


# Release Note\_TCCS-CCS/TMS Data Model enabled by ERA Ontology - Cover Document

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## 1 Document Overview

This document provides a comprehensive overview and formal introduction to the **Extended ERA Ontology** based on the ERJU SP Transversal CCS achievements of CCS/TMS Data Modelling. The Extended ERA Ontology is a harmonized, semantically-rich knowledge model that unifies the requirements of the **ERA RINF** (meso-level infrastructure abstraction) with the detailed, fine-grained specifications defined by the System Pillar **CCS/TMS** initiative (micro-level operational and component data). The ontology is the product of an extensive integration and alignment process of ERJU Transversal CCS with ERA that reconciles the structure, semantics, and usage expectations of both models.

## 2 References

1. ERA Extended Ontology CCS/TMS: [https://gitlab.com/era-europa-eu/public/interoperable-data-programme/era-ontology/era-ontology/-/tree/ext-ccstms?ref\\_type=heads](https://gitlab.com/era-europa-eu/public/interoperable-data-programme/era-ontology/era-ontology/-/tree/ext-ccstms?ref_type=heads)
2. CCS/TMS model specification documents:  [CCS/TMS Data Model](#)


## 3 Terms

### CCS/TMS Extended ERA Ontology (CCS/TMS Data Model)

The CCS/TMS Extended ERA Ontology and its derived CCS/TMS Data Model defines the harmonised data language for configuration, communication and diagnostics interfaces within ERJU System Pillar architecture. The Transversal CCS domain is responsible for the specification of the CCS/TMS Data Model in collaboration with

- the System Pillar domains, which apply the defined data structures in interface specifications
- the Innovation Pillar, which proves the applicability of the data model by demonstrators.

## 4 Motivation for CCS/TMS Data Modelling

**SPT2TS-2037 - A harmonised digital CCS/TMS system requires a shared data language applied at all relevant interfaces with similar exchange items. Furthermore, it requires comprehensive configuration data** for implementing systems according to the System Pillar architecture (i.e. radio-based ETCS only). With the  [SPT2TS-2040 - CCS/TMS Extended ERA Ontology \(CCS/TMS Data Model\)](#)

the System Pillar provides a data structure for standardised engineering and to align a data structure for standardised interface specifications within CCS including CCS-TMS. This data structure shall be suitable across all relevant use cases of the System Pillar such as engineering and communication for traffic control or automated train operation.

