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# A Road Map to the E-40B Standard

*( excerpt version for sample purposes )*



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# Abstract

*ECSS-E-40B is the standard for space software engineering. This module provides a road map to the standard, introducing the participant to its key concepts, processes, and supporting standards.*

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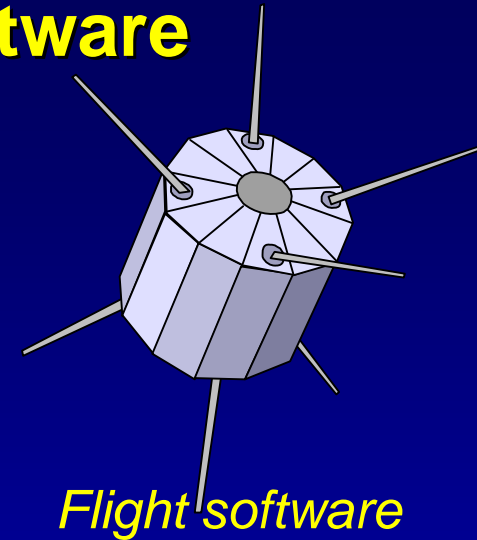


A Road Map to the E-40B Standard

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# A Standard for All Space Software

- The E-40B standard is intended for application to **all software** developed as part of a space project
  - ✧ E-40B is applicable to all the elements of a space system, including flight software and ground software
  
- E-40B also applies to the development of **non-deliverable software** that affects the quality of the deliverable product
  - ✧ Such as development toolsets



## ECSS E40 Status

*ECSS-E-40A      13 April 1999*

*Previous approved issue*

*ECSS-E40B Draft July 2000*

*Not a formal version but applied to several Projects*

*ECSS-E40B      Draft May 2002*

*Public Review Version*

*ECSS-E40B      Part 1 June 2003*

*ECSS-E40B      Part 2 June 2003*

*Public Review Version*

***ECSS-E40B      Part 1 28 November 2003***

***Final Version:      it is the reference for this course***

*Available from [www.ecss.nl](http://www.ecss.nl)*

# The E-40B Level 3 Standards

- ❑ The purpose of the **Level 3 standards** is to give specific guidelines for specific aspects of space software engineering
- ❑ **Software Life Cycles (E-40-04)**
  - ✧ Detailed information on a number of different life cycle models and how they can accommodate the E-40B software engineering processes
- ❑ **Flight Software (E-40-01)**
  - ✧ A guide to interpreting the E-40B standard for flight segment software
- ❑ **Ground Segment Software (E-40-03)**
  - ✧ A guide to interpreting the E-40B standard for ground segment software



*Life cycles*

*Flight S/W*



*Ground segment S/W*

# The Relationship of E-40B to the Q-Series

- ❑ E-40B covers all aspects of space software engineering from requirements definition to retirement
- ❑ Q-80B specifies SPA requirements on software engineering processes and product-related assurance over all the activities specified in E-40B
- ❑ Each of these two standards interfaces the other to its respective branch
  - ✧ The interface of Q-80B to the ECSS-E branch is via E-40B
  - ✧ Equally, the interface of E-40B to the ECSS-Q branch is via Q-80B
- ❑ **Together** the two standards either define or refer to definition of **all software relevant processes** for space projects

**E-40B**  
Software



S/W Product  
**Q-80B**  
Assurance

**Q-80B**  
4.4.2



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## ECSS Q80 Status

*ECSS-Q-80A      April 1999*

*Previous approved issue*

*ECSS-EQ0B Draft      April 2000*

*Not a formal version but applied to several Projects*

*ECSS-Q80B      Draft May 2002*

*Public Review Process.*

***ECSS Q-80B      10 October 2003***

***Final Version***

*Available from [www.ecss.nl](http://www.ecss.nl)*

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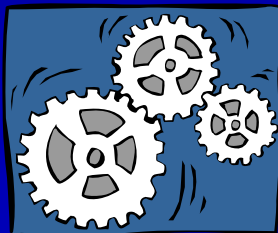
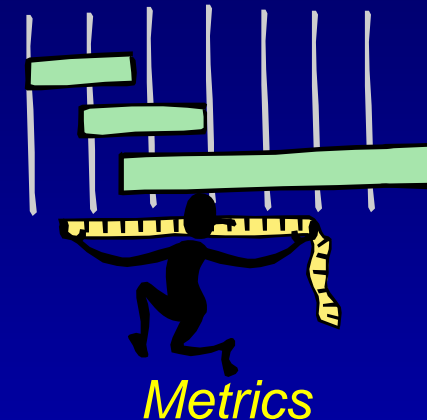


