



# The RTCM SC-134 Special Committee

## “Integrity for GNSS-based High Accuracy Applications”



**RTCM** – the Beacon for Maritime  
Communications and Navigation

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**SC-134 Chairman and BoD**  
**Member**

# Introduction to RTCM

- **RTCM (Radio Technical Commission for Maritime Services):** an International non-profit organization, founded on 1947 (US Advisory committee), nowadays members from all over the world
- **Started as an organization dealing with maritime radionavigation and communication systems standardization, RTCM is currently working with a broad range of applications and services**
- **Organized by several Special Committees (SC).** Some of the SCs are at the base of nowadays GNSS high accuracy positioning and implemented by most of the manufactures



# RTCM Special Committees

- Special Committee 101 on Digital Selective Calling (DSC)
- **Special Committee 104 on Differential GNSS Service**
- Special Committee 109 on Electronic Charting Technology
- Special Committee 110 on Emergency Beacons
- Special Committee 112 on Ship Radar
- Special Committee 117 on Maritime VHF Interference
- Special Committee 119 on Maritime Survivor Locating Devices
- Special Committee 121 on Automatic Identification Systems (AIS) and Digital Messaging
- Special Committee 123 on Digital Message Services over Maritime Frequencies
- Special Committee 127 on Enhanced Loran (eLoran)
- Special Committee 128 on Satellite Emergency Notification and Location Devices
- Special Committee 129 on Portrayal of Navigation-Related Information on Shipboard Displays
- Special Committee 130 on Electro-Optical Imaging Systems
- Special Committee 131 on Multi-System Shipborne Navigation Receivers
- Special Committee 132 on Electronic Visual Distress Signals
- Special Committee 133 on Data Exchange for Navigation-Related Applications for Mobile Devices
- **Special Committee 134 on Integrity Monitoring for High Precision Applications**
- Special Committee 135 Radio Layer for Real-Time DGNS Applications
- Special Committee 136 on Beacon Type Approvals
- Special Committee 137 on Electromagnetic Compatibility Requirements for LED Devices and other Unintentional Emitters Located Near Shipboard Antennas



# RTCM SC-134 Objectives

## Scopes of the SC-134 Committee:

- **Definition of a Standard Messages formats for GNSS Integrity Augmentation at User and Service Provider Level, with a Multimodal Approach**
- **Continuous review of emerging application requirements and safety metrics**
- **Update of existing single application Fault Models and Integrity Parameters for Integrity Monitoring**
- **Liaison with application domain and other standardization organizations**

