# D3.1 TCCS SD2 - Generic Diagnostic Concept

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# Content

## Contents

# 1 Summary

**SPT2TS-49121 -** This document provides a generic concept of diagnostic and monitoring services for the CCS system and features the needs for standardisation of the diagnostic and monitoring data collection process. The development of this concept considers a high level and generic architecture including interfaces to be standardised to support the intended diagnostic and monitoring services.
The concept described in this document provides a generic solution for the whole CCS system (including on-board and trackside) considering it as a black box in the first step and intended to be further refined in the next phases following the SEMP methodology.

# 2 Problem description and references

**SPT2TS-49123 -** In order to define system requirements for diagnostic and monitoring services in the CCS system, generic concept that is applicable for the whole CCS system (including on-board and trackside) at system level is needed. The developed concept covers the following:

- High level and generic concept
- Systems involved in the concept
- System actors and their interaction
- System capabilities

The workitems defined in this document according to the System Pillar - System Engineering Management Plan (SEMP) are deliverables of the System Analysis layer. The following picture shows the SEMP process declination towards DIAGNOSTICS workitems:

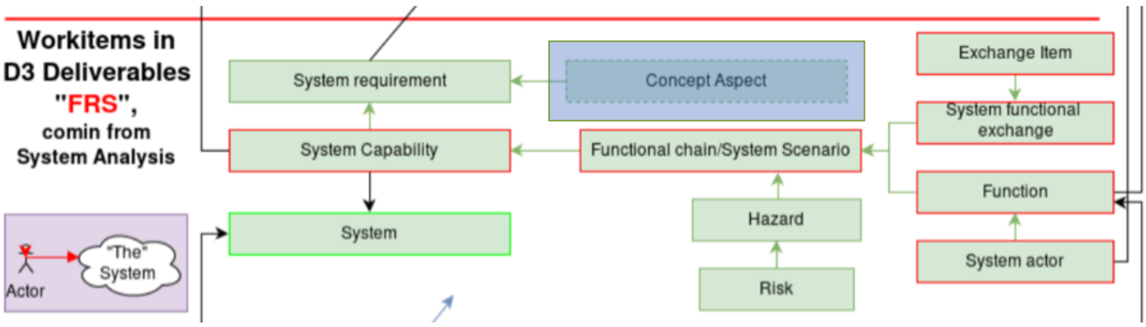


*Figure 1 Allocation of workitems of this document to the SEMP*

# 3 Glossary

## 3.1 Terms and Definitions

Diagnostics : Diagnostics is the assessment of health and performance of an asset or a group of assets. Furthermore, the diagnostic system also provides all information of single components in the field like: software version, parametrisation file version, firmware version, hardware version, manufacturer part number, manufacturer serial number, ID in the field (e.g. NID_ENGINE), cumulated hours in operation, IP address, etc. All this data is being used for analysis purposes.

Prognostics: is the ability to predict an impeding failure of a system based on the current system conditions [ISBN-13: 978-0849398797]. Prognosis technologies typically use measured or inferred features, as well as data-driven and/or physics-based models, to predict the condition of the system at some future time [DOI: 10.1002/9780470117842].

Monitoring: continuous supervision of the system condition for diagnostic or prognostic purposes.

Logging: is the activity of keeping a list of events that occur in a computer system, events such as problems, errors, or just information on current operations.
[https://en.wikipedia.org/wiki/Logging_(computing)]

Juridical recorder: collecting and storing juridical data (e.g. JRU data: SUBSET-027, possibly very similar data is also sufficient)

# 4 Solution concept and derived workitems

The diagnostic and monitoring service concept describes, on a generic level, the process, the systems, actors and functionalities enabling the collection of the CCS system asset conditions and providing it as a service. The concept at this level handles the CCS system as a whole system and provides a generic solution that is agnostic to the system from which the diagnostic/ condition data (on-board or trackside) is collected.
The solution presented in this concept is also applicable to CCS-external systems.

The goal of the generic concept for the diagnostic and monitoring services is to enhance the observability, availability and maintainability of the CCS system by leveraging data-driven analysis and proactive maintenance strategies. By continuously monitoring and analysing the performance of various components, it can minimise system downtime, optimise resources, and ensure smooth and reliable operation.

