Service Provision Aspects within GALILEO

Ian E. Casewell & Gordon T. Johnston
Civil GPS Service Interface Committee
1st December 2000

RACAL

GALILEO - WHY?

- There is increasing concern over growing world (European) dependency on the US military GPS for Navigation and timing needs

- GPS offers no service level agreements, T's and C's, & is not suitable for Safety of Life applications

- Europe foresees a civil owned, civil managed, comprehensive, high performance, navigation, positioning and timing system with a communications backbone

- Galileo will have defined service levels and will be certifiable

- Galileo will support a multi-modal single European transport market

- Galileo represents major opportunities for European Industry in space technology, ground systems and user/applications equipment

- Security issues will be considered

- Galileo is therefore the European version of GPS with significant extra benefits

RACAL

Current Studies

Four parallel studies run by EC:
- Overall Architecture, GALA
- EGNOS integration, INTEG
- Support to Standardisation, SAGA
- Service Definition, GEMINUS

Plus:
- ESA GALILEOSAT study

RACAL

GALA Study Structure

- 12 Top level work packages:
  - **Applications definition and sizing**
  - **Overall requirements and system trade offs**
  - **Galileo overall architecture**
  - **User segment definition**
  - **Components Definition**
  - **Safety analysis**
  - **Support segment**
  - **Pilot Projects**
  - **Programmatic and business issues**
  - **Liaison with other activities**
  - **Program management**
  - **GAST**

RACAL

Objectives

- To identify relevant applications.

- Define a small number of market driven services.

- Identify and define potential Galileo applications.

- For each of these applications we must:
    - determine the user requirements,
    - map each application on to a service,
    - forecast market size,
    - estimate revenue,

- To provide recommendations for the GALA programmatics and pilot projects work packages.
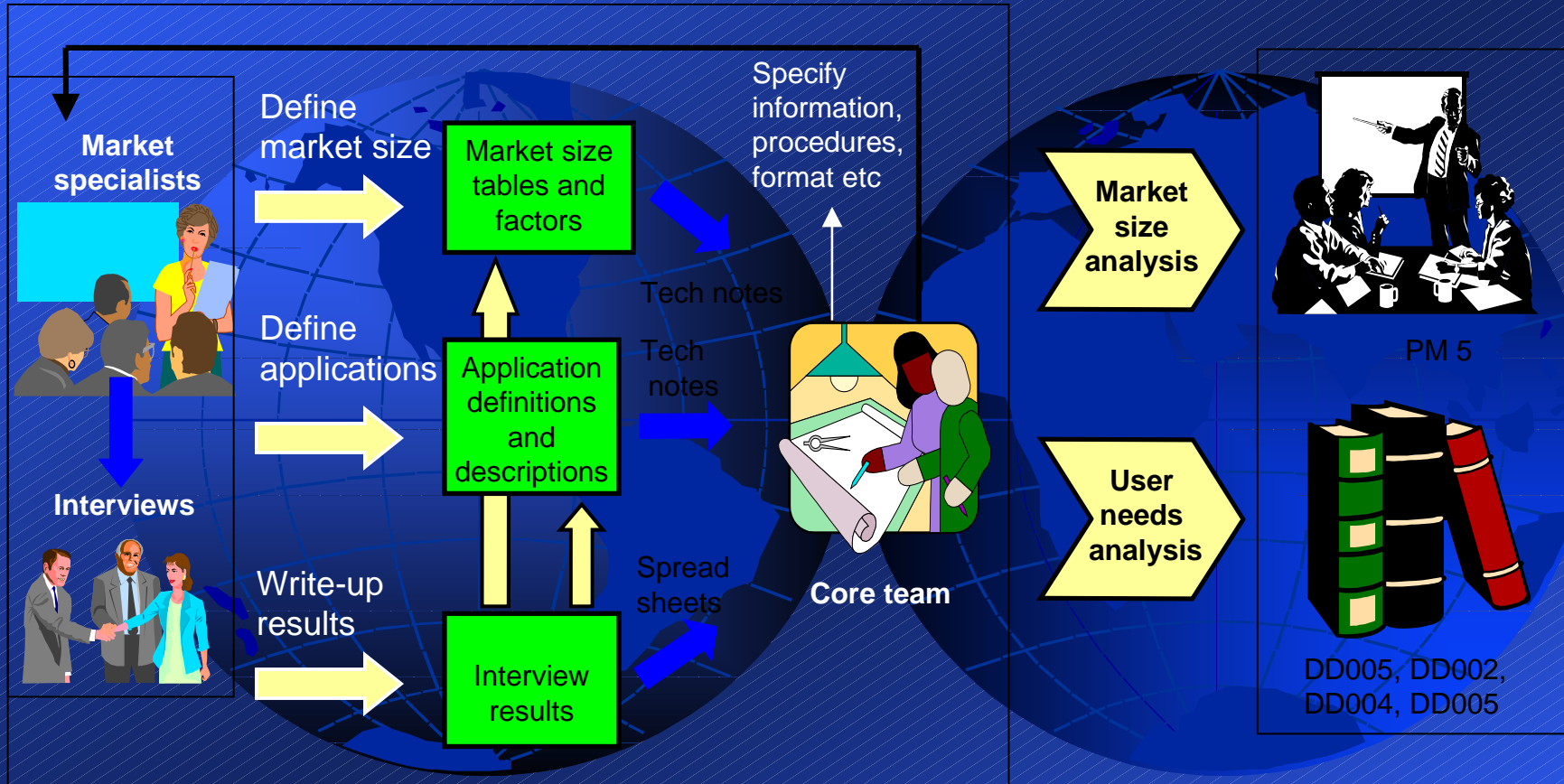
RACAL

