A-RNP Reversion in case of GPS loss

Conclusion of Desk Study

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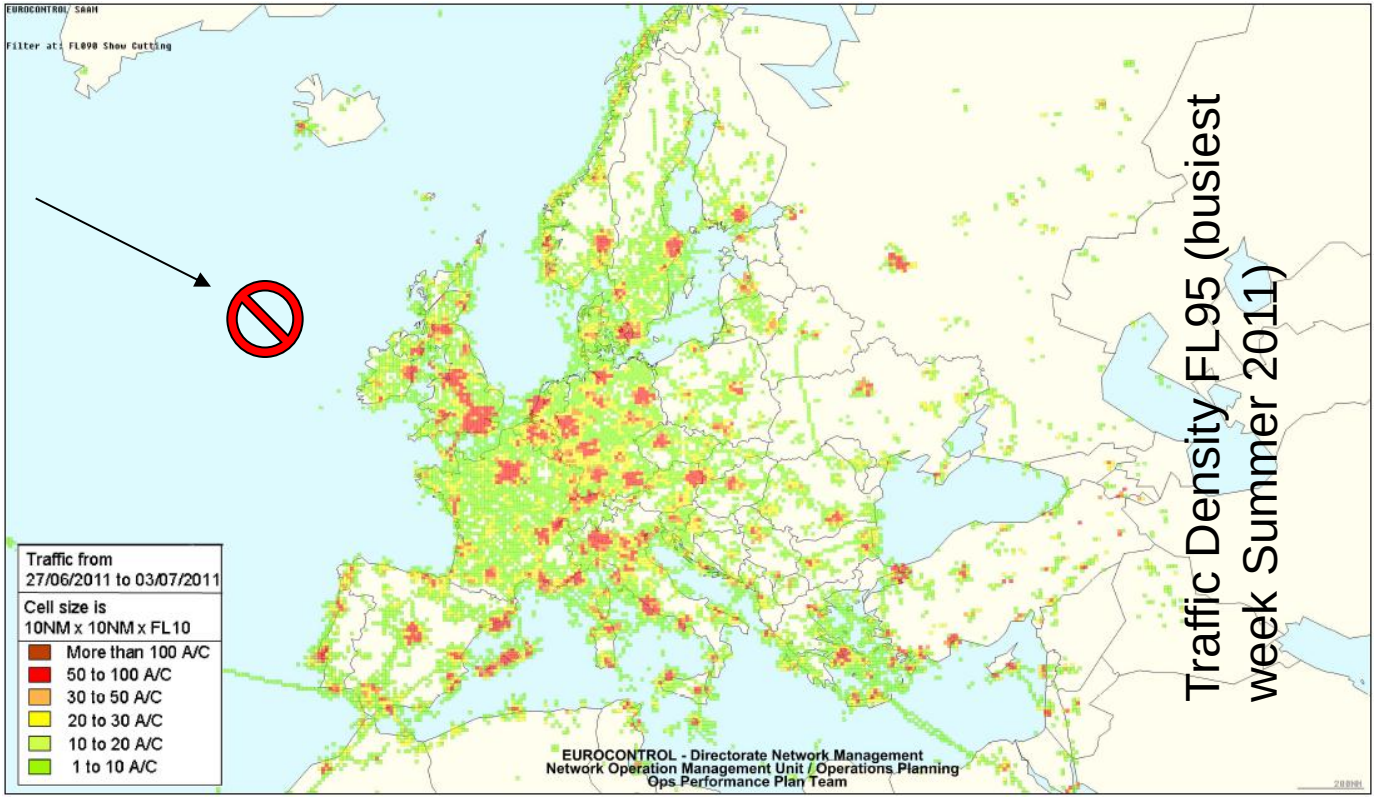
SESAR JOINT UNDERTAKING

