

## EVTOL AEROSPACE SYSTEMS DEVELOPMENT CRASH COURSE

Students will gain an understanding of the complexity of Aerospace Systems Development and the driving regulation framework established worldwide with specific focus on EU/EASA. Throughout the course series a complete explanation of all the relevant certification specifications and standards will be given with some practical examples. Workshops and group activities will reassert the knowledge and help understand its practical use.

### COURSES

- » Introduction to Aerospace Development, Regulation
- » Product Certification Specification
- » Overview of development and verification processes, ARP-4754A Intro
- » Electronic Hardware Development per DO-254, DO-160 Intro
- » Software Development per DO-178C
- » Safety process per ARP-4761A
- » Configuration Management Process and Quality Assurance
- » Introduction to EASA Part 21, Part 21 Light, DOA and POA
- » Introduction to Cybersecurity in Aerospace



**9 COURSES, 40h**



**TRAINING MATERIALS IN PAPER AND DIGITAL FORM**



**GROUP ACTIVITIES**



**KEY PRINCIPLES REASSERTED, DECOMPOSED**



**WORLDWIDE APPLICABILITY FOCUS ON EU/EASA**



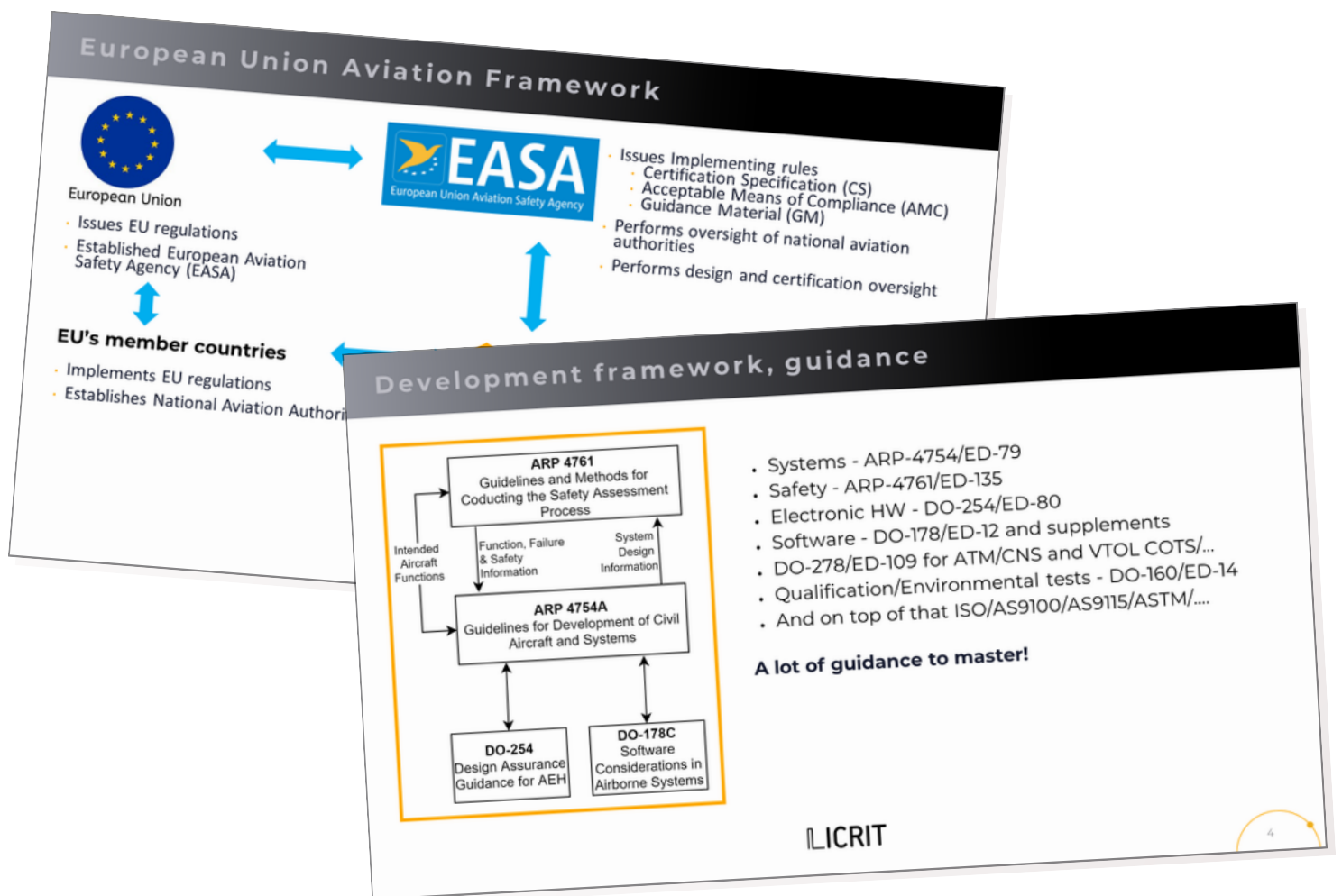
**FINAL QUIZ**

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# INTRODUCTION TO AEROSPACE DEVELOPMENT, REGULATIONS

This course (2 parts) will give an overview of the worldwide Aviation regulation framework (from ICAO Annexes down to CAA's Guidance Material), industry standards and what is the difference between Aerospace product development and consumer product development from the cost/BOM and development time point of view.



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# PRODUCT CERTIFICATION SPECIFICATION

This course provides an overview of eVTOL and electric/hybrid propulsion system relevant Certification Specifications and requirements (SC-VTOL, SC E-19 and a note on SC E-18). Comparison with CS-23 for Normal Category airplanes is included to highlight differences and explain changes in quantitative and qualitative safety objectives. Known Means of Compliance are outlined and discussed.

