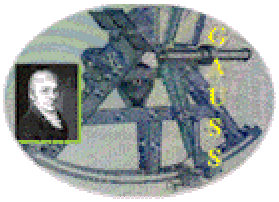

GAUSS
Project
Final Report

Contract N°.:	**IST-1999-20532**		
Doc. ID:	**GAUSS/TPZ/REP/031**	Deliverable Type:	**Report**
Deliverable N°:	**D30**	Emitting Company:	**TPZ**
Work Package:	**WP 1**	Issue Date:	**24/01/03**
Issue	**2**	Pages:	**38**

Function	*Responsibility / Company*	*Date*	*Signature*
Written by: GAUSS Team		16/01/03	
Checked by: A. Di Fazio	WP 1 Lead / TPZ	20/01/03	
Approved by: A. Di Fazio	GAUSS Project Coordinator / TPZ	24/01/03	

Reserved to EC

Approved by:			

EXTERNAL DISTRIBUTION LIST

Company	Quantity
European Commission	2
ARNI	1
ASCOM	1
THALES	1
ERICSSON TEI	1
GMV	1
SPACE ENGINEERING	1
TELEFONICA	1
TTI	1

INTERNAL DISTRIBUTION LIST

Company	Quantity
Telespazio S.p.A.	1

CHANGE RECORDS

ISSUE	DATE	§ : CHANGE RECORD	AUTHOR
1	20/12/02	All the document	A. Di Fazio
2	24/01/03	Document shortened and contents rearranged according to the EC guidelines "Final Report Guidelines EC, IST – Guidelines For Preparing Project Reports, For IST KA I, System and Services for the Citizen", version 1, 16.10.2000	A. Di Fazio

CONTRIBUTORS LIST RECORD

COMPANY	ADDRESS	CONTRIBUTOR NAME	PHONE/FAX/E-MAIL
TPZ	Via Tiburtina 965 – Roma I-00156	A. Di Fazio	+39 06 4079 6329 Antonella_difazio@telespazio.it

BIBLIOGRAPHIC RECORD

Project Number:	IST-1999-20532	
Project Title:	GAUSS: GALILEO AND UMTS SYNERGETIC SYSTEM	
Deliverable Type:	Report	
Deliverable Number:	D30	
Contractual Date of Delivery:	15/12/2002	
Actual Date of Delivery:	24/01/03	
Title of Deliverable:	Annual Project Review Report	
Workpackage contributing to the Deliverable:	WP 1	
Deliverable Type:	Report	
Authors:	A. Di Fazio	
Abstract	This document is the report of the activities, the achievements, the products of the GAUSS project during the first year of its work plan. This preliminary issue is purposely delivered for the Annual Project Review 2001 that does not cover one year of activities of the GAUSS project. The period of activities that is object of this report is included in: Dec. 00 – Sept.01.	
Keywords	Service	Navigation
	Standard	Intermodality
	S-UMTS	Satellite Systems
	Nav-Com	Infomobility
	Galileo	Emergency
	EC - IST	Final Report
Confidentiality Level	Public	
Name of Client:	European Commission DG INFSO	
Distribution List:	See relevant distribution list table	
Authorised by:		
Issue:	1	
Document ID:	GAUSS/TPZ/REP/030	
Total Number of Pages:	38	
Contact Details:	Antonella_difazio@telespazio.it	

TABLE OF CONTENTS

INDEX OF FIGURES

1 INTRODUCTION

1.1 SCOPE OF THE DOCUMENT

This document is the final report of the GAUSS project. It is aimed at providing the summary description of the most important issues concerning the projects, including its main activities, milestones, achieved results and future exploitation.

1.2 APPLICABILITY

The document is produced in the frame of the WP1 activities.

1.3 DOCUMENT OVERVIEW

For the generation of the Final Report, the specific EC guidelines (AD5) have been used. Hence the present document has been produced to be conforming to the subject guidelines.

According to the subject guidelines, the document is organised as follows:

The chapters 1 and 2 include the introductions and lists of documents and acronyms. In particular chapter 1 also includes and **Executive Summary.**

The chapters 3, 4 and 5 provide the description of the main important aspects and concepts of the GAUSS project and relevant activities:

- **Project Objectives**
  - State of the art
  - Initial Project objectives
- **Approach**
  - Concept
  - Project structure
  - Project partners and their contribution to the project
- **Results and achievements**
  - Technical Achievements, Technical assessment, Options for system improvement
  - Potential business opportunities, Exploitation strategies…

The chapter 6 refers to the list of project documentation:

- **Deliverables and other outputs**
  - Deliverables, Dissemination activities (including cooperation activities with other projects and programme Sectors, Contribution to the application domain, Contribution to IST Programme objectives,)

The chapter 7 contains an **outlook** on Commercial and Market Possibilities, Exploitation of Results,..

1.4 EXECUTIVE SUMMARY

GAUSS is a Research and Technological Development project, of the European Commission IST 5th Programme. It is a two-year project, starting from December 2000, and successfully completed.

GAUSS demonstrated the realistic feasibility of a system, integrating Satellite Navigation GNSS-1 and UMTS communication technology for the development of high quality location based services, for road info-mobility and safety, emergency assistance and intermodality applications.

A Demonstrator was built up, by combining new hardware and software ad-hoc developed components, along with the use of existing facilities. A prototype of user terminal was realised, integrating off-the-shelf equipment and technologically advanced parts, based on GNSS1, GALILEO and S-UMTS compatible units.

Mobility e-safety and transport efficient management are the core of the developed applications: road info-mobility and fleet management, inland waterways vessel traffic management and information, port/terminals appointment monitoring & control, dangerous goods transhipment supervision, emergency assistance.

A trial campaign, run into real environments, was performed in Summer 2002. GAUSS Demonstrator performances and benefits were validated with the direct involvement of an inter-modal transport user (ARNI, Partner of the GAUSS Consortium), specifically operating in inland-waterways and roads. Safety-of-life applications for assisted vessel navigation and for management of hazardous goods (gas) transhipment over the Po river were thoroughly tested and assessed. Applications for emergency assistance, Point of Interest inquiry, localisation of commercial fleet were also proven.

GAUSS successfully demonstrated integrated Satellite Navigation GNSS1 precise positioning based on EGNOS, and satellite UMTS packet communication, for provisioning of high quality location based services. The new technology with respect to the current state-of the art, developed within the project, was validated during the trial campaign, including the implemented broadcasting and multicasting communication of data packet compliant to 3GPP standard (current release 4). In this framework GAUSS had fruitfully contributed to the ETSI SES S-UMTS Working Group activities and results.

Horizontal accuracy better than 3-m was achieved in the trial area (Northern Italy - Lario, Como Lake, Parma and Po river areas). The MTB (Mediterranean Test Bed) was utilised because of the poor performance coverage of the ESTB system over the Italian regions.

GAUSS results open the way to the development and exploitation of advanced technology supporting high quality, reliable and effective services to the citizens for the transport sector and whole mobility domain, in view of GALILEO and UMTS scenarios: emergency assistance, safety-of-life applications, fleet and freight transport management (rail, road, maritime and inland waterway), dangerous goods transportation and containers tracking.

GAUSS URL: http://Galileo.cs.telespazio.it/gauss

Project co-ordinator: Antonella Di Fazio – Telespazio, e-mail:Antonella_difazio@telespazio.it

Project EC Officer: Fabienne Dricot

1.5 REFERENCES

AD	Applicable Document
ATS	Air Traffic Service
CV	Curriculum Vitae
EC	European Commission
ESA	European Space Agency
FTP	File Transfer Protocol
GAUSS	Galileo And UMTS Synergetic System
HW	Hardware
KO	Kick Off
N/A	Not Applicable
PMP	Project Management Plan
RTD	Research & Technological Development
RD	Reference Document
SW	Software
TBC	To Be Confirmed
TBD	To Be Defined
TBW	To Be Written
TOC	Table Of Contents
WBS	Work Breakdown Structure
WPD	Work Package Description

1.6 APPLICABLE DOCUMENTS

Ref.	Document Title	Document Number	Issue	Date
[AD 1]	Annex 1: Description of the work 11.04.2000	IST – 1999-20532	2nd Amendment	25.06.2002
[AD 2]	Annex 3: Special Conditions for the IST Programme	IST – 1999-20532	1.0	
[AD 3]	Consortium Agreement		1	May 2001
[AD 4]	Information Societies Technology – Transport Sector Annual Project review October 2001 – results of project GAUSS IST 20532	Letter DG IBFSO/B5/FD/D(2001)		Brussels, 26 October 2001
[AD 5]	EC IST – Guidelines For Preparing Project Reports, For IST KA I, System and Services for the Citizen		Version 1	16.10.2000

