The Global Language of Business

Introduction to the use of

GS1 Standards in the rail industry

Global identification, labelling and data exchange for parts, components and assets

1 Need for harmonisation

Like all products, components have a life cycle that is divided into several phases including production, storage, installation, operation, maintenance and disposal. Quality and safety management requirements are increasing across all these phases, as are demands in connection with the availability of materials and services. They are the main driver of efforts to increase the efficiency and effectiveness of material management systems.

Rail operators use standardised labelling in order to ensure the transparent and consistent flow of materials and information worldwide throughout the life cycle of components.

1.1 A global identification standard for the rail industry

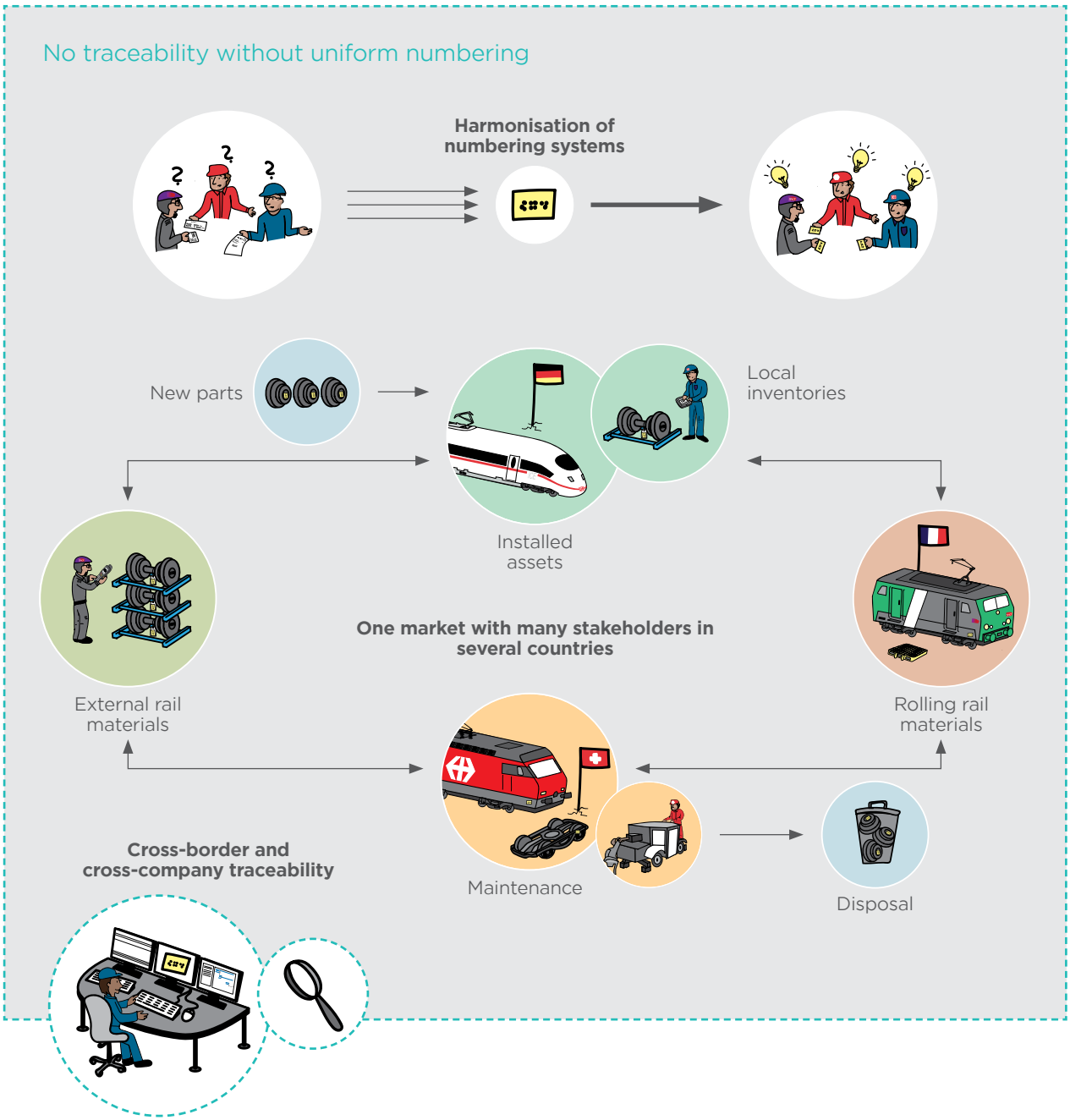
GS1 Global Standards are used for the standardised identification and labelling of rail components. It makes particular sense to use an independent and globally recognised standard because it harmonises differences and thus simplifies collaboration between the stakeholders in the market. A standard offers great potential in a sector where various supply-side industries interact, a large number of companies are involved and there is a coordinated flow of goods worldwide. It will not only benefit rail operators but also the manufacturers of parts and systems as well as the providers of repair and maintenance services and replacement parts. Standards will harmonise customer-specific requirements for the unique identification of parts and components. In summary, harmonisation will create interoperable processes along the entire value chain. This document provides an introduction to the GS1 system and the use of GS1 Standards in the rail industry.