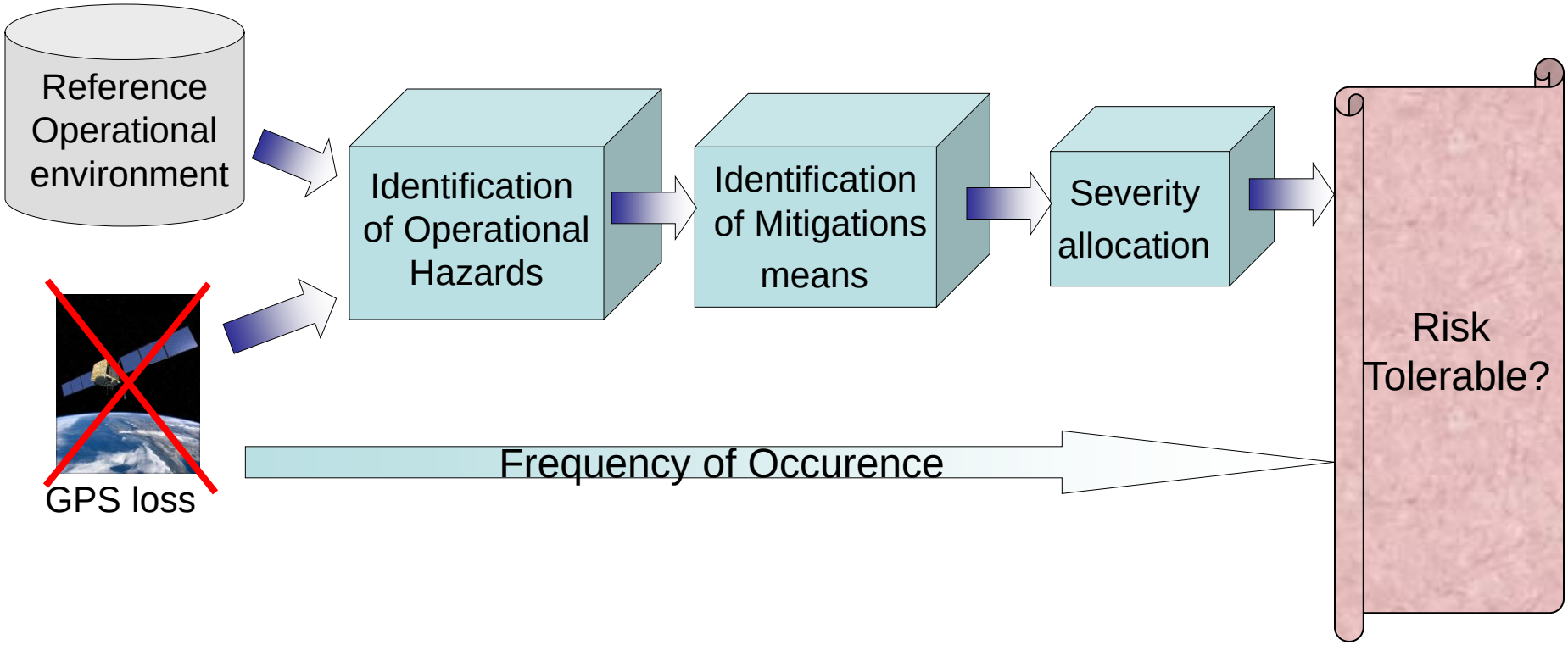
EASA Workshop
PBN Operations
January 2014

Reversion Scenario Work

- Wide Area GPS Outage
  - Intentional / Unintentional RFI
  - Unusual Iono
  - Constellation Weakness
- None of these are very likely, but cannot be excluded 100%
  - ATC must be able to cope
  - Procedures under development



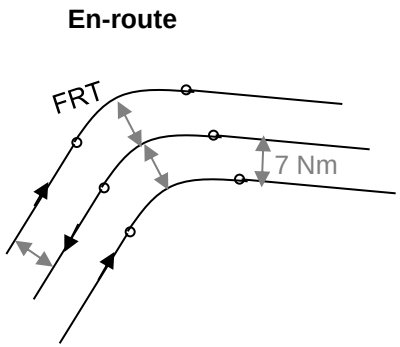
Desk Study overview

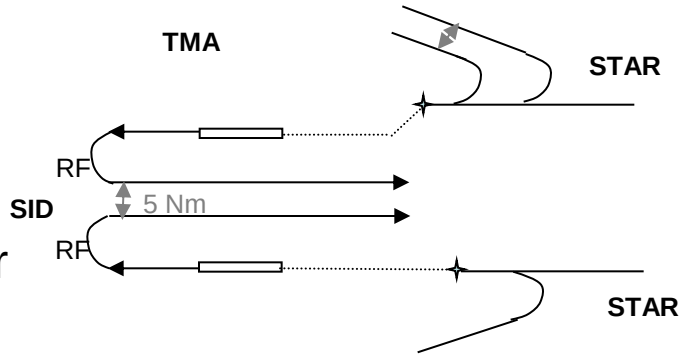


- Based on a traditional Risk assessment process
- Supported by a safety workshop with operational and technical experts

