




ERJU SYSTEM PILLAR

System Requirements Specification_TCCS - Part 1 Service Function Diagnostics and Diagnosable BuildingBlock (SERA Version)



System Requirements Specification_TCCS - Part 1 Service Function Diagnostics and Diagnosable BuildingBlock (SERA Version)

Author(s)	Karl-Albrecht Klinge
Abstract	This document is the output of system requirement phase activities (phase 4) as specified in SPPRAMSS-349 - EN 50126-1:2017 for the Service Function Diagnostics (SFD) . The objective of this document is to specify a comprehensive and identified set of requirements for the Service Function Diagnostics (SFD).
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Figure 1. Logical architecture

1 Preamble

1.1 Scope and intended audience

Note to author: This section shall describe the scope and intended audience for this document.

1.2 Purpose

This document is the output of system requirement phase activities (phase 4) as specified in SPPRAMSS-349 - [EN 50126-1:2017] for the Service Function Diagnostics (SFD) . The objective of this document is to specify a comprehensive and identified set of requirements for the Service Function Diagnostics (SFD).

1.3 Glossary

1.3.1 General abbreviations

Acronym	Definition	Features
AMS	<p>An Asset Management System is a structured approach, typically involving software and processes, used to manage an organization's physical assets throughout their lifecycle. This includes planning, acquiring, operating, maintaining, upgrading, and disposing of assets to maximize their value, ensure reliability, and meet organizational goals. Asset management systems often focus on optimizing performance, reducing risks, and ensuring compliance with regulations.</p> <p>An AMS needs to know the installed asset base.</p>	<ul style="list-style-type: none"> • Asset inventory and tracking • Maintenance scheduling (preventive and predictive) • Lifecycle cost analysis • Condition monitoring and diagnostics • Compliance and regulatory reporting • Integration with condition-based maintenance (CBM) systems
HDA	Historical Data Access	Historical Data Access is an OPC UA standard to read historical values and events based on their OPC UA NodeIds.

Acronym	Definition	Features
SDI	Standard Diagnostic Interface	
SDI-DS	Aggregates SDI-XX and possible additional AddIns into a single OPC UA server	
API	Application Programming Interface	
Subset 149	Interface MDCM onboard - MDCM offboard	Contains model for Product Groups ETCS and ATO. Data for other Product Groups can use this interface as a carrier (as customized data)
SFC	Service Function Configuration	Service Function to update the software artifacts on Building Blocks.
SFD	Service Function Diagnostics	Service Function to aggregate diagnostics data from the connected Building Blocks.
API	Application Programming Interface	<p>An API is a set of rules and protocols that allows software applications to communicate with each other.</p> <p>It defines:</p> <ul style="list-style-type: none"> • What operations can be performed. • How to make requests. • What data formats to use. • How the system will respond.
AMS	Asset Management System	<p>Key Features of an AMS are:</p> <ul style="list-style-type: none"> • Asset registration and categorization • Lifecycle tracking (acquisition, usage, maintenance, disposal) • Preventive and predictive maintenance • Inventory and spare parts management • Work order and task management • Cost tracking and budgeting • Integration with ERP, SCADA, or IoT systems
CBM	Condition Based Maintenance	Condition-Based Maintenance is a maintenance strategy where servicing or repair is performed only when there is evidence of need, based on the actual condition of an

Acronym	Definition	Features
		asset — not on time or usage alone.
NTS	Network Time Security	Network Time Security is an extension of NTP (Network Time Protocol) that adds authentication, integrity, and encryption to time synchronization over IP networks.


1.3.2 Document-specific abbreviations

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1.3.3 Term definition

Note author: The term definition might be represented by a table. Another possibility could be to refer to a project-specific term definition within this section or to add a reference to a term definition list to the "referenced documents section".

2 Assumptions and dependencies

Note to author: List any assumptions and dependencies applicable to the system requirements that should be taken into account in the allocation and derivation of lower-level system requirements. If applicable assumptions are covered by other documents such as  SPPR-7906 - System Definition, these can be referenced here instead.

