Investigating AIS AtoN Availability

NAV07

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Using safety assessment techniques to investigate the availability of the AIS AtoN service

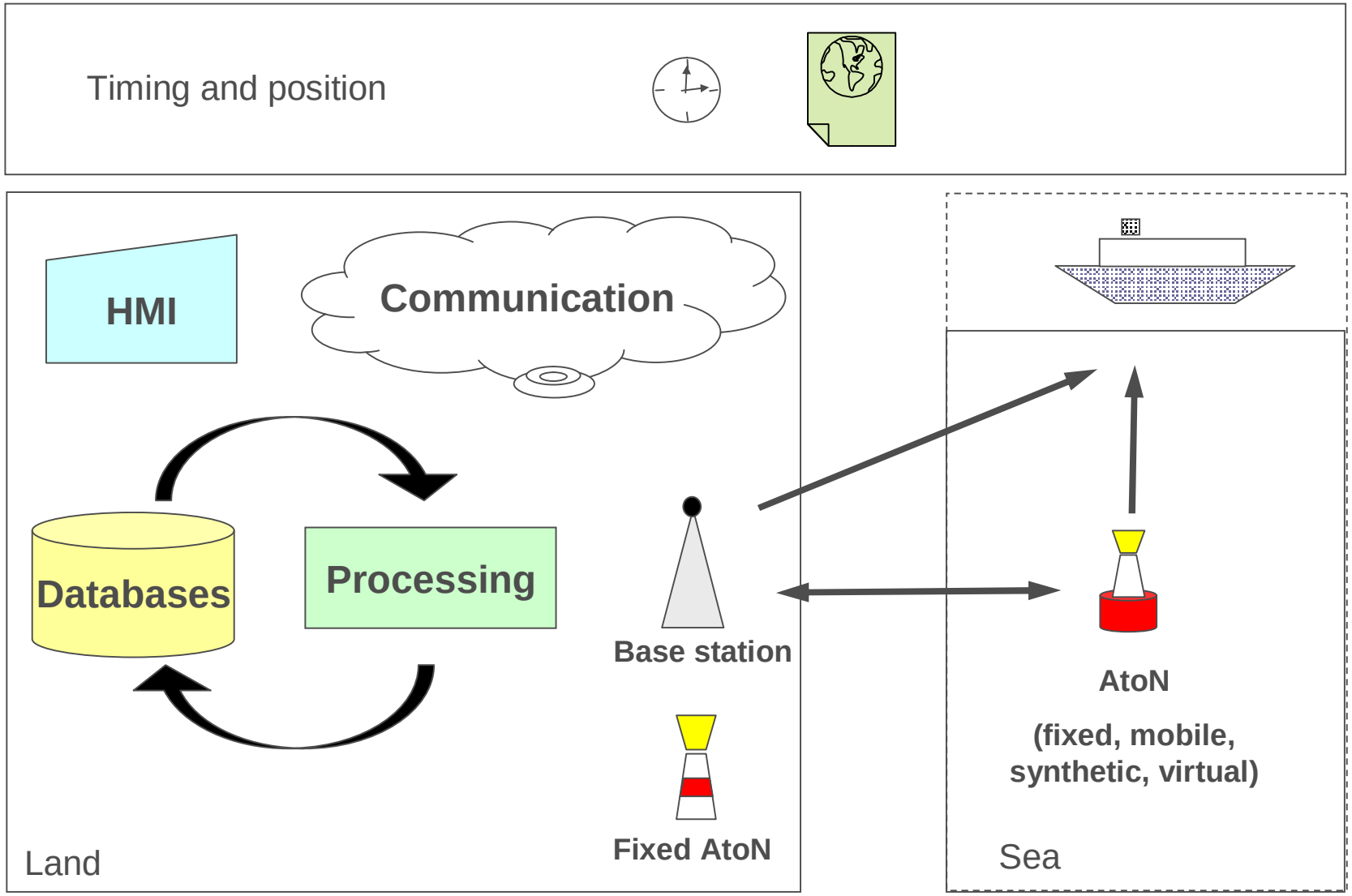
- Study carried out by Helios on behalf of General Lighthouse Authorities (GLA)
  - Assess a GLA AIS AtoN service
    - AIS – Automatic Identification System
    - AtoN – Aid to Navigation
  - Completed May 2007
- Safety assessment techniques
  - Failure Mode and Effect Analysis (FMEA)
  - Fault Tree Analysis (FTA)

- Why investigate AIS AtoN availability?
- What did we investigate?
- Four step approach
- Key results and conclusions
- What have we learnt?
- What next?