1.7 REFERENCE DOCUMENTS

Ref.	Document Title	Document Number	Issue	Date
[RD 1]	Report: Concertation plan and clustering with other projects	GAUSS/TPZ/REP/001	1.0	29.09.2001
[RD 2]	Report: Project Management Plan	GAUSS/TPZ/REP/002	1.0	29.09.2001
[RD 3]	Report: Risk Assessment Plan	GAUSS/TPZ/REP/003	2.1	28.02.2002
[RD 4]	Report: Dissemination Plan	GAUSS/TPZ/REP/004	2	30.11.2001
[RD 5]	Report: Standard and Regulation guidelines for the integrated UMTS and Galileo services	GAUSS/TEI/REP/005	2	30.11.2001
[RD 6]	Report: UMTS and Galileo synergy analysis and requirements	GAUSS/TEI/REP/006	2	21.21.2001
[RD 7]	Report: Use Implementation Plan	GAUSS/TPZ/REP/007	2	21.21.2001
[RD 8]	Report: Target System Definition	GAUSS/TPZ/REP/008	3	28.02.2002
[RD 9]	Technical Note: Guidelines for GAUSS Target System Trade-Off Analyses and Design Definition	GAUSS/TPZ/TNO/001	1	21.21.2001
[RD 10]	Report: Annual Project Review Report N. 1	GAUSS/TPZ/REP/009	1	29.09.2001
[RD 11]	Report: Liaison refinement to assess the coherence of the project progress wrt other EU projects	GAUSS/TEI/REP/010	2	30.11.2001
[RD 12]	Report: Demonstrator Architecture Specification	GAUSS/SE/REP/011	3.3	21.11.2002
[RD 13]	Technical Note: GAUSS Application Message Definition	GAUSS/TPZ/TNO/004	1.5	21.11.2002
[RD 14]	Report: Demonstrator Design Document	GAUSS/SE/REP/012	2.1	02.12.2002
[RD 15]	Technical Note: GAUSS Forward Link Design	GAUSS/SE/TNO/006	2.1	29.11.2002
[RD 16]	Technical Note: GAUSS Return Link Design	GAUSS/SE/TNO/007	2.1	04.12.2002
[RD 17]	Technical Note: GAUSS Access & Control Design	GAUSS/SE/TNO/008	2.1	21.11.2002
[RD 18]	Technical Note: GAUSS Applications Design	GAUSS/SE/TNO/009	2.1	29.11.2002
[RD 19]	Report: Demonstrator Assembly Integration & Test Plan	GAUSS/SE/REP/013	1.1	02.12.2002
[RD 20]	Technical Note: GAUSS RF Subsystem Test	GAUSS/SE/TNO/010	1.1	02.12.2002
[RD 21]	Technical Note: GAUSS Forward Link Test	GAUSS/SE/TNO/011	1	30.09.2002
[RD 22]	Technical Note: GAUSS Return Link Test	GAUSS/SE/TNO/012	1	30.09.2002
[RD 23]	Technical Note: GAUSS Access & Control Test	GAUSS/SE/TNO/013	1	30.09.2002
[RD 24]	Technical Note: GAUSS Applications Test	GAUSS/SE/TNO/014	1	30.09.2002

[RD 25]	Report: Liaison refinement to assess the trial combination potential with other EU projects	GAUSS/TEI/REP/014	2.1	22.11.02
[RD 26]	Report: Demonstrator Assembly Integration & Test Results	GAUSS/TEI/REP/015	2	05.12.2002
[RD 27]	Report: Validation Plan	GAUSS/TPZ/REP/025	1.1	05.12.2002
[RD 28]	Technical Note: Report on the GAUSS demonstration recovery	GAUSS/TPZ/TNO/015	1	30.09.2002
[RD 29]	Report: GAUSS Trials Results Summary	GAUSS/TPZ/REP/026	1.1	05.12.2002
[RD 30]	Report: Annual Project Review Report N. 2	GAUSS/TPZ/REP/026	1	30.09.2002
[RD 31]	Report: Trials Results Summary	GAUSS/TID/REP/027	1.1	05.12.2002
[RD 32]	Report: Trials Results Assessment	GAUSS/TID/REP/028	1.1	02.12.2002
[RD 33]	Technical Note: GAUSS Trial Results Assessment-Annexes	GAUSS/TPZ/TNO/016	1.1	02.12.2002
[RD 34]	Information Notes: Project technologies, services and applications	Poster Leaflet Sticker Brochure		
[RD 35]	Technical Note: GAUSS Reply to the Project Review Report	GAUSS/TPZ/TNO/002	1	26.11.2001
[RD 36]	Technical Note: GAUSS Market and Competitive Analyses And Re-direction of Applications	GAUSS/TPZ/TNO/003	1	30.11.2001
[RD 37]	The Navigation Receiver (Sagitta) User Manual			
[RD 38]	Technical Note: GAUSS reply to the Project Review n. 2 Report		1	15.11.2001
[RD 39]	Report: Project Final Report	GAUSS/TPZ/REP/030	1	20.12.2002
[RD 40]	Report: Technology Implementation Plan	GAUSS/TPZ/REP/031	1	20.12.2002
[RD 41]	'Packet Data Transmission in the GAUSS System'	Contribution to the ETSI SES S-UMTS 14th WG meeting		21-22.03.2002

2 PROJECT OVERVIEW

2.1 PROJECT IDENTIFICATION

GAUSS, **G**alileo **A**nd **U**MTS **S**ynergetic **S**ystem (**IST-1999-20532**), is an RTD (Research and Technological Development) project addressing Key Action I - Systems and services for the citizen, issued for the 2nd call of the **EC** (European Community) **5th Framework Programme** (call IST-99-2-1A, Information Society Technologies).

2.2 PROJECT OBJECTIVES

GAUSS main objective was to design and demonstrate the feasibility of a system providing Location-based services, from the integration of Satellite Navigation and Communications, within the contexts of GALILEO and the UMTS technology. The services considered for GAUSS are based on low-bit rate transmission of small data packets carrying positioning & timing information, as required by typical Info-Mobility and Inter-Modality oriented applications.

More in detail, the GAUSS project was aimed at:

- Designing and demonstrating a realistic integration between satellite navigation and communication, with reference to GALILEO and S-UMTS, for provision of Location-Based Services
- Developing new technology and applications for info-mobility (consumer market) and intermodality (professional users)
- Validating them through a trial campaign in a real environment
- Contributing to the assessment of market and business opportunities for the GALILEO services
- Contributing to the standardisation processes.

2.3 STATE OF THE ART

The project has two years duration, starting from beginning of December 2000. The project is today successfully completed, all foreseen activities finalised in time with respect to the planning.

In order to achieve the foreseen goals, GAUSS the following main activities had been performed:

- Study and assessment the feasibility of a system, for providing Location-based services, from the integration of Satellite Navigation and Communications, within the contexts of GALILEO and the UMTS technology
- Study and assessment of a reference model, integrating Navigation (GALILEO) and Communication (S-UMTS-compatible) functions (GAUSS Target System).
- Realisation of a Test bed, built up by exploiting existing facilities and performing new developments (the GAUSS Demonstrator), for validating the technical feasibility of the Target System

- Development of applications for Info-mobility and Inter-modality, aimed at increasing safety and efficiency in transport and mobility management
- Trial campaign, carried out in the real field, for proving the developed system and validating the user benefits and market opportunities of the provided services.

3 APPROACH

3.1 PROJECT CONCEPT AND METHODOLOGY

The GAUSS project basic concept relies on the feasibility of a solution for the provision of **high quality Location-Based services**, characterised by:

- **Global coverage**
- **Continuity**
- **Integrity** and high **accuracy** (1-5 m) for positioning
- **Two-way** communication
- Communication **reliable**, **near real-time**
- **Time response guaranteed** within 25 sec
- **Point-to-point, broadcasting** and **multicasting** communication
- **Acknowledgement** (ACK message) supported.

A descriptive image of the GAUSS methodology is reported in next figure, where also milestone relevant to the first and second year are shown.

User Needs Analysis ➔ Definition of **User Requirements** for Info-mobility and Inter-modality applications, aimed at increasing safety and efficiency in transport and mobility management

Target System Definition ➔ Reference model, integrating GALILEO for Navigation and S-UMTS for Communication, for providing Location-based services

Demonstrator Design & Development ➔ Real Test bed, built up by exploiting existing facilities and performing new developments where required, for validating the technical feasibility of the Target System

Trial Campaign & Result Evaluation ➔ Trials carried out in the real field, for proving the realised Demonstrator and validating the user benefits and acceptance and market opportunities of the provided services

Market Study, Competitive Analysis & Cost/Benefit Analysis ➔ Market and business analyses for the GAUSS solution, focused on two target customer profiles: consumer market and professional users

Project Dissemination Activities & Exploitation of results ➔ Concertation with related projects/Clusters/Thematic Networks, Dissemination & Exploitation of results, Contribution to relevant standardisation

Project Coordination ➔ Technical Coordination, Team and Activity Coordination, Program Coordination.

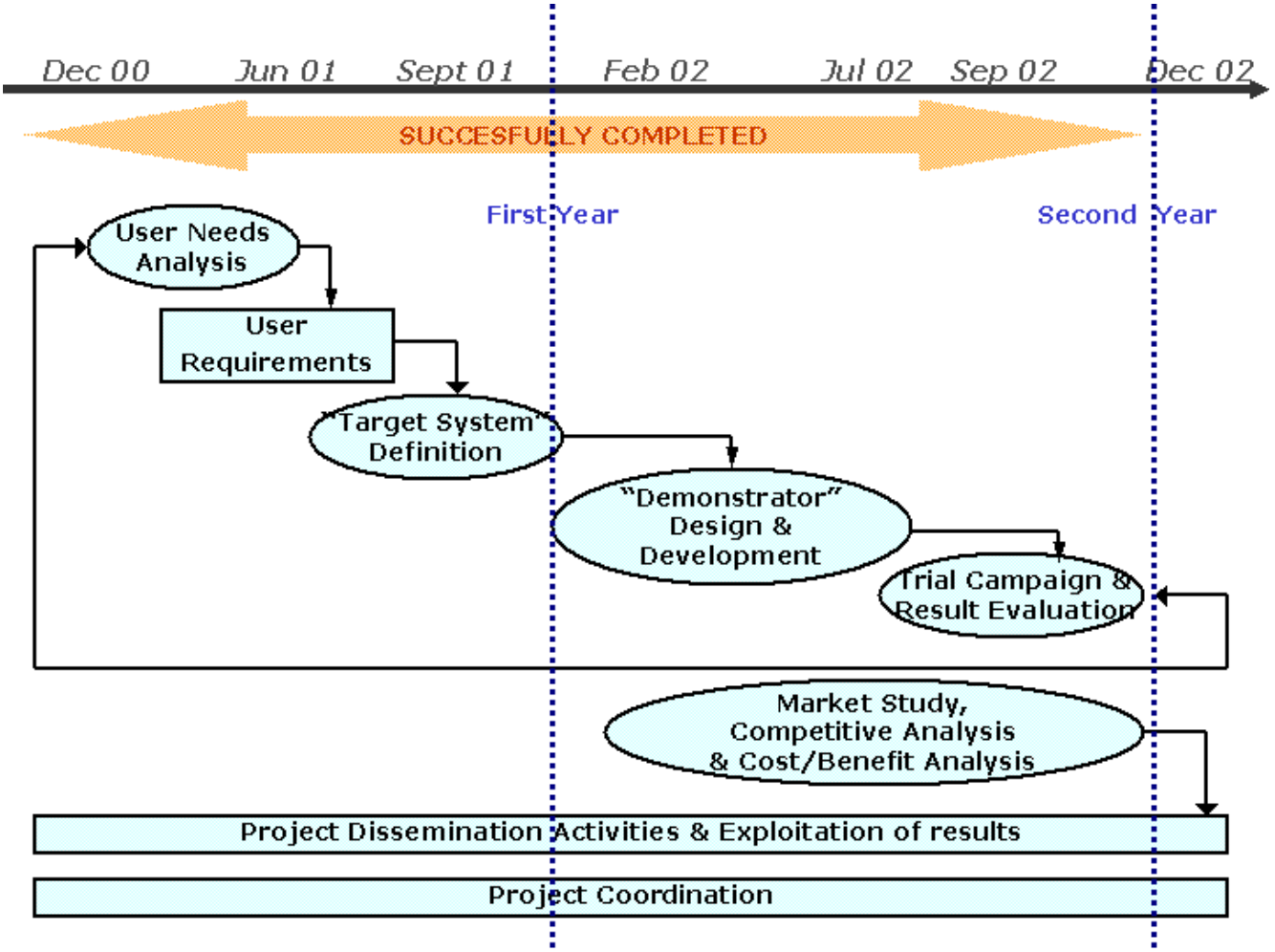

Figure 3-1 GAUSS project Work Methodology

3.2 PROJECT STRUCTURE

The GAUSS project Work Plan is basically split in two main parts (see Figure 3-2):