Predicting the future

"It is far better to foresee even without certainty than not to foresee at all. "

Henri Poincaré in *The Foundations of Science*.

RACAL

Team Organization

Overall method

Applications Defintion and Sizing

Navigation user requirements results

RACAL

Applications definition

- **The list of applications:**
  - **has been fully revised during Phase 2 to improve size estimate**
  - **addresses wide variety:**
    - of host platforms
    - environments
    - wide variety of sub-markets

- **Applications have been studied in three high level market sectors:**

	All	High Priority[1] (HP)
safety of life market:	30	23
mass market:	17	8
professional market:	45	13

---

[1] High Priority defined as an application which provides key infrastructure or has a net revenue of > 14M

RACAL

Applications

Position accuracy and integrity
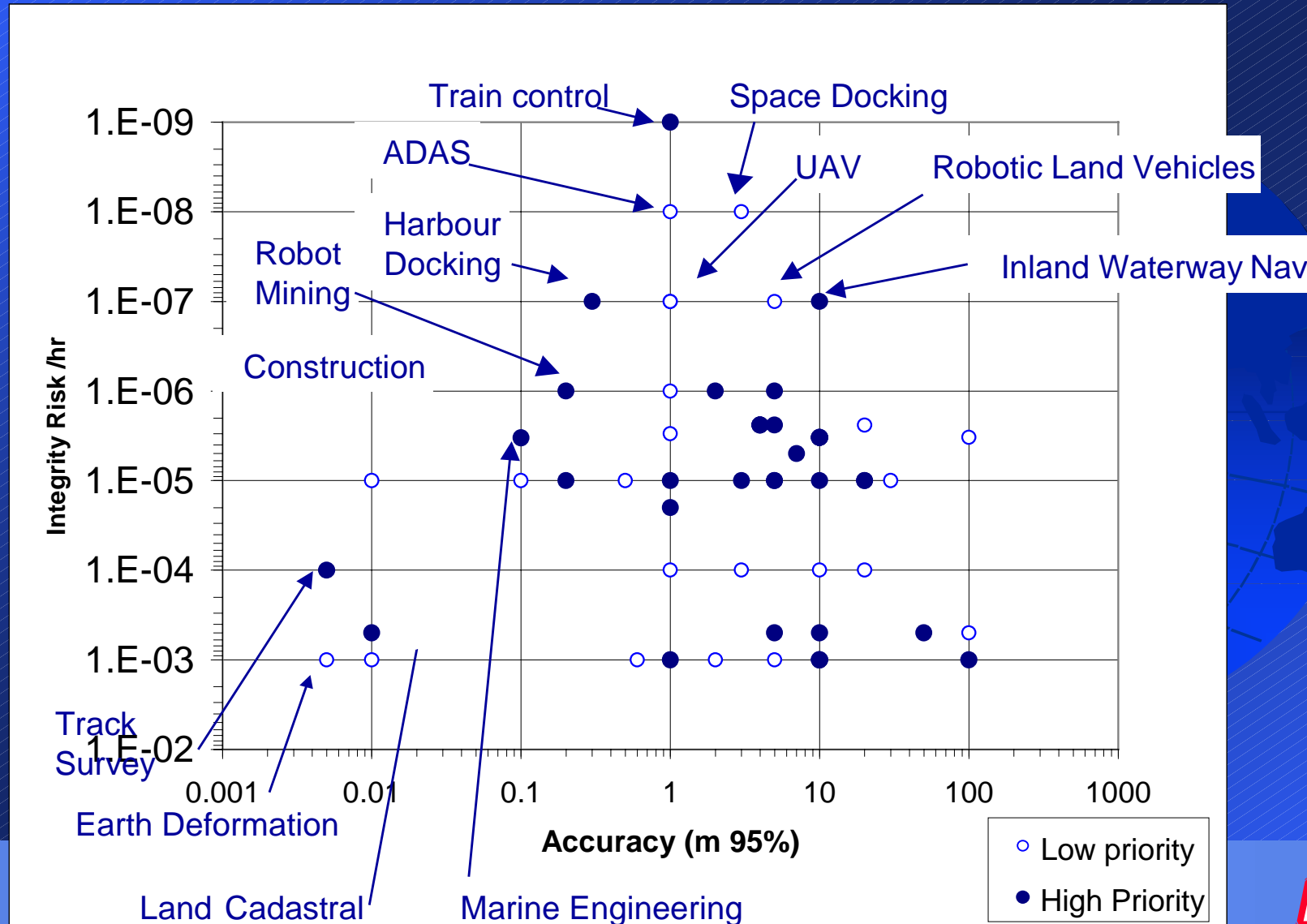
Non-performance discriminators

