



Symptom Agent

Agent-based integration and analysis of semantic monitoring data

Integration of information is a key for further growth of railway transport volume. Decision makers will be able to make better decisions once they have the right information at hand about their own processes and information shared with their business partners for optimized business decisions. InteGRail is the project that developed an enabling technology to allow transparent access to existing information systems, be it databases, monitoring systems or existing user applications. For this purpose InteGRail defined a standard approach for architecture and common information representation on a European scale. Using this standard approach a number of example applications were developed. Semantic monitoring data acquired in the railway domain across Europe can be processed by *distributed symptom agents*. These agents are located on top of the layered data integration architecture. Whereas the lower layers concentrate on information sharing, the symptom agents focus on intelligent monitoring to detect possible malfunctions in the railway domain at an early stage. Symptom agents in InteGRail compare acquired sensor data and their interpretations with the expected information to analyse symptoms in the infrastructure and rolling stock context. Based on these symptoms they can collaborate with each other to derive possible faults using intelligent technologies.



Based on the Distributed Reasoning technology the Symptom Agent offers:

- **collaborative symptom analysis:** collaboration of distributed agents to efficiently detect observations that deviate from expected values
- **context-aware fault detection:** correlation of analysed symptoms depending on the current context provided by other agents in the environment
- **distributed intelligence:** intelligent inference of faults from given symptoms based on distributed data
- **distributed data integration:** utilization of the *Railway Domain Ontology* in combination with the *Distributed Reasoning* technology (see also corresponding fact sheets) to provide seamless data interoperability based on formal semantics
- **strategy abstraction:** capsulation of individual process steps for symptom and fault analysis strategies by collaborating agents with different capabilities
- **support for uncertainties:** consideration of probabilities in the fault analysis process
- **performance:** spreading of computational load between agents using divide & conquer techniques
- **privacy:** stakeholders can apply the need-to-know principle to keep control of exchanged data by defining constraints for agent collaboration
- **extensibility:** support for flexible integration of additional agents with new capabilities (e.g. trend detection and prediction, data mining, rule-based decision making, learning, etc.) with the symptom analysis process

- **scalability:** additional agents with possible new capabilities can be added to the environment at run-time resulting in new capabilities for the overall symptom and fault analysis process

Symptom Agent – An intelligent software process

The symptom agent is a software component, which is able to interact with other agents to analyse particular situations. Especially the **detection of fault situations by correlating symptoms** depending on the current context is an important aspect in the railway domain. For instance symptoms referring to a train door malfunction, which is caused by intense sunlight at a station, might not be interpreted correctly in a shady environment such as in a maintenance depot. In order to properly detect the fault and its root cause in such situations the symptom agent can interact with other agents (e.g. a weather, station or depot agent) to integrate situation-dependent information such as

temperature, wind speed, etc in the interpretation process. For seamlessly exchanging such information software agents can rely on **agent communication and interaction languages** that are standardized by the Foundation of Intelligent Physical Agents (FIPA).

All railway domain stakeholders can benefit

The concept of symptom agents enables **flexible fault detection and root cause analysis** depending on dynamically changing situations anywhere in the railway domain. Situated on top of the layered data integration architecture symptom agents provide a flexible way for interchanging interpreted data sourced from distributed reasoning. All possible stakeholders engaged in **railway condition monitoring across Europe** can profit from the capabilities of the symptom agents. Among others this includes rolling stock and infrastructure management, operations and traffic management.

How the benefit is realised

Effective symptom correlation and fault detection requires **machine-interpretable semantics**. This means, agents that collaborate to infer fault situations must be able to understand the meaning of information they process and interchange with each other. This requirement is fulfilled by the InteGRail data integration architecture. Especially the combination of the **railway domain ontology** with **distributed reasoning** creates an effective basis on which symptom agents can rely on.

Present status, availability and future possibilities

The **layered data integration architecture** comprehensively supports the foundation for deploying symptom agents for supporting condition monitoring and maintenance optimisation in the European railway domain. Even **available agent platforms** can be easily integrated on top of the distributed reasoning layer to fully leverage the capabilities of this technology (see also the fact sheet about distributed reasoning).

Other results of InteGRail

Architecture definition of integrated information systems: IGRIS

Semantic data structure of the railway domain, the InteGRail ontology

Example user applications: ODSS for on-line operational decision support, IAC for on-line infrastructure availability, IDT for on-line vehicle maintenance information

Description of interdependence of performance of railway processes: the railway KPI tree, and a tool to assess and visualise performance

InteGRail - Facts and Figures

InteGRail started on 1/1/2005 and ends on 31/12/2008

Total project budget: 20 million Euros

EC funding : 11 million Euros

Total effort over 125 person-years

39 partners from 11 countries

Partners of InteGRail:

UNIFE • Alstom Transport • AnsaldoBreda • Bombardier Transportation • Siemens Mobility • UIC • Trenitalia • D'Appolonia • TSB-FAV • DeltaRail • ATSF • CAF • Nortel Networks • Laboratori Guglielmo Marconi • FAR Systems • MER MEC • Italcertifer • ATOC • České dráhy • MAV • UNICONTROLS • Strukton Railinfra • Deuta-Werke • Heriot-Watt University • IMEC • OFFIS • Televic • Seebyte • Kontron • University of Chile • INRETS • Wireless Future • University of Birmingham • ADiF • RFF • ARGE Corridor X • Network Rail • ProRail • SNCF

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