3.1 Publishable summary

Short project description

In the logistics industry, the advantages of networks with small local partners are widely recognised, as these bear the potential of offering flexible services at affordable costs. Small participants serving a wider network are locally more flexible, react faster to changes or region-specific challenges, and offer higher variety—however, not entirely without drawbacks. In the age of track-and-trace solutions and specialised, small consignments, the amount and variety of data accompanying logistics processes often presents major challenges, especially when it comes to transparent or coordinated action: it is difficult to filter the onslaught of data and make its appropriate portions available at the right time and place to support correct decisions, make better forecasts and issue timely warnings. The three-year FP7 project ADVANCE aims to tackle this problem by investigating and advancing the related scientific backgrounds as optimisation and machine learning, and offer a modelling and decision support framework which companies and networks can use to build solutions covering their own specific needs.

Specifically addressed RTD topics are:

- Analysis of very large amounts of data being streamed every second (e.g.: GPS data).
- Use of real-time data analysis at local level to take account of dynamically-changing customer demand, including prediction of customer activity, supply and demand;
- Use of machine learning and data mining methods for gathering quantitative information and filtering large amounts of structured but low-level data to detect trends, dependencies or information of network-wide importance;
- Use of advanced model building and optimization techniques to generate assumed models of the processes in question, and meeting predictions or detecting patterns and phenomena of interest relying on the models;
- Use of knowledge engineering and intelligent knowledge-based systems (relying on matching and/or inference) for providing human-interpretable decision support and early warnings in collaborative activities within the network;
- Introducing feedback techniques and cognitive models suitable for the adaptation of the computed output to human expectations, so that the output of the system can be placed and assessed in the context of the specific expertise of the human operators;
- Elaborating new operation strategies and new expert knowledge for multi-level networks (dispatching policies, locally or globally applicable rules, dependencies between actors and policies etc.) relying on the model building and decision support techniques, to the benefit of the central organisations deploying the solution, as well as their local partners/subcontractors.

Summary of Activities

Having started in October 2010, the project has already achieved significant results, both in exploring the de-facto challenges and potential theoretical background, as well as in building up an