Photos: DB AG, Siemens Mobility | © GS1 2020

Examples of different identification and labelling variants

1.2 Harmonisation: unique but not individual

All over the world, unique character strings are used as identifiers – in passports, on bank cards and driving licences, in e-mail addresses and on many convenience goods. In an increasingly connected world, it is essential to be able to clearly identify the participating organisations and objects. In short: **the digital world needs unique identification numbers.**

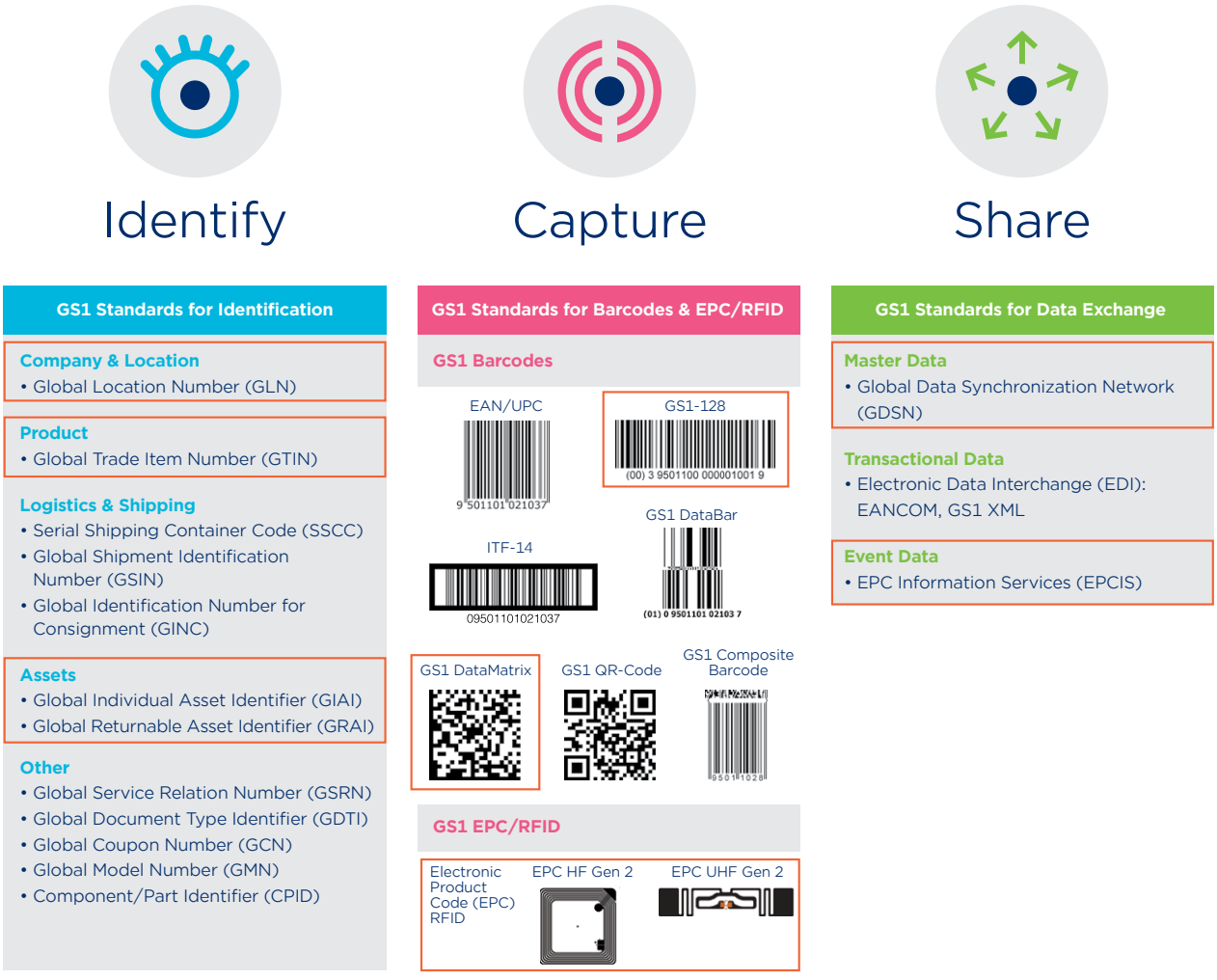


Widespread use of a common standard can potentially offer the following benefits:

- Electronic and enhanced sharing of data between manufacturers, operators and authorities
- Optimisation of logistic processes and vendor/sub-contractor management
- Improvement of fault and warranty management
- Collection and use of data for product development, operation and maintenance/repair
- Improved counterfeit protection

1.3 GS1 Standards: identification, labelling and data sharing

GS1 offers standards for identification (identify), labelling (capture) and data exchange (share) for use in many industries. The **relevant standards for the rail industry are highlighted in colour** and will be discussed in more detail on the following pages.



