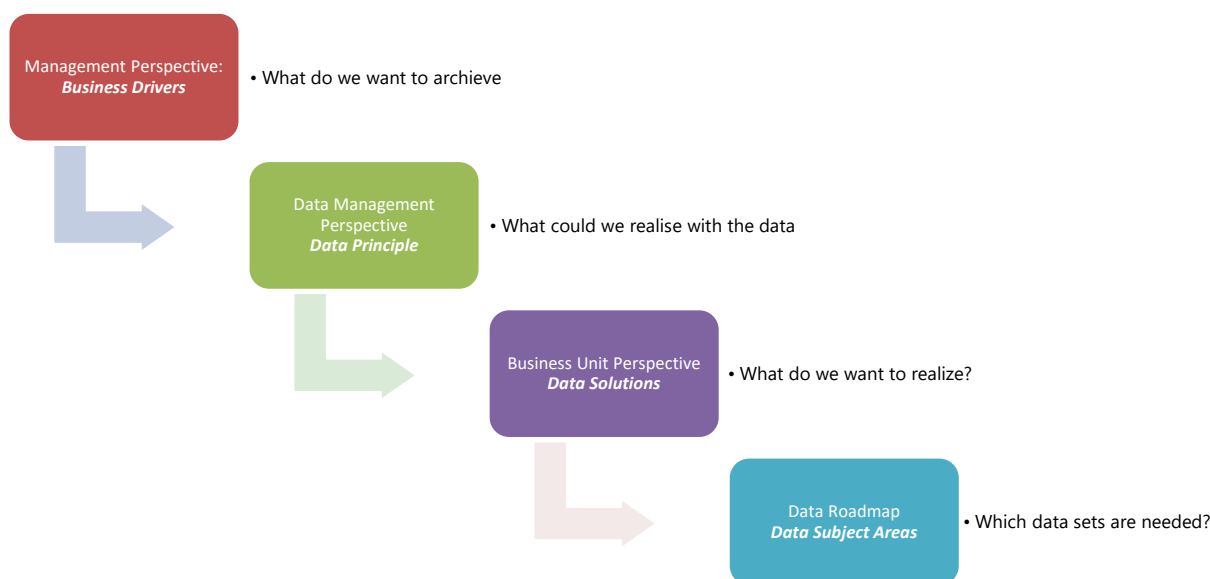


General challenges

In today's data-driven business landscape, the importance of an enterprise-wide Master Reference Data (MRD) model cannot be overstated. A comprehensive and centralized MRD system serves as the foundation for maintaining data integrity, consistency, and accuracy across various systems, processes, and departments within an organization. By establishing a unified and standardized approach to managing critical data elements, such as customer information, asset details, and market data, a MRD model enables seamless data integration, effective decision-making, and improved operational efficiency. It allows businesses to navigate the complexities of data governance, adapt to evolving industry dynamics, and drive successful outcomes in a rapidly changing digital world.

One of the most daunting obstacles lies in establishing a robust foundation for master and reference data. This data foundation must be reliable and trustworthy. As emphasized by the TenneT Board, our data, processes and systems require, just like tall buildings, strong foundations. They must be more transparent, streamlined, and efficient. Achieving this necessitates an integrated architecture and a focus on end-to-end processes, enabling a structural enhancement in these areas.



Business Drivers	Data Principles
Cooperation between TSOs and DSOs One European Market for Electricity Smart Grid Secure and robust grid Integration of renewables	One vocabulary between TSO's Integration of disparate local sources Compliance towards regulators (codes, rules and regulations) Reduction time-to-market for data High Quality Data

The approaches outlined in the Data Management Body of Knowledge (DMBOK) offer valuable insights into best practices for data governance, particularly in addressing key challenges related to master data, transparency platforms, the enterprise data model (CIM), and centralized metadata. By leveraging these approaches, organizations can establish effective data governance frameworks and strategies to ensure the integrity, consistency, and reliability of their data assets. The DMBOK provides guidance on implementing data management principles and methodologies, enabling organizations to optimize data governance processes and drive informed decision-making across the enterprise.

