PROJECT PROPOSALS FOR THE 2ND CALL OF FP7

(DEC 2007 – JAN 2008)

Template for the project synopsis

1. **Proposal for project name**
   SYMPATICO = **Symp**tom **A**nalysis **t**owards **I**ntelligent **C**oncepts for maintenance **O**ptimisation

2. **Problem that the project will address (why is the project being initiated?)**
   Today railway vehicles and infrastructure show many failures and as a consequence the reliability of the commercial railway service is quite often jeopardized.
   This project is initiated to put the railway operators in the position to achieve the ultimate objective to operate a railway service with the highest values gained from structured symptom analysis, and as a consequence through the minimization of the unplanned line stops and equipment breakdowns.
   This might lead to new concepts in train and infrastructure maintenance.
   In particular this requirement is very strong for driverless vehicle as Metro or Light System.

3. **Scope of the project**
   The project will analyse the actual monitoring data of the infrastructure and in-service vehicles to identify the weakness areas where the efforts will be concentrated.
   Then it will develop common metrics to approach the predictive analysis for a improved generation of railway assets.
   The common objective is to prevent a possible on-line stop of a train, or an equipment breakdown, and define a “new concept of maintenance”.
   A continuous monitoring process is used to systematically analyse the essential asset condition information and will be processed by means of an intelligent mechanisms so as to prevent the faults.
   In this way it will be possible to assure the performance evaluation of the asset and suggest the consequent actions to achieve the previous objectives.
   The Prognostics & Health Management represents the core element that monitors the health state of the equipment and assure automatically and quickly the interview of the logistics flows.
   The core of the project is the predictive diagnosis of the main on-board and infrastructure systems. A good possible project success is an approach that involves all equipment responsible of failures during service. It is important to study directly the main causes responsible of this negative event and not an evaluation of the effect (as today it does in many applications).
   Today it’s very “arduous” to evaluate any data automatically and relate the effect at the causes of the failure because the equipment diagnosibility in many cases is not deepened and the clear semantic of the datasets is not available. This situation often causes operators to be sceptic about sophisticated diagnostic systems in particular when a personal experience of the repairer has to resolve the problems. In this situation also the expert systems are not sufficient.
   The improved approach could change this situation because in this project we would like to propose a specific study to improve the relation between the fail causes and effect.

1. A first step is that to analyse and evaluate each possible cause of a failing train or track system and the equipment responsible of the failure in a consistent model.
2. The second step is to extend the diagnosibility in the equipment so that each symptom that might lead to a failure could be directly identified. After this analysis the logical causality will be clear in the relationships.
3. A final step represents the prevention/predictive extension. For each system it will be possible to anticipate the break-up and probabalistics within the intelligent component monitoring and relate it logically to the potential performance degradation. This phase will represent the true innovation in the project and a very strong opportunity for operators and manufacturers.

The project will cover issues such as:

a. On board continuous monitoring of all essential equipment connected with and the relations to vital train functionality;
b. In-track continuous monitoring of all essential equipment connected with and the relations to vital infrastructure functionality;
c. Evolution of a data repositories for the development of algorithms for the Decision Support System, to reduce the sizing of Spare parts stored and to maximize the availability of the same parts when required;
d. Optimization of maintenance through intelligent monitoring equipment status and the computation of remaining time to potential faults, used in preventive maintenance approach the predictive condition analysis for an improved generation of on-board train equipment and infrastructure components;
e. Possibility to test on line the experimental intelligent monitoring system mounted on the existing vehicles will be evaluated.

The general approach of this project is not competitive. The results of InteGRail project will be taken in account, in particular the holistic on board analysis that involves the main component responsible of the possible stops. Following equipment categories could be taken into account:

On rolling stock

- Electrical/electronic (as power pack, pantograph, driver cab etc.)
- Mechanical/mechatronics (bogie components, body to body connections, tilting system etc.)
- Auxiliary on-board (HVAC, braking, doors etc.)
- Others (as pneumatic/hydraulic etc.)

On railway track

- Switches and crossings
- Level crossings
- Track geometry
- Rail failures
- Overhead line equipment
- Signalling equipment
- Power supply equipment

The project will consider the optimal use of monitoring data from on-board and wayside monitoring systems. An important consideration is that the combination of these data sets will have an important added value, compared to unilateral use of data. So train-borne monitoring systems could be used to asses the condition of track and vice versa.