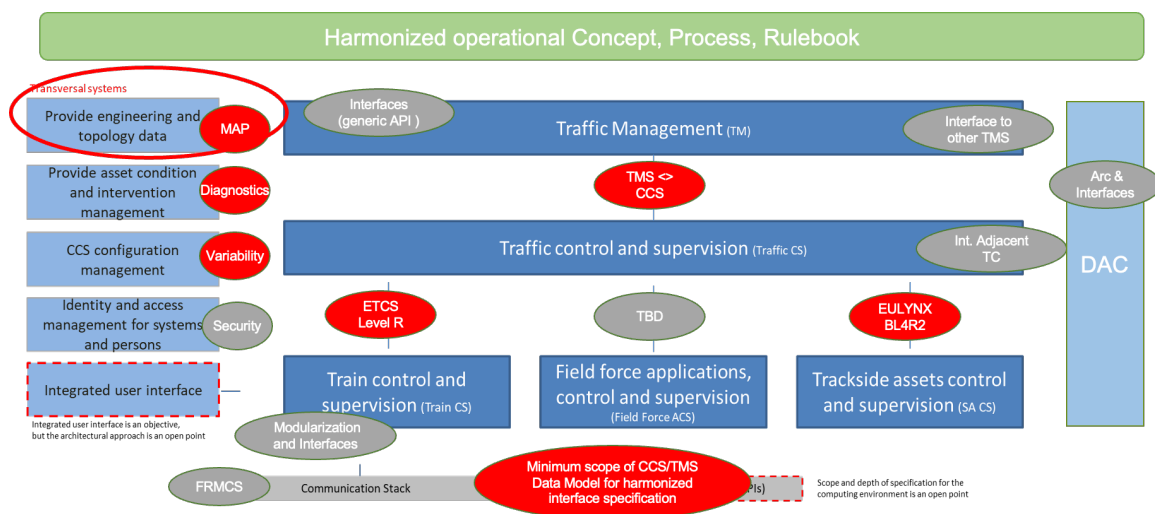


Figure 1 Interfaces between domains and minimum scope of CCS/TMS data model

The Data Model and interface specification must be comprehensive for SERA and therefore sufficiently detailed (not on a high conceptual level), at least on the Functional Interface Specifications (FIS) level within the System Pillar architecture. The development must be according to SEMP. The modelling approach is selected to support these goals.

While the TCCS domain is located in Task 2 of the System Pillar, it offers the inclusion of other tasks with the same and consistently applied CCS/TMS Data Model, as it is already applied for the interface between Task 2 and Task 3 TM.

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For more explanation, see [TCCS - Data Model\\_01\\_Approach](#).

## 5 CCS/TMS Extension of ERA Ontology

**SPT2TS-2052** - The CCS/TMS data language will be the base at least for ERJU specifications for communication interfaces, diagnostics and configuration. The CCS/TMS model specification is highly integrated into the System Pillar system engineering tool chain (Capella, Polarion,...).

Furthermore, the integration into the [ERA Vocabulary](#) as CCS/TMS extension is decided and performed for the purpose of legislation, long-term maintenance and semantical linking to further data models. Besides reusing semantic definitions and obtaining consistent use of terms within the railway domain, this approach also offers the possibility to benefit from existing links of other data models, which already are or will be connected with ERA vocabulary.

As a result of the integration, all further developments in the System Pillar regarding data models are reflected in ERA vocabulary. Official releases of the data model will always be derived from ERA vocabulary by an automatized process, as shown by the following process overview:

**Continuous use of ERA Ontology for extraction of CCS/ TMS Data Model as projects (use cases) need specific model**

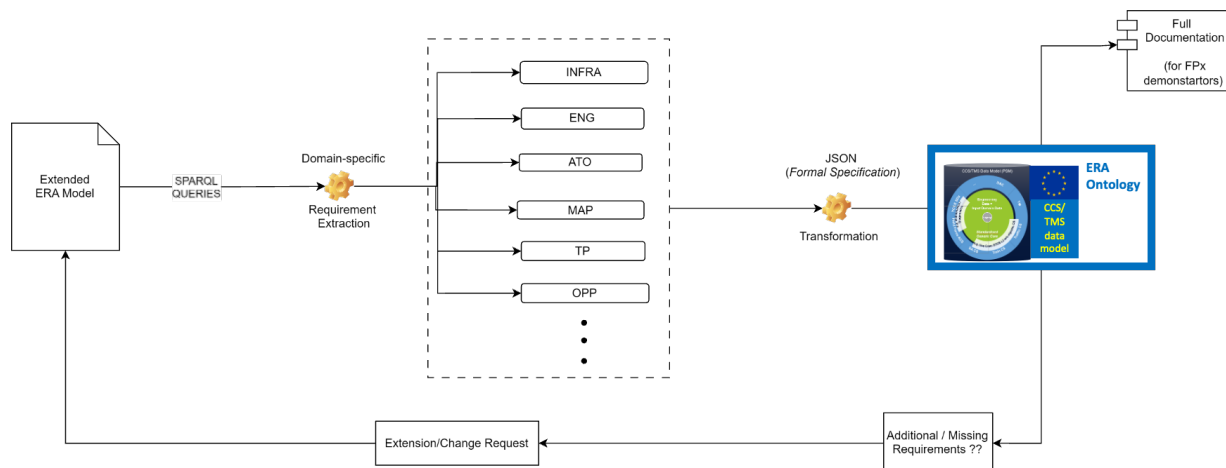


Figure 2 CCS/TMS Data Model derived from ERA Vocabulary to serve interface specification and demonstration needs

To support the specification process, the representation of the CCS/TMS data model in the toolchain of System Pillar (Polarion and Capella) is maintained by an automated toolchain, which keeps the connection to ERA vocabulary.