GS1 portfolio

2 Identification and labelling

To ensure the traceability of objects that are used worldwide, it must be possible to identify them uniquely. **This is why each object is assigned a unique GS1 identification key in addition to the description in the master data**. The identification is then encoded in a data carrier and used as the access key for the data pertaining to each object. Depending on the required level of granularity of the information, the GS1 System distinguishes between identification on the class level, on the batch or lot level or on the instance level (see section 2.5).

Example of a combination of identification and labelling on an aluminium plate

One example of the combination of identification and labelling is an aluminium plate lasered with a GS1 2D code and fitted with an RFID transponder. Both data carriers contain the same identification code.

The labelling examples reveal clear benefits:

- Coding of a globally unique serial identification number (here GIAI: 405564540001000000000107)
- Clear definition of data: meaning, structure and function of the data elements are specified by the GS1 Application Identifier Standard (here: 8004 for GIAI)
- High degree of data redundancy thanks to triple representation of the content (RFID, GS1 2D code and text)

2.1 The GS1 Company Prefix (GCP): foundation of the GS1 system

The basis of the GS1 System is the GS1 Company Prefix (GCP). This is essential to building globally unique GS1 identification numbers which in turn clearly identify different parts, components and assets (see graphic below).

The GS1 Company Prefix may vary between six and 12 digits in length. In the example below, the first nine characters of GTIN 9501101531239 are the GS1 Company Prefix.

Issued by national GS1 organisation, e.g. GS1 Austria, GS1 Germany or GS1 Switzerland
GS1 Company Prefix – e.g. **950110153**

Companies can use the GS1 Company Prefix to define their own identification keys		
GTIN (product) **950110153**1239	GIAI (asset) **950110153**41234567890	GLN (location) **950110153**0003

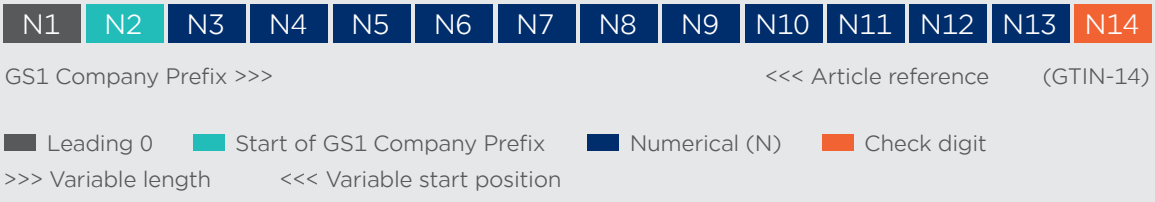
The link between GS1 Company Prefix (GCP) and GS1 identification code

2.2 Global Trade Item Number (GTIN): the global article number

Companies themselves can generate the Global Trade Item Number (GTIN) on the basis of their GS1 Company Prefix. **Each GTIN is unique – the global equivalent to a company's internal material number**. Companies therefore often map their internal material numbers to the GTIN. This enables them to continue using their material numbers for internal purposes but use the GTIN for intercompany business processes.

One of four formats may be used for the Global Trade Item Number (GTIN). **The most commonly used format is the 13-digit GTIN**. The GTIN is encoded as 14 digits in the GS1 data carrier. In the example here, a leading 0 is added to the 13-digit GTIN. In their databases, users should always allow a 14-digit format for the GTIN.

Structure of a 14-digit GTIN



2.3 Global Individual Asset Identifier (GIAI): one number for each asset

The GIAI is used as the unique identifier for each individual asset. Each asset is assigned one single GIAI which is used throughout the asset's life cycle as the access key to all information stored about that asset, such as installation information or the maintenance history. **In the rail industry, this identification number is intended for use on objects that are already in use.**

Like the GTIN, the GIAI is based on the GS1 Company Prefix of either the owner or the manager of the asset. This includes manufacturers who issue and assign identifiers that remain valid for the entire life cycle of a product.

The GIAI together with the GS1 Company Prefix may consist of 30 alphanumerical characters. The structure is at the descretion of the company which owns or manages the object. The European rail industry has agreed on a uniform structure for this purpose (see "AutoID in RAIL" application standard).

