D1.3 – Drive-by-Data Demonstrator Report

Project number:	826073
Project acronym:	Safe4RAIL-2
Project title:	SAFE architecture for Robust distributed Application Integration in rolling stock 2
Start date of the project:	1st October 2018
Duration:	34 months
Programme:	H2020-S2RJU-OC-2018
Deliverable type:	Report
Deliverable reference number:	ICT-826073 / D1.3
Work package	WP 1
Due date:	31st July 2021 – M34
Actual submission date:	3rd August 2021
Responsible organisation:	TTT
Editor:	Mohammed Abuteir
Dissemination level:	Public
Revision:	1.0
Abstract:	Drive-by-Data hardware validation and support procedures for CONNECTA-2 demonstrators.
Keywords:	Drive-by-Data, TSN, ETBN, Demonstrators

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 826073. The information and views set out in this document are those of the author(s) and do not necessarily reflect the official opinion of Shift2Rail Joint Undertaking. The JU does not guarantee the accuracy of the data included in this article. Neither the JU nor any person acting on the JU's behalf may be held responsible for the use which may be made of the information contained therein.

Editor

Mohammed Abuteir, TTTech

Contributors (ordered according to beneficiary numbers)

Daniel Machón, Moxa

Anna Hermansson, WESTERMO

Khawar Naeem, WESTERMO

Executive Summary

D1.3 is the third deliverable of the S4R-2 Work-Package 1. Its aims to define integration for the functional interoperability between the train-level and consist level switches as well as the functional testing of the DbD concepts based on the CTA-2 requirements.

This deliverable covers in detail the Drive-by-Data hardware validation and supporting procedures for the demonstrators for CTA-2. For this purpose, the definition of the testing strategy based on the functionalities that should be tested was the first step. The next step in the process was to classify the functionality testing based on the requirement analysis and as a last step, the tests needed to verify these functionalities were performed. The status of all the testing has been regularly reported and more than 90% of test requirements have passed successfully. Some of the tests have unfortunately not passed and the issues faced during these tests were reported in real-time as well as the lessons learnt that have then been incorporated into new requirements for the next project.

Finally, CTA-2 demonstrator was provided with regular support and updates from S4R-2 Work-Package 1. All the details are covered in the respective chapters.

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Chapter 1 Introduction

The basis of this document is the work performed in T1.5 during the Safe4Rail-2 project. T1.5 aims at conformance of interoperability of the different implementations from the previous tasks in the project, specifically concerning the functional interoperability between the train-level and consist level switches. The interoperability must be maintained in order to successfully perform the subsequent integration into different demonstrators provided by CTA-2 project. Additionally, this task also focusses on supporting these two demonstrators (on-site and off-site support). The technical validation of the performance of the components and the networked system has been done in this task as well.

The overall aim of this deliverable is to present how the S4R-2 partners supported the demonstrators and CTA-2 partners with on-site and off-site support as well as to present the technical validation of the performance of the Drive-by-Data components and the networked system.

Chapter 2 Description of workshops and support actions.

The test plan has been structured around the demonstrator that was provided by the complementary project CTA-2. Based on that, the tests were defined based on the need and purpose of the demonstrator. The demonstrator was tested in different small scenarios first, so that we are ready to test the final testing scenario in the last phase. Incremental testing scenario approach was opted for this phase.

The DbD team provided the prototype hardware to the CTA-2 as we shown in the below table:

Table 1: Prototype HW has been provided to CTA-2

Demo	CTA2-Partner	CTA2-Demo	Number of devices	Type of device	Supplier
Regional Demonstrator	BTG	Regional Consist 1	2	ETBN	WES
Regional Demonstrator	BTG	Regional Consist 1	2	CS	WES
Regional Demonstrator	BTG	Regional Consist 1	3	CS (DE Eval Board)	TTT
Regional Demonstrator	BTG	Regional Consist 1	2	PCIe card	TTT
Regional Demonstrator	SIE	Regional Consist 2	2	ETBN	Moxa
Regional Demonstrator	SIE	Regional Consist 2	2	CS	Moxa
Regional Demonstrator	SIE	Regional Consist 2	1	CS	TTT
Regional Demonstrator	SIE	Regional Consist 2	2	PCIe card	TTT
Regional Demonstrator	CAF	Regional Consist 3	2	ETBN	Moxa

Demo	CTA2-Partner	CTA2-Demo	Number of devices	Type of device	Supplier
Regional Demonstrator	CAF	Regional Consist 3	2(*)	CS	Moxa
Urban Demonstrator	CAF	Urban Consist 1	2	ETBN	Moxa
Urban Demonstrator	CAF	Urban Consist 1	5	CS	Moxa
Urban Demonstrator	CAF	Urban Consist 1	3	CS (DE Eval Board)	TTT
Other Equipment	SIE	Test Equipment	2	ETBN	MOXA
Other Equipment	SIE	Test Equipment	2	CS	MOXA

(*) One of them is an ETBN at hardware level

In order to ensure that the hardware works without any flaw, the DbD team validated their prototypes individually. The prototypes have been validated according to [1] and [2] and obtained results are reported in Annexes 1 & 2. Interoperability tests between MOXA and Westermo have also been done according to [3] and obtained results have been detailed in [4].

Furthermore, the DbD team planned for off-Site Support as well as on-site support for the CTA-2 partners in order to support their demonstrator.

TTTech preferred that the partners used the support ticket platform by sending their issue to the support email address (support@tttech.com). Based on the reported issues the support team sorted and assigned the persons to look deeply into the partner issue and provide support to them. The response could be a direct answer solving this issue or asking more information to find out what exactly was the source of this issue and reaching the solution finally. Some of the issues required organizing a support call with the partner to have more understanding of the issue and to enable remote support. See the figure below, which is an example of some of the issues that have been opened and closed on the TTTech support ticket system.

Id	Category	Title	Status	Responsible	Customer/Supplier
34203	pending	Question regarding multicast	closed	adnan@ds1.internal	WESTERMO
34208	pending	The drop of TTDP Hello frame issue	closed	adnan@ds1.internal	MOXA
34369	pending	Devicetree file for generating new u-boot	closed	adnan@ds1.internal	WESTERMO
34443	pending	RSTP frame in tag 4094	closed	abuteir@ds1.internal	MOXA
34646	pending	configuration issue with TSN IP	closed	abuteir@ds1.internal	Siemens
34789	pending	TTTech PCIe package differences and 802.1CB splting to different VLANs	closed	adnan@ds1.internal	Siemens
34907	pending	Questions about deptp	closed	koskiahde@ds1.internal	WESTERMO
34917	pending	Slate XSN :- ubuntu version	closed	loschmidt@ds1.internal	WESTERMO
35216	pending	Possible issue with deptp	closed	koskiahde@ds1.internal	WESTERMO
35425	pending	tagged frames comming in on vlan1 on arria10	closed	bamogo@ds1.internal	WESTERMO
36158	pending	Multiple time domains with deptp	closed	bamogo@ds1.internal	WESTERMO
36278	pending	Updated traffic pattern from CAF's ECN	closed	abuteir@ds1.internal	CAF
36471	pending	TTTech PCIe cards - SNMP support	closed	adnan@ds1.internal	Siemens
36507	pending	TSN traffic stream profile	closed	abuteir@ds1.internal	Siemens
36980	pending	forward a scheduled stream	closed	bamogo@ds1.internal	WESTERMO
37203	pending	Slate Tool troubleshooting	closed	abuteir@ds1.internal	CAF
37724	pending	netopeer2-cli on VM has ssh-key problem	closed	adnan@ds1.internal	CAF
37761	pending	URGENT SUPPORT: netopeer-server not runinng in CS from Moxa	closed	abuteir@ds1.internal	CAF
37766	pending	URGENT SUPPORT: netopeer-server not runinng in CS from Moxa	closed	adnan@ds1.internal	CAF
37776	pending	Slate netconf files not compatible	closed	ademaj@ds1.internal	CAF

