Flying into the Future with Safety Critical AI Capabilities

Introduction

The “AI is challenged” Rhetoric

- A key concept in DO-178C and related standards is ‘traceability of requirements'

- If one can’t explain why the system does one thing or another, and if systems are non-deterministic, how can a system be certified?

(the situation is actually a little better than this…more later)

DO-178C Certification Levels

Design Assurance Level	Description	Target System Failure Rate	Example System
Level A (Catastrophic)	Failure causes crash, death	$<1 \times 10^{-9}$ chance of failure / flight-hr	Flight controls
Level B (Hazardous)	Failure may cause crash, deaths	$<1 \times 10^{-7}$ chance of failure / flight-hr	Braking systems
Level C (Major)	Failure may cause stress, injuries	$<1 \times 10^{-5}$ chance of failure / flight-hr	Backup Systems
Level D (Minor)	Failure may cause inconvenience	No safety metric	Ground navigation systems
Level E (No Effect)	No safety effect on passengers/crew	No safety metric	Passenger entertainment

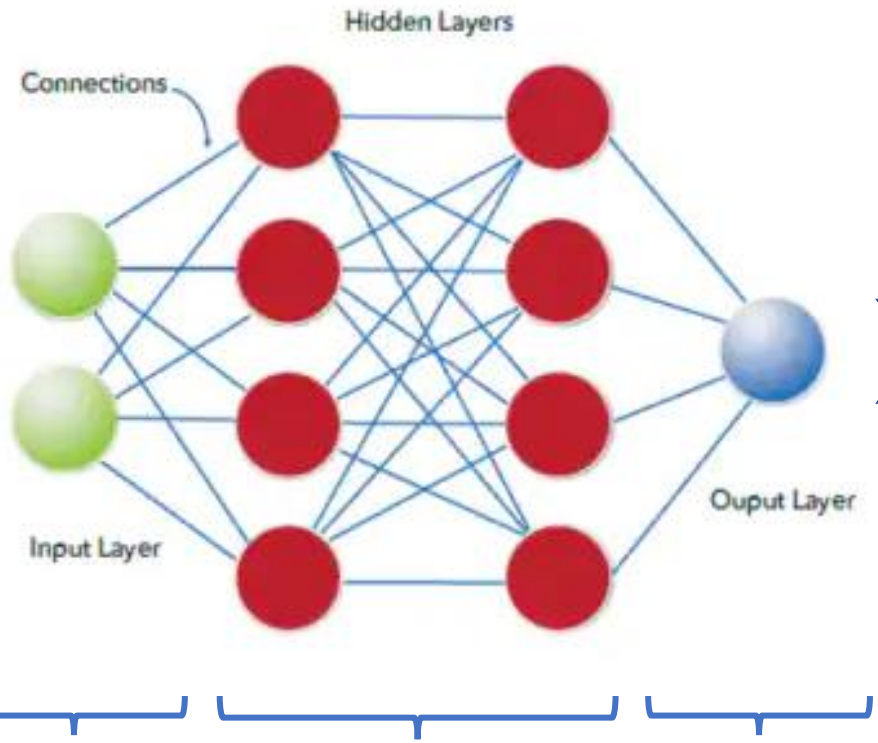
Source; Mistral Solutions, https://www.mistralsolutions.com/blog/airborne-electronics/

What is AI?

What are Neural Networks?

How do Neural Networks Work?

Data



Output

Data communicated to hidden layers

Processing takes place through system of weighted connections

Outputs are retrieved

*Graphic courtesy of SAS.com

Neural Networks and Safety

Neural Networks have an execution and expression phase.

- Execution must be deterministic
- Historically, there has not been an inferencing engine that could do deterministic execution, blocking their path to certification.