Structure of a GIAI

GS1 Company Prefix >>> <<< Object reference >>>

Start of GS1 Company Prefix Numerical (N) Alphanumerical (X)

i= Variable position number ≤ less than or equal

2.4 Global Location Number (GLN): unique company identifier

The GLN is a 13-digit numerical GS1 identification code that uniquely identifies the company worldwide. Like the GTIN and GIAI, the GLN also includes the GS1 Company Prefix. It describes legal entities, functional units or sites such as the location of the final recipient of goods consignments. It also represents companies in electronic data interchange.

Structure of a GLN

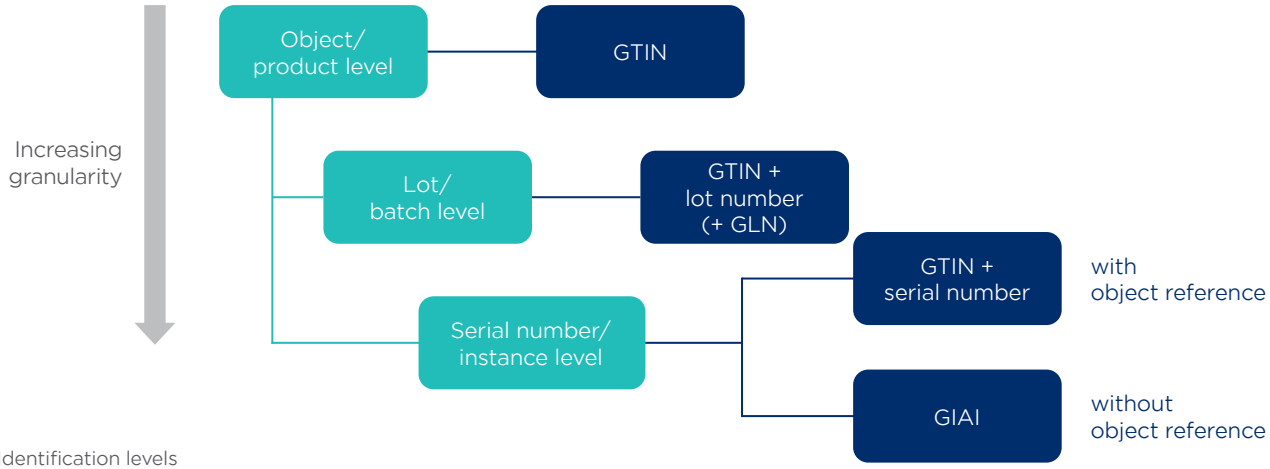
GS1 Company Prefix >>> <<< Location reference

Start of GS1 Company Prefix Numerical (N) Check digit

<<< Variable start position >>> Variable length

2.5 Identification levels: a question of granularity

Depending on the required level of granularity of the information, the GS1 system distinguishes between different identification levels: object or product level, lot or batch level, serial number or instance level.



Identification levels

On the **object or product level**, all objects are assigned the same GTIN and have identical characteristics (master data). On the **lot or batch level**, a smaller unit is identified by the same GTIN belonging to one batch (or lot) with identical production-specific characteristics. These characteristics may include the production date or manufacturing batch number.

Finally, on the **serial number or instance level**, each individual unit can be distinguished from other individual units by their serial number. The assignment of serial numbers enables the life cycle management of individual objects. Thus all the data relevant to the individual object including, for example, operating times, speeds and maintenance or repair work can be recorded and stored. **There are two options for identification at the serial number level**. The key characteristics are summarised in the table below.

	GTIN + serial number (SGTIN)	GIAI
Why is the key issued?	Object that can be ordered, priced and calculated as a trade item, supplemented by a serial number	Asset
Who issues the key?	Brand owner, manufacturer, owner of the technical specification	Owner or manager of the asset
Includes object reference?	Yes	No
Can it be used for ordering?	Yes	No
Can it be used for life cycle management?	Yes	Yes

Differentiating characteristics of identification options

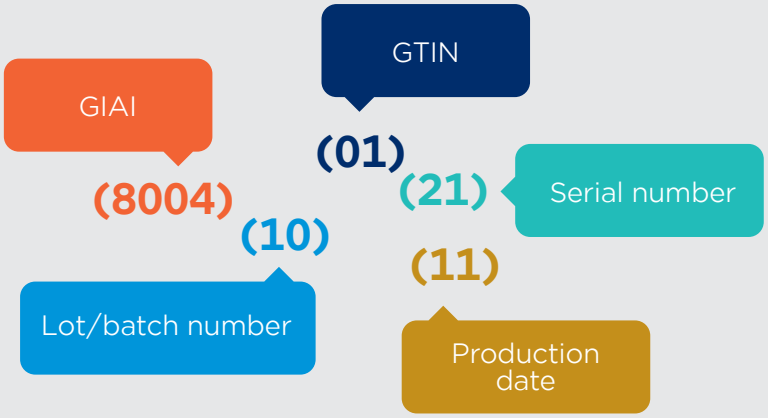
2.6 GS1 Application Identifier: standardised data elements