Figure 1: Example of the support ticket in TTTech system

Moxa provided to CTA-2 partners the email addresses of the S4R-2 team to be used for requesting support. Based on the received issues Moxa sorts them and assign the proper R&D resources for debugging. R&D team analysed partners issues and requested further information if needed. Depending on the issue further investigation was needed in the partner environment, and remote debug sessions were scheduled. This could be a direct answer solving the issue or requesting further R&D investigation in our developing environment. We reproduced the issues and searched for the root cause.

After finishing the analysis of the issue, Moxa provided an answer to the partners

- By helping partner to configure properly the topology and network devices
- By suggesting a workaround to overcome the situation
- By providing a new firmware version that fixed the issue
- By replacing a hardware which is suspected to be malfunctioned
- By providing a schedule that informs when the issue will be closed
- By rejecting the issue because it may happen the root cause could be external to our devices. In this case we provided detailed information to help the partners to continue debugging the issue.

You may find in the figure below an example of some of the issues managed with the Moxa tracking system.

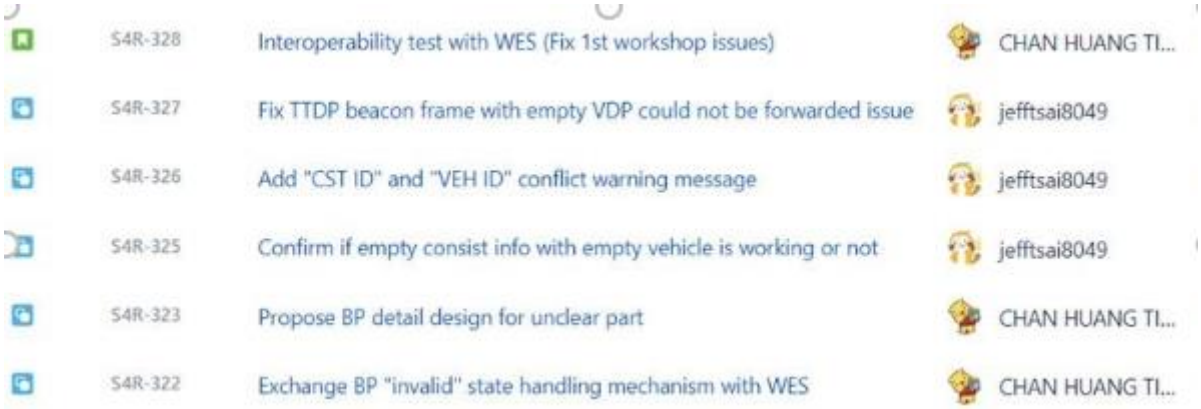


Figure 2: MOXA tracking system tool screen capture.

Westermo supported Bombardier continuously with high priority. Westermo has a technical project lead that handles all questions and distributes them internally.

Bombardier and Westermo SW developers were also in direct contact to be able to speed up the support handling. Westermo has HW units in their lab to be able to support in a fast and accurate manner. Westermo has a support ticket system where the DbD issues were reported and then handled on a regular basis.

Westermo´s technical experts have participated in all workshops and been available to answer questions and do fault finding online.

Westermo has delivered software drops to Bombardier whenever requested and required.

Moreover, we had planned an on-site support but due the COVID-19 crisis and the regulation for limitation on the number of the people in the same room as well as the travel restriction we decided to organize a virtual workshop to support that.

MOXA, SIEMENS and CAF organized the set up for the virtual workshop. The selected setup was:

- 3 consists scenario (2 from CAF, 1 from SIEMENS)
- Partial scenarios where tested (1 SIEMENS, 1 CAF)

The organization of the virtual workshops needed to overcome some important challenges with VPN connections. As showed in the figure below, for the first virtual workshop there was only one ETBN line via VPN connection available. ETBN B and D are drawn with dashed line indicating the scenario shall be tested in subsequent workshops but showing they could not be connected in a second ETBN line via another VPN at that moment in time.

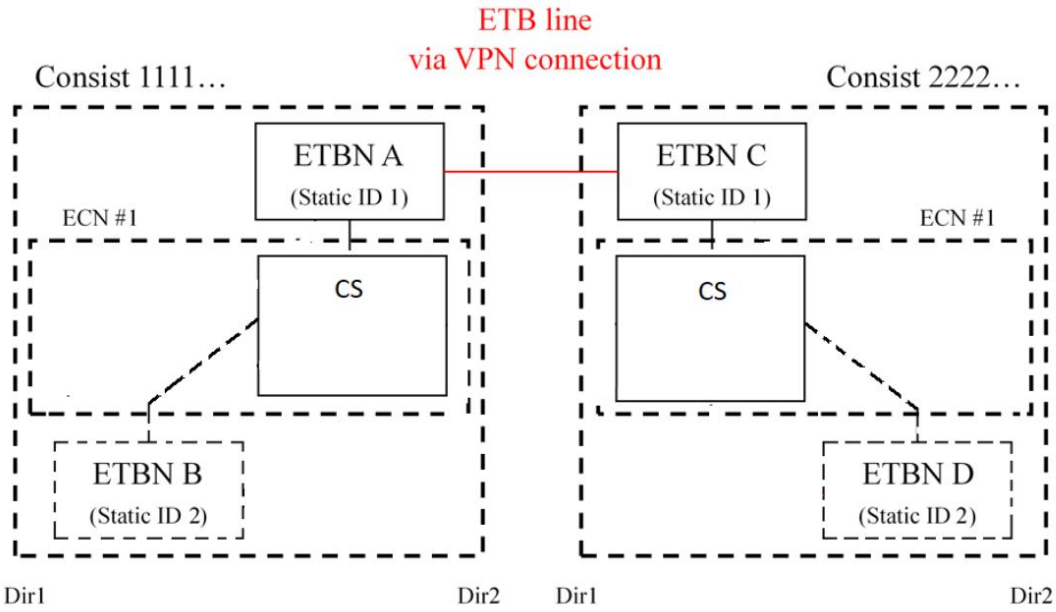


Figure 3: Virtual workshop setup between CTA2 and S4R2

Please find in the figure below a capture of the teams' session we held in the virtual workshop showing 1 ETBN in one consist.

