D1.1 – Drive-by-Data Requirements Specification

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Abstract:	Refinement of performance, availability and safety requirements of ETBN, consist switches and end-nodes.
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Executive Summary

Deliverable *D1.1 – Drive-by-Data Requirements Specification* – defines the requirements for the Network Devices (ND) of ETBN and consist switch requirements as well as end device. The requirements for safe train inauguration are also addressed.

The top-down analysis has been performed in order to identify the technological requirements. These requirements have been also discussed and analysed by the demonstrator providers that is the CONNECTA-2 project partners.

The overall set of requirements of different levels is complemented with the identification of particular services. The services can be either existing technologies or techniques or missing technologies that should be in the next-generation Train Control and Monitoring System (TCMS).

Requirements have been analysed and consolidated in the following levels:

- ETBN
- consist switch
- end-point or end-device
- network-wide configuration

The consolidated requirements offer a solid foundation for the “Drive-by-Data” concept, that is, the networking layer of the next-generation Train-Control and Management System.

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Chapter 1 Introduction

1.1 Scope

In the scope of Safe4RAIL-2 WP1 activities, the components that make up the Drive-by-Data are described. Drive-by-Data is the networking layer of the next-generation Train-Control and Monitoring System (NG-TCMS).

It covers the following areas:

- Ethernet Train Backbone Node (ETBN) requirements
- Ethernet Consist Switch (CS)
- Ethernet End-Point, also referred to as End-Device (ED).
- Safe Train Inauguration requirements
- Safe Data Transmission Requirements
- Network-wide Configuration Requirements

The requirements are defined in strong collaboration with the future users of these devices, i.e. the train manufacturers, associated in the complementary project CONNECTA-2.

1.2 Definitions

The table below[1] consists of some definitions of the terms present in the requirements. This scheme can be used in order to ease the understanding of the requirements and to avoid and clarify any confusion that might be caused within the requirement. Therefore, any time a conflict arises on the content / scope of a term, this table can be consulted. Abbreviations or acronyms are described in Chapter 6 at the end of the document

Term	Definition
Application	Software application
Computer	A computing unit/CPU/MCU that hosts a COM (NIC abstraction) layer and takes data from the Network Interface Card.
Drive-by-Data	Drive-by-Data enables the use of electrical/electromechanical/electrohydraulic systems connected via electronic networks, for performing vehicle functions traditionally achieved by pneumatic/hydraulic/mechanic subsystems. It is a term coined to describe the system concept which enables

[1] *Current list is taken from Safe4RAIL D1.8 to ensure consistency between the documents. However, it may be extended with new definitions or unused definitions may be removed in later versions.*

Term	Definition
	physical quantities to be transferred reliably as a digital information through an electronic distributed networked system, and not by dedicated physical subsystem domains (pneumatics, hydraulics, mechanical, ...).
Function	Results of operation of different software applications hosted on one or more computers
Global GMC time	Unique value within ETB; this is the FT AVG value, calculated from four GMC values. All network devices within the ETB synchronization domain (even GMCs themselves) adjust their local clocks to it.
GMC	Grandmaster Clock, a function available on both levels - ETB and ECN. It provides time into its synchronization domain.
gPTP clock domain	A unique combination of a GMC and a path for dissemination of GMC time. Devices within one gPTP domain must not synchronize to the disseminated clock value.
IMP (Integrated Modular Platform)	Integrated Modular Platform is a generic networked system designed to host many functions of different criticality and ensures their isolation and on-interference. It consists of SyIL and FDF layer, including RTOS, but without any applications.
Inactive Mode	An operation mode of an ETBN; in this mode, the ETBN is not exchanging any traffic with the NG TCMS. It is passive and waits for an externally initiated inauguration signal.
Key System Interfaces	Any interface that carries global state variables with predictable timing (Interface between WP1 and WP2)
Network (i.e. TCMS Network)	A set of networked ETB and ECN devices - switches, NIC End devices and ETB Gateways
NG TCMS	Integrated Next-Generation Train Control and Monitoring System, with TCMS applications and sensor function hosted on/via IMP
Stable synchronization	An operation mode of a device assuming a synchronization on a clock which has been fault-free for a predefined time period.
Synchronization domain	A unique set of network devices which run on the same clock, i.e. are synchronized to the same time base.
System Integration Layer	System Integration Layer (SyIL) consists of network (devices), network interface cards, NIC drivers, and interfacing to/via FDF, including all capabilities required for timely, robust and reliable transport of process and sensor data among applications.
Unrecoverable loss of synchronization	A permanent inability of a network device to synchronize to global GMC time, due to its own failure or absence of time information coming from 2 or more GMCs.
Virtual Networks	A logical subset of paths and devices within a physical network. The topology of a virtual network can differ from that of a physical network.

Table 1-1: Definition of Terms

Chapter 2 Requirements structure

The requirements of Safe4RAIL-2 project must be written according to a set of rules so that they are harmonized, consistent and of good quality. For this purpose, their characteristics, writing rules and their attributes are detailed in the next lines.

2.1 Requirements characteristics

Requirements should be specified in order to comply with the main characteristics listed in Table 4.

Characteristic	Definition
Necessary	The stated requirement is an essential capability, physical characteristic, or quality factor of the product or process. If it is removed or deleted, a deficiency will exist, which cannot be fulfilled by other capabilities of the product or process.
Concise (minimal, understandable)	The requirement statement includes only one requirement stating what must be done and only what must be done, stated simply and clearly. It is easy to read and understand. To be concise, the requirement statements must not contain any explanations, rationale, definitions or descriptions of System use. The place for these texts is analysis and trade study reports, operational concept documents or user manuals.
Attainable (achievable or feasible)	The stated requirement can be achieved by one or more developed System concepts at a definable cost.
Complete (standalone)	The stated requirement is complete and does not need further amplification. The stated requirement will provide sufficient capability.
Consistent	The stated requirement does not contradict other requirements. It is not a duplicate of another requirement. The same term is used for the same item in all requirements.
Unambiguous	Each requirement must have one and only one interpretation. Language used in the statement must not leave a doubt in the reader's mind as to the intended descriptive or numeric value.
Verifiable	The stated requirement is not vague or general but is quantified in a manner that can be verified by one of these 4 alternative methods: inspection, analysis, demonstration or test. The verifiability of a requirement should be considered at the same time that a requirement is being defined.

Characteristic	Definition
Modifiable	A Requirements Specification is modifiable if, and only if, its structure and style are such that any change to requirements can be made easily, completely, and consistently while retaining the structure and style. Modifiability generally requires a tagged document to have a coherent and easy-to-use organization with a table of contents, an index, and explicit cross-referencing, to be not redundant (i.e. the same requirement should not appear in more than one place / document) and to express each requirement separately, rather than intermixed with other requirements.
Traceable	The origin and the propagation of each requirement are clear, facilitating the reference to each requirement in future development. Two types of traceability are recommended. Backward traceability (i.e. to previous stages of development), this depends upon each requirement explicitly referencing its source in earlier documents. Forward traceability (i.e. to all documents spawned by the current document), this depends upon each requirement in the document having a unique name or reference number.

Table 2 Requirement characteristics

2.2 Requirements writing rules

In order to improve the quality of requirements, a standard approach to requirements syntax is recommended. The present document refers to the proposals made by the ISO 29148 and the Easy Approach to Requirements Syntax (EARS) developed by Rolls Royce.

ISO 29148:2011 focuses on a system being built up as follows:

[Condition] [Subject] [Action] [Object] [Constraint]

The generic syntax is shown in the following expression:

[<trigger>] [<precondition>] the <system name> shall <system response>

where:

- the square brackets denote optional items; the brackets < > denote a clause; in addition to the clauses, the templates contain keywords (e.g. when, while, if, then, shall);
- *Trigger* – defines event detected by the system that activates a requirement;
- *Precondition* – define conditions that must be true for a requirement to become active;
- *System name* – denotes requirement's subject, e.g. system, subsystem, software, component, module;
- *System response* – specifies the behaviour that the named system must perform as a result of the requirement becoming active or state a fundamental system property.

Each requirement must have zero or one trigger, zero or many preconditions and one or many system responses.

Regarding functional requirements, the <system response> clause can be in many cases unpacked in sub-clauses as follows:

<system response> → <action> [<object of action>] [<refinement of action>]

The EARS differentiates between five types (patterns) of requirements:

- *Universal requirements* – (i) state a fundamental system property, something that the system must always do or have; (ii) are unconditional and continuously active; (iii) are universal (exist at all times);
- *Event Driven Pattern* – (i) are initiated only when a triggering event occurs or is detected; (ii) use ***when*** keyword;
- *State Driven Pattern* – (i) are in force while a system is in a specific state; (ii) use ***while*** or ***during*** keywords;
- *Option Pattern* – (i) are invoked only in systems that include the particular optional feature; (ii) exist at all times; (iii) are used as a simple way to handle product or system variation; (iv) use ***where*** keyword;
- *Unwanted Behaviour Pattern* – (i) handle unwanted behaviours including error conditions, failures, faults, disturbances and other undesired events; (ii) use ***if*** and ***then*** keywords.

The simple patterns can be combined into *Complex combination pattern,* which: (i) concatenate multiple patterns to express a complex requirements; (ii) describe complex conditional events involving multiple triggers, preconditions, states and/or optional features with various constraints; (iii) use a combination of keywords.

A further pattern refers to the *Capability requirements*, describe high level capability and use ***shall be capable of*** keywords and optionally ***when, while*** keywords.

In Table 3, the syntax and some examples for each requirement pattern are provided.

Pattern	Syntax	Examples
Universal Requirements	***The <system name> shall <system response>***	The DI16 module shall provide 16 digital input channels. The software shall provide general-purpose read and write services to access FEPROM memory.
Event Driven	***When <trigger> [<precondition>], the <system name> shall <system response>***	When requested by the MDS Controller, the DTN-App shall provide the MDS Controller with its Software Version ID, CRC of its configuration data and CRC of the DTN-App software. When a higher priority announcement is requested, the PA system shall abort any in progress announcement and start the higher priority announcement.
State Driven	***While <system state>, the <system name> shall <system response>***	While in night mode, the DDU software shall reduce the intensity of the display to a configurable minimum level. While the device is running on the battery and the battery is below 20% charge, the device shall display warning message “low battery“.
Optional	***Where <feature is included>, the <system name> shall <system response>***	Where hardware encryption is installed, the software shall encrypt data using the hardware instead of using a software algorithm. Where multiple languages are available, the Information Display shall cycle through them displaying each for 10 second.

Pattern	Syntax	Examples
Unwanted Behaviour	***If <unwanted condition or event>, then the <system name> shall <system response>***	If the read input value is greater than 25 mA, then the AI8 module shall set the validity indicator to invalid. If opposing green signals are detected, then the traffic signalling controller shall de-energise all traffic lights.
Capability	***[<trigger>] [<precondition>], the <system name> shall be capable of <capability>***	When all communications are lost, the UAV shall be capable of automatically navigating to base.

Table 3 EARS Requirements patterns

A final (as obvious as fundamental) recommendation concerns the terms to be avoided or to be used carefully in the specification of requirements:

- Comparatives and superlatives: (better, best, higher, most, smallest, largest);
- Subjective statements: (easy, good, user friendly, nice, good looking, inviting);
- Ambiguous terms: (always, optimal, minimal, maximum);
- Open ended statements: (at least, not limited to);
- Loopholes: (possible, as applicable);
- Negative statements: (shall not have, shall not be, no);
- Connective statements: (and, or);
- Passive voice (it shall be possible to).

2.3 Requirements attributes

In order to better work on the specification, some attributes shall be specified for each requirement.

The next table provides the meaning of each attribute:

Name	Type	Description	Applicability
Id	ReqID	Unique identification of the requirement. Ensures that the requirement remains uniquely traceable and enables traceability to needs, solutions and documents. It shall be expressed according to the following formatting rule: “systemacronym-device/demoacronym-NNN”, where “systemacronym” can be ,for instance, “FDF”, “DF” or “HVAC”, “device/demoacronym” identifies either the device or the demonstrator to which the requirement applies (i.e. ETBN, ED or URB for Urban, REG for Regional) and N is a number between 0 and 9.	Mandatory
Name	Text	Short highlight of requirement.	Optional
Description	Text	Requirement description text.	Mandatory
Relevant for Demonstrator	Yes/No	Indicates if the requirement must be taken into account for the development of the demonstrator.	Mandatory
Safety related	Yes/No	Indicates if the requirement has safety implications.	Optional
Source	ReqID	Indicates a higher level requirement (such as CONNECTA or CONNECTA-2 requirements defined for the demonstrator) which the requirement traces to.	Mandatory
Status	Status Kind	Indicates the current status of the requirement (i.e. draft, under review, approved). It shall be managed by the specification responsible only.	Optional
Notes	Text	Additional explanations for the requirement.	Optional

Table 4 Requirement attributes

Chapter 3 Architecture Requirements

This chapter describes the requirements of the NG-TCMS architecture. The architectural requirements combine safety, fault tolerance and real-time performance with data, and system integrity considerations. In the following discussion a description of the main sections of this chapter is presented.

Section 3.1 is presenting the requirements from the demonstrator point of view based on the Bottom-up analysis to be performed and identified the needs of the next generation and the missing services.