Alongside identification numbers such as GTIN and GIAI, GS1 barcodes, GS1 2D codes and EPC/RFID transponders are used to encode additional information. A standardised structure is needed for these data carriers so they are uniform and can be clearly interpreted by all stakeholders in the global value chain.

Within the GS1 system, this uniform structure is provided by the **GS1 Application Identifier concept which describes the meaning, structure and function of the individual data elements**. The Application Identifier (AI) itself is a two to four digit number at the start of a data element.

You will find an exact description of the individual GS1 Application Identifiers as well as the dependencies and possible combinations of different Application Identifiers in the GS1 General Specifications.

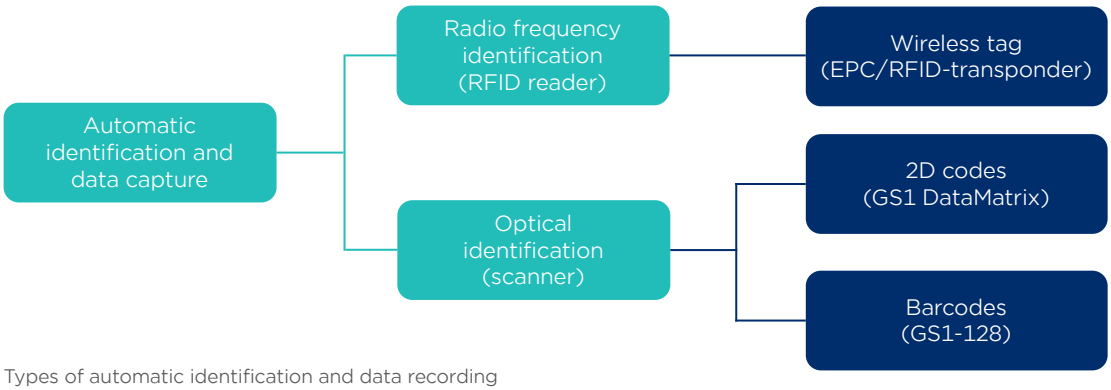
Meaning of some GS1 Application Identifiers (AIs)



2.7 Labelling: various types of automatic identification

The GS1 identification numbers and additional information can be encoded in different GS1 data carriers, for example in one- and two-dimensional (bar)codes or in EPC/RFID-transponders.

The GS1 DataMatrix, GS1-128 barcodes and EPC/RFID-tags are used to label parts, components, packaging and assets in the rail industry.



Types of automatic identification and data recording

The choice of the corresponding GS1 data carrier depends on various factors such as application and processes in the value chain, environmental conditions or the available reader infrastructure.

2.8 GS1 DataMatrix: a lot of information in a small space

The GS1 DataMatrix is a two-dimensional code for labelling parts and components. It encodes the data in a relatively small space and is suitable for the direct marking of metallic objects. Thanks to its error correction mechanism, these codes can be read even if they are partially damaged. The data elements are encoded according to the GS1 Application Identifier concept. The DataMatrix codes can be read using an image scanner.

GS1 DataMatrix

GTIN und serial number

(01)09501101531239
(21)Abc12345678790

GIAI

(8004)95011015341234567890

2.9 GS1-128: the logistics barcode

The GS1-128 barcode is used in logistics. One-dimensional barcodes need more space than 2D codes but can be read by any scanner. The GS1-128 barcode is also based on the GS1 Application Identifier concept. It should be noted that one-dimensional barcodes are not suitable for direct part marking.

GS1-128 with GTIN and serial number

2.10 EPC/RFID: reading information contact-free

Radio frequency (RFID) technology allows data capture where there may be no visual line of sight between the reader and the data carrier. **In addition, RFID tags are more suitable for rugged, dirty and harsh environments over the traditional barcode.** An RFID reader can read multiple tags in a bulk and thus relatively quickly. The content is encoded via the Electronic Product Code (EPC) following the GS1 Application Identifier concept.