First Year (WP2, WP3) during which the main effort is focused on the study activities related to:

- The analysis of the framework where the GAUSS project is,
- The user requirements identification, and

- The Target System definition

Second Year (WP4, WP5, WP6, WP7) during which the main effort is put on:

- The Demonstrator design
- The Demonstrator development, Assembly Integration & Testing
- The trial campaign definition and performing (WP6)
- The trial results analysis and evaluation
- The market researches, competitive analysis and cost/benefits study.

During both these phases, besides the project co-ordination and management work (WP1), also the technological transfer, promotion, exploitation, concertation and standardization activities (WP8) are, in parallel, performed.

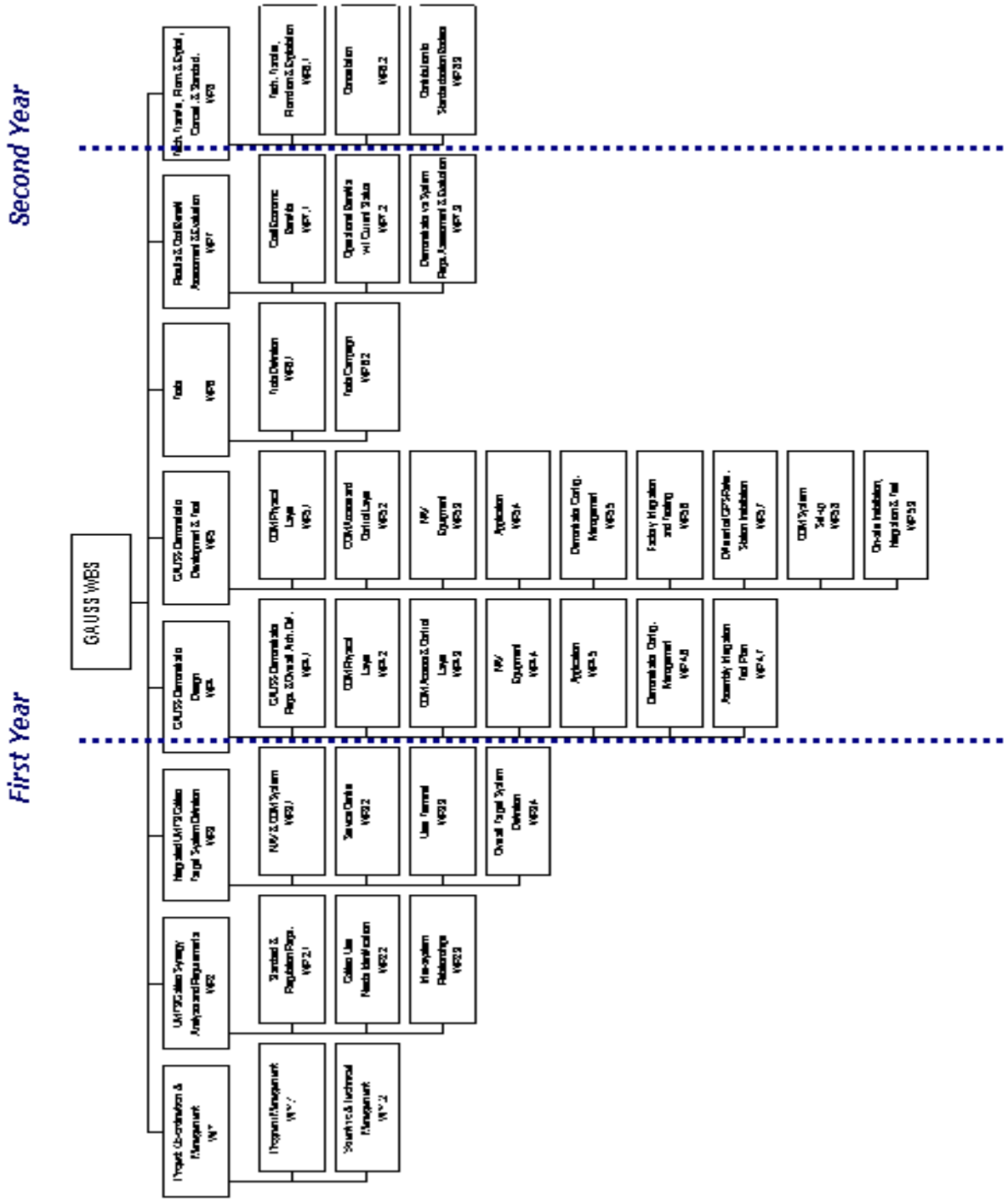

Figure 3-2 GAUSS project Work Plan

3.3 PROJECT CONSORTIUM

A Consortium of nine European companies, with proven experience and complementary skill in the fields of: telecommunication, equipment manufacturing, communication and navigation system engineering and service provisioning. The Consortium includes the following companies: ARNI (Azienda Regionale per la Navigazione Interna, I), ASCOM (CH), ERICSSON Telecomunicazioni (I), GMV (E), TELEFONICA (E), THALES Navigation (F), TTI Norte (E), and TELESPAZIO as project co-ordinator.

Next figure presents the GAUSS Consortium and the relevant work share.

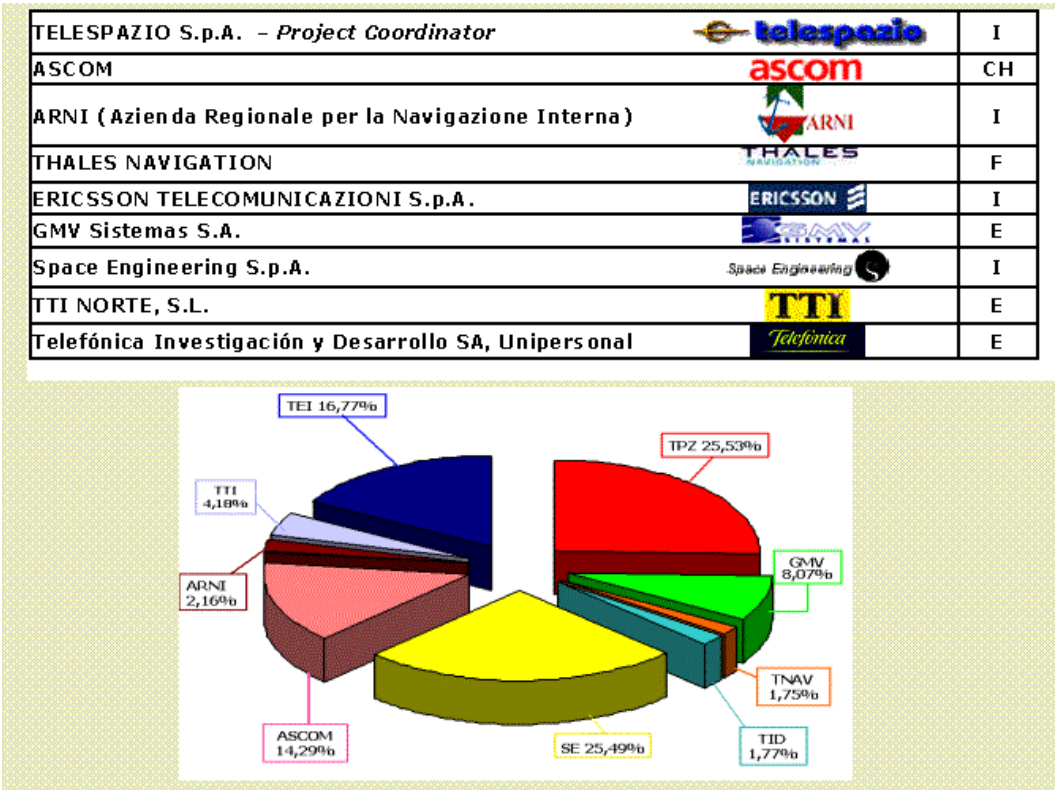

Figure 3-3 GAUSS Consortium and work share

The work allocation of the involved companies is in line with their market and technological prospects, in view of future developments taking benefits from the experience and know-how acquired in the GAUSS project.

- Telespazio (Italy), project coordinator, is responsible of the overall system definition, integration and validation. Furthermore is also responsible for the realisation of integrated communication & navigation applications for supporting the specific Location-Based services.
- GMV (Spain) is mostly involved in the definition of user requirements, definition and development of the software applications.
- Thales Navigation (France) is responsible for the Navigation component of the system, and for the development of the GNSS receiver composing the User Terminal.
- Space Engineering (Italy) role in GAUSS is mainly devoted to the design and development of the S-UMTS CDMA modems for the Forward Link and the digital receive front-end.