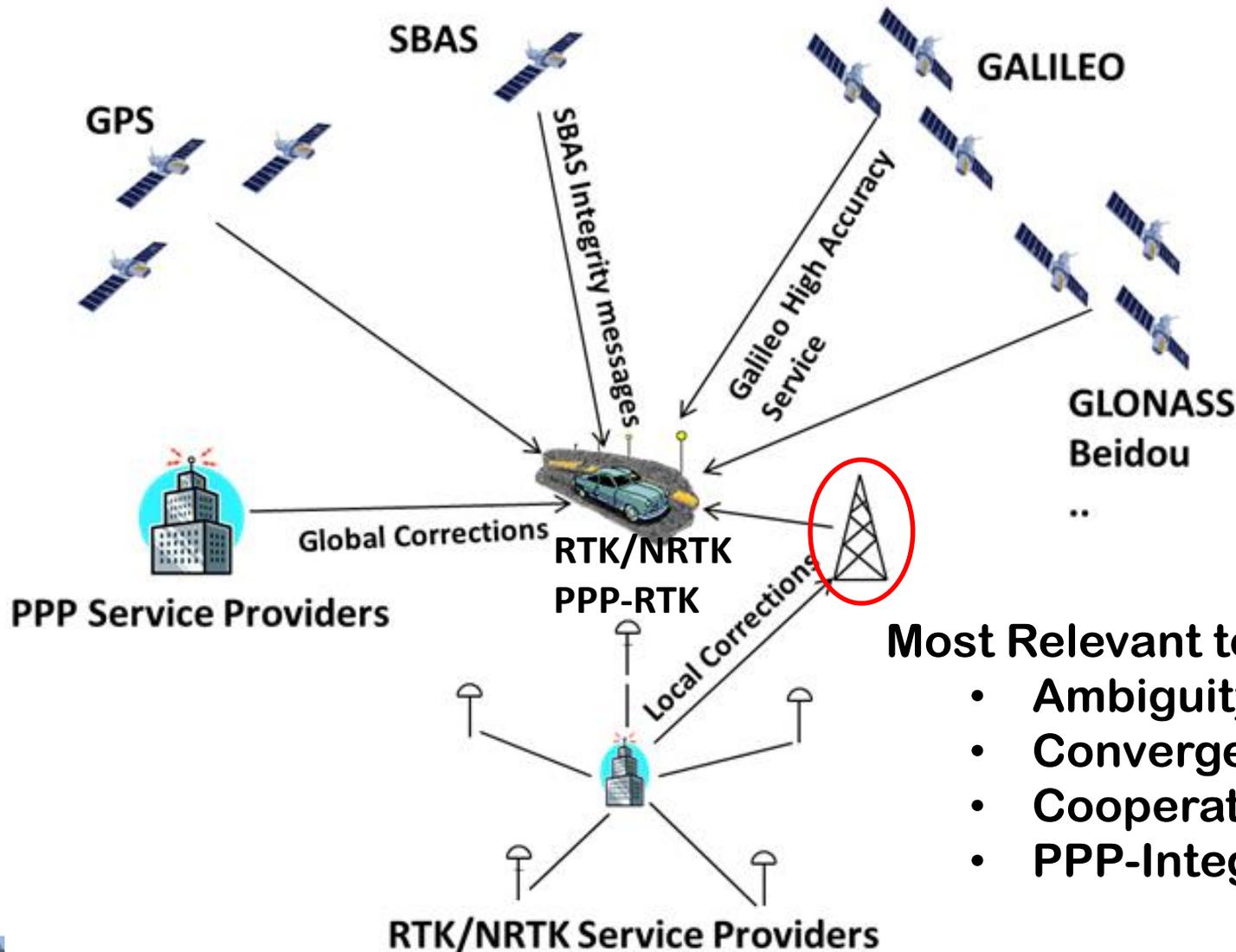
## RTCM SC-134 Membership:

**Current number of members: 267**

**Manufacturers, Service Providers, Universities**



# GNSS High Accuracy Systems

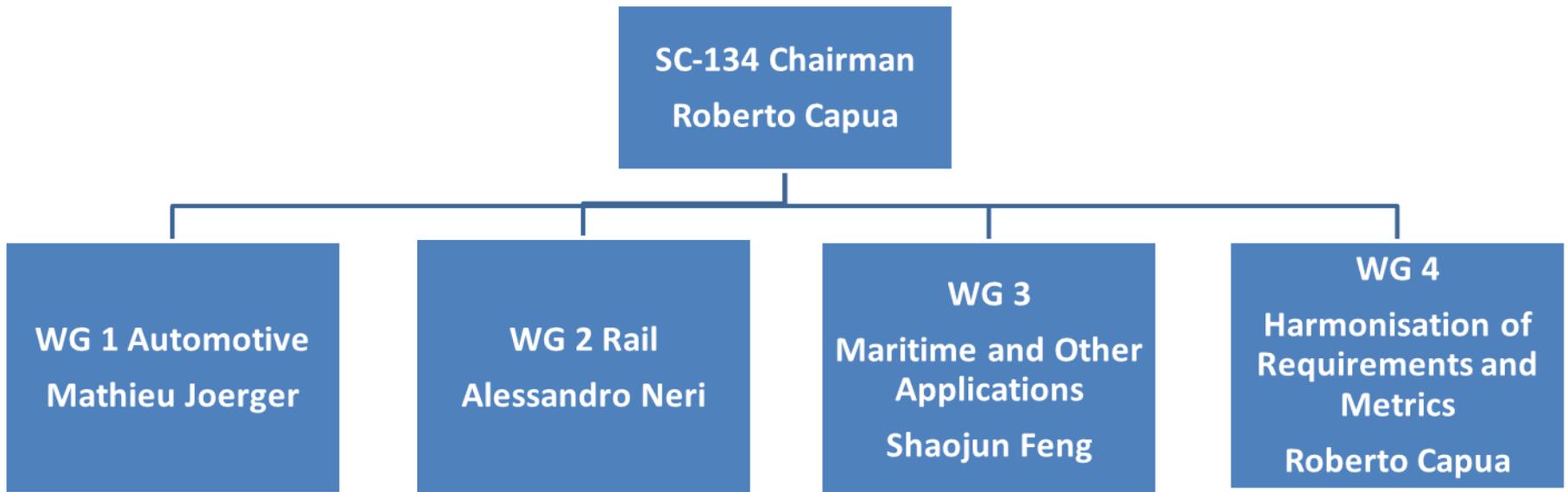


## Most Relevant topics:

- Ambiguity Fixing Integrity
- Convergence time
- Cooperative approaches
- PPP-Integrity



# RTCM SC-134 organization



Specific Task Forces are setup:

- Augmentation Transition Mode integrity
- NRTK Integrity
- ....