3 Constraints

Note to author: List any constraints applicable to the system requirements. If applicable constraints are covered by other documents such as  SPPR-7906 - System Definition, these can be referenced here instead.

4 System overview

The operation of the trackside and onboard CCS relies on two types of data: the dynamic operational data provided via SCIs and configuration data via SMIs. Additionally, it communicates its current state through diagnostic data via the SDIs. However, diagnostic data can only be effectively used if its semantics (meaning) are standardized and a powerful process of collecting, processing and aggregating for diagnostic data users is in place.

The digital twin model of the subsystems consists of both a physical and a logical model:

1. The **physical model** is a modular building block system that enables suppliers to describe their specific physical architectures in a standardized way. This ensures that maintenance teams can identify the correct spare part when a replaceable unit fails.
2. The **logical model** collects data relevant to a specific product group from an operational perspective, helping to determine whether production can continue. Examples of such models include the EULYNX SDI Product Group models for switches, IO devices, TVPs, IXL, RBC, TMS.

These two models are linked through references that establish connections, such as which physical device implements which logical function or which power supply provides energy to which components. These functional references are essential for root cause analysis, allowing maintenance teams to prioritize repairs efficiently. These models standardize the semantics while allowing suppliers to extend them to accommodate their specific needs. This standardization is crucial for ensuring interoperability of diagnostic data. However, not all diagnostic data is openly accessible. According to EU regulations (EU Data Act), railway operators (RU and IM) own the data generated by their assets, regardless of the supplier.

Data acquisition and processing for trackside elements are implemented using OPC UA and its rich set of services, including the client/server communication model for browsing, monitoring, and historical access. For trainside components, where intermittent connectivity and message-oriented communication are more critical, the use of AMQP is a viable alternative — particularly in conjunction with the OPC UA Pub/Sub model. In this setup, AMQP serves as a transport protocol within the OPC UA framework, enabling efficient and decoupled data exchange while preserving semantic consistency and interoperability through the OPC UA information model. The exact protocol stacks for trainside applications are still in discussions.

4.1 System context

The following picture describes the system context (ToDo: to be replaced from capella):

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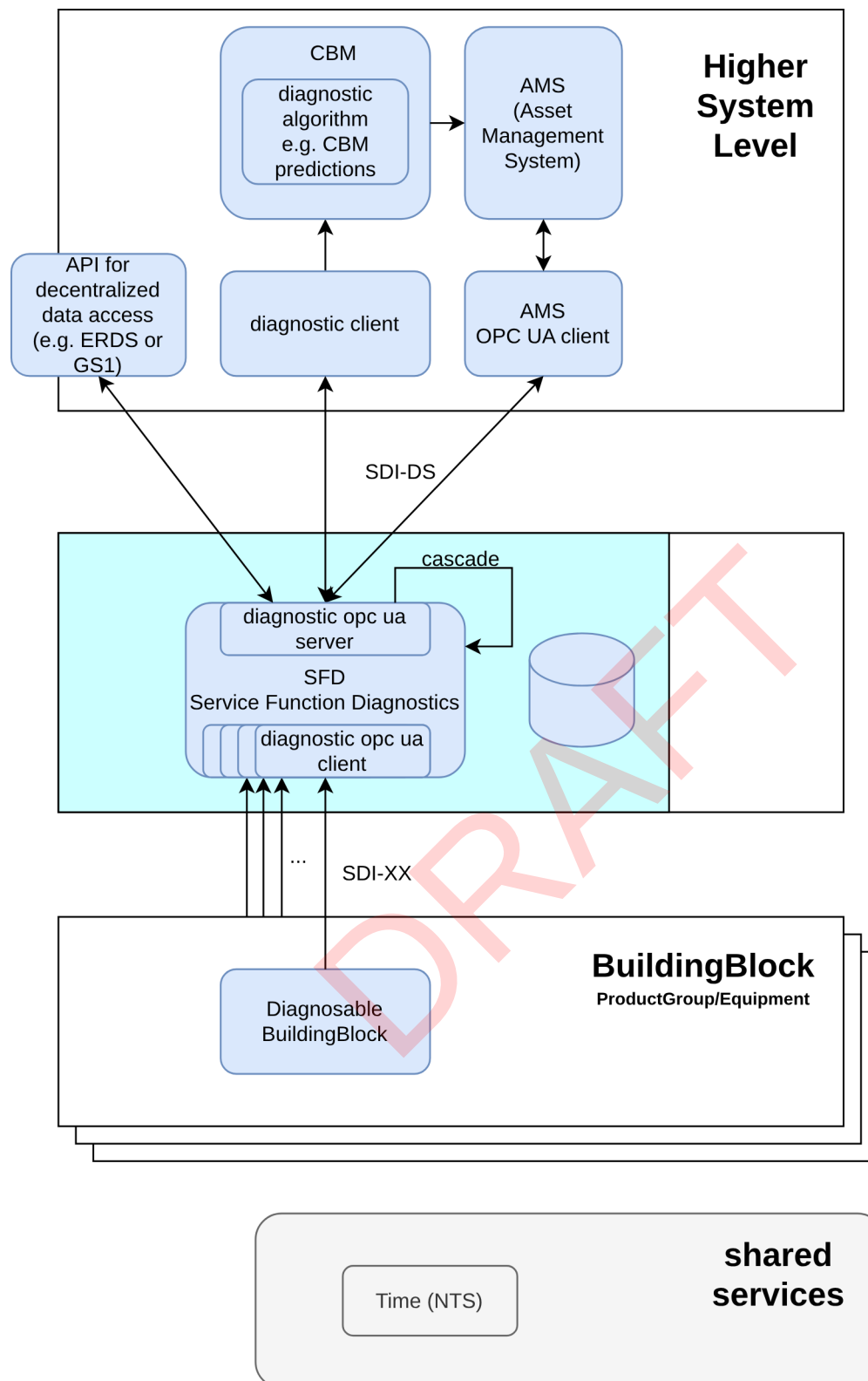