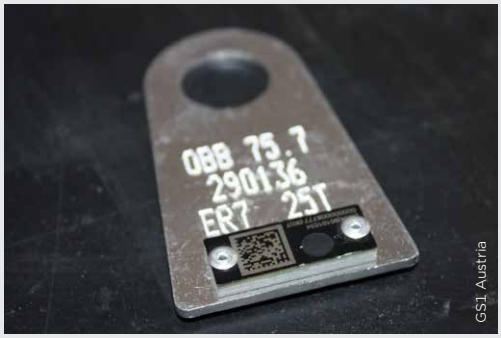
Today, RFID technology plays an important role in identifying parts and assemblies in the rail industry. Passive **UHF transponders** are used widely, and they need no independent energy source but are activated by the reader.

Symbolic representation of a UHF transponder

2.11 Practical examples of labelling

The photos below show examples of data carriers with GS1 identification numbers used by various manufacturers in the rail industry.

Labelling of objects in the rail industry (vehicles, parts, components, infrastructure)



3 Data sharing

Since 2016, the rail industry in the DACH region (Germany, Austria and Switzerland) and France have been using GS1 Standards for the identification and labelling of components and parts. This harmonisation is an important step towards greater efficiency in material management.

The adoption of GS1 Standards has also created the basis for data sharing in the rail industry. A distinction is made between two different levels: event data, i.e. all the data collected during the life cycle of a physical object, and master data, which can include static data such as product descriptions.

The tools required for data sharing can also be categorized correspondingly:

- Event data: Electronic Product Code Information Services (EPCIS)
- Master data: Global Data Synchronization Network (GDSN)

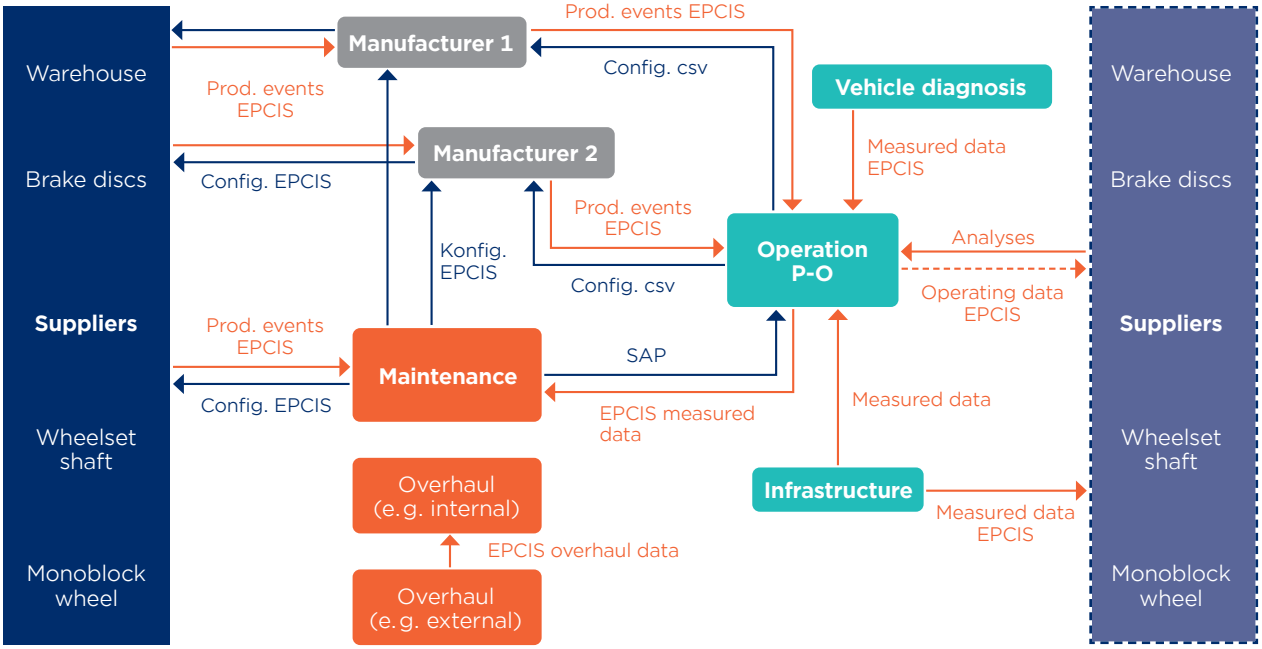
3.1 EPCIS: sharing event data

EPCIS is the main tool for data sharing in the rail industry. **It is an interface standard for sharing data between companies**. Thus, events taking place throughout the life cycle of an object can be captured, shared and evaluated. This results in the **intercompany life cycle management** of the product that benefits both customers (profitability of the asset) and manufacturers (compliance with specifications). For example, EPCIS can locate an object's current location in real time (tracking) and retrospectively follow the route it has taken (tracing).