In the Structured Symptom Analysis for Maintenance Optimization project, we start from this results and study a possibility to probabilistic evaluate the failure potentials root cause in the operation and prevent all possible stop train during the service.
A study of the on board equipment diagnosability it's specific in the vehicle and track systems, while in the InteGRail project the approach is more general at network level.
This approach allows a reduction of extraordinary maintenance cost and high asset availability, therefore a specific interest from the railway operators (train operators and infrastructure operators) can be expected. The positive cost-benefit balance this will bring will appeal to the operators. Another consideration is that the approach is in accordance with the general theme of the 2nd Call in optimising energy consumption and ecological values by elimination of unplanned failures.
In particular it will be also considered the numerical simulation of the diagnostic systems to be combined with the logical model; examples can be anti-derailment, running stability and over-turning, and verified the requisite for an optimised perception (number, type and position of the sensors compared to computable values) and the diagnostic signals elaboration techniques.
Analysis (based on experimental laboratory and numerical simulations) of the diagnostic signals; examples can be anti-yaw dampers and other critical components (for conventional and steering bogie). The study of the possible necessary additional signals and derived information sets for the diagnostic scope able to identify the worn wheel and the suspensions component degradation will be taken in account in the model. In addition it will be possible to investigate the integration of the diagnostic system with the dynamic simulation and comparison with acquisition of rail and catenary condition monitoring information.
Software able to define and to prevent possible problems in the monitored equipments..

4. Which section of the 2nd call draft is being addressed?

7.2.5.2.1 Innovative product and system concepts

Funding scheme: collaborative projects, large scale integrating projects

5. **State of the art: previous or on-going research or standardization initiatives in this area**

The project will be based on the results of InteGRail (2005-2008), whose purpose is to create a framework allowing the integration of the different railway subsystems, based on a common architecture. Within InteGRail three Demonstration Scenarios have been defined, in order to show at a detailed level some examples of applications of the developed information platform.

The purpose of the proposed project is to realize an applicable implementation of the considered framework particularly focused on rolling stock and infrastructure maintenance, including predictive maintenance and detection of incipient faults, in order to reach the goal. Such software implementation will take into account all the different train and track sub-components, exploiting also the results coming from other projects (i.e. FBS and PBS of trains defined in the scope of MODTRAIN project and the PBS of railway infrastructure made in InteGRail) and put them in a holistic view for improved symptom analysis to improve maintenance performance.

6. Estimated budget (total and EC Contribution)

20 M€ total budget and 10 M€ EC contribution. Increase with experimentation on line (about 2 M€ additional budget required)

7. Project duration *(indicative range: between 24 and 48 months)*

48 months (experimentation included).

8. **The leader of the proposal preparation**
   ANSALDOBREDA

9. **Main potential partners (names of companies supporting the proposal as opposed to potentially interested stakeholders)**
   Potentially interested stakeholders:
   - Train manufacturers: AnsaldoBreda, Alstom, Bombardier, Siemens, CAF, Vossloh.
   - Systems suppliers and consultancies: Ansaldo STS, DeltaRail, Selex SI, SeeByte, UniControls, MerMec.
   - Operators: Trenitalia , SNCF, DB, OBB, Czech-Railways, ATOC
   - Institutes: POLIMI, Technische Universitaet Graz, Università Florence, VUZ (Velim Cekia Rep.), Univ.Birmingham, Heriot-Watt-Univ. IMEC, OFFIS, University of Genua.

10. **Contributions to standards – can the results of this projects be transferred into future EN standards?** *(Maximum 5 lines)*
    Assuming industry standard on analysis models their metrics and dynamic simulation parameters for predictive analysis, clear and open standards will be issued about the logical application layer in order to allow semantic-interoperability and maintenance aspect. Such documents will be presented to the relevant standardization bodies.

11. **Implications of the project for current individual company products and practices – is the proposal supported internally within each major partner at the strategic level?**
    It is supported by AnsaldoBreda group Management.

12. **Risk factors that could jeopardize the implementation of results. How to ensure market up-take and who will have the responsibility over the implementation?**
    Risks:
    - Availability of industrial products and the granularity of existing monitoring system that today cannot be integrated due to the lack of a clear semantic interpretation
    - Lack of commitment by the operators and railway undertakings in setting up compliant global maintenance strategies
    - Lack of representativeness, by the partners, of the market, invalidating the implementation.

    How to ensure market uptake and responsibility of the implementation:
    - Responsibility is up to the project partners.
    - Modification of the regulatory framework in order to encourage the adoption of the new technologies. Responsibility is up to the European Commission.
    - Involvement in the project of major European actors. Responsibility is up to the project preparation leader and to the main partners.