Developing advanced Decision-Support Systems (DSS)  
An open and networked Transport DSS for Europe

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1 Summary

A Decision Support System (DSS) is computer system integrating data, forecast models and evaluation methods. To be effective, the development of DSS have to be customised to increase the skills and capabilities of their users, policy-analysts and decision-makers, given:

- The complexity of the multi-party negotiation processes (requiring effective communication tools)
- The increasingly difficulty of new emerging problems in the transport system (requiring access to more advanced and specialised scientific models).

In the European case, a DSS on transport policies has to be necessarily an integrated system with components distributed through a large number of universities, research institutions and consultants, and end-users have to have highly customised interfaces accessing the different components of the system. The more convenient technical approach to build such a system is using an “Extranet” approach (Internet with controlled access): Data and model providers should develop their own web-interfaces to their databases and models according to pre-defined guidelines, and these interfaces should be interconnected through Internet by a central communication server (controlling access from users and providers to the system, providing groupware facilities, data warehouse etc.). Future needs for very high bandwidth and dedicated lines between users and providers have to be assessed. Guidelines for any data and model provider to link new services to the system have to be defined in an open and inclusive development strategy.

All considered, because of the open and distributed character (necessary to make feasible an European DSS), the success depends on the capacity to sustain a cooperative effort from the three key stakeholders:

- Policy-Users (analysts, decision-makers)
- System Developers
- Service Providers (data, forecast, evaluation, presentation-tools, communication)

2 Architecture of advanced DSS: The need for open and networked system

The best system architecture for an European transport support system is an open and inclusive system, with components distributed in an integrated network enabling policy-users and service providers to interact in a more fruitful manner.

This networked approach is required because DSS will include highly sophisticated components (e.g. forecast models), running only on specialised computer facilities under expert supervision and permanent maintenance. Because of this, DSS has necessarily to be a “distributed system” located in different computer systems and interlinked through Internet and/or Intranet. In order to integrate the different components of the system, and offer them to end-users in a meaningful way, two main types of interfaces have to be developed:
• **User-interfaces** providing friendly, self-explanatory access, to the system as a whole, and to each module.

• **Links between software tools and computer systems**, to integrate and make work together the independent modules. Efficient links and productive software and computer resources are critical to allow on-line, interactive service provision (Internet links and Intranet core utilities).

Alternative approaches, such as integrating all modules in a single computer system, have to be rejected as technically unfeasible. There are also important legal and commercial difficulties linked to the transferability of software and database products from the developer’s computer sites to other systems.

The use of dedicated lines and specialized transmission protocols (additional to Internet) will be carefully analyzed since, in a long-term prospective, the volume of data to be transmitted, and the speed required, may recommend, to use higher bandwidth at least between busiest servers. Anyway, always DSS should have an Internet base to facilitate users access to the system and providers to develop and link easily to DSS new services.

In conclusion, an European transport DSS (and presumably also most advanced DSS) have to envisaged as an “Extranet” system (an Internet system with controlled access). The development of an Extranet system is mostly focused on developing (and linking) interfaces to data and modelling systems in a way the can provide useful services to end-users. For this to happen:

• **User-needs** will have to be carefully identified by applying effective methods (Kano) and running a First Users Programme.

• **System-requirements** will have to be identified based on user-needs, developers-experience and links with the industry on Information and Communication Technologies.

• **Interfaces** will have to be developed following harmonised design guidelines by each service provider. Each interface will share a communication protocol to dialogue through Internet (sending and receiving data and commands).

• **A communication server** will have to be established to centralise communications, provide groupware and common data warehouse services, register and control remote users and service providers, and protect the whole system.

• **Postimplementation plans** are indispensable to guarantee the future maintenance of the system.