The required core services related to the inauguration in the network and devices level are introduced in Sections 3.2 and 3.3. The requirements covered the safety for the two stages or kind of inauguration:

- ETB inauguration - discovering the ETB topology and generate the Train Network Directory (TND), inhibiting train inauguration on demand, indicating train lengthening/shortening.
- Operational train inauguration - computing the Train Topology Database (TTDB) after train composition change or after train leadership change.

As result from the CONNECTA and SAFE4RAIL projects, the ETB in parallel redundant layout (Variant D) (see Figure 1) has be selected and discussed as the basics for requirement of the integration.

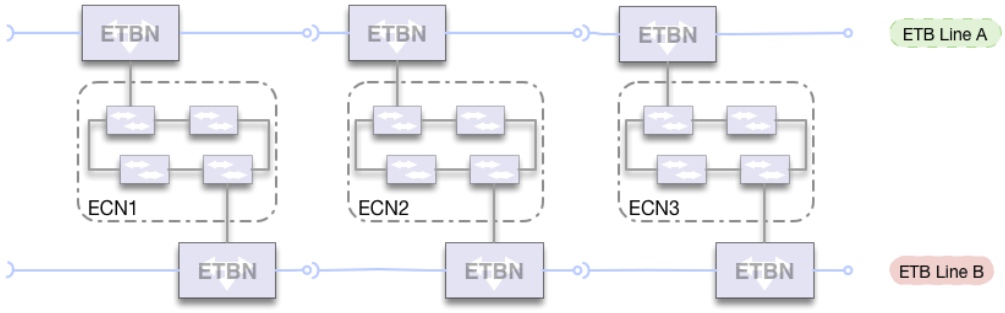

Figure 1 ETB in parallel redundant layout (Variant D)

The ETBN Device has been intensely discussed from technology partners as well as from the demonstrator partners from the CONNECTA-2 project. The requirements for the ETBN devices related to the clock synchronization, communication aspects, safety aspect and configuration are introduced in sections 3.4 to 3.13.

Finally, the requirement for the security in the network level has been presented in section 3.14.

3.1 Network Device - Requirements from CONNECTA-2

Requirement type	Requirement	**Requirement ID**	DBD_ND_001
Description		The ETBN shall provide at least 3 Ethernet ports following IEEE 802.3 with · 2 ports GbE for ETB connection · 1 port GbE for ECN connection	
Notes			
Requirement Source	Derived from [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_002
Description		The ND ports shall support the reception and transmission of Ethernet frames in accordance to IEEE 802.3	
Notes			
Requirement Source	Derived from [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_003
Description		The ND shall support clock synchronization in accordance to IEEE 802.1AS-rev	
Notes			
Requirement Source	S4R-DBD-303	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_004
Description		The ETBN shall provide master clock for train (GlobalMC) and for ECN (ConsistMC)	
Notes			
Requirement Source	Derived from [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_005
Description		The ETBN shall provide gateway functionality for TSN and time information	
Notes		TSN gateway is defined in [DbDArchSpec]	
Requirement Source	Derived from [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_006
Description		The ETBN shall support adding, recognizing, interpreting, and removing VLAN tags as defined in IEEE 802.1Q.	
Notes			
Requirement Source	S4R-DBD-522	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_007
Description		The ETBN shall provide 8 output queues per port, each allocated to one traffic class 1..8.	
Notes			
Requirement Source	S4R-DBD-525	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_008
Description		The ETBN shall support strict priority-based transmission selection algorithm (IEEE 802.1Q)	
Notes		All conventional data traffic shall be transmitted priority based	
Requirement Source	S4R-DBD-522	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_009
Description		The ETBN may support credit-based shaper algorithm (IEEE 802.1Q) to reduce bursts for conventional data traffic	
Notes			
Requirement Source	S4R-DBD-522	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_010
Description		The ETBN shall support scheduled traffic in accordance to IEEE 802.1Qbv	
Notes		For scheduled traffic	
Requirement Source	S4R-DBD-526	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_011
Description		The ETBN shall support per stream filtering and policing as defined in IEEE 802.1Qci	
Notes			
Requirement Source	S4R-DBD-523	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_012
Description		The ETBN shall act as a router between ECN and ETB for unicast and multicast IP packets including network address translation	
Notes		For non-deterministic data traffic.	
Requirement Source	Derived from [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_013
Description		The ETBN shall support the Internet protocol suite including · IP (RFC 791) · ARP (RFC 826) · UDP (RFC 768) · TCP (RFC 793) · ICMP (RFC 792)	
Notes			
Requirement Source	CTA-D3.5 Chapter 2.8.3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_014
Description		The ETBN shall support TRDP according IEC 61375-2-3	
Notes		Required by the ETBN service interface	
Requirement Source	IEC 61375-2-3; S4R-DBD-709	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_015
Description		The ETBN shall support SDTv4	
Notes		Required by the ETBN service interface	
Requirement Source	IEC 61375-2-3; S4R-DBD-802 (derived)	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_016
Description		The ETBN shall provide train backbone topology discovery according IEC 61375-2-5 with modifications defined in [DbDArchSpec]	
Notes			
Requirement Source	IEC 61375-2-3; S4R-DBD-710	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_017
Description		The ETBN shall provide train composition discovery according IEC 61375-2-3 with modifications defined in [DbDArchSpec]	
Notes			
Requirement Source	IEC 61375-2-3; S4R-DBD-709	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_018
Description		The ETBN may support sleep mode according IEC 61375-2-3	
Notes			
Requirement Source	IEC 61375-2-3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_019
Description		The ETBN shall implement an ECSP according IEC 61375-2-3 with modifications defined in [DbDArchSpec]	
Notes			
Requirement Source	CTA-D3.5-ID_40062 (specifies a "may" requirement)	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_020
Description		The ETBN shall implement a TTDB which is managed by a TTDB Manager function	
Notes		TTDB manager is to be implemented in CCU.	
Requirement Source	CTA-D3.5-ID_30012	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_021
Description		The ETBN shall support resolving TCN-URI addresses (IEC 61375-2-3) to IP addresses	
Notes		DNS service	
Requirement Source	IEC 61375-2-3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_022
Description		The ETBN shall provide service interfaces according IEC 61375-2-3 annex E: · ECSP interface · TTDB manager interface · DNS server interface (Standard & TCN) · ETBN control interface	
Notes			
Requirement Source	IEC 61375-2-3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_023
Description		The ETBN shall support IGMP snooping	
Notes		MC filtering	
Requirement Source	CTA-D3.5 Chapter 3.3.5	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_024
Description		The ETBN should support a DHCP server	
Notes		Can be removed if each CS shall have its own server	
Requirement Source	Derived from [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_025
Description		The ETBN shall support SNMP.	
Notes		Further SNMP and MIB requirements are provided as part of health monitoring/logging capabilities.	
Requirement Source	CTA-D3.5 Chapter 3.5.5	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_026
Description		The ETBN may provide an authentication server (IEEE 802.1x).	
Notes		Spares additional devices for authentication server	
Requirement Source	CTA-D3.5 Chapter 3.2.11	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_027
Description		The ETBN shall support detection and reporting of security events	
Notes		Refer to [DbDArchSpec] for a list of appropriate events. Open to add meaningful events or to remove events not needed (with justification).	
Requirement Source	CTA-D3.5 Chapter 3.5.7	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_028
Description		The ETBN shall support device redundancy with switch-over time of ≤ 0.8 s.	
Notes		This requires a sub second VRRP advertisement interval, which is readily supported by VRRP v3 (RFC5798)" (see also DBD_ND_405)	
Requirement Source	Derived	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

3.2 Network Level Inauguration Requirements

Requirement type	Requirement	**Requirement ID**	DBD_ND_029
Description		NG TCMS Network shall be scalable up to 64 switches on ETB level without gateways.	
Notes		Note: 32 in a row, two lines. For inauguration in serial form the max shall be 63 (IEC61375-2-5 Annex A). Thus, is 62 ETBNs (31+31) max in NG TCN.	
Requirement Source	S4R-DBD-210	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_030
Description		Each ECN shall be connected to ETB via two ETBNs.	
Notes		System requirement rather than ND requirement	
Requirement Source	S4R-DBD-700	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_031
Description		One ETBN shall connect ECN to one ETB line. Note: Two ETB lines A and B. Each ETBN is connected to one of the two lines and to ECN.	
Notes			
Requirement Source	S4R-DBD-701	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_032
Description		ETBN shall transfer non-TSN data between ECNs on one ETB line. Note: Link aggregation is not used.	
Notes			
Requirement Source	S4R-DBD-703	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_033
Description		ETBN shall use neighbour discovery results to dynamically select ETB line used for non-TSN data transfer between any two neighbour consists. Note: non-TSN data are transferred in dedicated VLAN on ETB. Tunnelling of this VLAN through ECN might be used to switch non-TSN traffic from one ETB line to the other within a consist.	
Notes		Note: In case of ETBN failure or link failure the selected ETB line must be automatically changed (redundancy). This failover method is described in DBD_ND_065.	
Requirement Source	S4R-DBD-704	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_051
Description		Train Inauguration shall be safety-related function of safety integrity level (SIL) 2.	
Notes		Furthermore, "Train Inauguration Validation" function is added to validate the result at the appropriate SIL level to increase the overall confidence in the Safe Train Inauguration.	
Requirement Source	S4R-DBD-706	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_052
Description		Train inauguration function shall perform ETB topology discovery and Operational Train Inauguration.	
Notes		ETB topology discovery is specified in IEC 61375-2-5. Operational Train Inauguration is specified in IEC 61375-2-3. Necessary modifications for NG-TCN-topology (see [DbDArchSpec]) are reflected here.	
Requirement Source	S4R-DBD-709	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_053
Description		ETBN shall use TTDP protocol specified in IEC 61375-2-5 for ETB topology discovery with the improvements for NG-TCN topology.	
Notes		The TTDP protocol shall take the relay of the TTDP Hello frames within consist and the VLAN reconfiguration on ETB line into consideration.	
Requirement Source	S4R-DBD-710 S4R D1.9 Chapter 3.1.1	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

3.3 Device Level Inauguration Requirements

3.3.1 Device Level Inauguration Requirements (Variant D topology)

Requirement type	Requirement	**Requirement ID**	DBD_ND_054
Description		ETBN shall use TTDP protocol HELLO frames for neighbour discovery on ETB.	
Notes			
Requirement Source	S4R-DBD-720	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_055
Description		When both ETBNs in a consist are functional the ETBN on line A shall send HELLO frames on both ETB lines in DIR 1 and the ETBN on line B shall send HELLO frames on both ETB lines in DIR 2.	
Notes		The aim is to emulate serial connection of ETBNs on ETB as specified in IEC 61375-2-5 even though ETBNs are in fact connected in parallel - one to each ETB line.	
Requirement Source	S4R-DBD-721	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_056
Description		ETBN shall use a dedicated VLAN to forward HELLO frames to its partner-ETBN in the same consist via ECN.	
Notes			
Requirement Source	S4R-DBD-722	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_057
Description		When one ETBN in a consist fails the other ETBN shall transmit own HELLO frames to the connected ETB line in both directions.	
Notes			
Requirement Source	S4R-DBD-723	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_058
Description		When both ETBNs in a consist are functional the ETBN on line A shall process HELLO frames received from both ETB lines in DIR 1 and the ETBN on line B shall process HELLO frames received from both ETB lines in DIR 2.	
Notes		Symmetrical to HELLO transmission - the aim is to emulate serial connection of ETBNs on ETB as specified in IEC 61375-2-5.	
Requirement Source	S4R-DBD-724	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_059
Description		When one ETBN in a consist fails the other ETBN shall process HELLO frames received from both directions on the connected ETB line.	
Notes			
Requirement Source	S4R-DBD-725	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

3.3.2 ETB topology discovery

Requirement type	Requirement	**Requirement ID**	DBD_ND_060
Description		ETBN shall transmit TTDP protocol TOPOLOGY frames in both directions on ETB as non-TSN data.	
Notes		TOPOLOGY frames belong to non-TSN data category and therefore are transmitted on one ETB line only in each direction.	
Requirement Source	S4R-DBD-730	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_061
Description		ETBN shall receive TOPOLOGY frames from all other ETBNs on ETB. Note: Since serial connection between ETBNs is emulated each ETBN receives TOPOLOGY frames from ETBNs connected to either ETB line.	
Notes			
Requirement Source	S4R-DBD-731	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_062
Description		ETBN shall use received TOPOLOGY frames to calculate Train Network Directory as specified in IEC 61375-2-5.	
Notes			
Requirement Source	S4R-DBD-732	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_063

Description		ETBN shall compute the Train Network Directory with tolerable functional failure rate (TFFR) of less than 10^-6/h to achieve safety integrity level SIL2.	
Notes			
Requirement Source	S4R-DBD-733	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

3.3.3 Inauguration requirements[2]

Requirement type	Requirement	**Requirement ID**	DBD_ND_064
Description		The ETBN shall provide TTDB information to TI validator via TTDB manager interface defined in IEC 61375-2-3, and shall transfer data via safe data transmission protocol (e.g. SDTv4).	
Notes		TTDB manager is implemented in CCU. This requirement covers the interface on the ETBN side.	
Requirement Source	CTA D3.5 chapter 3.5.4	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_065
Description		The ETBN shall support dynamic VLAN reconfiguration to handle ETB line and ETBN failover for non-TSN traffic.	
Notes			
Requirement Source	CTA D3.5 chapter 3.2.10	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	
Requirement type	Requirement	**Requirement ID**	DBD_ND_066
Description		The ETBN shall support up to 32 logical ECNs in each consist	