GLA responsible for providing AtoN to mariners

- Mariners making use of electronic based technology to navigate
- AIS
  - Provides accurate identification and position
  - Important element in maritime safety
  - Essential component of future e-navigation system
  - Under evaluation by GLA
- AIS availability
  - Affects overall maritime navigation performance
  - Not yet studied in depth

Scope of AIS AtoN system under investigation



The study was carried out using four steps

Define AIS AtoN service and service availability

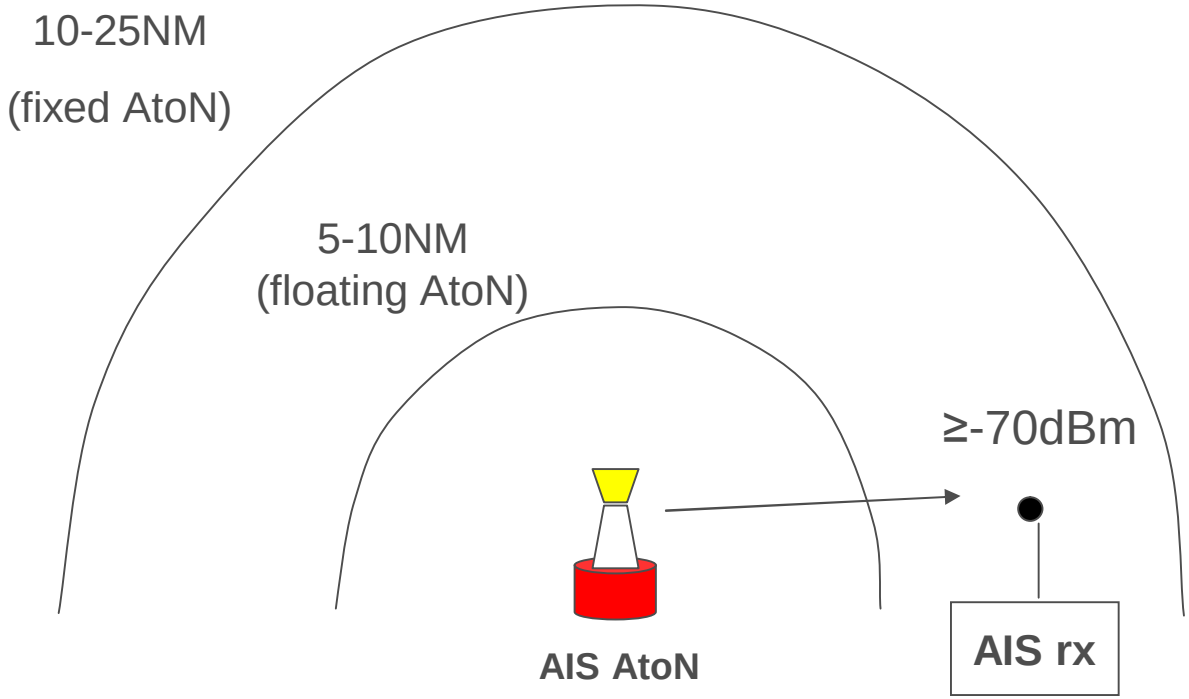
Identify system architecture