From a user point of view, the system may work as follows: The user of the DSS, after successful registration on DSS web-server, searches for a particular service. The search engine identifies one provider linked to the system with such a service and puts both user and service provider in contact. The service is then provided bilaterally. The service provider manages independently user requests (under system’s guidelines). If the user, for instance, is working on a corporate LAN not allowing him to download large databases neither to carry on specialised analysis (or the service provider does not offer all services required by the used), DSS Server “groupware” facilities can be used. For instance, the data warehouse will temporally store output data produced by the provider and the questions sent by the users, to be sent to another provider or be analysed by core utilities included in DSS Server.
<table>
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![Diagram](image)
3 How to build up and open and networked DSS?

The development plan for an advanced DSS, to increase chances of success, has to follow the structure of the services to be provided (“interfaced”) to the system:

1. The User-needs assessment should be carried out according to an standard well-recognised methodology (e.g. Kano) and a First User Programme

2. Original transport-specialised tools have to be assessed, together with tools from Information and Communication Technologies industries.

3. Data retrieval and strategic information services to answer “What’s up?” (interfacing Reference Data Warehouse)

4. Transport Forecast services to answer “What will happen if this policy action is taken?.

5. Scenarios and impact assessment services

6. Policy-evaluation services to measure the interest and feasibility of alternative decisions and executive policy-definition tools

7. System development and management services to integrate, maintain and update the system.

Resulting from DSS scientific modules, interactive multimedia presentations for key European transport policy-questions (CTP) should be developed (Communication services) for decision-makers, policy-analysts, experts and citizens in general. At the end, the goal of a DSS is both to integrate more scientific appraisal to decision-making processes and to help policy-analysts and decision-makers to communicate more efficiently their views and actions. An advanced DSS has to be developed as a “communication” service linking policy-users, scientists and citizens in general (groups, institutions, etc.). A number of multimedia presentations of key CTP questions, based on official documents and policy-analysis made by Firsts Users would be useful as reference for using advanced communication techniques to present complex policy questions to top-level decision-makers and non-specialised public. The interactive multimedia presentations (data, graphics, maps, GIS, simulation) can be developed as Internet applications using the same standard applications and programming languages used to develop user-friendly Internet front-ends (Macromedia Director/Flash, Java...). The presentations to be developed to provide for a comprehensive view of all relevant transport policies and their social, economic and environmental impacts. If the policy-analysis made by First Users do not cover the whole range of policies, information coming from already made studies and expert opinions will be added (as well as the basic facts and key indicators). These communication facilities would make the DSS a more “politically-oriented” tool, able to transfer knowledge to top executives and even to citizens in general.

The developers able to carry on these so divers and specialised tasks, need to:

- **Have long experience in the management of complex implementation projects**

- **Know the problem domain**
• Know the institutional complexity of European decision-making processes

• Know the available technologies and system’s requirements

• Have access to the appropriate technology

Ideally, the working process should be supervised by standard Quality Management methods (based on ISO9001). In order to achieve an operational system, a “pragmatic” development process, focused on user’s satisfaction has to be adopted.

4 Steps building open and networked DSS

These steps have been defined having in mind the development of a European transport DSS, but they can be useful for any other advanced DSS to be developed.

4.1 Project Management and Quality Control

The smooth execution of the project and the timely completion of the tasks/activities requires an intensive management effort since users are part of the working process and achieving users-satisfaction (not only scientific excellence) is fixed as a goal. Definition and implementation of quality control procedures will be based on ISO9001:2000 and monitored by an specialised institution.

4.2 Identification of User-Needs Assessment and Firsts User Programme

The identification of User Needs have to be integrated in an overall strategy aiming to promote and sustain a pro-active participation of end-users in the development of the system. This is strategy is based on a “First Users Programme”. Needless to say, there is an obvious difficulty providing “useful-enough” services for Firsts Users when the system is at early development stages. This is only feasible is First Users agree on the instrumental character of the programme and their needs properly assessed against the tools which are already available in hands of system’s developers. In return from their contribution to the system development at early stages, Firsts Users will become during the second and third year of the actual firsts users enjoying highly-customised interfaces and services.