[2] cover the requirements from safe train inauguration

Notes			
Requirement Source	IEC61375-2-5 Annex A S4R D1.9 Chapter 2.1.1" D3.5 Section 3.2.6	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_067
Description		The ETBN shall support local subnet addressing defined in IEC 61375-2-5 chapter 6.4.2 on ECN side.	
Notes			
Requirement Source	IEC61375-2-5 Chapter 6.4.2	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_068
Description		The ETBN shall support only ETB ID 0.	
Notes		Original IEC 61375-2-5 support up to 4 ETB ID.	
Requirement Source	IEC61375-2-5	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_069
Description		The ETBN shall support the beacon proxy function.	
Notes		This requirement is safety-relevant.	
Requirement Source	CTA-D3.5 Chapter 3.5.4, p.178	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

3.4 Network Device - Clock Synchronisation Requirements

3.4.1 Clock Sync Time Dissemination ETB

Requirement type	Requirement	**Requirement ID**	DBD_ND_101
Description		The network shall forward the timing information coming from world clock or system time generator to the end devices.	
Notes		external clock source support.	
Requirement Source	S4R-DBD-508	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_102
Description		Upon unrecoverable loss of synchronization, the ETBN shall stop synchronous time-aware operations.	
Notes		Without synchronous clock, no scheduled communication shall take place.	
Requirement Source	S4R-DBD-301	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_103
Description		The ETBN shall be a time-aware device as defined in 802.1AS-rev.	
Notes			
Requirement Source	S4R-DBD-303	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_104
Description		The ETBN shall include a precise clock which can be configured as GMC.	
Notes			
Requirement Source	S4R-DBD-307	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_105
Description		Master clock drift shall be <2ppm per second.	
Notes		allows longer synchronous operation on interruptions of synch messages from other clocks - stratum 3 TCXO class - in -45°C to 85°C temperature range, to keep GMC aligned as long se possible (>10sec), even if there is no alignment between them.	
Requirement Source	S4R-DBD-304	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_106
Description		ETBN shall synchronize by using redundant time information from multiple gPTP clock domains.	
Notes		Devices use gPTP domain foreseen for the synchronization in one synchronization domain. Device shall not be configured to synchronize to gPTP domain for different synchronization domains	
Requirement Source	S4R-DBD-305	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_107
Description		Device synchronization configuration shall enable synchronization to gPTP clock domains from only one train synchronization domain.	
Notes			
Requirement Source	S4R-DBD-306	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_108
Description		ETBN clocks in the first and the last consist on both communication lines shall act as GMCs.	
Notes			
Requirement Source	S4R-DBD-307	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_109
Description		ETB grandmasters clock (GMC) shall provide time information to the configured synchronization domain.	
Notes			
Requirement Source	S4R-DBD-308	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_110
Description		The GMC endpoint device shall disseminate time information over at least two gPTP clock domains.	
Notes		GMC endpoint attached to CS	
Requirement Source	S4R-DBD-159	**Relevant for Demonstrator**	X
Relevant for ETBN		**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_111
Description		ETBN switch shall police all synchronization packets.	
Notes		Action defined in next requirement.	
Requirement Source	S4R-DBD-310	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_112
Description		GMC shall drop and ignore all Sync packets out of the defined period, which is smaller than the half of the Sync transmission period and the maximum worst case latency for the dissemination of GMC time information throughout NG TCMS.	
Notes			
Requirement Source	S4R-DBD-318	**Relevant for Demonstrator**	
Relevant for ETBN		**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_113
Description		A GMC shall disseminate its clock over a configured gPTP clock domain to other GMCs in the synchronization domain.	
Notes			
Requirement Source	S4R-DBD-311	**Relevant for Demonstrator**	X
Relevant for ETBN		**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_114
Description		ETB GMC shall send time information on a dedicated stream (traffic class) according to its priority and topology position.	
Notes		For ETB domain stream ID shall be defined by IEC standard for interoperability. Priority of this message is 7, according to [DbDArchSpec] table 23.	
Requirement Source	S4R-DBD-312	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_115
Description		The priority of each GMC shall have values 0<priority<8.	
Notes		Assignment is done based on topology information.	
Requirement Source	S4R-DBD-313	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_116
Description		Each GMC shall have a unique priority within its synchronization domain.	
Notes		Synchronization domain represents a set of switches and nodes using same timebase. The timebase within synch. domain is defined by several clocks, which can have different priority.	
Requirement Source	S4R-DBD-314	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_117
Description		A grandmaster clock (GMC) shall disseminate time information by using IEEE 802.1AS-rev messages.	
Notes			
Requirement Source	S4R-DBD-315	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_118
Description		GMCs shall send clock information using Sync packets at defined time instants, within the Sync packet transmission period.	
Notes		This applies after synchronous startup for all GMCs.	
Requirement Source	S4R-DBD-316	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_119
Description		GMC shall monitor Sync packet order and arrival time.	
Notes			
Requirement Source	S4R-DBD-317	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_120
Description		Configuration of GMCs and network shall ensure that all Sync packets are received at expected order, within a defined period.	
Notes			
Requirement Source	S4R-DBD-319	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_121
Description		GMCs shall ignore ANNOUNCE messages and BMCA algorithms.	
Notes			
Requirement Source	S4R-DBD-320	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

3.4.2 Synchronization Architecture – Grandmaster Clock, Synchronous Startup on Power-Up

Requirement type	Requirement	**Requirement ID**	DBD_ND_122
Description		On synchronous startup and if external time reference is available, the highest-priority GMC shall abruptly adjust his clock to the external reference time.	
Notes			
Requirement Source	S4R-DBD-321	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_123
Description		On power-up, if an external time reference is not available, the highest priority GMC shall start sending Sync messages with its own RTC as a timebase.	
Notes			
Requirement Source	S4R-DBD-322	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_124
Description		The acquired time from an external time reference will be disseminated as a correction factor to the existing system time.	
Notes			
Requirement Source	S4R-DBD-323	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_125
Description		During the TCMS grandmasterclock (GMC) synchronization startup, the higher priority GMCs shall supply its own timebase (local clock) to the lower priority GMCs.	
Notes			
Requirement Source	S4R-DBD-324	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_126
Description		During the TCMS grandmasterclock (GMC) synchronization startup, a GMC shall align its time to higher priority GMCs' times within the Sync message period.	
Notes			
Requirement Source	S4R-DBD-325	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_127
Description		During the TCMS grandmasterclock (GMC) synchronization startup, in case of abrupt time changes coming from higher priority GMCs lower-priority GMCs shall detect such time changes.	
Notes			
Requirement Source	S4R-DBD-326	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_128
Description		During the TCMS grandmasterclock (GMC) synchronization startup, in case of abrupt time changes coming from higher priority GMCs lower-priority GMCs shall tolerate time changes if their consecutive number is lower than 2.	
Notes			
Requirement Source	S4R-DBD-327	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_129
Description		During the TCMS grandmasterclock (GMC) synchronization startup, in case of abrupt time changes coming from higher priority GMCs lower-priority GMCs shall tolerate such abrupt time changes if the number of GMCs on ETB is higher than 2.	
Notes			
Requirement Source	S4R-DBD-328	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_130
Description		During the TCMS masterclock (MC) synchronization startup, the lower priority MCs shall ignore higher priority GMCs which over a configured period exhibit implausible behaviour.	
Notes			
Requirement Source	S4R-DBD-329	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_131
Description		TCMS grandmaster clock (GMC) synchronization startup shall initialize after a completed topology discovery as part of the inauguration procedure.	
Notes		this defines the point in time (relevant for the inauguration requirements).	
Requirement Source	S4R-DBD-330	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_132
Description		ETBN shall begin synchronization after successful TCMS grandmaster clock (GMC) synchronization startup.	
Notes			
Requirement Source	S4R-DBD-331	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_133
Description		ETB GMC from the last ETBN in topology shall synchronize to the ETB GMC in the 1st ETBN on both communication lines after 1st train power-up and completion of ETB inauguration.	
Notes		this defines the point in time (relevant for the inauguration requirements).	
Requirement Source	S4R-DBD-332	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_134
Description		After completed synchronous startup, GMC shall obtain information from other GMCs on its own clock quality.	
Notes		Note: independent external monitoring.	
Requirement Source	S4R-DBD-333	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_135
Description		An ETBN shall synchronously start-up within a predefined maximum period of time.	
Notes			
Requirement Source	S4R-DBD-345	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

3.4.3 Synchronization Architecture – Master Clock Resynchronization

Requirement type	Requirement	**Requirement ID**	DBD_ND_136
Description		GMC shall align their clocks in precision of <=5µs	
Notes			
Requirement Source	S4R-DBD-334	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_137
Description		If the time difference is higher than 5µs for more than a defined period of time, then GMC shall go into inactive state until next power-up.	
Notes		The measurement of the difference between local time and system time can only be detected at the synchronisation interval. Therefore, the defined tolerable time must be at least the interval time, ideally a multiple of it to tolerate message losses.	
Requirement Source	S4R-DBD-335	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_138
Description		If the majority of other GMCs is not aligned with GMC for more than 10 seconds, then GMC shall go into inactive state until next power-up.	
Notes			
Requirement Source	S4R-DBD-336	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

3.4.4 Synchronization Slaves and Network Traffic Control

Requirement type	Requirement	**Requirement ID**	DBD_ND_139
Description		ETBN shall use time information from gPTP clock domains for fault detection, preselecting correct clocks and tolerating faulty clock sources.	
Notes			
Requirement Source	S4R-DBD-337	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_140
Description		Network devices shall monitor the origin (sender) of gPTP packets using MAC DEST and VLID / streamIDs and priority information.	
Notes			
Requirement Source	S4R-DBD-340	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_141
Description		Synchronization slave devices shall monitor the order of gPTP packets using sequence numbers.	
Notes			
Requirement Source	S4R-DBD-341	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_142
Description		Ordinary clock (OC) slaves shall diagnose and identify correct time by adapting the calculation approach, depending on the number of gPTP clock domains active and available: * For 1 active – take it as is with PDV; * For 2 active – average over two values, if within 5microseconds (ECN) or 10 microseconds (ETB), otherwise non-conclusive; * For 3 active - voting 2oo3 voting for 3 clocks, takes 2 clocks which are within 5 microseconds (ECN) or 10 microseconds (ETB), average over 2 correct gPTP instants, otherwise non-conclusive; * For 4 active - discarding the highest and lowest value and averaging over two remaining values assuming their difference is within 5microseconds (ECN) or 10 microseconds (ETB), otherwise non-conclusive.	
Notes			
Requirement Source	S4R-DBD-342	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_143
Description		The ETBN shall switch to the Inactive Mode, if unable to synchronize to the global GMC time values within the configured grace period (e.g. 1 sec).	
Notes			
Requirement Source	S4R-DBD-343	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_144
Description		The ETBN shall switch from Inactive to the Inauguration Mode upon external request.	
Notes			
Requirement Source	S4R-DBD-344	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_145
Description		ETBN shall tolerate link interruptions or failures of up to 1 second, before they are allowed to transfer into inactive mode.	
Notes			
Requirement Source	S4R-DBD-346	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_146
Description		The ETBN shall continue synchronous (GCL list) operation using the local clock time within a configured grace period. (e.g. at least 1sec), if there is no reliable information to identify correct/valid time sources.	
Notes			
Requirement Source	S4R-DBD-347	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_147
Description		ETB configuration shall define a standardized number of streams for transmission to the 1st and last consist, and from/to ECN, depending on its topology position.	
Notes		Defines standardized streams for clock sync messages between consists. Open item: standardization of which path.	
Requirement Source	S4R-DBD-300	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

