

A New GNSS Timing Service via EGNOS and Galileo

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EGALITE is an European Commission H2020 project for the high-level definition of a Galileo and GPS Timing Service providing end-to-end committed performances to Time & Synchronization users. In this work we present the GNSS Timing Safety Analysis conducted in EGALITE which allows to define a Safety Architecture for a GNSS Timing Service with integrity capability via Galileo and EGNOS

CONCEPT & APPROACH

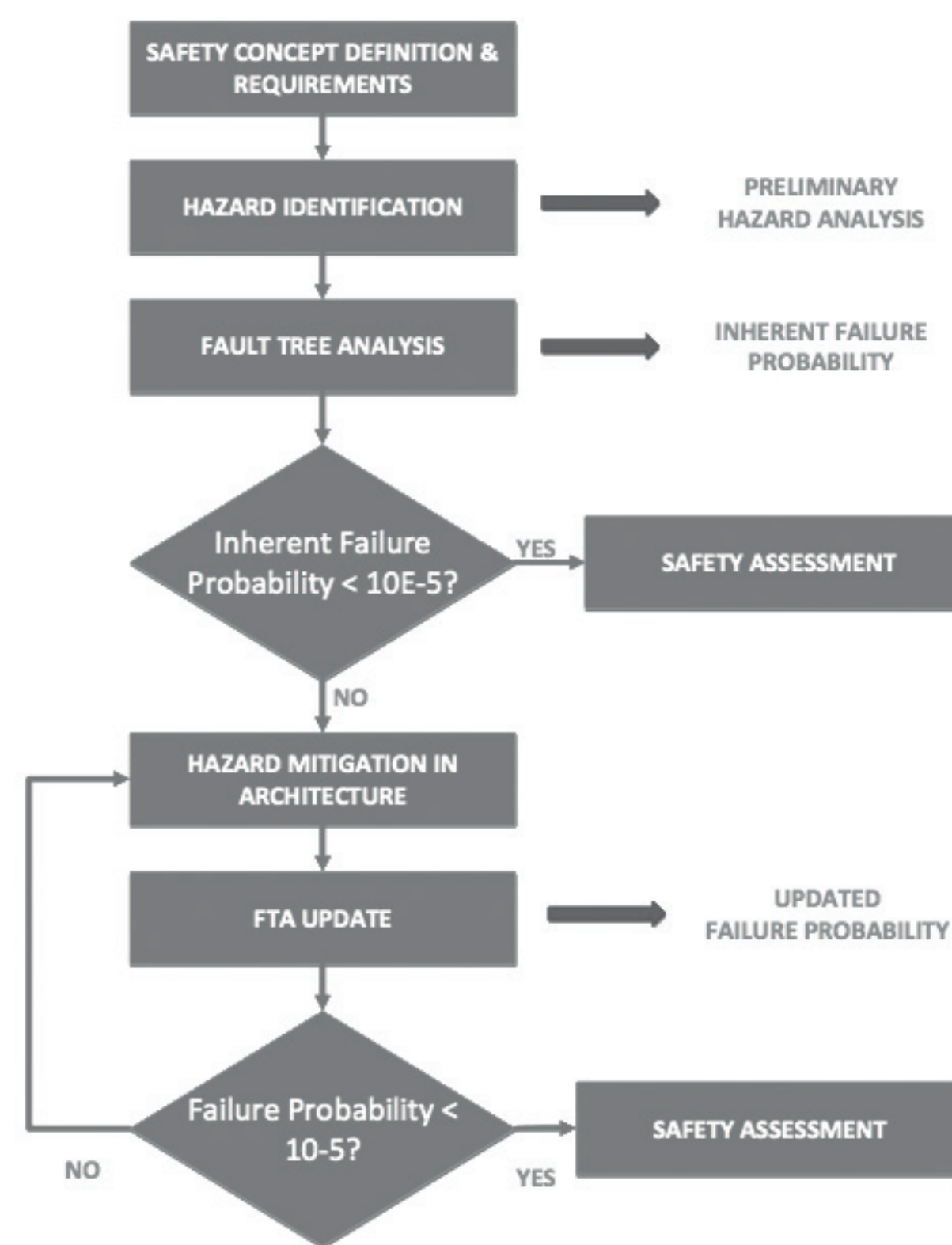
- Protection Level approach not used. Instead, a Maximum Time Error (MTE) is defined (versus UTC) and a maximum probability of failure $P < 10^{-5}$ failures/hour ("major" failure condition class)
- Three MTE values defined depending on different Service Levels according to user needs