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# The Q-80B Level 3 Standards

- ❑ There are three level 3 standards currently under development, working drafts at the Working Group level:
  - ✦ Metrics
  - ✦ Process assessment and improvement
  - ✦ Dependability (RAMS)



*Dependability*



*Process assessment and improvement*

# Overview of the E-40B Standard

## Space System Processes (Section 4)

*Key Concepts*

*Introduction to  
the processes*

## Requirements (Section 5)

*Requirements on  
each process*

## Informative Annexes

*References to other  
ECSS Standards*

*Tailoring guidelines*

## Software Documentation (Annex A - Normative)

*Contents of software  
documents*



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# Space System Processes (Section 4)

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# Space System Processes – Section 4

*Space System Processes  
(Section 4)*

*Key Concepts*

*Introduction to  
the processes*

*Requirements  
(Section 5)*

*Requirements on  
each process*

*Informative Annexes*

*References to other  
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# Key Concepts in the E40B Standard

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# Software in space systems

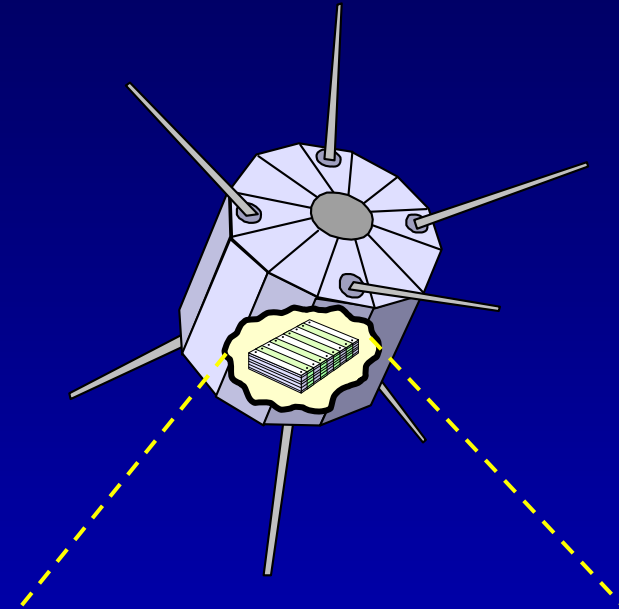
- ❑ **Software is different from other engineering disciplines**
  - ✧ Software has no mass, nor produces heat
  - ✧ Software has no other physical property
  
- ❑ **Software is highly flexible**
  - ✧ Ideal for highly complex functions
  - ✧ Increasingly used in space systems, from system level functions to the firmware of a specific part
  - ✧ Related effort (requirements, design, test) often underestimated
  
- ❑ **Software engineering is a *pure* intellectual activity**
  - ✧ Principal output is *documentation* (comprising code)
  - ✧ Focus of the E-40B standard is on requirements for *contents* and *structure* of documentation

## Summary of Key Concepts in E-40B

- ❑ **Software is part of the overall System**
  - ✧ Software is not treated in isolation
- ❑ **Customer-supplier relationship**
  - ✧ The relationship is made explicit
- ❑ **Process orientation**
  - ✧ Logical orientation (processes) rather than time-based (phases)
- ❑ **Reviews as synchronization points**
  - ✧ Reviews are a point of synchronization for the lifecycle processes
- ❑ **Expected outputs – files (not only documents)**
  - ✧ Straightforward, effective organisation of process outputs
- ❑ **Tailoring**
  - ✧ Fundamental underlying concept

# Software is Part of the Overall System

- ❑ E40-B makes explicit the fact that Space Projects generally involve **many engineering disciplines**, of which software is only one
- ❑ This is reflected in the inclusion of **requirements on system engineering processes** related to software in the Standard



*Software components are part of the overall mission system, together with other engineering components*

# The Customer-Supplier Relationship

□ A fundamental principle in the E-40B Standard is the **customer-supplier relationship**

- ✧ it is assumed for all software development
- ✧ the organisational aspects are defined in M-20