When data is provided in the EPCIS format, it is categorised on the basis of four criteria: what, when, where and why. This produces a uniform picture of each observation about a specific object. For technical industries, one particularly attractive aspect of EPCIS is the high degree of transparency. If required, all the maintenance, repair and overhaul (MRO) operations performed during the life cycle of a product, assembly or asset can be gathered and communicated.

The Core Business Vocabulary (CBV) Standard complements EPCIS. It specifies and defines the vocabulary to be used with EPCIS.

The use of EPCIS is **supported by the GS1 Global Traceability Standard**. This standard considers the entire value chain, including upstream and downstream partners such as the providers of maintenance or spare parts, and helps companies to achieve traceability and transparency.



EPCIS events between stakeholders in the value chain

The stakeholders have already defined **two application standards** (see References) for the specific application of EPCIS in the rail industry. Alongside operators and the manufacturers of components, the stakeholders involved are system manufacturers, system integrators and the providers of repair, maintenance and overhaul services. The common goal is to **use EPCIS to make vehicle diagnosis data or the life cycle of trains visible**. It should facilitate and optimise three things in the future:

1. Trace and locate goods en route
2. Improve the availability of vehicles
3. Estimate the distance covered to enable the planning of predictive maintenance

A further goal is to **link the data from the vehicles with the data from the Wayside Train Monitoring System (WTMS)**. This will ensure further progress in the predictive maintenance of vehicles and components.

One of the key steps in establishing EPCIS is drawing up lists of characteristics for sharing the data about specific components (e.g. wheel bearings, wheelsets, bogies).

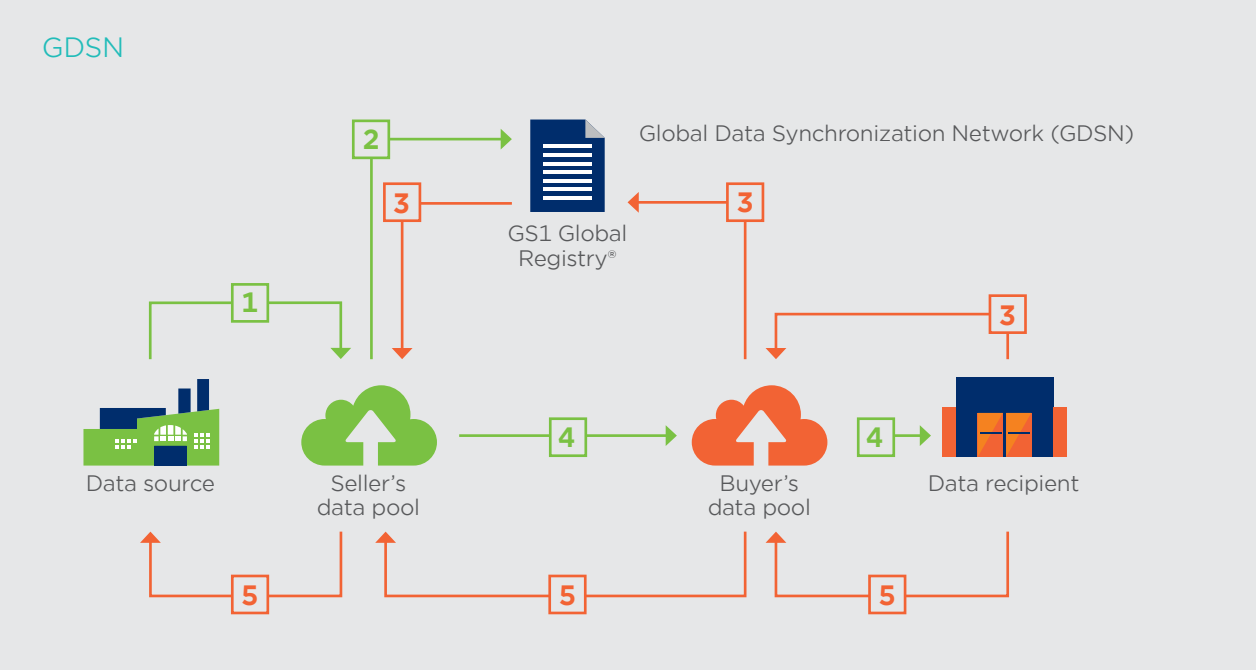
In principle, it is a question of using EPCIS-compliant data collection to make an object, labelled with a GS1 identification key (SGTIN or GIAI), both visible and interpretable to everyone. This ensures traceability at all times.

3.2 GDSN: sharing master data

In the rail industry, there is still no standard for collecting the master data of rail industry products and sharing these with other market stakeholders using structured formats. For this reason, the Australasian Railway Association (www.ara.net.au) launched the project iTRACE material master data initiative in 2019. In addition to identification and data collection there are two main goals for data sharing:

1. Definition of master data attributes for railway industry products; a total of 72 master data attributes were defined for this purpose.
2. Agreement of a method for sharing master data electronically between the systems operated by the various partners involved;

Master data will be shared via the National Product Catalogue which is part of the Global Data Synchronization Network (GDSN).