**EASA - certification regulations Structure**

**SC-VTOL-01 cont'd**

- For **Category Enhanced**, failure conditions that would **prevent continued safe flight and landing** of the aircraft are considered **catastrophic**
- For **Category Basic**, failure conditions that would **prevent a controlled emergency landing** of the aircraft are considered **catastrophic**
- The safety objectives for each failure condition are:

Category	Maximum Passenger Seating Configuration	Failure Condition Classifications			
		Minor	Major	Hazardous	Catastrophic
Category Enhanced	-	$\leq 10^{-3}$ FDAL D	$\leq 10^{-5}$ FDAL C	$\leq 10^{-7}$ FDAL B	$\leq 10^{-9}$ FDAL A
	7 to 9 passengers	$\leq 10^{-3}$ FDAL D	$\leq 10^{-5}$ FDAL C	$\leq 10^{-7}$ FDAL B	$\leq 10^{-9}$ FDAL A
Category Basic	2 to 6 passengers <small>(see note A)</small>	$\leq 10^{-3}$ FDAL D	$\leq 10^{-5}$ FDAL C	$\leq 10^{-7}$ FDAL C	$\leq 10^{-9}$ FDAL B
	0 to 1 passenger <small>(see note A)</small>	$\leq 10^{-3}$ FDAL D	$\leq 10^{-5}$ FDAL C	$\leq 10^{-6}$ FDAL C	$\leq 10^{-7}$ FDAL C

Note: A No considerations of the system architecture for a DAL reduction are acceptable.

Note:

- Corresponding safety objectives have been increased by one level compared to CS-23, due to the higher dependency on systems that are associated with distributed propulsion, VTOL and the possible invalidation of other CS-23 assumptions!

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# OVERVIEW OF DEVELOPMENT AND VERIFICATION PROCESSES, ARP-4754A INTRO

This course provides an overview of standard Aerospace development approach used when developing safety-critical products. Once the basics are explained the standards for System, Electronic Hardware, Safety assessment and Software are introduced with specific focus on ARP-4754A. An explanation of what does it take to write good requirements for the product is given with some requirement standard recommendation. Finally, a requirement workshop puts all this together and helps understand practical use.