Reference Operational Environment

- **Route design**
  - A-RNP for ATS routes, SIDs & STARs
  - 1Nm accuracy /95%
  - Traffic density/Complexity: High
- **Route spacing in A-RNP** :
  - 7 Nm (En-route)/ 5Nm(TMA) including during turn (FRT in En-route / RF in Terminal).
- **Surveillance**
  - Surveillance based on Radar / Not relying solely on ADS-B
  - Radar separation: 5 Nm (En-route); 3Nm (TMA)
- **Aircraft equipage**
  - FMS/RNAV with GPS, DME-DME and Inertial or
  - FMS/RNAV with GPS and DME-DME or
  - FMS/RNAV with GPS only

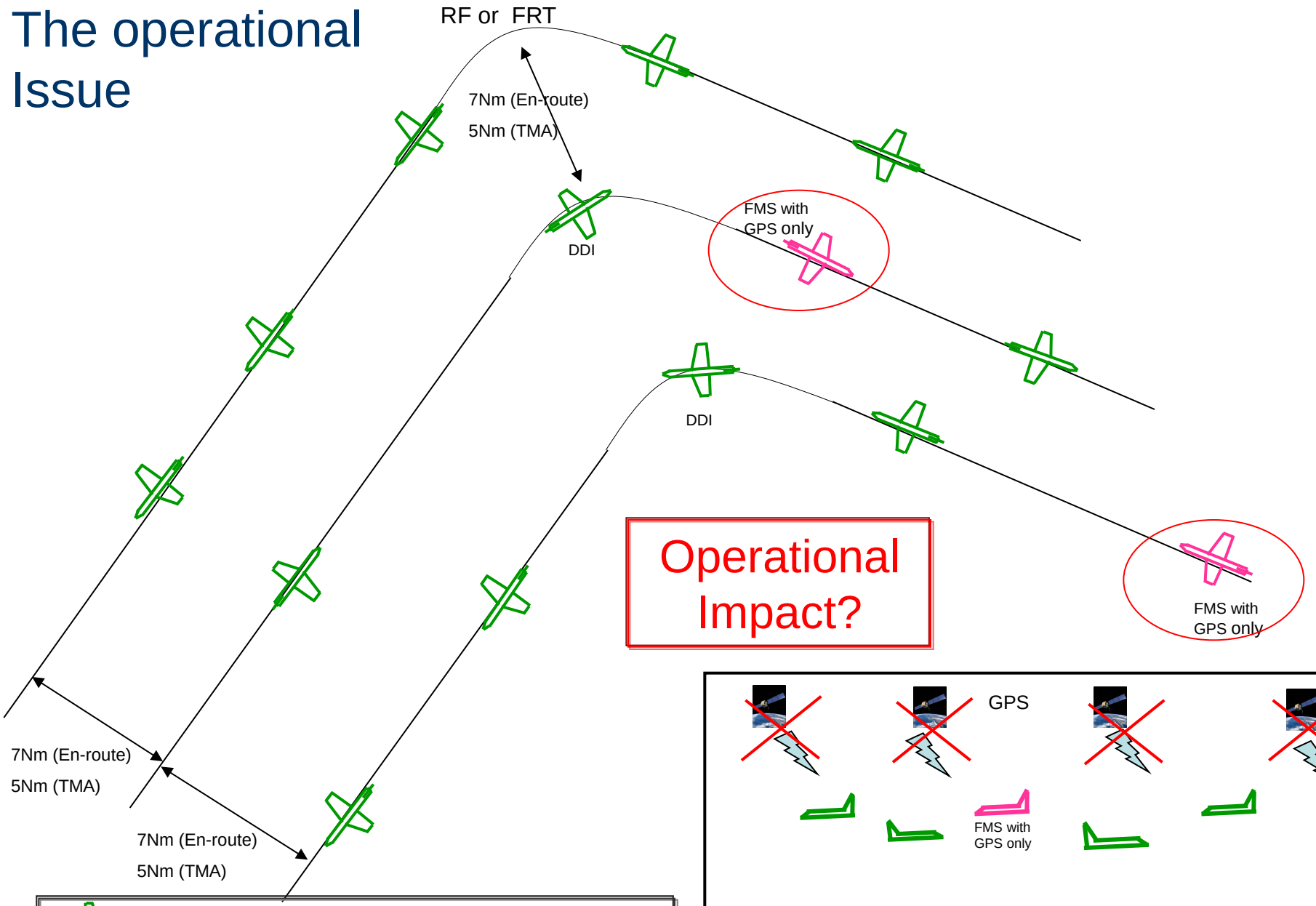




GPS loss characteristics

- Not easy to characterise GPS loss
- Multiple causes leading to GPS loss :
  - GPS service degradation, coverage gap, interference, ionospheric disturbances,,…
- Main cause for unexpected GPS loss affecting A-RNP navigation application is interference (intentional/non-intentional)
- Based on current experience and considering the potential threats, unexpected outages affecting one or more sectors or one complete TMA should be “occasional” events.
  - Outage may occur once every 1 to 10 years per sector
  - Likelihood might be greater in TMA - higher interference risk due to lower altitude