- Ascom (Switzerland) is involved in the design and development of the S-UMTS CDMA modems for the Return Link
- Ericsson Telecomuncazioni Italia (Italy) is responsible for the development of the UMTS standard Access & Control Subsystem
- ARNI (Azienda Regionale per la Navigazione Interna, Italy), is involved in the user requirement definition and trial campaign phase
- TTI (Spain) and Telefonica (Spain) are mostly involved in the analysis of the market opportunities and definition of the business plan.

4 MAIN PROJECT RESULTS AND ACHIEVEMENTS

4.1 TECHNICAL ACHIEVEMENTS

4.1.1 Demonstrator Development

A Demonstrator was built up by combining existing facilities with innovative hardware and software components, ad-hoc developed by some of the Consortium Partners.

A complex prototype of User Terminal was produced, integrating off-the-shelf components and technologically advanced parts, based on GNSS1, GALILEO and S-UMTS compatible units.

Mobility e-safety and transport efficient management are the core of the developed applications, purposely designed to make the best use of the resources of the GAUSS system, in terms of integrated Navigation and Communication capabilities: road info-mobility and fleet management, inland waterways vessel traffic management and information, port/terminals appointment monitoring & control, dangerous goods transhipment supervision, emergency assistance.

A trial campaign, run into real environments, was performed in Summer 2002. GAUSS Demonstrator performances and benefits were validated with the direct involvement of an inter-modal transport user (ARNI, Partner of the GAUSS Consortium), specifically operating in inland-waterways and roads. Safety-of-life applications for assisted vessel navigation and for management of hazardous goods (gas) transhipment over the Po river were thoroughly tested and assessed. Applications for emergency assistance, Point of Interest inquiry, localisation of commercial fleet were also proven.

4.1.2 Prototype User Terminal Development

One of the GAUSS objectives is to contribute to the development of an integrated user terminal that is capable to support the required navigation and communication functions. A maximum re-use of available and existing consolidated technologies enabled to reduce design and development risks and costs. This effort is orientated to future low-cost, small size, low power consumption, highly re-configurable user terminals.

A prototype **multi-mode Mobile Terminal** was produced using
ad-hoc developments and off-the-shelf items:

- A integrated NAV / COM digital receive front-end (DFRE),
- able to de-multiplex:
  - The NAV signals:
    - The current GNSS1 band
    - Simulated Galileo bands
  - And the COM signal, in the S-UMTS band

- For COM: a transmit front-end, and a baseband & control section operating in CDMA and supporting the upper protocol layers (UMTS packet transmission standard based – for short packet)

- An RF subsystem, including the L➔S bands conversion

- For NAV: a GNSS (GPS, EGNOS) navigation receiver (RTCM 1 & 3)

- The application based on standard graphic system for position visualisation on digital maps (GIS and freeware map server)

4.1.3 Trial execution

GAUSS successfully demonstrated integrated Satellite Navigation GNSS1 precise positioning based on EGNOS, and satellite UMTS packet communication, for provisioning of high quality location based services. The new technology with respect to the current state-of the art, developed within the project, was validated during the trial campaign, including the implemented broadcasting and multicasting communication of data packet compliant to 3GPP standard (current release 4). In this framework GAUSS had fruitfully contributed to the ETSI SES S-UMTS Working Group activities and results.

Horizontal accuracy better than 3-m was achieved in the trial area (Northern Italy - Lario, Como Lake, Parma and Po river areas). The MTB (Mediterranean Test Bed) was utilised because of the poor performance coverage of the ESTB system over the Italian regions.

GAUSS results open the way to the development and exploitation of advanced technology supporting high quality, reliable and effective services to the citizens for the transport sector and whole mobility domain, in view of GALILEO and UMTS scenarios: emergency assistance, safety-of-life applications, fleet and freight transport management (rail, road, maritime and inland waterway), dangerous goods transportation and containers tracking.

A deep analysis and assessment of the trial results has also been performed, taking into account the feedback from ARNI, a real commercial user of the GAUSS solution directly involved during the trial campaign. As a consequence of the involvement of ARNI during this project phase, it will result in a very realistic environment for the trial campaign. In GAUSS, feedback of the user directly involved in the trial campaign has been analysed, in order to evaluate benefits achievable by the usage of the GAUSS solution in the field of the river transport and assisted navigation. Strong aspect of the technologies adopted in the proposed system is also analysed, along with user acceptance evaluation made by ARNI as real user.

The effectiveness of shifting cargoes onto inland waterways hinges on adequate positioning and communication with the vessels concerned, which are aimed at decreasing safety risks and inefficiencies. The GAUSS trial main objective is to demonstrate that a modern, efficient transport infrastructure is an essential aspect of the free movement of goods and persons. In order to increase the competitiveness of inland navigation and enable a modal shift to waterborne transportation, telematic applications can enhance the safety of navigation while enhancing efficiency.

In this scenario, GAUSS is aimed at meeting these requirements, in view of promoting inland waterways in the transport-infrastructure sector. This aim is in line with the current guidelines of the European Community activities to gradually to implement the trans-European network, through the

integration of the infrastructures for inland, sea and air transport and increasing their inter-operability. This also includes the inland waterways network.

The trial campaign results along with the collected feedback from the involved user show that the use of the GAUSS solution advanced technologies will provide significant possibilities and is definitely expected to:

- Increase the effectiveness of inland waterway transport for the shipping industry and transport operators by improving transport quality and safety
- Set up innovative added value applications
- Boost the building up of an interactive network between all operating parties and using.

As demonstrated during the trials, real-time inland waterway traffic data, linked interactively with logistic planning and management data, creates benefits for consignors, shipping companies, logistic service providers and multimodal transport operators, as well as for transhipment points (ports) and national authorities. Reasons for these benefits are the optimised use and management of resources, the high quality of applications, and the possibilities for flexible reaction in case of any deviation.

Additionally, accurate information about vessel position, integrated with the actual and future situation of the waterway, is the foundation for reaching more accuracy in operation and more flexibility, while the automation of data interchange and the provision of interactive information will cut costs and provide better applications for customers.
Finally, another basic element of the concept is the compliance to certification that is mandatory when dealing with liability and institutional aspects. The use of GALILEO enables to meet this important requirement, considering the current trend in the transport scenario.

As a conclusion, the following achievements have been reached in the GAUSS project, and validated with trials:

- Proven technical feasibility of the GAUSS solution concepts
- Contribution to the creation of high quality services able to fulfil the needs of different users classes
- Improvement of safety and efficiency in transport and mobility management, allowing the development of intermodality scenarios
- Positive impacts on operational and daily activities, also in terms of cost/time savings, thanks to reliable and effective transport and infomobility services
- Demonstration of user benefits achievable from the integrated use of S-UMTS and GALILEO for Safety and Efficiency in transport and mobility
- Identification and validation of niche markets market opportunities, where use of integrated satellite NAV and COM services are fundamental for wide terrestrial network independent coverage
- Possible extension of the use of GAUSS services for other professional markets (such as waterway sea, train, valuable goods), where real-time position, tracing, tracking and information are extremely important

Validation of usage of UMTS for data services in particular for Location-Based services, more strongly for professional markets with respect to the mass market, where competition is very high (in particular form big network operators) and hitting the market requirements is more difficult.

Additionally, there are two main aspects to be also considered:

- **Legal framework**

  Today, the only mandatory equipment on board of vessels are radar and sonic depth finder. As soon as application of telematics has proven its reliability and safety relevance it can expected that this equipment will be put in the mandatory regulations of each country no later than 2005

  Most important institutions are IMO (International Maritime Organisation) and IHO (International Hydro graphic Organisation), whose recommendations/resolutions and current regulations are more oriented to the sea shipping, and not strictly applicable to inland navigation. However, they are applied considering the river as a special case of navigation in restricted and difficult waterways.

  Stringent regulations are dedicated to the digital map and charts used. These shall be taken from orthophotos (hence very accurate) and transformed to be in conform to the S57 standard format. Used symbols shall be certified and registered by the relevant institutions.

- **User Acceptance**

  User acceptance is one of the focus points of diffusion of telematics applied to the daily activities and operations. Evaluation has been done by ARNI, playing the role of the real GAUSS intermodality user, show that diffusion is direct proportional to the user perception of achievable benefits in adopting the GAUSS solutions. The factors driving the user acceptance are:

  - Improvement in communication quality and coverage
  - MMI friendliness
  - Reduction of transport costs
  - Impact on service quality provision.

  Based on the ARNI feedback, trial execution has proven that GAUSS telematics is able to produce positive impacts in terms of:

  - Improved operational efficiency
  - Improved service quality provision
  - Improved working conditions
  - Increased market opportunity.

4.2 TECHNICAL ASSESSMENT

4.2.1 Innovations

The GAUSS project activities enabled to achieve the following main innovations:

- Proving technical feasibility of the Target System concepts
- Integrated use of satellite UMTS COM and GNSS1 NAV technologies for wide terrestrial network independent coverage and real demonstration for Safety and Efficiency in transport and mobility

- Combination of existing facilities, off-the-shelf units and ad-hoc developed components fro the development of an integrated COM and NAV Mobile User Terminal, for S-UMTS communication and GPS, EGNOS and GALILEO navigation
- Implementation of an UMTS low-rate packet-based access system and validation through a real satellite
- Use of GNSS1 for precise positioning
- Applications based on open software and freeware for standardisation, interoperability, expandability
- Demonstration of integrated use of S-UMTS and GALILEO for Safety and Efficiency in transport and mobility
- Validation of market opportunities of future GALILEO services
- Validation of User Benefits in terms of:
  - Contribution to the creation of high quality services able to fulfil the needs of different users classes
  - Improvement of safety and efficiency in transport and mobility management, for the exploitation of intermodality scenarios
  - Provisioning of reliable and effective services, for positive impacts on operational and daily activities and cost/time savings
  - Contribution to the development and diffusion of standard applications and certified technologies for regulated operations and interoperability in the transport chain.

4.2.2 Contribution to the standardisation

GAUSS project had actively contributed to the ESTSI SES S-UMTS Working Group, in particular for the Packet Data Transmission.

For this reason, GAUSS contributed to the **TR 102 061 Packet Transmission Mode**, as a system where S-UMTS packet data transmission had been:

- Designed
- Implemented
- Tested with real satellite capacity.