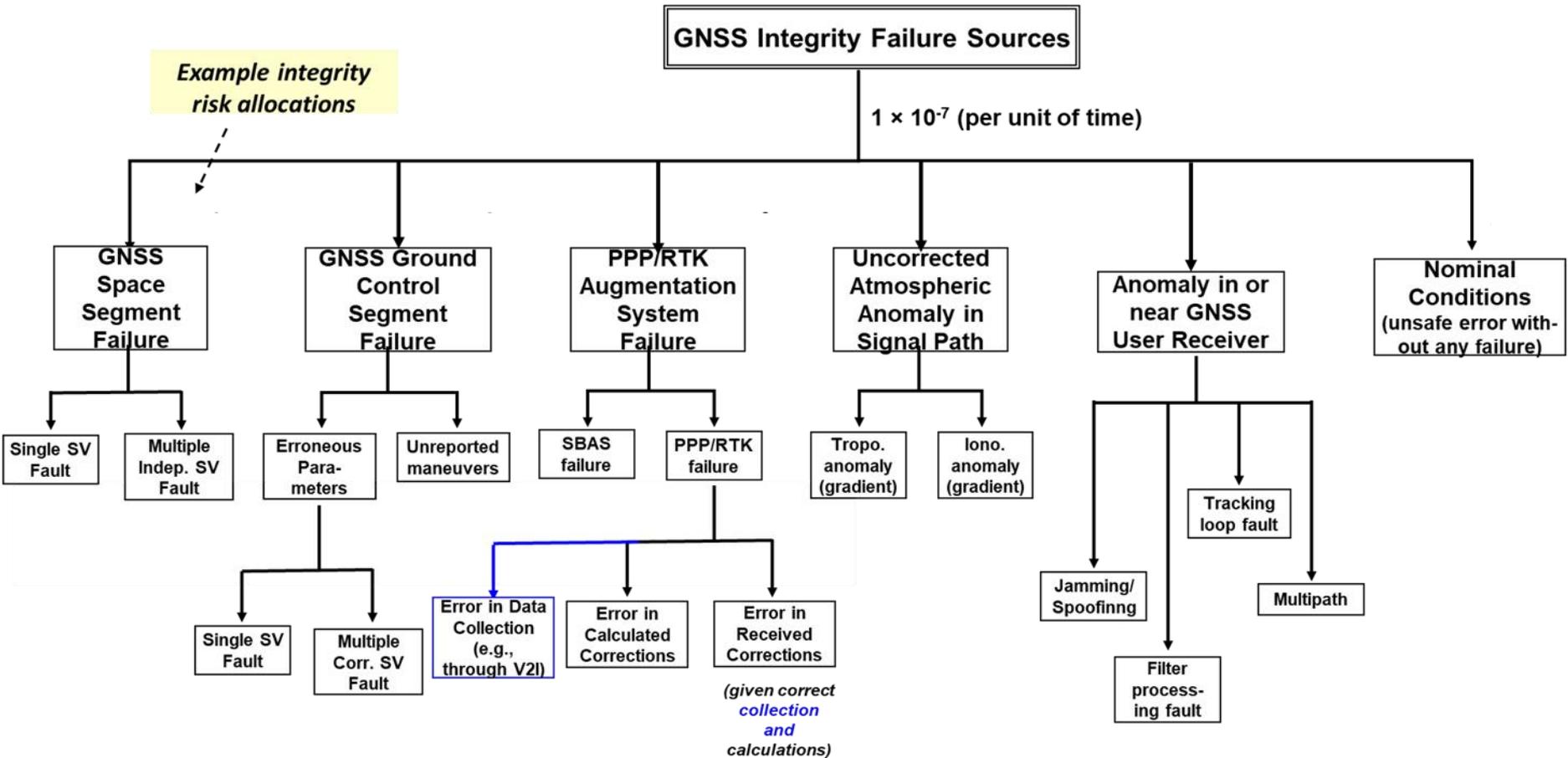


# WG1 - Automotive

- Analysis of Error Sources for Automotive
- Analysis and refinement of Fault Models for Automotive
- Definition of Integrity Parameter and messages for the automotive sector
- Comparison and mapping with existing standards (e.g. ISO 26262 and SAE J2735) – monitoring through RTCM Liaisons



# Example of Automotive Fault Tree



# Automotive Service Levels

Application	Description	Accuracy (95%)	Continuity	Integrity, Alert Limit	Integrity, Time to Alert	Integrity Risk / THR	Availability (%)	Max. Age of Integrity Data	Time to Become Available
High-speed maneuvers (autonomous)	(Highway driving) High-speed merging, lane changes, passing maneuvers	0.25 m (Lat); 0.50 m (Long); 0.45 m (Vert) [2]	$10^{-6}$ / 15 sec	0.75 m (lat); 1.5 m (long); 1.4 m (vert)[2]	6 / 1 sec (see notes)	$10^{-7}$ / hr (ASIL C/D) (1-4)	99.9% (1)	~ 30 sec unless alert	~ 1 min (see notes)
Follow temporary traffic control (autonomous)	(General) Detect and respond to police, accidents, detours	0.25 m (Lat); 0.25 m (Long); 0.5 m (Vert) [2]	$10^{-6}$ / 15 sec	0.75 m (lat); 1.5 m (long)	10 / 2 sec	$10^{-7}$ / hr (ASIL C/D) (1-4)	99.9% (1)	~ 30 sec unless alert	~ 1 min (see notes)
Regulatory Enforcement (non-autonomous)	Automatically enforce zone-based road tolls & speed restrictions	5 m (2-D horiz.); 0.5 m/s (2-D horiz.) [1]	$10^{-6}$ / 15 sec	0.75 m (lat); 1.5 m (long)	10 / 2 sec	$10^{-7}$ / hr (ASIL C/D) (1-4)	99.9% (1)	~ 30 sec unless alert	~ 1 min (see notes)

**Example Service Levels:**

- ~ASIL D
- ~ASIL C
- ~ASIL A

*TTA for detection of (but failure to exclude) slowly-growing error or PL / TTA for detection of (but failure to exclude) sudden large or rapidly growing error*

*TBA = time at which some probability of service can be provided, but not necessarily meeting the availability requirement.*