[📄 Normal]

**SPT2TS-130685** - The **Extended ERA Ontology** is publicly accessible via the following GitLab repository:

[https://gitlab.com/era-europa-eu/public/interoperable-data-programme/era-ontology/era-ontology/-/tree/ext-ccstms?ref\\_type=heads](https://gitlab.com/era-europa-eu/public/interoperable-data-programme/era-ontology/era-ontology/-/tree/ext-ccstms?ref_type=heads) [📄 Normal]

**SPT2TS-130683** - The Extended ERA Ontology was developed to unify and operationalize two complementary perspectives of the European railway system:

- The ERA RINF model, which offers a meso-level abstraction of railway infrastructure, emphasizing interoperability and regulatory compliance.
- The CCS/TMS specifications, which demand micro-level granularity for specific safety, control, engineering, and monitoring use-cases among others.

[📄 Normal]

**SPT2TS-130684** - The primary purpose of the Extended Ontology is to:

- Enable semantic interoperability between diverse railway information systems.
- Bridge the abstraction gap between high-level regulatory data and low-level technical details.
- Facilitate data reuse and integration by providing a shared vocabulary and formal semantics.
- Allow targeted sub-ontology extraction via metadata-driven queries, reducing complexity and increasing relevance per use-case.
- Promote modular, standards-based development by leveraging existing ontologies (e.g., SKOS, Time Ontology, GeoSPARQL)

[📄 Normal]

For more details regarding the CCS/TMS Data Model as ERA Ontology Extension it is referred to [TCCS - Data Model\\_01\\_ERA Ontology Extension](#)

## 6 Data Model follows Function

**SPT2TS-130734** - As shown in the figure below, the data structures of CCS/TMS are built from functional requirements of the systems. The functional requirements are derived from the operational requirements allocated to CCS and TMS systems. The resulting data structures are added to ERA Extended Ontology and mirrored to Polarion/Capella specification documents, which define the configuration, diagnostics, and communication interfaces and the communicating systems.

