CLEARSY DATA MANAGER
Tools & Services: a global offer

CLEARSY
Safety Solutions Designer

DATA EDITION, GENERATION
& FORMAL DATA VALIDATION
CLEARSY DATA MANAGER

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In railway signaling, large quantities of data are produced to represent the track and associated objects, and to parameterize railway signaling systems. This **data must be carefully designed, generated and validated**, as it (in part) guarantees the safe operation of signaling systems. As a pioneer in this field, CLEARSY has developed tools based on formal methods to ensure the secure and reliable validation of this data.

With the introduction of the European Rail Traffic Management System (ERTMS), rail operators must revamp many legacy tracks to meet the latest standards. These tracks, often decades old, are not stored in digital databases but are instead documented on paper or as digitized plans in PDF format. **How to make this revamping and its verification less expensive & safer?**

Managing existing infrastructure and planning the development of railway lines in a modern, computer-assisted manner presents significant challenges. This requires manual data verification and validation, making the process labor-intensive and complex, with a high risk of errors and prolonged timelines.

To comply with the CENELEC **EN50128** standard and achieve the highest safety integrity level for railway projects (**SIL4**) automating the development and validation processes for both existing (brownfield) and new lines (greenfield) is now crucial.

To enable an **optimized and secure data management** process, it is essential to address the following needs:
- Translate a "paper" track plan, whether in picture or PDF format into a digital twin.
- Map the necessary tracks' objects
- Automatically generate equipment positions and parameters according to the system requirements (ERTMS or CBTC)
- Securely validate that the generated data complies with all system requirements and safety application conditions

CLEARSY DATA MANAGER

With over twenty years of experience in the railway industry, CLEARSY is proud to offer a **complete solution** that meets all these needs through its tools and services, including the **CLEARSY DATA SOLVER T2 certified tool**.

This solution is modular, and each product can be complemented by services designed to assist and support customers in their development or validation efforts. Four key features are highlighted, each enriched by CLEARSY's past experiences and projects:
- A railway track editor to create or edit the scheme plan
- Automatic data generation to fill a database
- Formal data validation of the database
- Visualization of all the defects (if any) on the track plan using the editor's view to help the analysis

This global data management approach speeds up the deployments of railway lines and increases the level of confidence in their safety.
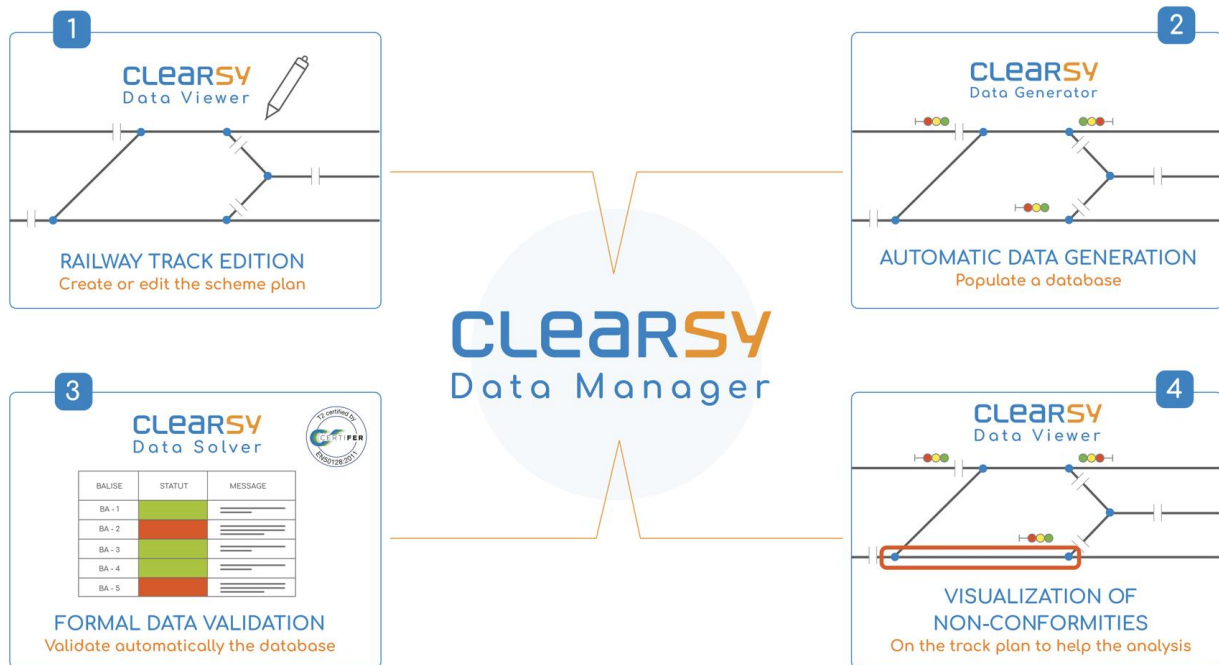
Graphical representation of the CLEARSY's tools