3.5 Network Device - ETB Services Requirements

3.5.1 TTDB, ECSP, Annex E

Requirement type	Requirement	**Requirement ID**	DBD_ND_201
Description		The ETBN shall be able to exchange consist information with all ETBNs on the ETB	
Notes			
Requirement Source	DBD_ND_017; IEC 61375-2-3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_202
Description		If the ETBN is the active ECSP within the consist, it shall be entitled to send and receive the CSTINFO telegrams for the consist	
Notes			
Requirement Source	DBD_ND_017; IEC 61375-2-3 Clause 5.2	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_203
Description		The ETBN may support closed train	
Notes		CSTINFO class 2 and 3 telegrams	
Requirement Source	DBD_ND_017; IEC 61375-2-3 Clause 5.2	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_204
Description		The ETBN shall provide a safe storage for TTDB, which is a repository for all the information related to the actual train composition and the actual ETB state - Consist information - Train network directory - Train directory - Operational train directory	
Notes		Safety relevant TTDB is required (for SIL2) that the memory must be protected, or integrity checked (safe memory), e.g. ECC RAM/ROM For the demonstrator, a prototype (non-certified/non-safe) implementation will be provided.	
Requirement Source	DBD_ND_020; S4R D1.9 Clause 3.1.2; IEC 61375-2-3 Clause 5.3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_205
Description		The TTDB shall be maintained by a TTDB Manager function, and it shall always keep the TTDB up-to-date	
Notes			
Requirement Source	DBD_ND_020	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_206
Description		The ETBN may support TTDB for multiple ETBs	
Notes			
Requirement Source	DBD_ND_020; IEC 61375-2-3 Clause 5.3.4	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_207
Description		The ETBN shall support computation of the train directory	
Notes			
Requirement Source	DBD_ND_017; IEC 61375-2-3 Clause 5.3.2.3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_208
Description		If train inaugurations are not inhibited, the ETBN shall (re-)compute the train directory each time there is a change of the etbTopoCnt.	
Notes			
Requirement Source	DBD_ND_017; IEC 61375-2-3 Clause 5.3.2.3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_209
Description		The ETBN shall support DNS server for resolving TCN-URI host part to IP addresses with the aid of the TCN-DNS as defined in IEC 61375-2-3 Clause 5.4.2	
Notes			
Requirement Source	DBD_ND_021; IEC 61375-2-3 Clause 5.5.1	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_210
Description		The ETBN shall map TCN-URI to IP multicast group addresses in accordance to the IP addressing scheme defined in IEC 61375-2-3 Clause 5.4.5.2	
Notes			
Requirement Source	DBD_ND_021; IEC 61375-2-3 Clause 5.4.5	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_211
Description		The ETBN shall map TCN-URI to IP addresses in accordance to the IP addressing scheme defined in IEC 61375-2-5 Clause 6.4	
Notes			
Requirement Source	DBD_ND_021; IEC 61375-2-3 Clause 5.4.5	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_212
Description		The ETBN shall provide DNS server service for TCN URI scheme defined in IEC 61375-2-3 Clause 5.4.4	
Notes			
Requirement Source	DBD_ND_021; IEC 61375-2-3 Clause 5.4.4	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_213
Description		The ETBN shall implement the standard DNS protocols as specified in RFC 1034 and RFC 1035	
Notes			
Requirement Source	DBD_ND_021; IEC 61375-2-3 Clause 5.5.1	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_214
Description		The ETBN shall support TRDP DNS server interface according to IEC 61375-2-3 annex E	
Notes			
Requirement Source	DBD_ND_021; DBD_ND_022; IEC 61375-2-3 Clause 5.5.1; IEC 61375-2-3 Annex E	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_215
Description		The ETBN shall only provide ETB control service on the operational network (ETB 0)	
Notes			
Requirement Source	DBD_ND_019; IEC 61375-2-3 Clause 6.1	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_216
Description		The ETBN shall support ECSP election mechanism to ensure only one ECSP is active at one time within a consist	
Notes			
Requirement Source	DBD_ND_019; IEC 61375-2-3 Clause 6.2	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_217
Description		A failure of the ECSC shall be detected latest after a time of TECSC_fail = 5,0 s	
Notes			
Requirement Source	IEC 61375-2-3 Clause 6.3	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_218
Description		If a failure is detected, the ECSP shall react as defined for the individual ETB control service functions.	
Notes			
Requirement Source	IEC 61375-2-3 Clause 6.3	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_219
Description		The ETBN shall be able to send and receive safe ETBCTRL telegram cyclically using SDTv4	
Notes		Safety relevant	
Requirement Source	DBD_ND_019; IEC 61375-2-3 Clause 6.4	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_220
Description		In case of multiple ETBs, ETBCTRL telegrams shall only be exchanged on the operational network (ETB0).	
Notes			
Requirement Source	DBD_ND_019; IEC 61375-2-3 Clause 6.4.1	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_221
Description		The ETBN shall collect ETBCTRL telegrams received from all ECSPs, including the own ECSP as well as the remote ECSPs	
Notes			
Requirement Source	DBD_ND_019; IEC 61375-2-3 Clause 6.4.5.1	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_222
Description		The ETBN shall support computation of the operational train directory	
Notes			
Requirement Source	DBD_ND_017; DBD_ND_019; IEC 61375-2-3 Clause 6.7	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_223
Description		The ETBN shall compute a new operational train directory each time there is a change of - Train Directory - Collection of ETBCTRL telegrams received from all ECSPs	
Notes			
Requirement Source	DBD_ND_017; DBD_ND_019; IEC 61375-2-3 Clause 6.4.5.1	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_224
Description		The ETBN shall support leading function to elect one of the vehicles within the train to become the leading vehicle	
Notes			
Requirement Source	DBD_ND_019; IEC 61375-2-3 Clause 6.5	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_225
Description		The ETBN shall be able to detect leading conflict	
Notes			
Requirement Source	DBD_ND_019; IEC 61375-2-3 Clause 6.5.3.3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_226
Description		The ETBN shall be able to indicate leading conflict to the ECSC latest 1.0s after detection	
Notes			
Requirement Source	DBD_ND_019; IEC 61375-2-3 Clause 6.5.3.3	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_227
Description		The ETBN shall follow the rules to determine the operational directions defined in IEC 61375-2-3 Clause 4.2.4.3	
Notes			
Requirement Source	DBD_ND_019; IEC 61375-2-3 Clause 4.2.4.3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_228
Description		The ETBN may support sleep mode function as defined in IEC 61375-2-3.	
Notes			
Requirement Source	DBD_ND_018; IEC 61375-2-3 Clause 6.8	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_229
Description		The ETBN shall enter sleep mode if there is a request from all consists, and leave if there are demands from at least one consist	
Notes			
Requirement Source	DBD_ND_018; IEC 61375-2-3 Clause 6.8.1	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_230
Description		The ETBN shall provide ECSP interface according to IEC 61375-2-3 annex E	
Notes			
Requirement Source	DBD_ND_019; DBD_ND_022	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_231
Description		The ETBN shall provide TTDB manager interface according to IEC 61375-2-3 annex E	
Notes			
Requirement Source	DBD_ND_020; DBD_ND_022	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_232
Description		The ETBN TTDB manager shall support a new specific telegram using non-safe data communication for providing own cstUUID value within the consist	
Notes			
Requirement Source	CTA D3.5, P.194	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_233
Description		The ETBN may provide ETBN control interface according IEC 61375-2-3 annex E	
Notes			
Requirement Source	DBD_ND_022	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_234
Description		The ETBN shall send TRDP process data telegrams with IEEE 802.1p traffic priority class 3	
Notes			
Requirement Source	CTA D3.5 Clause 3.2.4	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_235
Description		The ETBN shall send TRDP message data telegrams with IEEE 802.1p traffic priority class 2	
Notes			
Requirement Source	CTA D3.5 Clause 3.2.4	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_236
Description		The ETBN shall support the safe ECSP status telegram transmission using SDTv4	
Notes		Safety relevant A prototypical implementation (non-safety-certified) is to be provided for the demonstrator.	
Requirement Source	DBD_ND_015	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_237
Description		The ETBN shall support the safe TTDB information telegram transmission using SDTv4	
Notes		Safety relevant A prototypical implementation (non-safety-certified) is to be provided for the demonstrator.	
Requirement Source	DBD_ND_015	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_238
Description		The ETBN shall support the safe ETBCTRL telegram transmission using SDTv4	
Notes		Safety relevant	
Requirement Source	DBD_ND_015; DBD_ND_019	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_239
Description		The ETBN shall be able to receive safe ECSP control telegram using SDTv4	
Notes		Safety relevant	
Requirement Source	DBD_ND_015; DBD_ND_019	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

3.6 Network Device - Flow Control Requirements

3.6.1 Frame Identification, Queues, Priorization, Scheduled Traffic

Requirement type	Requirement	**Requirement ID**	DBD_ND_271

Description		The Network Device shall transfer datasets with a defined period, transmission time for each multi-cast.	
Notes			
Requirement Source	S4R-DBD-502	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_272
Description		The Network Device configuration shall contain all data sets and multi-cast sent from each consist to all other consists.	
Notes		Configuration for the flow control on ETB level.	
Requirement Source	S4R-DBD-501	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

3.6.2 Ingress Policing

Requirement type	Requirement	**Requirement ID**	DBD_ND_273
Description		Network Device shall support per flow policing according to 802.1Qci.	
Notes		ETBN shall monitor and enforce configured deterministic dataflows.	
Requirement Source	S4R-DBD-522	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_274
Description		Network Device shall support per flow policing of asynchronous dataflows according to 802.1Qci on queues with priority 0, 1 and 2.	
Notes		Asynchronous flows not considered in demonstrator.	
Requirement Source	S4R-DBD-523	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_275
Description		Network Device shall support per flow policing of synchronous dataflows according to 802.1Qci on priority higher than 1.	
Notes			
Requirement Source	S4R-DBD-524	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_276
Description		Network Device shall support Stream identification function according to 802.1CB	
Notes		Necessary for identification on ingress.	
Requirement Source	Derived	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_277
Description		The Network Device shall police all critical multi-cast messages using the same configuration data for traffic from left (toward leading car) and right (opposite from leading car) side.	
Notes			
Requirement Source	S4R-DBD-503	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_278
Description		The Network Device shall police and forward multi-cast message which are specified only for its topology position.	
Notes			
Requirement Source	S4R-DBD-504	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_279
Description		The Network Device shall contain a stream filter table in which the filtering and policing actions per stream filter are defined.	
Notes		The stream filters determine the filtering and policing actions that are to be applied to frames received on a specific stream.	
Requirement Source	DBD_ND_273	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_280
Description		The Network Device shall contain a stream gates table in which the opening and closing states and events per stream gate are defined.	
Notes		The stream gates are allowing or preventing frames from passing to the flow meters and further to queuing algorithms, by alternating their states, opening and closing due to a number of events.	
Requirement Source	DBD_ND_273	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_281
Description		The stream gates table shall contain a stream gate control list for ingress traffic.	
Notes		As defined in 802.1Qci	
Requirement Source	DBD_ND_273	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_282
Description		The Network Device shall contain flow meters instance table in which flow parameters are defined.	
Notes		The flow meters instance table contains a set of parameters for each flow meter instance (e.g. maximum burst size per flow).	
Requirement Source	DBD_ND_273	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_283
Description		The Network Device shall use the time information from valid and correct gPTP clock domains to align the cyclic operation of IEEE TSN Gate Control Lists (GCL).	
Notes			
Requirement Source	S4R-DBD-338	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_284
Description		The ETBN shall police and prevent synchronization SYNC traffic from any ECN, not being the consist 1 or last consist.	
Notes			
Requirement Source	S4R-DBD-339	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

3.6.3 Egress Policing

Requirement type	Requirement	**Requirement ID**	DBD_ND_285
Description		The ND shall support adding, recognizing, interpreting, and removing VLAN tags as defined in IEEE 802.1Q.	
Notes			
Requirement Source	DBD_ND_006	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_286
Description		The ND shall support strict priority-based transmission selection algorithm (IEEE 802.1Q)	
Notes		All conventional data traffic shall be transmitted priority based	
Requirement Source	DBD_ND_006	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_287
Description		The ND may support credit-based shaper algorithm (IEEE 802.1Q)	
Notes		Reducing bursts for conventional data traffic	
Requirement Source	DBD_ND_006	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_288
Description		Network Device shall support time-driven packet switching and forwarding (802.1Qbv) with capability to send packets in a defined time period.	
Notes			
Requirement Source	S4R-DBD-526	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_289
Description		Network Device shall support at least 8 egress queues.	
Notes			
Requirement Source	S4R-DBD-525	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_290
Description		Network Device shall have a gate control list (GCL) for every egress port that defines gate operations.	
Notes		As defined in 802.1Qbv	
Requirement Source	DBD_ND_288	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_291
Description		Each GCL shall allow at least 64 entries.	
Notes			
Requirement Source	S4R-DBD-527	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_292
Description		Network Device shall initiate the execution of the gate control list at startup.	
Notes		Note: before GCL is operational no time-critical messages are transferred.	
Requirement Source	DBD_ND_288	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_293
Description		Network Device shall ensure that the gating cycle time defined for the port is maintained	
Notes			
Requirement Source	DBD_ND_288	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_294
Description		Network Device shall execute the gate operations in the gate control list, in sequence	
Notes			
Requirement Source	DBD_ND_288	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_295
Description		Network Device shall establish the appropriate time delay between each operation	
Notes			
Requirement Source	DBD_ND_288	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

3.7 Network Device - Gateway Requirements

3.7.1 ETBN/ECN-Gateway

Requirement type	Requirement	**Requirement ID**	DBD_ND_351
Description		TSNGW shall collect and store all system-relevant time-sensitive (or critical) traffic from ECNs.	
Notes			
Requirement Source	S4R-DBD-400	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_352
Description		TSNGW shall collect and periodically disseminate incoming train-relevant data from other TSNGWs to its local ECN, and vice versa.	
Notes			
Requirement Source	S4R-DBD-401	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_353
Description		TSNGW shall periodically/deterministically disseminate system-relevant data in line with schedule.	
Notes			
Requirement Source	S4R-DBD-403	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_354
Description		TSNGW shall send only to configured stream identifiers, with configured timing and periodicity depending on its position in the topology.	
Notes			
Requirement Source	S4R-DBD-405	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_355
Description		TSNGW shall collect all the train-relevant data in datasets multicast from other ETB switches for forwarding to its connected ECN nodes.	
Notes			
Requirement Source	S4R-DBD-406	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_356
Description		GCL list period for gate control shall be configurable at least 2.5ms	
Notes		Minimum defined cycle time	
Requirement Source	S4R-DBD-407	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_357
Description		TSNGW shall inspect and store received ECN packets which contain system-relevant data and match configured packet header identifiers (e.g. MAC SRC/DEST, VLID, …).	
Notes			
Requirement Source	S4R-DBD-413	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_358
Description		TSNGW shall inspect and forward received ECN packets to ETBN, only if they match the configured packet headers.	
Notes			
Requirement Source	S4R-DBD-414	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_359
Description		TSNGW shall inspect and forward received ETB packets to ECN network, only if they match the configured packet headers.	
Notes			
Requirement Source	S4R-DBD-415	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_360
Description		TSNGW shall disassemble ECN packet data with application CRC according to configuration.	
Notes		Note: optional to assemble/disassemble frames from/to PDUs and new frames in the gateway. (SDTvX protected) PDUs are always untouched.	
Requirement Source	S4R-DBD-419	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_361
Description		TSNGW shall assemble datasets, consisting of at least one ECN packet data.	
Notes		Note: optional to assemble/disassemble frames from/to PDUs and new frames in the gateway. (SDTvX protected) PDUs are always untouched.	
Requirement Source	S4R-DBD-420	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_362
Description		With each piece of data assembled, the data freshness timer (system time stamp) will be stored.	
Notes			
Requirement Source	S4R-DBD-421	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_363
Description		Only provably correct data (CRC, bitwise comparison, redundant data etc.) shall be used for the assembly of datasets.	
Notes		Note: for invalid data will not be stored and data freshness will not be updated, therefore the last generation of data will be used. Note: not safety-relevant (operates as part of black channel)	
Requirement Source	S4R-DBD-422	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