Carry out FMEA to identify the different failure modes

Carry out FTA to calculate the overall failure rate

1. AIS AtoN service definition

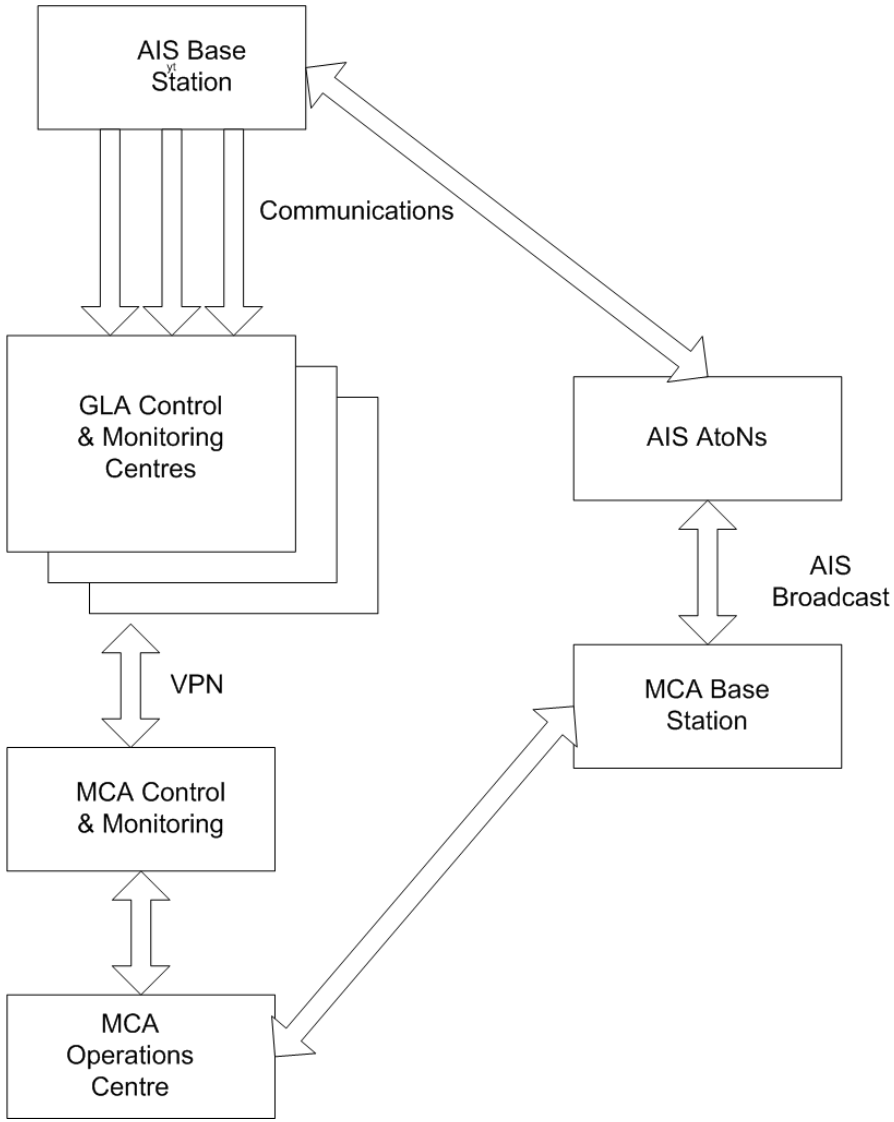
- Transmission of position and identity information relating to all AtoNs identified as AIS AtoNs



1. AIS AtoN availability definition

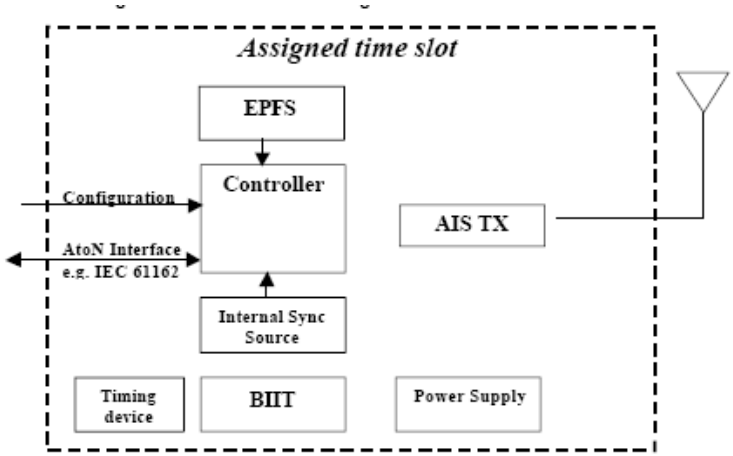
- The AIS AtoN service shall be available for ZZ% of the intended transmissions
  - Calculate separately for each AIS AtoN
  - Assumes transmission rate configured to meet AtoN requirements
  - Assumes user expects to decode each transmission

