of part 14 of the OPC UA specification,
b) integration of the publisher in a regular OPC UA server with additional real-time interrupting,
c) implementation of the subscribers as standalone software, and
d) a first step towards secure client/server communication.

In a subsequent phase #2 of the project in 2019, throughput of the OPC UA stack was improved among other by adding a fast message path in order to further pave the way towards low-latency real-time communication. In addition, a number of lacking features have been added and adapted to the standard – a work that was crowned by the successful OPC Foundation certification of an OPC UA server built with the open62541 SDK according to the "Micro Embedded Device Server" profile. Last not least, a four-node network demonstrator was built around Intel Apollo Lake processors equipped with I210 network adapters that are connected via Altera SOCFPGA TSN-capable switches made by Kontron and loaded with TTTech switch software. This demonstrator was used to establish and benchmark newly added network interface features of OPC UA PubSub over TSN. The Letter of Intent of phase #2 of the project was signed, among other, by the following participants

a) Intel Corp.
b) iss innovative software services GmbH/Balluff GmbH
c) Kontron Europe GmbH
d) Nestfield Co. Ltd
e) Pepperl+Fuchs GmbH
f) Siemens AG
g) WIKA Mobile Control GmbH

In phase #3 of the project the OPC UA stack open62541 has been successfully developed further and has meanwhile become the second most used OPC UA stack worldwide. The certification according to the "Standard UA Server" profile is also part of phase #3. An outstanding achievement of phase #3 was the complete implementation of an encryption layer, so that the requirements for PubSub security are now met. With the help of a Quick Start Guide under an Open Source license that was developed as part of the project, interested individuals can set up an OPC UA PubSub connection over TSN and run own performance tests between two Intel systems that are equipped with a standard Linux distribution. The included instructions explain the steps to set up real-time Linux and to run examples of publisher and subscriber applications on one of the two systems respectively. These applications use bandwidth reservation and timestamp-based transmission of network packets, and the maximum latency between the theoretical and the actually measured arrival time of the network packets is provided as result. If the systems are correctly configured, the measured latency is of the same order of magnitude as the system latency; this proves that an ideal real-time Ethernet connection was created. Thus, the real-time Ethernet set of methods that OPC UA PubSub over TSN provides qualifies as a worthy Open Source successor to the existing predominantly proprietary protocols and for the first time opens up novel end-to-end communication concepts from the sensor to the cloud.

The Letter of Intent of phase #3 of the project was signed by the following participants

a) ABB Automation GmbH
b) Arm Limited
c) B&R Industrial Automation GmbH
d) Intel Corporation
e) Kontron Europe GmbH
f) Siemens AG

The support of all participants is gratefully acknowledged. All above mentioned companies participating in the project have made a significant contribution to the technological progress of the automation industry, which is recognized and appreciated.

The Open Source licensed OPC UA software open62541 including all above mentioned features and example applications can be accessed via Github at the URL https://github.com/open62541/open62541/. A quick-start guide and a performance measurements whitepaper is available at https://www.kalycito.com/how-to-run-opc-ua-open62541-with-realtime-pubsub-on-realtime-linux-and-tsn-from-source/. In addition, a technology demonstrator that continuously runs a peer-to-peer OPC UA PubSub over TSN network link and monitors its round-trip time was hosted at OSADL and could be inspected publicly.

The final steering committee meeting of phase #3 happened on January 11, 2022. The following were the main outcomes:

1. All participants agreed to consider the work outlined in the Letter of Intent of phase #3 complete.
2. Fraunhofer IOSB committed to complete the certification for “Standard UA Server” profile in 2022.
3. It was also announced that an online survey will be launched to find out the features to be focused on during a possible phase #4.

This survey was announced to happen between January 25, 2022 and February 21, 2022, but some more inputs were taken into consideration for a short period after that. It is clear that though the survey participants had responded positively to contributing in the amount of up to EUR 200,000, there were several interest groups and not all groups were interested in all the items.

## Operative partner companies of former project phases

1 Fraunhofer IOSB
Fraunhofer IOSB (Institute of Optronics, System Technologies and Image Exploitation) is based in Karlsruhe, Germany, and its department of Information Management and Production Control has a long history of successfully developing and researching solutions for the design, operation and maintenance of information, control and test systems. As one of these activities they provide the maintainership of the open62541 project and have largely been contributing to the project.

2 Kalycito Infotech
Kalycito Infotech helps leading machine builders and automation OEMs globally with consulting and integration services. The company very early identified the potential behind the open62541 stack, PubSub and TSN as candidates to become a universal communication standard from field level to the cloud. Kalycito triggered the initial move and funded Fraunhofer IOSB to develop the PubSub parts under an Open Source license suitable for industry and to build an ecosystem around it.

