ARCHER

MSG-3 Analysis of highly integrated electronic devices

International MRB Policy Board - May 2023 @ EASA - Cologne, Germany

Agenda

- Objective;
- Motivation;
  - The emerging technologies environment: UAM;
  - Technical motivation;
- White paper shared with the MPIG;
  - Initial Concepts;
- Conclusion;

Objective of this presentation

- Share MPIG's discussions about how to enhance MSG-3 analysis effectiveness;
  - One area identified as opportunity:
    - *Analysis of highly integrated electronic devices (initiated CIP IND 2022-02 - Draft);*
- Hear from the IMRBPB if the MPIG should continue pursuing the approach;
  - for MSG-3;
  - for MSG-4;
  - for both.
- The MPIG has neither reached consensus yet, nor explored all options;
- The intent is not to agree with the technical contents, but with the intent to pursue the opportunity.

MSG-3 Analysis of highly integrated electronic devices

Motivation

MSG-3 Analysis of highly integrated electronic devices - How it started

The emerging technologies environment: UAM

- Certification basis not harmonized amongst Certifying Authorities;
- No current commercial utilization of a program under the UAM expected utilization;
- Scheduled Maintenance identification processes not yet established;
  - Part 25 has MRB/MSG-3 as "*the standard*";
  - Part 23 is moving towards "*performance based*"
  - UAM has an uncommon combination of:
    - Part 23 certification & Part 135 Ops
- Most UAM OEMs projects are fomented by small start-ups, or companies with limited resources;
  - Focus must be given to **efficiency**;
    - Safety is paramount - no questions asked;
- All applications would benefit from a more effective approach.

MSG-3 Analysis of highly integrated electronic devices - Archer's experience

UAM

Archer's experience on justifying use of MSG-3/MRB

- Use of MSG-3 requires higher upfront investment vs. 'OEM recommended' maintenance based on other methods (i.e. Part 43 Appx D);
- Justification for resources;
  - Safety considerations → Check ✔
  - Maintenance Operations efficiency → Check ✔
  - Upfront Investment → "Why is a MRB/MTB process using MSG-3 more efficient than other methods?"
    - "What is the value added for the analysis of highly integrated electronic equipment, producing potentially ~1,000 page-analysis for an equipment we know maintenance would not be applicable and effective"
    - Concern on using regulator resources for those analysis that are known to be ineffective.
- Archer Employees (as of Dec 2022): 483*

*Source: https://en.wikipedia.org/wiki/Archer_Aviation

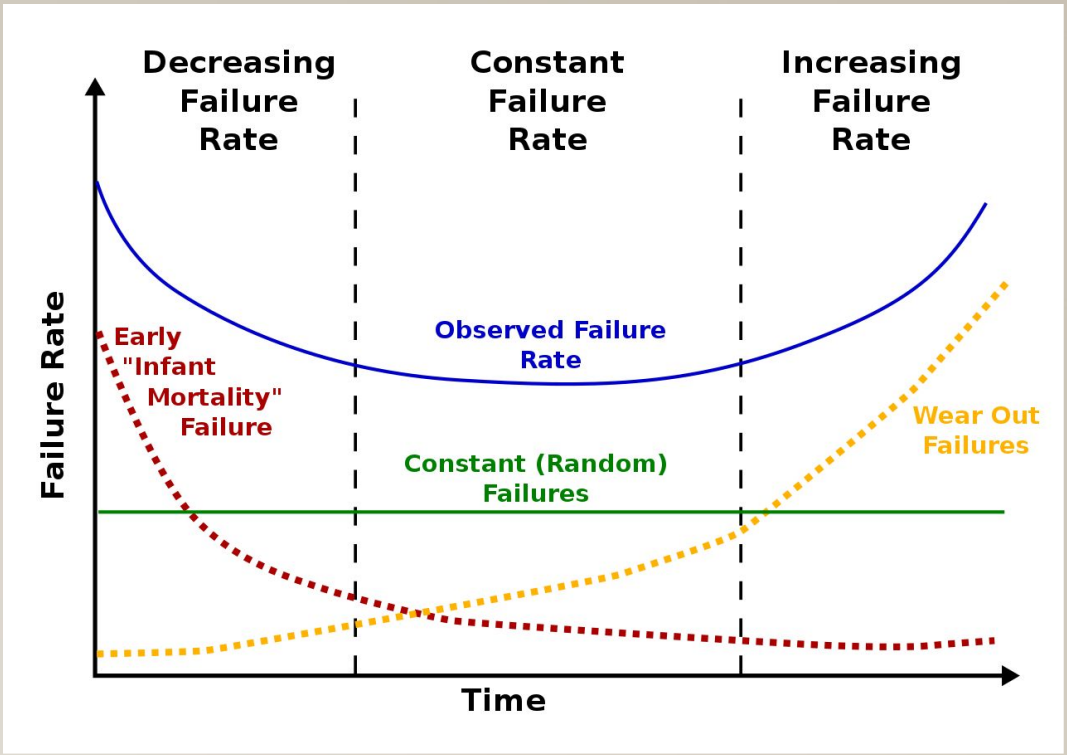
MSG-3 Analysis of highly integrated electronic devices

