

Transport and Urban Development (TUD) domain

TUD COST Action TU1302

SaPPART

Satellite Positioning Performance Assessment for Road Transport

Positioning Integrity in Challenging Road Applications

Wildhaus (CH) – Nov. 26, 2015

Pierre-Yves Gillieron

EPFL - ENAC – Laboratoire TOPO, Switzerland

pierre-yves.gillieron@epfl.ch

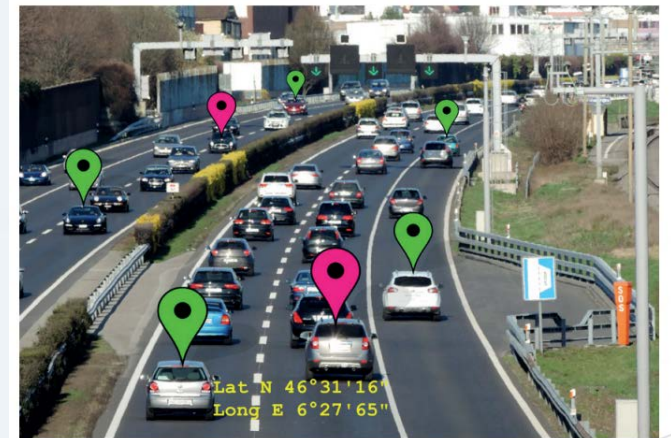


ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

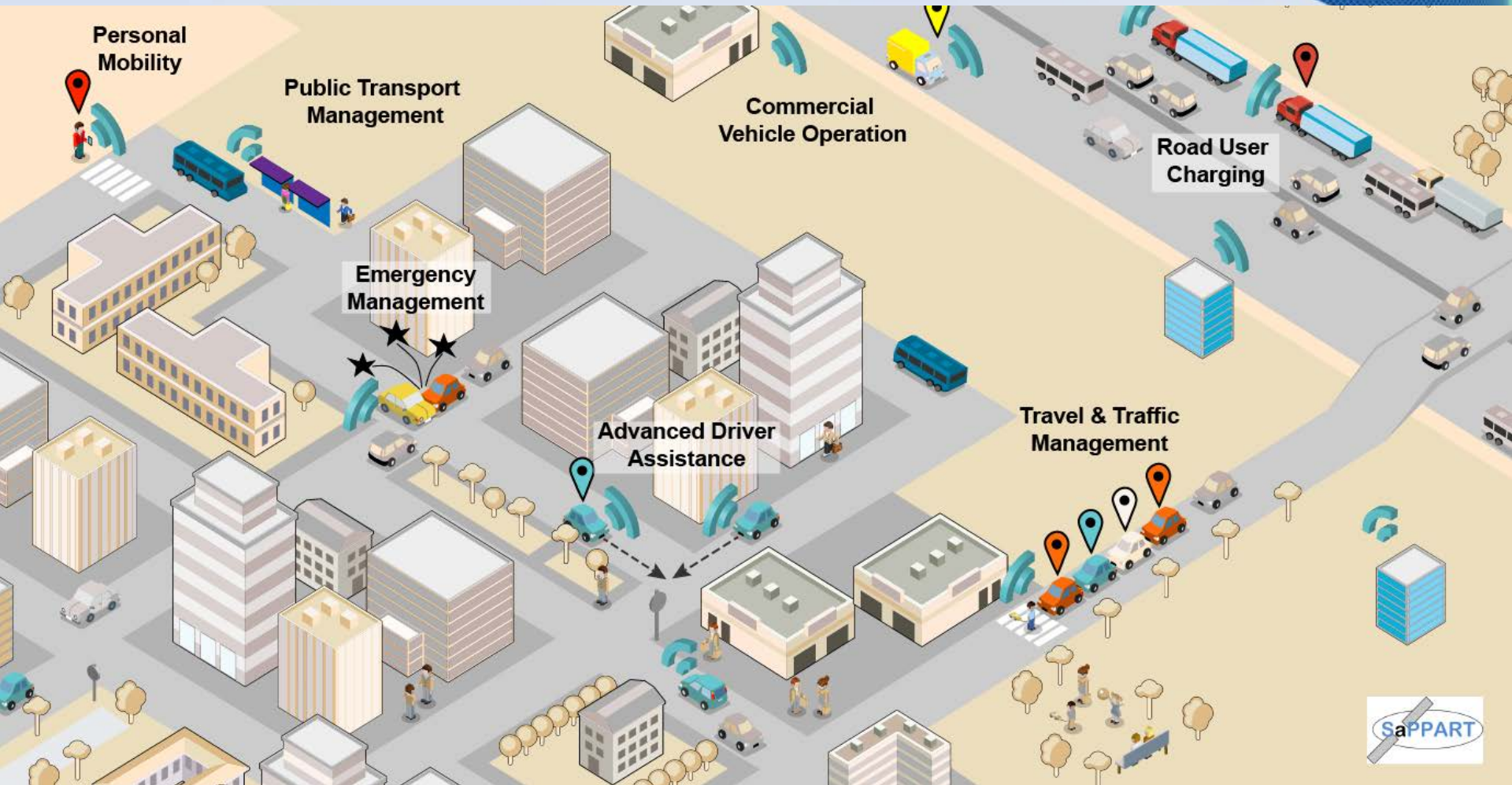


Outline

- **SaPPART COST Action**
 - Context of the Action
 - Objectives & impacts
 - Organisation
- **Positioning Performance**
 - Requirements for ITS
 - Management
 - Features & Metrics
- **Standardization of GNSS for ITS**
- **Conclusion**