Our general challenges on MRD are:

- Operating in a dynamic environment: Our work is influenced by constant changes in the national and international markets, political landscape, and regulatory frameworks. Adapting our MRD system to these evolving factors requires flexibility and agility.
- Managing a large and diverse organization: Being a major company, we have multiple business units and departments, each generating a significant amount of data. Coordinating and aligning the MRD processes across these different entities can be complex.
- Dealing with decentralized data systems: Our organization utilizes various local systems, each with its own master and reference databases. Ensuring data consistency and synchronization across these systems poses a challenge.
- Integrating with external parties: The need to exchange data with external entities, such as suppliers, partners, or regulatory bodies, introduces additional complexities in data interfacing and integration. Establishing secure and efficient data connections is crucial. Addressing these challenges requires a well-designed MRD strategy, effective data governance practices, and the use of modern technologies to streamline data management processes and ensure the accuracy and reliability of our data assets.

Most companies are spending too much time and money to prevent and handle:

- Data silos and multiple versions: Dealing with disparate systems and departments often leads to data fragmentation, where different versions of the same data exist in isolated silos. This creates inconsistencies and difficulties in consolidating and reconciling data.
- Manual data entry and maintenance errors: Reliance on manual processes increases the risk of human errors during data entry and maintenance activities, resulting in inaccuracies, duplication, or incomplete data.
- Lack of data timeliness and awareness: Organizations struggle to maintain up-to-date data and face difficulties in identifying which data elements are current and reliable, leading to potential decision-making challenges.

- Inconsistent data models: Incompatibilities and inconsistencies in data models across various systems can hinder data integration and hinder accurate reporting and analysis.
- Lack of data trustworthiness: Organizations encounter difficulties in establishing trust in their data due to quality issues, unreliable sources, or a lack of data governance frameworks.
- Interface problems and inconsistencies: Inadequate data integration and inconsistent data formats can lead to difficulties in exchanging data with external systems, partners, or stakeholders.
- Limited sharing and reuse of master/reference data: Despite the potential benefits, organizations often struggle to share and reuse master/reference data effectively, leading to data redundancy and inefficient data management practices.

Sounds familiar?

To overcome these challenges, organizations should prioritize implementing comprehensive data management strategies, leveraging modern technologies for data integration and automation, enforcing data governance frameworks, and promoting a culture of data quality and accountability. By addressing these issues, companies can reduce costs, improve operational efficiency, enhance decision-making processes, and unlock the full value of their master/reference data.

As a former application manager, and with the help of very critical and innovative colleagues, we developed a prototype and working method. This prototype offers a seamless solution for initiating the definition of the data model and facilitating the registration of relevant data.

Our model and prototype simplify the process of defining subject types (classes), properties (attributes), records (instances), and their relationships. Model definition can be achieved solely through configuration, allowing us to define and manage the model efficiently. This is the first step. Once configured, the model is ready to be used, eliminating the need for complex programming or extensive development efforts. With this approach, we have the flexibility to define everything we need, streamlining the data modelling process.

In the next step, our focus shifts to registering the master and reference data. This includes capturing all instances, their corresponding attribute values, and establishing direct relationships between records (instances). One of the key advantages of our solution is that interdependencies are automatically created, alleviating the need for manual intervention.

What do we think is important

We consider the following points as important regarding Master-, Reference-, and Metadata:

Concerning Master-, Reference-, and Metadata

- SINGLE POINT OF REGISTRATION: Following a principle of single point of registration to establish a single source of truth by connecting different MRD sources and enriching MRD.
- FLEXIBLE IMPLEMENTATION STYLES: The MRD environment should accommodate different implementation styles, such as coexistence and centralized approaches, to handle different masters and facilitate collaboration and authorship.
- CONSISTENCY: Ensuring the model's consistency to maintain data integrity and coherence.
- QUALITY MANAGEMENT: Implementing good quality management practices outlined by DAMA DMBOK, including developing a governed approach, defining standards and specifications for data quality controls, measuring and monitoring data quality levels, and continuously improving data quality.
- COMPLIANCE WITH STANDARDS: Adhering to standards wherever possible.

Concerning the application

- CONNECTABILITY: The MRD-module is capable of connecting models of deviating source- and target systems without adjusting the MRD datamodel, by means of configuration
- USER-CONFIGURABLE META MODEL: The authorized operator should have the ability to define new object types, associate properties with these object types, and manage MRD for these new object types fully by configuration.
- CONTEXT-BASED MRD: MRD should be related to a context, with properties representing different key values for different systems.
- AGGREGATION SUPPORT: The MRD module should handle aggregations of data.
- FLEXIBLE DATA MODELLING: The MRD-module is capable of connecting items from whatever type, to other items of whatever type, via any type of relation, without adjusting the datamodel
- IMPORT AND EXPORT CAPABILITIES: The MRD module should be able to import MRD data from any source and export MRD to any target system, if necessary filtered by context.
- PARENT-CHILD RELATIONSHIPS: The MRD module should function as a child or parent of another MRD module without requiring changes to the data model.
- ENRICHMENT CAPABILITIES: The MRD-module is capable of enriching information received as a child (combined parent/child pattern)
- VALIDATION: The MRD module should provide validation for both master(-, and reference) data and relationships between different objects.