- **Performance rated as:**
  - **strong discriminator for 37% of applications,**
  - **unlikely discriminator for 15% of applications,**
    - an application-by-application basis, high priority.

- **Non-performance discriminators with respect to other navigation solutions (including GPS) include:**
  - **long term commitment by service provider,**
  - **guarantee of service, including legal liability,**
  - **traceability and auditability of past performance,**
  - **contractual and operations transparency,**
  - **certified SIS,**
  - **interoperability with GPS,**
  - **integrated service provision ("one stop shopping").**

RACAL

Use of navigation services within WP1
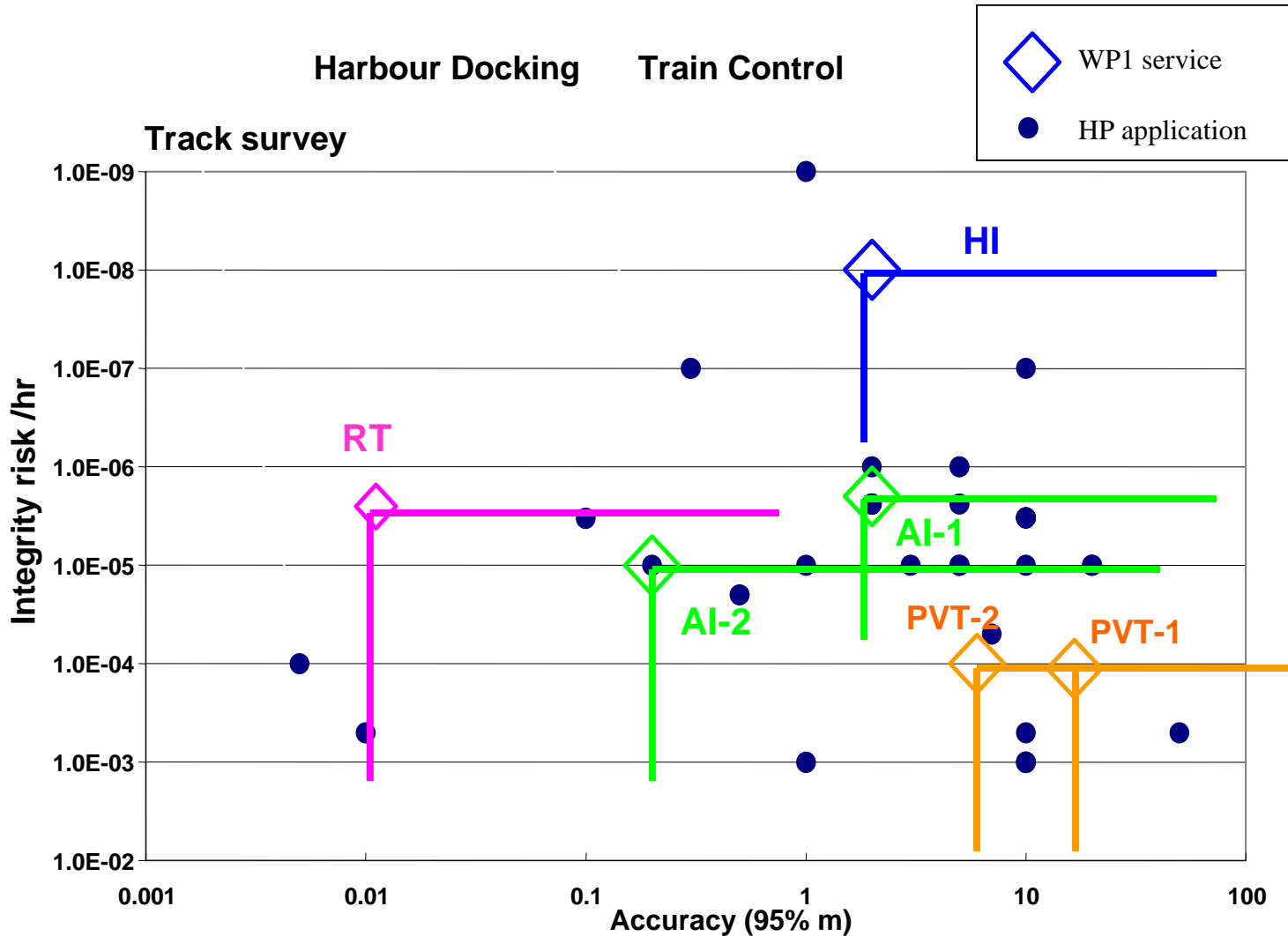
- **Bottom-up approach:**
  - **market driven,**
  - **driven by market characteristics and user requirements,**
  - **independent of implementation.**