Context of the Action

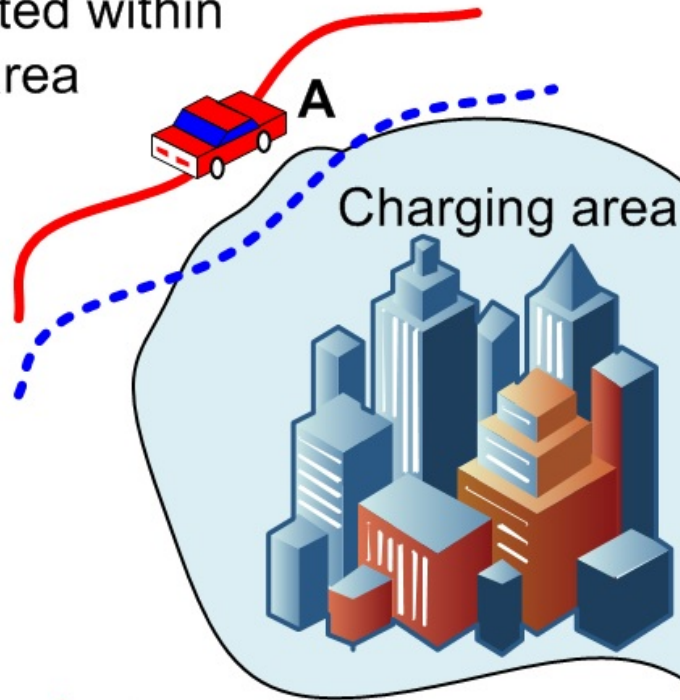


Role of positioning in the Intelligent Transportation Systems (ITS)