Real Life AI Examples

Amazon
Alexa

Industrial
Automation

AI-powered Hedge
Funds predicting
stock markets

Self-driving
Vehicles

AI is Happening in Avionics

- This is happening now
- Significant resetting of expectations of fully autonomous automotive platforms
- Replacing the human pilot is still someway off
- Embracing Artificial Intelligence is inevitable

SYCL for Safety Critical Systems in Avionics

AI in Avionics

Automated in-air refueling

AI in Avionics

Autonomous
Flight

AI in Avionics

Windowless Cockpit

Three Key Recommendations

- Sandboxing of functions
  - Isolation of workloads
  - Maintaining real-time determinism irrespective of what else is occurring in system
- Migration to zero-day-threat architecture
- Aligning certification strategy to evolving guidance from authorities

Segmenting Workloads is Critical

System Requirements

- Isolated applications
- Deterministic
- Secure
- Certifiable
- Fine-grained system instrumentation
- Immutable

Security apps	Real-time Functionality/ connectivity	Real-time Functionality/ connectivity	Non-real time system functionality/ connectivity	Cloud Connectivity + Node Mgr
Bare Metal	RTOS	3rd Party RTOS	Linux/ Windows	Linux/ Windows

Hypervisor

Hardware (Arm, PowerPC, x86)

Enhancing Cybersecurity; The AI you cannot see

Cybersecurity Events

Define NORMAL

- Create a model for normal behavior
- Typically involves running hypervisor + guests in controlled environment
- Typically, on-prem in a secure location

Identify ABNORMAL

- Rootkit detection
- API intercept
- Monitor APIs of interest
- Monitor memory pages of interest
- Hypervisor fingerprinting
- Secure domain isolation

Handle ABNORMAL

- Snapshot and restore
- Restore specific subject/guest or the entire system

AI's Path to Safety Critical

EASA releases its Concept Paper 'First usable guidance for Level 1 machine learning applications'

20 Dec 2021

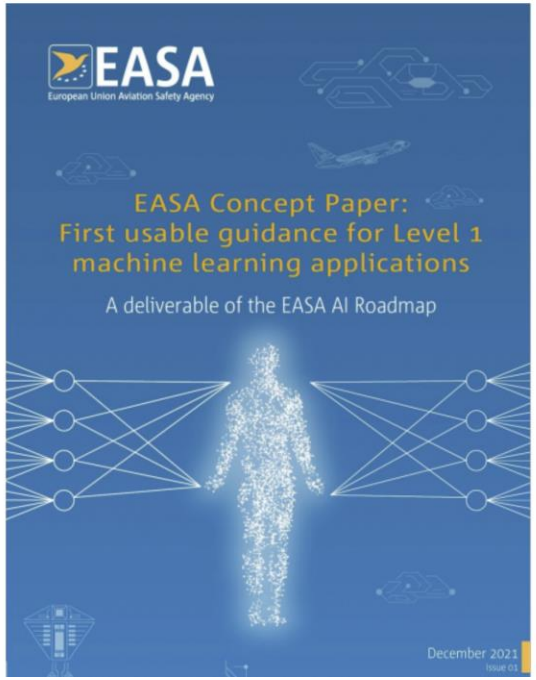
News category: AI Roadmap

In line with the first major milestone of the EASA Artificial Intelligence (AI) Roadmap 1.0, this concept paper presents a first set of objectives for Level 1 Artificial Intelligence ('assistance to human'), in order to anticipate future EASA guidance and requirements for safety-related machine learning (ML) applications.

The goal of this document is twofold:

- to allow applicants to have an early visibility on the possible expectations of EASA with respect to the implementation of AI/ML solutions.
- to establish a baseline for Level 1 AI applications that will be further refined for Level 2 and Level 3 AI applications.

This document has been matured over the last 1,5 years and underwent several stages of consultation including a 10 weeks period of public consultation from April to June 2021. It covers only an initial set of AI/ML techniques and will be enriched with other advanced techniques, as the EASA AI Roadmap is implemented.