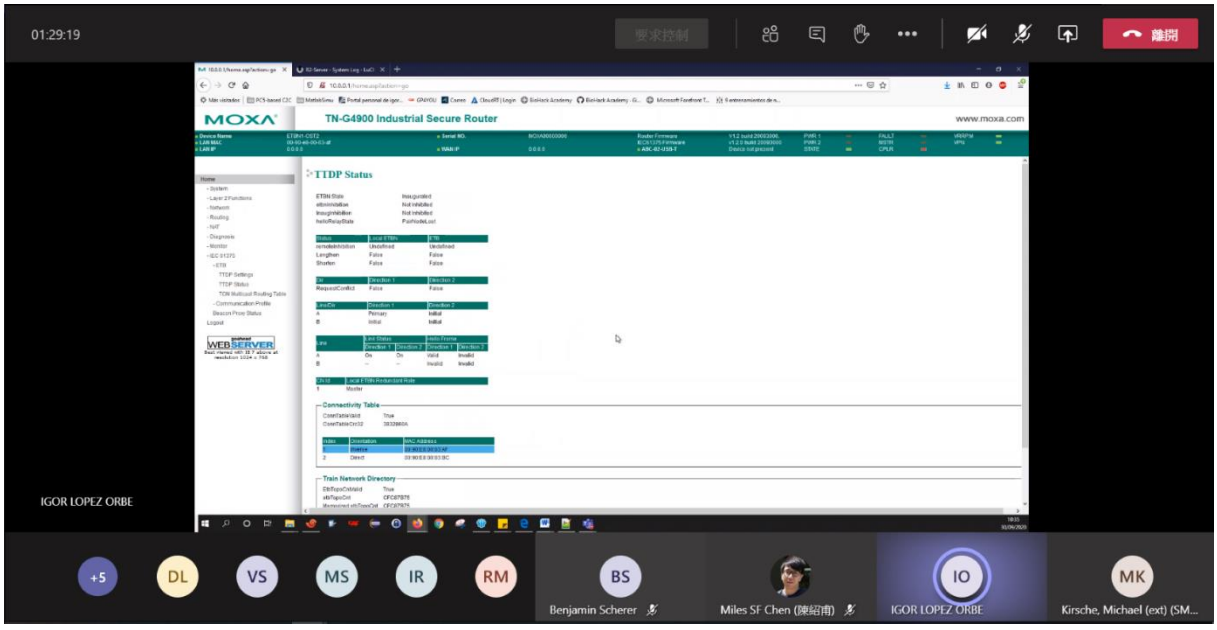


Figure 4: A capture of one of the teams' session

The following table lists the organized workshop and the test purpose for each of them.

Table 2: List of the organized workshop

Meeting Title	Start Date	End Date	WP	Location	Purpose	Attendance List
WP1 Integration workshop	10.09. 2019	12.09. 2019	WP1	Västeras	Interoperability tests of the IEC 61375 implementations have been performed between Moxa and Westermo The purpose was to ensure that ETBNs provided by both partners are interoperable which will facilitate successful collaboration during development of Next-Generation Train Communication Network (NG-TCN) in the Drive-by-Data WP of Safe4Rail-2	MOXA, WES
WP1/WP3 Integration Workshop	03.12. 2019	05.12. 2019	WP1, WP3	Erlangen / Germany	From 3th to 5th of December 2019, an integration workshop between FDF and DbD was held at Siemens premises in Erlangen, Germany	MOXA, TTTech, WES, SIE, CAF, BT
WP1 Integration workshop	17.12. 2019	18.12. 2019	WP1	Västeras	The purpose was to ensure that NG-TCN ETBNs provided by Moxa and Westermo are interoperable which will facilitate successful collaboration in CTA-2/S4R-2 DbD integration workshop The difference as compared to previous interop test was to use new NG-TCN ETB topology while the previous used current IEC 61375 ETB Topology	MOXA, WES
Drive-by-Data integration workshop w. CTA2	05.02. 2020	06.02. 2020	WP1	Mannheim	The workshop offers the first opportunity to integrate the CCU devices with the network components provided by S4R2 in the regional demonstrator. Therefore, the planned activities are concentrating on basic interactions and functions: • ECSP/ECSC interface • Hello relay • VLAN reconfiguration • Beacon telegram	MOXA, TTTech, WES, SIE, CAF, BT
CTA-2/S4R-2 TSN-GW Functionality	09.09. 2020	09.09. 2020	WP1	online	TSN-GW Functionality	MOXA, TTTech, WES, SIE, CAF, BT
CTA-2/S4R-2 TSN-GW Functionality	24.11. 2020	24.11. 2020	WP1	online	TSN-GW Functionality	MOXA, TTTech, WES, SIE, CAF, BT

Meeting Title	Start Date	End Date	WP	Location	Purpose	Attendance List
CTA-2/S4R-2 TSN-GW Functionality	17.12. 2020	17.12. 2020	WP1	online	TSN-GW Functionality	MOXA, TTTech, WES, SIE, CAF, BT
WP1 Integration Workshop	18.12. 2020	18.12. 2020	WP1	Online	The goal is to control inauguration (e.g. set leading), check status/inauguration data and exchange beacon telegrams with the ETB application running on CCU.	MOXA, TTTech, WES, SIE, CAF, BT
WP1 Integration Workshop	09.02. 2021	09.02. 2021	WP1	online	the goal is to control inauguration (e.g. set leading), check status/inauguration data and exchange beacon telegrams with the ETB application running on CCU.	MOXA, WES, SIE, CAF, BT
CTA-2/S4R-2 TSN-GW Functionality	17.02. 2021	17.02. 2021	WP1	online	TSN-GW Functionality	TTTech, SIE, CAF, BT
CTA-2/S4R-2 TSN-GW Functionality	22.03. 2021	22.03. 2021	WP1	online	TSN-GW Functionality	TTTech, SIE, CAF, BT
WP1 Integration Workshop	29.03. 2021	29.03. 2021	WP1	online	We have decided today in our CTA2 internal meeting that we want to repeat the failed activities from the last DbD integration workshop on 29/03/2021. Therefore, the goal is to control inauguration (e.g. set leading), check status/inauguration data and exchange beacon telegrams with the ETB application running on CCU.	MOXA, WES, SIE, CAF, BT
CTA-2/S4R-2 TSN-GW Functionality	15.04. 2021	15.04. 2021	WP1	online	TSN-GW Functionality	TTTech, SIE, CAF, BT
WP1 Integration Workshop	21.04. 2021	21.04. 2021	WP1	online	Goal is to validate the beacon frames (including SDTv4 check) and performing some first tests with redundant ETB lines.	MOXA, WES, SIE, CAF, BT
WP1 Integration Workshop	28.04. 2021	28.04. 2021	WP1	online	We will continue on the A/B plane integration and (ETB) redundancy testing.	MOXA, TTTech, WES, SIE, CAF, BT
WP1 Integration Workshop	05.05. 2021	05.05. 2021	WP1	online	as agreed in workshop the activities shall be continued next week at same time.	MOXA, WES, SIE, CAF, BT
WP1 Integration Workshop	19.05. 2021	19.05. 2021	WP1	online	as agreed in workshop the activities shall be continued in two weeks to check that the remaining problems are solved.	MOXA, WES, SIE, CAF, BT
CTA-2/S4R-2 TSN-GW Functionality	19.05. 2021	19.05. 2021	WP1	online	TSN-GW Functionality	TTTech, SIE, CAF, BT