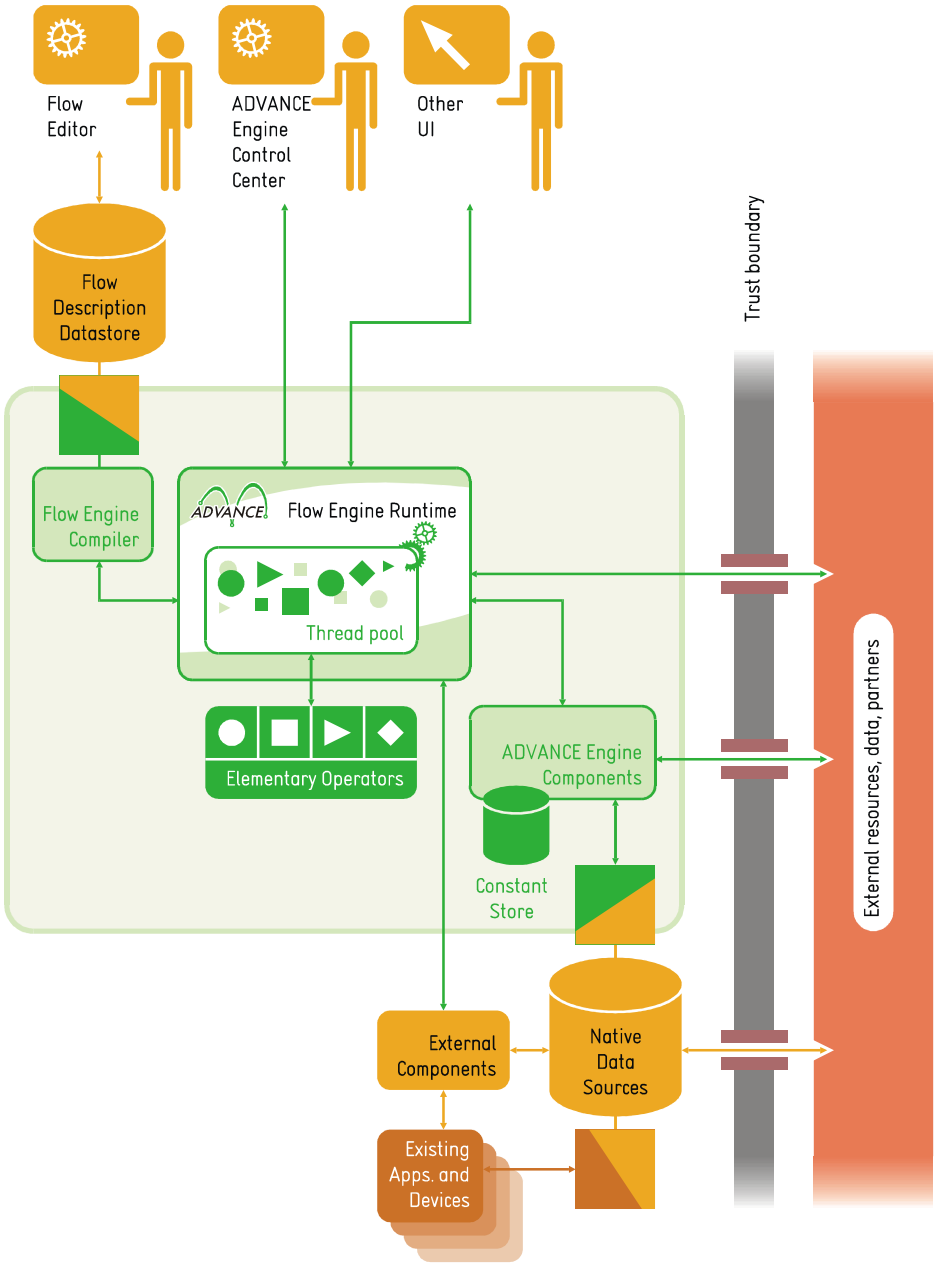
IT environment that will support practical experiments and will serve as a runtime framework for solutions deployed in the industry.

In-depth insight in the application field

Logistics networks typically accumulate OVER 1 BILLION new items of information each month (customer orders, pallets, trailer images, postcodes, depot data, GPS tracking of vehicles, etc.), generated every minute of every day by thousands of pallets travelling on hundreds of trailers for more than one million customers scattered across hundreds of thousands of postcodes, each with multiple different service requirements. Every second, thousands of data items come on stream at any point of the network and need analysis to guide short-term decisions about lorry deployment (within minutes) as well as longer term plans for carrying capacity. The patterns and dependencies that exist in the 50 million or more data elements created daily can only be meaningfully processed by intelligent data-mining approaches linked to strategic decision making based on longer term analyses of billions of pieces of information.

The ADVANCE decision-support engine will enable strategic planning coupled with instant decision making to provide vision in a blizzard of data. It will provide a dual perspective on transport requirements and decision making dependent on the latest snapshot information and the best higher-level intelligence.

This fundamental framework, the ADVANCE engine, is in essence an environment where the solutions of our targeted application domain can be built and run. Assembling a specific solution would mean a large assortment of technical details to care about: we would have to sort out and properly match data models of the information handled, we would have to ensure proper timing of operations or sequences, etc. Many of these chores pose no technical challenge in the individual case, but require lots of almost automatic development work—the purpose of the ADVANCE engine and the associated development environment is to take this unnecessary burden off the shoulders of developers and researchers, shorten development time and reduce the risk of errors where this can be done automatically.



Serving initially as a test bed, the ADVANCE engine will also fit into real-life applications as a configurable framework for advanced modelling and prediction services.