3.7.2 TSNGW Configuration

Requirement type	Requirement	**Requirement ID**	DBD_ND_365
Description		TSNGW shall store the complete constructed dataset into configured ETB_SHMEM_POSITION(n). Note: n = constant sampling memory position defined by configuration data.	
Notes			
Requirement Source	S4R-DBD-424	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_366
Description		For each ECN packet sent to ECN, and assembled from ETB_SHMEM data, TSNGW configuration shall define for each data piece, the source of the dataset (ETB_SHMEM_POSITION(n)),its exact position in the dataset, and data length.	
Notes			
Requirement Source	S4R-DBD-425	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_367
Description		Configuration Parameters: For each dataset parameter or variable, the TSNGW configuration shall define: The source of the ECN data (packet header identifiers, MAC SRC/DEST) and its length (LEN) and position (FR_POS) in the frame.	
Notes			
Requirement Source	S4R-DBD-426	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_368
Description		TSNGW shall send datasets from “ETB SHMEM” at configured time instants by using a predefined data stream packet identifier (SRC MAC, DEST MAC, VLAN ID/priority, IP Address, UPD port)	
Notes			
Requirement Source	S4R-DBD-428	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_369

Description		A dataset from “ETB SHMEM”, the TSN packet shall multicast to all other ETBNs, when an interval/period timer indicates the time is ready for transmitting at least one packet associated with this periods, as defined by configuration.	
Notes			
Requirement Source	S4R-DBD-429	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_370
Description		TSNGW shall provide configuration (5) for mapping of ECN packet data to ETB datasets	
Notes		Note: Source (ECN packet header, length, offset) -> Destination (ETB packet header, length, offset, ETB_SHMEM_POSITION(n))	
Requirement Source	S4R-DBD-436	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_371
Description		TSNGW shall provide configuration (6) for periodic sending of the consist's own ETB datasets.	
Notes		Note: A list with the following information is required Send Cycle ETB_SHMEM_POSITION(0 for our ECN data)), sending time within the cycle, period ETB_SHMEM_POSITION(1 for our ECN data)), sending time within the cycle, period ETB_SHMEM_POSITION(2 for our ECN data)), sending time within the cycle, period ETB_SHMEM_POSITION(3 for our ECN data)), sending time within the cycle, period	
Requirement Source	S4R-DBD-437	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_372
Description		TSNGW shall provide configuration (2,3) for mapping of ETB datasets data to ECN packets.	
Notes			
Requirement Source	S4R-DBD-438	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_373
Description		TSNGW shall provide configuration (4) for periodic sending of consist's own ETB datasets.	
Notes			
Requirement Source	S4R-DBD-439	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

3.7.3 Status and Health of TSNGW

Requirement type	Requirement	**Requirement ID**	DBD_ND_374
Description		TSNGW shall periodically collect and store its own ETB switch health status including port error statistics from MIB list: • For left and right ETB port • for ETB to ECN port • for ETB to TSNGW port	
Notes			
Requirement Source	S4R-DBD-430	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_375
Description		TSNGW shall collect and store its own ETB switch current state (synchronous, asynchronous, …), as they occur (event-driven).	
Notes			
Requirement Source	S4R-DBD-431	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_376
Description		TSNGW shall periodically collect and store gPTP synchronization information and history from at least one second (100x).	
Notes			
Requirement Source	S4R-DBD-432	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_377
Description		TSNGW health status and/or synchronization history, or their constituents shall be disseminated via ETB to other consists periodically, if configured.	
Notes			
Requirement Source	S4R-DBD-433	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_378
Description		TSNGW health status and/or synchronization history, or their constituents shall be disseminated to ECN on request.	
Notes			
Requirement Source	S4R-DBD-434	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

3.8 Network Device - Redundancy Requirements

3.8.1 802.1CB related requirements

Requirement type	Requirement	**Requirement ID**	DBD_ND_401
Description		NG TCN shall transfer TSN data between ECNs on both ETB lines in redundant data streams.	
Notes		Seamless redundancy according to the IEEE802.1CB based on frame duplication and deletion.	
Requirement Source	S4R-DBD-702	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_402
Description		The Network Device shall support the forwarding of frames duplicated according to 802.1CB FRER	
Notes		Note: the ETBN does not actually need to handle FRER frames specially. The duplication / deletion is done by the end-points only.	
Requirement Source	S4R-DBD-702	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_403
Description		The Network Device shall be able to remove R-TAG from incoming frames	
Notes			
Requirement Source	DBD_ND_402	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_404
Description		The Network Device shall re-insert R-TAG into outgoing frames if they carried R-TAG on ingress (unrecognized/unconfigured streams).	
Notes			
Requirement Source	DBD_ND_402	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

3.8.2 VRRP related requirements

Requirement type	Requirement	**Requirement ID**	DBD_ND_405
Description		The ETBNs within a consist shall use VRRPv3 over the ECN to select a master router for routing of non-TSN unicast traffic between ECN and ETB.	
Notes		Note: If ETBNs cannot hear each other over the ECN both ETBNs will act as masters. For example, multiple breaks in the ECN ring or a failure in the end-device network stack might cause the loss of such frames. It is left to higher level applications need to detect and mitigate the failure case resulting in two active ETBNs.	
Requirement Source	DBD_ND_028 [DemoComp]; 3.2.10 of [DbDArchSpec] RFC 5798	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_406
Description		The ETBN which is currently selected master by the VRRP shall also be responsible for routing non-TSN multicast traffic between ECN and ETB.	
Notes			
Requirement Source	Derived from [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_407
Description		The ETBN which is currently selected master by the VRRP shall also act as "active" ECSP, while the VRRP backup will be passive ECSP.	
Notes		Note: If ETBNs cannot hear each other over the ECN, both ETBNs will act as active ECSPs. For example, multiple breaks in the ECN ring or a failure in the end-device network stack might cause the loss of such frames. It is left to higher level applications need to manage that situation.	
Requirement Source	Derived from [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_408
Description		The ETBN shall support device redundancy with switch-over time of ≤ 0.8 s.	
Notes		Note: This requirement is also listed as DBD_ND_028.	
Requirement Source	DBD_ND_028 [DemoComp];	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_409
Description		The CS shall support a ring protocol with a ring failure recovery time of less than 50ms.	
Notes		Ring redundancy used for conventional data traffic.	
Requirement Source	CS-REQ-24 of [DemoComp];	**Relevant for Demonstrator**	
Relevant for ETBN		**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_410
Description		The CS ring protocol shall not interrupt scheduled data traffic related to one of the planes A or B.	
Notes		A ring protocol has to interrupt the ring in order to prevent loops. This interruption shall not affect the scheduled data traffic.	
Requirement Source	CS-REQ-25 of [DemoComp];	**Relevant for Demonstrator**	
Relevant for ETBN		**Relevant for CS**	X

3.9 Network Device - Network Management Requirements

3.9.1 DHCP, DNS, other generic network services

Requirement type	Requirement	**Requirement ID**	DBD_ND_451
Description		The ETBN ports shall support the reception and transmission of Ethernet frames in accordance to IEEE 802.3	
Notes			
Requirement Source	DBD_ND_001	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_452
Description		ETBN shall act as a router between ECN and ETB for unicast and multicast IP packets including network address translation	
Notes		For conventional data traffic	
Requirement Source	DBD_ND_002	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_453
Description		ETBN shall support IP as defined in RFC791	
Notes			
Requirement Source	DBD_ND_013	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_454
Description		ETBN shall support ARP as defined in RFC826	
Notes			
Requirement Source	DBD_ND_013	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_455
Description		ETBN shall support UDP as defined in RFC768	
Notes			
Requirement Source	DBD_ND_013	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_456
Description		ETBN shall support TCP as defined in RFC793	
Notes			
Requirement Source	DBD_ND_013	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_457
Description		ETBN shall support ICMP as defined in RFC792	
Notes			
Requirement Source	DBD_ND_013	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_458
Description		ETBN shall support IGMP Message Format as defined in RFC3376 Clause 4	
Notes		ETBN as an IGMP Querier	
Requirement Source	DBD_ND_023	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_459
Description		ETBN shall support IGMP Router Filter-Mode as defined in RFC3376 Clause 6.2.1	
Notes		ETBN as an IGMP Querier	
Requirement Source	DBD_ND_023	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_460
Description		ETBN shall support IGMP Querier Election as defined in RFC3376 Clause 6.6.2	
Notes		ETBN as an IGMP Querier	
Requirement Source	DBD_ND_023	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_461
Description		ETBN shall support IGMP Interoperation With Older Versions of IGMP as defined in RFC3376 Clause 7	
Notes		ETBN as an IGMP Querier	
Requirement Source	DBD_ND_023	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_462
Description		ETBN shall support IGMP Query Interval setting as defined in RFC3376 Clause 8.14.2	
Notes		ETBN as an IGMP Querier	
Requirement Source	DBD_ND_023	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_463
Description		CS shall support IGMP snooping, prevent hosts on a local network from receiving traffic for a multicast group they have not explicitly joined	
Notes		IGMP snooping applies to CS. It also applies to ETBN if it has switching function.	
Requirement Source	DBD_ND_023	**Relevant for Demonstrator**	
Relevant for ETBN		**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_464
Description		ETBN shall support DHCP server to provide IPv4 address allocation as defined in RFC2131 Clause 3.	
Notes			
Requirement Source	DBD_ND_024	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_465
Description		ETBN may support DHCP server to provide Router Option as defined in RFC 2132 Clause 3.5	
Notes			
Requirement Source	DBD_ND_024	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_466
Description		ETBN shall support DHCP server to provide Domain Name Server option as defined in RFC2132 Clause 3.8	
Notes			
Requirement Source	DBD_ND_024	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_467
Description		ETBN shall support DHCP server to provide IP Address Lease Time option as defined in RFC2132 Clause 9.2	
Notes			
Requirement Source	DBD_ND_024	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_468
Description		ETBN shall support DHCP server to provide TFTP Server Name option as defined in RFC2132 Clause 9.4	
Notes			
Requirement Source	DBD_ND_024	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_469
Description		ETBN shall support DHCP server to provide Bootfile Name option as defined in RFC2132 Clause 9.5	
Notes			
Requirement Source	DBD_ND_024	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_470
Description		ETBN may support DHCP server to provide Client-identifier option as defined in RFC 2132 Clause 9.14	
Notes			
Requirement Source	DBD_ND_024	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_471
Description		ETBN may support DHCP server to provide Relay-agent information - Server operation as defined in RFC 3046	
Notes			
Requirement Source	DBD_ND_024	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_472
Description		CS shall support a DHCP relay agent with DHCP option 82 support	
Notes			
Requirement Source	CS-REQ-21	**Relevant for Demonstrator**	
Relevant for ETBN		**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_473
Description		ETBN shall support IEC61375-2-5 MIB to meet requirements which is defined in ETBN inauguration sheet	
Notes			
Requirement Source	DBD_ND_025	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_474
Description		ETBN shall support IEC61375-2-3 MIB to meet requirements which is defined in ETBN Service sheet	
Notes			
Requirement Source	DBD_ND_025	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