Figure 1 Logical architecture

[SPT2TS-129475]

4.2 System interfaces

The Service Function Diagnostics has the following external interfaces:

4.2.1 SDI-XX

see TCCS System Interface I_DIAG

4.2.2 SDI-DS

see TCCS System Interface I_DIAG_AGG

4.3 System modes and states

Note to author: If the system can exist in various operational modes or states define these and, as appropriate, use diagrams. Define modes and states requirements. If the modes and states are already covered by other documents such as System Definition, these can be referenced here instead.

5 System requirements

Define functional and non-functional requirements applicable to system following SPPROCESS/SEMP Annex R Requirements/SEMP Annex R3 - Rules for writing textual requirements : 723889.

5.1 Non-functional requirements

ToDo: add RAM requirements

5.2 Functional requirements

5.2.1 Generic OPC UA Server requirements

The following requirements are valid for OPC UA servers in the Service Function Diagnostics and the Diagnosable BuildingBlock. [SPT2TS-130151]

The OPC UA server in the Diagnosable BuildingBlock and the OPC UA server in the Service Function Diagnostics shall implement at least the following facets in addition: [SPT2TS-130147]

Reverse Connect Facet [SPT2TS-130153]

Event Access [SPT2TS-130154]

Historical Data Access [SPT2TS-130155]

The binary protocol defined in the "Standard 2017 UA Server Profile" is used for communication [SPT2TS-130149]

Secure Communication for OPC UA is based on the requirements specified in SP-SEC-Comm-Spec Chapter 4. [SPT2TS-130161]

ToDo Requirement to use SSI-NTS for time sync [SPT2TS-130169]

ToDo Requirement to use IAM for getting the roles ... [SPT2TS-130170]

5.2.2 Generic OPC UA Security Requirements

Permissions in diagnosable BuildingBlocks and Service Function Diagnostics.

The OPC UA endpoint in the Diagnostic Server shall support the following permissions:

Permission Name	Description	Corresponding OPC UA Node Permissions(*)
eu.rail.sdi.diagnostics-read	Permission to read OPC UA nodes containing diagnostics-related information.	Browse Read ReceiveEvents (if applicable) ReadHistory (if applicable)

Permission Name	Description	Corresponding OPC UA Node Permissions(*)
		(*) If required, the list of OPC UA node permissions might be extended with additional OPC UA node permissions.

