Open Source OPC UA over TSN Ecosystem

Project phase #4: “open62541 feature improvements”

Why OPC UA?

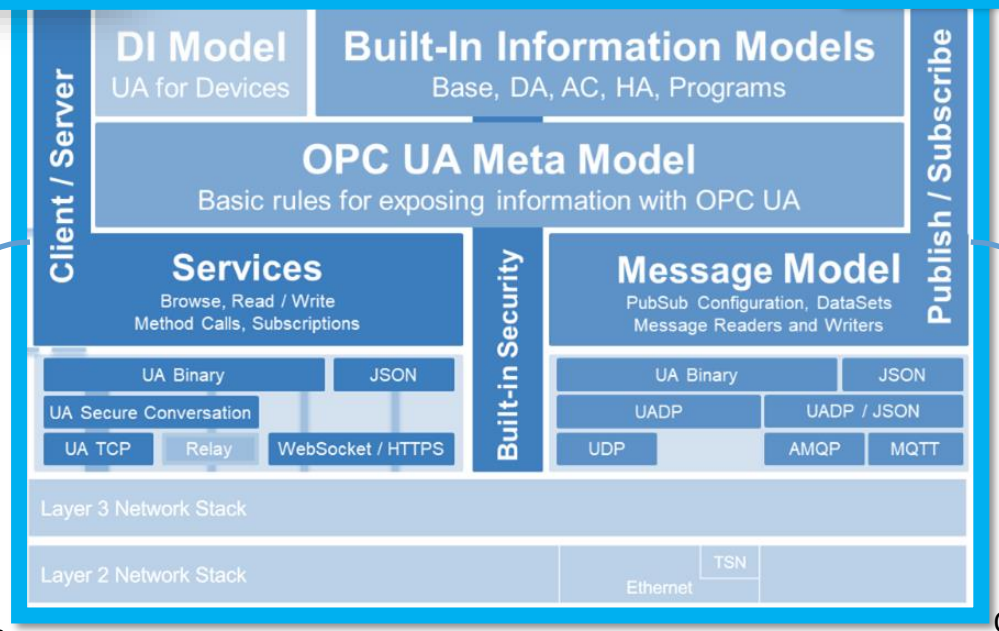
OPC UA has travelled some distance in the endeavor of

- being the “English” language of the equipment world
- through its industry widespread adoption, cooperation and collaboration and
- enabling digitization and Industry 4.0 use-cases by offering an Open Platform for Communications & an Unified Architecture

Unlike MQTT, OPC UA is a complete package – both horizontal and vertical use-cases!

Domain Specific Information Models

Oil and gas
Plastics and rubber machinery
CNC machine tools
Packaging machinery
etc.



Client/Server

Browse information model for device capabilities

Read and write current and historical data

Execute actions through method calls

Data change and event notifications

Pub/Sub

One-to-one and one-to-many communications

High frequency data and event notifications

Power and latency constrained devices

One-to-many communications

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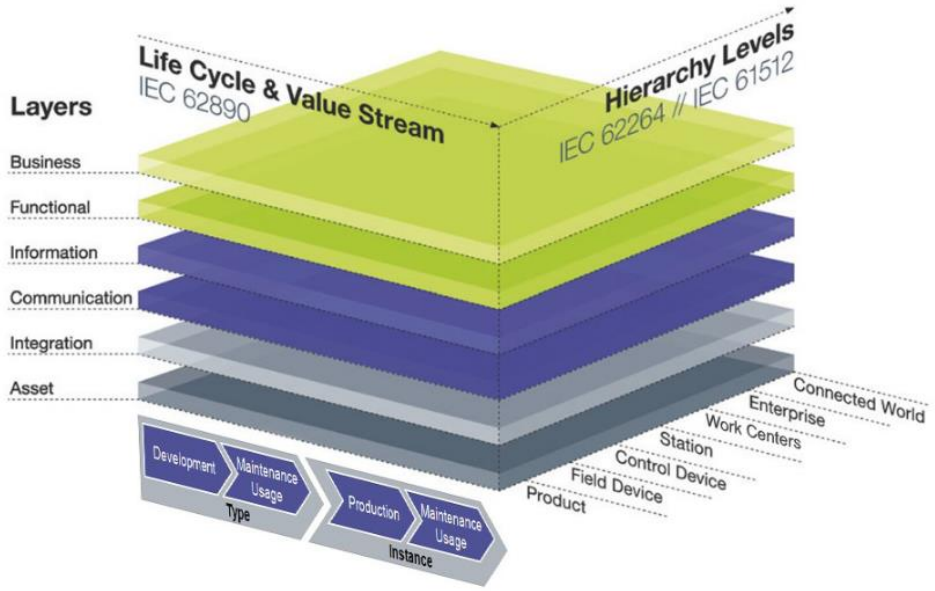
Fraunhofer IOSB

How does OPC UA fit into Industry 4.0?

OPC UA has been recommended as an important technology in the implementation strategy of the Industry 4.0 platform.
-Platform Industrie 4.0
https://www.plattform-i40.de/PI40/Redaktion/EN/Downloads/Publikation/secure-implementation-of-opc.pdf?__blob=publicationFile&v=5

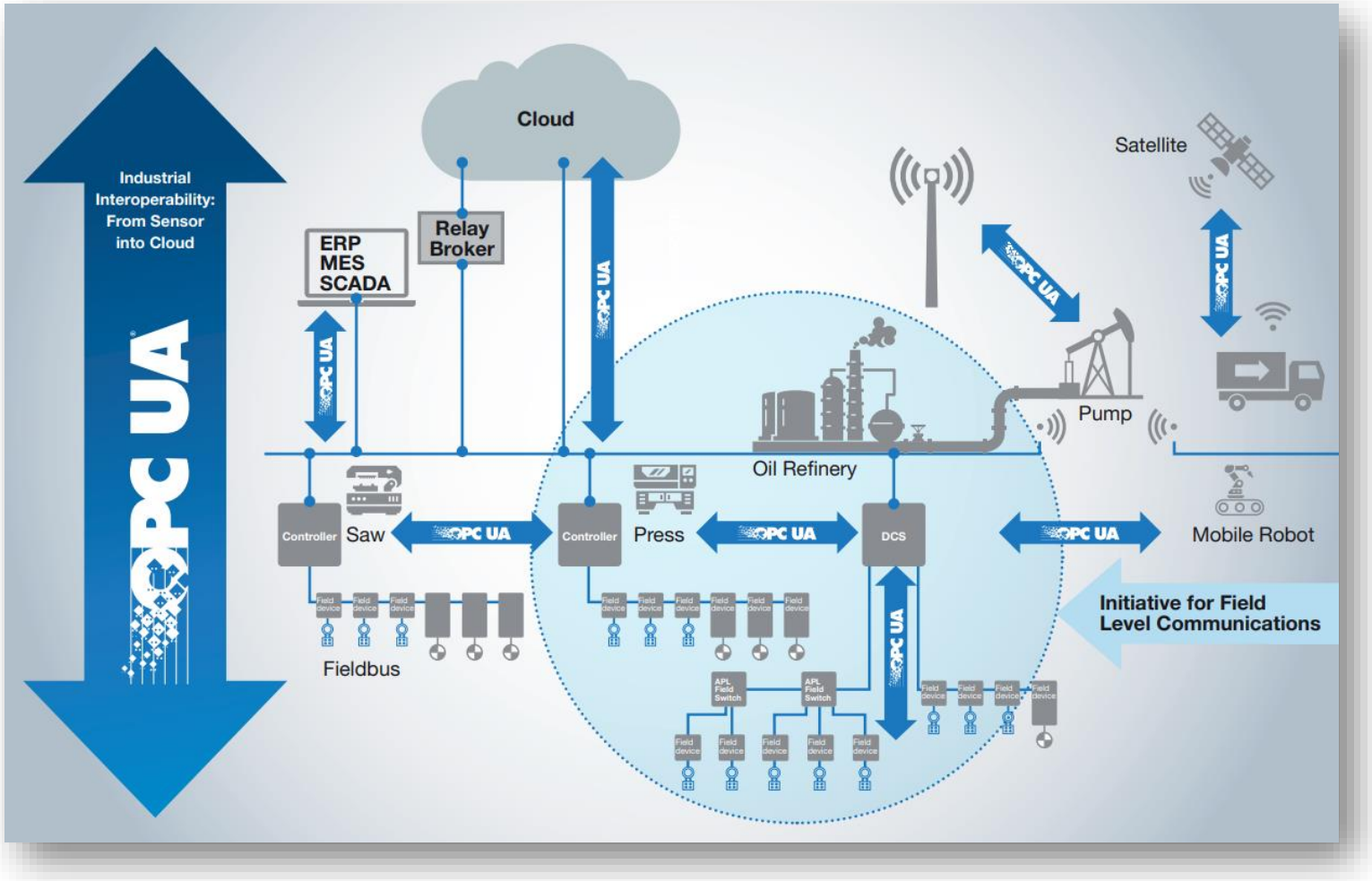
OPC-UA IS THE COMMUNICATION TECHNOLOGY IN RAMI4.0
-OPC Foundation
https://opcfoundation.org/wp-content/uploads/2016/05/OPC-UA-Interoperability-For-Industrie4-and-IoT-EN-v5.pdf

RAMI 4.0



OPC UA Field Level Communications

Why OPC UA Field Level Communications?



Security by design

Interoperability by design

Enable all Industrial use-cases (IEEE 60802)

Realtime pub/sub and scaling down to embedded devices

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OPC Foundation & OPC Field Level Communications Steering Committee

OPC Foundation

Board of Directors

Mitsubishi Electric, Ascolab, ABB, Siemens AG, BECKHOFF, Schneider Electric, Honeywell Process Solutions, Microsoft, Yokogawa, SAP SE, Rockwell Automation

Members companies

Over 884 typically from small system integrators to the world's largest automation and industrial suppliers.

FLC steering committee

Nearly all major automation suppliers are part of this group

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OPC UA & Leading IoT Vendors

Leading IoT Vendors Commit to OPC UA Adoption

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Open Source Ecosystem for OPC UA

Why Open Source

Going forward

You will see open source becoming a critical part of your commercial solutions

Standard Hardware

- Intel x86, ARM, FPGA
- IEEE 802.1 AS
- IEEE 802.1 Qbv, etc

Standard interfaces for Industry 4.0

will result in common software components to be delivered via collaborative effort

Standard Software

- Linux Kernel 5.18+
- Realtime Linux (PREMPT_RT is now a mainline)
- Linuxptp 3.0+
- Iproute 2+
- Open62541 1.3+

Landscape is complex

Open-source projects enable sharing of costs and lets you invest more on your core differentiators

Why this community project?