Meeting Title	Start Date	End Date	WP	Location	Purpose	Attendance List
WP1 Integration Workshop	02.06. 2021	02.06. 2021	WP1	online	To check we are still interoperable (WES, MOXA) after supporting the consist and vehicle properties.	MOXA, WES, SIE, CAF, BT
CTA-2/S4R-2 TSN-GW Functionality	02.06. 2021	02.06. 2021	WP1	online	TSN-GW Functionality	TTTech, SIE, CAF, BT
CTA-2/S4R-2 TSN-GW Functionality	17.06. 2021	17.06. 2021	WP1	online	TSN-GW Functionality	TTTech, SIE, CAF, BT
WP1 Integration Workshop	22.06. 2021	22.06. 2021	WP1	online	SDT & active cab change	MOXA, WES, SIE, CAF, BT
WP1 Integration Workshop	28.06. 2021	28.06. 2021	WP1	online	1CB	MOXA, TTTech, WES, SIE, CAF, BT
WP1 Integration Workshop	06.07. 2021	06.07. 2021	WP1	online	1CB	MOXA, TTTech, WES, SIE, CAF, BT
WP1 Integration Workshop	13.07. 2021	13.07. 2021	WP1	online	TSN	MOXA, TTTech, WES, SIE, CAF, BT
WP1 Integration Workshop	20.07. 2021	20.07. 2021	WP1	online	TSN	MOXA, TTTech, WES, SIE, CAF, BT

Chapter 3 Compliance matrix against functionalities.

In this section we summarize the functionalities that have been tested and their test status. We consider the test is successful if the entire observed results match the defined requirement to this functionality that has been defined in deliverable D1.1. If only some of the observed requirement matches, the test is only partially successful. If none of the observed result matches the defined expectation, the test has failed.

Table 3: Listed of the performed test for the S4R-2 functionalities

Objective		Status
IEC61375-2-5 - TTDP / NG-TTDP	NG-TTDP	**Partially successful** DBD_ND_016 pass DBD_ND_053 pass DBD_ND_068 pass DBD_ND_203 not implemented DBD_ND_408 pass DBD_ND_659 pass DBD_ND_660 pass
	Hello Frames	**Successful** DBD_ND_016 pass DBD_ND_054 pass DBD_ND_055 pass
	Hello Relay	**Successful** DBD_ND_016 pass DBD_ND_054 pass DBD_ND_056 pass DBD_ND_057 pass DBD_ND_058 pass DBD_ND_059 pass
	VLAN Reconfiguration	**Successful** DBD_ND_016 pass DBD_ND_033 pass DBD_ND_065 pass
	ETB lengthening/shortening	**Successful** DBD_ND_016 pass
	Topology Frame Exchange	**Successful** DBD_ND_016 pass DBD_ND_060 pass DBD_ND_061 pass DBD_ND_062 pass
	Train network directory build-up	**Partially Successful** DBD_ND_016 pass DBD_ND_052 pass DBD_ND_053 pass DBD_ND_063 failed

Objective			Status
		Inter-consist IP communication	**Successful** DBD_ND_067 pass DBD_ND_405 pass DBD_ND_406 pass DBD_ND_407 pass DBD_ND_452 pass
		Train inhibition	**Partially Successful** DBD_ND_016 pass DBD_ND_051 failed DBD_ND_052 pass
IEC61375-2-3 - ECSP	ETB CONTROL SERVICE	Provide ETB control functions: Function leading	**Partially Successful** DBD_ND_019 pass DBD_ND_215 pass DBD_ND_219 SDTv4 not implemented DBD_ND_220 pass DBD_ND_221 pass DBD_ND_224 pass DBD_ND_225 pass DBD_ND_226 not tested DBD_ND_227 pass DBD_ND_233 pass
		Function confirmation/correction: Confirm/correct indicated train composition	**Successful** DBD_ND_019 pass DBD_ND_215 pass
		ECSP redundancy	**Successful** DBD_ND_019 pass DBD_ND_028 not tested DBD_ND_216 pass DBD_ND_408 pass
		ECSP Interface	**Partially Successful** DBD_ND_019 pass DBD_ND_018 Not implemented DBD_ND_020 pass DBD_ND_022 pass DBD_ND_204 pass DBD_ND_228 Not implemented DBD_ND_229 Not implemented DBD_ND_230 pass
	TRDP protocol	Several ComID transmitted	**Partially Successful** DBD_ND_064 SDTv4 not implemented DBD_ND_232 pass DBD_ND_234 not tested DBD_ND_235 not tested DBD_ND_236 SDTv4 not implemented DBD_ND_237 SDTv4 not implemented DBD_ND_238 SDTv4 not

Objective			Status
			implemented DBD_ND_239 SDTv4 not implemented DBD_ND_501 pass DBD_ND_502 pass DBD_ND_503 pass DBD_ND_504 pass DBD_ND_505 pass DBD_ND_506 pass DBD_ND_507 pass DBD_ND_508 pass DBD_ND_509 pass DBD_ND_510 not implemented DBD_ND_511 pass DBD_ND_512 pass DBD_ND_513 pass DBD_ND_514 pass DBD_ND_515 pass DBD_ND_516 pass DBD_ND_517 pass DBD_ND_518 pass DBD_ND_519 pass DBD_ND_520 pass DBD_ND_521 pass DBD_ND_522 pass DBD_ND_523 pass DBD_ND_524 pass DBD_ND_525 pass DBD_ND_526 pass DBD_ND_527 pass DBD_ND_528 pass DBD_ND_529 pass DBD_ND_530 not tested DBD_ND_531 pass DBD_ND_532 not implemented DBD_ND_533 not implemented DBD_ND_534 not implemented DBD_ND_535 not tested DBD_ND_536 pass DBD_ND_537 pass DBD_ND_538 pass DBD_ND_539 pass DBD_ND_601 pass DBD_ND_602 pass DBD_ND_603 not tested DBD_ND_604 pass DBD_ND_605 not implemented
	Train directory build-up (including the exchange of vehicle property)		**Successful** DBD_ND_017 pass DBD_ND_052 pass DBD_ND_201 pass DBD_ND_202 pass DBD_ND_207 pass DBD_ND_208 pass
	Operational train directory build-up		**Successful** DBD_ND_017 pass