4.3 Definition of system requirements

The definition of system requirements (for the provision of added-value services, system management and network communications) is based on the needs obtained from users and the experience of system’s developers. Links with the industry on Information and Communication Technologies are indispensable to assess the interest of standard solutions and the need to complement them with original and highly-specialised developments. This will constitute the knowledge-base needed to validate the initially proposed system architecture.

4.4 Development of the System Architecture and System Management Services

The system will be developed based on a pragmatic and incremental strategy, aiming to use as simple and effective tools and methods as feasible, in an scalable design able to become more sophisticated as needed.
4.5 Information Services

Provision of services for retrieval and analysis of the reference data. Establishment of statistic quality controls on data before “acquiring” it for DSS. Organisation of a Data warehouse.

4.6 Knowledge-based Services I (Transport Forecast Services)
Interfaces to six European strategic transport forecast models are going to be developed and linked to the system. This will provide for a comprehensive forecast service and allow for an experience-base to define the guidelines for other modellers to provide DSS forecast services (development and linkage of web-interfaces).

4.7 Knowledge-based Services II (Scenario-definition and policy-impact assessment Services)
Interface to a cross-sectorial model (macroeconomic, spatial development, environmental, transport) able to analyse the consistency of transport scenarios and carry on impact assessment. Development of a knowledge-base by expert panels and conclusions from previous policy-studies.

4.8 Decision-Support Services (Policy definition and evaluation Services)
Interface of evaluation models able to integrate results from forecast models (under pre-defined scenarios) and impacts in multicriteria decision frameworks. Complementary development of interactive policy-definition tools.

4.9 Communication Services
Communication services are needed to extend the potential users of the system (or policy-analysis made with the system) to top decision-makers and even citizens in general. Strategies for external dissemination and organisation of electronic on-line forums open to citizens participation will be carried out.

Implementation of links to Directories (Data, Models, Studies, Experts)
Development of interactive presentations for key European transport policy-questions
On-line forums

4.10 Postimplementation (in co-operation with Subtask 3)
Preparation of detailed plans for the sustainability and further development of the system

Validation of DSS architecture as Organisational Decision-Support System
Adherence to standards
Maintenance protocols
Postimplementation plan

5 Existing tools for building up an European transport DSS

It is a fact that, until now, there are no totally successful experiences of transport policy-support systems neither at national nor at continental level. Despite few interesting cases, to mention a single one as a benchmark for DSS is not possible (beyond transport policies, there are also some valuable experiences especially in the environmental field and at local and regional level, often with less ambitious purposes than DSS has).
However, European Strategic Transport research projects, as well as the industry itself,
have already developed the advanced tools and methods indispensable to make DSS feasible.

5.1 User-Interfaces and system-links

There is an increasingly number of commercial tools providing solutions to develop Internet and Intranet highly-customised front-ends able to drive remote advanced applications, as well as managing the communication flows between users accessing the system.

To help data and model providers to identify the best technologic solution to interface their tool, the 4th FP spotlightsTN project is developing on-line documentation with all available alternatives. On the other hand, spotlightsTN is also discussing specialised tools to interface transport models (standard data exchange formats, harmonised descriptions of advanced models and procedures for quality control).

ASSEMBLING project developed Internet interfaces to a number of transport models as well as defined a design-guideline to develop harmonised transport policy-oriented interfaces, focused on communicating strategic information at European users. Some models, such as Astra, NEAC and VIA, have already developed intranet interfaces and/or interactive policy-oriented versions. THINK-UP is exploring how the knowledge provided by models is actually understood and used by policy-analysts, and decision-makers. And ATOM is exploring the organisational implications of DSS implementation (in relation to users access to models). At a more technical level, Bridges project developed a software technology to build up open multi-software support systems specialised on transport policies.