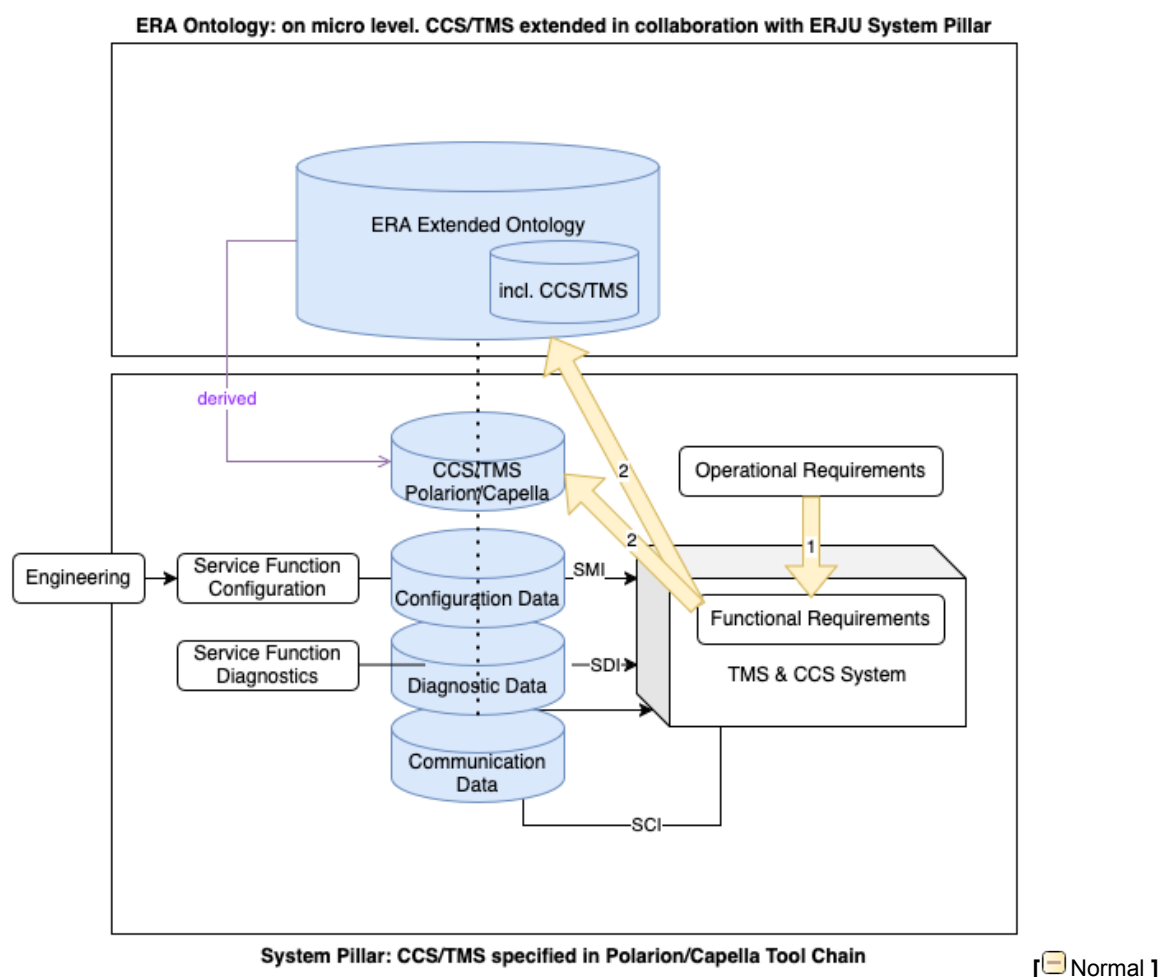





Figure 3 : CCS/TMS Data Model as ERA Extended Ontology follows functional needs

### 6.1 Functional-driven Harmonization of Configuration Data


**SPT2TS-123984** - Today, Engineering Data-related processes are too often paper/drawing-based, manual activities, inefficient, and not state-of-the-art – compared to the available technical possibilities. Subsystem-specific, propriety formats characterise the Domain Data. Consequently, standardised digital toolchains in the field of CCS engineering are not yet established in the railway domain.

As with national BIM plans by infrastructure managers, a proper digitisation strategy also relies on the standardisation of interfaces within this process to support coordination, data exchange, and close collaboration within the project. The standardisation is also a consequence of the SERA objectives and call for a harmonised solution. [  Normal ]


**SPT2TS-123985** - The data structures developed in national contexts are a first step towards this digitised process flow. The international standardisation of data formats, rules, and processes improves the business case and ROI due to scale. Higher development costs related to safety, such as CCS, increase the need for a standardised environment with the semi-automated, digitised engineering process, i.e. planning, validation or transformation functions. Today, several initiatives provide interface data formats, such as EULYNX Data Prep, railML, RSM, RCA, IFC-rail, Linx4Rail, and X2R4-PSM. These partially overlapping standards complicate the decision process of IMs or other parties to invest and build toolchains following long-term roadmaps. Also, the coexistence of several data standards in parallel for the same use case is not acceptable for safety, functional or economic reasons if a new, standardized architecture, as intended by the System Pillar, is developed. ERJU System Pillar shall improve the situation by harmonising the input information required from engineering or infrastructure data inputs to operate the System Pillar systems within their area of operation. As it will be shown in the following chapters, the decisions will be driven by the functional needs of the consumers, though the technical and economic feasibility is equally essential for the System Pillar design process. [  Normal ]

**SPT2TS-130733** - The results of this function-driven configuration data specification is specified and approved with Polarion and Capella tool chain of the System Pillar according to SEMP. [  Normal ]