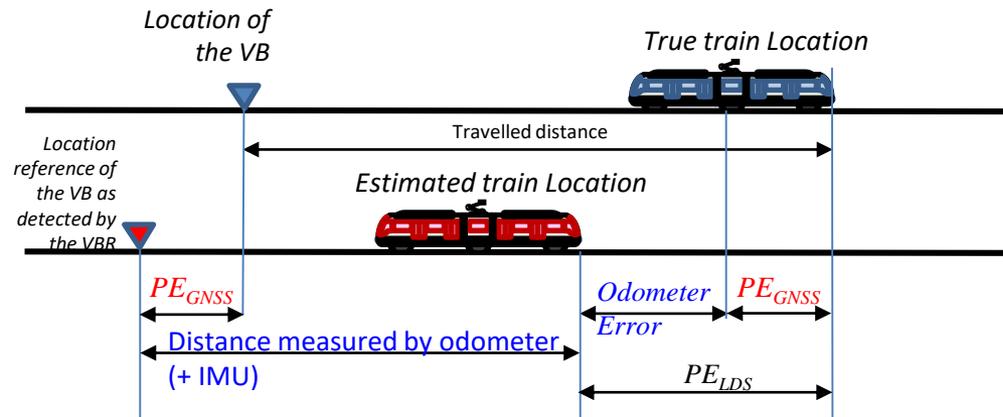
# WG2 activities

- Rail Safety analysis, following ERTMS and PTC requirements
- Virtual Balises and GNSS Traffic Control
- Multipath characterization