BENEFITS AND RETURN ON INVESTMENT

- **Automation and speed:** Fully automated verification process, guaranteeing considerable time savings
- **High Return On Investment:** thanks to its modularity and reusability, only few project/version iterations cover the initial investment
- **Customized tool:** HMI and reports can be specifically adapted to meet precise needs
- **Increased reliability:** the validation tool is T2 certified, and the rule creation process has been independently assessed to meet SIL4 project safety requirements
- **Modularity:** possibility of adopting a single tool and/or service according to project needs. Also, validation rules are independent from each other i.e. adding or removing a rule does not affect the other ones
- **Knowledge capitalization:** transformation of verification principles into clear written specifications and then into reusable formal rules, favoring the sustainability of expertise
- **Industry adoption:** formal data validation is now the standard required by operators such as SNCF and RATP, and used by key suppliers such as Alstom, Siemens, and Hitachi

TOOLS & SERVICES ASSOCIATED WITH CLEARSY DATA MANAGER SOLUTION

CLEARY DATA VIEWER: railway track edition

The railway track editor enables to design new railway lines or redesign existing ones and associated equipment through:

- **Data manipulation:** import, display, and adjust data on an interactive track plan
- **Object management:** draw tracks, add, modify, and delete objects or equipment as needed
- **Display customization:** use a customizable icon library to adjust the visibility of elements, ensuring clear and tailored visual representations
- **Background image:** import a PDF or image as a background layer to help the operator redesign existing lines
- **Navigation assistance:** enjoy simplified navigation with a global overview and zoom indicators for precise editing

This product streamlines the editing process, enhancing productivity and user experience.

Proposed services:

- **Specific functionalities developments**
- **Customer operators training**

With several years of experience in track editor developments, our teams understand easily the operator's needs.
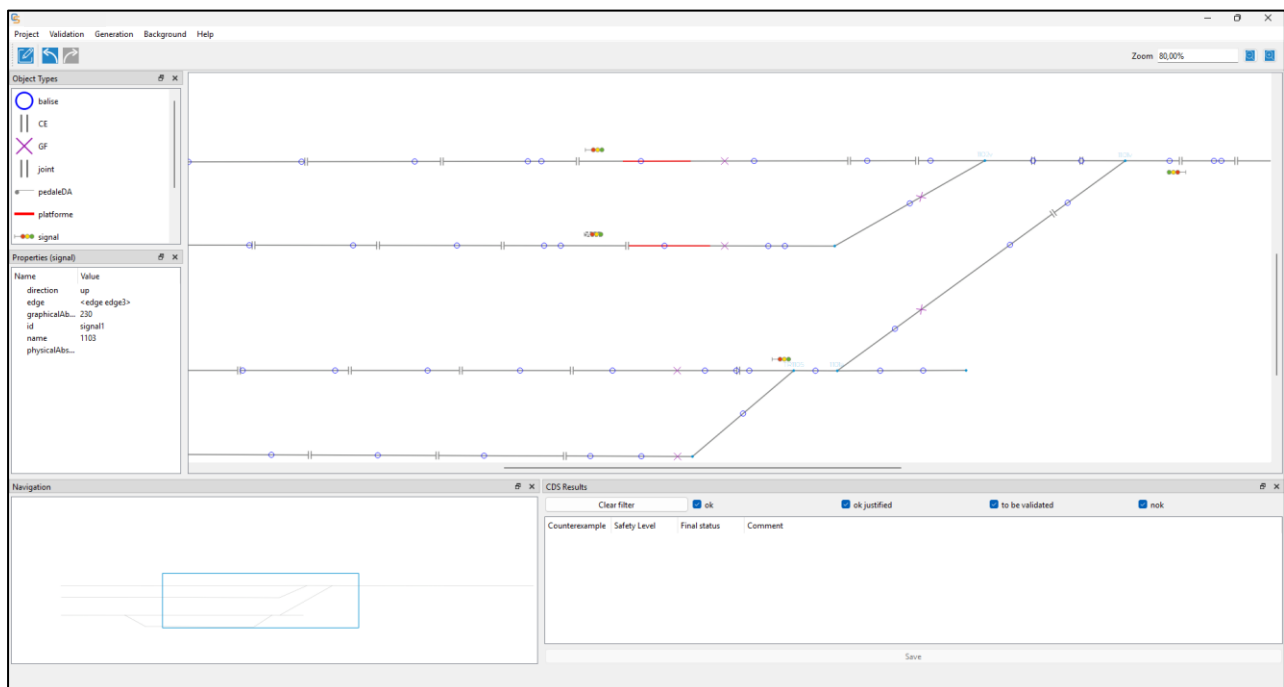
View of the track edition tool of the CLEARSY DATA MANAGER

