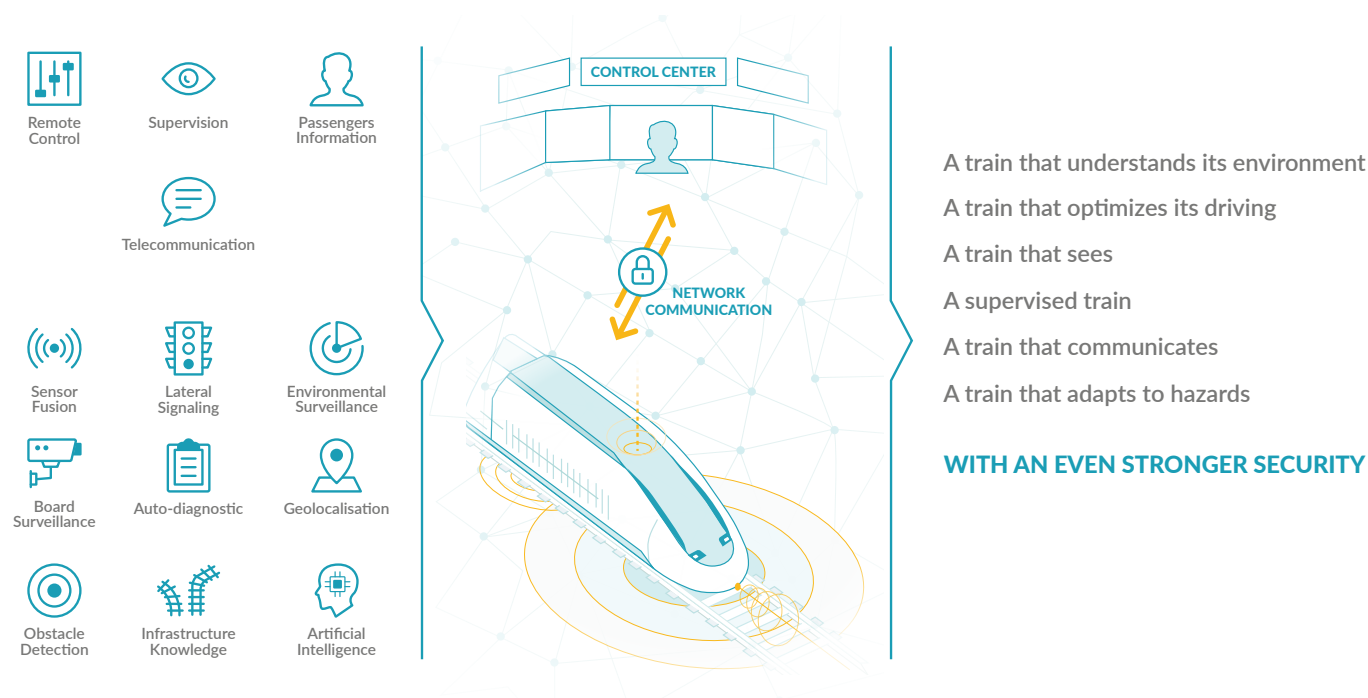A U T O N O M O U S   T R A I N

Collaborative work in a consortium with Capella

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"Models shared between partners, allowing quick start, effective communication and facilitated collaboration for a complex project.

Context

TRAIN AUTONOME - SERVICE VOYAGEURS is a project conducted by a consortium gathering several companies (Bombardier, Robert Bosch, Railenium, SNCF, SPIROPS and Thales) with the objective of realizing a prototype of autonomous train carrying passengers running on the SNCF existing infrastructure.

Remote Control

Supervision

Passengers Information

Telecommunication

CONTROL CENTER

NETWORK COMMUNICATION

Sensor Fusion

Lateral Signaling

Environmental Surveillance

Board Surveillance

Auto-diagnostic

Geolocalisation

Obstacle Detection

Infrastructure Knowledge

Artificial Intelligence

A train that understands its environment

A train that optimizes its driving

A train that sees

A supervised train

A train that communicates

A train that adapts to hazards

WITH AN EVEN STRONGER SECURITY

The consortium is simultaneously facing strong industrial constraints and technical challenges. 28 work packages are spread between the different partners.

Some constraints on the solution

- Different levels of autonomy are required (from GoA1 to GoA4 Grade of Automation)
- Trains must have the ability to make decisions
- No change on the existing infrastructure such as tracks or train station
- Adaptive to different rolling stocks
- Compatibility with ETCS (European Train Control System)

Technical challenges

- Safety demonstration with on-board Artificial Intelligence
- Autonomous Hazard management
- Communications for remote driving (TC-Rail)
- Cybersecurity
- Mapping-positioning performance
- Qualification of the obstacle detection

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Solution

Arcadia and Capella are used to support three main objectives:

- Capture the operational need and opportunities
- Share a common view of the future solution between the partners
- Clearly define the responsibilities and contributions of each partner

Modeling occurs at three engineering levels. The Capella system-to-subsystem transition add-on is used to continuously synchronize the different models.

1. **A global Autonomous Train system model, addressing Rolling Stock + autonomous driving system.** Operational Need Analysis and System Need Analysis capture what is an autonomous train and its main concepts. The Logical Architecture specifies the responsibilities and interfaces of the Onboard/Trackside Autonomous Driving System and the Rolling Stock.

2. **Three models: Onboard Autonomous Driving System, Trackside Autonomous Driving System and Rolling Stock.** A particular focus is put on the Onboard Autonomous Driving System, and in particular on the formalization of the building blocks allocated to each partner.

3. **One model per building block.** Each partner manages its subsystem model freely within the interfaces defined in the Autonomous train system model or the Onboard Autonomous Driving System model depending on the building blocks for which they are responsible.

Result

The Executive Board of SNCF for the Autonomous Train project has noted the great quality of the consortium outputs.

In a context of this particularly innovative project, Arcadia and Capella help to:

- Secure a shared vison between the different partners of what is the autonomous train and how it operates,
- Define the workshare repartition between partners
- Justify key decisions

On a more daily basis, only a minimum of training/coaching has been necessary to enable a collaborative modeling in Capella involving both the customer and the partners. Thanks to the Arcadia integrated method, system engineering activities are guided and structured. The consortium was led to put the focus primarily on the user needs and the system definition, while typical engineering practices would have led to quickly to technical, solution-related discussions.

The outputs of this modelling effort are appreciated and make this complex system understandable to all the stakeholders, thanks to easy-to-read diagrams showing the appropriate level of details.

In 2020, model-based engineering is continuing on the project. Key stakes include driving V&V activities from the model and conducting model-based safety analyses.

BOMBARDIER   **BOSCH**   RAILENIUM TEST & RESEARCH CENTER   SNCF   SPIROPS SPIRITUS OPERATIONES   THALES

Capella