Context of the Action

Overcharging

User **A** is located within the charging area



Impact of positioning

— Actual trajectory
- - - Measured trajectory

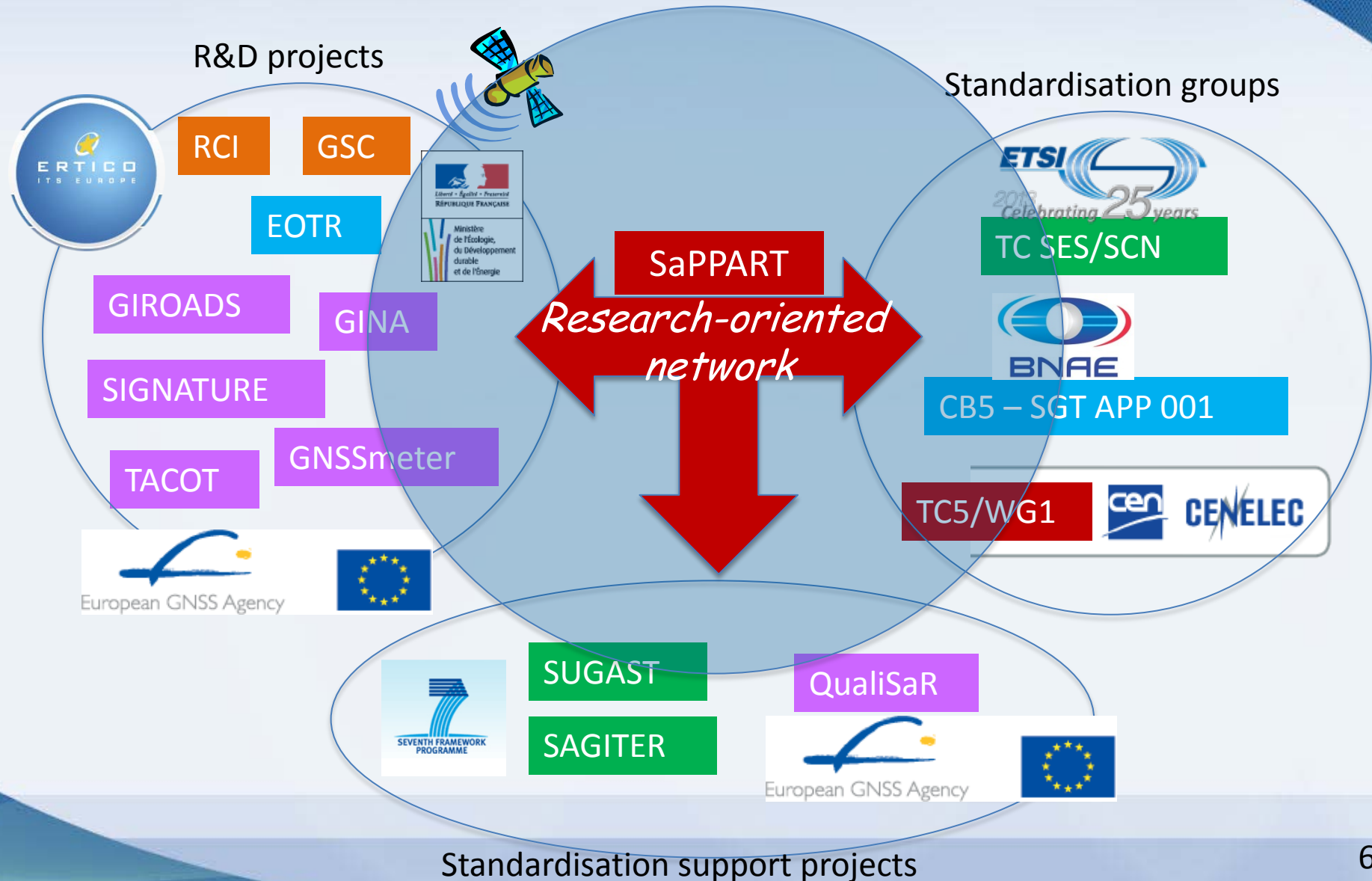
Undercharging

User **B** is located outside of the charging area

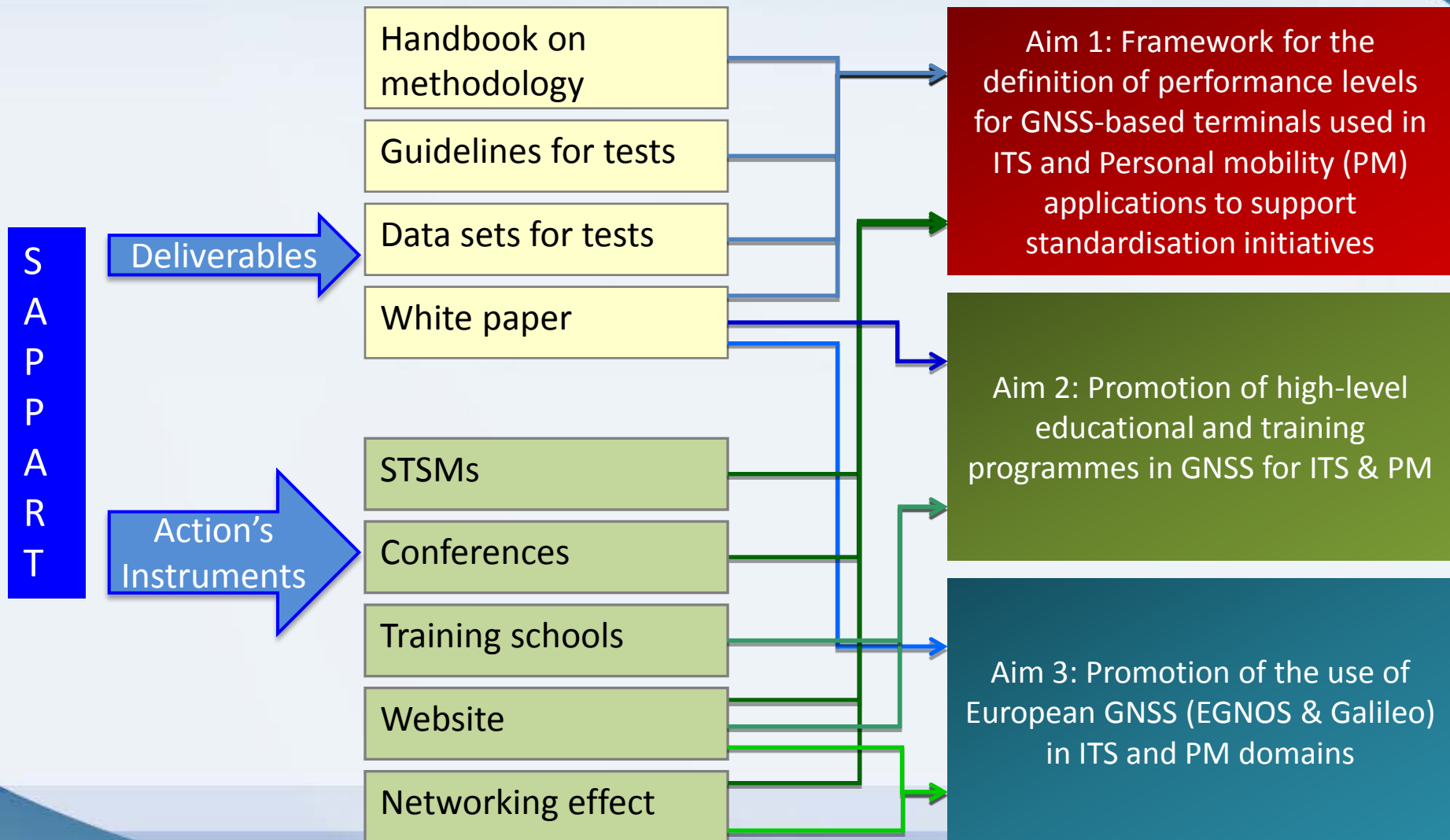
COST within the European Research Area (ERA)

- Enhance **research** progress through creation of new international networks.
- **Connect** scientists with policy-makers, governmental + regulatory bodies.
- Foster **innovation** through technology transfer (academia, spin-offs, industry)
- Build capacity through **inclusive participation** (trans-disciplinary).