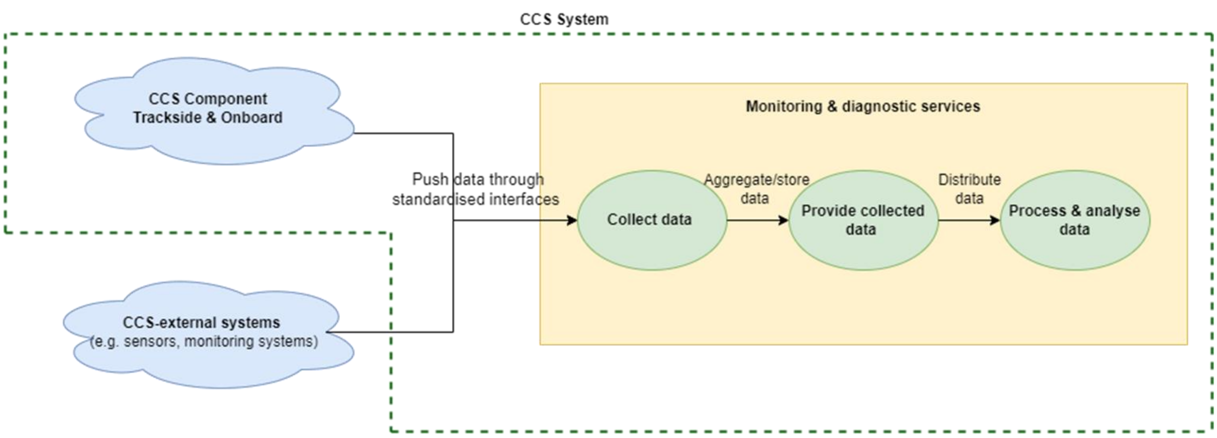


*Figure 2 - Generic Monitoring & Diagnostic Concept*

In this concept, the Monitoring and Diagnostics are considered as services within the CCS system architecture that have the main functionality to be able to collect data over standardised interfaces and protocols, and provide it for further analysis and processing. The concept describes the process of collecting data, processing it and identifying issues or potential issues in the CCS system. In addition as part of the TCCS SD2 remit, collecting from CCS- external systems (like sensors in the field, train control and monitoring system...etc.) is also in the scope and will be considered in the future specification.

## 4.1 Concept description

**Monitoring & diagnostic services**

Monitoring and diagnostic services in this concept covers the continuous collection and observation of data related to operation, performance and health of the CCS system. This includes the detection and reporting of failures to provide information that guide the root causes analysis, in order to support maintenance teams in resolving issues timely. It also covers the surveillance and detection of safety and security-related aspects. Diagnostic services in this concept covers the assessment and analysis of collected data in order to provide insights and help identify patterns to predict potential faults.

**Collect data**

The concept typically starts by collecting data from different sources; CCS system including On-Board and trackside and CCS-external systems . This collected data covers information about performance, status, health, condition, and other parameters of the systems, communication networks, and associated hardware. The collection of the data should be ensured over standardised interfaces to enable exchangeability.

**Provide collected data**

After data collection, the second phase of the concept, focuses on storing and managing the collected data for the purpose of providing it to further analysis over standard interface and also other users in the context of CCS system or also Traffic Management system.

**Process & Analyse data**

Once the data is collected and provided over standard interface for analysis, advanced analytical techniques are applied to extract further information. This includes applying algorithms and statistical models to detect deviations from normal operational mode, issues, or patterns within the data. The analysis of the data should enable to determine the faults root cause, which may involve further processing of historical data. The processing of the data and understanding of the patterns should enable the prediction of potential faults or issues before they arise in the future.
The analysis outcome generated through this process provides the information as a service back to the CCS system, ensuring the smooth and reliable operation. In addition it supports the decision-making with regard to maintenance schedules, repairs, replacements, and system upgrades.