- Lean, Scalable, Standards-based, Secure, Open-Source path for customers to achieve:
  - real-time machine-to-machine applications, as well as
  - simplified cloud integration
- Top Goals of Phase 4
  - Update stack to comply with evolving specifications
  - Feature enhancement and optimization for resource-constrained devices

Why should I spend money on an open-source project?

- OPC UA is a standard - it is not your core differentiator
- You can
  - Share cost of development
  - Avoid duplication of work
  - Reduce standard compliance and certification effort
  - Reduce after sales support cost – interoperability surprises from the field
- By investing money in open source, you can have a say in prioritizing features that you need and also influence the long-term roadmap of the project

If its already a successful project, then why should I fund now?

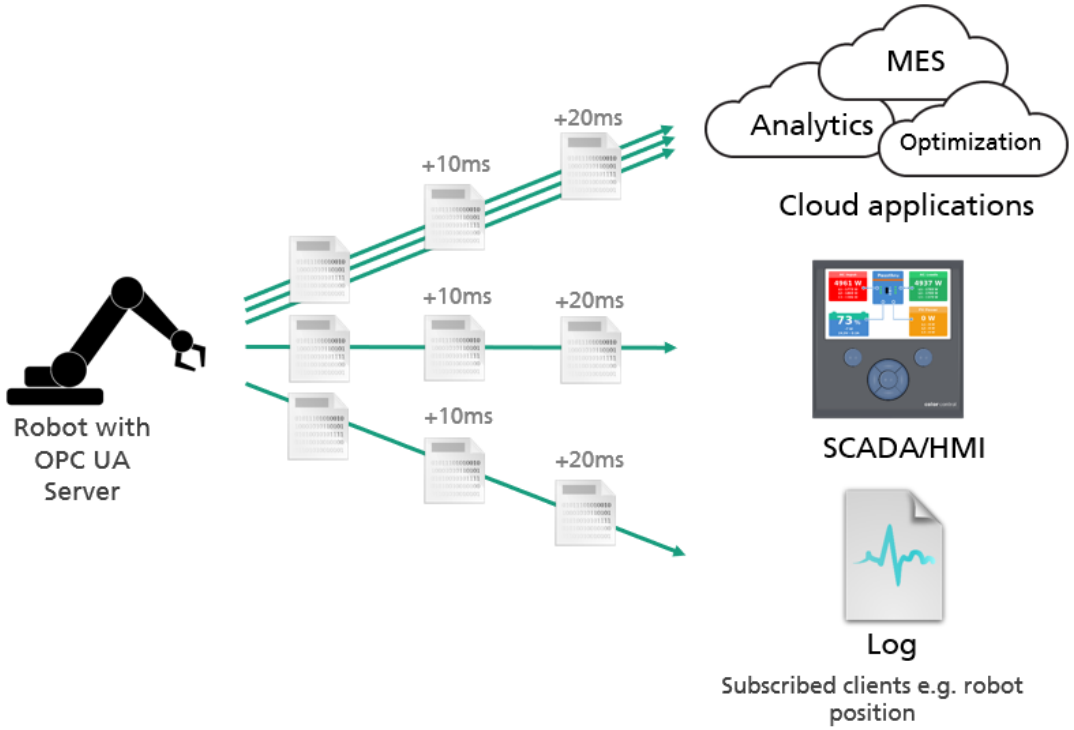
- Phase 1 added PubSub
- Phase 2 certified the stack for micro-embedded & optimized for CPU cycles
- Phase 3
  - Focused on PubSub TPM security and test infrastructure for monitoring 24x7 using munin
  - Stack will be ready for Standard profile certification by 2022
- Phase 4 will focus on open62541 feature improvements with
  - Customer feedback related to ease of use
  - Update stack to complying with evolving specifications
  - Feature enhancement and optimization for resource-constrained devices

Why open62541?

open62541

- Open Source OPC UA SDK (Stack / Server / Client / PubSub)
- Licensed under the MPLv2 (weak copyleft)
- Professional Development Processes and Continuous Integration
  - 80%+ test coverage
  - Static Code Analyzers
  - Runtime Sanitizers
  - Build on several Platforms and Setups
- Used in commercial products
- Extended Plugin concept for ease of integration and customization

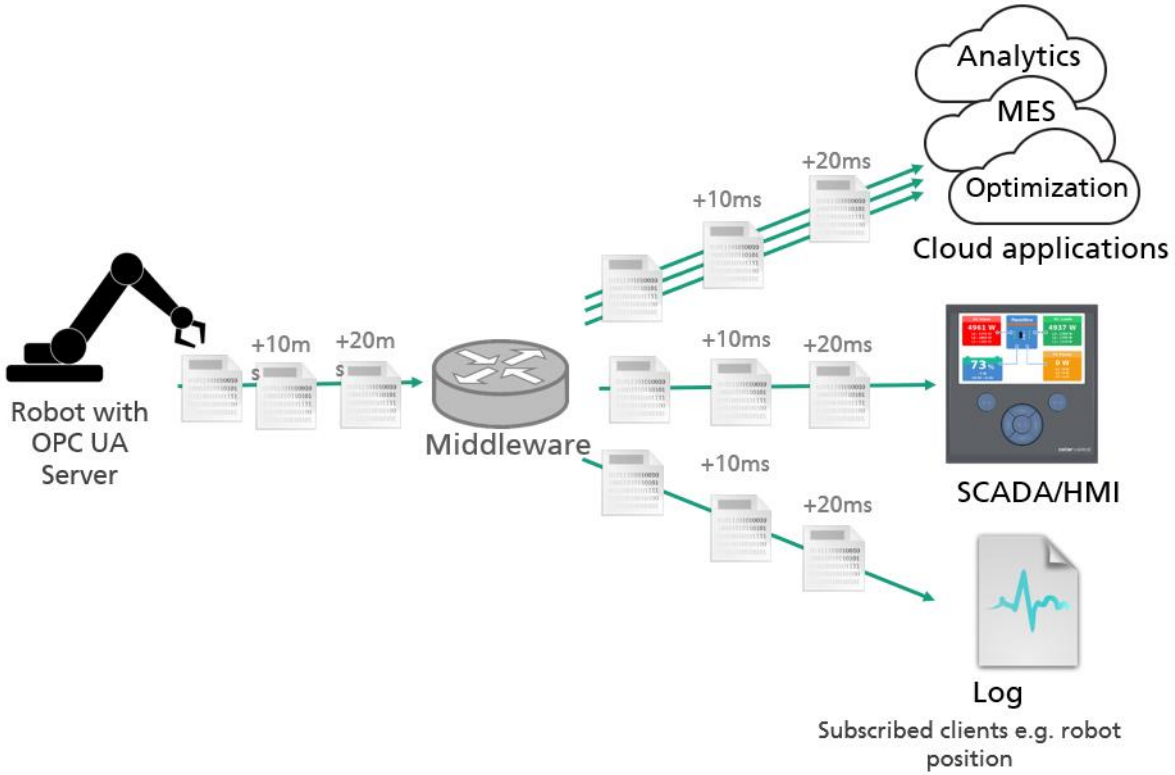
Why PubSub?



OPC UA **without** PubSub

OPC UA Server Load : e.g. 5 Clients @ 10ms

msg per sec * devices = 100 * 5 = 500 msg/sec



OPC UA **with** PubSub

OPC UA Server Load : e.g. 5 Clients @ 10ms

msg per sec = 100 msg/sec (const)

Deliverables

LoI Phase #1

- Deliverables
  - Brokerless OPC UA PubSub with binary message encoding via IP multicast
  - Integration of the publisher in a regular OPC UA server with additional real time interrupting
  - Standalone subscriber
  - Integration of TBS in OPC UA Publisher to publish the packets at hard real time (nano second jitter)
  - First step of secure Client/Server communication
- The above deliverables were gradually merged in existing open62541 repository in April 2018

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An Open Source implementation of OPC UA Publish/Subscribe over TSN and a related demonstrator to be exhibited at Embedded World 2018 in Nuremberg, Germany

Letter of Intent (V5, January 15, 2018)

This Letter of Intent is signed between

hereafter OPC UA Pub/Sub project participant and the

Open Source Automation Development Lab (OSADL) eG, 69120 Heidelberg, Germany

hereafter OSADL.

Introduction

In order to overcome the various shortcomings of the currently available Ethernet-based industrial communication methods, it was proposed to further develop and standardize the existing OPC UA protocol and to equip it with new features requested by industry. Such features include broadcasting messages simultaneously to many listeners (Publish) and the ability to install callback mechanisms to trigger automatic message submission when a state changes (Subscribe) to avoid polling. However, for the time being there is no implementation available that includes these features and can be used by industry – either since the features simply are not available or, if available, the implementation uses a strong-copyleft Open Source license which makes it impossible to be combined with a proprietary application and to be conveyed to customers. In addition, real-time capabilities may be needed when used in industry, but they are lacking as well. It, therefore, is the aim of this Letter of Intent to launch a community project to develop an Open Source OPC UA library equipped with Publish and Subscribe features and real-time capabilities. An Open Source license shall be used that allows to deploy the library in industrial products.

Deliverables
LoI Phase #2

- Deliverables
  - Integration of TSN functionalities with user defined time triggered send (ETF) in OPC UA Brokerless PubSub Ethernet communication
  - Improvement in the real-time (RT) capabilities of PubSub
    - Faster encoding and decoding – Encode and decode only the modifiable values (datasets, timestamps, sequence number, …)
    - Introduction of external Datasource variable for the faster access of value nodes in the Information model
  - Certified SDK - The open62541 v1.0 (server_ctt sample) is certified by the OPC Foundation regarding the 'Micro Embedded Device Server' profile
  - Alpha release of OPC UA PubSub Security Layer (SKS) & MQTT

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Building an Open Source OPC UA/TSN Ecosystem

Project phase #2: "Security & Certification"

Letter of Intent, 2nd edition

(V6, January 31, 2019)

This Letter of Intent is signed between

hereafter Open Source OPC UA/TSN Ecosystem participant or simply as participant

and the

Open Source Automation Development Lab (OSADL) eG, 69120 Heidelberg, Germany

hereafter OSADL.