4 GS1 Standards in technical industries

The global GS1 Standards are mature and have been used for consumer goods for decades and already benefit many sectors. **The Rail industry's initiative for the adoption of global standards is a new departure for this industry, GS1 Standards are a low risk, robust, tried and tested framework that will benefit this and other technical sectors.**

4.1 Examples in related industry sectors

The examples given below provide insights into existing and planned uses in related industry sectors. They clearly show that the manufacturing and supplier industry especially can benefit from the harmonisation of requirements.

The **automotive** industry has been using GS1 Standards for many years to prevent counterfeiting in aftermarket parts. Serial GS1 DataMatrix symbols can be checked for authenticity via a database connection. To date, more than one billion codes are available for checking. Users include Continental, MANN+HUMMEL and Schaeffler.

In **machinery and plant engineering**, the focus is on the implementation of Industry 4.0 solutions in particular. The basis for this is the ability to uniquely identify products, components, containers and machines. A globally valid and widely accepted language like that provided by GS1 is essential.

- **DIN SPEC 91406** concerns the automatic identification of physical objects and their information in IT systems – especially IoT systems. As IoT systems are about making web-based information available, GS1 Standards and the GS1 Digital Link have been included in the specification. Work started in spring 2021 to develop the DIN SPEC into an ISO standard.
- **Germany's Mechanical Engineering Industry Association (VDMA)** also uses GS1 Standards for tracking, tracing and life cycle management. VDMA Standard Sheet 354193 (serialisation/labelling of tools and tool clamping systems) defines the GTIN and serial number as the identifier for labelling precision tools, describes the necessity for unique identification and labelling and offers examples of solutions using the GS1 Standards.

The German army (Bundeswehr) took a similar route like the rail industry several years ago. In its technical supply specification TL A-0032, the German Ministry of Defence specified that an AIT element should be applied on all supply items. AIT stands for Automatic Identification Technology and strictly follows GS1 specifications and requires the use of a GTIN.

4.2 Outlook

As a result of increasing digitalisation and the growing significance of solutions for sustainability, the GS1 Community is working together with companies to develop global cross-industry solutions that resolve the challenges they face.

GS1 Digital Link connects GS1 identification numbers with the Internet so that information can be made available via a specific link and amended in the target system at any time without having to renew the link. As well as **standardising the link structure**, there is a further big advantage. At GS1, the link and associated redirects are managed directly by the code managers. This ensures the reliability and strength of the link as well as its independence from the target system.

As part of the **Green Deal**, the EU has the goal of making the European economy climate neutral by 2050 and achieving existing emissions targets. Digitalisation is one of the initiative's key enablers that will improve access to product data. The focus here is on the **Electronic Product Passport** which should contain all information (origin, composition, instructions for installation, deinstallation and repair). For the **construction industry**, using open GS1 Standards would mean that all relevant planning, manufacturing, operating, safety and maintenance data could be clearly assigned to a building for the entire life cycle of a product. For example, the information relevant to modification or demolition (e.g. recycling and reuse) would make it possible to return valuable resources to the economic cycle.

5 References

Application guidelines

- Identification of components and parts in the rail industry – application standard
- AutoID in RAIL – European application recommendation
- GS1 EPCIS for Rail Vehicle Visibility – application standard

GS1 Standards

- General GS1 Specifications
- GS1 RFID/Barcode Interoperability Guideline
- Core Business Vocabulary Standard
- EPC Information Services (EPCIS) Standard
- EPCIS and CBV Implementation Guideline
- EPC Tag Data Standard
- EPC™ Radio-Frequency Identity Protocols Generation-2 UHF RFID Standard

ISO Standards

- ISO/IEC 16022: Information technology; automatic identification and data capture techniques; Data Matrix bar code symbology specification
- ISO/IEC 15417: Information technology; automatic identification and data capture techniques; bar code symbology specifications; GS1-128 symbology specifications
- ISO/IEC 29158: Information technology; Automatic identification and data capture techniques; Direct Part Mark (DPM) Quality Guideline

GS1 – The Global Language of Business

GS1 provides a globally unique identification system for locations, articles, logistic units, etc. The GS1 system is the basis for the electronic exchange of business data and the standardisation of intercompany communication and business processes. GS1 links the flow of goods with the flow of information, making business processes faster, less costly and more secure. GS1 has some 2 million members in more than 150 countries worldwide. More than 5 billion barcodes are scanned every day. GS1 is a non-profit organisation that was established in 1977.

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