**Failure Conditions & Development Assurance Levels**

„An anomalous behaviour, as shown by the system safety assessment process, would **cause or contribute** to a failure of system functions...

Qualitative objectives range from...

**How does it all fit together?**

- System design per **ARP 4754A** defines **Functional Design Assurance Level(s)/Item Design Assurance Level(s) (FDAL/IDAL)**
- These DALs are then **allocated to HW, SW**
- **ARP 4761** used for **Safety Assessment**
- **DO-254/AMC 20-152A** used for **Electronic HW**
- **DO-178C and supplements/AMC 20-115D** used for **SW**

**ARP 4761**  
Guidelines and Methods for Conducting the Safety Assessment Process

**ARP 4754A**  
Guidelines for Development of Civil Aircraft and Systems

**DO-254**  
Design Assurance Guidance for AEH

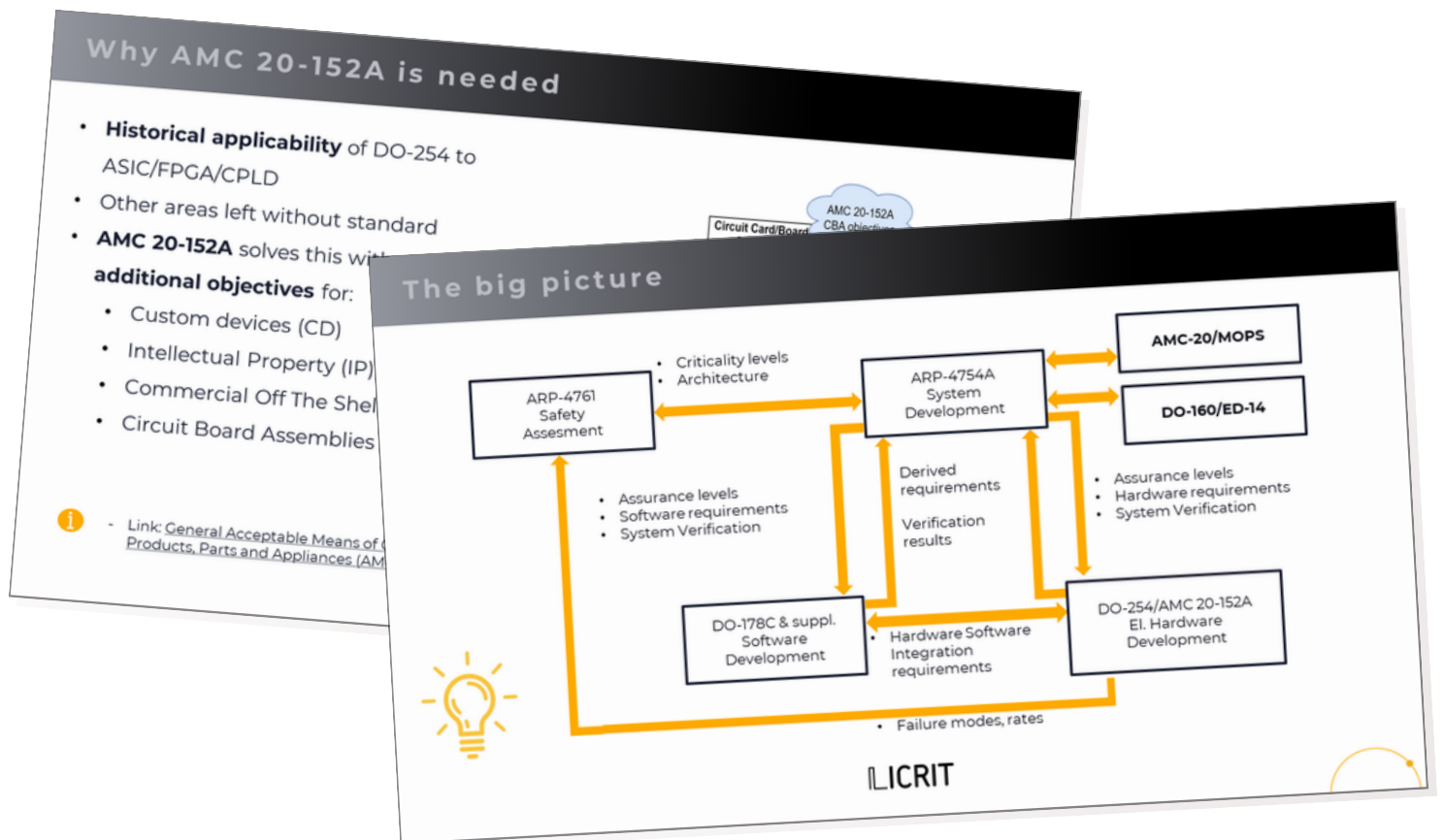
**DO-178C**  
Software Considerations in Airborne Systems