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CLEARSY DATA GENERATOR: equipment positioning

In the case of new projects (greenfield) or existing lines renovations (brownfield) equipment shall be positioned with respect to the signaling constraints and deployment rules. The CLEARSY DATA GENERATOR automatically fills a database by following predefined rules or constraints.

- **Logical execution of generation rules:** the generation is ordered according to the inputs/outputs of each rule, enabling a progressive and structured data generation process
- **Language independence:** any computer language can be used to develop the generation rules. Existing scripts / programs can be reused / mixed within this tool
- **Modification detection:** if data is manually or externally modified after generation, the tool automatically identifies the affected generation step and resumes the process from that point, avoiding full regeneration. This ensures complete and consistent data generation
- **Runs on a laptop:** No specific computer is required to use this tool; any standard computer is sufficient

This automated approach simplifies the management of standard cases, allowing users to focus on complex scenarios that require in-depth business expertise.

Proposed services:
- **Generation rules development**
- **Customer operators training**

CLEARSY developers can assist customers or independently create these rules.
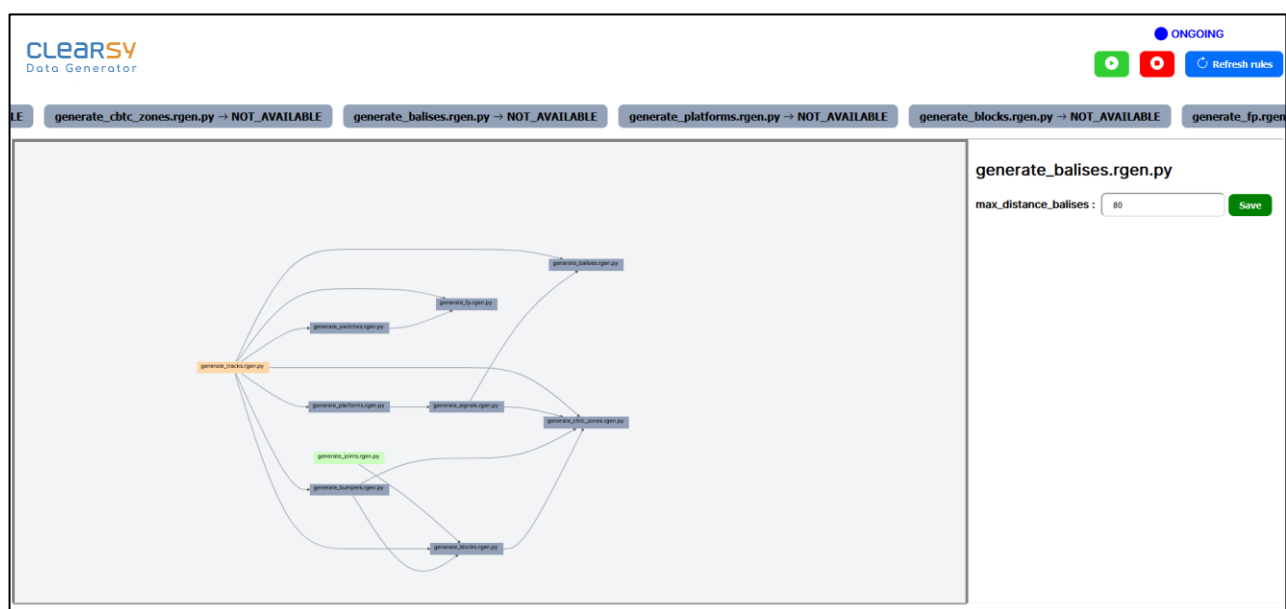