## 4.2 Data Flow

**Figure # Data Flow in the Monitoring & Diagnostic context**

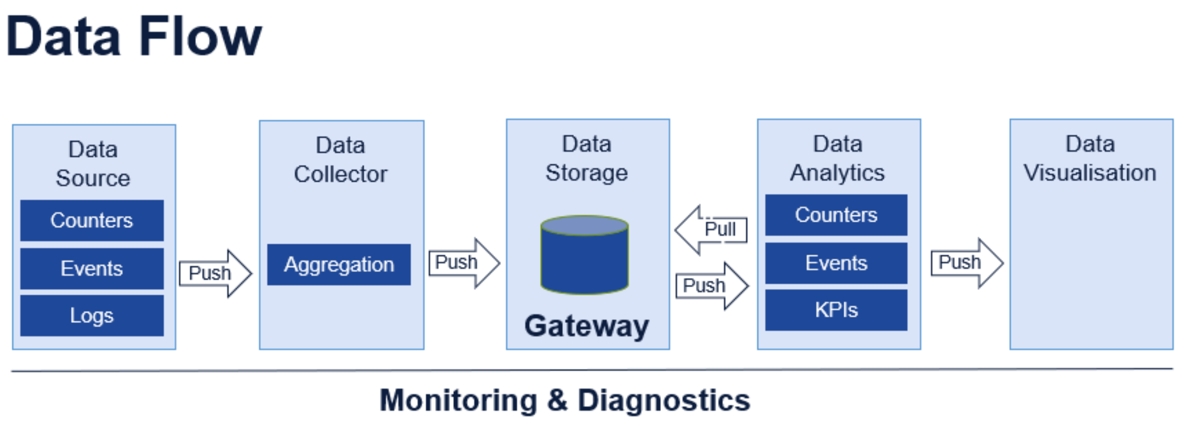


*Figure 3 Data Flow in the Monitoring & Diagnostic context*

### 4.2.1 Data Source /CCS Component

Data Source /CCS component represents here a subsystem of the System Pillar's CCS architecture which is a target for monitoring and collecting data. In this concept the data source could represent for example a train, a field element or an interlocking that shall provide condition/status data (e.g. counters, events, logs ...etc) over standard interfaces.

In order to be able to integrate and further process the collected data from  different CCS components (several aspects of diagnostic data analysis, including correlation, event sequencing), the timestamps associated with collected data shall reflect the correct timing. Therefore it is assumed that the data source is receiving time information from  a central service "TimeSynchronisation".

### 4.2.2 Data Collector

The data collector enables the automated and systematic capturing and gathering of data form different Data Source /CCS components over standardised interface that will be identified and specified in the context of the System pillar.
The data collector ensures the availability, integrity and quality of data for further analysis. It shall ensure the automation of the collection process reducing the manual intervention. In addition, the data collector is responsible  for aggregating and consolidating data from a group of CCS components to provide a comprehensive view on the CCS system. It shall be able to handle efficiently large volumes of data and provide scalability.

### 4.2.3 Data Storage

**Data storage represents in this concept the role for collecting and managing cen...**

Data storage represents in this concept the role for collecting and managing centrally the various data coming from different instances of data collectors. The data storage shall be able to integrate this collected data and have periodic synchronisation to ensure that latest update is captured. The data storage will provide access to different consumers which could be authorised personnel, maintenance teams, through an interface collect or another technical subsystem. In the scope of SD2 we will focus on the interface to provide access to the Analytics focusing on the diagnostic use case.

### 4.2.4 Data Analytics

Data analytics represents the step of analysing and interpreting the collected data from various sources. After the collecting of data and data storing phases, the data is provided over standardised interface to the analytics and aimed to be defined and specified also as part of the SD2 scope. The analytics focuses on processing the data to extract insights, detect patterns and failures, and provide diagnostic information to guide maintenance activities and contribute to operation optimisation.

### 4.2.5 Data Visualisation

**Data visualisation step in this concept covers the providing of the analysed inf...**

Data visualisation step in this concept covers the providing of the analysed information to the different consumers. The consumers in this concept refers to the group of end users like maintenance teams or external CCS system like TMS, for example, that uses the output of the monitoring and diagnostic services to optimise operation and support decision making process.

## 4.3 Concept application at Logical Architecture level

The application of the concept described in the chapter 4.1 results in the following diagram:

**Figure 4 Generic Concept -Logical Architecture level**

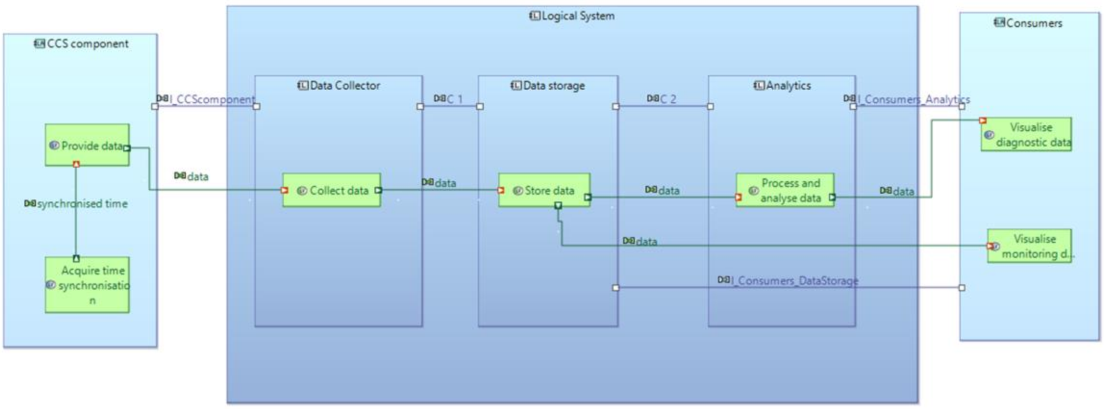


*Figure 4 Generic Concept -Logical Architecture level*

**SPT2TS-124996 -** The logical architecture depicted in this section represents an initial example draft that applies the general concept outlined in earlier chapters of this document at the logical level. A more comprehensive analysis, focusing on both the logical architecture and the subsystem architecture (SRS), will be conducted in future deliverables as per the SEMP process.