Customer



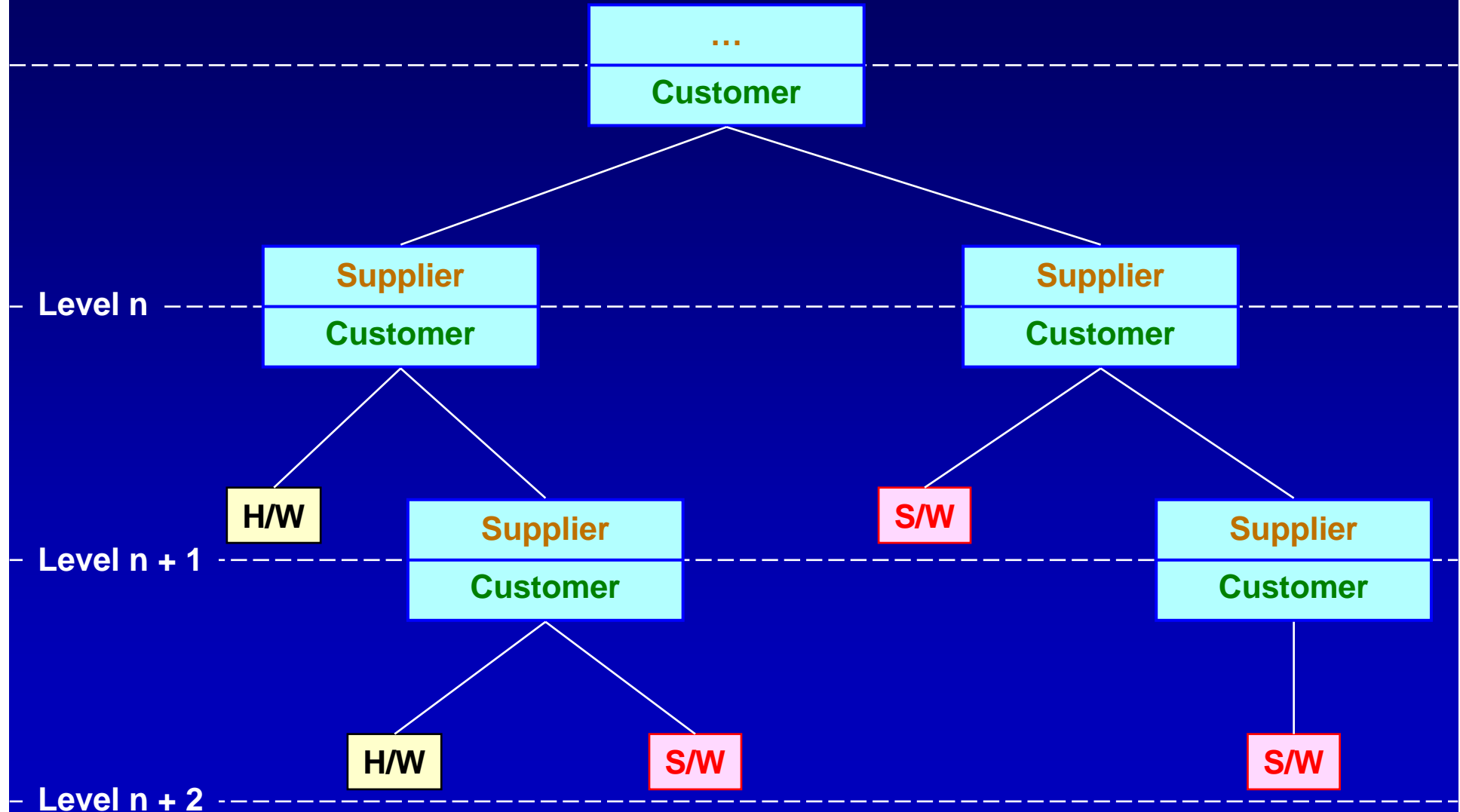
Supplier

*organisational aspects*

Project  
**M-20**  
Organisation

**E-40B**  
4.2.1

# The Recursive Customer-Supplier Model



## A Process-Oriented Approach

- ❑ The major heritage from the ISO standard is the **process-oriented approach** to the life cycle
  - ✧ More **freedom** this way!
- ❑ Many previous approaches to engineering standards prescribed exactly *when* activities were to be carried out
  - ✧ In contrast, the E-40B approach prescribes only *what* needs to be done, allowing the organisation considerable freedom in deciding when to do it
- ❑ For example, **different life cycle models** can be chosen by the organisation
  - ✧ Waterfall, incremental, evolutionary, etc.