3.10 Network Device - Communication Integration Layer Requirements

3.10.1 TRDP-related requirements

Requirement type	Requirement	**Requirement ID**	DBD_ND_501
Description		The ETBN shall support TRDP process data protocol for the exchange of TCN process data	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A1, annex A.6	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_502
Description		The ETBN shall support TRDP message data protocol for the exchange of TCN message data	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A1, annex A.7	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_503
Description		The ETBN shall send TRDP process data telegram with UDP	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.2.3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_504
Description		The TRDP process data packet size shall be restricted to the size of one Ethernet frame	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.2.3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_505
Description		The ETBN shall send TRDP message data with UDP or with TCP	
Notes		At least UDP for the demonstrator	
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.2.3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_506
Description		The ETBN shall use the well-known ports for receiving any process data telegrams and for receiving UDP message data notification, request and confirm telegrams	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.2.3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_507
Description		The ETBN shall use a private source port different from the well-known port for sending any process data telegrams and for sending UDP message data notification, request and confirm telegrams	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.2.3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_508
Description		The ETBN shall use the same port related to request for receiving UDP message data reply telegrams	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.2.3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_509
Description		The ETBN shall use any source port different from the one the request was received from for sending UDP message data reply telegrams.	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.2.3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_510
Description		The TRDP TCP connections shall be established between a source port different from the well-known port and the well-known port as destination.	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.2.3	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_511
Description		The ETBN may use different well-known port numbers for project specific purposes.	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.2.3	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_512
Description		The ETBN shall compute TRDP FCS CRC according to IEC 61375-2-3 annex A.3	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_513
Description		The ETBN shall support push communication pattern to transmit PD-PDUs cyclically	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.6.3.1	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_514
Description		The ETBN shall support pull communication pattern to transmit PD-PDUs on request	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.6.3.2	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_515
Description		The ETBN shall use an IP unicast address for addressing a known process data subscriber/publisher.	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.6.4	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_516
Description		The ETBN shall use an IP multicast address for addressing groups of known process data subscribers/publishers (e.g. redundancy groups).	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.6.4	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_517
Description		The ETBN shall use an IP multicast address for addressing unknown process data subscribers/publishers.	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.6.4	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_518
Description		The ETBN shall send process data telegram according to the PD-PDU structure defined in IEC 61375-2-3 annex A.6.5	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.6.5	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_519
Description		The ETBN shall support TRDP PD redundancy groups	
Notes		Active ECSP shall be in leader state and hot-standby ECSP shall be in follower state	
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.6	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_520
Description		The ETBN shall follow the PD protocol state machine defined in IEC 61375-2-3 annex A.6.8	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.6.8	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_521
Description		If the ETBN support pushed PD-PDU, it shall apply a traffic shaping mechanism for equal distribution of the PD-PDU's over the time	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.6.8.1	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_522
Description		The TRDP message data packet size shall be limited to 64 kBytes	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.7.1	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_523
Description		The ETBN shall support MD push and pull communication pattern	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.7.1	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_524
Description		The ETBN shall support the following message data transfer options a) request without reply ('notification') b) request with reply but without confirmation c) request with reply and confirmation	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.7.3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_525
Description		As a message data caller, the ETBN shall use an IP unicast address or an IP multicast address for addressing known replier(s)	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.7.4	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_526
Description		As a message data caller, the ETBN shall use an IP multicast address for addressing unknown repliers.	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.7.4	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_527
Description		As a message data caller, the ETBN may use an IP multicast address for addressing a known replier redundancy group.	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.7.4	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_528
Description		As a message data replier, the ETBN shall respond to the caller's unicast address.	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.7.4	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_529
Description		The ETBN shall send message data telegram according to the MD-PDU structure defined in IEC 61375-2-3 annex A.7.5	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.7.5	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_530
Description		The ETBN shall support the filtering rules according to IEC 61375-2-3 annex A.7.6.3	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.7.6.3	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_531
Description		The ETBN shall follow the MD protocol state machine defined in IEC 61375-2-3 annex A.7.8	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.7.8	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_532
Description		As a message data caller, the ETBN shall close an existing TCP connection (active end) if one of the following conditions is met: • A signal that the TCP connection will be closed has been received. • TRDP shut down or re-initialization. • A timeout occurred because the TCP connection has not been used for a defined time.	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.7.9	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_533
Description		As a message data replier, the ETBN shall use the TCP connection opened by the caller.	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.7.9	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_534
Description		As a message data replier, the ETBN shall close an existing TCP connection (passive end) if one of the following conditions is met: • A signal that the TCP connection will be closed has been received. • TRDP shut down or re-initialization. • Another TCP connection was opened from the same caller device and the old connection is not used anymore for a defined time.	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.7.9	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_535
Description		The ETBN may support MD echo function	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.9	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_536
Description		The ETBN shal provide topography counter check specified in IEC 61375-2-3 annex A.6.7 and A 7.7	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.6.7, A.7.7	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_537
Description		If the topography counter check fails before sending a telegram, the ETBN shall not send the telegram	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.6.7, A.7.7	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_538
Description		If the topography counter check fails after receiving a telegram, the ETBN shall not accept the telegram	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex A.6.7, A.7.7	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_539
Description		If the TRDP configuration is not supported, the ETBN shall support the default TRDP configuration value as in IEC 61375-2-3 annex C	
Notes			
Requirement Source	DBD_ND_014; IEC 61375-2-3 annex C	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

3.10.2 SDTv4-related requirements

Requirement type	Requirement	**Requirement ID**	DBD_ND_571
Description		The ETBN shall provide independent safety and standard (regular) communication	
Notes		Safety relevant	
Requirement Source	DBD_ND_015; IEC 61375-2-3 annex B.2	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_572
Description		The ETBN shall follow the algorithm for SC-32 algorithm defined in IEC 61375-2-3 annex B.7 for SID and SafetyCode computation	
Notes		Safety relevant	
Requirement Source	DBD_ND_015; IEC 61375-2-3 annex B.3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_573
Description		The ETBN shall implement SC-32 and the coding of SID for TRDP protocol only.	
Notes		Safety relevant	
Requirement Source	DBD_ND_015; IEC 61375-2-3 annex B.10	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_574
Description		The ETBN shall identify a source identifier (SID) for each safety related data source (SDSRC)	
Notes		Safety relevant	
Requirement Source	DBD_ND_015; IEC 61375-2-3 annex B.8	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_575
Description		As a SDSRC, the ETBN shall encapsulate safety critical data in a vital data packet (VDP), and the VDPs are transmitted within the user data part of a TRDP process data telegram	
Notes		Safety relevant	
Requirement Source	DBD_ND_015; IEC 61375-2-3 annex B.9	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_576
Description		As a SDSRC, the ETBN shall produce the VDP periodically	
Notes		Safety relevant	
Requirement Source	DBD_ND_015; IEC 61375-2-3 annex B.12.3.1	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_577
Description		As a SDSRC, the ETBN shall increment the safe sequence counter (SSC) for each produced VDP	
Notes		Safety relevant	
Requirement Source	DBD_ND_015; IEC 61375-2-3 annex B.12.3.1	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_578
Description		As a SDSRC, the ETBN shall produce VDPs only when a valid SDI is computed	
Notes		Safety relevant	
Requirement Source	DBD_ND_015; IEC 61375-2-3 annex B.12.3.1	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_579
Description		As a SDSRC, the ETBN may support redundancy defined in IEC 61375-2-3 annex B.12.3.2 only for increased availability	
Notes		Safety relevant	
Requirement Source	DBD_ND_015; IEC 61375-2-3 annex B.3 IEC 61375-2-3 annex B.12.3.2	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_580
Description		As a SDSINK, the ETBN shall compute the SIDs of expected VDPs from SDSRC according to the information from TTDB	
Notes		Safety relevant	
Requirement Source	DBD_ND_015; IEC 61375-2-3 annex B.8	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_581
Description		As a SDSINK, the ETBN shall provide the following validation when receiving VDPs from SDSRC - Integrity check (B13.5) - Sink time supervision (B13.6) - Guard time check (B13.7) - Latency monitoring (B13.8) - Channel monitoring (B13.9)	
Notes		Safety relevant	
Requirement Source	DBD_ND_015; IEC 61375-2-3 annex B.13	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_582
Description		If the received VDP pass all validation, the ETBN shall consider the communication channel is safe	
Notes		Safety relevant	
Requirement Source	DBD_ND_015; IEC 61375-2-3 annex B.13.3	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_583
Description		If a train composition change occurs, the ETBN shall not affect the SDTv4 channel withing a consist	
Notes		Safety relevant	
Requirement Source	DBD_ND_015; IEC 61375-2-3 annex B.8	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_584
Description		The ETBN should provide the statistic counters listed in IEC 61375-2-3 Table B.5	
Notes		Not safety relevant.	
Requirement Source	DBD_ND_015; IEC 61375-2-3 annex B.14	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

3.11 Network Device - Health Monitoring Requirements

3.11.1 TRDP-signalling-related requirements

Requirement type	Requirement	**Requirement ID**	DBD_ND_601
Description		The ETBN shall send out TTDB status telegram periodically	
Notes			
Requirement Source	IEC 61375-2-3 Annex E	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_602
Description		The ETBN shall provide TTDB information on request	
Notes			
Requirement Source	IEC 61375-2-3 Annex E	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_603
Description		The ETBN may support TRDP echo function	
Notes			
Requirement Source	IEC 61375-2-3 annex A.8 IEC 61375-2-3 annex F.9	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_604
Description		The ETBN shall send out ECSP status telegram to ECSC periodically	
Notes			
Requirement Source	IEC 61375-2-3 Annex E	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_605
Description		The ETBN shall send out ETBN status telegram periodically with multicast destination address	
Notes			
Requirement Source	IEC 61375-2-3 Annex E	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

3.11.2 SNMP protocol requirements

Requirement type	Requirement	**Requirement ID**	DBD_ND_621
Description		The network device shall support SNMP.	
Notes			
Requirement Source	2.8.3 (table 10) and 4.3 of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_622
Description		The network device shall be capable of exchanging SNMP messages securely using SNMPv3.	
Notes			
Requirement Source	3.5.5 of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

3.11.3 SNMP MIB requirements with respect to health monitoring

Requirement type	Requirement	**Requirement ID**	DBD_ND_623
Description		It shall be possible to read out Ethernet port operational status via SNMP	
Notes		IF-MIB (RFC2863) ifOperStatus	
Requirement Source	3.5.6 of [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_624
Description		It shall be possible to get an SNMP Notification (Trap/Notify/Report) when an Ethernet port changes state.	
Notes		IF-MIB (RFC2863) linkUp/linkDown traps	
Requirement Source	3.5.6 of [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_625
Description		ND shall provide packet error counters via SNMP to facilitate better Diagnostic Coverage (DC) in the case of an increasing bit error probability.	
Notes		Etherlike-MIB (RFC3635) dot3StatsFCSErrors, dot3StatsAlignmentErrors, dot3StatsSymbolErrors; IF-MIB (RFC2863) ifInErrors	
Requirement Source	2.11.4 of [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_626
Description		It shall be possible to use SNMP to read out ingress and egress packet statistics to faciliate monitoring of packet loss rate.	
Notes		IF-MIB (RFC2863) ifInErrors, ifOutErrors, ifInDiscards, ifOutDiscards	
Requirement Source	3.5.6 of [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_627
Description		It shall be possible to use SNMP to read out ingress and egress packet statistics to faciliate monitoring of link load.	
Notes		IF-MIB (RFC2863) ifHCInOctets, ifHCOutOctets, ifHighSpeed or the ifXTable	
Requirement Source	3.5.6 of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_628
Description		It shall be possible to use SNMP to read out ETBN operational state for router redundancy role (master/backup/other)	
Notes		VRRPv3 MIB (RFC6527), vrrpv3OperationsStatus	
Requirement Source	3.5.6 of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_629
Description		It shall be possible to get an SNMP Notification (Trap/Notify/Report) when a redundant router changes operational role.	
Notes		VRRPv3 MIB (RFC6527) vrrpv3NewMaster	
Requirement Source	3.5.6 of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_630
Description		It shall be possible use SNMP to read out Ring Status of the ECN Ring Redundancy protocol (intact/broken)	
Notes		Define suitable status OID in a new NG-TCN MIB	
Requirement Source	3.5.6 of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_631
Description		It shall be possible to get an SNMP Notification (Trap/Notify/Report) when the ECN ring changes state (intact => broken or vice versa)	
Notes		Define suitable trap OID in a new NG-TCN MIB	
Requirement Source	3.5.6 of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

3.12 Network Device - Configuration Requirements

3.12.1 Config setting requirements

Requirement type	Requirement	**Requirement ID**	DBD_ND_651
Description		IP Address: Static IP addresses of the switches shall be set.	
Notes			
Requirement Source	4.2.1 (Table 52) of [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_652
Description		DHCP Server: When DHCP is available for dynamic IP addressing and the ECSP is located within the ETBN, the DHCP server shall be configured.	
Notes		Configuration for central DHCP server only in case of centralized DHCP server is used. As an alternative, a decentralized DHCP server (one per ring switch) may be chosen, as described in [DBD_ND_464 to -472].	
Requirement Source	4.2.1 of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_653
Description		Port settings: Port assignment and ingress and egress policing configuration shall be set.	
Notes			
Requirement Source	4.2.1 of [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_654
Description		VLAN configuration: For traffic distinction within the networks as well as for network management, VLAN configuration shall be set in the network devices ports. More detailed information about this configuration can be found in the chapter 3.2.6 of this deliverable.	
Notes			
Requirement Source	4.2.1 of [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_655
Description		TSN Gateway settings: Scheduled data streams must be predefined according to application specific requirements.	
Notes			
Requirement Source	4.2.1 of [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_656
Description		TSNGW: When the gateway is located within the ETBN, the configuration for ETB/ECN data mapping and the configuration of the ETB/ECN scheduled data shall be set.	
Notes			
Requirement Source	4.2.1 of [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_657
Description		Static consist information: When ECSP is located within the ETBN, the static consist information as detailed in IEC61375-2-3 shall be configured.	
Notes			
Requirement Source	4.2.1 of [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_658
Description		Ring protocol settings: Ring protocol settings for the ECN shall be configured such as the master or manager assignment, or the blocked port to interrupt the ring.	
Notes		Primarily CS, but could apply to ETBN	
Requirement Source	4.2.1 of [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN		**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_659
Description		ETB Inauguration (TTDP) settings: Settings required for the ETBN to conduct ETB inauguration according to IEC 61375-2-5	
Notes		Also include multicast addresses used for non-TSN traffic being routed to /from ECN.	
Requirement Source	IEC 61375-2-5	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_660
Description		Settings required for the ETBN to act as redundant router for non-TSN traffic on ECN and ETB.	
Notes		This relates to TTDP settings above, which handles redundancy on ETB. virtual IP on ETB. Mechanism for ECN may need to be refined.	
Requirement Source	4.2.1 of [DbDArchSpec]	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_661
Description		Settings required for the ETBN to act as firewall.	
Notes		See DBD_ND_806	
Requirement Source	4.2.1 of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