### 6.2 Functional-driven Harmonization of Communication Data

**SPT2TS-130731** - To enable harmonised data structures for communication interfaces, the functional exchanges are analyzed regarding their data needs and also checked against the variable data model classes of CCS/TMS. This process requires an intense collaboration between Transversal CCS and the domains specifying the systems and interfaces applying the data. It is expected that this process can start on any System Level of Architecture Process, though it is on a conceptual characteristics until System Analysis. The process is documented in Capella/Polarion as specified by the SEMP. [  Normal ]






### 6.3 Functional-driven Harmonization of Diagnostic Data











**SPT2TS-130732** - Diagnostic data as specified by Transversal CCS in collaboration with the domains responsible for the CCS/TMS systems will also be derived from functional needs. As a result, the structures of the same CCS/TMS data model are used and extended. The process is documented in Capella/Polarion as specified by the SEMP. [  Normal ]

## 7 CCS/TMS Model Development History and Next Steps

### SPT2TS-122465 - Revisions of CCS/TMS Extended ERA Ontology and CCS/TMS Data Model














In the following table, the revision history of the CCS/TMS modelling developments (first as standalone ERJU development, now integral part of ERA Ontology) is documented, containing details about the release notes and the review activities. The feedback for one release leads to improvements within the next iteration of the data model and its documentation. Also, schemas are added or extended to cover more use cases of ERJU System Pillar. Besides the history, the planned releases are listed to give an overview of the next steps.










Data Model Version	Release Date	Release Notes	Publish and Review
0.1	31.03.2023	<p>By the following documentation, we would like to inform you about the defined scope and mode of work of SP TCCS SD1, i.e. regarding the derived  SPT2TS-2040 - CCS/TMS Extended ERA Ontology (CCS/TMS Data Model) and the intended collaboration with the other domains/FAs:</p> <p> <a href="#">TCCS SD1 - Scope and Approach for Collaboration and Specification</a></p> <p>Attachments:</p> <p> <a href="#">TCCS SD1 - Data Model</a></p> <p> <a href="#">TCCS SD1 - Data Model Schema</a></p> <p>We kindly ask you to take note and provide comments in Polarion (or exported word file).</p> <p>Some additional contexts regarding the  SPT2TS-2040 - CCS/TMS Extended ERA Ontology (CCS/TMS Data Model): The data model initially focuses on the first layers (topology, geometry) and shall demonstrate the SD1 approach in a practical way. This paves the way and defines a base for further extensions in collaboration with you. Besides just providing clarification about the scope and approach of SD1, we also encourage (i.e. the FAs) to give feedback based on their implementation experiences.</p>	<p>The release (Polarion, PDF, JSON) has been shared via email and presentation with:</p> <ul style="list-style-type: none"> <li>• All System Pillar Domain Leads for further distribution to responsible domain members</li> <li>• Innovation Pillar FA1 (incl. CDM)</li> <li>• Innovation Pillar FA2 (WP27)</li> </ul> <p>The documentation was used for general scope &amp; approach alignment rather than detailed model content discussion. The received comments (written form, discussions) are used to improve the explanations and structure of documents.</p>