*Freedom to choose an appropriate life cycle model is one advantage of the process-oriented approach*







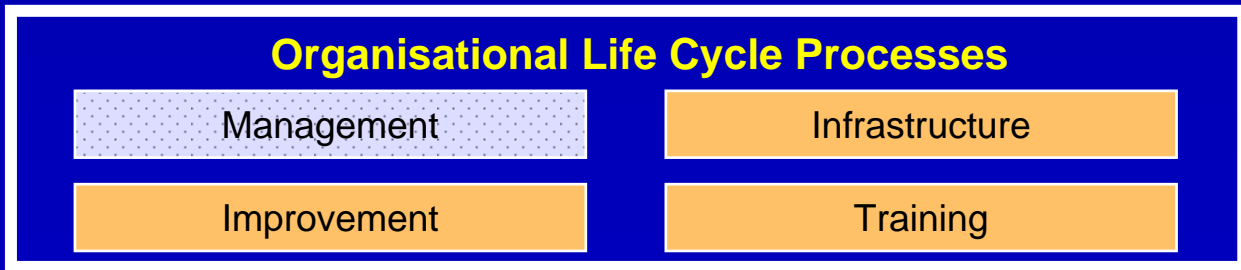
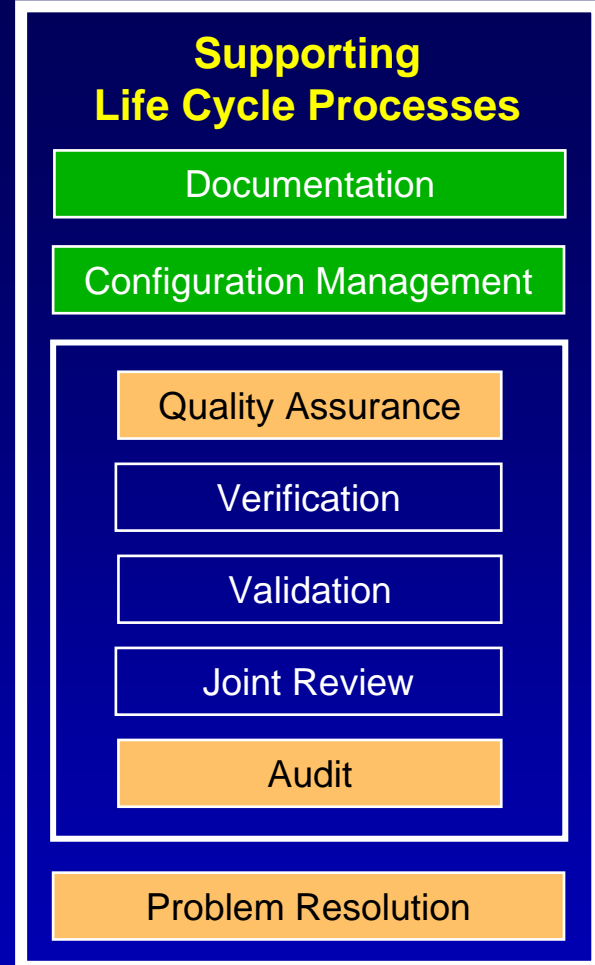
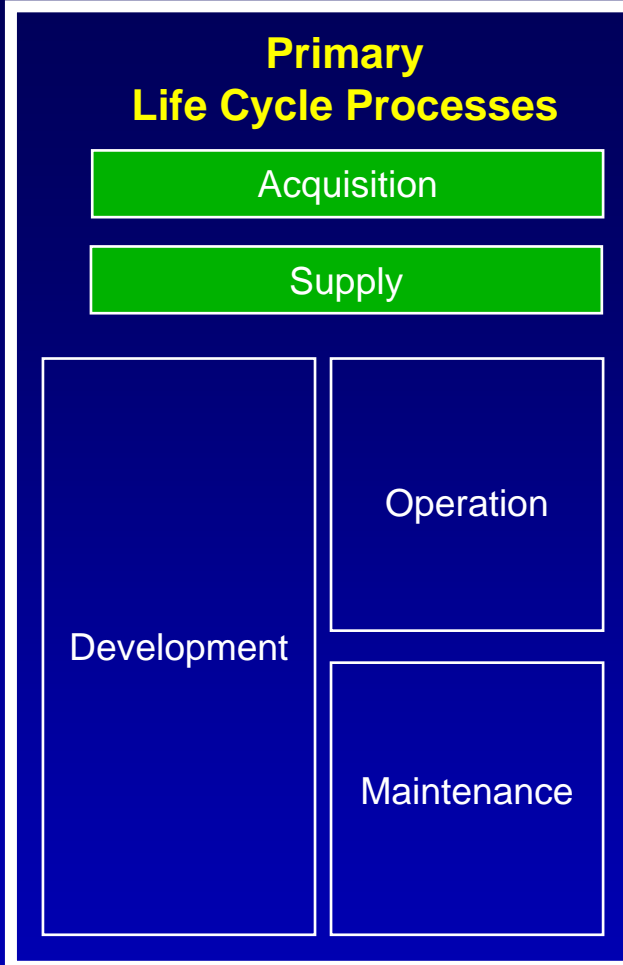
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# ECSS Covers the ISO/IEC 12207 Standard