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# ELECTRONIC HARDWARE DEVELOPMENT PER DO-254, DO-160 INTRO

This course (2 parts) will explain how to develop DO-254 and AMC 20-152A compliant Airborne Electronic Hardware including the design of Programmable devices. The whole product development lifecycle and objectives are introduced with some specific examples ranging from requirement creation to verification procedures. The first part covers adjacent areas like Electronic Component Management and Single Event Effects too. The second part of the course will introduce the topic of Environmental Qualification per DO-160G.



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```
require 'capybara/rspec'

Capybara.javascript_driver = :webkit
Category.delete_all; Category.create
Shoulda::Matchers.configure do |config|
  config.integrate do |with|
    with.test_framework :rspec
    with.library :rails
  end
end

# Add additional requires below this line
# Requires support for
# spec/support/ and its subdirectories
# run as spec files by default, but
# spec.rb will both be recommended
```

## SOFTWARE DEVELOPMENT PER DO-178C

This course will provide a comprehensive overview of Airborne Software development per DO-178C and AMC 20-115D with objectives and guidance listed. The whole product development lifecycle and objectives are introduced with some specific examples ranging from requirement creation to verification procedures. Supplements DO-330, DO-331, DO-332 and DO-333 are introduced as well as DO-278 for ground based software. Some hints related to SW tool use to improve quality (and productivity) are provided.

**DO-178C/ED-12C and supplements/AMC 20-115D**

**Software Development Processes**

Target / System 1<sup>st</sup> level  
 Microcontroller Unit 1  
 Software application X 2<sup>nd</sup> level  
 Component B 3<sup>rd</sup> level  
 Component A 3<sup>rd</sup> level  
 Function B1  
 Function A1  
 Function A2  
 Software Application Y 2<sup>nd</sup> level  
 Microcontroller Unit 2

System Functions, System Requirements  
 System Design: Architecture & Item Requirements  
 Software Requirements

A standard for developing Airborne Software.  
**Supplements** aim to cover specific areas:

- DO-330/ED-215 - Software **Tool Qualification**
- DO-331/ED-218 - **Model Based Testing**

**Levels/Layers of testing: Error detection objectives**

**Low-level**

- Algorithm Failures
- Incorrect Loop Operations