5.2 Service Provision of data:

The lack of a common pan-European reference one have resulted in modellers and policy-analysts developing their own databases, each one valuable in itself, but incompatible in practice. INFOSTAT and MESUDEMO have analysed in depth the best structure of such a reference database, SCENES has created a socioeconomic database, ASSEMBLING detailed graphs, GEOSYSTRANS detailed transport cartography. MYSTIC has elaborated surveys and assembled data towards origin-destination matrices. Moreover, EC DG TREN is developing, based on GISCO, a transport-GIS database that will have to be necessarily integrated within Subtask 2 works.

5.3 Service Prevision of forecast.

A large number of advanced models have been developed in the 4th FP: STEMM, STREAMS, SCENES, VACLAV, VIA, MATISSE, EUFRANET, NEAC, successfully applied in policy-studies (Ten Helsinki corridors, Forecast 2000...) for EC DG TREN.

The first antecedent at European level towards interfacing models was, probably, the “Memorandum of Understanding” signed, under EC DG TREN initiative, by the modelling consortia in the 4th FP: STEMM, STREAMS, EUNET, TENASSES, INFOSTAT/OD-ESTIM & COMMUTE, in the so-called “UTS Workshop”, Barcelona, July 1996. Since then, European modellers have gained experience trying to integrate models. This is largely because many models have been developed in a modular manner by multiple partners. In one case, different forecast models, scenarios-building methodologies and environmental impact assessment were linked at least to the extend
of exchanging data (e.g. SCENARIOS-STREAMS-COMMUNTE-MEET). These experiences show both the interest and the practical difficulty of model’s integration. Not much work has been devoted yet, to facilitate end-users’ best possible interaction with models.

**STREAMS-SCENES.** The SCENES model (an improved version of the STREAMS model) will be interfaced. The model has been applied to evaluate the Strategic Environmental Impact of TENs (DG TREN). Covers EU at NUTS2. The model internalises regional economy in input-output tables and translate them into trade and freight volumes, which are then split between modes and assigned to the networks. Passenger generation is modelled by trip rates, with highly desegregated demand segmentation by country. Distribution follows a gravitational-like formulation and modal split a logit formulation. The model is based on MEPLAN software and is transferable. It runs on a PC.

**VIA and STEMMS-VACLAV.** These long-distance traffic models (EU and Eastern Europe at NUTS3) have been applied for the recent Forecast 2020 and Ten Helsinki Corridors (DG TREN). The VIA Generation module is based on a set of trip purposes specific models to generate annual journeys per individual based on household surveys. VIA Distribution module between NUTS3 centroids is based on a gravitational formulation. VAACLAV Modal Split considers four main modes and integrates non-linear logit functions calibrated in the STEMM project. VAACLAV assignment process considers congestion levels and includes an estimation of local traffic. Results are validated with available scree-line counts and traffic link counts. VAACLAV software is original C++ code and TCL/TK a free available script language allowing for Intranet interfaces. It runs on Windows. VIA is also a C++, with Motiv graphical interface and runs in Unix.

**NEAC covers EU and Eastern Europe at NUTS2.** Is based on NSTRT commodity chapters and crude oil. It is based in a highly desagregated segmentation of demand and a precise inventory of transport chains (transhipment sites). 8 submodels are used to estimate the different commodity groups. NEAC has been applied for the Ten Helsinki Forecast and the Forecast 2020 studies. EUFRANET provides analysis of rail transport services, allowing to model the impact of alternative rail management strategies on freight transport. The databases contain all important freight terminals and stations. EUFRANET model has been tested to analyse the interest of a “rail system dedicated to freight” in Europe, in terms of its capacity to attract traffic from other modes.

Guidelines to include new models: Based on the experience of the models being “interfaced”, and contacts with other existing or under development forecast models (e.g. EXPEDITE...) a guideline proposal will be established. Contacts with models from DG TREN Energy sector (TRENEN, TREMOVE....) as well as to other sectors, will be established under Subtask 3 co-ordination.

5.4 Scenario-definition and policy-impact assessment:

Tools and methods for scenario-definition (SCENARIOS, SCENES) and policy-impact assessment (e.g. MEET, COMMUTE, PETS...) have been developed.