- Other ECSS 
- E-40B 
- Q-80B 
- Details for SPA and/or SWE 



## Origins of E-40B in ISO/IEC 12207

- ❑ The structure and approach of the E-40B standard has its origins in the ISO/IEC standard 12207
  - ✧ Title: **Information Technology – Software Life Cycle Processes**
- ❑ The ISO standard has a clear set of goals:
  - ✧ “This International Standard establishes a **common framework for software life cycle processes**, with **well-defined terminology**, that can be referenced by the software industry.”
  - ✧ “It contains **processes, activities**, and **tasks** that are to be applied during the acquisition of a system that contains software, a stand-alone software product, and software service and during the supply, development, operation, and maintenance of software products.”
  - ✧ “This International Standard also provides a process that can be employed for **defining, controlling**, and **improving** software life cycle processes.”

*A common framework for the entire software industry*

# Reviews are the Main Synchronisation Points

- The reviews are the main interaction points between the customer and the supplier
  - ✧ All reviews are applicable to software
  - ✧ They are sequenced according to the overall system-level planning
- The reviews are the main synchronisation points between processes



**E-40B**  
4.2.1

# Expected Outputs and Files

- ❑ The E40-B requirements cause **information** to be collected into **files** (in the sense of “collection of information”)
- ❑ This information may be, depending on the requirements:
  - ✧ A document (e.g. a plan)
  - ✧ A form (e.g. a nonconformance)
  - ✧ A report
  - ✧ An approval
  - ✧ Program code
  - ✧ A diagram
  - ✧ Tests
  - ✧ Procedures
  - ✧ A set of requirements
  - ✧ Etc.

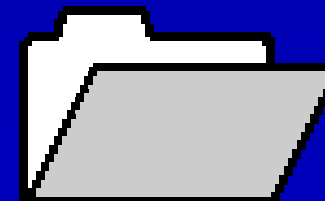
👉 Requirement 👈



📁 Expected Output 📁



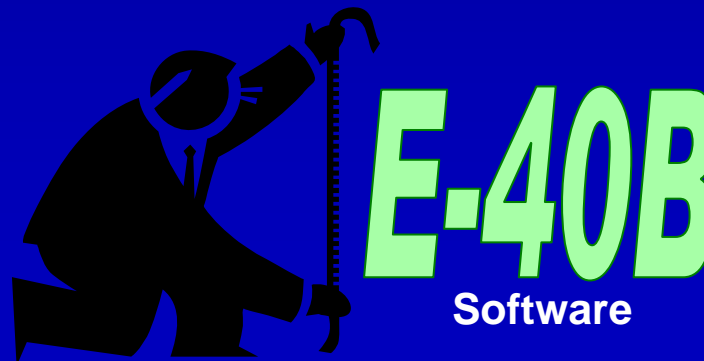
file



# Tailoring

- ❑ The ECSS family of standards is intended to be **tailored** for each individual project
  - ✧ This is a fundamental underlying concept throughout the system
- ❑ The ECSS-E-40B standard lists **exhaustively** the requirements for the **best practices** in space software engineering
  - ✧ that is, it covers *all possible types* of space software engineering projects
- ❑ But it is tailored for each individual project
  - ✧ A way to apply the standard in the most efficient manner possible

*Tailoring  
for E-40B*



**E-40B**  
Annex C



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# Introduction to the Processes