Data Model Version	Release Date	Release Notes	Publish and Review
0.2	05.07.2023	<p>Version 0.2 of the  <a href="#">SPT2TS-2040 - CCS/TMS Extended ERA Ontology (CCS/TMS Data Model)</a> has been updated with incoming needs from first use cases like ETCS, ATO, and Train Protection. In addition, the document structure has been modified to provide data model separation between different domains with sufficient linking between the domains.</p> <p>The  <a href="#">SPT2TS-2040 - CCS/TMS Extended ERA Ontology (CCS/TMS Data Model)</a> version 0.2 contains the following set of documents:</p> <ul style="list-style-type: none"> <li> <a href="#">TCCS SD1 - Scope and Approach for Collaboration and Specification</a> (for additional information)</li> <li> <a href="#">TCCS SD1 - Data Model_00_Release Notes</a> (this document)</li> <li> <a href="#">TCCS SD1 - Data Model_01_Introduction</a></li> <li> <a href="#">TCCS SD1 - Data Model_02_Schema</a></li> <li> <a href="#">TCCS SD1 - Data Model_10_INFRA</a></li> <li> <a href="#">TCCS SD1 - Data Model_11_ATO</a></li> <li> <a href="#">TCCS SD1 - Data Model_11_ENG</a></li> <li> <a href="#">TCCS SD1 - Data Model_11_TP</a></li> </ul> <p>We ask you to take note and provide comments in Polarion (or exported word file).</p>	<p>The release (Polarion, PDF, JSON, XML) has been shared with:</p> <ul style="list-style-type: none"> <li>• All System Pillar Domain Leads for further distribution to responsible domain members</li> <li>• Innovation Pillar FA1 (incl. CDM)</li> <li>• Innovation Pillar FA2 (i.e. WP27, WP13, WP44)</li> </ul> <p>Amongst others, the release with extended model content was used for the following collaborations:</p> <ul style="list-style-type: none"> <li>• Discussion and model improvement together with FA2 WP13 and WP27 experts regarding data model needs for Moving Block demonstrator (TP, INFRA schema)</li> <li>• Discussion of needs regarding the onboard system (e.g. localisation) data needs with FA2 WP27 experts (INFRA Schema)</li> <li>• Discussion with engineering and tool development experts regarding data and model needs, i.e. for ETCS, Interlocking, and Infrastructure; including practical feedback from tool development supporting the data model for import/export. All feedback comments are used for model improvement (ENG/INFRA schema) to ensure applicability for implementation.</li> <li>• Check of ATO schema against actual ATO configuration data (i.e. Segment Profiles)</li> </ul> <p>All relevant data model schemata have been commented on within Polarion (or by PDF comments).</p>

Data Model Version	Release Date	Release Notes	Publish and Review
0.3	31.08.23	<p>Correction release based on all comments of previous release. In addition, more clarification is given in the <a href="#">TCCS - Data Model_02_Methodology</a> document regarding the structure and linking of data model schemas, identification and referencing (between data model parts and between instances).</p> <p>The <a href="#">SPT2TS-2040 - CCS/TMS Extended ERA Ontology (CCS/TMS Data Model)</a> version 0.3 contains the following set of documents:</p> <ul style="list-style-type: none"> <li><a href="#">TCCS/TMS Data Model - Scope and Approach for Collaboration and Specification</a>: updated i.e. regarding top-down / bottom-up development process</li> <li><a href="#">TCCS SD1 - Data Model_00_Release Notes</a>: this document</li> <li><a href="#">TCCS SD1 - Data Model_01_Introduction</a>: more details regarding modelling language, structure, linking, identification</li> <li><a href="#">TCCS SD1 - Data Model_02_Schema</a>: error corrections</li> <li><a href="#">TCCS SD1 - Data Model_10_INFRA</a>: processed feedback from model usage and review</li> <li><a href="#">TCCS SD1 - Data Model_11_ATO</a>: processed feedback from model usage and review)</li> <li><a href="#">TCCS SD1 - Data Model_11_ENG</a>: processed feedback from model usage and review</li> <li><a href="#">TCCS SD1 - Data Model_11_TP</a>: processed feedback from model review</li> </ul> <p>In addition to the documentation, the data model for implementation in the formats JSON, XML and the JSON Schema will be published.</p> <p>The following use cases are in the focus of this release regarding test case scenarios (e.g. in collaboration with Innovation Pillar)</p> <ul style="list-style-type: none"> <li>- ETCS/Balise Engineering</li> <li>- ATO Engineering</li> </ul>	<p>The release was used for SP Steering Group information in Sep 23, which led to an official sharing of the data model to Innovation Pillar for specification and demonstration purposes.</p> <p>In addition, the release was shared and discussed with ERA to clarify the connection to ERA vocabulary.</p>