Archer's White Paper (shared with MPIG) & MPIG discussions

MSG-3 Analysis of highly integrated electronic devices

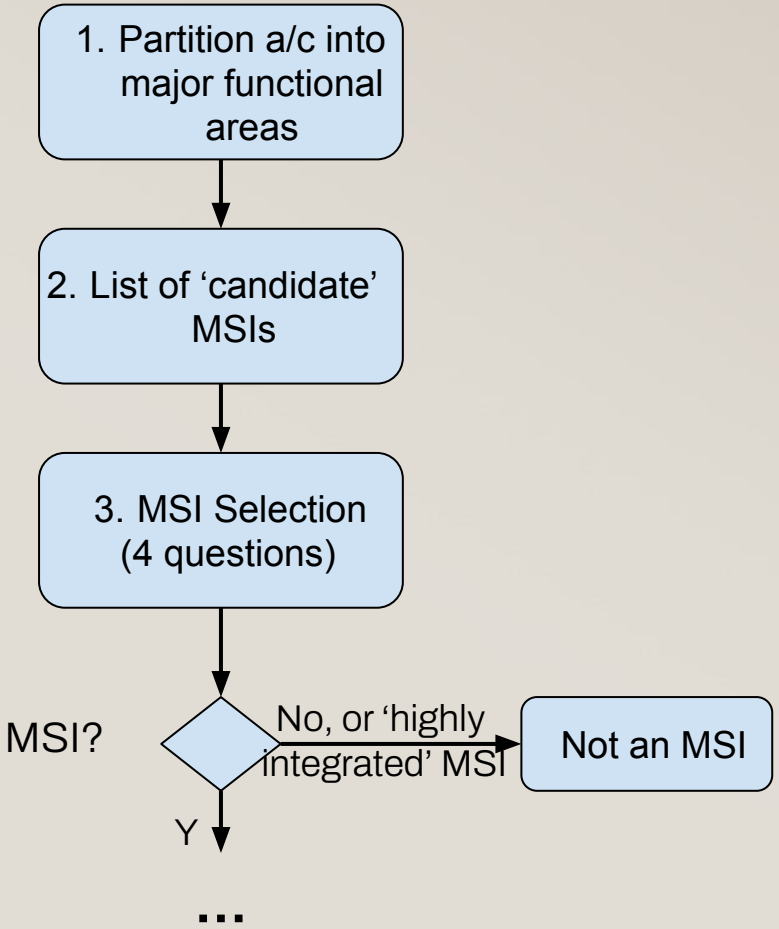
- White paper may be considered for MSG-3 and/or MSG-4