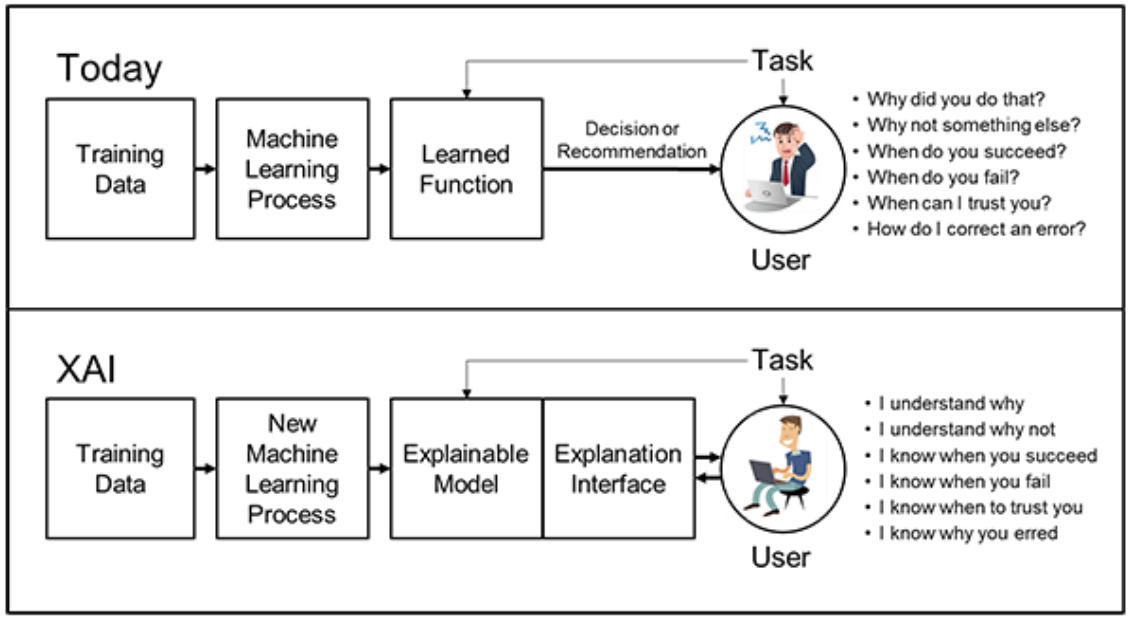
EASA AI Roadmap AI Level	High level function/task allocated to the (sub)systems
Level 1A Human augmentation	Automation support to information acquisition
	Automation support to information analysis
Level 1B Human assistance	Automation support to decision-making
Level 2 Human-AI collaboration	Overseen automatic decision-making
	Overseen automatic action implementation
Level 3A More autonomous AI	Overridable automatic decision-making
	Overridable automatic action implementation
Level 3B Autonomous AI	Non-overridable automatic decision-making
	Non-overridable automatic action implementation