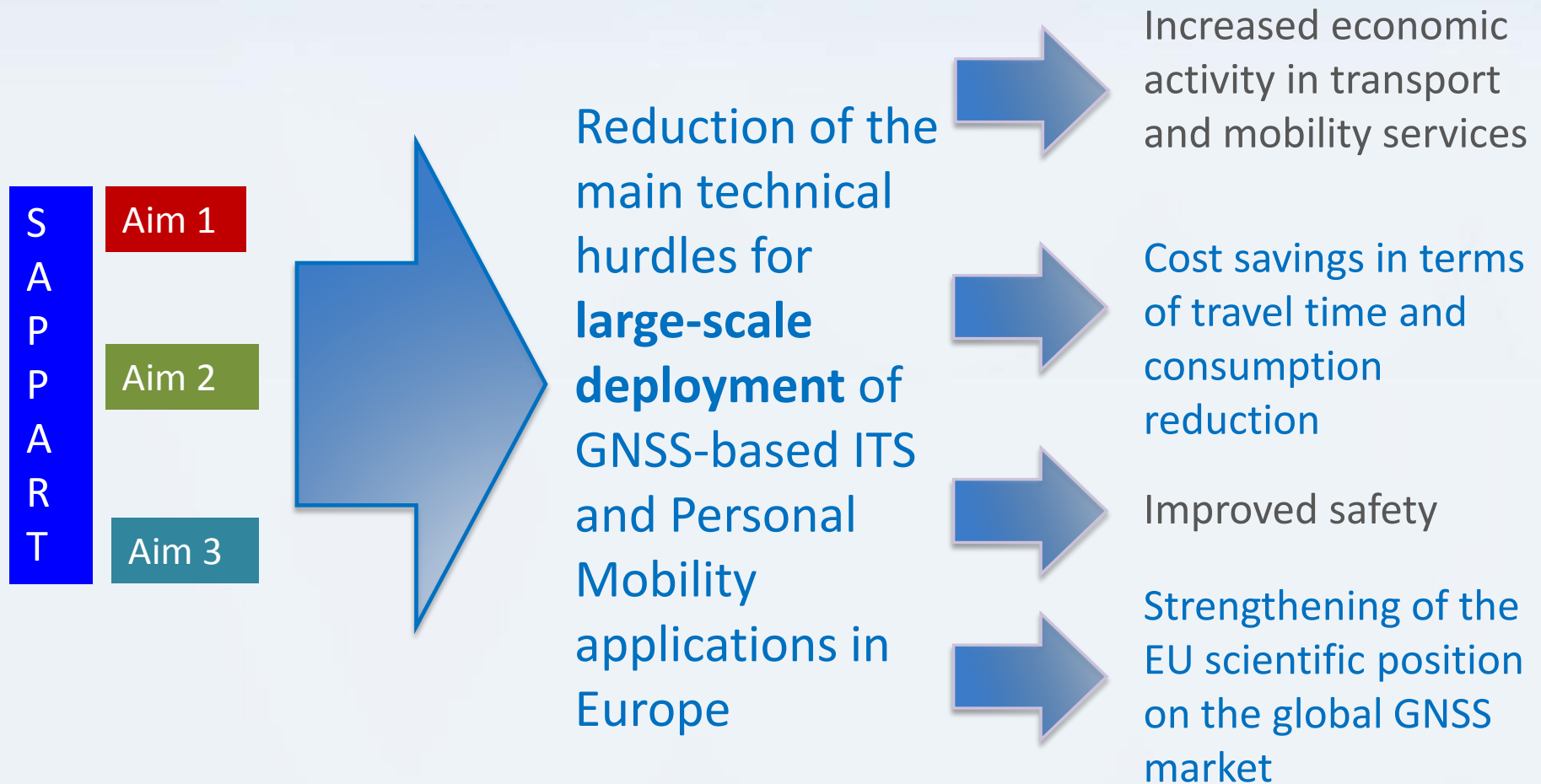
Context of the Action



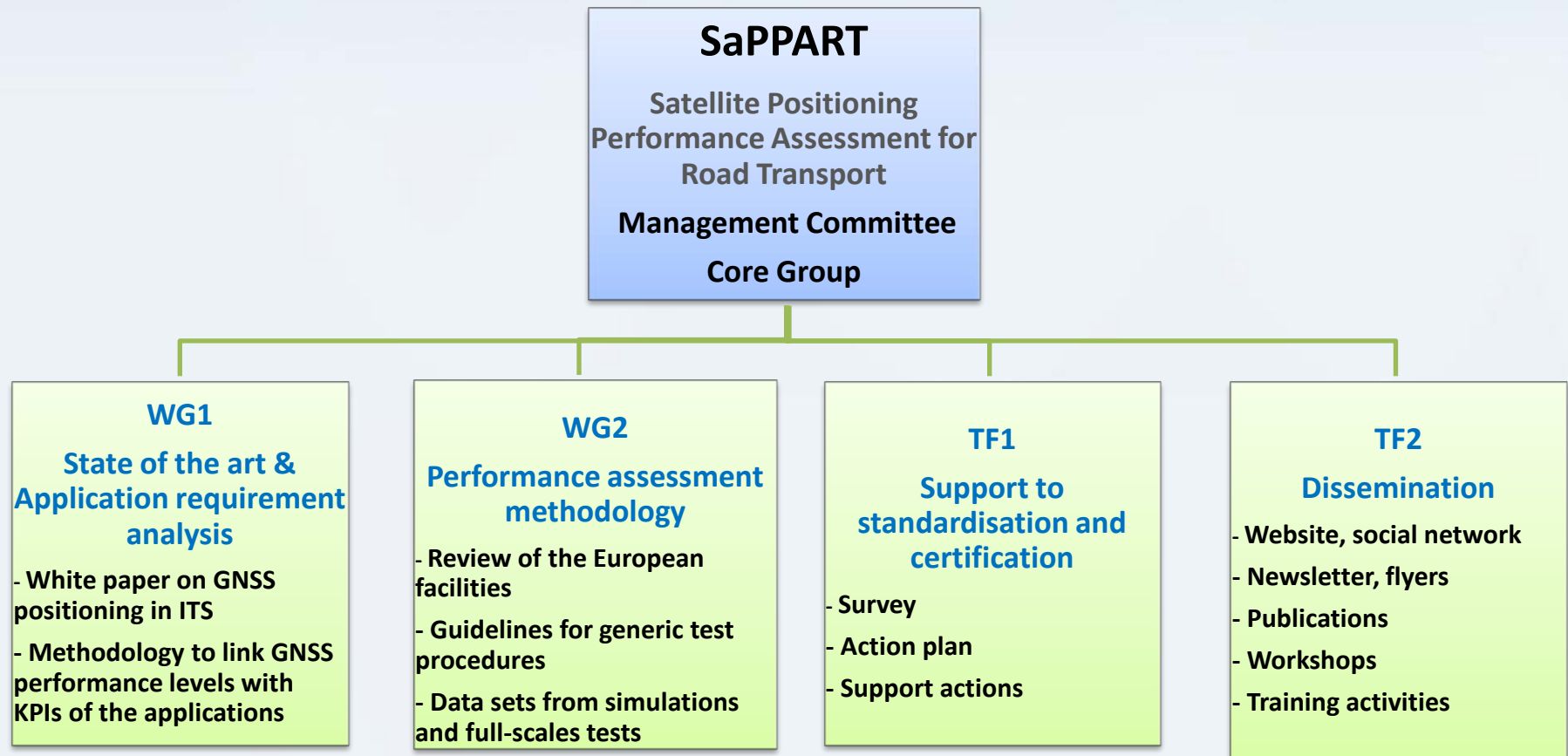
Objectives & impacts



Objectives & impacts



Organisation



Partnership (May 15)