Objective		Status
		DBD_ND_052 pass DBD_ND_201 pass DBD_ND_222 pass DBD_ND_223 pass
	TCN-DNS	**Successful** DBD_ND_021 pass DBD_ND_022 pass DBD_ND_209 pass DBD_ND_210 pass DBD_ND_211 pass DBD_ND_212 pass DBD_ND_213 pass DBD_ND_214 pass
	TTDB	**Partially Successful** DBD_ND_022 pass DBD_ND_204 not tested DBD_ND_205 pass DBD_ND_206 not tested DBD_ND_231 pass DBD_ND_232 not implemented
BEACON PROXY		**Successful** DBD_ND_069 pass
INTEROPERABILITY WES/MOXA		**Successful** 1. Comparison of NG-TTDP HELLO Frame 2. NG-TTDP Inauguration Test pass 3. ECSP Operational Train Directory / TopoCnt 4. ECSP Consist info exchange pass 5. VPN performance 6. Beacon Frame Exchange 7. Leading changes
SDTv4		**Failed** SDTv4 feature not implemented DBD_ND_571 to DBD_ND_584 failed
TSN	QBV	**Successful**
	1CB	**Successful**
	QCI	**Partially implemented**
	TSN Gw functionality	**Failed** The GW has been implemented and tested based on the system architecture in the S4R-1. And we found out some issues about the original architecture. We discuss that issues with CTA-2 and we re-defined the new architecture specification for the GW.

Chapter 4 Supporting CTA-2 demonstrators

The demonstrator for the CTA-2 is made of 3 different consists from Siemens, CAF and Alstom/Bombardier. In order to support the demonstrator, we asked CTA-2 partners to provide their traffic information additionally to the demonstrator architectures. The traffic information has been asked to be provided in the following format:


```
{
 "StreamName_TSN-CCU-M1": [
  {
   "address": {
        "DMAC_addr": "01:00:00:00:00:01",
        "pcp": 7,
        "vid": 4
    },
   "talker": {
        "endstation": {
          "host": "setup.ixial.card1.P14",
          "name": "endstation01"
        }
    },
   "traffic_spec": {
          "frame_interval": 1000,
          "frame_size": 64,
          "frames_per_interval": 1,
          "time_aware": {
            "earliest_tx": 500,
            "jitter": 100,
            "latest_tx": 600
          }
        },
   "listeners": [
        {
          "endstation": {
            "host": "setup.ixial.card1.P15",
            "name": "endstation02"
          },
          "usr2net_spec": {
            "latency_us": 800,
            "num_trees_1CB_redundnacy": 2
          }
        },
        {
          "endstation": {
            "host": "setup.ixial.card1.P16",
            "name": "endstation03"
          },
          "usr2net_spec": {
            "latency_us": 900,
            "num_trees_1CB_redundnacy": 1
          }
        },
        ],
    ],
    "version": 1
}
```


Figure 5: TSN traffic pattern

After receiving the required information from CTA-2, we started the work in the configuration files and set up different virtual meeting in order to understand more the system and the traffic generator. An example of the configuration files is shown in the figure below.

qbv_ccu1_sw0p2.cfg

```
1  sgs 30000 223
2  sgs 10000 32
3  sgs 30000 223
4  sgs 10000 32
5  sgs 450000 223
6  sgs 20000 32
7  sgs 30000 223
8  sgs 20000 32
9  sgs 430000 223
10 sgs 20000 32
11 sgs 650000 223
12 sgs 650000 223
13 sgs 650000 223
14 sgs 650000 223
15 sgs 650000 223
16 sgs 650000 223
17 sgs 650000 223
18 sgs 650000 223
19 sgs 650000 223
20 sgs 650000 223
21 sgs 650000 32
22 sgs 650000 32
23 sgs 650000 255
24 sgs 650000 223
25 sgs 650000 223
26 sgs 650000 223
27 sgs 650000 223
28 sgs 650000 223
29 sgs 650000 223
30 sgs 650000 223
31 sgs 650000 223
32 sgs 650000 223
33 sgs 650000 223
```

Figure 6: Example of configuration file

We organized different workshops to implement the demonstrator and support the CTA-2 partners in applying the configuration and the test for the demonstrator as we mention earlier in Chapter 2.

Chapter 5 Summary and Conclusion

This deliverable described in detail the DbD hardware validation and supporting procedures for the demonstrators for CTA-2. For this purpose, the definition of the testing strategy based on the functionalities that should be tested was the first step. The next step in the process was to classify the functionality testing based on the requirement analysis and as a last step, the tests needed to verify these functionalities were performed. The status of all the testing has been regularly reported and more than 90% of test requirements have passed successfully. Some of the tests have unfortunately not passed (see Table 3) and the issues faced during these tests were reported in real-time as well as the lessons learnt that have then been incorporated into new requirements for the next project.

Finally, CTA-2 demonstrator was provided with regular support and updates from S4R-2 Work-Package 1.

Chapter 6 List of Abbreviations

Abbreviation	Translation
CCU	Central Control Unit
CS	Consist Switch
CTA-2	CONNECTA-2
DbD	Drive-by-Data
DNS	Domain Name System
ECSC	ETB Control Service Client
ECSP	ETB Control Service Provider
ETB	Ethernet Train Backbone
ETBN	Ethernet Train Backbone Node
FDF	Functional Distribution Framework
GW	Gateway
HW	Hardware
IEC	International Electrotechnical Commission
IP	Internet Protocol
LAN	Local Area Network
NG	Next Generation
PCIe	Peripheral Component Interconnect Express
SDT	Safe Data Transmission
SW	Software
TCN	Train Communication Network
TRDP	Train Real Time Data Protocol
TSN	Time Sensitive Network
TTDB	Train Topology DataBase
TTDP	Train Topology Discovery Protocol
VLAN	Virtual Local Area Network
VPN	Virtual Private Network
WP	Work Package

Chapter 7 Bibliography

[1] MOXA, “Overall Software Test Specification” (Document Code: TR18061201) – Confidential
[2] WESTERMO, “Unit Test Specification Westermo Safe4Rail Demonstrators” (Document Code: 250004) – Confidential
[3] MOXA-WESTERMO, “S4R2-M12-Interoperability-Test-Report” – Confidential
[4] MOXA-WESTERMO, “Test summary of IEC 61375 and NG-TCN interop test”, Available at: https://safe4rail.eu/downloads/technical-seminar-brussels/07a-Test-Summary-of-IEC-61375-and-NG-TCN-Interoperability-Tests.pdf

Chapter 8 Annex – Unit Test Specification from Westermo and Hardware Test Report from MOXA

Unit Test Specification - Westermo Safe4Rail Demonstrator

Table of content

1 Scope

The scope of this document is to specify the routine test procedure of the product(s):

Product Type	Article Numbers
Westermo Safe4Rail Demonstrator	DUT-A

2 Reference and Abbreviations

2.1 Reference Documents

2.1.1 Applicable Standards and References

Standard Number	Standard Name
EN 50155:2017	Railway applications – Electronic equipment used on rolling stock

Reference Number	Reference Name / Document name

2.1.2 Reference Drawings

Drawings Number	Drawing Name
250003	Westermo_ug_250003_s4rd_reva

2.2 Abbreviations

DUT	Device Under Test
CoC	Certificate of conformance
CON	Console, sometimes referred to as Service Port or Debug Port
GND	Electric ground or Earth
USB	Universal Serial Bus
VDC	Voltage Directive Current
TBD	To Be Decided

3 Test Equipment

The test equipment should be capable of meeting the requirements of this specification.