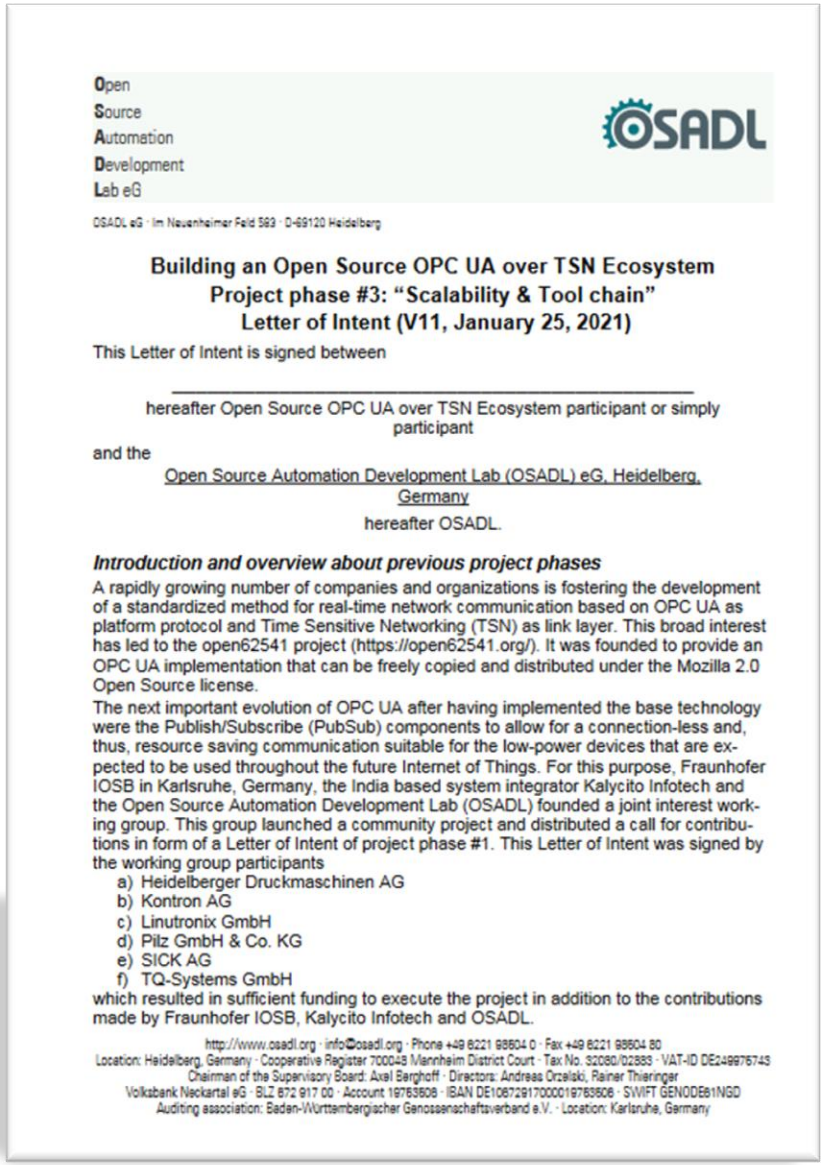
Introduction

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 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, the India based system integrator Kalycito In-

Deliverables
LoI Phase #3

- Deliverables
  - Security support for the PubSub UADP protocol
  - TPM for PubSub implementation
    - PubSub + TPM - encryption and decryption
    - PubSub + TPM - hardware key storage
  - FPM integration on top of PubSub security implementation
  - Providing certification prerequisites according to the “Full Embedded Profile” by OPC Foundation
  - Creating a new Quick Start Guide for OPC UA PubSub - monitoring 24x7 using munin
  - Stack will be ready for Standard profile certification by 2022



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Building an Open Source OPC UA over TSN Ecosystem
Project phase #3: “Scalability & Tool chain”
Letter of Intent (V11, January 25, 2021)

This Letter of Intent is signed between

hereafter Open Source OPC UA over TSN Ecosystem participant or simply participant

and the

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

hereafter OSADL.

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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.

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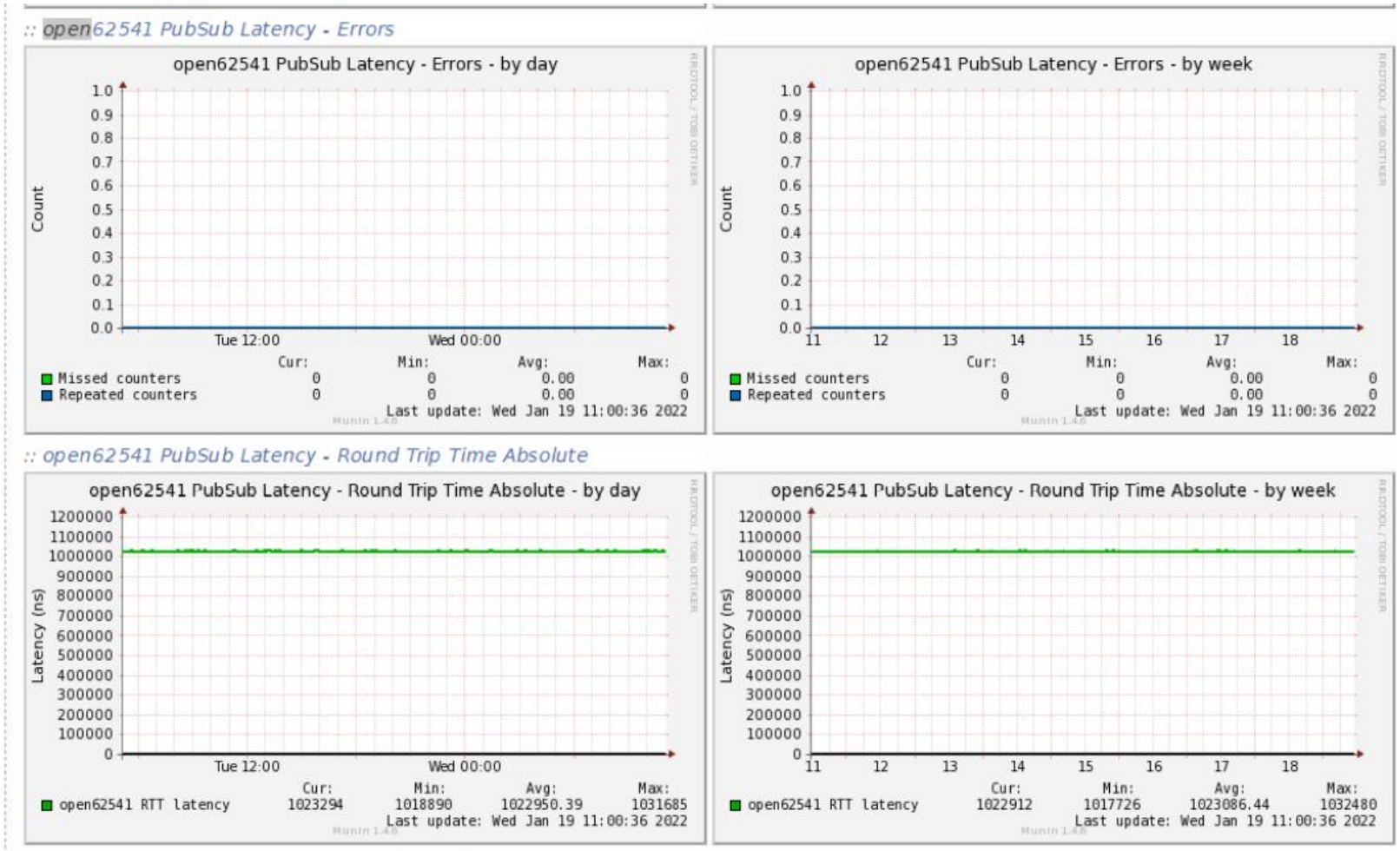
OPC UA PubSub Application

Round Trip Time @ 250us cycle time – 24x7 results



- On a 30 days long run the system was stable.
- For the entire 30 days, there were no repeated/ missed counters and the Round trip time was 4x the cycle time

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Customer feedback after phases 1, 2 and 3

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. The following are the feedback from the survey, and this serves as the input for the next phase.

- OPC UA features
- OPC UA optimizations to run on constrained hardware and freeRTOS
- OPC UA FX specification implementations
- TSN + Linux Interface Standardization

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

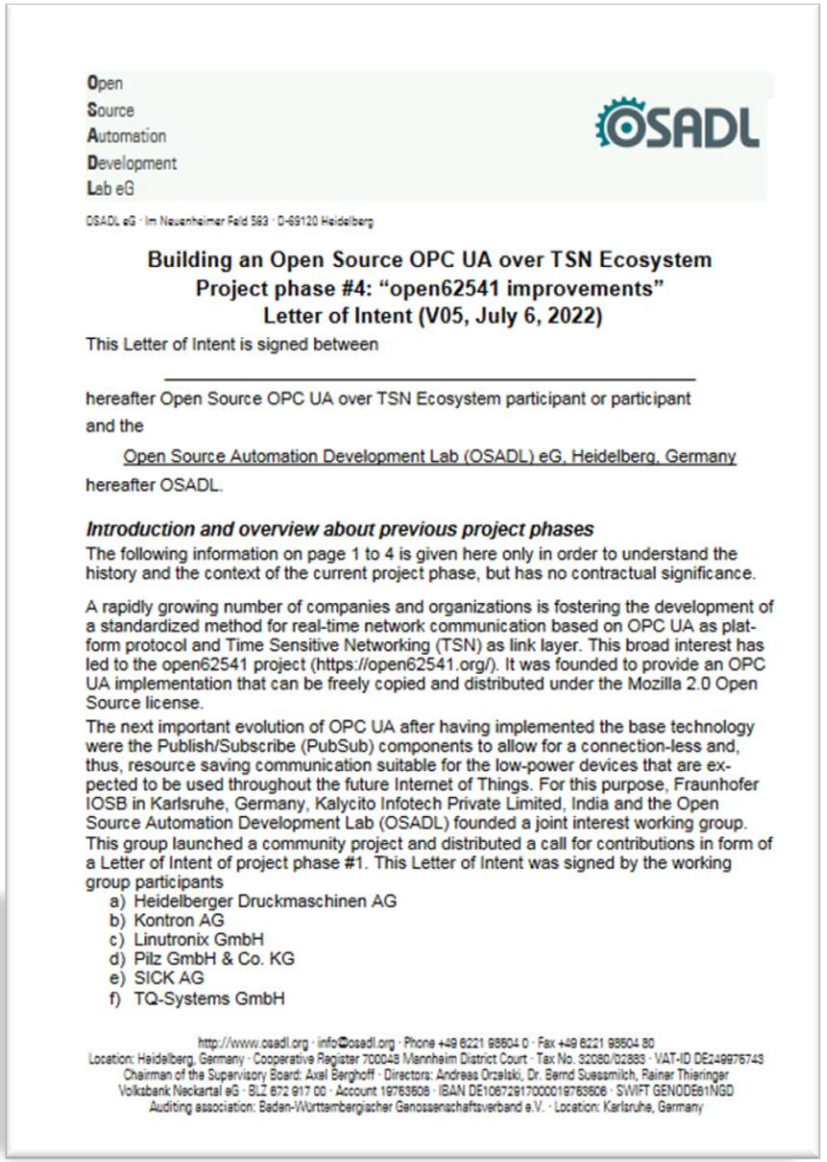
Based on the feedback and priorities given by several stakeholder's phase #4 will concentrate on further improvements of the open62541 community project. This LOI will focus on “OPC UA features“ and if more funds become available, optimizations to run on constrained hardware like freeRTOS