- Incorrect Logic Decisions
- Failure to Process Correct Input combinations
- Incorrect Response to bad Input data
- Incorrect Exception Handling
- Incorrect Computation Sequence
- Inadequate Algorithm Precision, Accuracy, Performance

**HW/SW integration**

- Incorrect Interrupt Handling
- Timing & Performance
- Hardware Transient Errors
- Resource Contention
- BIT Detection Errors
- Bad Feedback Loops
- Incorrect Device Control
- Stack Overflow
- Software Partitioning Violations

**SW/SW integration**

- Incorrect initialization of variables
- Parameter passing errors
- Data Corruption
- Inadequate Numerical Resolution
- Incorrect Sequencing of Events and Operations

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# SAFETY PROCESS PER ARP-4761A

This course introduces the concept of Safety Assessment per ARP-4761A. The importance of an early inclusion of safety approach/philosophy during concept and architecture design phases to guarantee that the designed product will be safe/high integrity and reliability is highlighted. Methods used for safety assessments and their interaction/relationship with other domains through the product's development lifecycle are explained.

**Safety Assessment Process Model - Aircraft Level**

- **AFHA** - Aircraft Functional Hazard Assessment
- **PASA** - Preliminary Aircraft Safety Assessment
- **ASA** - Aircraft Safety Assessment

**Accident Evolution**

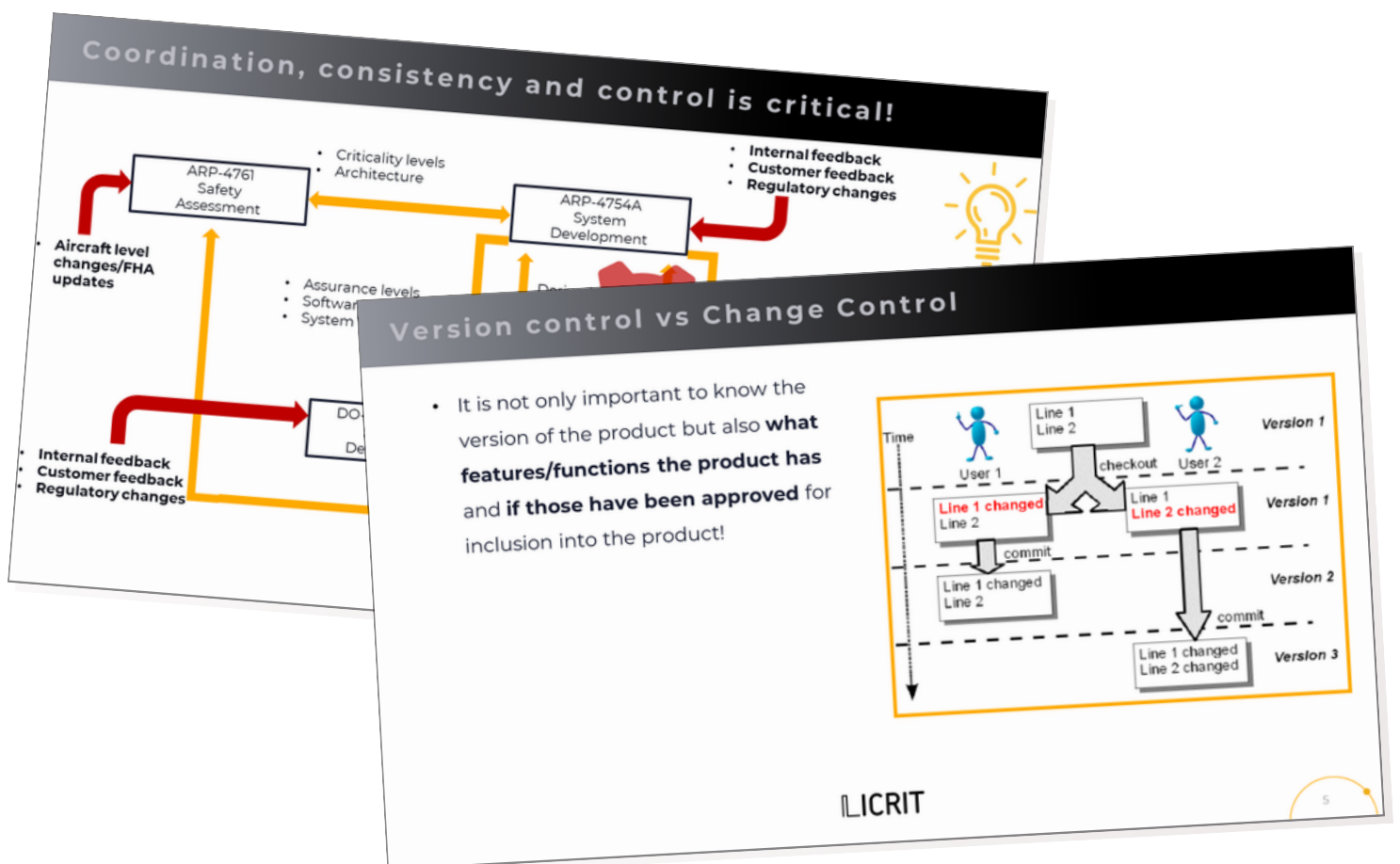
- **Fault** - An undesired anomaly in an item or system.
- **Errors**
  1. An occurrence arising as a result of an incorrect action or decision by personnel operating or maintaining a system
  2. A mistake in specification, design, or implementation.
- **Failure** - A loss of function or a malfunction of a system or a part thereof
- **Failure Conditions (Hazards)** - A condition with an effect on the aircraft and its occupants...

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# CONFIGURATION MANAGEMENT PROCESS AND QUALITY ASSURANCE

This course explains the critical integral component of Aerospace product development – Configuration Management. Having a good understanding of this is mandatory even if nowadays most of the activities are guided by advanced SW tools that implement complex workflows/enforce rules, roles and responsibilities that meet the CM objectives as defined in ARP-4754A, DO-254 and DO-178C. The other integral part of the development and its role – Quality Assurance - is explained as well.