4 Functional Tests

The test voltage applied during functional tests can be chosen to be anything between 10.8VDC to 13.2VDC.

The tests shall be performed at room temperature.

4.1 Current Consumption

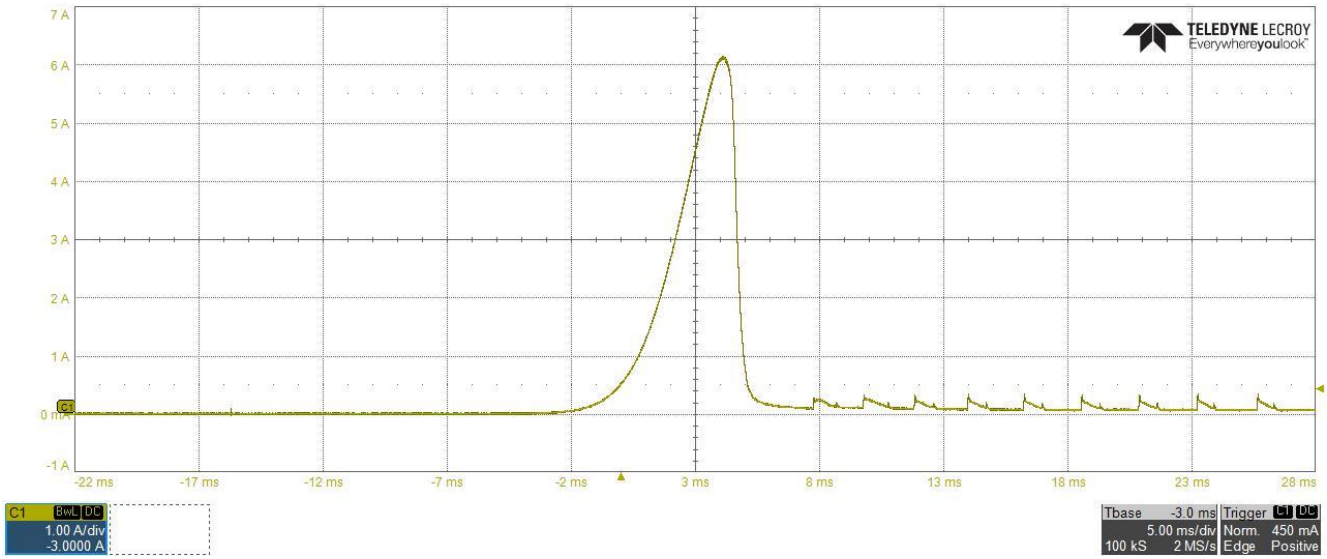
The test verifies correct current consumption, to verify that no damage has occurred during assembly.

4.1.1 Inrush current @ 5ms timebase

Measure the starting current with a time scale of 5ms/div.

Verify that the input current is less than 7A.

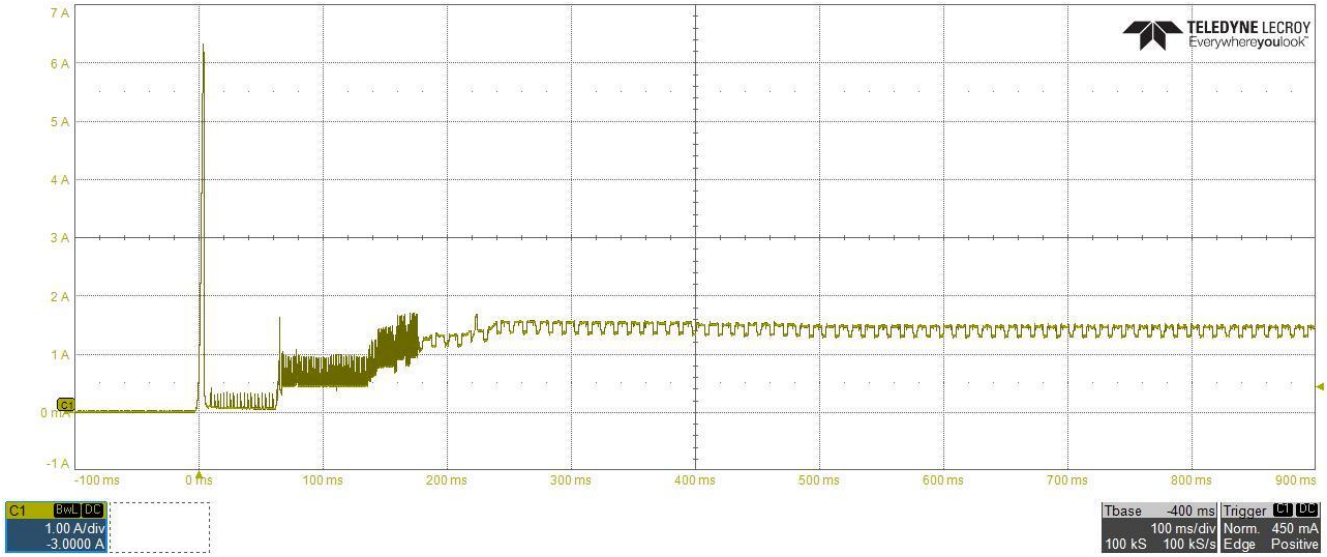
Item	Port	Criteria	Result	Pass	Fail
Inrush @ 5ms	PWR	<7A @12VDC	6.2A	Pass	



4.1.2 Inrush current @ 100ms timebase

Measure the starting current with a time scale of 100ms/div. Verify that the "normal" current is below 3A

Item	Port	Criteria	Result	Pass	Fail
Inrush @ 100ms	PWR	<3A @12VDC	1.4A	Pass	



4.1.3 Boot at min/max voltage

verify that the product starts during max / min input voltage. And the current is below 3A

Min voltage: 10.8VDC

Max voltage: 13.2VDC

Item	Port	Criteria	Result	Pass	Fail
Boot @ min/max voltage	PWR	<3A @ 10.8VDC <3A @ 13.2VDC	2.2A@10.8V 2.1A@12V 1.9A@13.2V	Pass	

4.2 WeOS Startup and Login

The test shall verify the function of the serial port and to make sure that WeOS starts and is working properly and login to the unit.