3.13 Network Device - Physical and Environmental Requirements

3.13.1 Form-factor related requirements, connectors, dimensions, etc.

Requirement type	Requirement	**Requirement ID**	DBD_ND_701
Description		The ETBN shall provide at least 3 Ethernet ports following IEEE 802.3 with · 2 ports GbE for ETB connection · 1 port GbE for ECN connection	
Notes			
Requirement Source	DBD_ND_001	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_702
Description		The Network Device shall use Ethernet M12 X-coded 8-pin female connector for Gigabit Ethernet port according to IEC 61076-2-109	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_703
Description		The Network Device shall be at least an IP30 class device	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_704
Description		The Network Device should support wall or rack mounting for installation	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_705
Description		The Network Device shall provide a console for maintenance / debugging	
Notes		E.g. RS232	
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_706
Description		The Network Device may provide a reset function to reset the user configurations	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_707
Description		The Network Device may provide an out-of-band Ethernet port for maintenance	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_708
Description		The Network Device may provide system indicators, at least ok and sum of error indication	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_709
Description		The Network Device may provide port status indicators (link, traffic, blocked)	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_713
Description		The CS shall provide at least 8 Ethernet ports following IEEE 802.3 with · 2 ports GbE/(10GbE) for ECN ring connection · 1 port GbE for ETBN connection · Other ports 100FDX or GbE for ED connection	
Notes		This requirement will be partially fulfilled by the demonstrator, as the amount of ports will likely be lower than 8.	
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN		**Relevant for CS**	X

3.13.2 Power related requirements

Requirement type	Requirement	**Requirement ID**	DBD_ND_710
Description		The Network Device shall support input power voltage 24V, and should support the range 24V-110V.	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	X
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_711
Description		The Network Device may use M12 K-coded 5-pin male or M12 A-coded 4-pin male connector as the power connector.	
Notes		Pin-out to be defined.	
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_712
Description		The power consumption of the Network Device should not exceed 30W (non-PoE)	
Notes		May have different power consumption limit for CS.	
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_714
Description		The CS may support PoE according to IEEE 802.3af/3at	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN		**Relevant for CS**	X

3.13.3 EMC related requirements

Requirement type	Requirement	**Requirement ID**	DBD_ND_721
Description		The Network Device shall comply with EN 50155:2017 class OT4, -40 °C to +70 °C	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_722
Description		The Network Device shall comply with EN 50121-3-2:2015	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_723
Description		The Network Device shall comply with EN 50124-1:2017	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_724
Description		The Network Device shall comply with EN 50125-1:2014	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_725
Description		The Network Device shall comply with EN 50125-3:2014 if signalling functions are integrated on TCMS network	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_726
Description		The Network Device shall comply with EN 45545-1:2013	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_727
Description		The Network Device shall comply with EN 45545-2:2013	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_728
Description		The Network Device shall comply with EN 45545-5:2013	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_729
Description		The Network Device shall comply with EN 50126-1:2017	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X
Requirement type	Requirement	**Requirement ID**	DBD_ND_730
Description		The Network Device shall comply with EN 50657:2017	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_731
Description		The Network Device shall comply with EN 50128:2011 if signalling functions are integrated on TCMS network	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_732
Description		The Network Device shall comply with EN 50129:2018	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

3.14 Network Device - Security Requirements

3.14.1 Port Network Access Control

Requirement type	Requirement	**Requirement ID**	DBD_ND_801
Description		CS shall be capable of acting as IEEE 802.1x Authenticator	
Notes			
Requirement Source	CS-REQ-14 of [DemoComp] 3.5.7 of [DbDArchSpec] S4R-DBD-220 of [D1.11-ReqAss]	**Relevant for Demonstrator**	
Relevant for ETBN		**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_802
Description		CS shall support MACsec to achieve authentiticy, confidentiality and integrity for EDs	
Notes			
Requirement Source	CS-REQ-12 of [DemoComp] 3.5.7 of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN		**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_803
Description		ETBN may be capable of acting as IEEE 802.1x Authentication Server (RADIUS)	
Notes		Changed to "may" as compared to DBD_ND_026	
Requirement Source	DBD_ND_026; 3.5.7 of [DbDArchSpec] S4R-DBD-220 of [D1.11-ReqAss]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_804
Description		CS shall support EAP method(s) supporting derivation of master key for MACsec.	
Notes		As EAP methods capable or master key derivation, EAP-TLS, EAP-TTLS and PEAP are recommended to be used (3.5.7)	
Requirement Source	3.5.7 of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN		**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_805
Description		If ETBN supports IEEE 802.1X Authentication Server, it shall support EAP method(s) supporting derivation of master key derivation for MACsec.	
Notes		As EAP methods capable or master key derivation, EAP-TLS, EAP-TTLS and PEAP are recommended to be used (3.5.7)	
Requirement Source	3.5.7 of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_834
Description		The CS shall support Ethernet port configuration to assign all ingressing frames to a defined VLAN ID.	
Notes		Ethernet port statically assigned to a specific VLAN (security feature)	
Requirement Source	CS-REQ-12 of [DemoComp]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type		**Requirement ID**	
Description			
Notes			
Requirement Source		**Relevant for Demonstrator**	
Relevant for ETBN		**Relevant for CS**	

3.14.2 Firewall functionality

Requirement type	Requirement	**Requirement ID**	DBD_ND_806
Description		ETBN shall provide a network-based firewall service	
Notes			
Requirement Source	3.5.7 of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_807
Description		ETBN shall be able to filter IP telegrams at least based on IP source address, IP destination address, Source port (UDP/TCP), Destination port (UDP/TCP) and TRDP ComId	
Notes			
Requirement Source	3.3.3 of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type		**Requirement ID**	
Description			
Notes			
Requirement Source		**Relevant for Demonstrator**	
Relevant for ETBN		**Relevant for CS**	

3.14.3 Protocols for secure device management

Requirement type	Requirement	**Requirement ID**	DBD_ND_808
Description		Network device shall support HTTPS for secure file transfer	
Notes			
Requirement Source	2.8.3 of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_809
Description		Network device shall support SSH for secure login	
Notes			
Requirement Source	2.8.3 of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_810
Description		Network device shall support syslog for logging if security related events	
Notes			
Requirement Source	2.8.3 and 3.5.7 of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

3.14.4 Logging-related security requirements

Requirement type	Requirement	**Requirement ID**	DBD_ND_811
Description		The network device shall support detection and reporting of security events	
Notes			
Requirement Source	CS-REQ-25; DBD_ND_027; of [DemoComp]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_812
Description		If a user logs in, the concerned device shall create a log message including the user name.	
Notes			
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_813
Description		If a user login fails in maximum tries, the concerned device shall create a log message including the user name and the connection details of the client.	
Notes			
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_814
Description		A network device shall generate an audit log message whenever any of the following events occur: - Creation of a new user account - Deletion of a user account - Modification of the privilege level, or group membership, of a user account	
Notes			
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_815

Description		A network device shall generate an audit log message whenever any of the following events occurs: - A user spawns a shell, terminal or other application or command using different user credentials than his own (e.g. uses sudo) - A user changes his effective user credentials, group membership, privilege level, or similar credentials (e.g. uses su).	
Notes			
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_816
Description		A network device shall generate an audit log message whenever any of the following events occurs: - A user changes his password or any other persistent authentication token - A user password or other authentication token is changed for any other reason, or - Grant, modify, or revoke access rights, including adding a new user or group, changing user privilege levels, changing file permissions, changing database object permissions	
Notes			
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_817
Description		When the firewall is taken up during system operation, the concerned device shall generate firewall log messages.	
Notes			
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_818
Description		When the firewall is taken down during system operation, the concerned device shall generate firewall log messages.	
Notes			
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_819
Description		When the firewall is reconfigured, reinitialized, or reloaded at runtime, the concerned reconfiguration device shall generate firewall log messages.	
Notes			
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_820
Description		When unexpected traffic is received on the external interface, the concerned device shall generate a firewall log message.	
Notes		Note: The firewalls are configured via a white list. All traffic not included in the white list is unexpected. This applies only to the internal firewall between network zones.	
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	

Requirement type	Requirement	**Requirement ID**	DBD_ND_821
Description		A device shall create a log message whenever a security-related system service is started.	
Notes			
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_822
Description		A device shall create a log message whenever a security-related system service gets shut down.	
Notes			
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_823
Description		A device shall create a log message whenever the system as a whole starts up or enters an operational state. Message shall include run level and firmware version.	
Notes			
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_824
Description		A device shall create a log message whenever the system gets rebooted, including a reboot reason/trigger.	
Notes		Note: System reboot is defined as the system re-initializes itself by reboot command, software update, watchdog etc.	
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_825
Description		A device shall create a log message whenever the system gets shut down.	
Notes		Note: System shutdown is defined as the system is powered off either safely or unexpectedly	
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X
Requirement type	Requirement	**Requirement ID**	DBD_ND_826
Description		A device shall create a log message whenever an attempt is made to update the system software and specify whether the attempt was successful. The log message	

		should also include the previous and current version numbers of the software.	
Notes		Note: shall not cover a reboot process, but merely the check whether a flash write is performed correctly.	
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_827
Description		A device that support a dedicated maintenance mode, used for testing, debugging, fault-finding or software updates or similar tasks, shall create a log message when entering this mode.	
Notes		ETBN/CS if maintenance mode is applicable	
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_828
Description		A device that support a dedicated maintenance mode, used for testing, debugging, fault-finding or software updates or similar tasks, shall create a log message when exiting this mode.	
Notes		ETBN/CS if maintenance mode is applicable	
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_829
Description		Network device shall generate a log message whenever a connected end device attempts to use a supported authentication method and uses valid credentials.	
Notes			
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN		**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_830
Description		Network device shall generate a log message whenever a connected end device attempts to use a supported authentication method but uses invalid credentials, or an unsupported authentication method.	
Notes			
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN		**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_831
Description		Network device shall generate a log message whenever a connection loss to an externally accessible device is detected on	

		the physical or link layer. This only applies to the originator device to which the externally accessible device was directly connected.	
Notes			
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_832
Description		Network device shall generate a log message whenever a connection to an externally accessible device is established on the physical or link layer. This only applies to the originator device to which the externally accessible device is directly connected.	
Notes			
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Requirement type	Requirement	**Requirement ID**	DBD_ND_833
Description		Devices may generate a log message when they drop log messages to prevent a flooding of the network. The text of the message should contain the number of messages dropped if known.	
Notes		Note: changed to a 'may' requirement	
Requirement Source	3.5.7 (table 50) of [DbDArchSpec]	**Relevant for Demonstrator**	
Relevant for ETBN	X	**Relevant for CS**	X

Chapter 4 Endpoint Requirements

This chapter describes the requirements of the Endpoint that may be implemented by different devices at different levels of service (determinism, replication, etc), depending on the desired needs. These requirements cover the most strict use case, and can then be mildewed for other use cases.

We will focus on the high-level requirements from the demonstrator point (CONNECTA-2 project) of view based on the Bottom-up analysis to be performed and identified the needs of the next generation and the missing services. Since the FDF will implemented in the CONNECTA-2 project the full requirement and details will be delivered from CONNECTA-2 project.

The requirement for protocol support, Clock Synchronisation, Security, Performance and Reliability have been presented in separated section.