The main important achievements concerning the GAUSS contribution of the standardisation can be summarised as follows:

- Design and development of a 3GPP Release 4 compliant “Access & Control subsystem” for supporting transmission of small data packets at low data rate, based on:
  - RLC configuration for optimised data packet ACK and retransmission mechanisms
  - Polling time for avoiding useless retransmission
  - Synchronisation with Physical Layers for packet handling
  - Broadcasting and Multicasting functions using static groups

- Design and development of W-CDMA modems designed for:
  - Forward Link: Low data rate
  - Return Link: synchronised bursty and low data rate
- Implemented technology proven during a real demonstration campaign through Satellite capacity

.

4.2.3 Basic Concepts

The GAUSS proposed solution supports highly reliable, near real-time two-way communication between Mobile Users and Service Centre/Provider. The services considered for GAUSS are based on exchange at low data rate transmission of small data packets carrying very accurate positioning & timing information, as typically required by Info-Mobility and Inter-Modality oriented applications. These services are characterised by bursty and unbalanced traffic, generated by a large number of Mobile Users towards a relatively small number of Service Providers, and viceversa from the Service Providers towards widely geographically sparse Mobile Users (i.e. greater amount of traffic in the return link with respect to the forward link).

The GAUSS system supports both asynchronous and synchronous communication, based on:

- broad-casting (i.e. data distribution from a SP to MUs)
- broad-catching (i.e. data collection from MUs to a SP)
- point-to-point schemes.

Resource access is based on CDMA (Code Division Multiple Access), according to the UMTS standard.

The GAUSS system design has an open and flexible architecture, based on the adoption of current standards and consolidated technologies. This represents one of the challenging aspects of the GAUSS system: flexibility and conformity to widely adopted standards, while reducing design and development risks and costs, guarantee compatibility with current and future NAV and COM systems, and capability to be fully integrated with available infrastructure for providing complementary added-value services.

The key element of the GAUSS defined system is the NAV and COM integration and the synergy achievable from the two technologies, based on criteria of providing the specified services with maximum efficiency.

Main design concepts are at the basis of the GAUSS solution:

- A common flexible format message for all the applications, based on 424-bit cells which are able to carry the required information:
  - Single-cell messages
  - Multiple-cell messages (up to 8 concatenated cells) are supported.
  - GAUSS packet is the bit stream including the GAUSS cell plus the overhead for EDC and preamble for burst transmission.
- The open architecture based on current standard interfaces and protocols

- The compliance to S-UMTS standards, suitably adapted and optimised to support the envisaged low bit-rate data services envisaged
- New developments starting from the usage of consolidated and existing technologies
- Tight harmonisation between the Terrestrial 3G Mobile System and the Satellite components for supporting the integrated NAV/COM Services, with the perspective of deploying a single highly-integrated network, based on:
  - Common Core Network, but distinct Radio Access Networks
  - And a future Single User Terminal (dual mode) for Satellite and Terrestrial access.

The radio access of the GAUSS system towards the external networks is conceived as a distinct RAN of the S-UMTS family, optimised for low-bit rate packet-based services. The standard interface towards the Core Network ensures compatibility and inter-operability with 3GPP systems. This is not against the common vision of the UMTS to be a system mainly aiming at the high bit-rate mobile service market. GAUSS has not to be intended as a competitor with other systems (UMTS itself), but a system capable of fulfilling effectively and efficiently the requirements of inter-modality and info-mobility applications compatible with the GAUSS concepts (small size messages, low bit rate). The background guideline of the designed architecture is that of pursuing an open standard for the communication services to be integrated with the navigation ones, rather that a proprietary standard.

In this framework, it has to be noted that the GAUSS architecture is compliant with the current assessed release 4 of the UMTS, and some optimisations are applied for taking into account the envisaged low-rate data transmission. More specifically:

- The radio access scheme designed to use as much of the work done for S-UMTS as possible, and appropriately adapted

The radio protocol layer designed to be compliant to the standard, and optimised to support the defined services.

4.3 MARKET STUDIES

4.3.1 Overview and Study Assumptions

An important phase of the GAUSS project was the market studies and cost/benefit analysis, with the main purpose of performing a comprehensive GAUSS market analysis, in terms of its position in the market, business plan and cost/benefit ratio.

The analysis had been carried on, considering both the future scenario for GAUSS and the built-up Demonstrator system. In the first case, the two possible architectures envisaged for the GAUSS Target System, differing one other from the satellite constellation implementation scenario, had been taken into account.

Furthermore, the analysis of the GAUSS competitive systems, both existing and planned ones, had been carried on, and subsequent evaluation of the GAUSS solution with respect to the identified competitive systems, had also been performed. The main purpose of the subject analysis has been to:

- Gain a realistic picture of the location bases services (LBS) market in Europe today in terms of revenue, market size and market segmentation
- Identify which applications are the most successful today and learn from business models that are supporting them

- Determine how personalised content when linked with presence and privacy management will generate new revenue streams
- Assess how bundling positioning functions with third generation mobile communications will drive the uptake of LBS
- Fit the GAUSS solution within the identified scenario in order to get a realistic dimensioning of its market size
- Analyse the techno-economical viability for a possible commercial introduction of the proposed solution, identification of potential actors/players (operators, manufacturers, professional and mass market users, service providers, authorities, etc.), cost/benefit analysis and new services opportunities.

As a general framework for the study, the following criteria has been taken to bound the study:

- Time period: 2008-2020
- Geographical area considered: Europe
- Market segments: inter-modality and info-mobility
- Galileo will be operational in 2008
- T-UMTS will be widely adopted in Europe in 2008
- GAUSS will be operational either with a COM payload on board Galileo satellites or with a different S-UMTS constellation or satellite.
- GAUSS users terminals will be available on the market.

Furthermore, the following considerations must be taken into account:

– Any market research or commercial feasibility analysis of a new service (satellite service in the case of GAUSS) must prove in a credible way that its proposed business plan is profitable, and that the IRR (Investment Return Ratio) is attractive enough to convince investors. This business plan suitability demonstration must take a number of logically connected steps, which are defined by the methodology of the study.

– In any business plan, and even more in the present one, there are some uncertainties about commercial and technical choices, and also some assumptions for yet unknown values, so any business plan is subject to some degree of inaccuracy. Then the more realistic and accurate a business study take the assumptions, the better and more realistic and credible that study is. In the following case of GAUSS commercially feasibility analysis, being explored, the assumptions are always justified with some rationales and background, and there is pessimistic-optimistic bounds to avoid too shallow conclusions.

4.3.2 The methodology

Next figure presents the methodology used for the GAUSS market researches, cost/benefit study and financial analyses.

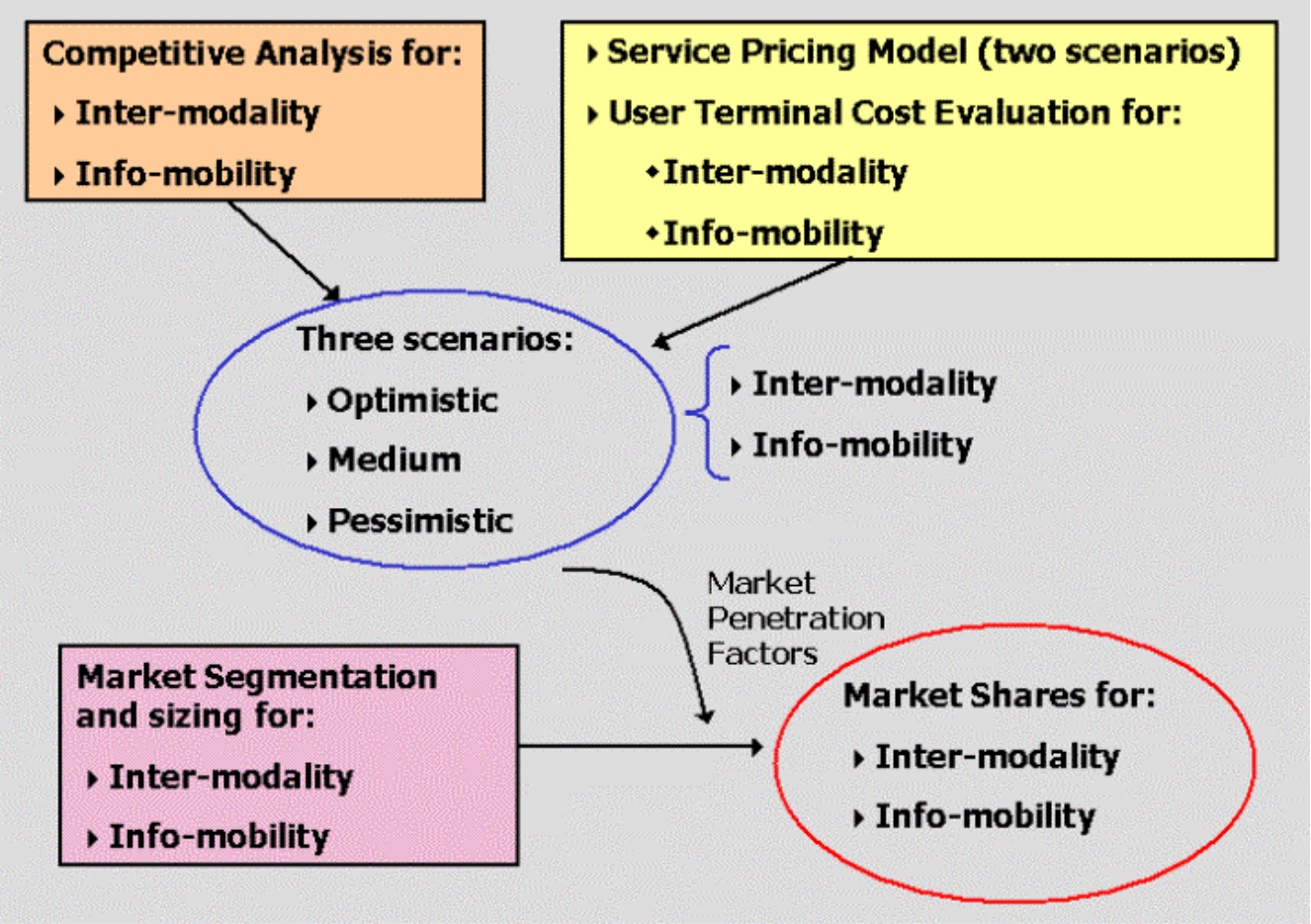

Figure 4-1 GAUSS Market Study methodology

The methodology starts with the analysis of the main GAUSS applications, to understand the typical users, services and terminal needs. An important differentiation must be done with regard to the Info-mobility and the Inter-modality. The competitive environment is analysed next, studying the competing systems that can offer services with technical performances that match those offered in GAUSS. These competing systems will represent a key benchmark for GAUSS services and terminals prices calculation. A second input for those costs will be coming from the GAUSS service provisioning real running costs, as the service has at least pay off its real running cost. The GAUSS services and terminals costs will lay somewhere around those two figures. With the costs of the GAUSS services, and the GAUSS real costs, it is possible to start the market research analysis that will proceed by studying the potential and the expected acquired markets for Info-mobility and Inter-modality. Given the fact that the acquired market will strongly depend of the competing systems and their relative positioning with respect to GAUSS, the market research must be done for three basic market cases: optimistic where GAUSS type of services are just provided by GAUSS system, a medium case where there is just one competing system offering similar performance and pricing, and a pessimistic scenario where there will be strong competition for the GAUSS users, with at least three (or more systems) offering those services.