2. Identify the AIS AtoN system architecture



- High level system architecture

- AIS AtoN functional architecture



3. Carry out FMEA to identify different failure modes of AIS AtoN service

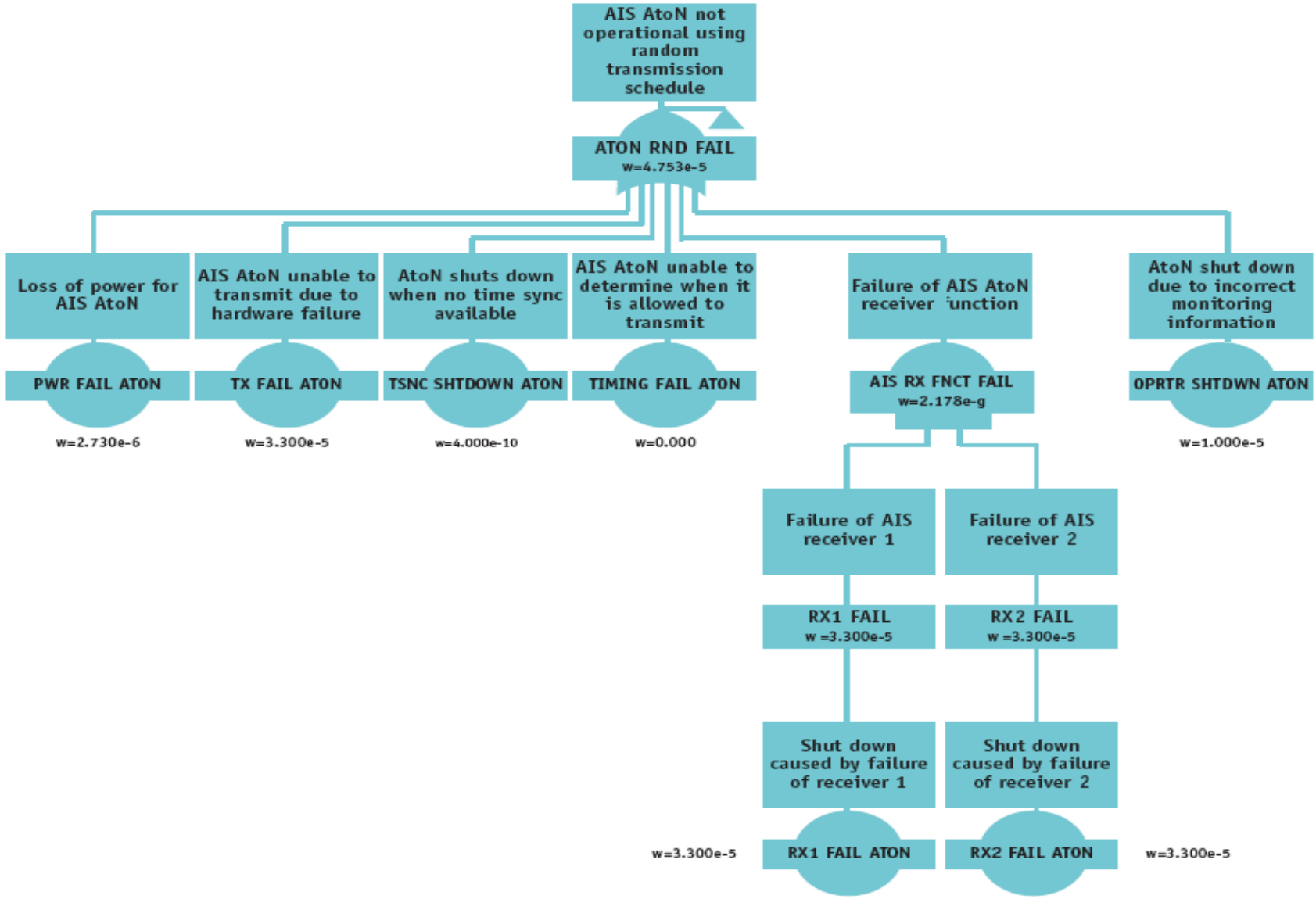
- The FMEA is a systematic method for identifying the failure modes of a system

Function name	**Functional element**	**Failure mode**	**Failure effect**	**Assumed failure rate (per hr)**
AIS AtoN	Positioning system (GPS)	Hardware failure Signal unavailable No line of sight Software/ firmware failure	No position information transmitted AIS AtoN service unavailable	GPS failure = $9x10^{-6}$
GLA control and monitoring	AIS control and monitoring server	Data corruption Incorrect configuration	Incorrect data for synthetic\virtual AIS AtoN transmissions AIS AtoN service unavailable	Corruption = $1x10^{-5}$ Input error = $1.48x10^{-7}$