- MONITORING AND MAINTENANCE: MRD processes should be monitored and maintained by responsible individuals.
- DATA DISTRIBUTION: The ability to distribute data to subscribed and authorized environments in various forms; The context based MRD-module facilitates every scenario concerning model-differences when operating interfaces between in- and external systems.
- CONFIGURABILITY: The MRD module should be fully configurable, allowing for defining, adjusting, and extending properties or property characteristics without changing the data model.
- INCONSISTENCY DETECTION: The MRD module should provide insights into key inconsistencies between source and target systems.
- DATA SERVICES: Apart from generic distribution mechanisms, data services should be developed to effectively consume MRD data in target applications.
- VALIDATION ON SOURCE DATA: The MRD module should allow for configurable validations on data sets received from source systems.
- VALIDITY PERIOD: Every MRD element should have a validity period, allowing for historization of data.
- AUDIT TRAIL: The MRD module shall be capable of providing insight into all mutations as for the user who made the mutation, the moment the mutation was made, the situation before change and the situation after change, thus providing a complete audit trail.
- USER FRIENDLY MAINTENANCE: The core activity of MRD maintenance must be easy to understand, easy to execute, have the full and merely focus on the data itself

Quite a long list. However, a lot of the above listed requirements can be realized on a decent MRD-application. No matter the model; Most fully fledged MRD applications have the ability to fulfil most requirements. Just like the tool we designed. The distinguishing element between the traditional MRD environments and our approach? The simplicity.

The Trick. The whole trick and nothing but the trick

Our approach is designed to encompass the entire scope of data registration, providing a comprehensive solution for managing all types of data in a consistent manner.

- The trick: Our approach enables the registration of "everything" by following a uniform data processing principle. It allows for the registration of diverse data subjects, attributes, and relations, providing a flexible framework for capturing and managing data.
- The whole trick: Our approach supports the registration of every imaginable data subject, attribute, and relation. There are no limitations on the types of data that can be registered, allowing for a comprehensive representation of the organization's data landscape.

- Nothing but the trick: Registering forms the nucleus of this section of the application. Tasks such as data distribution, managing bulk validations, establishing governance, and other critical aspects necessary to uphold MRD quality and governance will be managed in distinct modules that leverage the same data model.

This aspect of our approach (the trick, the whole trick and nothing but the trick) is particularly important as it not only facilitates the storage of data but also ensures clarity and ease of understanding. The data model is designed in a way that enhances the comprehension of data, even for individuals who may not have an extensive background in data management. This clear representation of data promotes better understanding and accessibility for all users involved.

At TenneT we are investigating how this approach can help us to face all current and future data challenges. For starters, it makes datamodeling easy. A new data-related development or insight can be processed quickly and directly provides you all insights concerning the consequences of this functional datamodel change. You can build the model step by step based on study on business processes, or you can collect all data that is stored in your business processes, and register that in the prototype via the reverse engineering approach.

In summary, our prototype offers a powerful solution that covers the entire spectrum of data registration, making it easy to capture, manage, and comprehend data in a uniform and efficient manner.

At TenneT, we are in the process of designing the final MRD datasolution, incorporating valuable insights gained from the reverse engineering of data in the EAV (Entity-Attribute-Value) database. The insights derived from this process form a significant input for creating the canonical datamodel. Additionally, we are considering the possibility of building the actual MRD solution based on the EAV approach, leveraging its proven storage capabilities and flexibility.

Currently, we have successfully implemented two small business cases using this approach, demonstrating its practical viability. Our ongoing study is now focused on assessing the architectural suitability of data storage and distribution as elaborated in this prototype solution for wider deployment within individual business units or across the entire corporate organization.

By carefully considering the architectural components and their alignment with our business needs, we aim to create an MRD solution that optimally supports our operational requirements and ensures efficient management of master, reference, and metadata across the organization.