Once that the acquired market is found out for those three scenarios, then the multi-year business case can be evaluated, from the point of view of different actors in the GAUSS scenario, and for the main applications of Info-mobility and Inter-modality. The conclusion of this business plan must be a

credible financial report where the profit figures are presented backed by the study and the number of realistic assumptions. Furthermore, some sensitive analyses of the profits, in functions of the assumptions, are also done.

4.3.3 Summary of Main Results

It shall be noted that for the business analysis, some basic assumptions, which make sense for GAUSS due to the involved technologies (UMTS and Galileo), have been considered as applicable, in terms of time range, addressed markets and target geographical area. Furthermore, the study has considered the different implications due to the two architecture scenarios for the Galileo and Satellite communication infrastructure, as envisaged in the Target System: NAV and COM P/L co-located on the Galileo satellites or located in different constellations.

The work has been carried out through the following main steps.

The study starts with an exhaustive **competitive analysis** carried on, considering the summary outlook of the GAUSS framework and the proposed solution. The GAUSS satellite based solution quality of services has been compared to terrestrial and satellite based solutions. The performed analysis has covered the potential GAUSS competitive systems, for the communication and navigation components, terrestrial and satellite solutions have been considered. Two different scenario have result from the performed analysis, correspondingly to the two different addressed markets. For infomobility, the more relaxed requirements in terms of quality of services, make systems based on terrestrial communication real competitors for the GAUSS solution. In the case of intermodality, the stringent user requirements for coverage, latency and service availability, make a dropping selection of the terrestrial based systems.

In parallel a **pricing structure** has been defined for the GAUSS services, along with an estimation of the user terminal costs. For the price scheme, reference has been made to that adopted in most telecommunication systems, envisaging a **subscription fee**, a **monthly fee**, and a **pay-per-use fee for messages**. However, possibilities that these schemes will be modified (for example, dropping of subscription or monthly for remaining competitive) have been also taken into account. The price of the message has been estimated by calculating the compensation of the operational costs and value chain actors margins, integrated with the GEMINUS suggested price.

GAUSS Pricing Scheme

Service Pricing Model:

- Initial (Access) Fee
- Monthly Fee
- Pay per use (message)

User Terminal Costs:

- Inter-modality
- Info-mobility

Cases of large production also considered

		INTERMODALITY	INFOMOBILITY
INITIAL FEE			
NAVCOM INT		15€	10€
S-UMTS PAYLOAD		20€	15€
MONTHLY FEE	NAV/COM INTEGRATED PAYLOAD	0 – 10 €	0 – 5 €
	S-UMTS PAYLOAD	0 - 15 €	0 - 10 €
MESSAGE PRICE	NAV/COM INTEGRATED PAYLOAD	0,01 **Normal** 0,04 **Safety-related**	
	S-UMTS PAYLOAD	0,01 **Normal** 0,04 **Safety-related** + roaming usage of terrestrial mobile networks	

- Two scenarios: NAV/COM P/L co-located and not co-located
- Pricing definition for Intermodality and Infomobility market segments
- Relevant margins for Satellite Operator, Service Centre and Service Provider taken into account

Figure 4-2 GAUSS pricing scheme

In this calculation, values as much as realistic as possible have been used to evaluate the operational costs in the two cases: NAV and COM P/L co-located on the GALILEO satellites, or located in different constellations.

The **cost of the user terminals** has also been calculated, for both intermodality and infomobility usage, based on the evaluation of the component costs in the 2004 (the time range considered for GAUSS), and taking into account possible reduction due to high number production.

Hence, based on the prices of GAUSS services and mobile terminals and on the output of the competitive analysis, three scenarios have been identified for the info-mobility and inter-modality markets, based on the number of potential competitors: **pessimistic, optimistic** and **medium** cases. Correspondingly, the relevant **penetration factors** have been also identified.

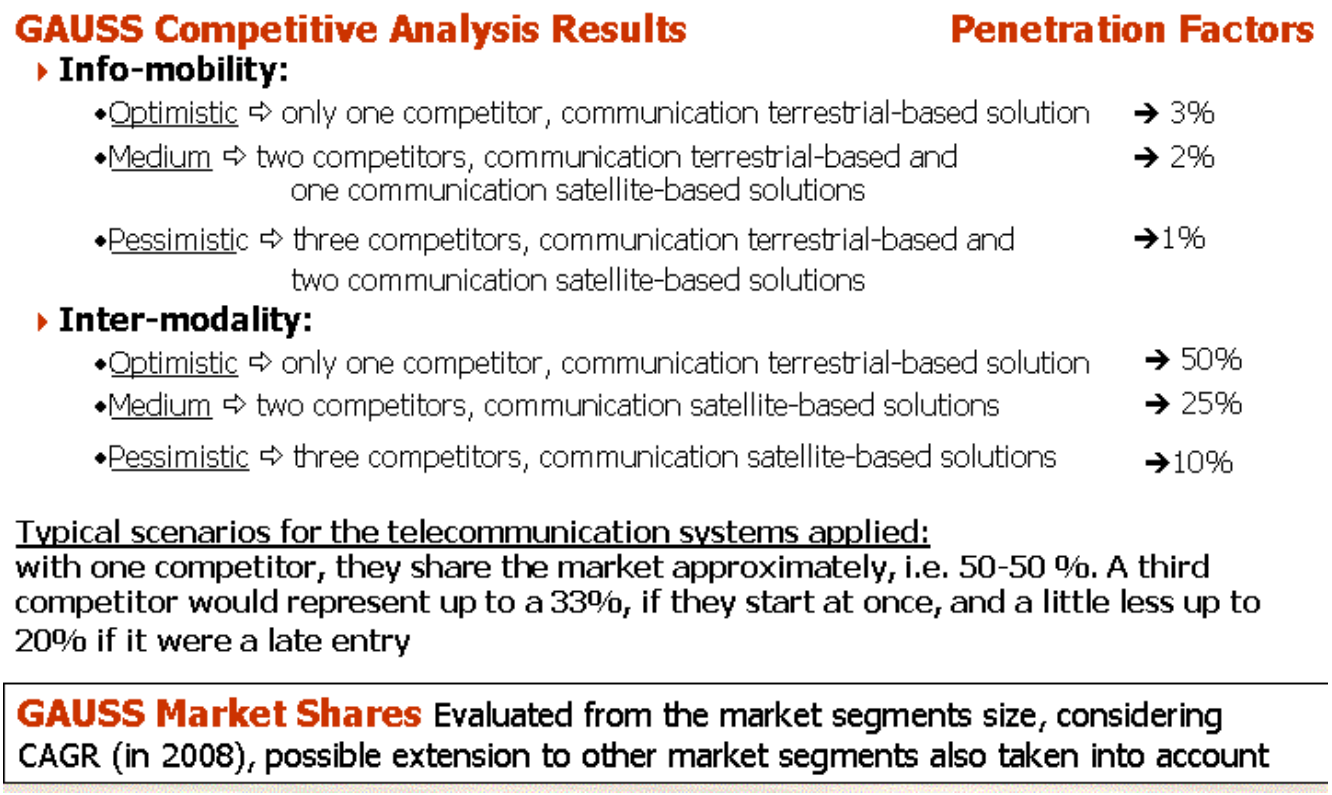

Figure 4-3 GAUSS Competitive Analysis Summary

Next step has been the **market analysis**. An evaluation of the target market has been done, using the last updated **available statistical data on transport**:

– Annual Bulletin of Transport Statistics of the United Nations Economic Commission for Europe, 2001 edition

– Panorama of transport (Eurostat), 2001 edition

The **size of the potential market** has been defined, considering the EU15 and new accession countries (in 2008) statistics. Based on three cases before identified, the **market share** relevant to the info-mobility and inter-modality applications for the pessimistic/optimistic/medium scenarios has been calculated. Extension to other market segments for which the GAUSS services can be employed, is also considered.

Then the **business models** have been studies in the scenarios of info-mobility and inter-modality, along with the **business cases** of some actors in the GAUSS value chain: the Service Centre, the Service Providers for info-mobility and inter-modality/inland vessel navigation, User Terminal Manufactures. The selection of these business cases has been carried out by considering the know-how and the business areas of the companies involved in the project, with the purpose to provide a picture as much realistic as possible. For each business case, the **financial analysis** has been done, along with some **risk sensitive analysis** considerations.

Next figures present the GAUSS value chain and business models for the inter-modality and info-mobility cases.