Explainable AI shifting to "Certifiable" AI

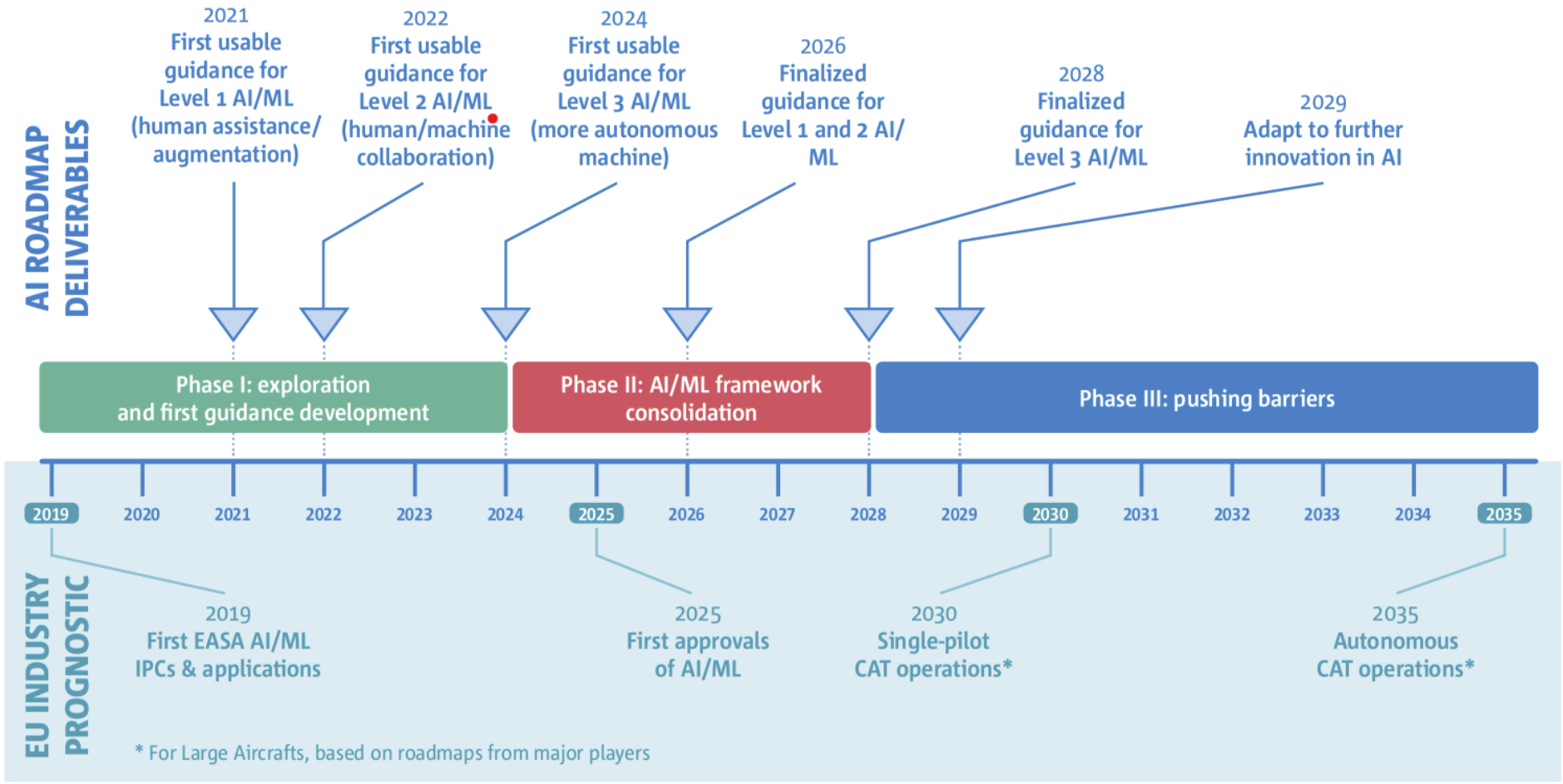
- Several companies exploring explainable AI
  - Supply “evidence, support, or reasoning for each output”
  - Provide explanations that users can understand
  - Explanation accuracy
  - Knowledge limits

- The more pragmatic approach is certifiable AI since outputs from AI engines will be “unexplainable”, confidential etc. Focus is on demonstrating system
  - Is fit for purpose
  - Has no unintended function

- Sandbox AI decision making and specifically define those boundaries



EASA Roadmap Projections



Using Intel® technology to enable safety critical avionics

Debra Aubrey, Technical Product Marketing Manager

Relevant Avionics Standards

DO-178C: Software Considerations in Airborne Systems and Equipment Certification

DO-254: Assurance Guidance for Airborne Electronic Hardware

ARP4754A: Guidelines for Development of Civil Aircraft and Systems

ARP4761A: Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment

AMC 20-152A: Development Assurance for Airborne Electronic Hardware

AMC 20-193: Use of Multi-Core Processors

Relevant AI/ML Standards:

RTCA DO-365: Minimum Operation Performance Standards (MOPS) for Detect and Avoid Systems

RTCA DO-366: Minimum Operational Performance Standards (MOPS) for Air-to-Air Radar for Traffic Surveillance

RTCA DO-387: Minimum Operational Performance Standards (MOPS) for Electro-Optical/Infrared (EO/IR) Sensor Systems for Traffic Surveillance

Providing Intel® technology to enable safety critical avionics

Introduce the Intel® Airworthiness Evidence Package (Intel® AEP)

The Intel® AEP helps address design assurance considerations for certifying artificial intelligence and machine learning in avionics.