Progress in the design and development of the ADVANCE engine was considerable during the first project year, with reactive support of runtime behaviour and type inference mechanisms in data model negotiation being in the focus. These results alone are less in the field of attention of prospective users than the graphical interface of the environment will be. Their importance, nevertheless, is shown by the fact that “by-products” of our development efforts are already highly appreciated and used in other developer communities—as it turned out, others were already “lining up” waiting for an open-source solution to appear for problems that have been around for years.

Also contributing to the creation of re-usable structures was the elaboration of data models that can be used throughout the targeted sector of the logistics domain, and adapted to concrete

business cases with minimal additional work. In addition to identifying the best choices between specific and general, much care was taken in elaborating the best means of formalising the description of data flows.

Exploring the scientific backgrounds

Several areas of optimisation and artificial intelligence must be relied on to solve the information handling problems targeted in the project, and considerable efforts are planned to be spent on selecting and harmonising solution components from all these areas into a practicable and industry-ripe solution. In the first months of the project, the modelling and global optimisation of logistics networks—primarily the so-called hub-and-spoke type characterising the project's key application scenario—were surveyed. It was revealed that the required methods are highly specialised for each case, conveying two implications:

- the solution framework should be able to host a wide spectrum of algorithms in order to guarantee the targeted versatility, and
- researchers, developers and users should be made aware of the high degree of required specialisation to prevent pitfalls at less experienced companies.

The perceived degree of specialisation proved to be a valuable guide for our focal research efforts which were, in the first year, directed towards the following areas:

- pre-processing of large data sets for analysis,
- use of incomplete data appearing in collaborative networks,
- machine learning and generic optimisation algorithms.

Research in these areas will continue throughout the next year.

Getting involved and being aware—interaction with industry, science and the public

The outstanding commitment of the main industrial consortium member, Palletways, gives the consortium the opportunity of gaining a realistic picture of the application area, revealing aspects of importance and keeping research and development in the project always close to the reality of everyday industrial operation. The constant collaboration ensures a co-evolution of views and insight on both the industrial and the academic side which is to the benefit of all participants involved. This mutual matching of attitudes is also expected to be of advantage while approaching the targeted users, once the solution framework reaches adequate ripeness. Close contact also has the advantage that realistic data and implicit knowledge, often omitted even by domain experts, is always at hand and can be consulted at critical points.
In the second project year, a major part of research and development took place, focusing on building up the solution framework to allow testing of theoretical results, as well as the elaboration of the aforementioned results. This required frequent and intense exchange of experience and expectations with the industry which characterised the level of communication throughout the entire second year. Also important is the addition of two new work packages to the planned work—activities in these (shared model generation and improvement of hub throughput) have also ramped up in the second year.

In addition to R&D work and integrating user feedback, the second project year has seen intense publicity activities as well. With notable R&D results already at hand, initial "awareness-oriented" emphasis has now shifted to the presentation of actual results in scientific and technical communities. In addition to these papers, the ADVANCE project received special attention as one

of the supporting projects of the MITIP2012 conference, and was presented to the general public in various other public appearances.

The road ahead—coming up in 2013

The concluding 3rd project year has to take the R&D results and the prototype implementation to a level where the outcome of the project can maintain itself beyond the project lifespan: it has to become an integral part of everyday workflow at Palletways, and has to be present as a usable framework in the open-source community.

To this end, implementation of further theoretical results into the framework will follow, and tests (including field tests) will go on in close collaboration with the industry. Assembling a good corpus of publicity and training materials will be part of elaborating a sustainable output—these will be finalised relying on the final year's experience with the industry.

Further Information

Official project web site: **http://www.advance-logistics.eu/**

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Consortium:

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Aston University	Aston	United Kingdom	www.aston.ac.uk
University of Groningen	RUG	The Netherlands	www.rug.nl
Technology Transfer System srl	TTS	Italy	www.ttsnetwork.com
Palletways UK	Palletways	United Kingdom	www.palletways.com