Service Level	Maximum Timing Error (MTE)
1	1000 ns
2	100 ns
3	10 ns

Failure Condition Class	Quantitative Safety Requirement (failures/h)	Development Assurance Level
Catastrophic	$P < 10^{-9}$	A
Hazardous	$P < 10^{-7}$	B
Major	$P < 10^{-5}$	C
Minor	None	D
No safety effect	None	E

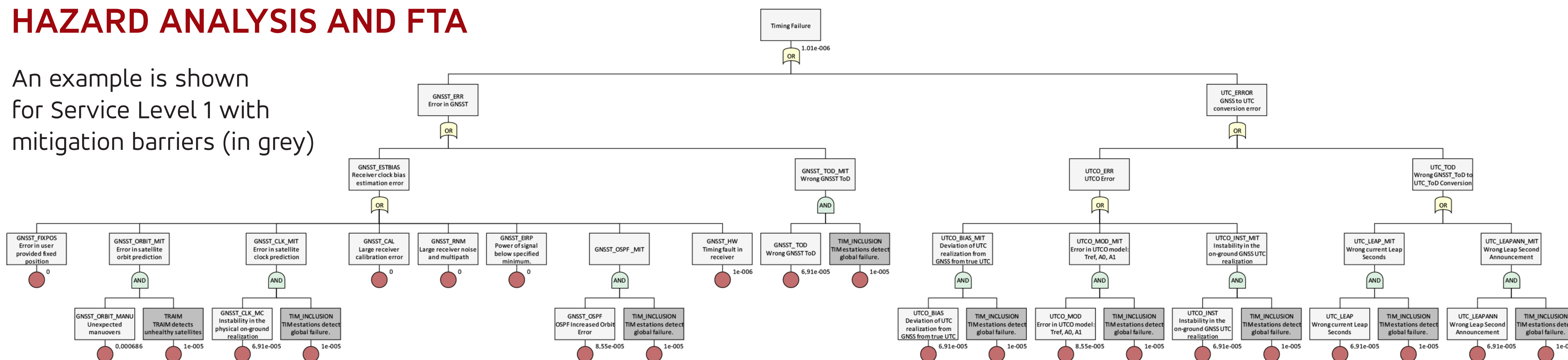
SAFETY METHODOLOGY

- Thorough identification of all hazards and a Fault Tree Analysis (FTA)
- FTA presents two main branches:
 - Hazards related to GNSS Time calculation
 - Hazards related to conversion from GNSS Time to UTC
- Probabilities evaluated for each Service Level
- It is found that in general the inherent probability of failure (without mitigations) is higher than target
- Target probability of failure achieved with mitigations