Data Model Version	Release Date	Release Notes	Publish and Review
0.4	22.12.2023	<p>The  SPT2TS-2040 - <a href="#">CCS/TMS Extended ERA Ontology (CCS/TMS Data Model)</a> is now extended with Data Model for CCS - TMS Interface (SCI-OP) and semantic linking for ERA. In addition, corrections based on all comments of the previous release were performed.</p> <p>The  SPT2TS-2040 - <a href="#">CCS/TMS Extended ERA Ontology (CCS/TMS Data Model)</a> version 0.4 contains the following set of documents:</p> <ul style="list-style-type: none"> <li> <a href="#">TCCS - Data Model_01_Approach</a>: processed feedback from model review</li> <li> <a href="#">TCCS - Data Model_00_Release Notes</a>: this document</li> <li> <a href="#">TCCS - Data Model_02_Methodology</a>: processed feedback from model review</li> <li> <a href="#">TCCS - Data Model_02_Schema</a>: processed feedback from model review</li> <li> <a href="#">TCCS - Data Model_10_INFRA</a>: processed feedback from model usage and review; added ERA Linking</li> <li> <a href="#">TCCS - Data Model_11_OI</a>: processed feedback from model usage and review</li> <li> <a href="#">TCCS - Data Model_11_ENG</a>: processed feedback from practical model usage, comparison against other engineering model, and review; added Fouling Point and other details required for engineering phase.</li> <li> <a href="#">TCCS - Data Model_11_TP</a>: processed feedback from model review ; added Field Object Controller with first details as required by first demonstrators</li> <li> <a href="#">TCCS - Data Model_11_OPP</a> : new schema to cover needs of CCS-TMS interface. The current state is aligned with <a href="#">Concept_Interface_TMS_CCS_V1_2</a> and will be further developed in collaboration with TMS (and Traffic CS) in 2024</li> <li> <a href="#">TCCS - Data Model_11_MAP</a>: Map data model (coordinates) has been extracted out of INFRA as a new domain.</li> </ul> <p>Not included: the connection to the diagnostic data model as developed by the responsible taskforce has not been included yet due to needed alignment with other model parts. The plan is to include it in the next release.</p>	<p>Besides the release of documents (Polarion and PDF in SP Open Share), the automatically created data model files (json, xml/xsd,...) are provided for further review and usage within specification and demonstration.</p> <p>Links to SP Open Share:</p> <ul style="list-style-type: none"> <li>• <a href="#">Data Model Files (json)</a></li> <li>• <a href="#">JSON Schemata</a></li> <li>• <a href="#">UML diagrams / UML pdf version</a></li> <li>• <a href="#">XSD Files</a></li> </ul> <p>In addition, based on the alignment process started with ERA, a semantic version (TTL files) of  SPT2TS-2040 - <a href="#">CCS/TMS Extended ERA Ontology (CCS/TMS Data Model)</a> is provided for this release, including linking to ERA vocabulary:</p> <ul style="list-style-type: none"> <li>• <a href="#">CCS TMS Data Model Semantic (ttl)</a></li> </ul> <p>The model will further evolve during the further collaboration with ERA.</p>