Phase 4: Overview

The Letter of Intent Phase 4

Subproject and priorities

- The project activities are divided into two different subprojects
  - Project #1: open62541 improvements



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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

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hereafter Open Source OPC UA over TSN Ecosystem participant or participant
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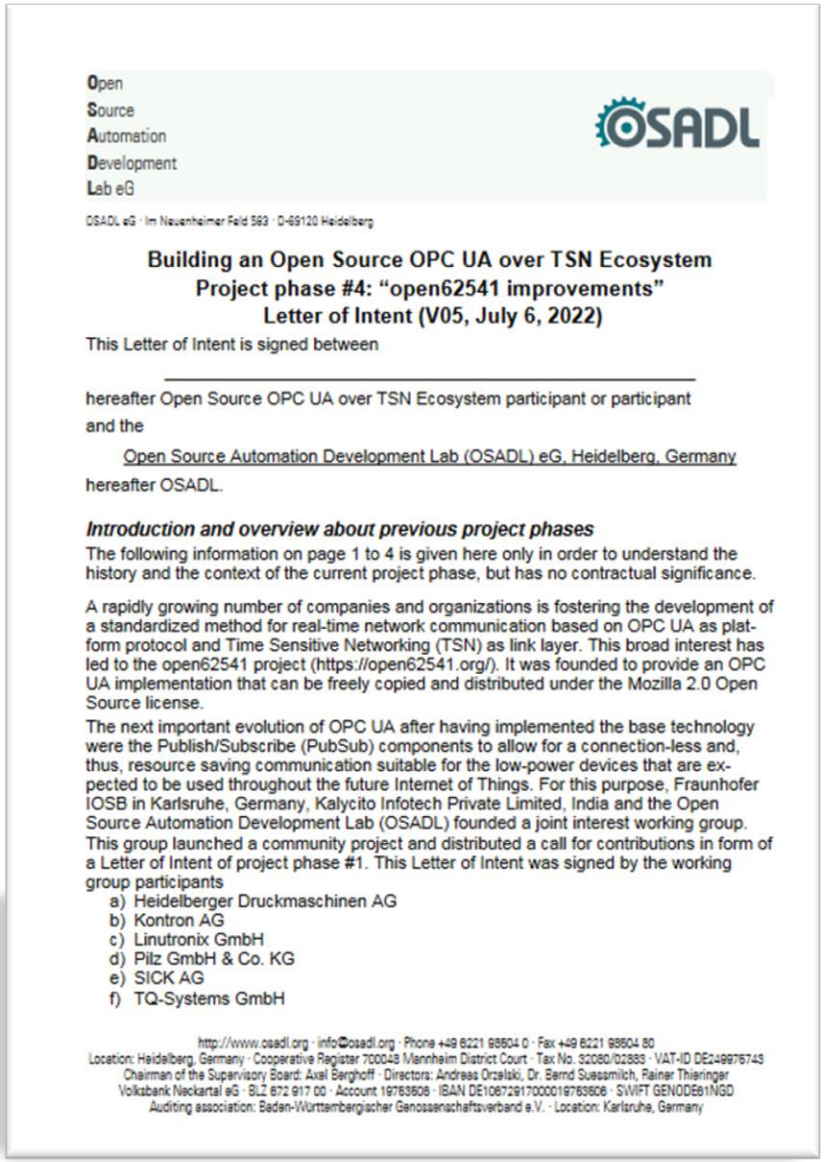
The Letter of Intent Phase 4
Project #1: open62541 improvements

- Parse 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
- Companion specification selection in the build system for fast integration
- Automatic size-reduction of the information model by white-listing and dependency resolution
- Further CPU and memory optimizations for resource constrained devices (identify, document and implement optimizations for memory and CPU footprint)



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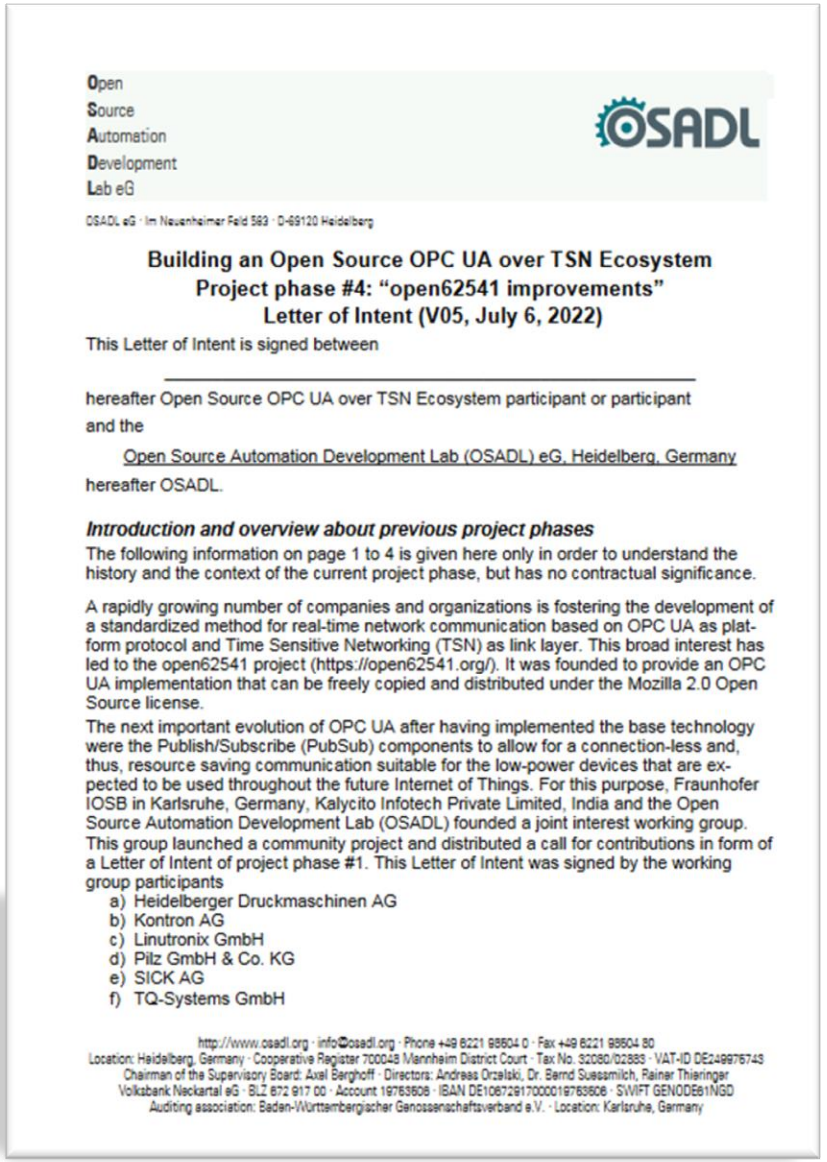
The Letter of Intent Phase 4

Project funding and management

- The project will be managed in form of a so-called OSADL 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.



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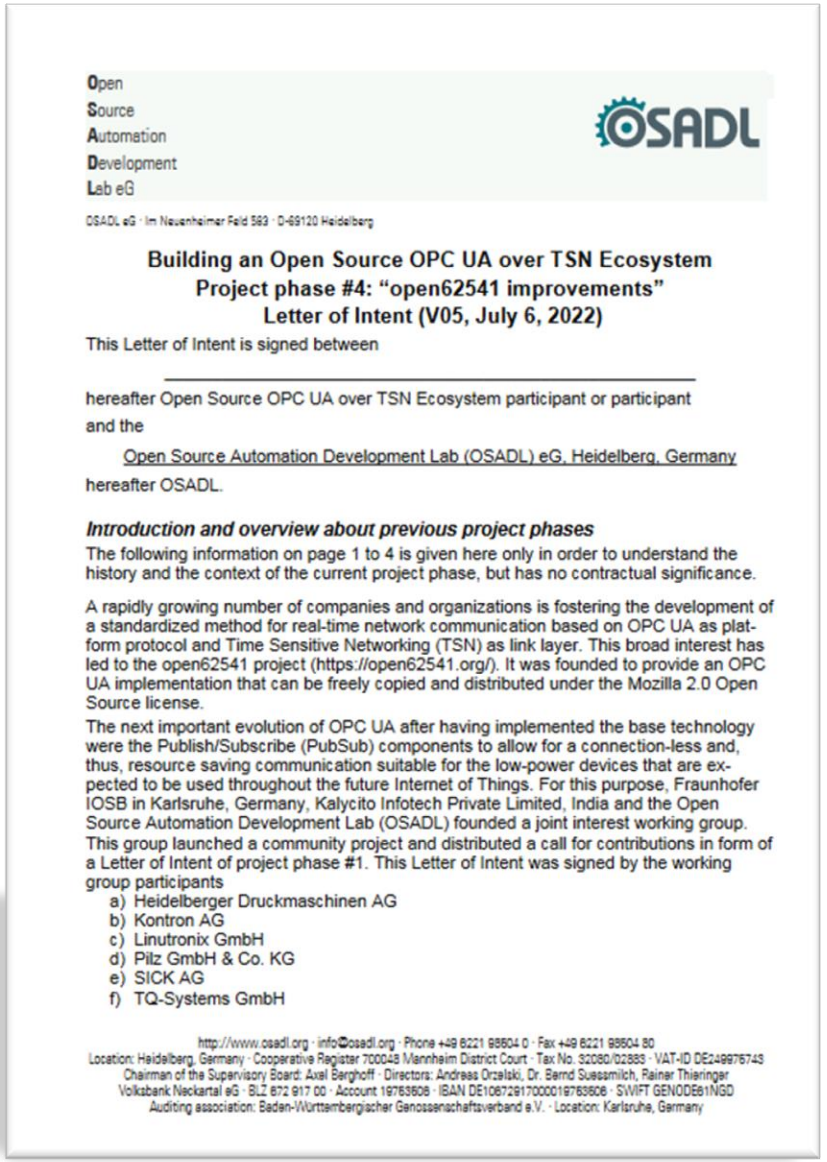
The Letter of Intent Phase 4