The operational Issue

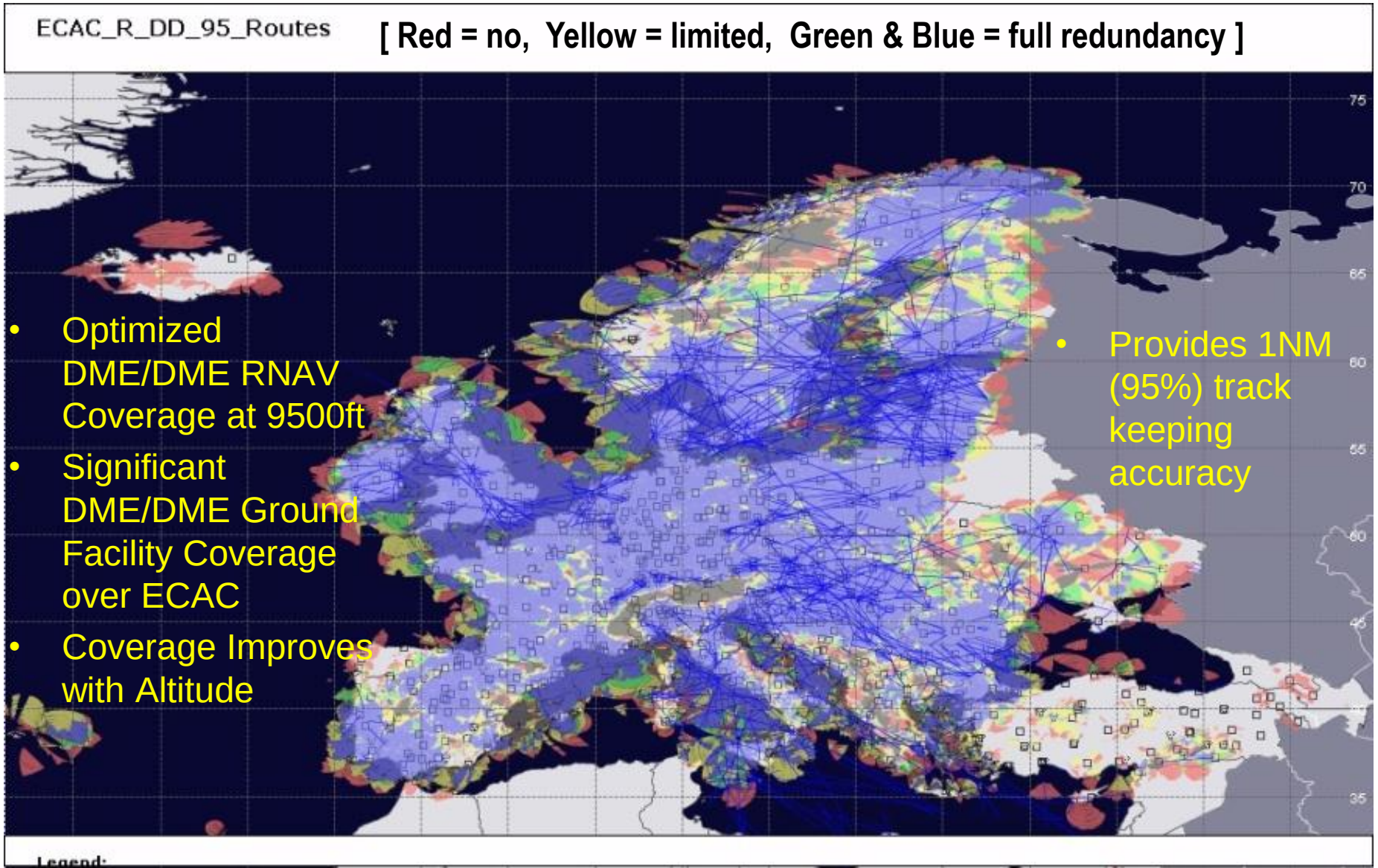


Operational Impact?

Main Mitigation Means identified

- Controllers want to be unambiguously informed about the unexpected GPS outage when it occurs
- Controllers want to know which aircraft are impacted by this outage
- There are a limited number of aircraft having only GPS for positioning
- Aircraft equipped with DME-DME positioning do not report to ATC that they have lost GPS
- Controllers provide radar vectoring to “GPS only aircraft”
- DME-DME coverage is available on A-RNP ATS routes, SIDs and STARs.
- Aircraft with DME-DME positioning navigate accurately on A-RNP routes including during FRT/RF
- As soon as the unexpected GPS loss is confirmed, an ATC reversion plan is applied to:
  - Reduce the capacity of the affected sector(s)
  - Reduce if necessary their complexities.

The DME Investment in Europe



- Optimized DME/DME RNAV Coverage at 9500ft
- Significant DME/DME Ground Facility Coverage over ECAC
- Coverage Improves with Altitude

- Provides 1NM (95%) track keeping accuracy

Fleet Numbers

(EUROCONTROL PRISME Database, new 2012 ICAO Flight Plan)

DME/DME RNAV Capability (All sensors, DME only, with / without Inertial)	***FLIGHTS*** in ECAC (European Civil Aviation Conference)
RNAV 5 Approved	**97.2%**
RNAV 1 Approved	85.9%
RNP 1 Approved	51.1%

Aircraft Capability

The Problem…

- Goal: Maintain A-RNP1 Operations Safely during GPS Outage