Data Model Version	Release Date	Release Notes	Publish and Review
0.4.1	04.04.2024	<p>This is a minor release of the  SPT2TS-2040 - CCS/TMS Extended ERA Ontology (CCS/TMS Data Model) with an update of the data model for CCS - TMS Interface as well as further improvements based on inputs from Innovation Pillar FA2 Demonstrators.</p> <p>Updated documents:</p> <ul style="list-style-type: none"> <li> TCCS - Data Model_10_INFRA: integrated feedback from IP FA2 Moving Block Demonstrator</li> <li> TCCS - Data Model_11_OI: minor changes to the data model</li> <li> TCCS - Data Model_11_ENG: Replace mileage by Km-Signs.</li> <li> TCCS - Data Model_11_TP: integrated feedback from IP FA2 Moving Block Demonstrator</li> <li> TCCS - Data Model_11_OPP : integrated feedback from Task 3 CMS/TMS and added upstream data model objects.</li> </ul>	<p>Besides the release of documents (Polarion and PDF in SP Open Share), the automatically created data model files (json, xml/xsd,...) are provided for further review and usage within specifications and demonstrators (IP FA1, FA2, FA3, FA5, and FA6).</p> <p>Links to SP Open Share for XML, UML, JSON, and PlantUML exports: <a href="#">results</a></p>
0.4.2	28.06.2024	<p>This is a minor release of the  SPT2TS-2040 - CCS/TMS Extended ERA Ontology (CCS/TMS Data Model) with following changes:</p> <ul style="list-style-type: none"> <li> TCCS - Data Model_11_OPP : integrated feedback from Task 3 CMS/TMS and IP FA2 Moving Block Demonstrator</li> <li> TCCS - Data Model_11_TP: integrated feedback from IP FA2 Moving Block Demonstrator</li> </ul> <p>Amended certain naming conventions in the data model to make the data model compatible for ERA integration.</p>	<p>Besides the release of documents (Polarion and PDF in SP Open Share), the automatically created data model files (json, xml/xsd,...) are provided for further review and usage within specifications and demonstrators (IP FA1, FA2, FA3, FA5, and FA6). In addition the ontology version for ERA integration is published.</p> <p>Links to SP Open Share for Ontology, XML, UML, JSON, and PlantUML exports: <a href="https://eeigertms.sharepoint.com/sites/SPOpenShare/Gedeelde%20documenten/Forms/AllItems.aspx?FolderCTID=0x0120009759543C5D980E4786FE7B845BBBAF5A&amp;id=%2Fsites%2FSPOpenShare%2FGedeelde%20documenten%2FGeneral%2F24%2D06%2D28%20TCCS%20CCS%20TMS%20Data%20Model%20v0%2E4%2E2&amp;viewid=7d2094bc%2D4ed7%2D4bd4%2D8055%2Dcda6a753bac3">https://eeigertms.sharepoint.com/sites/SPOpenShare/Gedeelde%20documenten/Forms/AllItems.aspx?FolderCTID=0x0120009759543C5D980E4786FE7B845BBBAF5A&amp;id=%2Fsites%2FSPOpenShare%2FGedeelde%20documenten%2FGeneral%2F24%2D06%2D28%20TCCS%20CCS%20TMS%20Data%20Model%20v0%2E4%2E2&amp;viewid=7d2094bc%2D4ed7%2D4bd4%2D8055%2Dcda6a753bac3</a></p>

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1.0	04.09.2024	<p>Final release of CCS/TMS Data Model for remit period SC2.3</p> <ul style="list-style-type: none"> <li>• Improvements based on Innovation Pillar demonstrator feedback</li> <li>• Alignment with domains and already defined interfaces - including feedback from domain approval</li> <li>• Improvements after Mirror Group Approval</li> <li>• added schema  <a href="#">TCCS - Data Model_20_SDI_Generic</a>, imported from already approved Equipment Model from EULYNX (partial transfer based on needs, to be extended by other aspects according user needs during next remit period, i.e. for OC configuration and diagnosis)</li> </ul>	As usual, all model files are created for this release. The files are published on ERJU GitHub and Polarion.
1.1	21.03.2025	<p>Minor release of the CCS/TMS Data Model in framework of remit SC2.4</p> <ul style="list-style-type: none"> <li>• <b>First data model release that is aligned with ERA Ontology Extension, see <a href="#">extended-era-ontology</a></b> Includes naming changes to all domains keeping the naming consistent with ERA Vocabulary.</li> <li>• New Domain On-Board Infrastructure (OI) has been introduced. OI now the static on-board infrastructure data needs for systems like Perception, ASTP, ATO, etc.</li> <li>• Includes updates data model classes in TP and OI domain based on needs coming Innovation Pillar</li> </ul>	As usual, all model files are created for this release. The files are published on ERJU GitHub and Polarion  <a href="#">CC S/TMS Data Model</a> .

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