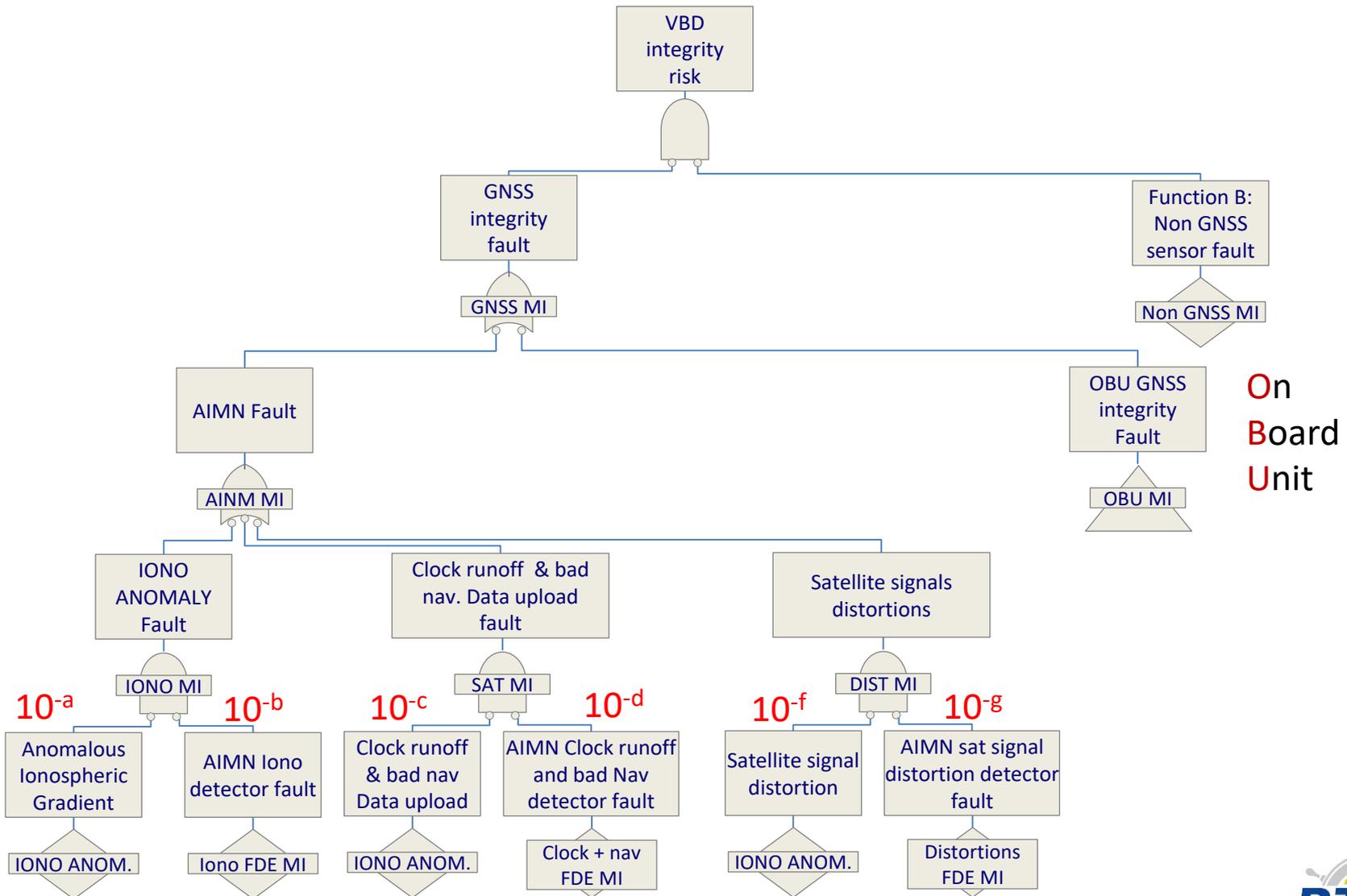


# Rail Safety Apportionment (ERTMS)

- The core THR parameter with reference to subsystems functions shall be the “exceedance of safe speed or distance as advised to ETCS” and shall be equal to  $2.0 \cdot e^{-9}$  / hour (see UNISIG Subset 088).
- The total THR shall be equally apportioned between
  - ONBOARD,
  - TRACKSIDE
  - TRANSMISSION (components or “gates”)