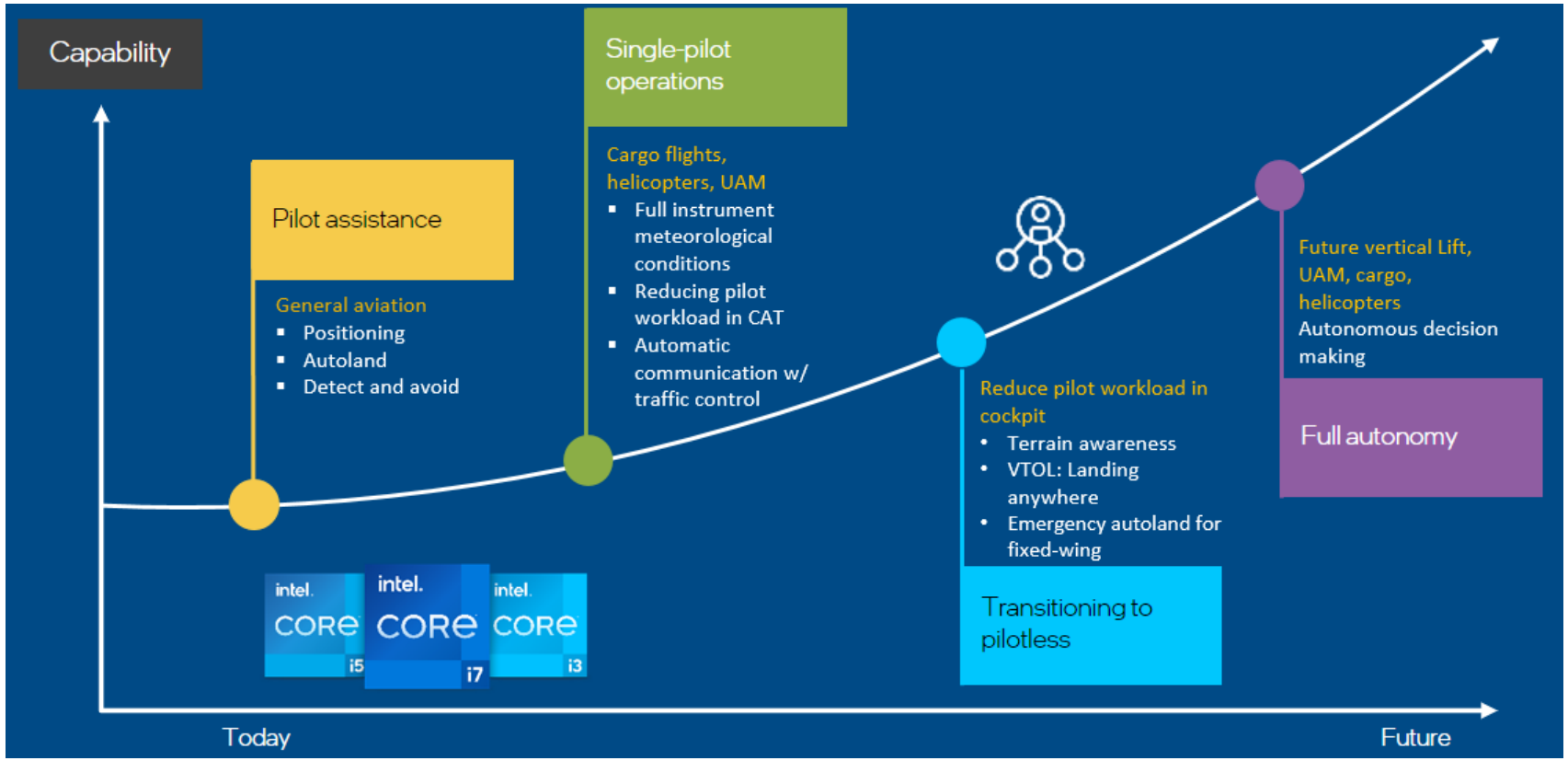
11th Gen Intel® Core™ Processor Family assists the rapid development and addresses the growing complexity of multicore avionics.