#	Country
1	Belgium
2	Bulgaria
3	Switzerland
4	Croatia
5	Germany
6	Denmark
7	Spain
8	Finland
9	France
10	Greece
11	Israel
12	Netherlands
13	Poland
14	Portugal
15	Romania
16	Slovakia
17	Slovenia
18	Czech Republic
19	UK
20	Italy
21	Norway
22	Sweden

Research

Industry

Public authorities

~80 registered experts



women ~ 20%

Towards safety/liability-critical ITS applications





ITS World Congress 2015 in Bordeaux (~9'000 participants)

Space technology and **GNSS** have been presented as a main topic of interest

Challenges related to positioning performances

- Relatively poor knowledge of the **complex behaviour** of GNSS
- General (false) believe that high accuracy is a guarantee of reliability
- Emergence of the **Liability and Safety Critical ITS** applications with strongly demanding performance requirements
- Highly complex process from technical and legal perspectives
- **Lack of experts** with dual experience in ITS and GNSS

Positioning Performance

Main requirement for ITS

ITS systems have been designed and developed in the past to exploit positioning capabilities “as they are”

The emergence of more demanding and critical applications requires a substantial change to develop systems according to the actual customer needs

In order for these changes to be implemented properly many actions are required in particular in standardization and certification

Positioning Performance

Main requirement for ITS

Generally speaking, **integrity** is a key factor for the following types of applications (from the GSA report March 2015):

- **Safety-Critical Applications (SCA)**
 - Autonomous Driving
 - ADAS (such as Intelligent speed adaptation)
 - Hazardous Material Tracking
- **Payment-Critical Applications (PCA)**
 - Road User Charging (RUC)
 - Pay-per-use services (PAYD, PPUI...)
- **Regulatory-Critical Applications (RCA)**
 - Emergency services (eCall)
 - Emergency vehicles navigation