- **Provides structure for:**
  - **building up market size,**
  - **assessing common factors within user requirements,**
  - **allocating conjoint attributes,**

- **Comparison performed with GALA baseline services.**

RACAL

WP1 Navigation Service Definitions

- ## Position Velocity and Time service (PVT)

  - Basic service for the mass market. Free access (if GPS is free)

- ## Accuracy and Integrity service (AI)

  - High accuracy and availability with real-time integrity messages for less demanding SOL and professional markets. Access to subscribers only.

- ## High Integrity service (HI)

  - Provides highest integrity, availability and continuity and resistance to signal interference. Access to trusted subscribers

- ## Ranging and Timing service (RT)

  - Very precise ranging, positioning and timing signals for the knowledgeable professional
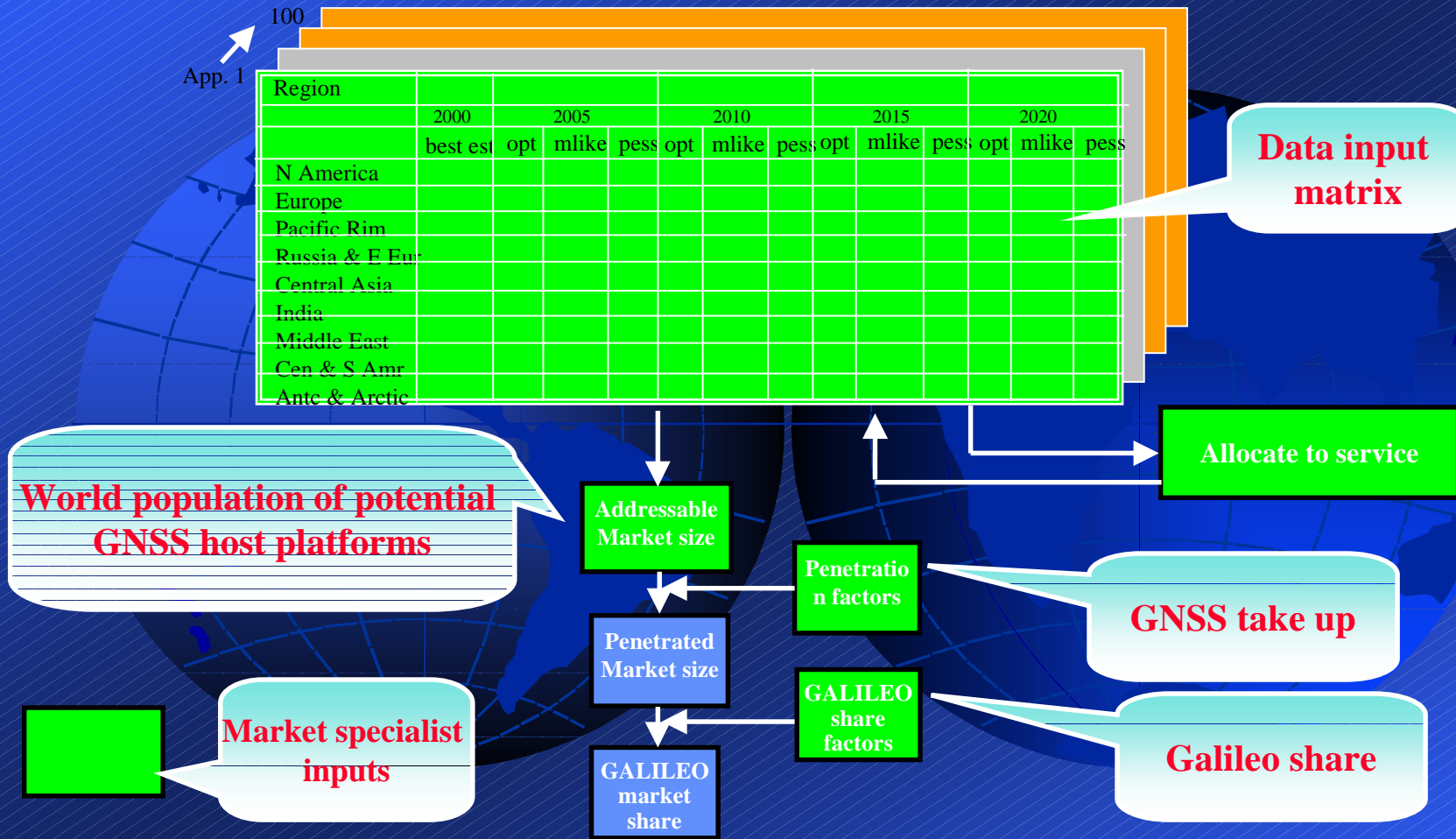
RACAL