4. Carry out FTA to calculate overall failure rate

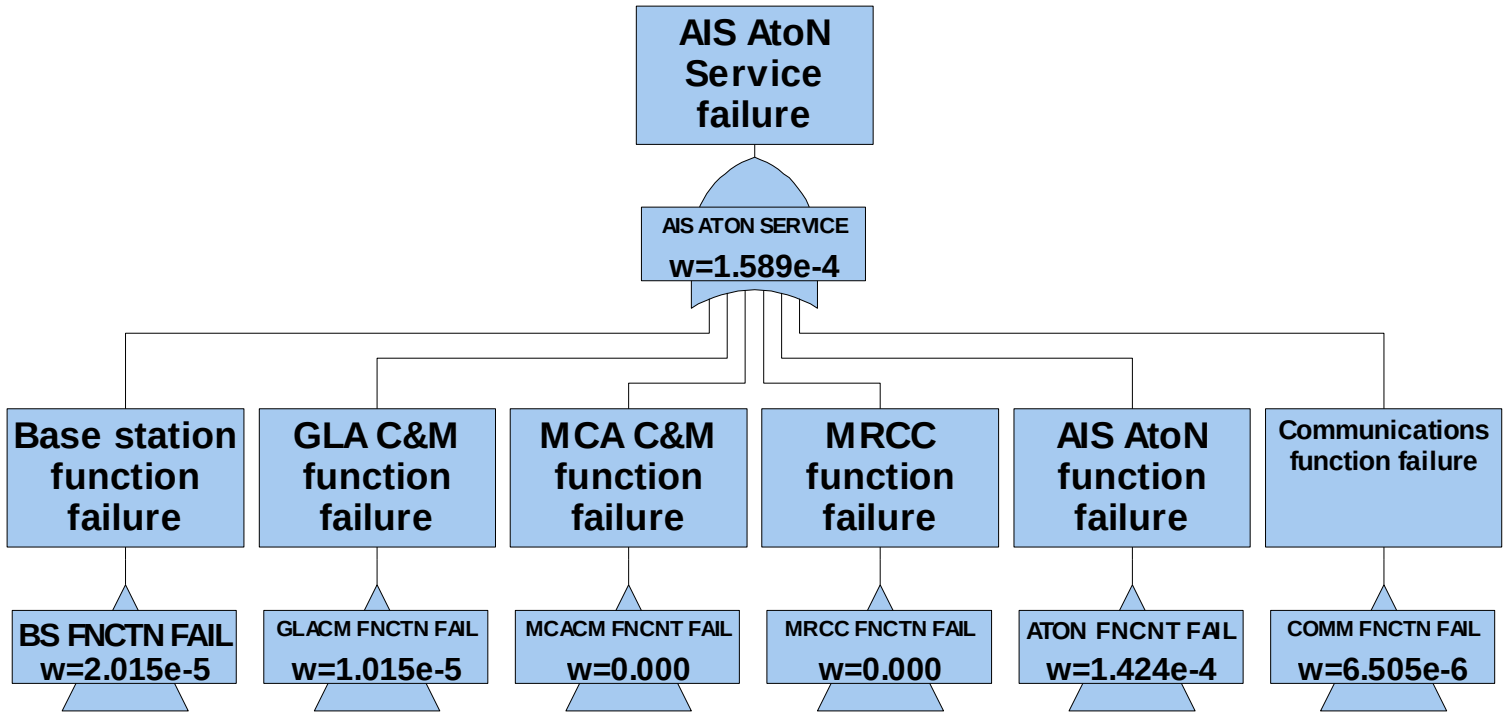
- The FTA is a deductive analysis which focuses on one particular undesired event and determines the causes (with associated probabilities) for this event
  - Focus on AIS AtoN service unavailability event
  - Uses output from FMEA
- Important to assess
  - Mean time to fix requirements
  - Monitoring function requirements
  - Service availability

4. Probability of each failure event determined by failure rates of constituent parts



4. FTA used to assess likely service availability when failure rates combined with time to fix

- This FTA only one part of process for calculating availability of AIS AtoN service



The key results from the study were as follows

- Service availability definition proposed
- Two types of failure modes identified
  - Direct
  - Indirect
- Approximately 1.4 failure events per year per AIS AtoN
  - AIS AtoN and base station dominant functions
  - No dominant primary failure events

Key conclusions

- AIS AtoN is the critical function directly affecting service availability.
- *The calculated typical service failure rate of 1.4 failure events per year appears high:*
  - Need to validate failure rate assumptions
  - Performance of control and monitoring function is important
- *To calculate service availability the following also need to be considered:*
  - Failure rate of AIS AtoN control and monitoring function
  - Times for detection and repair of failures
  - Effect of co-channel interference due to correct operation of the AIS channel access protocols
  - GPS signal availability
- FMEA and FTA process can be re-used to provide a means of specifying system performance requirements to ensure a target level of availability is achieved.

What have we learned?

- Practical definition of service availability
- FTA and FMEA logical process for
  - assessing system reliability and availability
  - assigning system element requirements
  - assessing system design
- Greater understanding of how to implement AIS AtoN service
  - Focus resources for successful implementation
  - Reduce risk of implementation
  - Ensure high quality service provided

What next?

- Validate critical assumptions and failure rates
- Ensure AIS AtoN service provided to user is fit for purpose
- International agreement on AIS performance for AtoN application
- AIS AtoN service providers to carry out assessment of service availability prior to implementation
- Re-use FMEA and FTA methodology
  - to assess other service provision and system design

Thank you for your attention

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