Item	Port	Criteria	Result	Pass	Fail
Startup and login	CON	It is possible to communicate with the unit through console port		Pass	

```
.--.--.--.-----.-----.------.-----.-.--.--------.-----.
|  |  |  |  -__|__ --|_    _|  -__|   _|  .  .  |  _  | http://www.westermo.com
 \__/\__/|_____._____| |__| |_____|__| |__|__|__|_____|       info@westermo.se
   Robust Industrial Data Communications -- Made Easy


\\/ Westermo WeOS v9.99 feature/5.x/safe4rail-aria10/safe4rail-alpha8-hw2 -- Jun 10 12:49 CEST 2021
Type: 'help' for help with commands, 'exit' to logout or leave a context.
```

```
a10-wmo-1:/#> show system-information
SYSTEM INFORMATION
System Name        : a10-wmo-1
System Description : Westermo Arria, primary: v0.00, secondary: v0.00, bootloader: v0.00
System Contact     :
System Location    :
System Timezone    : Etc/UTC

Product            : Arria-Virtual
Article Number     : 0000-0000-001
Serial Number      : 0
Platform           : Arria
Class              : Extended
Base MAC Address   : 00:07:ed:2b:2a:00
Manufacturing date : Jan  1, 2015



BOOT INFORMATION
Boot loader ver.   : 0.00             Active firmware    : Unknown
Primary ver.       : 0.00             Primary CRC        : N/A
Secondary ver.     : 0.00             Secondary CRC      : N/A
Config media       : internal         Config file        : startup

CARD #1
Type               : CPU
Article no         : 0000-0000-00
Revision           : 1
Batch id           : 150101-00000000-00000
```

4.2.1 Ethernet Interface Link Test

Verify that all ethernet ports make link at 1Gbit / s, verify with command "`show port`".

Item	Port number	Criteria	Result	Pass	Fail
Ethernet Link Test	X1-X7	Link up, 1Gbit/s, Full Duplex.	X1-X6 Ok X7 fail		Fail

```
arria-2b-2a-00:/#> show port
PORT        LINK    TYPE     SPEED  STATE       OWNER/VLAN
```

eth0 Down 1000-T ---------- No-Link vlan U:1
eth1 Up N/A N/A Disabled vlan U:1
ethX1 Up 1000-T 1000M-Full Forwarding vlan U:1
ethX2 Down 1000-T ---------- No-Link vlan U:1
ethX3 Down 1000-T ---------- No-Link vlan U:1
ethX4 Down 1000-T ---------- No-Link vlan U:1
ethX5 Up 1000-T 1000M-Full Forwarding vlan U:1
ethX6 Down 1000-T ---------- No-Link vlan U:1
ethX7 Down -T ---------- No-Link vlan U:1
arria-2b-2a-00:/#> show port
PORT LINK TYPE SPEED STATE OWNER/VLAN
eth0 Down 1000-T ---------- No-Link vlan U:1
eth1 Up N/A N/A Disabled vlan U:1
ethX1 Up 1000-T 1000M-Full Forwarding vlan U:1
ethX2 Down 1000-T ---------- No-Link vlan U:1
ethX3 Down 1000-T ---------- No-Link vlan U:1
ethX4 Down 1000-T ---------- No-Link vlan U:1
ethX5 Down 1000-T ---------- No-Link vlan U:1
ethX6 Up 1000-T 1000M-Full Forwarding vlan U:1
ethX7 Down -T ---------- No-Link vlan U:1
arria-2b-2a-00:/#> show port
PORT LINK TYPE SPEED STATE OWNER/VLAN
eth0 Down 1000-T ---------- No-Link vlan U:1
eth1 Up N/A N/A Disabled vlan U:1
ethX1 Up 1000-T 1000M-Full Forwarding vlan U:1
ethX2 Up 1000-T 1000M-Full Forwarding vlan U:1
ethX3 Down 1000-T ---------- No-Link vlan U:1
ethX4 Down 1000-T ---------- No-Link vlan U:1
ethX5 Down 1000-T ---------- No-Link vlan U:1
ethX6 Down 1000-T ---------- No-Link vlan U:1
ethX7 Down -T ---------- No-Link vlan U:1
arria-2b-2a-00:/#> show port
PORT LINK TYPE SPEED STATE OWNER/VLAN
eth0 Down 1000-T ---------- No-Link vlan U:1
eth1 Up N/A N/A Disabled vlan U:1
ethX1 Down 1000-T ---------- No-Link vlan U:1
ethX2 Down 1000-T ---------- No-Link vlan U:1
ethX3 Up 1000-T 1000M-Full Forwarding vlan U:1
ethX4 Up 1000-T 1000M-Full Forwarding vlan U:1
ethX5 Down 1000-T ---------- No-Link vlan U:1

ethX6 Down 1000-T ---------- No-Link vlan U:1

ethX7 Down -T ---------- No-Link vlan U:1

arria-2b-2a-00:/#> show port

PORT LINK TYPE SPEED STATE OWNER/VLAN

eth0 Down 1000-T ---------- No-Link vlan U:1

eth1 Up N/A N/A Disabled vlan U:1

ethX1 Down 1000-T ---------- No-Link vlan U:1

ethX2 Down 1000-T ---------- No-Link vlan U:1

ethX3 Up 1000-T 1000M-Full Forwarding vlan U:1

ethX4 Down 1000-T ---------- No-Link vlan U:1

ethX5 Down 1000-T ---------- No-Link vlan U:1

ethX6 Down 1000-T ---------- No-Link vlan U:1

ethX7 Down -T ---------- No-Link vlan U:1

4.2.2 Ethernet Interface Traffic Test

Generate the packet between two ports at a time.

With setting 97% line load at 1Gb / s, packet size 1518byte for 5 minutes.

Item	Port number	Criteria	Result	Pass	Fail
Ethernet Traffic Test	X1 – X2 X1 – X3 X1 – X4 X1 – X5 X1 – X6 X1 – X7	No errors or lost packets allowed.	Ok @ X1-X2 Ok @ X1-X3 Ok @ X1-X4 Ok @ X1-X5 Ok @ X1-X6 Fail @ X1-X7		Fail

4.2.3 Power LED Check

The functionality of the Power LEDs shall be checked.

Item	Criteria	Result	Pass	Fail
Power LED	The power LED shall be lit when unit is powered		Pass	

5 Revision History:

Rev	Description	Prepared by / Date	Reviewed by / Date	Approved by / Date
01	First draft	MLI/2020-11-20		
02	Released version	AHE/2021-05		

Hardware Test Report

Project Number : TR18061201
Project Name : Safe4RAIL-2 ETBN & CS
Model Name : TN-G4900, TN-G6500

Approved By	Reviewed By	Prepared By
Roland Chan	Charles Yeh	Andy Chen

Revision History

Version	Description of Change	Reason	Date	Author
V0.0.1	First created	First created	2020/5/5	Andy Chen

CONTENTS

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List of Tables

1. Overview

1.1 Purpose

The Hardware Test Report is to ensure the hardware is working as expected under the test items mentioned in chapter 3.