WP1 Mapping results

Harbour Docking   **Train Control**

Legend:
- ◇ WP1 service
- ● HP application

Track survey

HI

RT

AI-1

AI-2

PVT-2   PVT-1

Integrity risk /hr

Accuracy (95% m)

RACAL

Combined Use of GALILEO and GPS SPS

Id	Performance Benefit	Condition	Services and Applications (HP)
1	Improved position accuracy: 6m to 4m (95% H) 10m to 6m (95% V)	Good satellite visibility ie satellites visible at 10°	**PVT:** *emergency call cars m'cycles (35)* **AI-1:** *vehicle tracking police/fire(20), covert tracking police (22), emergency call cars m'cycles (35)*
2	Improved RAIM providing improved integrity risk : ~1.0E-4 /hr to ~1.0E-5 /hr	Accuracy > 10 m	**PVT:** *lone worker protection (28), ambulance tracking (17),* **A1-1:** *pedestrian tracking police/fire (21),*
3	Improved DOP providing improved availability	Environment with poor satellite visibility (urban) Accuracy > 10m	**PVT:** *route guidance cars m'cycles (33), personnel outdoor recreation (46)* **AI-1:** *pedestrian tracking police/fire (21)*
4	Improved robustness & TTFF	Accuracy <0.3 m ie use of RTK	**RT:** *earth deformation monitoring (62), Land/Cad.survey (83), ocean cryospheric env. studies (94)*
5	Improved availability	Availability >99.9%	**HI**: *commercial air transport, train control, auto land vehicles etc*

RACAL

Market size methodology

Region		2000	2005			2010			2015			2020		
		best est	opt	mlike	pess	opt	mlike	pess	opt	mlike	pess	opt	mlike	pess
N America														
Europe														
Pacific Rim														
Russia & E Eur														
Central Asia														
India														
Middle East														
Cen & S Amr														
Antc & Arctic														