Contribution levels - Financial contribution

Contribution Level	OSADL Member(EUR)	Non-Members(EUR)
Silver	5,000	7,500
Gold	10,000	15,000
Platinum	20,000	30,000
Diamond	30,000	45,000



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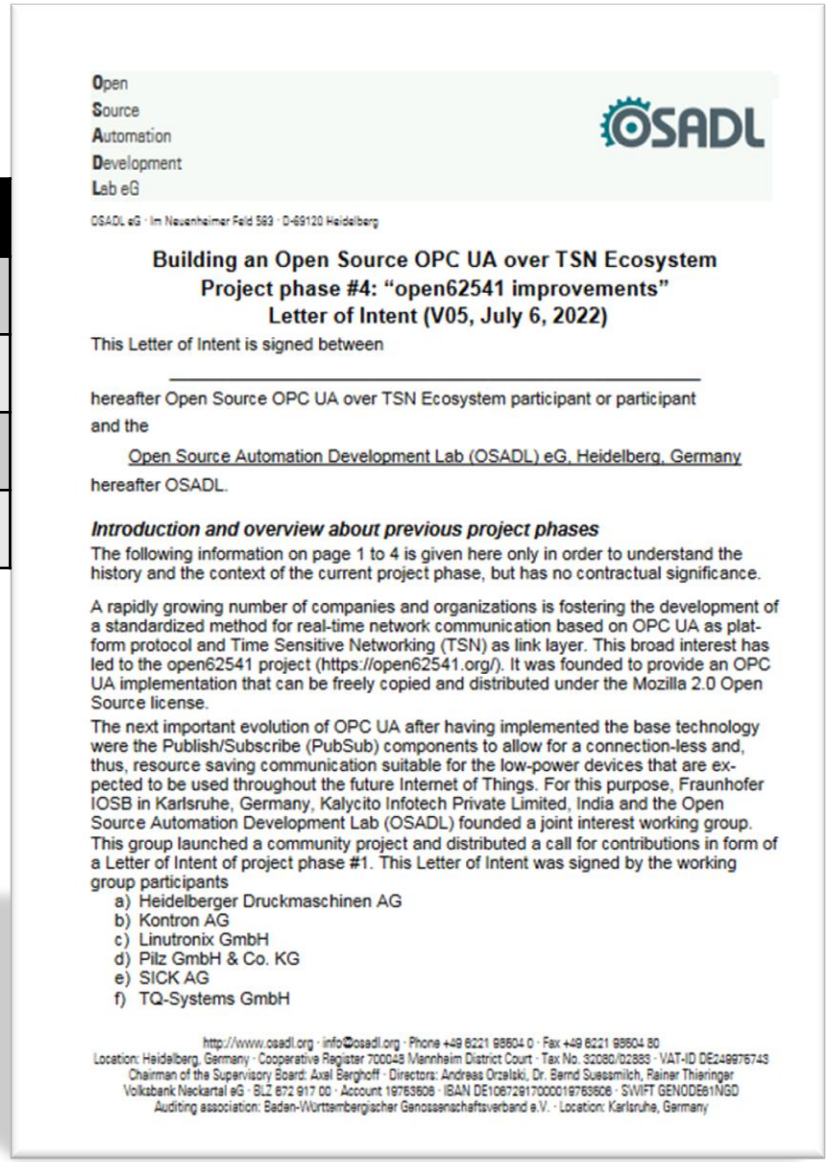
The Letter of Intent Phase 4

Contribution of development resources

Contribution Level	OSADL Member(Workdays)	Non-Members(Workdays)
Silver	10 days	15 days
Gold	20 days	30 days
Platinum	40 days	60 days
Diamond	60 days	90 days



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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

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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

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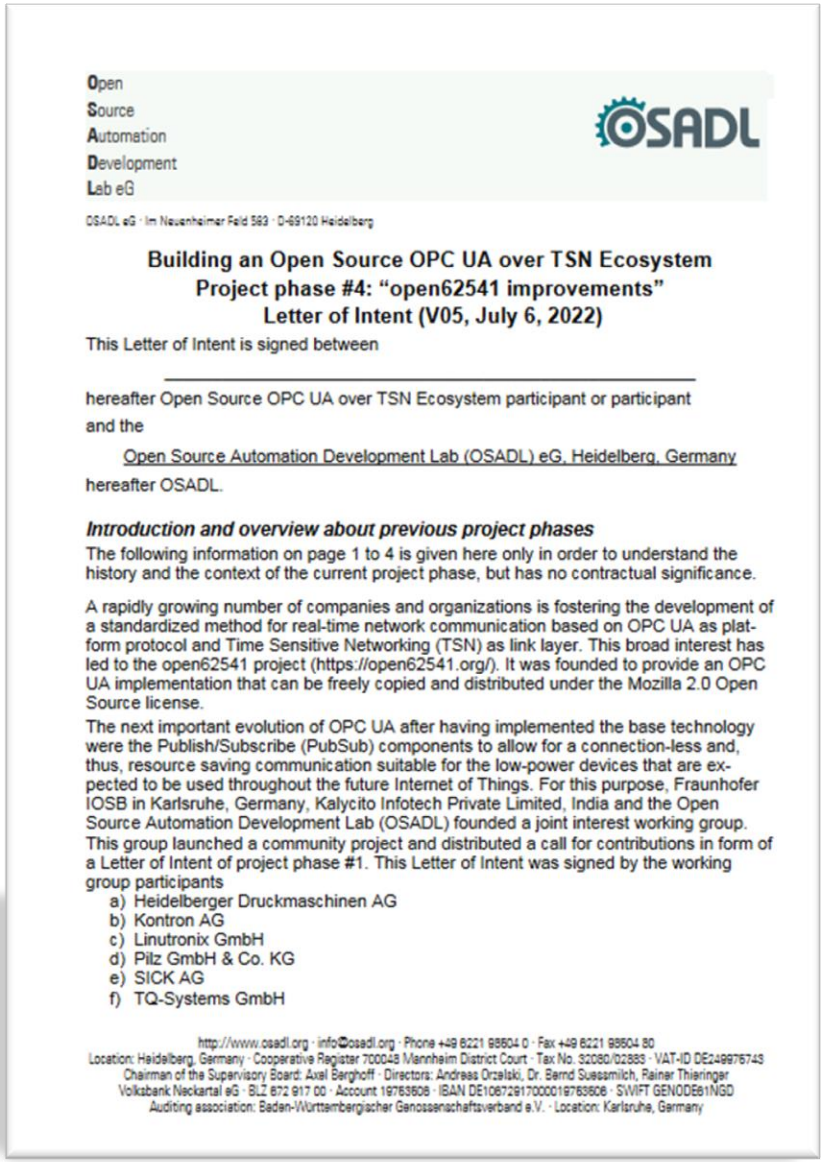
Benefit of various contribution levels

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

The Diamond contribution provides the privilege on adding the company's hardware or software components as part of the technology demonstrator that is built.



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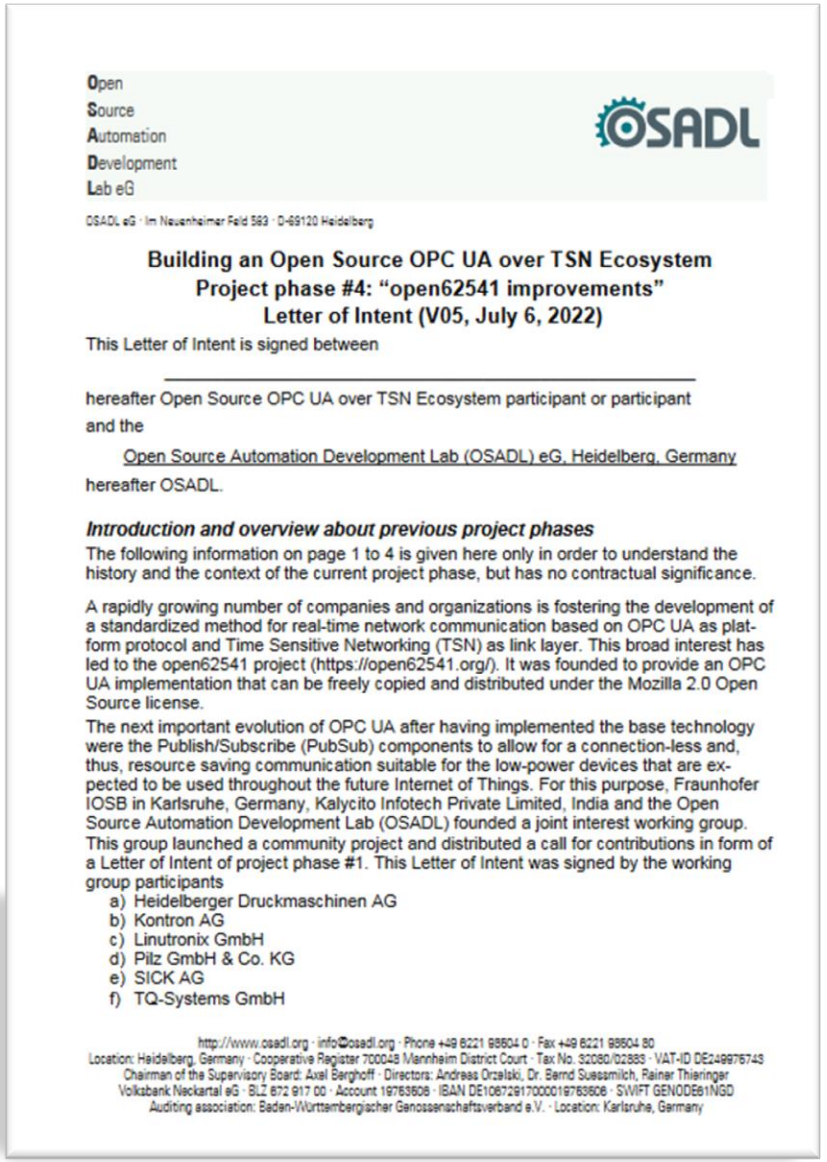
The Letter of Intent Phase 4

Overall budget and schedule

- Overall budget - 100,000 euros.
- Minimum funding threshold - 30,000 euros
- If minimum funding is available – only partial or even rudimentary software components
- The more budget will be available, the more software components will be developed and reach production
- Tentative launch date - August 31, 2022