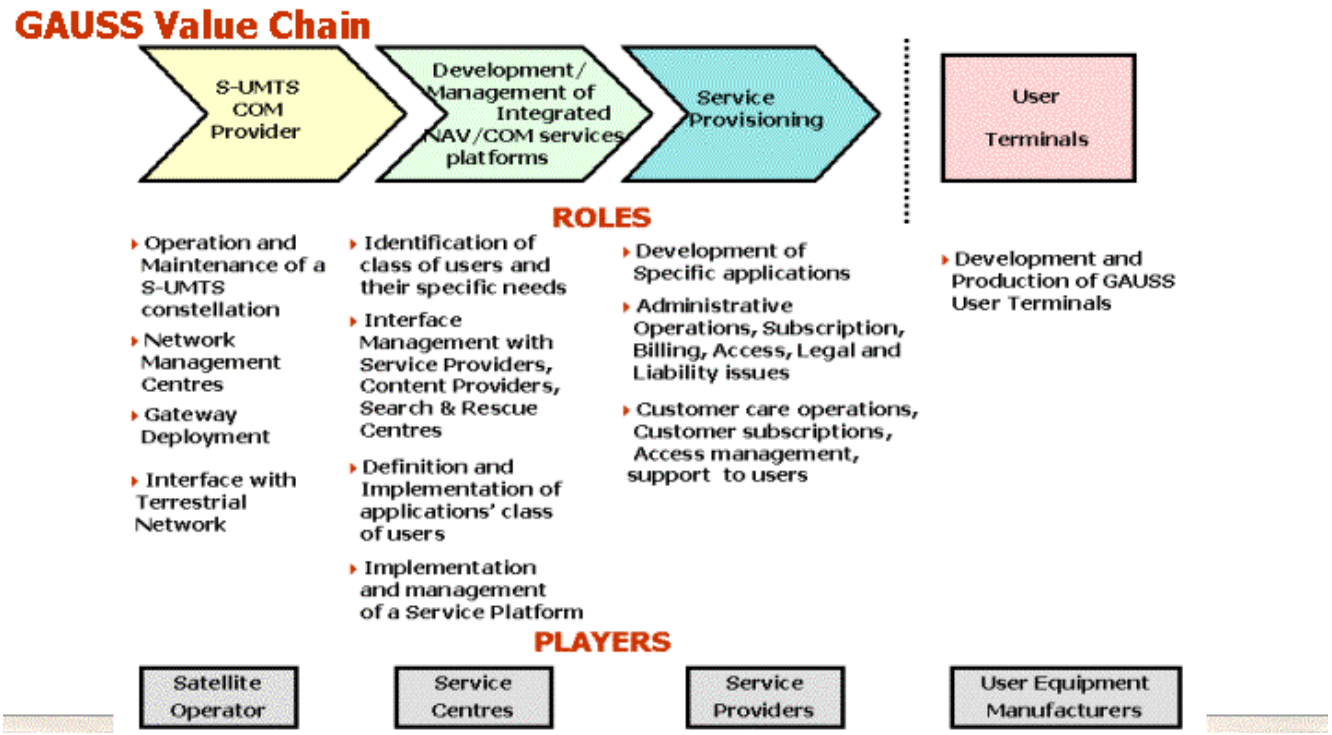

Figure 4-4 GAUSS Value Chain

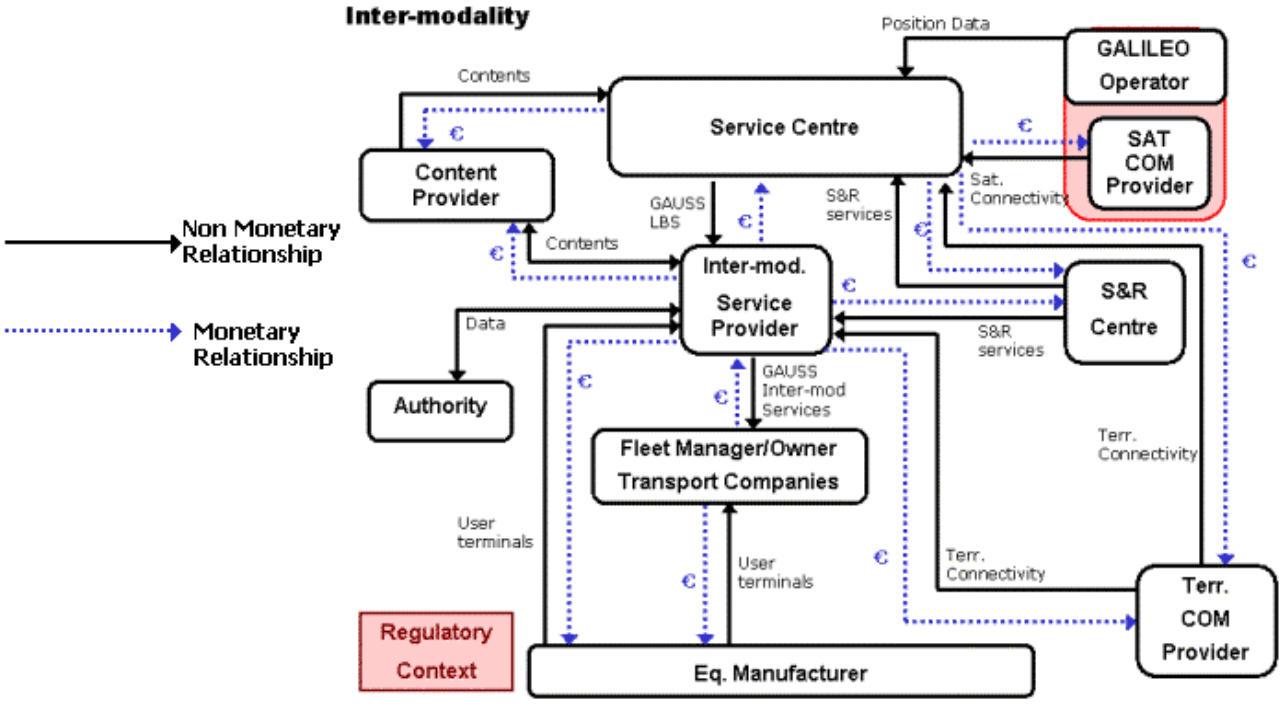

Figure 4-5 GAUSS Business Model Inter-modality case

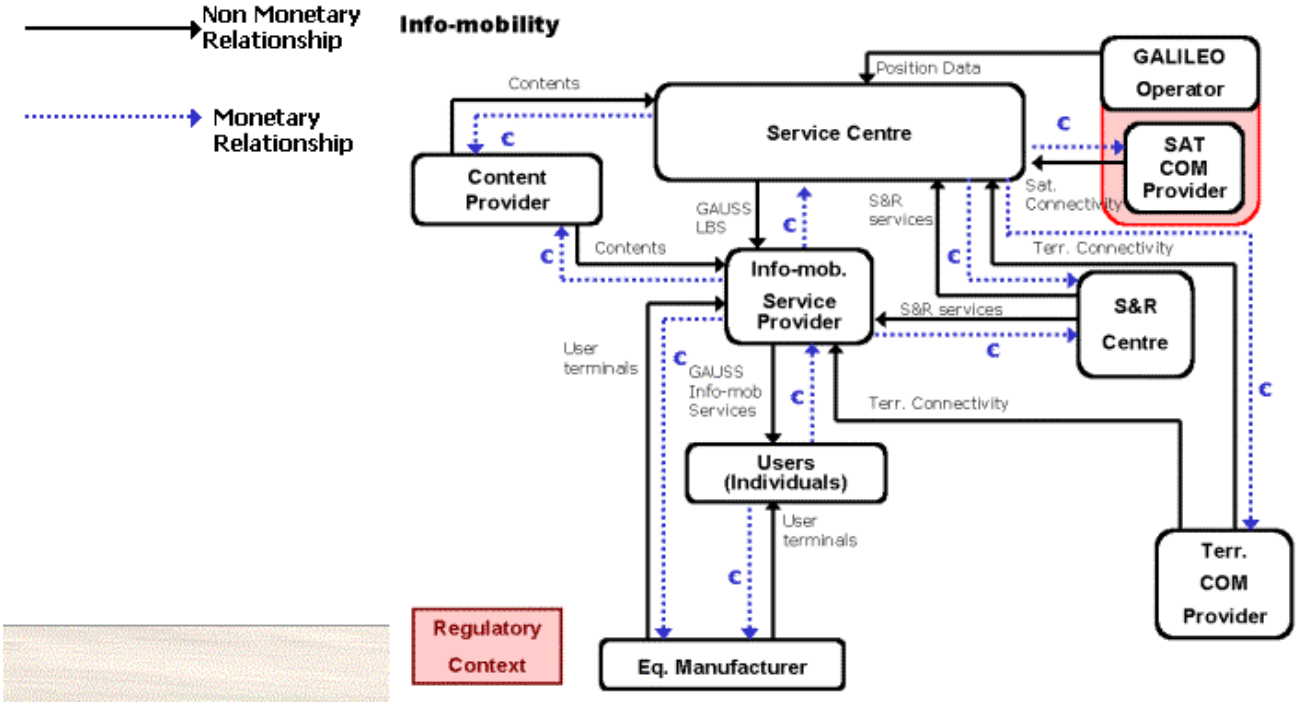

Figure 4-6 GAUSS Business Model Info-mobility case

The financial analyses have been done for the three scenarios before identified (optimistic, pessimistic and medium). Impacts due to the two different architectures for the NAV and COM P/L (co-located on the GALILEO satellites or located in different constellation) have also been taken into account, when applicable.

5 PROJECT DOCUMENTATION

5.1 PROJECT DELIVERABLES

The list of deliverable documents is included in the Document Reference List (section 1.7).

5.2 DISSEMINATION AND CONCERTATION

A huge activity of dissemination and concertation had been carried on in the project.

In the following, the list of the GAUSS project papers and presentations, performed so far. They have to be considered in addition to the nominal concertation activity, previously described.

They represent the clear evidence of the strong dissemination and concertation activity performed by the GAUSS project.