100

App. 1

Data input matrix

Allocate to service

World population of potential GNSS host platforms

Addressable Market size

Penetration factors

GNSS take up

Penetrated Market size

GALILEO share factors

Galileo share

Market specialist inputs

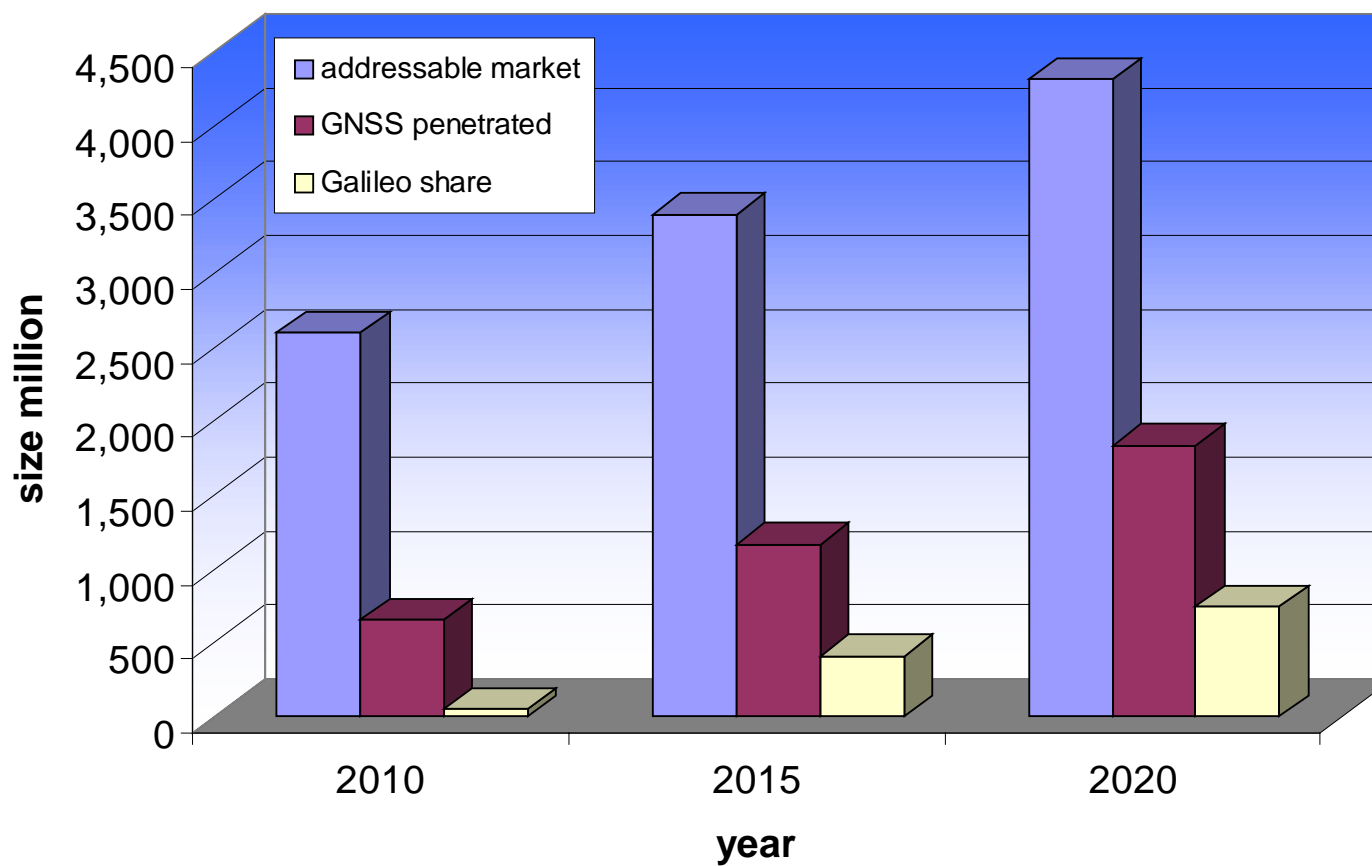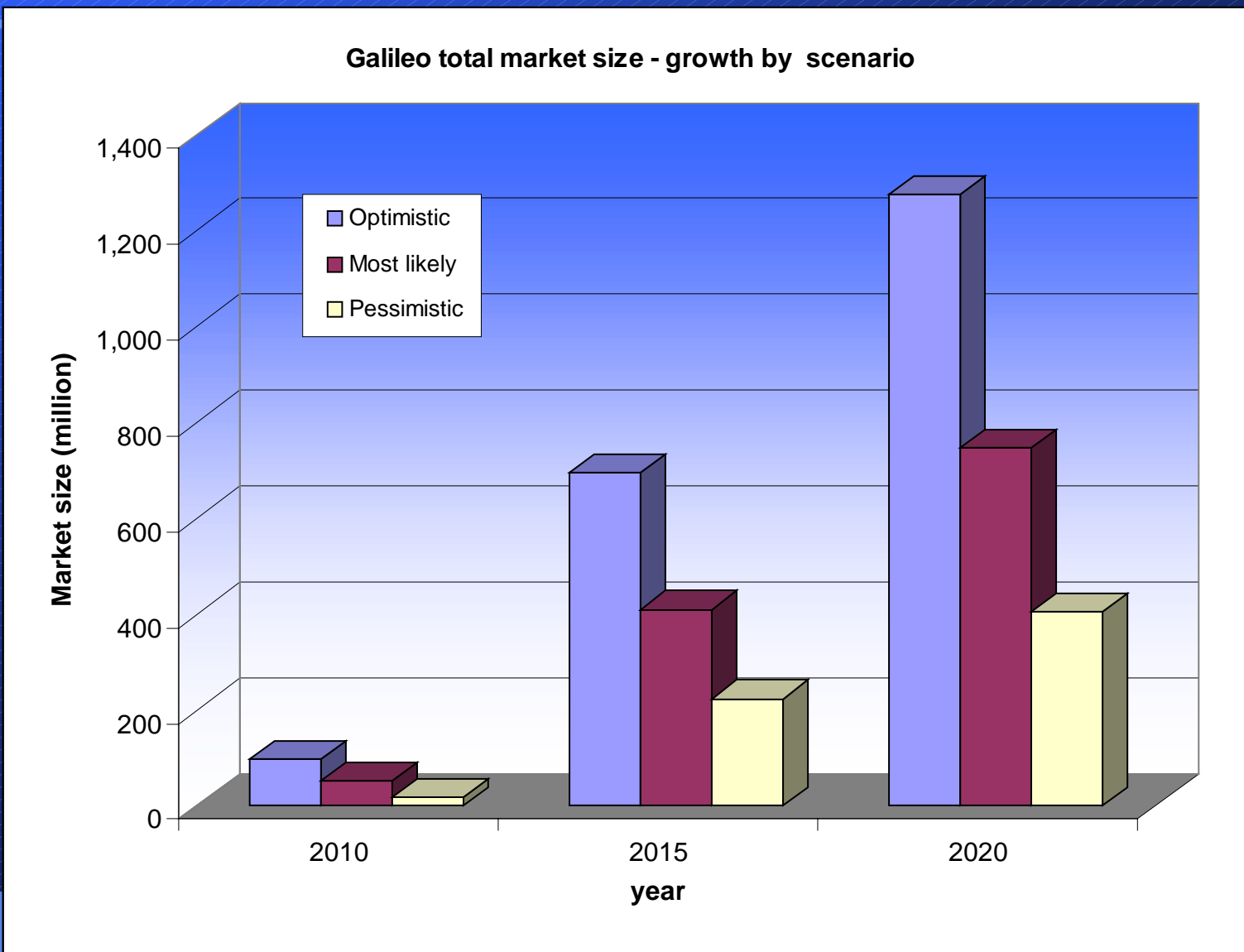**GALILEO market share**