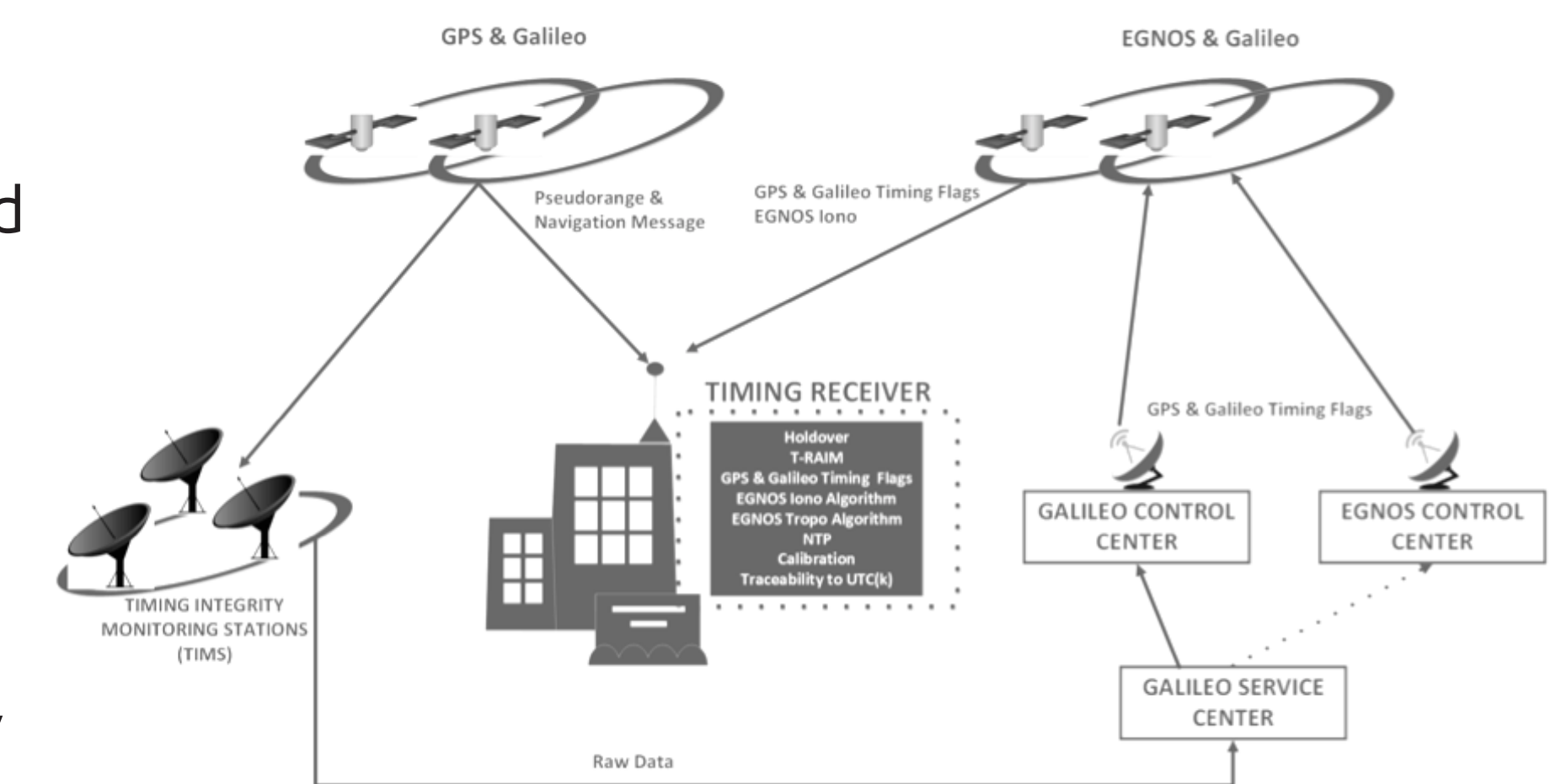
HAZARD ANALYSIS AND FTA

An example is shown for Service Level 1 with mitigation barriers (in grey)



SYSTEM ARCHITECTURE

- The user receives new GPS and Galileo timing flags (per satellite and per constellation) from the Galileo and EGNOS Navigation Messages
- Timing flags calculated based on a global network of calibrated TIMS (Time Monitoring Stations)
- Additional requirements imposed on the user receiver (e.g., dual-frequency mandatory for SL 3)



CONCLUSIONS

- An end-to-end Safety Analysis for GNSS Timing has been carried out
- In general, current GNSS timing capabilities do not inherently comply with a probability of failure $P < 10^{-5}$ failures/hour
- A new timing service is proposed to disseminate Galileo and GPS timing flags in the Galileo and EGNOS Navigation Messages, calculated from a global network of time monitoring stations