# Example of Rail Fault Tree

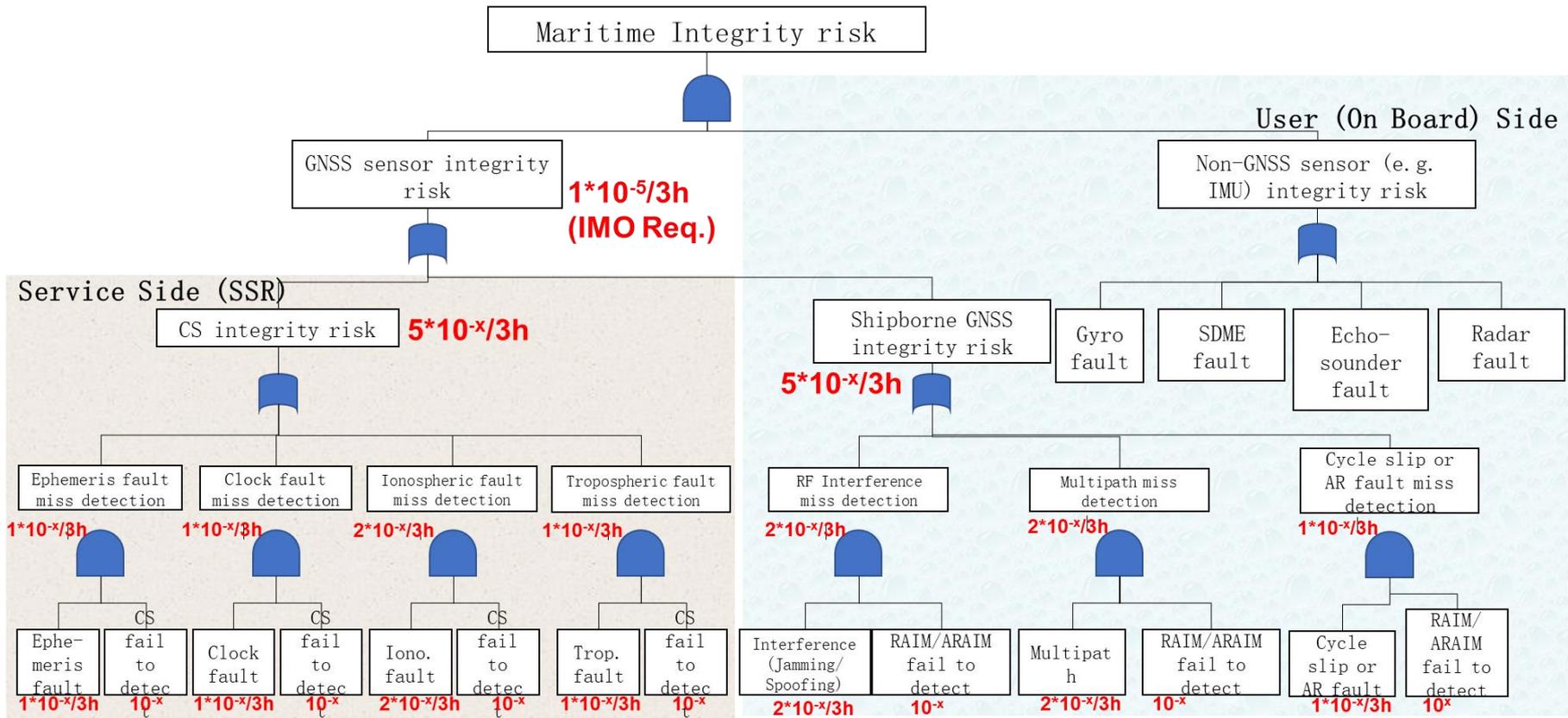


# WG3 activities

- Maritime application Safety Analysis
- Emerging applications (IoT, Red Ligth, etc..)
- PPP and PPP-RTK application and preliminary messages definition



# Exmple of Maritime Fault Tree



# PPP Integrity Messages

Group Name	Message Type	Positioning Method
Network Integrity	N.A.	
Local Integrity	Area Definition	
	Area Satellite Mask	
	Area Grid Integrity	
	Area Satellite Integrity	
	Area Grid Satellite Integrity	
	Troposphere Polynomial Correction	
	Troposphere Grid Correction	
	Ionosphere Polynomial Correction	
Ionosphere Grid Correction		