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# INTRODUCTION TO EASA PART 21, PART 21 LIGHT, DOA AND POA

This course explains the Management System concept in conjunction with Production Organization Approval(POA) and Design Organization Approval(DOA) as defined in Part 21 that defines rules for airworthiness and environmental certification as well. Some practical hints and details are provided including an explanation of Annex A.139/239 requirements. The upcoming lightweight Part 21 Light is introduced with an explanation of its scope and limitations. Other Part 21 subparts are presented to give a complete understanding of the framework.

**Part 21 Reporting under Regulation 376/2014**

- **Timely(72h) and diligent reporting is critical for the aviation safety!**
  - If there is **actual or potential aviation safety risk** (failures, malfunctions, defects or other occurrences, incl. near misses)
    - Parts/LOTs/etc. that are already
- Based on the classification/
- **to mandate grounding/fix**
- Manufacturer can issue a Se

**DOA - Functional process hierarchy**

Declaration of Compliance

Independent CVE Verification

Technical Documents

Design data

By Airworthiness staff

By Design Engineers

Compliance Demonstration

Final Design

Design frozen

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# INTRODUCTION TO CYBERSECURITY IN AEROSPACE

This course introduces the historically overlooked and neglected area of cybersecurity in aviation. The complex approach devised to address the whole cybersecurity chain from ground personnel/domain to product's development requirements and objectives is explained. An introduction of standards that drive these activities necessary not only for successful certification but also for safe operation through the products lifecycle is provided.


## ED-201 & Aeronautical Information System Security Framework

**Shared information risk**

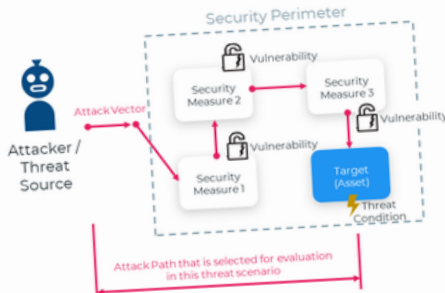
- Where systems, processes, products or data are shared, or are passed from one organisation to another.

**External Agreements**

- Express the trust placed in a




## Threat Scenarios



Attack Path that is selected for evaluation in this threat scenario

1. Consider Threat Sources & Threat Catalogues
2. Consider Attack Paths
3. Consider Inherent Vulnerabilities
4. Ensure Consistency and Completeness



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