View of the CLEARSY DATA GENERATOR with display of dependencies between generation rules

CLEARSY DATA SOLVER: formal data validation

This tool, the core of the CLEARSY DATA MANAGER, is a **T2-certified** formal data validation tool developed by CLEARSY over several years.

- **Tailor-made tool:** any data format can be validated (XML, XLSX, parameter files, RailML, CSV, TXT, etc.), and a custom user interface (UI) can be developed based on customer needs upon the CLEARSY DATA SOLVER, the T2-certified tool. The output report can be modified according to customers' needs

- **Fast and comprehensive analysis:** in just a few seconds, a rule identifies non-conformities for static data (configuration data, ERTMS telegram content)

- **Detailed reports:** for each case of non-conformity (NOK), the tool generates clear messages (in any language), with full traceability of the data entered

- **Data coverage:** reports show the status of each data point (OK, NOK, or Untested) concerning selected safety constraints, providing a clear and comprehensive overview

- **Runs on a laptop:** no specific computer is required to use this tool; any standard computer is sufficient. Non-regression analysis can be planned nightly on a server to assess the impact of a new project's version

Thanks to its precision and certification, the CLEARSY DATA SOLVER is a reliable and powerful tool to ensure data configuration compliance with safety requirements. It becomes easy for an operator to repeat validation and avoid human errors.
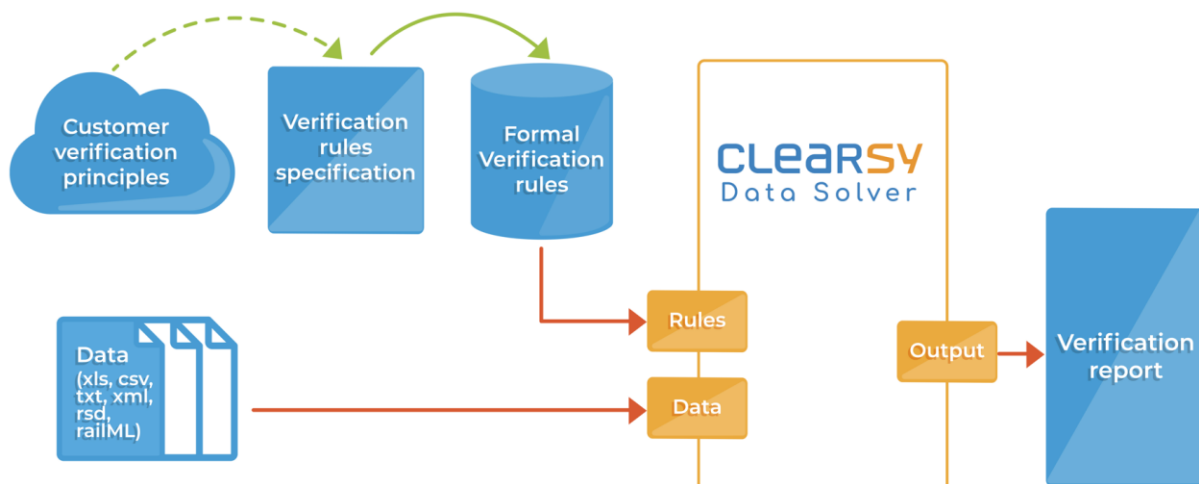
View of the formal validation process with the CLEARSY DATA SOLVER