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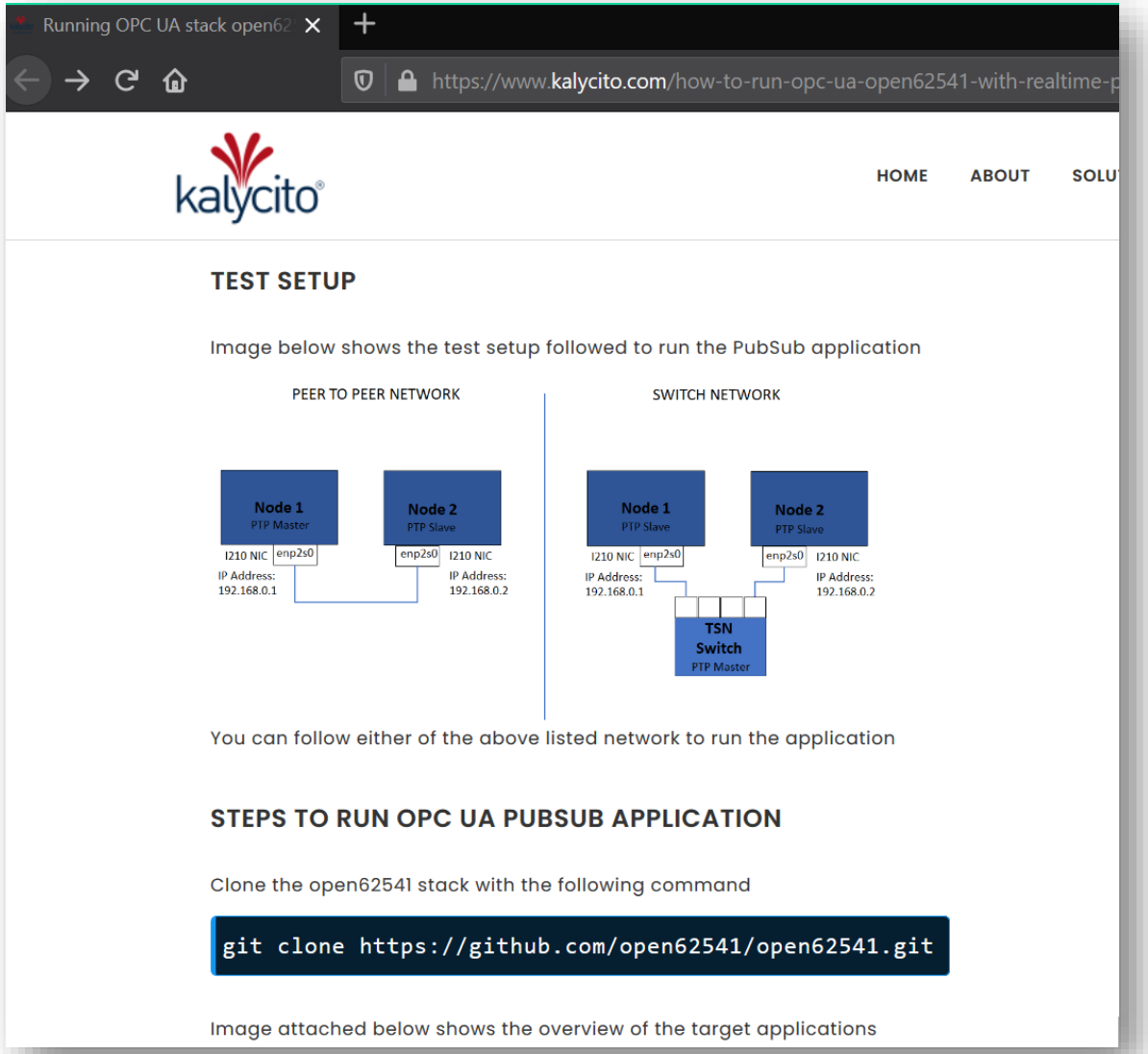
Phase 4: For more Information

Visit: https://www.osadl.org/OPCUA-Project

Open Source Resources

Quick Start Guide



How to run OPC UA stack open62541 with Realtime PubSub on Realtime Linux and TSN using Intel i210 ethernet card

This quick start guide serves as a starting point for a user in learning/evaluating OPC UA including TSN technology for their products/projects.

This quick start guide uses “Open Source OPC UA stack open62541 with Pub/Sub feature” and leverages the TSN features available on “standard Linux kernel + PREMPT_RT patches” on an X86 PC hardware with intel i210 Ethernet Card.

The initial release of the quick start guide may not have worked on all platforms, but the most recent version repeatedly and successfully underwent test runs for about 30 days.

https://www.kalycito.com/how-to-run-opc-ua-open62541-with-realtime-pubsub-on-realtime-linux-and-tsn-from-source/

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Whitepaper

Based on IEEE 60802 use-cases…

Real-time Open Source Solution for Industrial Communication Using OPC UA PubSub over TSN

Gopiga S K[1], Keerthivasan A S[2], Nikhil Vannan K[3], Selva Suba Jenifer J[4], Shriya Chaurasia[5], Suriya Narayanan P V[6], Thangavalia K T[7]
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***Abstract*— The world is moving in a direction where any future Industry 4.0 device shall support Open Platform Communication Unified Architecture (OPC UA) - a platform independent, service-oriented modelling framework to achieve interoperability through a vendor neutral standard. There is general alignment among different industry players to leverage OPC UA along with emerging time aware Ethernet standard Time Sensitive Networking (TSN) for seamless connectivity between different Industry 4.0 devices (spanning from sensor to cloud). The OPC UA Publisher/Subscriber (PubSub) standard together with TSN standards will enable deterministic real-time networking capabilities that in so far needed proprietary extensions. TSN is expected to be established as a standard with wide availability of network interface chipsets in two years from now.**

In this whitepaper, the requirements for such Industry 4.0 devices are extracted from the use-cases described in the 'IEC/IEEE 60802 TSN Profile for Industrial Automation', implemented and tested using Open Source Software components. The performance measurements in this whitepaper focus on isochronous communication traffic as specified in the IEC/IEEE 60802 document, while other traffic types according to IEC/IEEE 60802 are still present in the network for the purpose of recreating load conditions similar to actual application use cases.

This whitepaper improves the results from the previous whitepaper (of the same name) and will help OEMs looking at technology readiness aspects for adoption into their products and services.

Keywords*— *Industry 4.0, M2M, M2C, PubSub, OPC UA, TSN

I. Introduction

Prior to Industry 4.0, manufacturers and users of automation components such as sensors, drives and PLCs were predominantly using a variety of different fieldbus/industrial Ethernet standards that are not interoperable (analog signaling before moving to legacy fieldbuses protocols such as Modbus, Profibus, DeviceNet over physical medium such as RS485, CAN, etc for the last 40 years).

Since the last 10 years, there are multiple Ethernet based communications protocols promoted by different PLC vendors in the market. This has created a fragmented ecosystem where device manufacturers constantly face additional costs to support as many protocols as possible in their automation products. This also prevents end-users like smart cities and smart factories from seamlessly interconnecting equipment from different manufacturers.

To fully exploit the potential of Industry 4.0 and Industrial IoT, it must be possible for data to flow securely to wherever in the system it can add value: from field devices like sensors and actuators to the control devices, between control devices, to edge gateway devices, data aggregation/ingestion devices, to cloud-based applications and enterprise systems for big data analytics, IT-OT and supply chain integration. In recent years, the industry has been demanding the development of a standard communications interface that will provide increased interoperability together with increased bandwidth, reduced wiring complexity and reduced costs while also guaranteeing deterministic performance.

While OPC UA can address this at higher layers, it cannot by itself guarantee deterministic real-time data transfer – a typical requirement for field level devices. In such a scenario, TSN is an IEEE 802.1 standard that is fast emerging as the upgrade to the IEEE 802.3 Ethernet standard capable of delivering deterministic real-time performance at the layer 2 – data link. Going up to the higher layers, IEC 62541 OPC UA is fast emerging as the application data modeling standard to enable interoperable data exchange between devices, systems and applications.

Table 1 lists the related TSN standards both released and under development for audio-video, industrial and automotive use cases. This paper is focusing on the time synchronization standard IEEE 802.1AS and scheduled traffic IEEE 802.1Qbv that are important for industrial use cases. The configuration standard IEEE 802.1Qcc is also an important topic for interoperability but is beyond the scope of this paper.

Table 1
TSN Standards

Standard	Description
IEEE 802.1AS - a specific profile of IEEE 1588 (AS-rev which is more suited for industrial applications is under development)	Timing and Synchronization for Time-Sensitive Applications
IEEE 802.1Qav	Forwarding and Queuing Enhancements for Time-Sensitive Streams
IEEE 802.1Qbu and IEEE 802.3br	Frame Preemption
IEEE 802.1Qbv	Enhancements for Scheduled Traffic
IEEE 802.1Qca	Path Control and Reservation

1

The performance measurements in this whitepaper focus on isochronous communication traffic while other traffic types according to IEC/IEEE 60802 are still present in the network for the purpose of recreating load conditions similar to application use cases that are relevant in actual end-user use cases. This is also the first version of the whitepaper prepared after the integration of fully featured implementation of the subscriber part. This is also the first time that the Fast Path Message (FPM) optimization is included in the publisher part of OPC UA PubSub.

III. Test Setup

A. Hardware setup

Figure 2: Hardware setup for performance measurements

The hardware setup consists of two quad core Atom processor systems with i210 network interface cards connected via PCIe. Both the systems are connected peer to peer with an Ethernet cable at a link speed of 1 Gb/s.

B. Software setup

All the software packages used in the system are open source and available to download from the respective developer forums. Intel's Earliest TxTime First (ETF) implementation in i210 igb driver is used for IEEE 802.1Qbv implementation whereas IEEE 802.1Qav is already present in the i210 solution. In order to increase the performance in the receiver side, XDP (eXpress Data Path) has been integrated with the Subscriber. The idea behind XDP is to add an early hook in the RX path of the kernel. To use XDP, bpf-next kernel tree is required.

Table 2
Software Package Information

Software package	Versions
Linux OS	Ubuntu1-18.04.3, Kernel 4.19.37-rt19
Linux PTP	ptp v2.0
OPC UA stack	open62541 master
bpf-next	4.19

IV. Real-time Performance

The deterministic real-time performance (max latency or worst-case latency) of the system is measured using the *cyclictest* application. Briefly, *cyclictest* consists of a main task that initially starts a number of child tasks. The latter install cyclic alarms using a real-time capable timer at a given interval and repeatedly wait for the expiration of the timer. When a timer expires the current time is obtained and compared to the theoretically expected wake-up time. The difference that represents the inability of the system to exactly wake up in time, but a little later represents the so-called system latency. If the measurement is repeated frequently enough and under as many conditions as possible, the longest latency ever obtained may be used to describe a system's worst-case latency.