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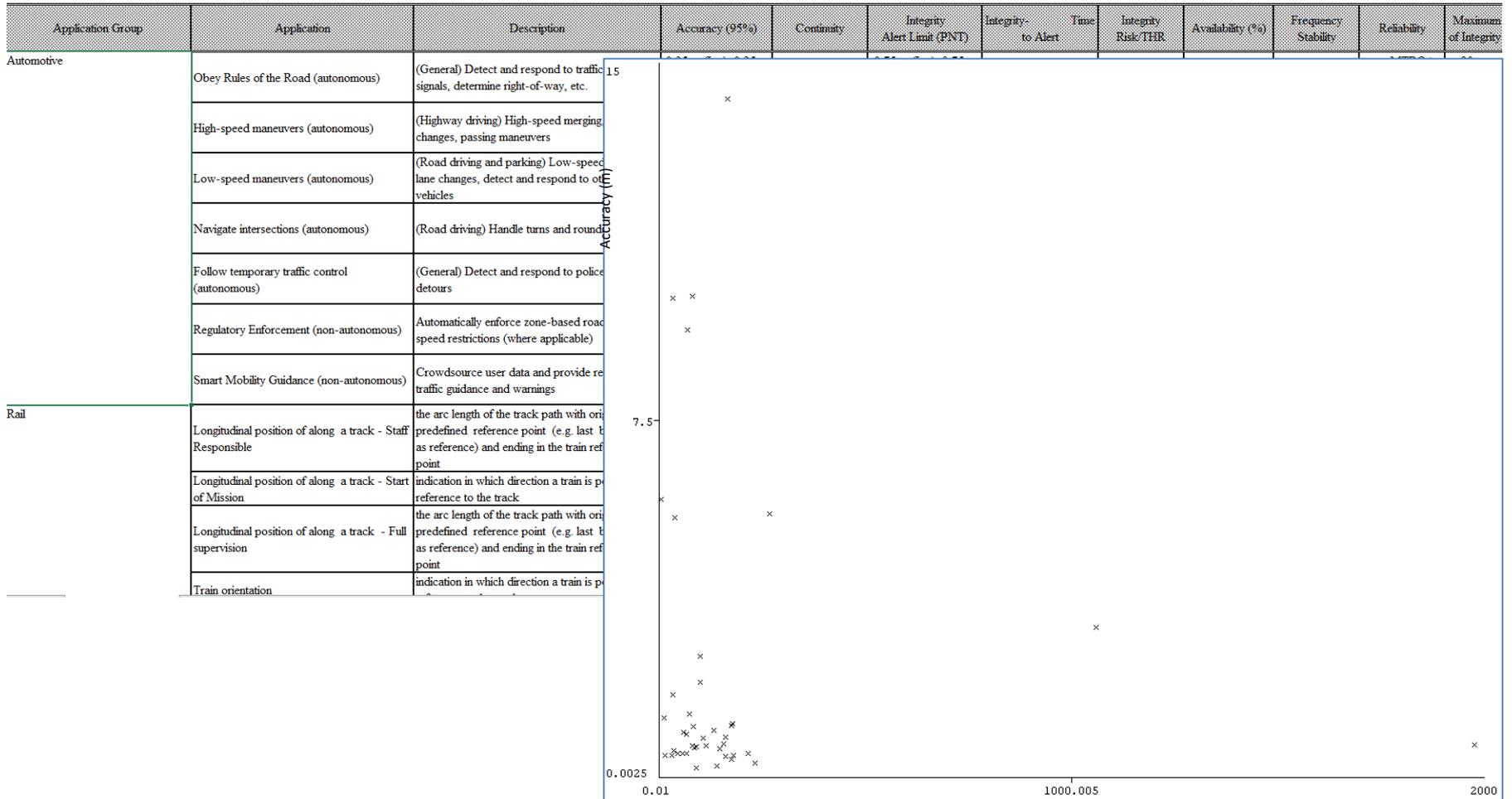


# WG 4 activities

- **Requirements collection and continuous update**
- **Requirements Harmonization and Service Level Definition**
- **Metrics Harmonization**
- **Network RTK Integrity Task Force**



# WG 4 activities



THR ( $10^{-7}/\Delta t$ )

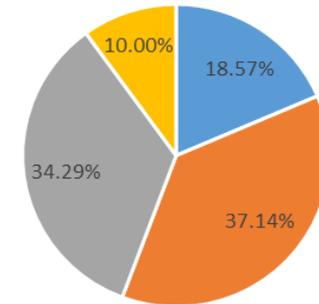


# Requirements Analysis

- Accuracy

Accuracy Classification	% applications
0.01-0.1 m	18.57%
0.1-0.3 m	37.14%
0.3-10 m	34.29%
NA	10.00%

Accuracy



■ 0.01-0.1 m ■ 0.1-0.3 m ■ 0.3-10 m ■ NA

- Integrity (THR/SIL)

General IEC-61508	Dangerous Failure/h	ISO 26262	Rail CENELEC 50126/128/1	% application
SIL-1	$10^{-5}$ - $10^{-6}$	ASIL-A	SIL-1	50.79%
SIL-2	$10^{-6}$ - $10^{-7}$	ASIL-B/C	SIL-2	0.00%(*)
SIL-3	$10^{-7}$ - $10^{-8}$	ASIL-D	SIL-3	9.52%
SIL-4	$10^{-8}$ - $10^{-9}$	-	SIL-4	4.76%
NA				41.27%

(\*) On the boundary of two levels





# Possible Collaboration Activities

- **Analysis of Safety and Integrity for emerging applications**
- **Common definition and harmonization of GNSS application requirements**
- **Collaboration on the development of application standards for next generation Satellite Navigation Systems**
- **Analysis of interfacing standard between Ground and Service Segments**
- **Mutual Participation to Plenary Meetings**





**Thank you!**

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