Proposed services:

- **Formal rule design:** development of the formal rules that the data must comply with
- **Specification of described rules:** each rule's detailed verification is written in plain English (or French) to avoid a black-box effect when using the tool. The rule descriptions provide context for operators conducting the analysis, ensuring clarity and transparency
- **Readability and accessibility:** the formal models are easily understandable after appropriate training
- **Ownership and reusability:** the formal rules are fully owned by the client, allowing them to be reused in different project iterations and future projects
- **Training**: to help the operators specify their safety constraints, handle the tool, read and modify the formal rules
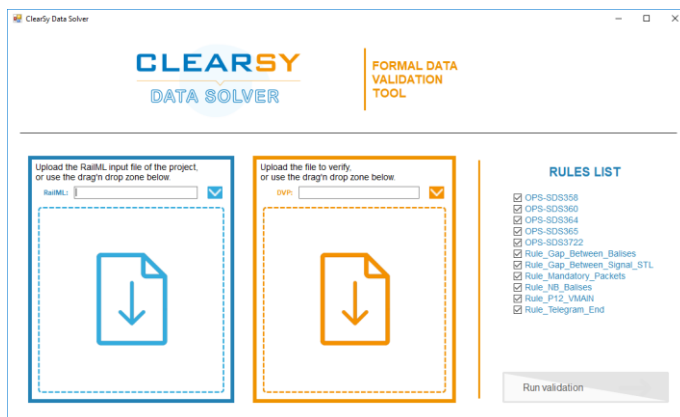
View of a standard HMI

The validation tool is certified T2 according to CENELEC EN50128.

CLEARSY DATA VIEWER: non-conformities analysis

Although the non-conformities messages (NOKs) generated by the formal validation are self-explanatory and written in plain English (or any human readable language), the safety analysis required to evaluate their impact can be considerably simplified thanks to direct visualization of problem cases in their context on the track plan.

- **Simplified navigation:** by clicking on a non-conformity message, the view automatically focuses on the object concerned, facilitating identification of the critical areas to be analyzed

- **Contextual visualization & risk assessment:** this approach enables the user to determine whether the non-conformity (NOK) is the result of an error to be corrected or a justified exception, and to explain the reasons

- **Easier collaboration:** users can write comments or justifications directly next to each non-conformity message. Completed reports can be saved, shared and imported again, optimizing communication between validation and data preparation/on-site teams hence simplifying anomaly tracking

This feature saves a significant amount of time, while improving accuracy and collaboration across the teams.

Rule		Rule_Distance_Balises		
Status		NOK		
Runtime		0:00:07		
Safety Level		SIL4		
Data Verified		0		
Number of OK		2		
Number of NOK		2		
Errors				
Status		Message		Location
				Rule Details
Verify Index	Status	Message	Final status	Comment
2	NOK	There is no balise 140.00m from the balise "balise15" on the edge "5" at position "70.00" along the following edge path [5] in the END direction.	OK justified	Special case	-
2	NOK	There is no balise 140.00m from the balise "balise16" on the edge "5" at position "230.00" along the following edge path [5] in the BEGIN	NOK	Should be moved	-
1	OK	-	-	-	-
2	OK	-	-	-	-

View of CLEARSY DATA SOLVER report exported with the comments added in the tool

Proposed services:

- **Customer operators support training & services:** CLEARSY has several years of experience analyzing non-conformities (NOKs) on CBTC & ERTMS projects. A lot of engineers work daily at CLEARSY to help our customers to assess the criticality of the identified NOKs and to understand their impact on safety
- **Specific functionalities developments**
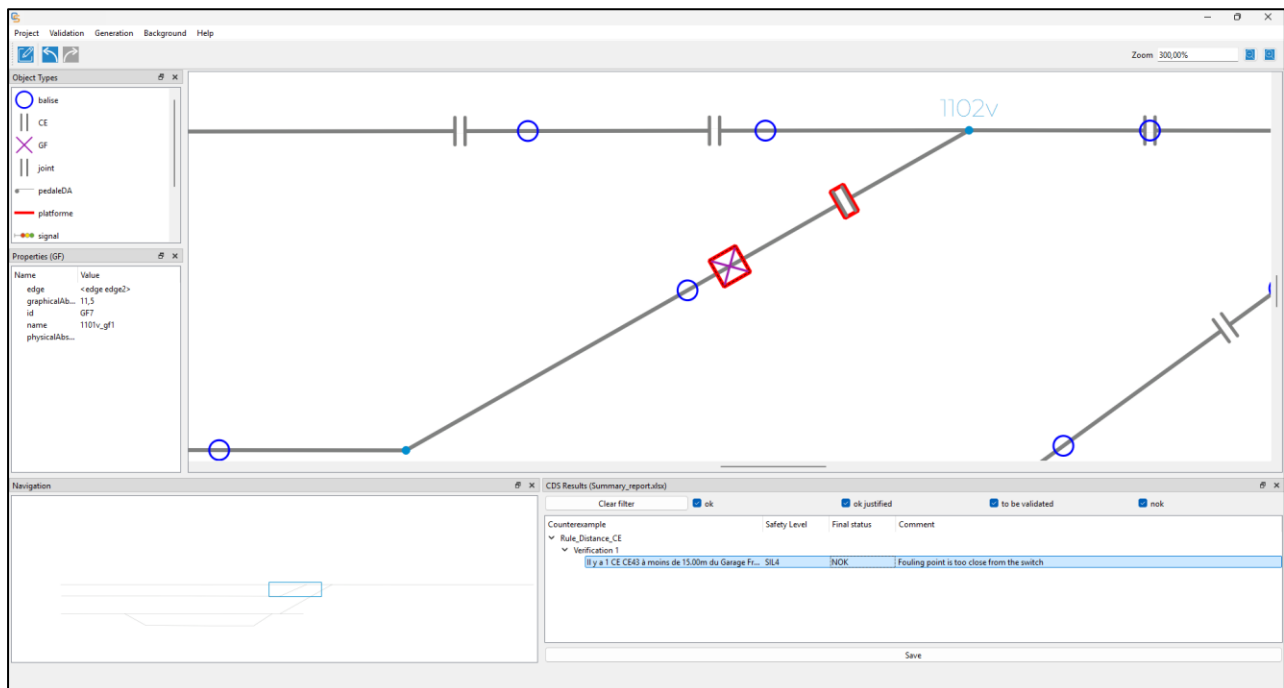
View of CLEARSY DATA SOLVER non-conformities messages (NOKs) visualized in red on the track plan using the CLEARSY DATA VIEWER

REFERENCES

The customers are railway or subway operators, or industrial companies.

ALSTOM   SNCF RÉSEAU   EVIDEN an atos business

setec   HITACHI Inspire the Next   RATP

SIEMENS

SNCF

- Since 2018
- ERTMS track data for freight corridors (ETCS): Tool and rules
- ETCS Baseline 2 level 1 with KVB fallback
- Compatibility for B3 braking curves

RATP: CBTC OCTYS: Tool and rules

- Since 2021
- Use of CLEARSY DATA SOLVER
- OCTYS lines data configuration verification
- L14 validation for Paris Olympic Games

EVIDEN and SNCF (ATS Mainline) parameters of MISTRAL NG (new centralized command/control rail management system): Tool and rules

- Since 2017
- Specific tool, customized by CLEARSY for ATOS and SNCF
- Improved performance, new features: client-server architecture connected to a database of parameters to validation
- Rules designed; Additional rules designed specifically for SNCF (final customer)

ALSTOM
- Since 2012
- More than 15 complete CBTC projects verified
- One ERTMS Level 1 project verified
- 2000+ validation rules designed + training
- Tailor-made HMI with special features
- Development of Alstom track plan editor: RIGHT