Positioning Performance

Main requirement for ITS



ITS World Congress 2015 in Bordeaux
Autonomous driving: from Paris to Bordeaux

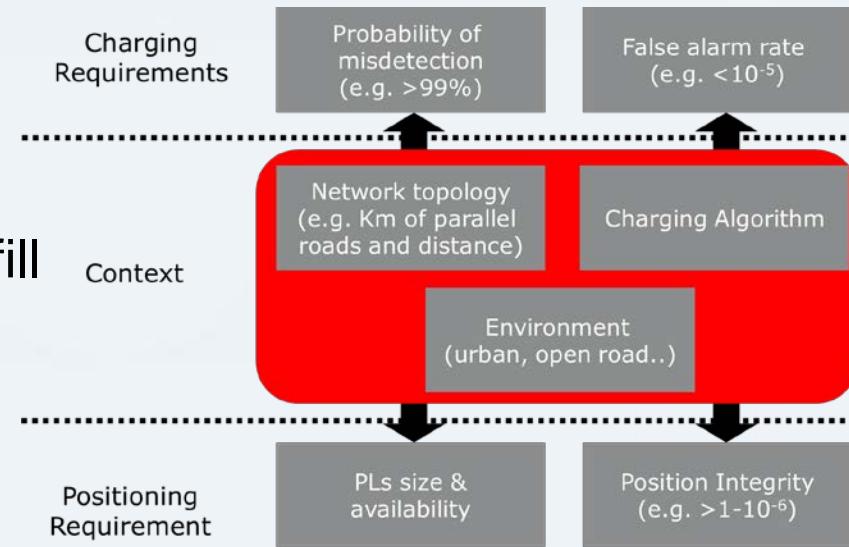
Positioning Performance Management

Performances need to be managed for each project/system development

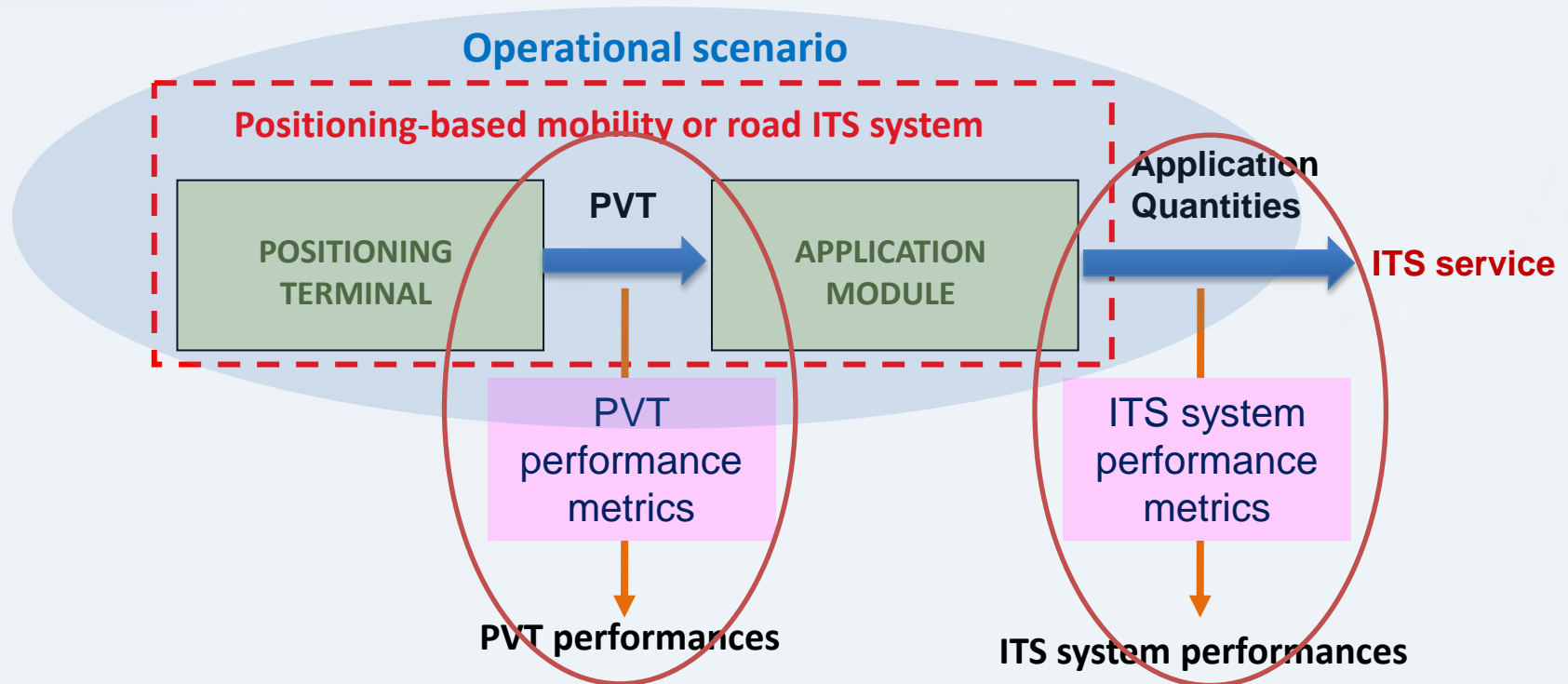
Two main process:

- What the performance of my **positioning system** have to be to fulfill the application performance (apportionment)
- What the performance of the **application** will be for a given positioning performance (analysis)

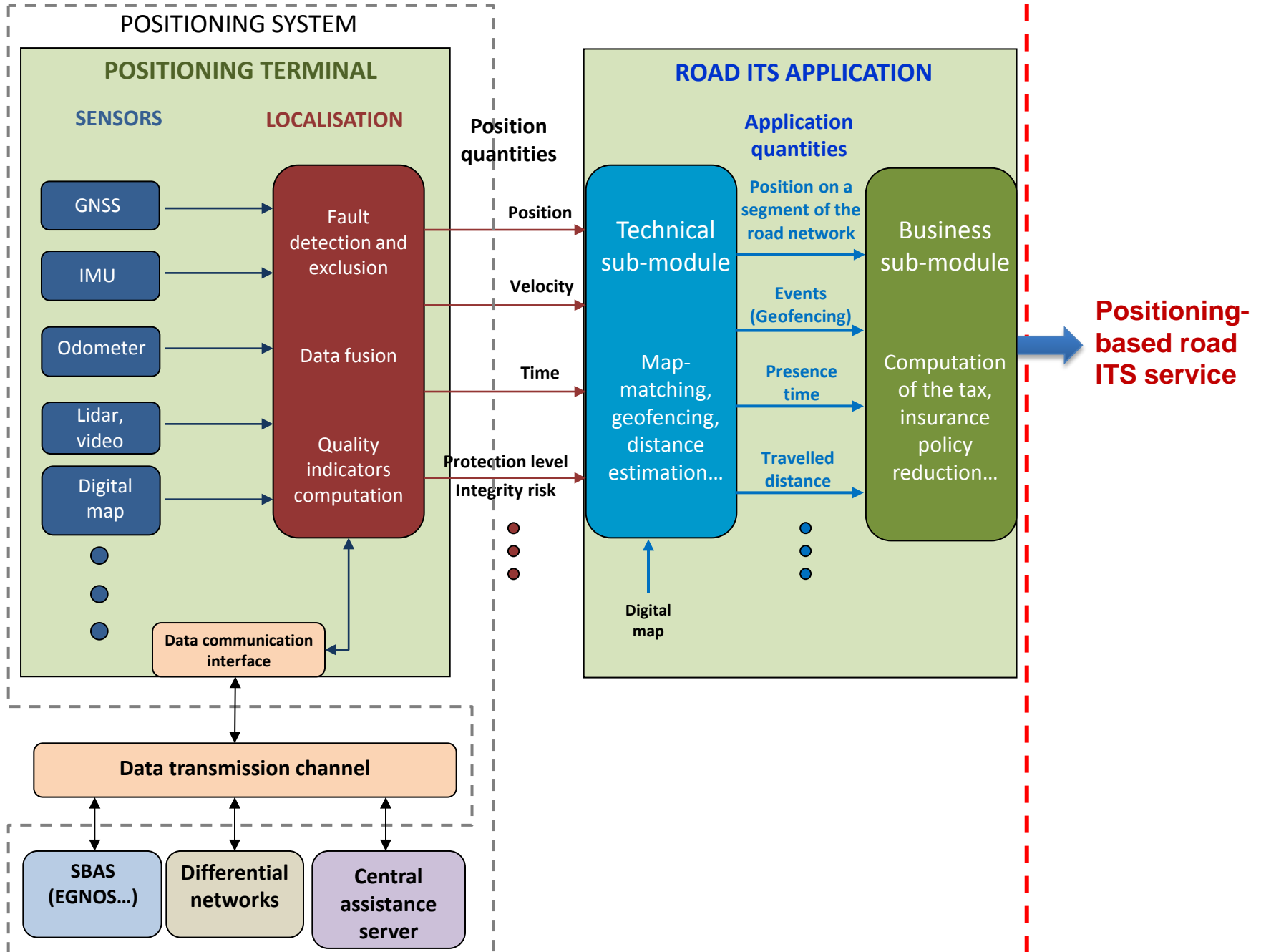
First process is of special relevance for developing systems according to customer specifications