2

Figure 4b shows the results of the PTP accuracy measurement between the two nodes over a period of 12 hours; the observed clock offset is in the range of -1.2 µs to +1.2 µs and, thus, close to the performance that is theoretically achievable.

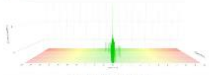

Figure 4b: PTP clock offset

C. PTP hardware clock to system clock synchronization

The system clock is used by most user-space applications; hence the system clock needs to be synchronized between nodes on the network. This can be achieved by synchronizing the system clock with the PHC by using the *phc2sys* utility.

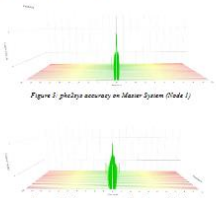

Figure 5: phc2sys accuracy on Master System (Node 1)

Figure 6: phc2sys accuracy on Slave System (Node 2)

Referring to figures 5 and 6, *phc2sys* jitter values of PTP master and slave nodes are at -5 µs to +3 µs and -140 ns to +124 ns respectively, it is evident that the system can synchronize the system clock to hardware clock at single-digit microsecond range which matches the requirements of most, if not all, industrial real-time applications.

V. PubSub Network Performance

Once the PTP synchronization was established and was verified to work accurately, the next step was to test the OPC UA PubSub application. In this case, OPC UA PubSub application was configured to publish Ethernet packets at 100 µs cycle time. One of the main factors that affect the performance is the jitter we experience to place the packet in the network. Figures 7 and 8 show the jitter performance of the OPC UA PubSub application for 1 million samples without ETF and with ETF respectively. It must be noted that the cycle time needs to be a multiple of 31.25 µs i.e. 125 µs. We

3

Note: T3 denotes packets captured at Node 2 (for packets transmitted from Node 1). T7 denotes packets captured at Node 1 (for packets transmitted from Node 2).

Figure 9b is similar to 9a except that it shows only best effort ping traffic (leaving out the six other types of traffic) along with time critical OPC UA PubSub traffic that is always placed at the intended time in the beginning of the second window.

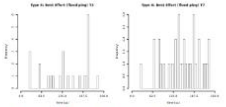

Figure 9b: Histogram plot for Qbv including best effort and PubSub

Figure 9c illustrates only the time critical OPC UA PubSub traffic for a clearer view when compared with 9a and 9b.

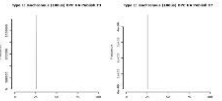

Figure 9c: Histogram plot for Qbv including PubSub only

ETF ensures that the transmission (Tx) of high priority traffic is prioritized through the high priority hardware queue. It also helps to buffer packets and make sure that the packets are sent out in the configured time before their deadline (Tx time). If ETF is not enabled, the network device will not be able to distinguish between priorities of different traffic. So, no guarantee for an end-to-end delivery time can be given when ETF is disabled.

VI. PubSub Round-Trip Time Measurements

The previous section looked at performance of an application in meeting the deadline to place a packet on the network. This section goes further and looks at the application round-trip time (RTT) measured using the OPC UA PubSub application over TSN. This is important for the communication latency from a PLC application to an I/O or motion control node application and back to the PLC.

4

If we know the max latency of our system (from *cyclictest* results) and also the time spent in the locks inside each thread involved in publish, subscribe and application control loop as well as the priorities of each thread, it is possible to compute the application safety margin and the transfer safety margin. Then it will be possible to configure the maximum values for application safety margin and transfer safety margin and guarantee the deadline in the ideal scenario as shown in figure 11.

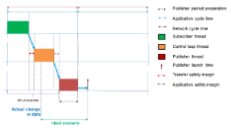

Figure 11: Ideal Scenario - Isochronous Publish Latency

However, it should be noted that this may mean the network cycle time is not the smallest possible value. Also, the final goal is to provide the lowest possible deterministic deadline for end-to-end transfer of data and not merely providing a very low number for the lowest possible network cycle time. In this paper, we are trying to achieve the lowest possible network cycle time and also comment on the worst-case deterministic deadline for end-to-end transfer of data in the lowest possible network cycle time as we see that this is the route most customers are expected to take. For example, figures 12 and 13 additionally show the practical and worst-case scenarios that can occur for an implementation that is based on the design in figure 11.

Figure 12 shows a scenario where there is sensor value change just after the application control loop scans the sensor inputs. In this case, the change will be available to the application control loop only after a one cycle delay i.e. until the application control loop executes in the next cycle.

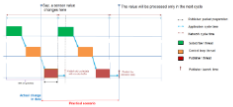

Figure 12: Practical Scenario – Isochronous Publish Latency

Figure 13 shows a scenario (in addition to the one cycle delay introduced in figure 12) where the application loop takes longer to complete execution (than the configured application safety margin) and introduces one more cycle of delay. This means the data finally

5

value to be available at the application control loop of node 1. Therefore, it will take 3+1+4+1 = 9 cycles for the worst-case round-trip of the counter value to complete.

With the above design and the worst-case latency possible from it, we tried to configure the minimum possible application safety margin and transfer safety margin and a very low cycle time (say when the measured max latency was 34 µs, we were configuring the network cycle time to be 100 µs – a value that looks improbable to work). However, we measured the maximum RTT in 1 million samples for a payload size of 100 bytes when XDP was disabled in the receiver side, to be 940 µs as shown in figure 15. We found a packet miss of about 30% in a total of 1 million samples.

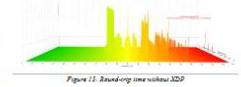

Figure 15: Round-trip time without XDP

When XDP was enabled in the OPC UA Subscriber, the maximum RTT in 1 million samples for a payload size of 100 bytes was measured to be 701 µs as shown in figure 16. The packet miss was 7% in a total of 1 million samples.

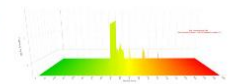

Figure 16: Round-trip time with XDP

This shows that when XDP is used with the OPC UA Subscriber, the performance was increased to about 25%. The above measurements were taken under nominal load conditions in which realistic CPU and network loads were applied to both the nodes. The CPU load was about 30% utilization on each of the four cores. Realistic network loads were created using Apache, sipp and OPC UA Client/Server traffic.

Note: On both nodes, Core 0 is made entirely available for OS and kernel. Core 1 is entirely reserved to run PTP to maintain time synchronization. Core 2 is used for running OPC UA PubSub application. Core 3 is used for user specific real-time application. Network loads (i.e. realistic load on Apache, sipp, OPC UA Client/Server) are run on Core 0 in this test setup which is a four-core system in which Cores 0, 1 and 2 are reserved as described above.

6

sumers and repeated counters with a maximum round-trip time tency of 1.25 ms under nominal load condition. This is our commended cycle time which can be used for motion control plications.

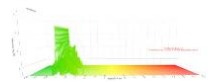

Figure 19: Round-trip time measurements in 250 µs

ur next steps involve improving the stability and reducing the rwork cycle time to achieve better performance at cycle time lesser an 250 µs.

VII. Known challenges & Next steps

he above measurements were made in a test setup that used OPC A PubSub packets with 100-byte payload size at 100 µs application id network cycle time. When we shortened the cycle time, the nserved occurrences of data duplication or data loss (i.e. counter lues were repeating or missed respectively) was minimum in XDP tegrated Subscriber than that of the Subscriber without XDP.

igure 20 shows the Round-trip time measured with 100-byte yload size at 31.25 µs application cycle time and network cycle me measured is 3.1GHz Intel i5 processor PCs shows a total missed umber occurrence of 2.5 million in a total of 5 million samples. By tegrating Just in Time compilation (JIT) and XDP transmit in the ablisher side along with the XDP ZC in the subscriber we can hance this existing performance number thus achieving the dustry standard 31.25 µs network cycle time in 1.6 GHz Intel Atom ocessor PCs thus enabling the solution to run in current loop plications.

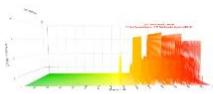

Figure 20: Round-trip time measurements in 31.25 µs

he market requirement expects the number of Industry 4.0 devices the test network shall be increased and each of the devices shall be nfigured to publish more packets as well as subscribe to a larger mber of publishers. The impact of OPC UA Client/Server ichanges on the values (i.e. need to update the same nodes in the formation model for both Pub/Sub and Client/Server) needs to be nsidered. The performance impact introduced due to using security both Client/Server and Pub/Sub shall also be explored. There is so the possibility to achieve more real-time performance in Linux to duce the network cycle time further. The design calculation used to rive at the number "9" can be promised as the deterministic

Acknowledgment

e authors would like to thank the industry consortium supporting e joint project for developing the PubSub extension for the en62541 OPC UA SDK. Special thanks go to Carsten Iemde of the pen Source Automation Development Lab (OSADL) for assistance setup the real-time systems and to Julius Pfrommer of Fraunhofer ISH for providing continuous support on the open62541 stack velopment and maintenance.

References

[1] "Hardware Assisted IEEE 1588 Clock Synchronization Under Linux." By Balint Ferencz, Budapest University of Technology and Economics

[2] "The Road Towards a Linux TSN Infrastructure", Jesus Sanchez-Palencia

[3] "OPC UA TSN A new Solution for Industrial Communication" by D. Bruckner, R. Blair, M-P. Stanica, A. Ademaj, W. Skeffington, D. Kutscher, S. Schriegel, R. Wilmes, K. Wachswender, L. Leurs, M. Seewald, R. Hummen, F-C. Liax and S. Ravikumar

[4] "IEC/IEEE 60802 Use cases for Industrial automation v1.3" by Rudy Belliardi, Josef Dorr, Thomas Estringer, Florian Essler, János Farkas, Mark Hantel, Maximilian Riegel, Marina-Petra Stanica, Guenfed Steindl, Reiner Wamller, Karl Weber, Karl Weber and Steven A.Zuponcic.

https://www.kalycito.com/how-to-run-opc-ua-open62541-with-realtime-pubsub-on-realtime-linux-and-tsn-from-source/