ALSTOM

SETEC
- Since 2022
- Interlocking data verification
- LGV+ ERTMS Level 2 project

setec

SIEMENS
- Since 2018
- Formal validation of graphical objects for ATS and ATS+ projects (Mainline)
- Workshops on rules specification definition
- Automatic validation of objects installation on-site
- More than 6 complete CBTC projects verified
- System analysis of parameterization errors

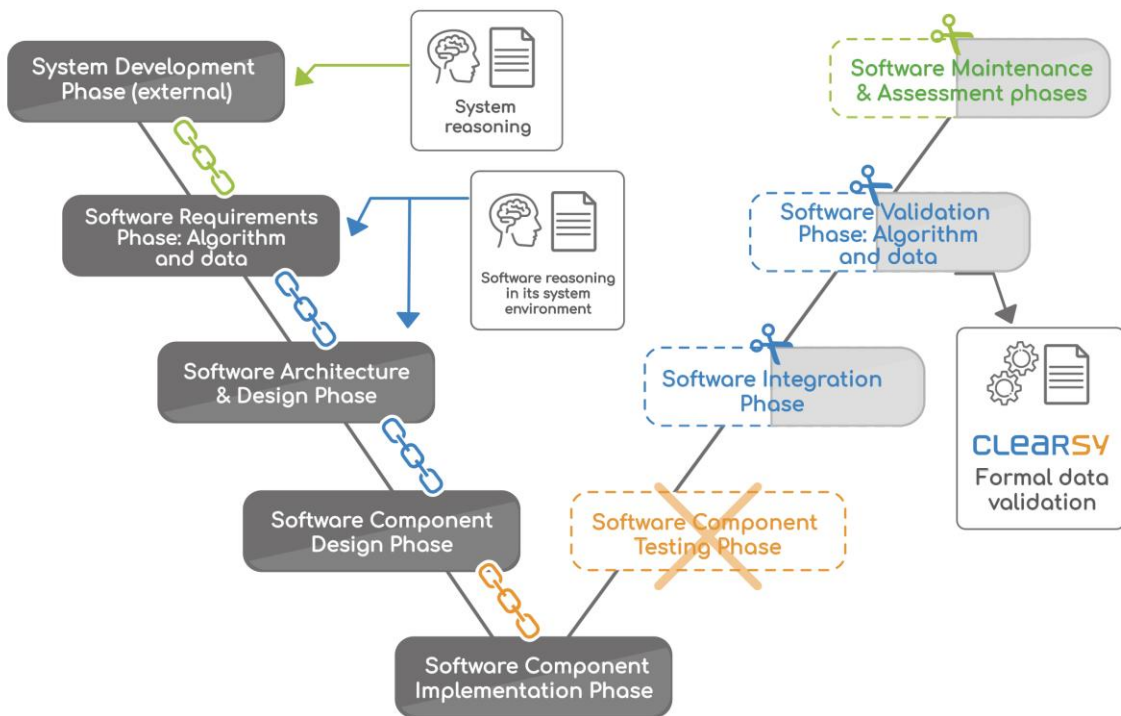**SIEMENS**

HITACHI (former Thales Toronto)
- Since 2019
- Generic rules developed (high reusability level)
- Project specific rules designed
- Operators training + tailor-made HMI with special features
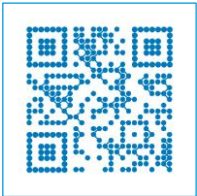
HITACHI
Inspire the Next

SERVICES

Re-engineering of signaling schematics / track plans
Development of generation rules to enrich track plans
Development of formal validation rules to verify data
Analysis of non-conformities and support for the drafting of validation documents and any restrictions during testing or commissioning
Customization of the tools for the own customer's needs

Formal activities through the V cycle

System Development Phase (external)

System reasoning

Software Requirements Phase: Algorithm and data

Software reasoning in its system environment

Software Architecture & Design Phase

Software Component Design Phase

Software Component Implementation Phase

Software Maintenance & Assessment phases

Software Validation Phase: Algorithm and data

Software Integration Phase

Software Component Testing Phase

CLEARSY Formal data validation

✂ Activity reduction
🔗 Formal Proof

▬ Formal Proof at system level
▬ Formal Proof at equipment level
▬ Formal Proof at software level