Socioeconomic and Environmental impact models (e.g MEET, COMMUTE...) are also available as inputs to define scenarios for transport models, or to produce policy-indicators based on transport model results.
ASTRA model integrates transport scenarios and policy impact in a dynamic system framework where transport interrelations with socioeconomic, spatial development and environmental sectors can be assessed in their evolution over time. ASTRA already has a user-friendly Intranet Interface which will be used as starting point to build up the Internet one, however, an important redefinition of the model is needed in order to make the system able to integrate input variables from forecast models (in order to evaluate impacts to be transferred to evaluation models) and to provide outputs to forecast models (scenarios). The situation “in between” forecast and evaluation, and the necessary inclusion of non-transport related models (e.g. macroeconomic, environmental...) in a modular architecture, makes the architecture of this service provision rather complex.

3.5 Decision-support tools

Decision-making tools, policy-definition and assessment methodologies have been developed in projects such as EUNET, CODE-TEN, TENASSES. These evaluation models, following a multi-criteria framework, cover policy goals definition, selection of indicators to measure goal-achievement (e.g. Cost-Benefit...) and different procedures to select alternative decisions based on the type of problem being assessed (quantitative, qualitative, presence of incertitude etc.).

Decision-makers and high-level officers are often less interested on carrying on the analysis themselves (being this the role of “policy-analysts”) than in understanding in depth the answers provided by experts to their policy questions, as well being able to communicate and negotiate efficiently. To fulfil these needs, data, forecasts and evaluation analysis must be presented to them according to the specific policy actions being considered. Some 4th FP researchers have developed interesting methodologies to develop dynamic and user-interactive policy-presentation tools. A sample of these tools are the ASSEMBLING “Is EU going to meet Kyoto’s agreement?” or “When TETN will be completed?” tools, or the “Phare Toolbox” CDRom, helping end-users to see the impact of transport infrastructure investments on Central and Eastern Europe Corridors in terms of traffics. These policy-presentation tools also provide explanatory texts, key indicators and graphics to be printed to produce conventional memos in paper.

Evaluation models, following a multicriteria framework, cover policy goals definition, selection of indicators to measure goal-achievement (e.g. Cost-Benefit...) and different procedures to select alternative decisions based on the type of problem being assessed (quantitative, qualitative, presence of incertitude etc.). A number of already existing evaluation models (and/or methods) will be assessed and linked to DSS to create a comprehensive evaluation framework: The assessment tool for infrastructure projects developed by the EUNET research project and its integration with STREAMS model to receive the necessary inputs, the tool for the strategic assessment of infrastructure corridors developments and its integrated DSS module developed by the CODETEN research project, the evaluation tool for the needed multi-modal seaports, rail, terminals, rolling stock) investments in PACT corridors developed by the PACT programme, the multicriteria and cost-benefit tools developed for the assessment of the needed interventions, the multimodal network of the Adriatic Corridor developed by the specific programme of DG TREN, the model for the appraisal of investments for Freight Villages construction and operations developed for the DG for regional Development, tool for the evaluation of terminal performances improvements developed by the IQ research project (to be complemented by the framework tool developed by the FV-2000 research project), tool for the assessment of attractiveness of infrastructure investments to the private sector for the promotion of PPPs to TEN developed by the PROFIT research project, tools for the assessment of innovative urban transport systems...
and policies options developed by the AUITO research project, as well as the tools
developed under TRENEN II-STRAN research project. In addition they are some tools
developed for the evaluation of Transport Programmes, like the ones for the ex-post
evaluation of the Phare Transport Programme for the DG of External Relation and the
one for the ex-post and ex-ante evaluation of the Structural Funds Programme in
Transport for the DG for Regional Development

PAM and Goal Achievement models for the assessment of the implementation of CTP
(Common Transport Policies) were developed by the TENASSESS research project, the
Barrier model and tool for the assessment of barriers in the implementation of CTP and
their overcoming developed again by the TENASSESS research project.