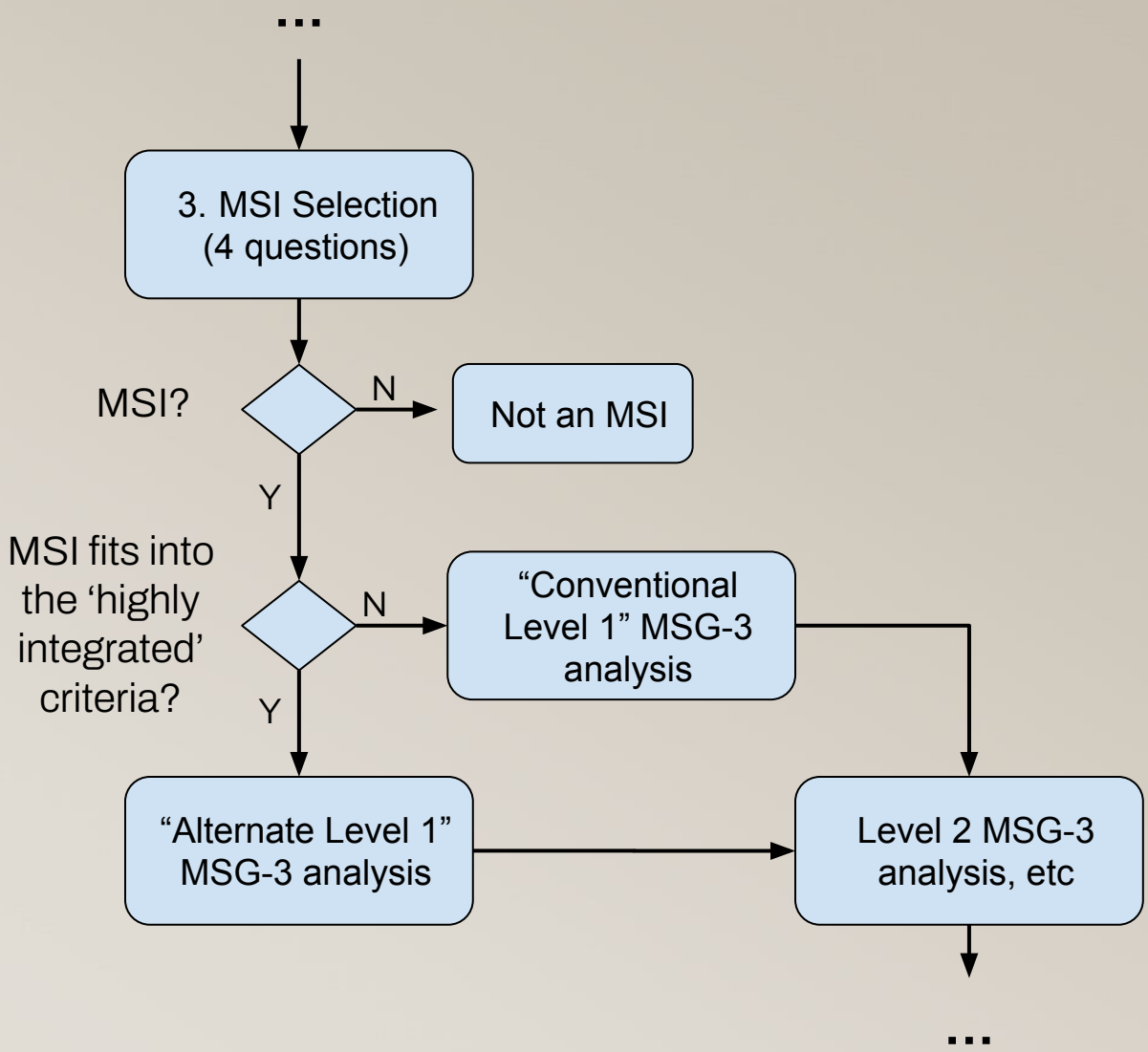
- Technical Basis for White Paper
  - Highly integrated electronic devices are to be understood, in the scope of this discussion, as those **devices comprised of electronic components such as resistors, transistors, capacitors, microcontrollers, etc**;
  - Experience that the failure rate of those components is constant, therefore failures are **“random”**;
  - Solder failures are related to **thermal cycling**, and may be one exception.
  - Archer’s white paper provide a literature reference to typical failure modes and possible assigned MSG-3 tasks for each, based on high level engineering review → **iBIT is prevalent**.