Positioning Performance Management



Positioning-based road ITS system



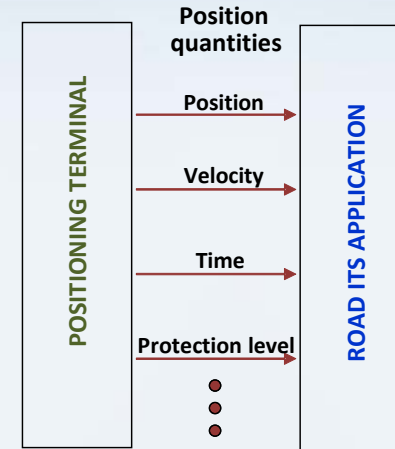
Positioning Performance Management

Appropriate **management of performance** requirements needs:

- Establishment of a **common language** for their measurements (metrics)
- Definition of **performance at system/application level**
- Definition of **performance at positioning level**
- **Engineering procedure** to link the two above
- Establishment of procedures for **testing** (measurement of performance metrics)

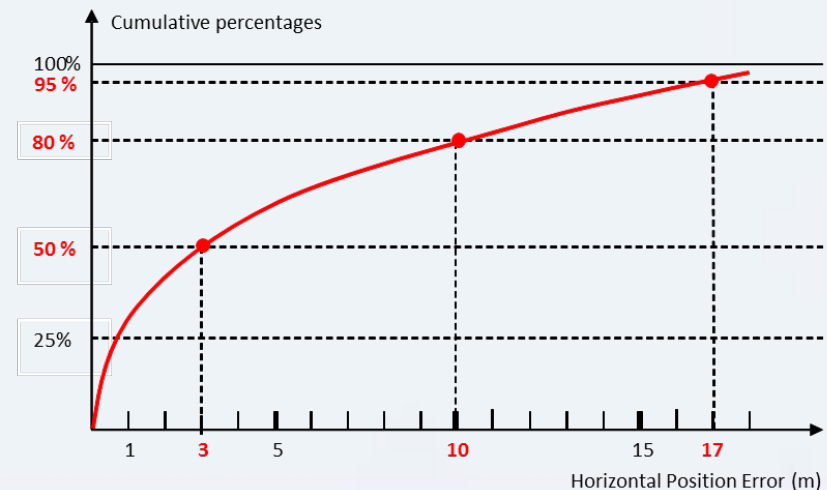
Positioning Performance Features

Performance features are defined for each of the most relevant components of the **outputs** of the Positioning Terminal (position, velocity, time...)



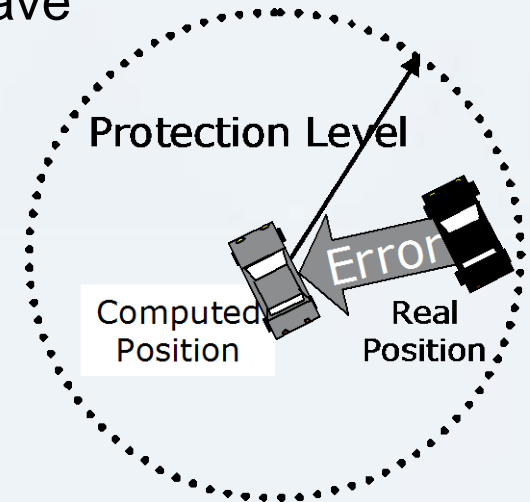
Performance features are generally statistical figures of merit of the:

- **Errors** (difference between the output value and the truth) of the output parameter (e.g. horizontal position)



Positioning Performance Features (as considered at CEN)

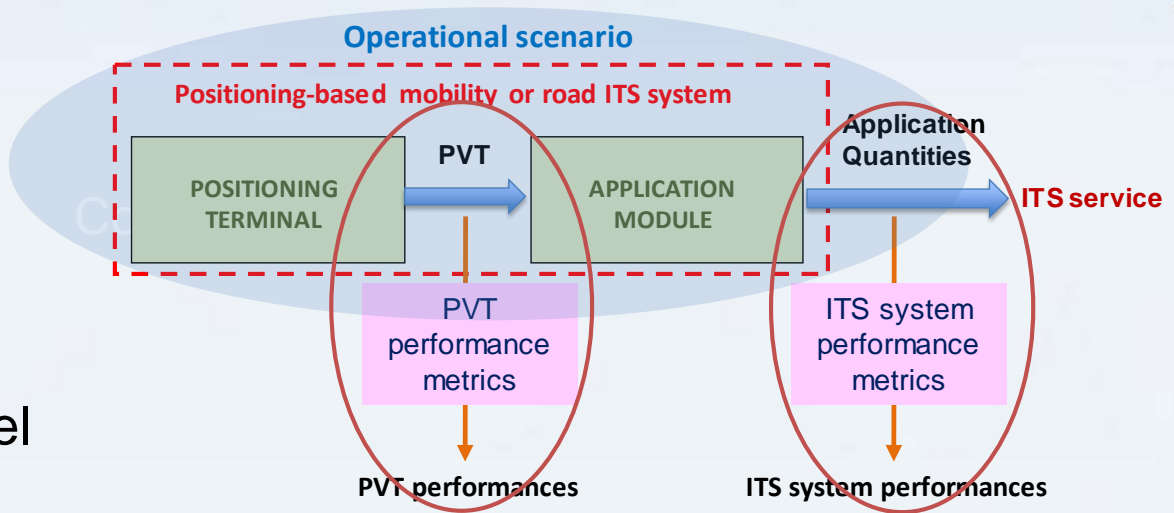
- **Accuracy:** it refers to statistical figures of merit of position error, velocity error or speed error
- **Integrity:** it refers to the level of **trust** a user can have in the value of a given component :
 - in terms of reliability (*Integrity risk*)
 - efficiency and usability (size of the *Protection level*).
- **Availability:** generally speaking, it refers to the percentage of time during which the output of the positioning terminal is available.
- **Timing performance:** it refers to timestamp resolution, output latency, rate stability and Time To First Fix.