Intel® Airworthiness Evidence Package (Intel® AEP) delivers unparalleled access to flight safety evidence

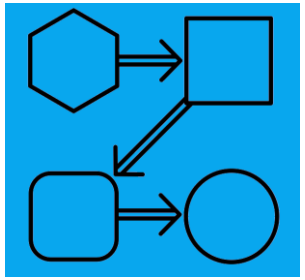
intel ATOM | intel CORE i7 | intel XEON

- Accelerate time to market with evidence tailored for DO-254/ED-80 and AMC 20-152A
- Leverage Intel® AEP reliability data to reduce engineering characterization efforts
- Reduce BOM cost by consolidating workloads while reducing core counts
- Maximize deterministic performance with Intel® TCC and AMC 20-193 Guide

Intel® Core™ processors are powering the certifiable AI roadmap



Intel® provides unparalleled insight to its development and change management processes

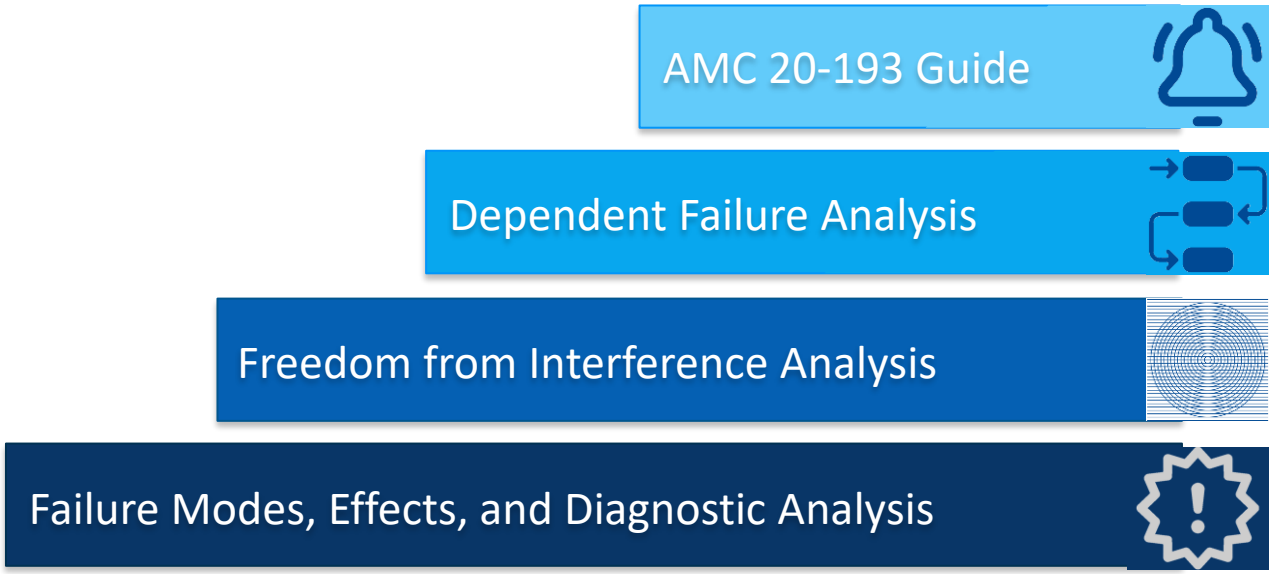


Silicon product lifecycle and integrated product lifecycle descriptions

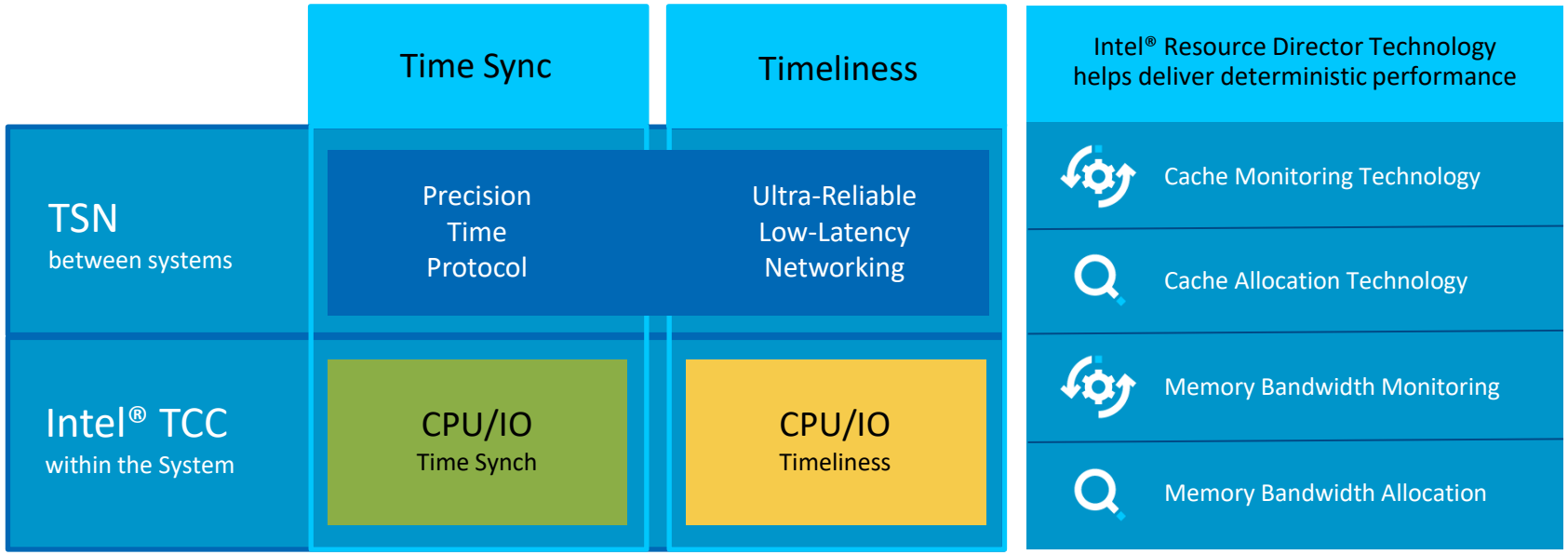
Resource and Design Center provides access to design specifications, errata, and sightings

Simple subscription enables automatic product change notifications

Potential effects of failures and interference are identified



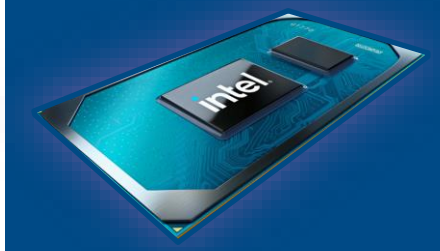
Intel® processors* provide real-time and resource management, improving network determinism



* On select SKUs

11th Gen Intel® Core™ Processor Family (Tiger Lake-UP3)

Avionics Markets i7-1186GRE (with Thermal Throttle Disabled)



Built from the ground up to assist the rapid development and address the growing complexity of IoT infrastructures

- Achieve new levels of performance
  CPU, graphics/media/display, AI and deep learning
- Powering aerospace applications in integrated flight deck, visual AI, flight and mission management, detection and avoidance
- IoT-centric capabilities
  In-band ECC, extended temperatures, functional safety
- Real-time compute
  Intel® Time Coordinated Computing, Time-Sensitive Networking
- Intel® Airworthiness Evidence Package includes detailed technical data and other collaterals to enable faster and easier development of DO-254/DO-178C certified solutions

To learn more about how Intel enables airworthiness certification, contact your Intel account executives

- Solution brief

  Airworthiness Enablement of Systems Using Intel Multi-Core Processors
- Intel's Government Technology and Digital Transformation Solutions

  Building Blocks for Government Digital Transformation
- www.intel.com/aerospacedefense

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