4.1 Network protocols and services

Requirement type	Requirement	**Requirement ID**	DBD_ED_001
Description		The device shall be compliant and interoperable with the 100BASE-TX or 1000BASE-T.	
Notes		Implementation choice.	
Requirement Source	ID_40012; S4R-DBD-521	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_002
Description		The device shall support the reception and transmission of Ethernet frames in accordance to IEEE 802.3 and IEEE 802.1Q	
Notes		Added 802.1Q as general network standard.	
Requirement Source	S4R-DBD-521; ID_40011; ID_40012; ID_60015	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_004
Description		The device shall support clock synchronization as defined in IEEE 802.1AS-rev	
Notes		Initiallly support only IEEE 802.1AS.	
Requirement Source	S4R-DBD-303; S4R-DBD-528; ID_40072	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_005
Description		The device shall support VLAN tags as defined in IEEE 802.1Q.	
Notes			
Requirement Source	ID_40022; ID_40023	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_006
Description		The device shall support at least 8 output queues per Ethernet port, each allocated to one traffic class 1..8.	
Notes			
Requirement Source	S4R-DBD-525	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_007
Description		Network device shall have at least 64 entry gate control list for every egress port.	
Notes			
Requirement Source	S4R-DBD-527	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_008
Description		The device shall support scheduled traffic as defined in IEEE 802.1Qbv	
Notes			
Requirement Source	ID_40067; S4R-DBD-526, refinement of original requirement.	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_015
Description		End Device shall provide the possibility to limit the transmission rate of egressing data per data class ('traffic shaping').	
Notes		NOTE: The correct ED traffic shaping can be supervised by the switch.	
Requirement Source	ID_40068	**Relevant for Demonstrator**	

Requirement type	Requirement	**Requirement ID**	DBD_ED_009
Description		The device may support per stream filtering and policing as defined in IEEE 802.1Qci	
Notes		Optional for ED (may requirement); must-have requirement for ND (shall requirement)	
Requirement Source	S4R-DBD-522	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_010
Description		The device may support Frame Replication and Elimination for Redundancy according to IEEE 802.1CB.	
Notes		FRER increases availability, which is especially relevant for critical ED.	
Requirement Source	S4R-DBD-205; S4R-DBD-702	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_011
Description		The device shall support the Internet protocol suite including · IP (RFC 791) · ARP (RFC 826) · UDP (RFC 768) · TCP (RFC 793) · ICMP (RFC 792)	
Notes			
Requirement Source	CTA_D3.5_ID_40009	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_010
Description		The ED shall support strict priority-based transmission selection algorithm (IEEE 802.1Q)	
Notes			
Requirement Source	Derived requirement	**Relevant for Demonstrator**	

4.2 Clock Synchronisation

Requirement type	Requirement	**Requirement ID**	DBD_ED_012
Description		If the application requires synchronised operation, the device shall be able to synchronize to the gPTP clock provided by the network.	
Notes			
Requirement Source	DBD_ED_004; ID_40072; ID_40028 and ID_40070	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_013
Description		The device shall be able to synchronize to multiple gPTP clock domains using the fault-tolerant average mechanism.	
Notes		It is to be decided whether ED(-S) requires a FT average, or only the CS will do this and the ED receives a 'simple' clock.	
Requirement Source	ID_40072; S4R-DBD-305	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_014
Description		All time-aware network devices shall use the time information from valid and correct gPTP clock domains to align the cyclic operation of IEEE TSN Gate Control Lists (GCL).	
Notes			
Requirement Source	S4R-DBD-338	**Relevant for Demonstrator**	X

4.3 Security

Requirement type	Requirement	**Requirement ID**	DBD_ED_020
Description		The device shall support 802.1X as a supplicant.	
Notes		Security features may be added at a later stage.	
Requirement Source		**Relevant for Demonstrator**	

Requirement type	Requirement	**Requirement ID**	DBD_ED_021
Description		The device may support MACSec as defined in IEEE 802.1AE	
Notes			
Requirement Source		**Relevant for Demonstrator**	

4.4 Performance

Requirement type	Requirement	**Requirement ID**	DBD_ED_024
Description		Network end-device NIC power-up time shall be less than 1 second.	
Notes			
Requirement Source		**Relevant for Demonstrator**	

Requirement type	Requirement	**Requirement ID**	DBD_ED_025
Description		Network end-device NIC start-up on reset time shall be less than 0.3 second.	
Notes			
Requirement Source	S4R-DBD-514; ID_40070	**Relevant for Demonstrator**	

Requirement type	Requirement	**Requirement ID**	DBD_ED_026
Description		Network end-device NIC line/link bandwidth for ETB and ECN networks may be 100Mbit or higher	
Notes		Some devices may only require 100Mbit/s link.	
Requirement Source	S4R-DBD-515	**Relevant for Demonstrator**	

4.5 Addressing

Requirement type	Requirement	**Requirement ID**	DBD_ED_041
Description		Addressing on network layer shall use the IP address schema defined in IEC61375-2-5 (inter-consist) and IEC61375-3-4 (intra-consist) in case IPv4 is deployed.	
Notes			
Requirement Source	CTA_D3.5_ID_40010; CTA_D3.5_ID_40047	**Relevant for Demonstrator**	X

4.6 Environment

Requirement type	Requirement	**Requirement ID**	DBD_ED_003
Description		The device may provide at least 2 Ethernet ports to support redundant communication.	
Notes		Redundancy increases availability. The second port is needed to support IEEE802.1CB (FRER) features at the ED, which is especially relevant for critical ED.	
Requirement Source	ID_60012; ID_60032;	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_052
Description		The ED-internal interface between NIC and ED shall be provided in the form of a PCIe interface.	
Notes		The connectivity to the internal host internal host is based on the PCIe interface, other possible solution could be provided.	
Requirement Source	Derived requirement	**Relevant for Demonstrator**	

Requirement type	Requirement	**Requirement ID**	DBD_ED_053
Description		The ED shall use Ethernet M12 X-coded 8-pin female connector for Gigabit Ethernet port according to IEC 61076-2-109	
Notes			
Requirement Source	DBD_ND_702	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_055
Description		The ED may support Power over Ethernet PoE as an option	
Notes			
Requirement Source	ID_40064	**Relevant for Demonstrator**	

Requirement type	Requirement	**Requirement ID**	DBD_ED_056
Description		The Network Device shall comply with EN 50155:2017 class OT4, -40 °C to +70 °C	
Notes			
Requirement Source	ID_60035	**Relevant for Demonstrator**	

Requirement type	Requirement	**Requirement ID**	DBD_ED_057
Description		The ED physical layer shall be compliant to and interoperable with 802.3ab.	
Notes		Note: i.e. 1000BASE-TX and/or 1000BASE-T1 for 1Gbit/s speed.	
Requirement Source	S4R-DBD-521	**Relevant for Demonstrator**	

Requirement type	Requirement	**Requirement ID**	DBD_ED_058
Description		The Network Device may provide port status indicators (link, traffic, blocked)	
Notes			
Requirement Source		**Relevant for Demonstrator**	

Requirement type	Requirement	**Requirement ID**	DBD_ED_059
Description		The ED shall comply to the EMC requirements as defined in EN50155	
Notes			
Requirement Source		**Relevant for Demonstrator**	

Requirement type	Requirement	**Requirement ID**	DBD_ED_060
Description		The ED shall be able to function with Input Power Voltage Range 24V-110V	
Notes			
Requirement Source		**Relevant for Demonstrator**	

4.7 "Gateway device" (3-port switch) Requirements

Requirement type	Requirement	**Requirement ID**	DBD_ED_071
Description		In the case that the NIC of a critical ED does not provide a redundant Ethernet interface by itself, it may be connected by means of an external "gateway device".	
Notes		This provides an alternative way to DBD_ED_052 to implement core requirements such as DBD_ED_051, DBD_ED_006, DBD_ED_008, DBD_ED_010.	
Requirement Source	Derived requirement	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_072
Description		The gateway device shall act as a transparent proxy for the connection between an ED and the ECN.	
Notes			
Requirement Source	DBD_ED_071	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_073
Description		The gateway device shall provide at least three external Ethernet ports. - two ports facing the ECN - one port facing the ED.	
Notes			
Requirement Source	DBD_ED_071	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_073
Description		The gateway device shall fulfill the ED requirements as stated in this document.	
Notes			
Requirement Source	DBD_ED_071	**Relevant for Demonstrator**	X

Requirement type	Requirement	**Requirement ID**	DBD_ED_054
Description		In the case of a "gateway device" is used (see DBD_ED_071), the Network Device shall be at least an IP30 class device	
Notes			
Requirement Source		**Relevant for Demonstrator**	

4.8 Reliability

Requirement type	Requirement	**Requirement ID**	DBD_ED_091
Description		The architecture of the NG-TCN shall be designed to reach the required failure rate in a way that the NG-TCN can continue executing its functionality correctly in case of a failure which can lead to a service failure.	
Notes			
Requirement Source		**Relevant for Demonstrator**	

Requirement type	Requirement	**Requirement ID**	DBD_ED_092
Description		The maximum failure rate of each function of the NG-TCN shall be: ƛ ≤ 10-7 failures/hour. NOTE: only functions which may cause a service failure as defined in ID_20003 are affected	
Notes			
Requirement Source		**Relevant for Demonstrator**	

Requirement type	Requirement	**Requirement ID**	DBD_ED_093
Description		Reliability of the ED NIC shall be in-line with the maximum failure rate	
Notes		It must be derived from the overall tolerable failure rate of the ED-S	
Requirement Source	ID_60030	**Relevant for Demonstrator**	

Requirement type	Requirement	**Requirement ID**	DBD_ED_094
Description		Endpoint shall monitor the origin (sender) of gPTP packets using MAC DEST and VLID / streamIDs and priority information.	
Notes		Security/reliability feature	
Requirement Source	S4R-DBD-340	**Relevant for Demonstrator**	

Requirement type	Requirement	**Requirement ID**	DBD_ED_095
Description		Synchronization slave devices shall monitor the order of gPTP packets using sequence numbers.	
Notes		Security/reliability feature	
Requirement Source	S4R-DBD-341	**Relevant for Demonstrator**	

Requirement type	Requirement	**Requirement ID**	DBD_ED_096
Description		Network devices shall support configuration protection.	
Notes		Note: this prevents any unintended change in configuration on critical devices. Mechanisms are dip-switching or electronic keys.	
Requirement Source	S4R-DBD-500	**Relevant for Demonstrator**	

Requirement type	Requirement	**Requirement ID**	DBD_ED_097
Description		Network devices shall have Built-in Self-Test capability.	
Notes		BIST capabilities to be further specified	
Requirement Source	S4R-DBD-520	**Relevant for Demonstrator**	

Chapter 5 Summary and Conclusion

The goal of this deliverable is to present requirements as a solid foundation for the components that form the “Drive-by-Data” train network, required for integrated modular architectures and next-generation Train Control and Monitoring System (NG-TCMS).

These requirements contribute to the main objectives of Shift2Rail, i.e. cutting life-cycle cost, increasing railway capacity and increasing reliability and punctuality. A first part covers overall requirements for CONNECTA-2 partners that presented the rail OEM needs. These requirements lead us to discuss and verify with CONNECTA-2 partners different requirements for the ETBN, CS and ED for NG-TCMS. We classified these requirements based on the following topics:

- Train inauguration
- Clock synchronisation
- ETB services
- Flow control
- ETB/ECN Gateway
- Network and data redundancy
- Security
- Safety
- Monitoring
- Management
- Environment

For this we used a bottom-up approach and brainstorming to generate the mature and significant requirements to accommodate OEM program needs. Summarizing, the requirements specified in this document will be leading for the development of the NG-TCMS devices.

Chapter 6 List of Abbreviations

Table 6-1: List of Abbreviations

API	Application Programming Interface
BIST	Built-in Self-Test
BMCA	Best Master Clock Algorithm
CCU	Central Control Unit
CMS	Configuration Management System
CN	Consist Network
COM	COMmunication
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
CS	Consist Switch
CTA	CONNECTA
DbD	Drive-by-Data
DC	Diagnostic Coverage
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
EAP	Extensible Authentication Protocol
ECN	Ethernet Consist Networks
ECU	Electronic Control Unit
ED	End Device
EMC	Electro-Magnetic Compatibility
ETB	Ethernet Train Backbone
ETBN	Ethernet Train Backbone Node
FCS	Frame Check Sequence
FDF	Functional Distribution Framework
FRER	Frame Replication and Elimination for Reliability

FT AVG	Fault Tolerant Average
GbE	Gigabit Ethernet
GCL	Gate Control List
GLC	Global Clock
GMC	Grand Master Clock
GPS	Global Positioning System
gPTP	Generalized Precision Time Protocol
HTTP	Hypertext Transfer Protocol
HW	Hardware
ICMP	Internet Control Message Protocol
IGMP	Internet Group Management Protocol
IMP	Integrated Modular Platforms
IP	Intellectual Property
LRM	Line Replaceable Module
LRU	Line Replaceable Unit
L-TTA	Loosely Time-Triggered Architectures
MAC	Media Access Control
MCU	Micro Computer Unit
MD	Message Data
MoCC	Model of Computation and Communication
NAT	Network Address Translation
ND	Network Device
NG-	Next Generation (TCN/TCMS)
NIC	Network Interface Card
NTW	Network
OC	Ordinary Clock
OEM	Original Equipment Manufacturer

PD	Process Data
PDU	Process Data Unit
PDV	Packet Delay Variation
PHY	Physical Layer (Transceiver)
PoE	Power over Ethernet
PTP	Precision Time Protocol
QoS	Quality of Service
RAMS	Reliability, Availability, Maintainability, Safety
RAMSS	Reliability, Availability, Maintainability, Safety, Security
RTC	Real-Time Clock
RTOS	Real Time Operating Systems
S4R	Safe4RAIL
SDT	Safe Data Transmission
SHMEM	Shared Memory
SID	Source IDentifier
SIL	Safety Integrity Level
SNMP	Simple Network Management Protocol
SRC/DEST	Source/Destination
SSC	Safe Sequence Counter
SSH	Secure SHell
SW	Software
SyIL	System Integration Layer
TCMS	Train Control and Monitoring System
TCN	Train Communication Network
TCP	Transmission Control Protocol
TDMA	Time Division Multiple Access
TFFR	Tolerable Functional Failure Rate

TFTP	Trivial File Transfer Protocol
THR	Tolerable Hazard Rate
TLS	Transport Layer Security
TND	Train Network Directory
TRDP	Train Real Time Data Protocol
TSN	Time-Sensitive Networking
TTA	Time-Triggered Architectures
TTDB	Train Topology DataBase
Tx/Rx	Transmitter/Receiver
UDP	User Datagram Protocol
URI	Uniform Resource Identifier
V&V	Verification & Validation
VDP	Vital Data Packet
VLAN	Virtual Local Area Network
VLID	Virtual Link Identifier
VRRP	Virtual Router Redundancy Protocol
WCTT	Worst Case Traversal Time
WP	Work Package

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