Integrity can be defined at different levels

In general, **integrity** can be defined at 2 different levels:

- At the system level
- At the position (PVT) level

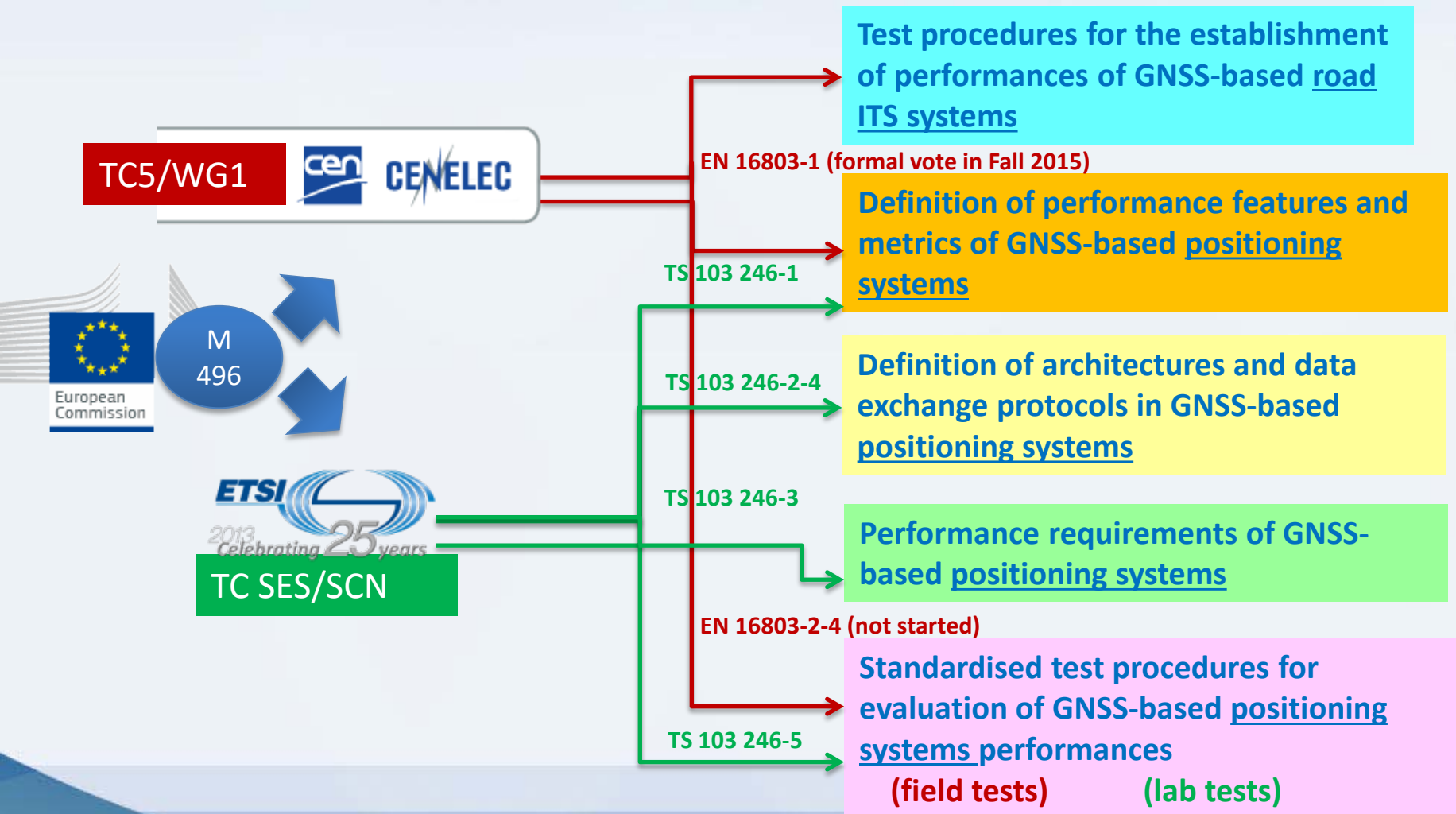


At system level, the relevant performance feature is not the position **integrity** expressed by PL and IR, but an end-to-end performance feature such as *False detection rate* in the case of a *Road User Charging* system

But for some applications, like anti-collision ADAS or autonomous driving, the confidence in the raw position is absolutely essential and the concept of **protection level** is as essential as in civil aviation

Standardization of GNSS for ITS

Active standardization groups in Europe



Summary

- Positioning is a key topic of the ITS community
 - Safety/liability-critical applications
- Car manufacturers are developing cooperative systems and autonomous driving
 - Global positioning is needed
 - Relative positioning is not enough
- **COST Action SaPPART** is contributing actively to the «promotion» of positioning integrity for the road domain
- GNSS-based Positioning is fully integrated in the **standardization activities of CEN & ETSI**

SaPPART



COST is supported by the EU Framework Programme Horizon 2020

Satellite Positioning Performance Assessment for Road Transport - www.sappart.net



Thank you for your attention !

Pierre-Yves Gilliéron
EPFL – TOPO Lab
CH – 1015 Lausanne
pierre-yves.gillieron@epfl.ch