[SPT2TS-129936]

5.2.3 Service Function Diagnostics requirements

The OPC UA server in the Service Function Diagnostics shall implement the "Standard 2017 UA Server Profile" or newer. [SPT2TS-130152]

The Service Function Configuration must subscribe to all nodes in the object space of the Diagnosable Building Blocks connected that can be found below EquipmentSet and ProductGroupSet, ensuring continuous monitoring of diagnostic attributes and event data. [SPT2TS-130090]

The Service Function Diagnostics captures both real-time and historical data from each Diagnosable BuildingBlock, using the OPC UA Historical Data Access (HDA) of the Diagnosable BuildingBlocks to fill possible data gaps. [SPT2TS-130144]

The Service Function Diagnostics server must aggregate diagnostic data from multiple Diagnosable BuildingBlocks into a single unified aggregate namespace.

This allows clients to access all diagnostic data in a unified structure, rather than querying each Diagnostic BuildingBlock separately. [SPT2TS-130145]

The namespace management in the Service Function Diagnostics must include versioning to differentiate updates in standardized and supplier-specific models. [SPT2TS-130146]

The namespace management must aggregate all Nodeset2 information models in all versions used by any of the aggregated Diagnosable BuildingBlock. These Nodeset2 information models must be available to and usable by the Service Function Diagnostics. [SPT2TS-130166]

The Service Function Diagnostics OPC UA server acts as a centralized diagnostics system that collects, aggregates, and provides historical data from multiple Diagnosable Building Blocks. It must ensure seamless historical data retrieval (if Diagnosable BuildingBlocks provide the data), minimizing gaps even in cases of temporary disconnections or data synchronization delays. The Service Function Diagnostics OPC UA server must expose historical data to clients using OPC UA HDA methods. [SPT2TS-130088]

The OPC UA server in the ServiceFunctionDiagnostics shall use the SourceTimeStamp from the Diagnosable BuildingBlock while using its system time to set the ServerTimeStamp for all diagnostic data. [SPT2TS-130168]

AddIns

MaintenanceMode?

[SPT2TS-130143]

5.2.4 Diagnosable BuildingBlock requirements

The OPC UA server in the Diagnosable BuildingBlock shall implement the "Embedded 2017 UA Server Profile" or newer. [SPT2TS-130148]

The OPC UA server on the Diagnosable BuildingBlock shall allow simultaneous connection to at least 3 OPC UA clients. This would e.g. allow a georedundant architecture and an additional local connection. [SPT2TS-130158]

The OPC UA server on the Diagnosable BuildingBlock shall allow at least 2 sessions per OPC UA client. Each session can operate independently, meaning different sessions can access different parts of the address space concurrently. [SPT2TS-130159]

The OPC UA server on the Diagnosable BuildingBlock shall allow at least 5 subscriptions per session. [SPT2TS-130160]

If the communication on the diagnostics interface fails or is not yet available, at least all diagnostic data of attribute type diagnosis and status shall be stored on the Diagnosable BuildingBlock for at least 6 hours. Note: The methodology to calculate the storage capacity and the required inputs are defined by national requirements.


Note: In future phases of the System Pillar, national specifications will be replaced by harmonised specifications.

[SPT2TS-130162]

After the OPC UA connection to the Diagnosable BuildingBlock has been restored, the stored diagnostic data shall be accessible with OPC UA "Historical Data Access (HDA)". [SPT2TS-130163]

If the memory allocated to the storage of diagnostic data is full, the Diagnosable BuildingBlock shall discard the respective oldest attribute data and events.

[SPT2TS-130164]

The OPC UA server on the Diagnosable BuildingBlock and its backend shall fulfill the timing requirements that are defined according to the SDI-XX Base meta data model, see  SPT2TS-130132 - Temporal Measurement Backend Requirements . [SPT2TS-130165]

The OPC UA server in the Diagnosable BuildingBlock shall use the system time to set the SourceTimeStamp and the ServerTimeStamp for all diagnostic data. [SPT2TS-130167]

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