"If you can look into the seeds of time and say which grain will grow and which will not, speak then unto me"   William Shakespeare

RACAL

Total market size 1

Galileo total market size as share of addressable market
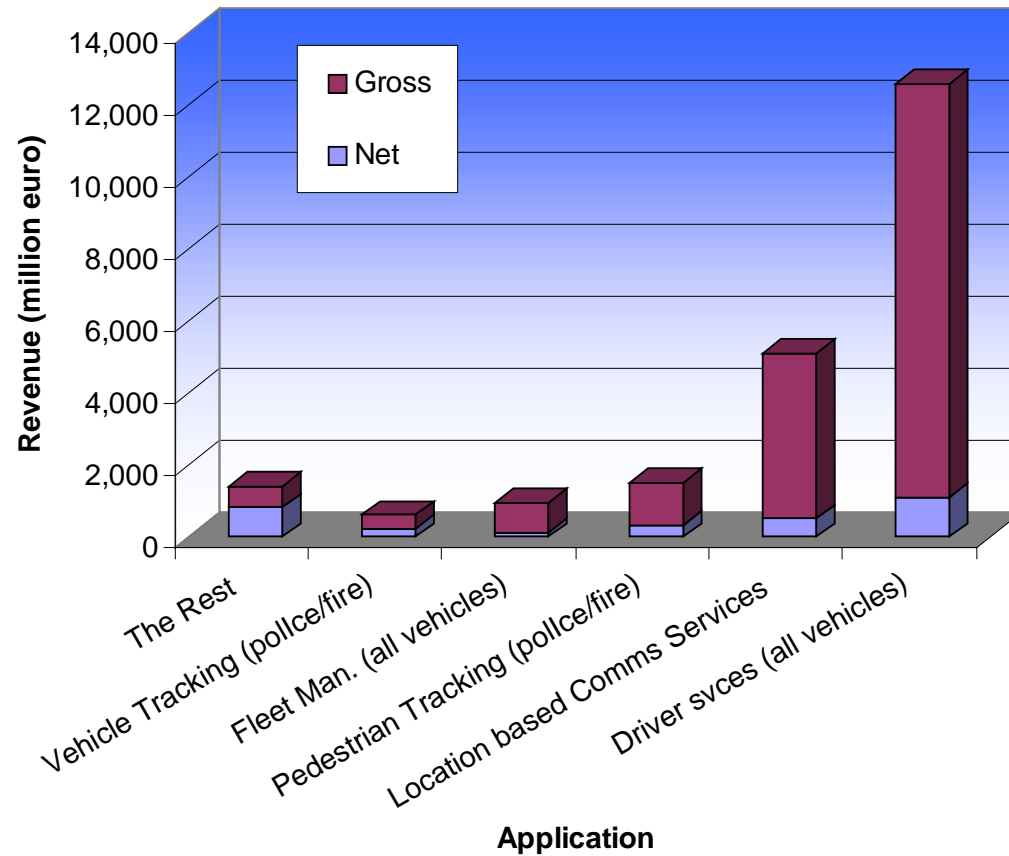most likley values