**SPT2TS-124997 -** This architecture showcases the CCS components as the data sources for monitoring and diagnostic services. It's important to note that these CCS components are expected to be time-synchronised, providing accurate timestamps for the data collected. While time synchronisation is crucial for diagnostic and monitoring services, it is considered an independent service and not a direct part of the monitoring and diagnostic framework.

**SPT2TS-124998 -** In this logical system, the focus is on diagnostics and monitoring. The system is broken down into distinct logical components and functionalities, which include data collection, data storage, and analytics. These components collectively provide services that enable various stakeholders to visualise and utilise the data for diagnostic or monitoring purposes. The term 'consumers' here refers to all entities and systems making use of these services. This includes maintenance teams, who rely on this data to plan field interventions and maintenance activities. In addition this could support the Traffic Management Systems (TMS) by providing the status of the CCS system from diagnostic and monitoring perspective.

## 4.4 Overview and alignment of different standardisation activities to the Generic concept

**Figure 4 Overview of different Standardisation activities**

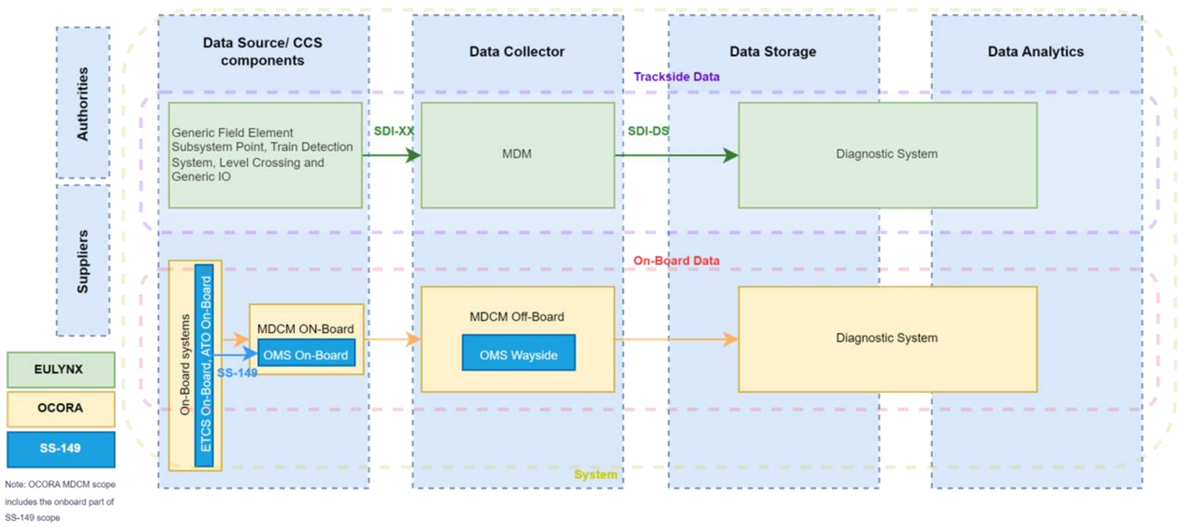


Figure 5 Overview of different Standardisation activities

**Overview description**

This figure illustrates the alignment of the high-level generic concept presented in this document with the entire CCS system, encompassing both track-side and on-board subsystems. The focus is on integrating this generic diagnostic concept with existing standards and standardisation initiatives within the CCS system.

**Trackside data**

For the trackside, the EULYNX standards facilitate the collection of diagnostics and monitoring data from field elements through standardised interfaces (SDI-XX), feeding into the maintenance and data management system (MDM). Future efforts -in the scope of TCCS domain- will expand this to other track-side CCS components such as interlocking, moving block system, and ATO-TS, in collaboration with relevant domains.

This also includes developing specifications for different subsystems/interfaces involved in various stages of the diagnostic process, like data collection, storage, and analysis.

**Onboard data**

Regarding the on-board subsystem, the OCORA initiative concentrates on diagnostics and monitoring within the on-board CCS system. In this context, the primary data source is identified as the on-board data collector (MDCM – onboard), rather than the CCS on-board components themselves. However, this assumption requires validation with the Train CS domain for the further development of specifications.

# 5 Status of the work, open points, issues

# 6 Tables

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