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## Development processes

### 5.2 System engineering processes related to software

5.2.2 System requirements analysis

5.2.3 System partitioning

5.2.4 System level reqs. for SW V&V

5.2.5 System level integration of SW

5.2.6 SW operations requirements

5.2.7 SW maintenance requirements

### 5.4 SW req. & arch. engineering process

5.4.2 Software requirements analysis

5.4.3 Software architectural design

### 5.5 SW des. & impl. engineering process

5.5.2 Design of software items

5.5.3 Coding and testing

5.5.4 Integration

### 5.6 Software validation process

5.6.2 Validation process implementation

5.6.3 Validation w.r.t. the technical spec.

5.6.4 Validation w.r.t. the req. baseline

### 5.8 Software verification process

5.8.2 Verification process implementation

5.8.3 Verification activities

### 5.7 Software delivery and acceptance process

5.7.2 Software delivery and installation

5.7.3 Software acceptance

## 5.9 Software operations process

5.9.2 Process implementation

5.9.3 Operational testing

5.9.4 Software operations

5.9.5 User support

## 5.10 Software maintenance process

5.10.2 Process implementation

5.10.3 Problem & modification analysis

5.10.4 Modification implementation

5.10.5 Conducting maintenance reviews

5.10.6 Software migration

5.10.7 Software retirement

## 5.3 Software management process

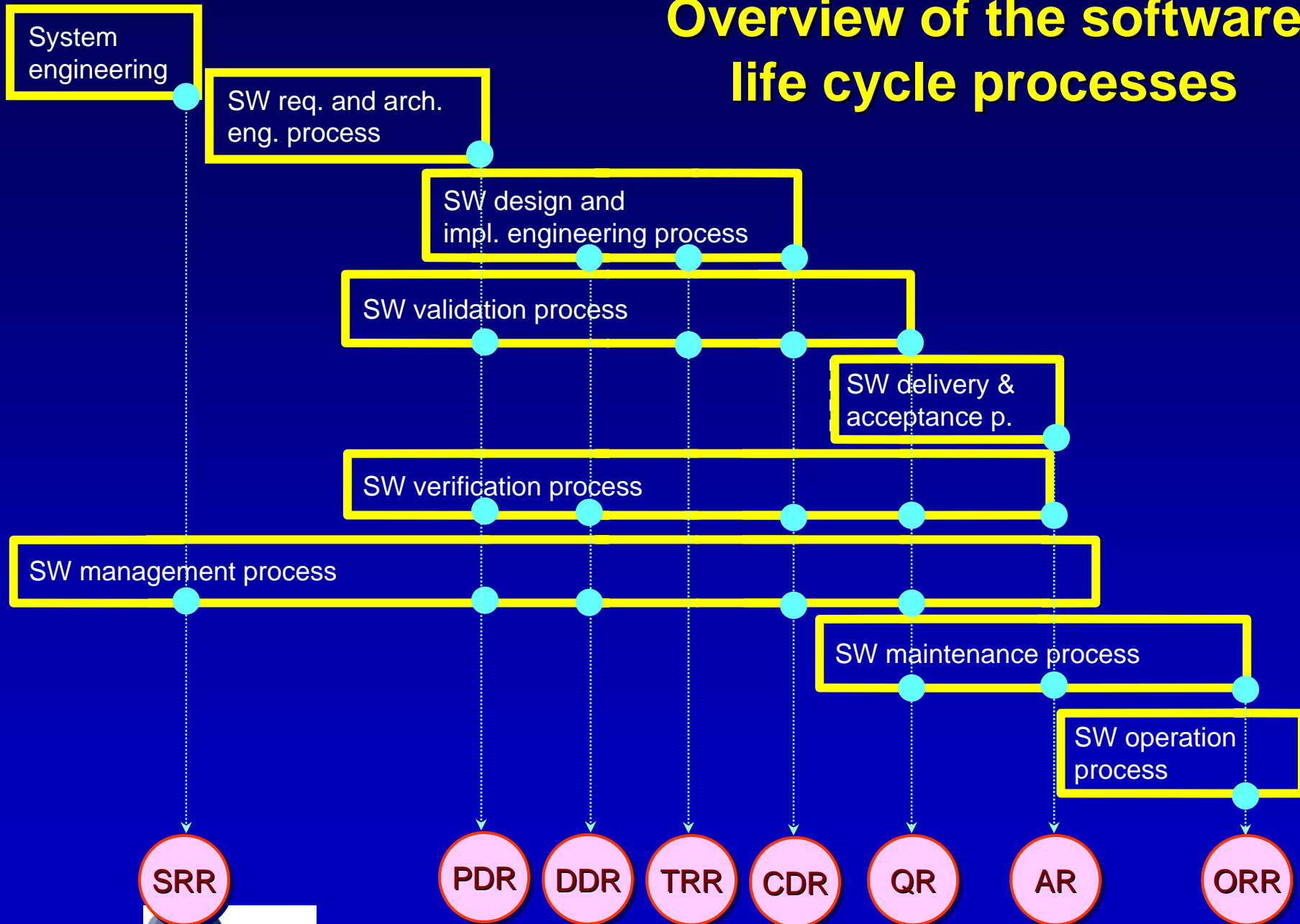
5.3.2 Software life cycle management

5.3.3 Joint technical review process

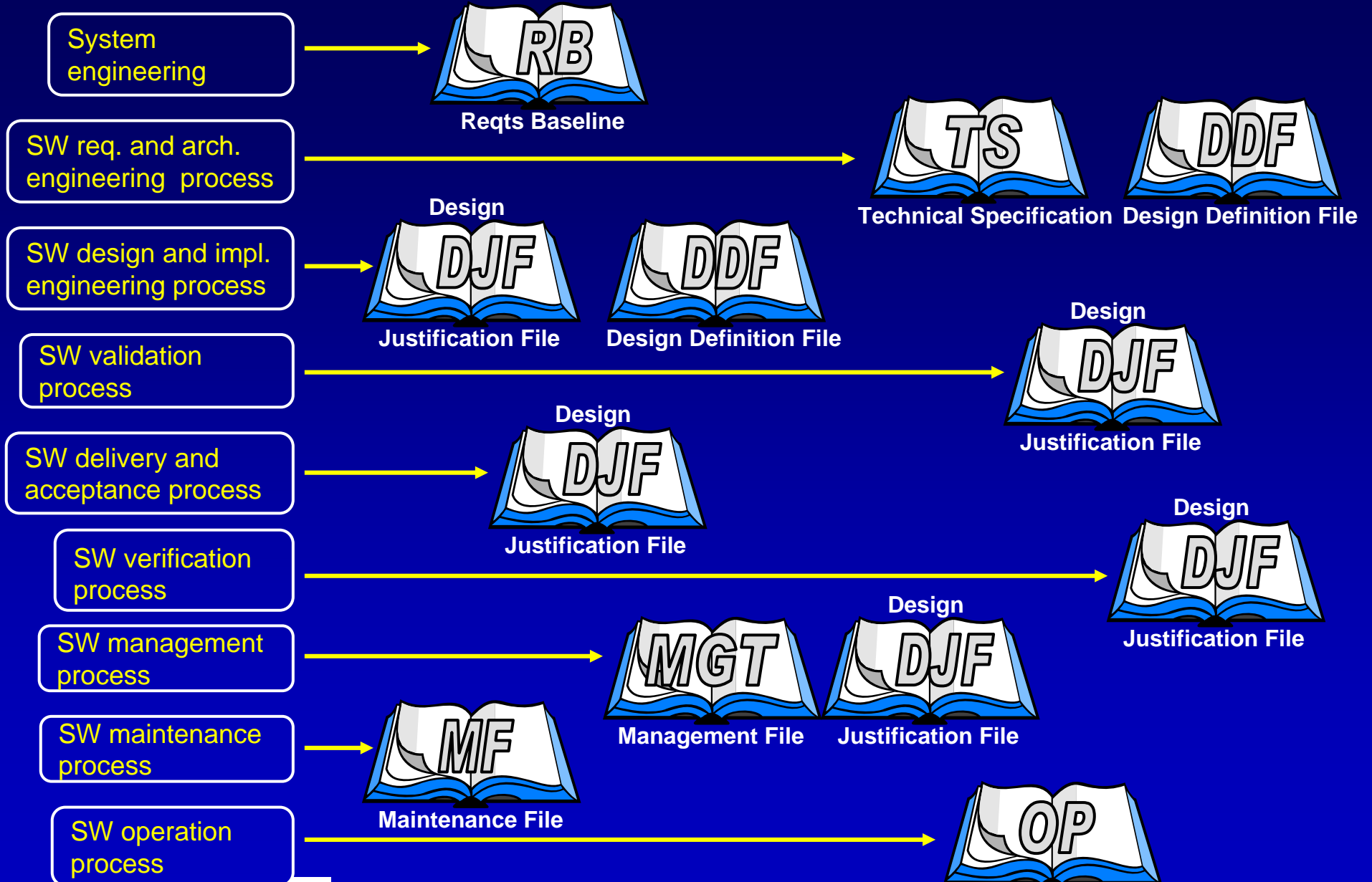
5.3.4 Interface management

5.3.5 Technical budget and margin management

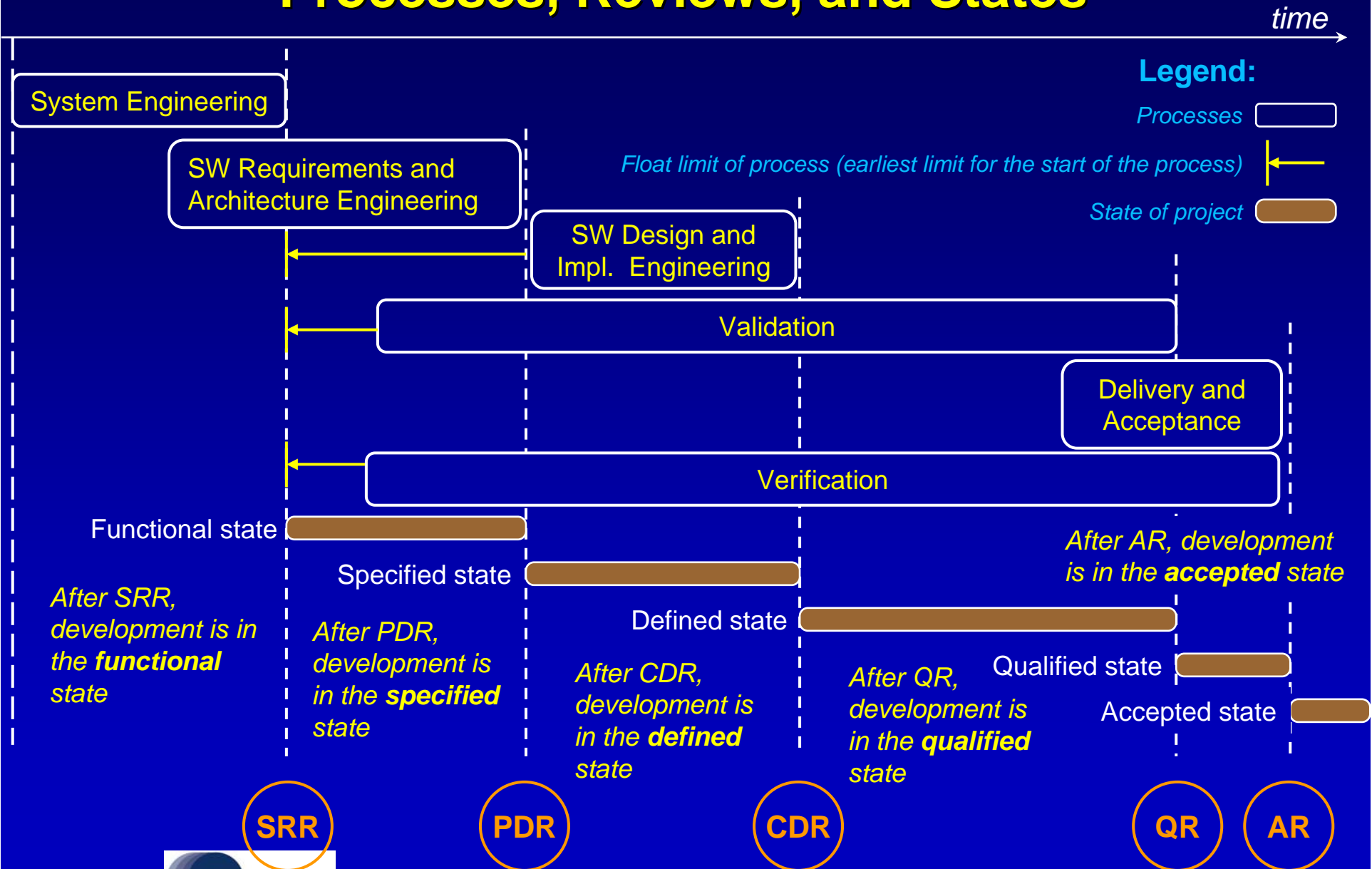
# Overview of the software life cycle processes



# Processes to Files (excerpt version for sample purposes)



# Processes, Reviews, and States





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