5.2.1 List of Project papers

- ESA DSP 2001 - 7th International Workshop on Digital Signal Processing Techniques for Space Communications, Sesimbra-Lisbon, 1-3 October 2001
- NAVITEC'2001 First ESA Workshop on Satellite Navigation User Equipment Technologies, Noordwijk, The Netherlands, 10-12 December 2001
- EMPS 2002, 5th European Workshop on Mobile/Personal Satcoms, 25-26 September 2002, Baveno-Stresa, Lake Maggiore, Italy
- GNSS2003, abstract submitted for a paper and poster presentation, 22-25 April 2003 Graz, Austria

5.2.2 Presentations

- 1th SWAN Forum on Intelligent Shipping - London, 19 March 2001
- IST-Workshop on DATA SERVICE EVOLUTION in Wireless, Satellite and Mobile Domains - Turin, 29-30 March 2001
- 6th International Business Forum on MOBILE SYSTEMS - Moscow, 26-30 March 2001, 1th Location-Based Service Cluster Meeting - Paris, 17 May 2001
- 3th Location-Based Service Cluster (LOBSTER) Meeting - Sitges-Barcelona - Spain, 10 September 2001
- EURISY Conference - Management of Dangerous Goods' Tranport and Relief Convoys: Integrating the Space Solution, Naples - Italy, 18-19 October 2001
- EUROWAYS - Forum Italiano Aerospaziale 2001
- NAVSAT 2001 - Satellite navigation and positioning world show, Nice France, 13-14-15 November 2001
- 3rd International Conference - LOCAL ECONOMY AND ADVANCED RESEARCH IN THE NEW WORLD SCENARIOS - From Galileo satellites to environment and security technologies, Varese, 3 December 2001

- 2nd IST Workshop on DATA SERVCES EVOLUTION in Wireless, Satellite and Mobile Domains - State of the art and perspectives, Turin, 24 - 25 January 2002
- TC-SES WG S-UMTS, 14th Meeting, 21-22.03.2002
- International seminar "European cooperation on mobile personal communication-IST projects" - Svyaz' Expocom Exhibition, Moscow, 13-17 May 2002
- Forum Italiano Aerospaziale 2002 and SAT ECONOMY Conference, Milan, 8 July 2002
- Advanced Satellite Mobile System - Task Force, ESTEC, Noordwijk, 11 July 2002
- E-safety Exhibition (EC stand), Lyon 16-18 September 2002
- 8th Ka utilisation Conference, Baveno (Stresa) Italy
- NAVSAT 2002 - Satellite navigation and positioning world show, Nice France, 12-13-14-15 November 2002
- Participation to the Satexpo, Vicenza October 2002
- Participation to the IST2002 summit, Copenhagen November 2002
- Participation to the ASMS-TF, November 2002
- Participation to the next LOBSTER concertation meeting, 09 December 2002 (presentation of the project results)
- Presentation to the Galileo Information Meeting - Opportunities for the Telecommunication sector, Brussels 17 December 2002

5.2.3 Contributions

- Contribution with user requirements to the LOBSTER User requirement database
- Contribution to the ATLANTIC questionnaire on info-mobility service development
- Contribution to the ASMS-TF WG3
- Contribution to the Galileo News Letter
- Preparation of a paper for Special Issue of the International Journal of Satellite Communications (which will feature selected satellite projects funded under the EC's IST Fifth Framework Programme), January 2003.

5.2.4 Publicity Material

- Brochure
- Leaflet
- Sticker
- Poster.

5.3 PLANS FOR THE FUTURE

GAUSS results will be exploited in the framework of the FP6, in order to continue the development of NAVIGATION and COMMUNICATION integrated technologies for transport and mobility management.

6 CONCLUSIONS AND OUTLOOK

In the following conclusions are done for the commercial and market opportunities, where GAUSS results can be exploited.

The following market segments are considered in GAUSS:

1. info-mobility mass market
2. inter-modality/river professional market
3. inter-modality/road market.

1. In the first scenario, the end users are drivers of road vehicles. Since info-mobility applications involve the safety of the vehicle occupants, certification and liability issue is mandatory in order to establish the appropriate level of liability of the service provider and the legal and institutional implications. Regulation and legislative support as well as the clear definition of service responsibilities are necessary for the success of the GAUSS solution. Furthermore, the reliability of the positioning information, in terms of guaranteed continuity and integrity (thanks to the use of Galileo), will permit an efficient and effective implementation of drive assistance services. This definitely represents a challenge for GAUSS, giving the opportunity to penetrate the multi-million user market.
2. Today, a great emphasis is placed on the tracking and monitoring of vehicle. For a transport company operating competitively on a European wide basis, effective fleet management is essential. A fleet management system brings many benefits including optimal vehicle & personnel usage, reduce operating costs, and potentially, greater security of hazardous, dangerous and valuable goods. Technologies now exist that allows the position reporting of a fleet vehicles in near real-time, current fleet management systems perform adequately and allow fleet managers to manage and control their fleets. However, the market is still emerging and it is clear that the presence of a satellite navigation system that is both accurate and reliable. Satellite positioning is a fundamental component of a system that allows fleet managers to monitor and control their vehicles. The application of GAUSS solution is expected to be a differentiator within other fleet management applications, in terms of performance and certificability issues. Furthermore, the use of Galileo as positioning system, will enable to develop a common platform for support all mode of transportation, guaranteeing correctness of information, integrity, certified and regulated services.
3. The last part of the study is focused on the application of the GAUSS solution to the inter-modality/inland navigation, that is the real environment of the trials execution. Based on the results of the executed trial campaign, along with the feedback collected from the real user involved in the trials, the analysis of cost/benefits of the application of the GAUSS solution to the inland navigation transport has been carried out.

There are some considerations and recommendations that can be done, in terms of architecture and applications, as summarised in the following.

In terms of system architecture, it has been traded off along the business analysis the two basic scenarios

- The one envisaging the NAV and COM P/L co-located on the same satellites (named scenario ‘one’)

- And the scenario where they are not co-located (named scenario 'two').

In order to be comprehensive in the study, two parallel analysis have been performed in the two scenarios, showing that they are comparable in terms of costs and services pricing. A better quality of services will be guaranteed in the scenario 'one', thanks to the complete synergy and integration of NAV and COM functions. Moreover, the scenario one will allow some synergies at marketing, terminal development, and system operation viewpoints. The scenario one is expected to lead an increment in terms of penetration in the target market and increasing of confidence towards the provided services. However, the current satellite scenario seems to favour the scenario two, as it is unlikely that GALILEO will carry a COM payload on-board. Consequently the conclusions derived in scenario two are very likely the one applicable.

For what applications are concerned, it has been demonstrated that the development of new technology solutions is capable to greatly improve the river transport, in terms of safety and effectiveness, where the mobility in restricted and low-depth waters requires a high need for accurate positioning and timely information exchange, collection and processing. Furthermore, for the inter-modality, when conveyance involves different modes of transport (rails, roads, air, inland and sea waterways), distribution of information across the different modes of transport and standardisation play an important role: freight operators are attracted by the benefits achievable with an efficient and timely management of their resources, especially planning and real-time re-planning at port/terminal appointments.

It shall be noted that these issues are particularly strengthened in the case of dangerous goods transhipment. As a matter of fact, there is a great potential of endangering human life and damaging our environment, caused by possible mishaps in the course of transportation.

It has been addressed that present day inland navigation is based on voice communication and shipboard radar. More information needs to be available and presented to ships' crew as traffic density areas, movement of any dangerous goods, vessel grow larger and in consequence have more limited manoeuvrability. In order to ensure safety, operations are slow, resulting in limited efficiency that makes the inland waterway a bottleneck of the inter-modal transport chain. Additionally, the lack and inadequacy of infrastructure represent a barrier between means of transport and prevented their optimum combination.

The above factors lead to low reliability of inland navigation, resulting in its slow economic development and diffusion as means of transport. Currently, transport agents and shippers rarely consider the options offered by inland navigation as part of a holistic logistics network.

The validation of the GAUSS Demonstrator performed using a boat carrying GPL over the river and on the road, is very representative, in particular thanks to the involvement of a real inland navigation inter-modal user. The main purpose is to thoroughly and realistically prove the developed applications for assisted vessel navigation and for control of hazardous freight transportation, along with road typical info-mobility and emergency assistance services. Hence such a real environment used during the trial campaign, guarantees the results being very representative for proving the developed applications and provided services.

At present, the congested traffic on roads is leading to transport network saturation. As road infrastructures cannot be expanded indefinitely, efficiency can be attained by moving to a multi-modal environment. However, the poor acceptance of the Po waterway (and more in general, the inland waterways) is based on bottlenecks in its navigability, a lack of investment in transhipment and fleet infrastructure, and the weak quality of applications, especially where reliability is concerned.

The analysis of potential benefits that can be achieved by the application of telematic solution to the Po inland navigation system, has showed that a bundle of attractive applications based on navigation and two-way communication will generate:

- Commercial advantages for users (e.g. ship operators, port authorities, consignors, consignees, operators of other modes of transport)
- Socio-economic benefits for authorities (e.g. supreme shipping authorities, customs and passenger control, canal authorities).

As far as the info-mobility is concerned, the GAUSS solution is in line with the current trend of developing services aimed at improving the user mobility, such as emergency assistance and driver information. There is currently also a certain interest towards the use of the satellite, for guaranteeing coverage and reliable services (in particular for emergency services). Furthermore, the GAUSS solution, thanks to its flexibility, is also capable of further extension to provide added-value contents that, according to the latest market researches, will be of great interest for the users (such as traffic and news).

As a conclusion, some considerations can be done from the analysis of the business plans studied in this document. Even if conservative hypothesis have been done, the potential market for location based services is very huge, in particular for the info-mobility services. What is very clear from the studies performed, is that the dimensioning of the market shares is the most crucial variable, and figures resulting from the financial analyses change drastically when considering the different scenarios (optimistic, pessimistic, medium), scenarios that are associated to various competing environments

Hence, the main recommendations coming out from this study are the following:

First is a warning, for today common among actors operating in the development of location based service: deeply understanding the user requirement and needs is important in order to hit the target market and realise services that the users are willing to pay, because the sensitivity of the market shares is key in any business plan.

For these reasons, flexibility and openness of the solution (in terms of technologies and interfaces) are the key factors, enabling high degree of adaptation for realisation of the so-called “Killer applications” for satisfying the different needs coming from the market.

Second is the evidence of a great potentiality in terms of business perspectives that a service offer like GAUSS has for the identified customer bases, specially in the Inter-modality sector, for which a demo has been successfully performed.

And third is the confirmation that from a technical viewpoint, for a better QOS and synergies, a system based in payloads embarked in commons satellites is superior to a system with payloads in independent systems.