Total market size 2
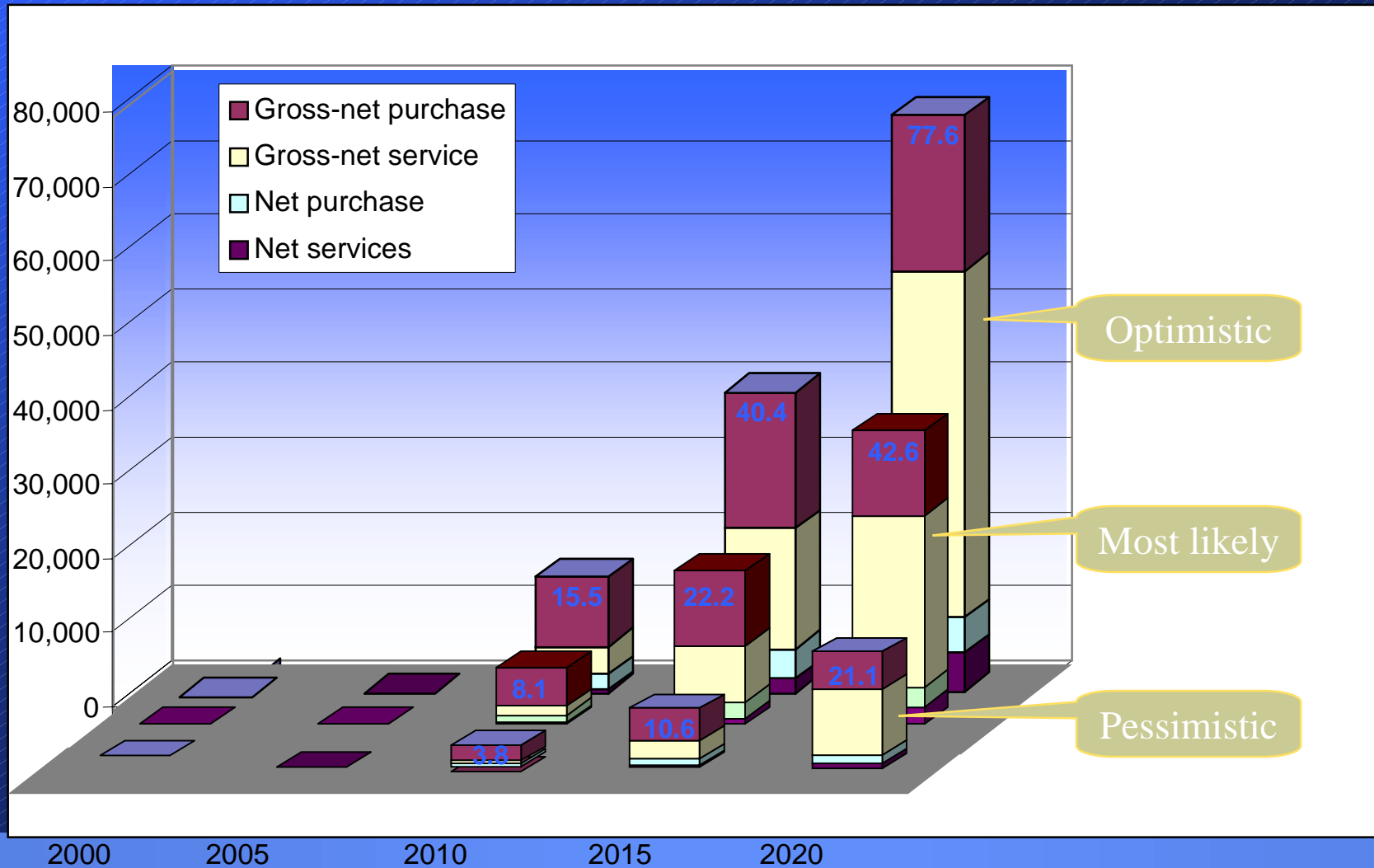

Galileo total market size - growth by scenario

Gross/net ratio for top applications

Galileo gross & net revenue breakdown by application
Top 5 applications - Most likely (2015)

RACAL

Revenue methodology

Total Revenue Breakdown

RACAL

Applications Definition and Sizing

Conclusions and Recommendations

RACAL

Conclusions & Recommendations

- Bottom up analysis of user needs, market size and revenue has been produced.

- Approximately 100 applications identified, defined and quantified.

- Seven services have been defined solely from the user needs point of view.

- Established minority of applications demand integrity, other applications may follow suit as the level of their reliance increases.

- For many applications, non-technical discriminators are as important as technical performance.

- Total Galileo market size estimated to be 410M in 2015 rising to 745M in 2020.

- *Location based communications* and *driver services* are the top two applications by size.