  - "RNP Loss" ***but turn functionality still available***
- Short Term A-PNT:
  - **GPS L1 + Current Terrestrial NAVAIDS**
- Medium / Long Term A-PNT:
  - GNSS Multiconstellation + possibly new A-PNT Technologies?

The Solution?

Risk acceptability

- Operational Hazard have been identified:
  → The most relevant is: « One or Several aircraft deviating from the A-RNP route following GPS loss »

  Considering identified assumptions on the operational environment and identified mitigation means:

  → Consequence of operational hazard corresponds to a Severity Class SC 4a
  - SC4a = crew/aircraft induced conflict prevented by tactical conflict management (by the executive controller)

- The combination of (…):
  - The likelihood of unexpected GPS loss affecting one or more sectors(1-10 years)

  and
  - The severity of the consequence of the identified operational hazard

  (…) leads to a tolerable risk.

Conclusion and Next Step

- Achievability of Mitigation Means is a key aspect
- Some actions associated to assumptions/Mitigation Means have been raised
- A validation exercise (RTS) is under preparation
  - Supported by a representative operational environment (Enroute and TMA)
  - To validate Mitigation means and possible implementation solution
    - E.g. indication of GPS outage to ATC, RNAV loss aircraft reporting to ATC, capacity adjustment,…
  - To Validate assumptions:
    - E.g. acceptable number of “GPS only A/C” in a sector; acceptable capacity in degraded mode;…