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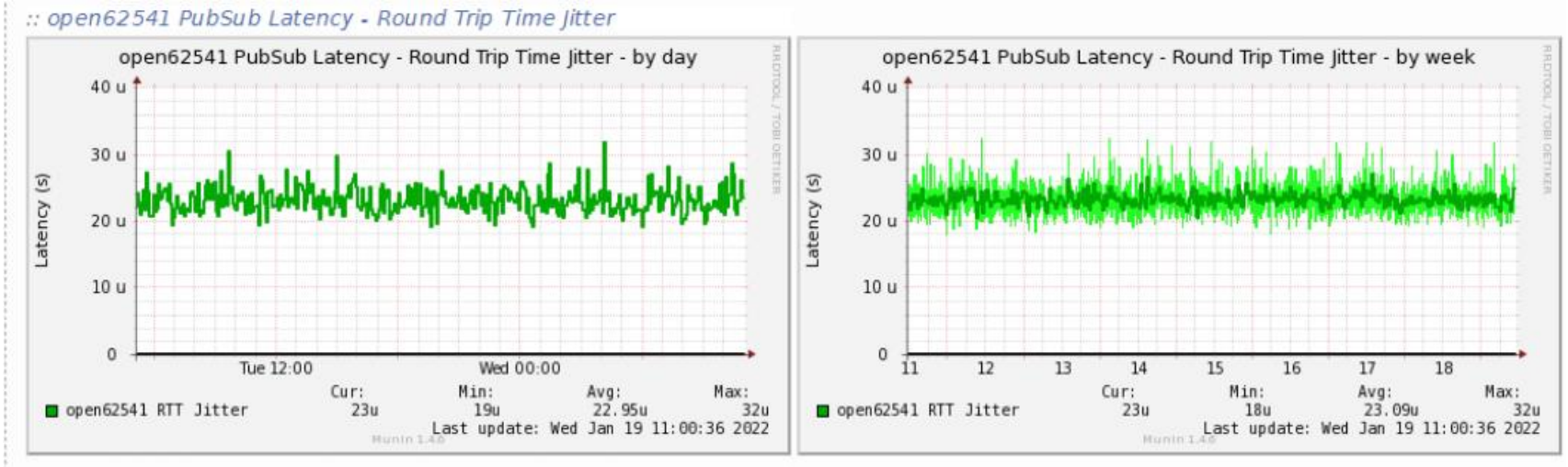
24x7 Demonstrator @ OSADL

- OSADL primarily defines the criteria for real-time Linux and focuses on benchmarking the identified kernel in different processors using a Quality Assurance (QA) farm.
- The tests are performed in the systems hosted in the QA farm on OSADL Test Racks in several OSADL testing labs to monitor the systems under stress test.
- One pair of real-time verified nodes (latency value < 70us in cyclictest results) is used to run OPC UA Publisher/Subscriber over TSN application at 250us cycle time and the round trip time latency of the application is monitored for 24*7. (https://www.osadl.org/?id=3394)

OPC UA PubSub TSN Application

Round Trip Time Results – 24 * 7



This shows the performance graph with Round trip time jitter of PubSub TSN Application running in peer to peer connected nodes with 250 microseconds cycle time.

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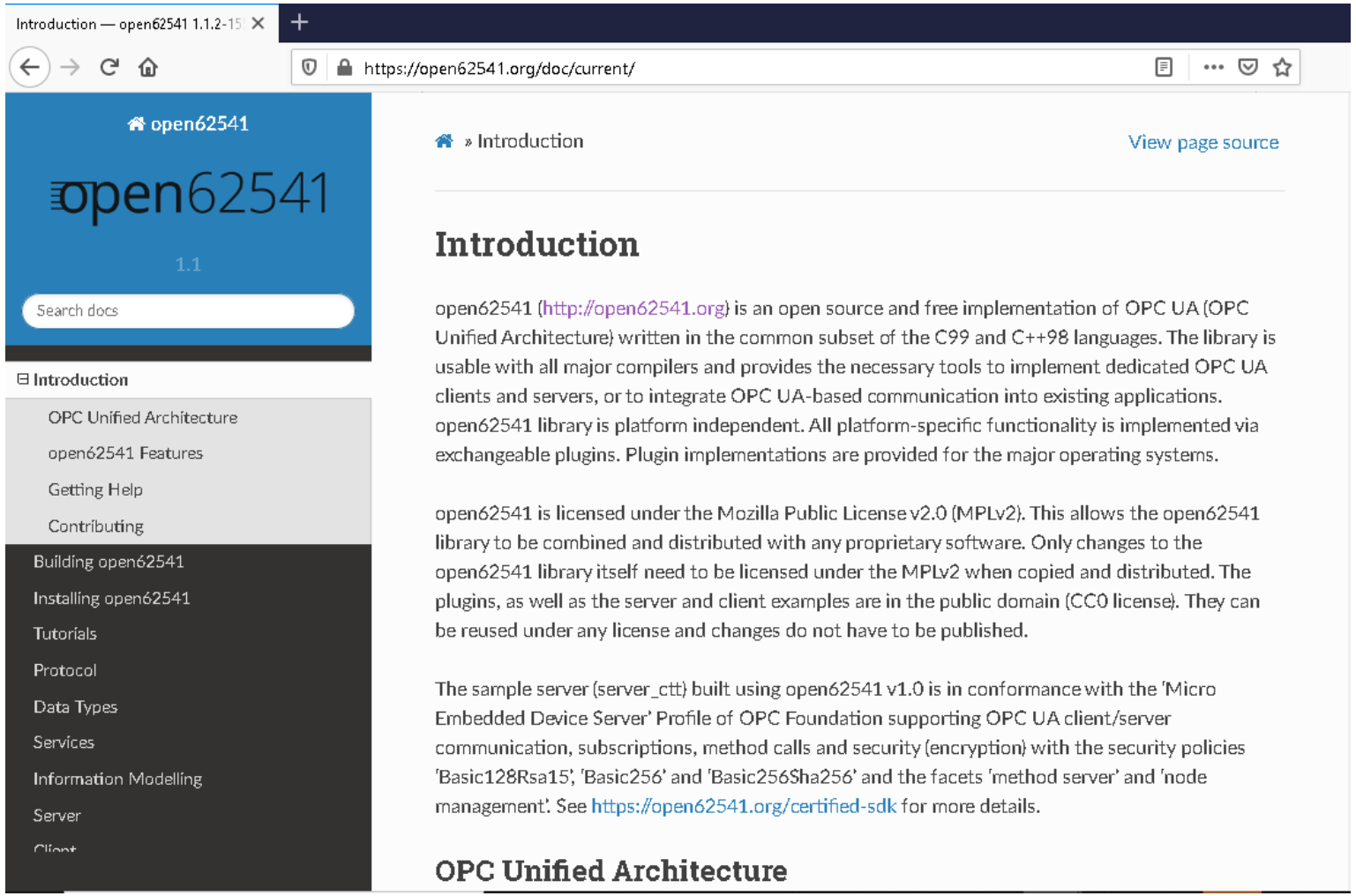

This open62541 documentation page serves as a starting point for a user in learning OPC UA technology using open62541for their products/projects.

https://open62541.org/doc/current/

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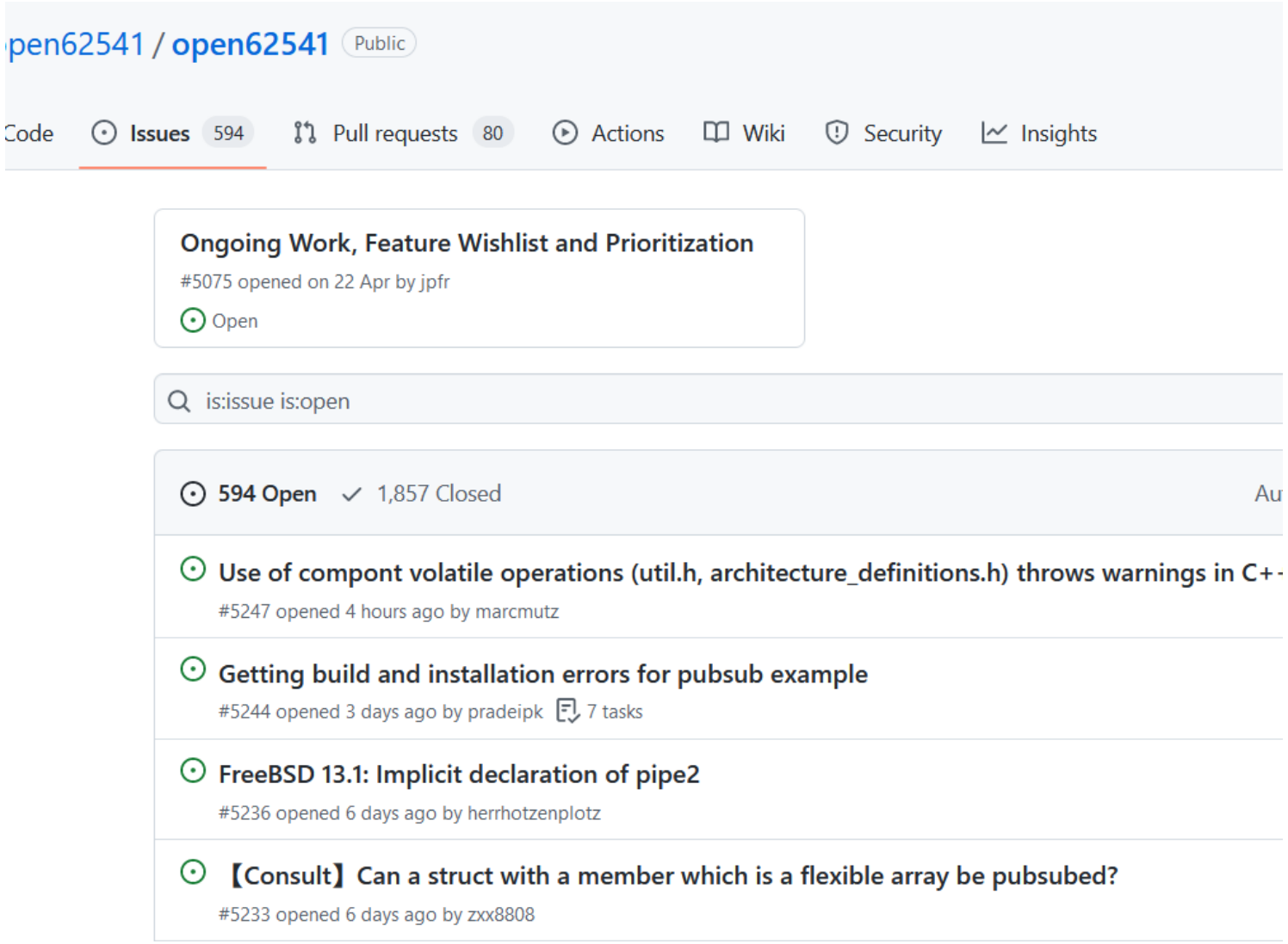

This forum exhibits active collaboration and support in improving open62541 stack.

https://github.com/open62541/open62541/issues/new

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