iBIT - initiated Built-in-test

Two school of thoughts within the MPIG:





Archer's approach to the issue

- From all failure modes, one stands out:
  - Solder - thermal cycling phenomena: **Thermal management → Analysis required.**
    - Electronic devices thermal management may be:
      - Active (i.e. heat sinks + cooling fan); OR
      - Passive (i.e. heat sinks).

- Archer broke down the task as follows:
  1. How to distinguish MSIs that fit into the 'highly integrated electronic devices', from others?
  2. What kind of analysis would be applicable?
     - Archer's prerequisites:
       - Application of 'end-to-end' MSG-3 analysis of Functions;
       - Systems and components Design Assurance Levels (DAL) are commensurate with the System Assessment process (e.g. ARP4754A, ARP4761);
       - Components are qualified to the environment in which they are installed (e.g. DO-160G);
       - Reliability tests are performed or reliability is satisfactory verified and support the required System Safety process requirements;
       - Production quality processes are robust and adequate to aviation standards;
       - No single failure can cause a Catastrophic condition (e.g.: 25.1309/23.2510 criteria);
  3. What inputs are required to ensure safety aspects are considered with the use of a 'simplified approach'?

1. *How to distinguish MSIs that fit into the 'highly integrated electronic devices', from others?*

Example:

The MSI should:

- ✓ Be comprised of electrical/electronic components only; AND
  - ✓ Does not physically interface with pneumatic, fluids, mechanical parts (except for physical support of the LRU); AND
    - ✓ Provides data passthrough functions only; OR
    - ✓ Provides electronic (Software and/or Micro processing) hosted functions only;

iBIT - initiated Built-in-test (BIT)
pBIT - power-up BIT
cBIT - continuous BIT
FMEA - Failure Modes and Effects Analysis
SSA - System Safety Assessment
ASA - Aircraft Safety Assessment

2. *What kind of analysis would be applicable?*

"Alternate Level 1" - only applicable to those MSIs that would fit into #1 (previous slide)

The Alternate Level 1:

- ✓ It **is** an analysis;
- ✓ Failure of internal electronic components would be detected via iBIT, pBIT, cBIT or user systems;
- ✓ Consider latent failures identified in the FMEA, if any;
- ✓ Intent is to **focus on** the only failure mode identified as potentially 'not random': **thermal management**;
  - ✓ Consider component OEM **maintenance recommendations**;
  - ✓ Identify MSI's **thermal management characteristics**;
  - ✓ Identify **contribution to Safety** event (Major or above failure conditions - from SSAs/ASA)
  - ✓ Identify zone characteristics for **lint and dust accumulation**;
  - ✓ **FEC is assigned** per the failure effect of loss of the thermal management function;
  - ✓ **Level 2 would be conducted as per current MSG-3 document**.

3. *What inputs are required to ensure safety aspects are considered with the use of a 'simplified approach'?*

- ✓ Components FMEA → common input to existing MSG-3 analysis;
  - ✓ FMES may also be used;
- ✓ Component's thermal management characteristics;
- ✓ Zonal exposure to lint and dust;
- ✓ Contribution of component failures to aircraft level safety effects → SSA and/or ASA;

FMES - Failure Mode and Effects Summary
FMEA - Failure Modes and Effects Analysis
SSA - System Safety Assessment
ASA - Aircraft Safety Assessment

Conclusion

- MPIG has started looking for opportunities to enhance the MSG-3 analysis efficiency;
- MPIG is willing to offer a future CIP for an alternate method to consider ‘highly integrated devices’; Also considering the concept to MSG-4.
- IMRBPB feedback on intent is highly appreciated.

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Thank You