## Relation between the OSADL initiative to foster the OPC UA PubSub over TSN development and the open62541 project

The open62541 project is a community-led Open Source project. A group of maintainers ensures the long-term development. The OSADL project “Building an Open Source OPC UA over TSN Ecosystem” supports the open62541 project for well defined development goals on a midterm timeline. Fraunhofer IOSB, one of the open62541 project maintainers, supports the OSADL initiative to foster the development of OPC UA PubSub over TSN. This includes assistance for development suppliers with the goal to merge the results into the mainline repository of the open62541 project.

### *Letter of Intent of project phase #4 of the community project*

There is now an Open Source licensed OPC UA SDK available to be used by industry to create a state-of-the-art OPC UA server that can be certified by OPC Foundation to adhere to the “Standard UA Server” profile.

In addition, a PubSub implementation is available that meets the requirements for PubSub security and allows using Virtual Local Area Network (IEEE 802.1Q) along with components of Time-Sensitive Networking (TSN) such as high-precision time synchronization (802.1AS) and time-aware traffic shaping (IEEE 802.1Qbv) to establish real-time communication via Ethernet. A Quick Start Guide helps interested parties to test a OPC UA PubSub connection over TSN between two Intel systems.

Due to the great demand from the project participants and other interested parties, it was decided to launch phase #4 of the community project. Since the outcome of the above mentioned survey showed a wide range of different topics and, as it turned out in phase #3, it is rather difficult to synchronize OPC UA development activities on the one side and PubSub TSN activities on the other side, a clear focus for phase #4 had to be chosen. Based on the feedback and priorities given by several stakeholders phase #4 will concentrate on further improvements of the open62541 community project.

## Project funding and management

The project will be hosted and managed by the Open Source Automation Development Lab (OSADL). OSADL is a registered cooperative based in Heidelberg, Germany. It was founded in 2005 to provide support for industry when using Open Source software in products. OSADL provides services that are requested by its members but makes many of them available not only to its members, but also to the entire community. These services comprise software development, hardware and software quality assessment as well as legal support, project management and consulting. OSADL is a member of the OPC foundation.

Phase #4 will be organized in form of a so-called mixed-funded project, i.e. a subgroup of OSADL members and non-members is formed who contribute to the project. Project management, software development and testing provided by OSADL is partly funded by the project and partly provided from the regular annual OSADL budget while employing existing office and laboratory infrastructure. Deciding which components to develop with which priority is done according to a poll among the participants while taking into consideration the number of votes of their contribution level (see chapter “Contribution levels”). The work packages will be distributed among selected project partners and suppliers. In any case, suppliers will be asked to submit offers for selected work packages which will then be commissioned by OSADL according to usual business practices. Progress reporting and adjustment of the priorities will happen in a steering committee which will meet on a monthly basis. The steering committee will consist of the project partners and delegates of project participants who would like to make use of this right.

## Potential suppliers

- basysKom GmbH, Darmstadt (Germany)
- BE.services GmbH, Kempten (Germany)
- Fraunhofer IOSB, Karlsruhe (Germany)
- Kalycito Infotech Private Limited, Coimbatore (India)
- KEBA Industrial Automation GmbH, Linz (Austria)

## Open Source policy

OSADL wholeheartedly agrees and adheres to the principles of community funded Open Source software development:

- Release early, release often
- Manage everything as transparently as possible
- Do not retain any community funded material for proprietary purposes

## Licensing

Every software component that is uploaded to the open62541 project and is intended to finally be copied and distributed to end customers will be licensed under the Mozilla 2.0 (MPL-2.0) license. This license is an internationally accepted Open Source license with a so-called restricted (“weak”) copyleft. In consequence, the mandatory unrestricted rights of an Open Source license to use, analyze, modify and convey the software are granted. In turn, copyright notices and the license text must be made available to recipients when conveying the code. In addition, recipients of a binary delivery must be informed “how they can obtain a copy of” the source code “by reasonable means in a timely manner, at a charge no more than the cost of distribution to the recipient”. Software that merely links to such MPL-2.0 licensed software can be distributed under a license of choice of the owner. Example code and similar material not intended to be copied and distributed is and will be licensed under the Creative Commons Zero v1.0 Universal (CC0-1.0) that does not impose any license obligations. It is conceivable that in the course of the project patches to the Linux kernel may need to be applied. In this case, such code that is intended to be combined with the Linux kernel will be licensed under a GPL-2.0-only license.

## Confidentiality and IP Issues

Any contribution or communication will be kept confidential on request of the Open Source OPC UA over TSN Ecosystem participants with the only exception that the developed software will be made publicly available under Open Source licenses as outlined above.