1.2 Terms and abbreviations

Table 1 abbreviations

CS	Consist Switch
ETBN	Ethernet Train Backbone Node
FE	Fast Ethernet (100Mbps)
GbE	Gigabit Ethernet
IP code	International Protection / Ingress Protection Code
LED	Light-emitting diode
TFFR	Tolerable Functional unsafe Failure Rate
TSN	Time Sensitive Network

2. Reference document

[01] Hardware Requirements Specification.doc

[02] IEEE 802.3:2008 - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements

3. Test cases

3.1 Power Test

3.1.1. HW_TST_PWR_001: Power input and output Test

Testing Purposes	Power input and output Test
Test Condition	Vin 24~110VDC K-code connector : 5 pin Loader : 0~50Watt
Test Principle/Criteria	Vout: 12VDC , Output voltage tolerance:+/- 5%
Test Result	Pass ■ | Fail☐

3.2 IO Test

3.2.1. HW_TST_IO_001: ETBN LED color check

Testing purposes	ETBN LED color check
Test Principle/Criteria	

LED Name	Color	ETBN/CS
PWR	Amber	ETBN/CS
State	Green/Red	ETBN/CS
MSTR /Turbo Ring	Green	ETBN/CS
INAUG	Green	ETBN only
INHBT	Green	ETBN only
OPTRN	Green	ETBN only
LEAD	Green	ETBN only
AECSP	Green	ETBN only
PRIM on port 1	Green	ETBN only
PRIM on port 2	Green	ETBN only
Each port LED	Green/ Amber	ETBN/CS

Test Result

PWR(Amber)	Pass ■	Fail ☐
STATE(Green)	Pass ■	Fail ☐
STATE (Red)	Pass ■	Fail ☐
MSTR /Turbo Ring (Green)	Pass ■	Fail ☐
INAUG(Green)	Pass ■	Fail ☐
INHBT(Green)	Pass ■	Fail ☐
OPTRN(Green)	Pass ■	Fail ☐
LEAD(Green)	Pass ■	Fail ☐
AECSP(Green)	Pass ■	Fail ☐
PRIM 1(Green)	Pass ■	Fail ☐
PRIM 1(Green)	Pass ■	Fail ☐
ETH 1(Green)	Pass ■	Fail ☐
ETH 1(Amber)	Pass ■	Fail ☐
ETH 2(Green)	Pass ■	Fail ☐
ETH 2(Amber)	Pass ■	Fail ☐
ETH 3(Green)	Pass ■	Fail ☐
ETH 3(Amber)	Pass ■	Fail ☐
ETH 4(Green)	Pass ■	Fail ☐

	ETH 4(Amber)	Pass ■	Fail ☐
	ETH 5(Green)	Pass ■	Fail ☐
	ETH 5(Amber)	Pass ■	Fail ☐

3.2.2. HW_TST_IO_002: CS LED color check

Testing purposes	CS LED color check		
Test Principle/Criteria	**LED Name**	**Color**	**ETBN/CS**
	PWR	Amber	ETBN/CS
	State	Green/Red	ETBN/CS
	MSTR /Turbo Ring	Green	ETBN/CS
	INAUG	Green	ETBN only
	INHBT	Green	ETBN only
	OPTRN	Green	ETBN only
	LEAD	Green	ETBN only
	AECSP	Green	ETBN only
	PRIM on port 1	Green	ETBN only
	PRIM on port 2	Green	ETBN only
	Each port LED	Green/ Amber	ETBN/CS
Test Result	PWR(Amber)	Pass ■	Fail ☐
	STATE(Green)	Pass ■	Fail ☐
	STATE (Redr)	Pass ■	Fail ☐
	MSTR /Turbo Ring (Green)	Pass ■	Fail ☐
	ETH 1(Green)	Pass ■	Fail ☐
	ETH 1(Amber)	Pass ■	Fail ☐
	ETH 2(Green)	Pass ■	Fail ☐
	ETH 2(Amber)	Pass ■	Fail ☐
	ETH 3(Green)	Pass ■	Fail ☐
	ETH 3(Amber)	Pass ■	Fail ☐
	ETH 4(Green)	Pass ■	Fail ☐
	ETH 4(Amber)	Pass ■	Fail ☐
	ETH 5(Green)	Pass ■	Fail ☐

	ETH 5(Amber)	Pass ■	Fail ☐
	ETH 6(Green)	Pass ■	Fail ☐
	ETH 6(Amber)	Pass ■	Fail ☐

3.2.3. HW_TST_IO_003: UART Test

Testing purposes	UART Test	
Test Conditions	Baud rate 115,200 bps	
Test Principle/Criteria	Check if the UART console is shown	
Test Result	Pass ■	Fail ☐

3.2.4. HW_TST_IO_004: TSN Micro SD card Test

Testing purposes	TSN Micro SD card read/write Test	
Test Principle/Criteria	Compliant to UHS-1 V3.0.1 with speed 100MHz	
Test Result	Pass ■	Fail ☐

3.3 Network Test

3.3.1. HW_ NMA _MAIN_001: IEEE802.3 Compliance Test

Testing purposes	1.DUT should support M12 X-Coded Ethernet Cable 2.DUT should comply IEEE802.3.		
Test Principle/Criteria	IEEE802.3		
Test Result	10M	Pass ■	Fail ☐
	100M	Pass ■	Fail ☐
	1000M	Pass ■	Fail ☐

3.4 Environment Test

3.4.1. HW_TST_ENV_001: IP30 Test

Testing purposes	Evaluate the Degree of Protection Provided by a Product's Enclosure with Ingress Testing.	
Test principle/Criteria	IEC 60529，Visual inspection: The test rod shall not penetrate and adequate clearance shall be kept.	
Test Result	Pass ■	Fail ☐

3.4.2. HW_TST_ENV_002: Dry Heat Test

Testing purposes	Dry Heat Test
Test Condition	1. Operating Temperature: +40C 2. Wire speed traffic to each Ethernet port 3. Duration: 2 hours
Test Principle/Criteria	1. No packet loss on all Ethernet ports 2. The temperature of TSN FPGA does not exceed its limit, i.e. 95℃
Test Result	Pass ■ | Fail ☐

3.4.3. HW_TST_ENV_003: Storage Environment Test

Testing purposes	Storage Environment Test
Test Condition	1. Device is powered off 2. Operating Temperature: -20 ~ +60C 3. Rapid Temperature Variation, 8 cycles, each cycle 200 minutes
Test Principle/Criteria	Device can boot up and the traffic forwarding is normal
Test Result	Pass ■ | Fail ☐

3.4.4. HW_TST_ENV_004: Cyclic Temperature Test

Testing purposes	Cyclic Temperature Test
Test Condition	1. Operating Temperature: -10 ~ +40C 2. Rapid Temperature Variation, 8 cycles, each cycle 320 minutes
Test Principle/Criteria	Device can boot up and the traffic forwarding is normal
Test Result	Pass ■ | Fail ☐