## Contribution levels

There are the following four contribution levels that participants may select from:

| | Contribution amount (euros) | |
|---|---|---|
| Contribution level | OSADL member | Not OSADL member |
| Silver | 5,000.00 | 7,500.00 |
| Gold | 10,000.00 | 15,000.00 |
| Platinum | 20,000.00 | 30,000.00 |
| Diamond | 30,000.00 | 45,000.00 |

Participants can also contribute by providing developer resources. The contribution level will then be based on a valuation of the work: One month (20 work days of 8 hours) is considered the equivalent to a financial contribution of 10,000 euros. In the case of participation with staff, a close communication and support channel to the core developers of the particular component will be provided.

## Benefits of the various contribution levels

Participants enjoy a number of benefits that are graded according to the contribution level as given in the following table:

| Contribution level | Logo display and listed as contributor | Certification assistance | Number of votes when deciding on the development priority of components |
|---|---|---|---|
| Silver | yes | no | 1 |
| Gold | yes | no | 2 |
| Platinum | yes | yes | 4 |
| Diamond | yes | yes | 6 |

## Overall budget and schedule

The overall budget to provide the below given software components is estimated to amount to about 100,000 euros. However, the project will already be launched if and when a minimum funding threshold of 30,000 euros has been reached. If this is also the final budget, some of the software components listed below will only have a partial or even rudimentary or even no implementation at all. The more budget will be available, the more software components will be developed and reach production quality. It is therefore expected that project participants will also join in after the start of the project which will be possible during its entire duration. The project is intended to start latest on August 31, 2022 and will last as long as project funds are available.

## Deliverables

In contrast to conventional software development projects where the software is normally directly delivered to the project managers and/or collaborating parties, the entire software developed throughout this project will either be uploaded to the repository of the open62541project or, if applicable, submitted to the relevant mailing lists. Whenever a significant portion of the developed software is upgraded or added, or a relevant mile-stone is reached the project participants will be notified.

## Tasks and priorities

The project activities are broken down into the work packages described below. All follow-ing software components planned to be developed and support planned to be delivered will be governed under the conditions of this Letter of Intent:

Project #4: open62541 improvements

*High priority:*

- Load and store information data model at run time through configuration file (not statically compiled in firmware)
- Implement “reverse connect feature” as described in "OPC 10000-7 - Part 7: Profiles", chapters 6.6.5 Reverse Connect Server Facet and 6.6.75 Reverse Connect Client Facet
- Complement the ongoing project to update the OPC client/server release to version 1.05 without overlapping with the parts already commissioned
- Implement support of PubSub state machine according to OPC10000-14, chapter 6.2.1

*Medium priority:*

- Companion specification selection in the build system for fast integration

- Automatic size-reduction of the information model by white-listing and dependency resolution

*Low priority:*

- Further CPU and memory optimizations for resource constrained devices (identify, document and implement optimizations for memory and CPU footprint)

## Agreed intent

By signing this Letter of Intent, the Open Source OPC UA over TSN Ecosystem participant agrees to accept the conditions outlined here. When the funding threshold is reached, this Letter of Intent is converted into a definitive agreement and is concluded without further action. At the same time, the committed funding is becoming due.

## Termination of the agreement

This agreement shall terminate on the same date that the provided project funding is exhausted, without the need for express notice of termination.

## Place of jurisdiction

This Letter of Intent will be governed by the laws of Germany, except for its conflicts of laws principles. The place of jurisdiction for all disputes arising from or in connection with this Letter of Intent shall be Mannheim, Germany.

## Contribution level

### *Financial contribution:*

| Selection (please tick) | | Contribution amount (euros) | |
|---|---|---|---|
| | Contribution level | OSADL member | Not OSADL member |
| □ | Silver | 5,000.00 | 7,500.00 |
| □ | Gold | 10,000.00 | 15,000.00 |
| □ | Platinum | 20,000.00 | 30,000.00 |
| □ | Diamond | 30,000.00 | 45,000.00 |

### *OR contribution of development resources:*

| Selection (please tick) | | Contribution amount (work days) | |
|---|---|---|---|
| | Contribution level | OSADL member | Not OSADL member |
| □ | Silver | 10 days | 15 days |
| □ | Gold | 20 days | 30 days |
| □ | Platinum | 40 days | 60 days |
| □ | Diamond | 60 days | 90 days |

## Signatures

Open Source OPC UA over TSN Ecosystem participant:

Name of the company:

Location:

Date:

Name(s) of the signatory or signatories:

Signature(s):

Open Source Automation Development Lab (OSADL) eG:

Location:

Date:

General Manager or OSADL Director:

Signature: