ECSS

Standardization training program

Space project management

TEC-QR

March 2017

Table of Content

Before starting…

The object of this session

What this session is about…

This is a session on “Project management **standardization**”

What this session is NOT about

This session is NOT about “Project management techniques”

What is the difference?…

A clue: ECSS standards are for **use in contracts**…

The approach followed

After a brief introduction to project management:

- An “ECSS universal principle” will be introduced.

  In this presentation it is called the “**ODSI**” principle

- Then the M books “will be open”, to confirm how much the ODSI principle is applied

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Standardization
training program
Space Project Management

1. Introduction – PM activities
2. ECSS overview and terminology (covered by Level 1)
3. ECSS management structure & approach
4. ECSS M-standard content
5. ECSS M-standards application & tailoring

What is Project Management, and why is it needed?

- Project Management is an integrated process for documenting, monitoring, and controlling complex projects from conception, through design, development, manufacturing, operations, and disposal (i.e. throughout the life cycle of a project)

- The key objective of any Project Management system is to continuously **"keep in balance" 4 key parameters** common to all projects. These are:
  - **Project Risk**
  - **Project Scope**
  - **Project Schedule**
  - **Project Cost**

- These 4 key parameters (**Risk, Scope, Schedule, Cost**) are directly linked to each other and interact continuously throughout the project life cycle. A change in any one of the 4 will automatically have an impact on at least one of the other three.

- For example, the measures needed to resolve an unforeseen problem can easily lead to one, several, or all of the following:
  - need for additional resources to correct the problem
  - modifications to the scope
  - a change in the perceived risk associated with the project
  - a need to extend the project schedule

- Any, or all of the above will have an impact on cost

1 - Introduction – PM activities
Project Management – Project Content & Schedule

- **The scope** of a project essentially comprises:
  - the products and services to be delivered by the project
  - the facilities and resources needed to create the products and services
  - a detailed breakdown of all of the major tasks to be performed to implement the project.

- **The schedule** of a project is the accumulated **time needed** to:
  - Establish the project objectives, define the Mission Statement and Organise the project
  - Design, develop, manufacture, qualify and deliver the project's products, based on detailed planning and a logical flow of all tasks to be completed, within the available resources and facilities
  - Utilise the project deliverables during their operational lifetime
  - Safely dispose of project products at their end of life

- **The cost** of a project is the **total cost incurred** during the life cycle of the project for all:
  - parts, materials and services
  - Labour
  - Facilities
  - external support
  - launch, operations and disposal
  - any other unforeseen expenditures needed to complete the project within the allocated timescale.

1 - Introduction – PM activities

Project Management – Project Risk

- **The risk** associated with implementing a project has to be determined very early in setting up the project.
- This level of perceived risk is based on an assessment of:
  - the **complexity** of the project (including comparisons with similar projects)
  - the **technology** to be used → See next for TRL
  - any **known constraints** or limitations to be imposed
  - any **other factors** that may apply.
- The initial risk assessment is one key input for finalising the project content, schedule and funding, including any reserves considered necessary
- Errors in initial risk assessment are likely to lead to cost and schedule increase beyond the normal margin planned

1 - Introduction – PM activities

Project Management – Project Risk

- **TRL (Technology readiness level) is a tool to measure the maturity of a technology**
- To knowing the TRL is a key factor to evaluate the risk of using a given technology for a critical function.
- TRL termometer establishes 9 levels (from observation of physical principles, to flight proven) (see next slide for definition of levels)
- A new ISO document (ISO 16290) was published DEFINING these levels (but not when to use them, this is left to managerial decision)
- ECSS adopted this ISO document by the following actions:
  - Adoption of the ISO doc via AS, introducing few req's to make the ISO doc mandatory (it does not contain any "shall")
  - A new column is introduced in the "Techno matrix" (a DRD in E-ST-10 "SE"), to assess the TRL of the critical technologies
  - One requirement is introduced in Q-ST-10 "PA" that the evaluation of a TRL shall be confirmed by PA/QA.
  - An ECSS TRL HB has been published to help in the application of the AS (and therefore, of the ISO doc) → See Next

(Cont'd)

1 - Introduction – PM activities

Project Management – Project Risk

- Also a HB has been recently published to help in the application of the TRL ISO and ECSS AS.

- It is based in an existing ESA HB for TRL.

- It includes:
  - Identification of critical technologies in a project (for a non-critical technology, the TRL is much less important)
  - Typical situations in which the several TR Levels are used.
  - How to move from a TRL to the next
  - Good practices for TRL evaluation (process)
  - TRL for SW, EEE components and materials

1 - Introduction – PM activities

Project Management – Project Risk

Standardization training program
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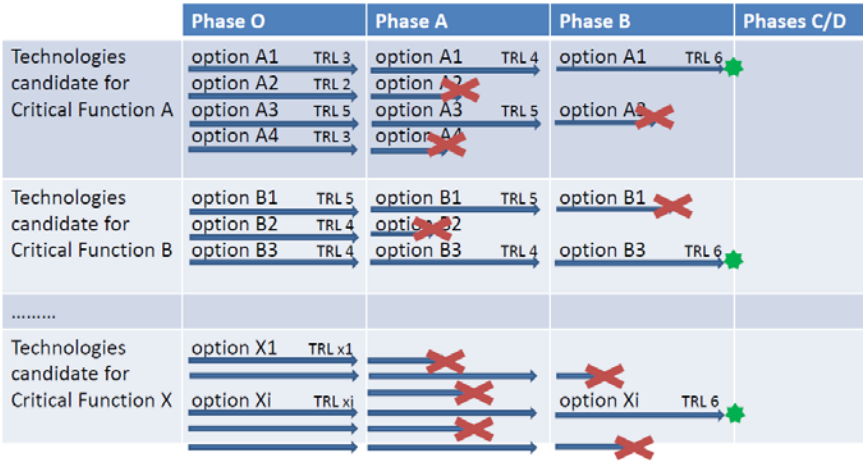
	Mankins 95 reference		ISO 16290 standard
TRL 1	Basic principles observed and reported	Equivalent	Basic principles observed and reported
TRL 2	Technology concept and/or application formulated	Equivalent	Technology concept and/or application formulated
TRL 3	Analytical and experimental critical function and/or characteristic proof-ofconcept	Equivalent	Analytical and experimental critical function and/or characteristic proof-ofconcept
TRL 4	Component and/or breadboard ***validation*** in laboratory environment	Equivalent	Component and/or breadboard ***functional verification*** in laboratory environment
TRL 5	Component and/or breadboard ***validation*** in relevant environment	Split	Component and/or breadboard ***critical function verification*** in **a** relevant environment
TRL 6	***System/subsystem*** model ***or prototype*** demonstration in a relevant environment ***(ground or space)***	Shifted	Model ***demonstrating the critical functions of the element*** in a relevant environment
TRL 7	***System prototype demonstration in a space*** environment	Removed	***Model demonstrating the element performance for the operational*** environment
TRL 8	Actual system completed and ***"flight qualified" through test and demonstration (ground or space)***	Equivalent	Actual system completed and ***accepted for flight ("flight qualified")***
TRL 9	Actual system "flight proven" through successful mission operations	Equivalent	Actual system "flight proven" through successful mission operations

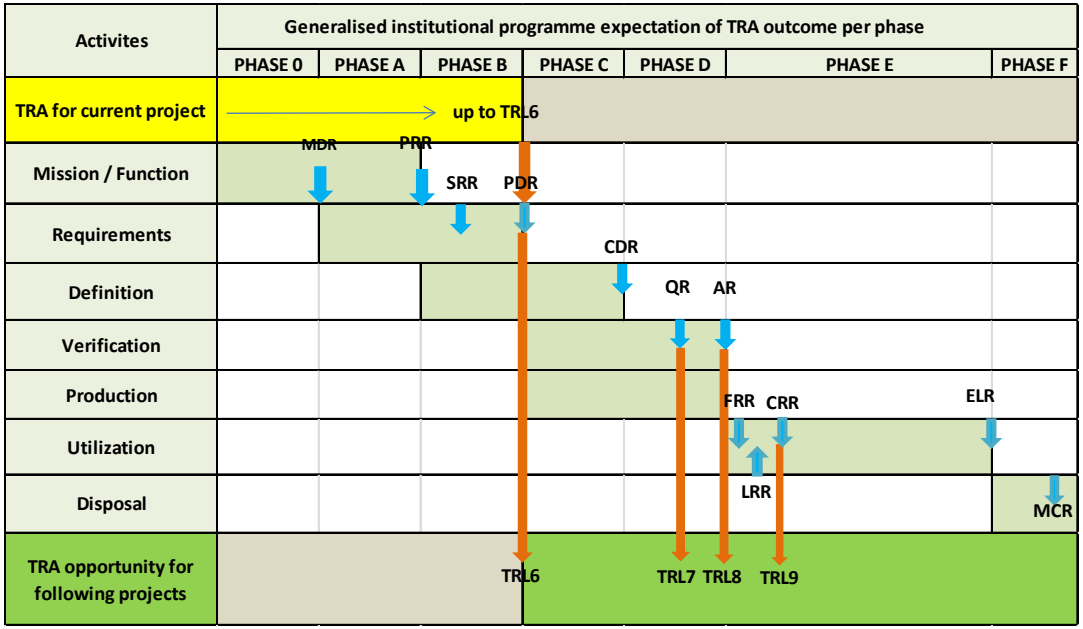
At TRL 5 and above, **the TRL is not linked to a technology**, but to **a technology in a given environment** => If a technology TRL9 is used in a different environment, it can fall down even to TRL5

How the definitions are applicable to SW is explained in the TRL HB

TRL implementation in a typical project



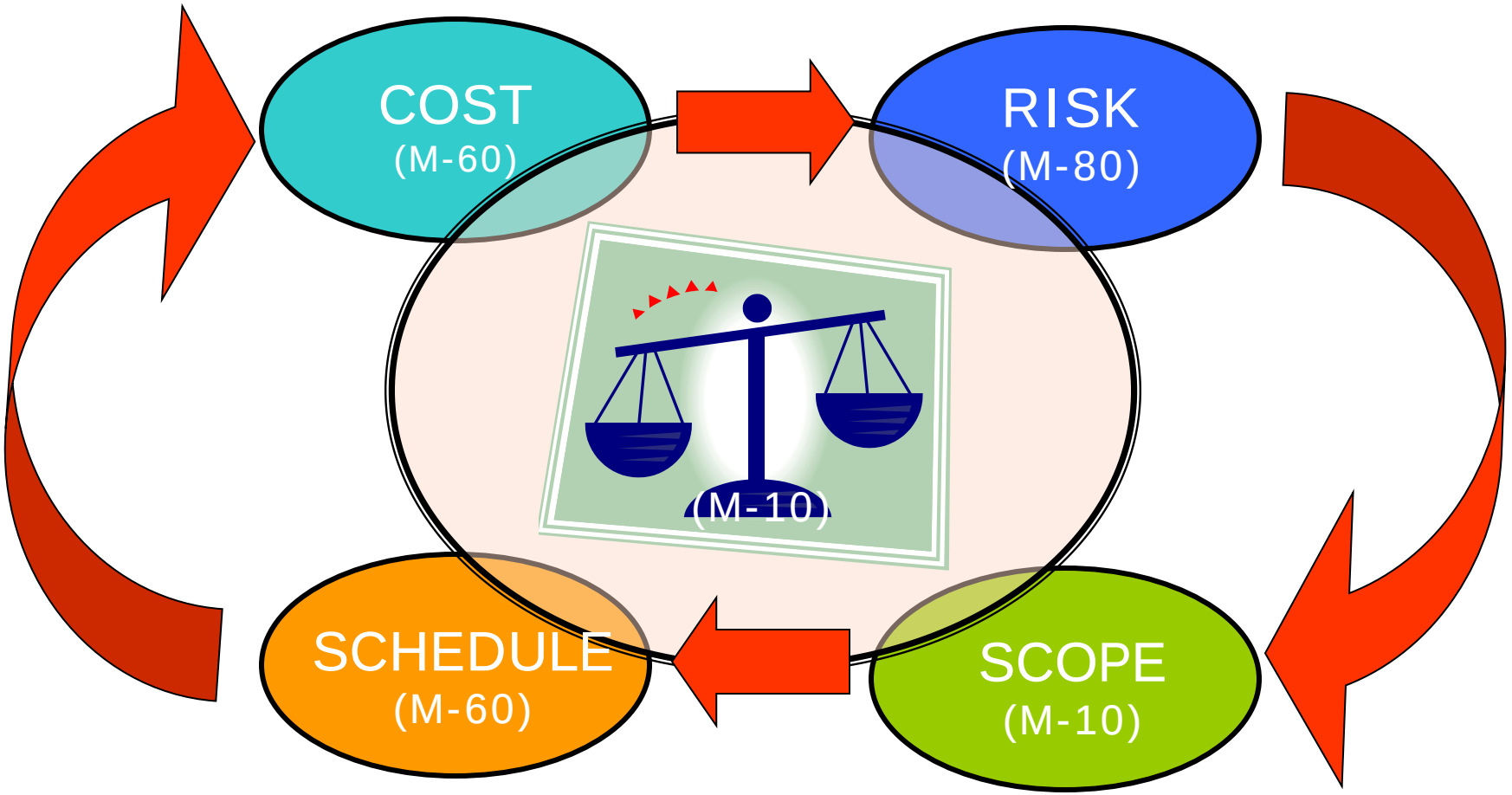
Evolution of technology options during preliminary project phases



Project phases and generalized institutional expectations of TRA outcome

1 - Introduction – PM activities

Project Management – Interaction & Balance



2 – ECSS overview & terminology

Key objectives

- To establish a coherent set of standards (ECSS system) for direct use in a wide range and type of projects irrespective of the type of business agreement used to implement the project.
- To achieve this objective some requirements statements, especially in project management, have to be non-specific.
- In order to meet the specific requirements of individual projects, some tailoring of the standards is necessary in applying them.

2 - ECSS overview & terminology

General information

- ECSS documents have been developed through a joint activity between European Space Agencies and industry (represented by EUROSPACE) to cover a wide range of project types

- Current set of documents available comprises:
  - 125 standards (of which 6 are M standards)
  - 28 handbooks (No handbooks in M branch)
  - 10 technical memoranda (No TMs in the M branch)

- European major industry (e.g. TAS, AST) is now very familiar with the content of the standards and in many cases has already integrated, or mapped, the content into their own in-house systems.

2 - ECSS overview & terminology

ECSS branches' organization

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S – standardization system	Define the system of standardization documents, and specifies how to use it in Space projects	2 ST 0 HB 0 TM
M - management	Project management is responsible for the achievement of the totality of the project objectives and specifically for quality organization and its timely and cost effective execution	6 ST 0 HB 0 TM
Q - product assurance	Product assurance is responsible for the implementation of the quality assurance elements of the project and other activities like dependability, safety, parts, material and processes, software, and audits	52 ST 7 HB 5 TM
E - engineering	Engineering is responsible for the definition of the end product, verification that customer's technical requirements are achieved and in conformance with the regulation and company constraints	53 ST 14 HB 6 TM
U - sustainability	Sustainability is responsible for defining requirements contributing to the long term sustainability of space activities, including orbital debris mitigation, space situation awareness, and planetary protection	1 ST 0 HB 0 TM

2 - ECSS overview & terminology

ECSS branches / disciplines

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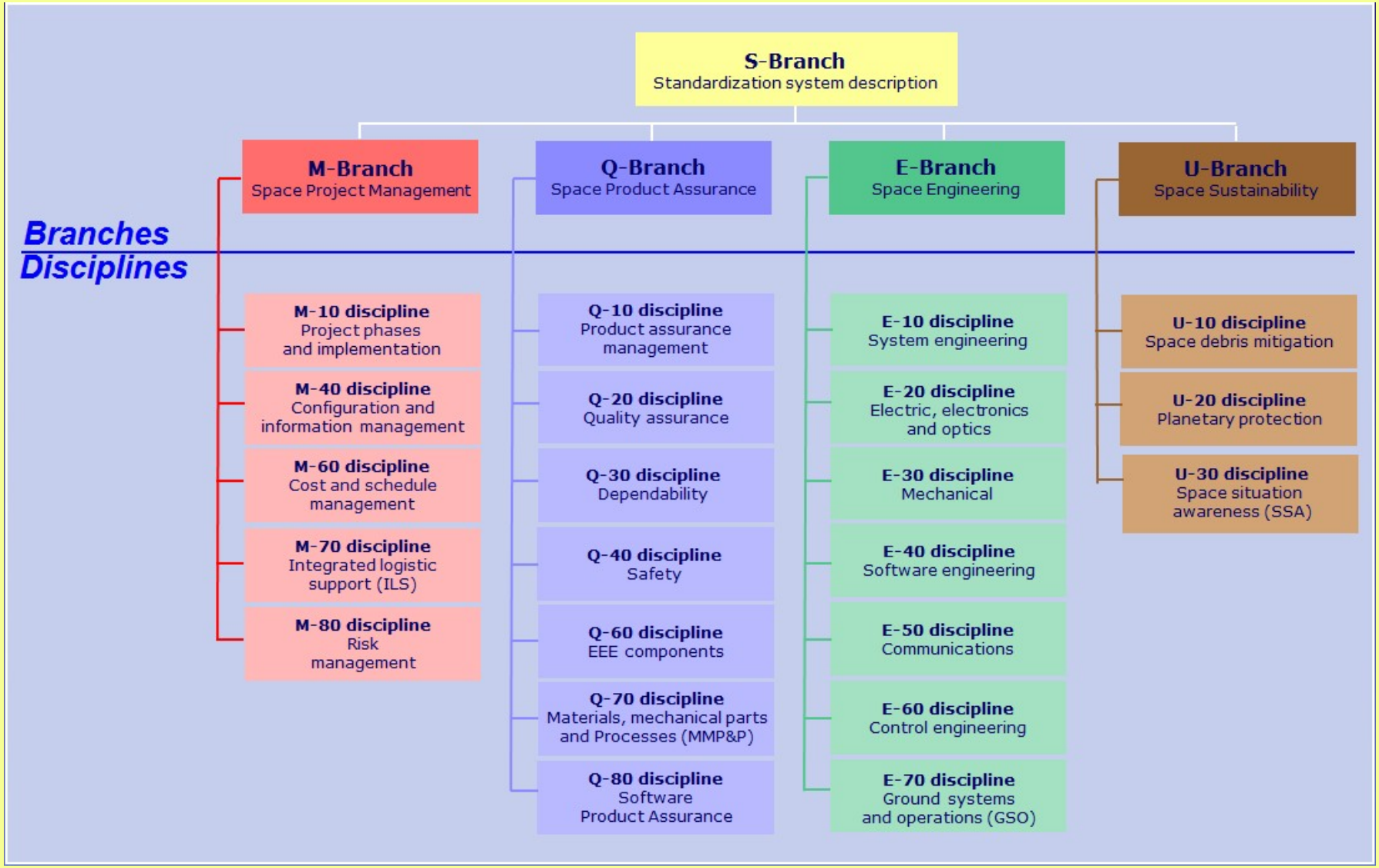

- ECSS standards focus mainly on “WHAT” is required rather than “HOW” to achieve
  - Some lower level Q-standards specify “How” for processes, e.g. soldering
- Common structure and format of standards across the different branches/disciplines
- Standard identification for normative statements as follows:
  - Requirements, with SHALL
  - Recommendations, with SHOULD
  - Permissions, with MAY

- Descriptive and normative statements are separated
- Only short descriptive texts to support understanding of the requirements
- Documents produced in response to requirements are specified in Document Requirements Descriptions (DRDs)
- Unique identifier per requirement and per DRD

2 - ECSS overview & terminology

Use this area for the sub-chapter title

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Anatomy of a typical standard (ESA-only and ECSS)

- ❑ **Change log, ToC** & *[Introduction]*
1. **Scope**
   Clearly and concise identification of the coverage and the applicability of the standard
2. **Normative references**
   Listing ONLY documents referenced from requirements.
3. **Terms, definitions and abbreviations**
4. *[Principles and/or background]*
   Containing ONLY informative/guidance material
5. **Requirements**
   Containing the normative provisions.
   It may contain some NOTES and some few guidance sub-clauses with only guidance material.
6. *[More requirements…]*

Last Clause: **Pre-tailoring (per product type & project phase)**
Only mandatory if standard is subject to pre-tailoring

A,B,…[Annexes]
First Normative annexes **(DRDs)**, and then Informative annexes]

- ❑ **Bibliography**
  Listing the documents referenced from the informative/guidance text

Clause/section always present
[Optional clause/section]

What are DRDs? (Document Requirement Definition)

- ❑ DRDs are Normative Annexes, i.e. they are requirements
- ❑ They specify the content of a deliverable document
- ❑ They do not specify the format, only the information to be provided.
- ❑ They are always referenced from a requirement specifying who, when, and how often the document shall be provided. The DRD specifies ONLY the content.

2 - ECSS overview & terminology

Customer/Supplier chain (1/2)

- Customer = organization or person that receives a product as part of a business agreement
- Supplier = organization or person that provides a product as part of a business agreement

  Note: the term product covers: services, software, hardware and processed materials.

- All space project actors are either a customer or a supplier, or both.

- Any actor in the Customer / Supplier chain could be a provider of a product to any other actor as a …., (e.g. Customer Furnished Equipment)

2 - ECSS overview & terminology

Customer/Supplier chain (2/2)

Standardization training program
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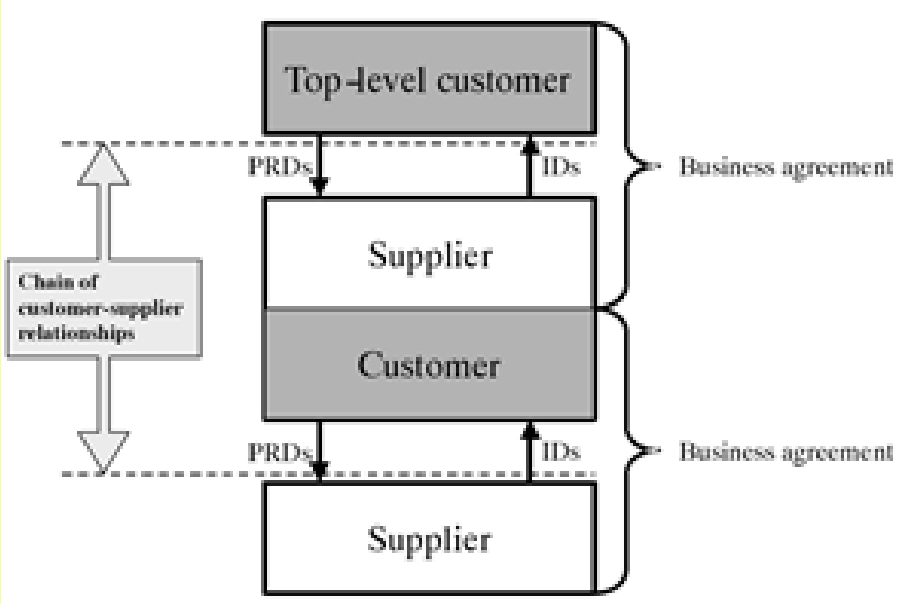
- A typical space project comprises a number of hierarchical levels:
  - the actor at the top level of the hierarchy is the top level customer with the overall responsibility for the implementation and management of the project,
  - the actors at intermediate levels of the hierarchy are both supplier and customer,
  - the actors at the lowest level of the hierarchy are suppliers only.



PRDs = Project Requirement Documents
IDs = Implementation Documents

2 - ECSS overview & terminology

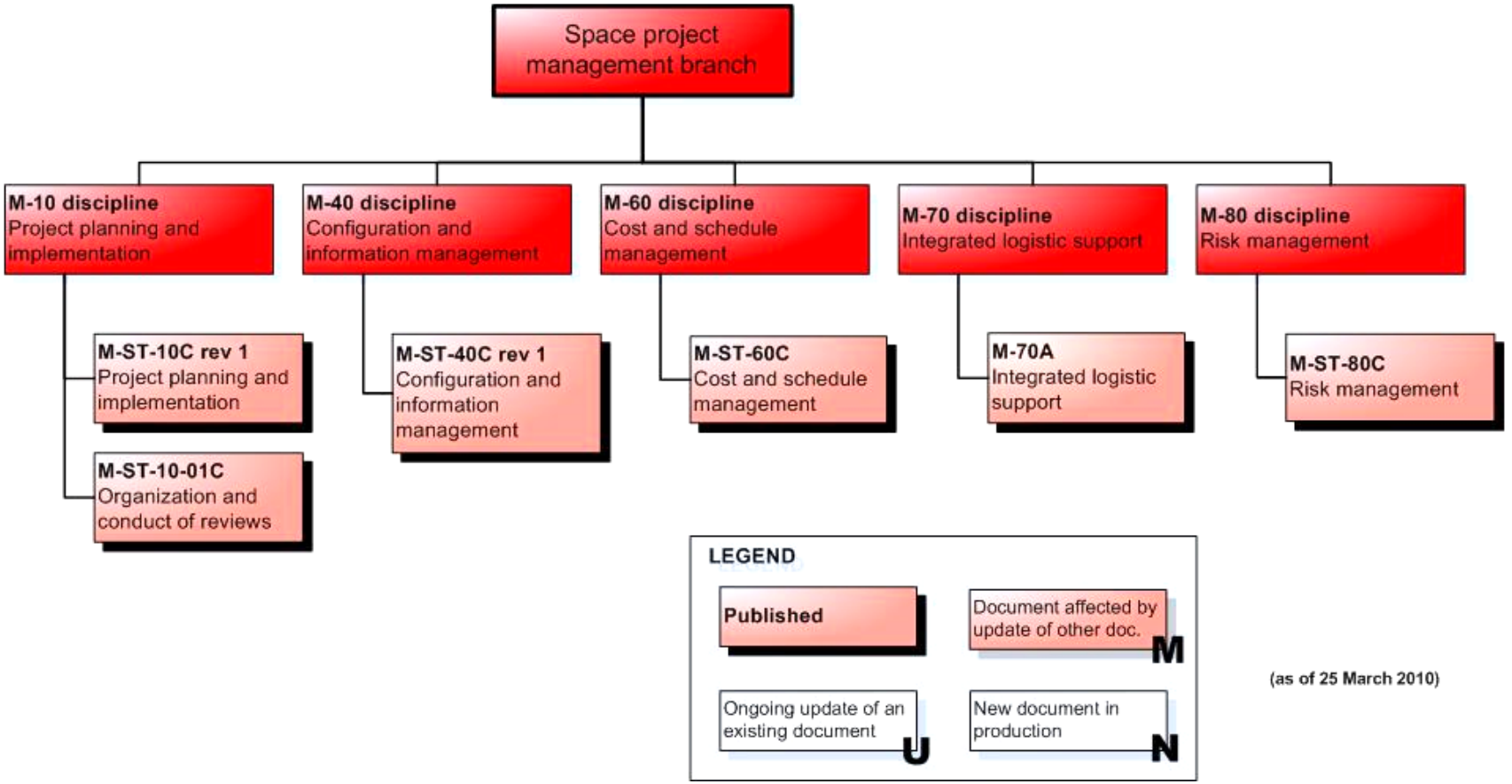
Business agreement

- Business agreement = legally binding agreement, for the supply of goods or services, between two or more actors in the customer–supplier chain

- Business agreements are recorded in a variety of forms, such as:
  - Contracts,
  - Memoranda of understanding,
  - Inter-governmental agreements,
  - Inter-agency agreements,
  - Partnerships,
  - Bartering agreements, and
  - Purchase orders.

3 – ECSS-M structure & approach

ECSS Management Tree



(as of 25 March 2010)

3 – ECSS-M structure & approach

ECSS Management disciplines description

Discipline	Title & (Document)	Scope / Objective
M-10	Project Planning and Implementation (ECSS-M-ST-10 and ECSS-M-ST-10-01)	Set of processes/requirements for *minimizing* the technical, scheduling and economic *risks* of the project. In particular this is done by: •introducing **phases and formal milestones** enabling the progress of the project to be controlled with respect to cost, schedule and technical objectives. •defining **project breakdown structures**, which constitutes the common and unique reference system for the project management to: •identify the **tasks and responsibilities** of each actor; •ensure the **coherence between all activities** (technical, documentary, administrative and financial) of the whole project; •perform **scheduling and costing** activities. •setting up a **project organization** to implement a structured and complete approach to perform all necessary activities on the project.

3 – ECSS-M structure & approach

ECSS Management disciplines description

Discipline	Title & (Document)	Scope / Objective
M-40	Configuration and Information Management (ECSS-M-ST-40)	Set of processes/requirements for performing configuration and information management : •identifies, describes and controls the **technical description of a system** in a logical and consistent manner throughout the system's life cycle, and •ensures that the **information** necessary for effective execution of all management processes are recorded, retrieved, distributed and modified in a traceable manner.
M-60	Cost and Schedule Management (ECSS-M-ST-60)	Set of processes/requirements for verifying the compliance of project planning and organization to ensure the **consistent use of resources** (human, facilities, materials and funds) to achieve the successful completion of the space project within its established goals: costs, schedule and performance. It provides alerts to trigger necessary adaptations (e.g. re-planning, resource reallocation).

3 – ECSS-M structure & approach

ECSS Management disciplines description

Discipline	Document & Title	Scope / Objective
M-70	Integrated Logistic Support (ECSS-M-70)	Set of requirements necessary for minimizing cost of the logistic support **throughout the system life cycle**.
M-80	Risk Management (ECSS-M-ST-80)	Risk management discipline identifies all risks (incl. new opportunities) and **keeps these risks within defined and accepted boundaries** that are defined in the risk policy of the project. Risk management aims at **all aspects of the programme**, including technical and quality performance, programmatic (e.g. funding, political environment), cost (e.g. contract type, project cost), schedule and operation (e.g. logistic support, security). In particular it includes: •The systematic identification, assessment and classification of all risk causes and consequences prior to definition and implementation of a decision to accept, to monitor or to take action. The risk assessment supports the decision making process, including consideration of uncertainties about the risk involved. Independent verification of the risk assessment ensures its objectiveness. •The systematic definition, implementation, control and verification of actions appropriate for elimination or reduction of risk to an acceptable level.

3 – ECSS-M structure & approach

ECSS Management branch evolution

The merging of M standards undertaken between Rev B and Rev C is shown below:

Revision B management standards	Revision C management standards
M-00 Project Management	Requirements to M-ST-10/Descriptive to S-ST-00
M-00-02 Tailoring of Standards	Moved to S-ST-00 Description, implementation and general requirements
M-00-03 Risk Management	Updated and Renumbered M-ST-80
M-10 Project Breakdown Structures	Merged in M-ST-10 Project Planning & Implementation
M-20 Project Organisation	
M-30 Project Planning & Phasing	
M-30-01 Conduct of Reviews	M-ST-10-01 Conduct of Reviews
M-40 Configuration Management	M-ST-40 Configuration & Information Management
M-50 Info/Doc Management	Merged into M-ST-40
M-60 Cost and Schedule Management	M-ST-60 Cost & Schedule Management
M-70 Integrated Logistics Support	Not changed – Still in Issue A

3 – ECSS-M structure & approach

Content structure of ECSS-M standards

Standardization training program
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	Clauses									Annexes		Bib
	1	2	3	4	5	6	7	8	9	Normative (DRDs)	Informative	
M-ST-10C	SCOPE	Normative References	Terms and definitions	#	@					@ 5 DRDs	3	BIBLIOGRAPHY
M-ST-10-01C	SCOPE	Normative References	Terms and definitions	#	@					@ 4DRDs	2	BIBLIOGRAPHY
M-ST-40C	SCOPE	Normative References	Terms and definitions	#	@					@ 10 DRDs	3	BIBLIOGRAPHY
M-ST-60C	SCOPE	Normative References	Terms and definitions	#	#	#	@	@	@	@ 15 DRDs	3	BIBLIOGRAPHY
M-ST-70C	SCOPE	Normative References	Terms and definitions	#	@	@	@	@				BIBLIOGRAPHY
M-ST-80C	SCOPE	Normative References	Terms and definitions	#	#	#	@			@ 3 DRDs	2	BIBLIOGRAPHY

Informative

Normative

Principles

@ Requirements

Note that Clauses 4 (and for M-ST-60 and M-ST-80, also Clauses 5 and 6) describe the principles, i.e. how the activities are performed in a typical project

3 – ECSS-M structure & approach

General approach (1/2)

1. Many high level requirements (mainly in the 5 Level-2 standards) are drafted following the "**ODSI**" principle:

   a. - **O**rganize yourself in your own way

   b. - **D**ocument how you have organized yourself

   c. - **S**ubmit this document to your customer for approval

   d. - **I**mplement this organization (once approved)

2. This philosophy is very convenient for already established suppliers, but newcomers may have difficulties in understanding what it is required from them. To help them, many times some information is available.
   Therefore, the ODSI principle can be extended to:

   e. If you don't know how to comply with a. above, informative material may be available in Chapter 4, informative annexes or handbooks.

3 – ECSS-M structure & approach

General approach (2/2)

1. This “To document” normally implies that a **DRD** is required
2. Approval by the customer is important for 2 reasons:
   a. To ensure correctness
   b. To ensure consistency through the whole project
3. Example: M-ST-10C “Project planning and implementation, # 5.1.3:

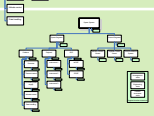
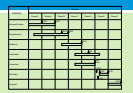
h. “The supplier shall establish the Work Breakdown Structure (WBS) for his work share, incorporating the WBS of his lower tier suppliers, in conformance with Annex C”

k. The WBS shall be subject to customer approval”

In the next slides, anything with the background in green is following this principle

4 - ECSS M-standards content
M-ST-10
Project Planning & Implementation

Standardization training program
Space Project Management

Clause & Req	Topic (what reqs are addressing)	DRD (Annex)	Provided information (Clause 4)
5.1 Project planning			
5.1	Tailoring by the customer	-	Will be described in S-ST-00-02
5.2	Project management Plan (PMP)	A	General guidelines in 4.1
5.2 Project organization			
5.2.1	Organization structure	Part of PMP	General guidelines in 4.2.1 & 4.2.2
5.2.2	Communication & reporting		General guidelines in 4.2.3
5.2.3	Audits		*Basic* guidelines in 4.2.4
5.3 Project breakdown structures			
5.3 a to g	Product tree	B	4.3.4 
5.3 h to l	Work Breakdown Structures (WBS)	C	4.3.5, Annex H NOTE: WBS refers to Functional responsibilities 
5.3 m to o	Work Packages (WP) Descriptions	D	4.3.6 NOTE: A WP is any WBS element(s) that can be measured and managed for planning, monitoring and control
5.3 p to r	Organization Breakdown Structure (OBS)	Part of WBS	4.3.7 NOTE: OBS refers to responsible parties for each work package in the WBS.
5.4 Project phasing			
5.4 a to d	Project phases & reviews (including criteria to next phase)	-	4.4 

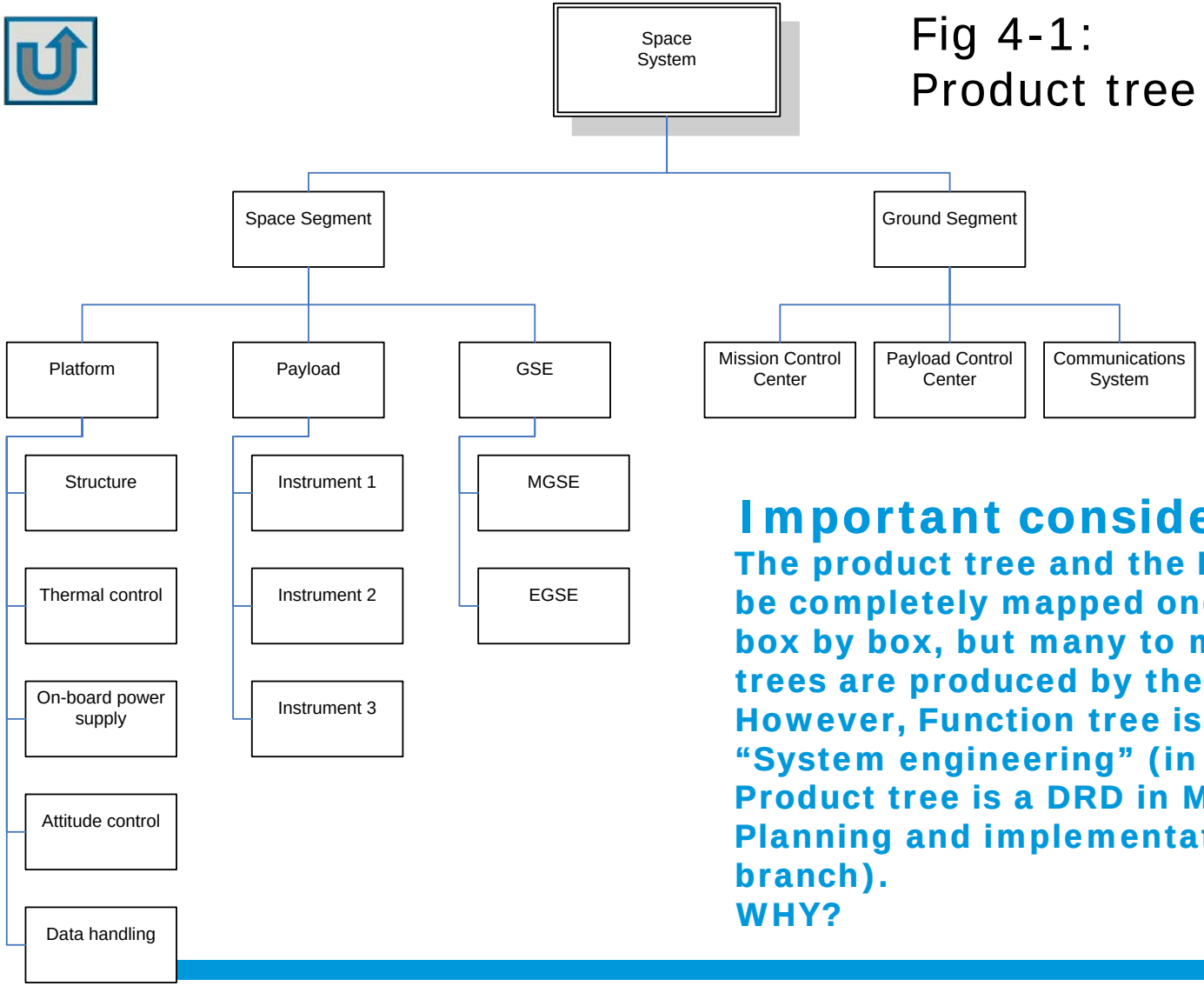


Fig 4-1:
Product tree example

Important consideration

The product tree and the Function tree shall be completely mapped one to the other (no box by box, but many to many). In fact, both trees are produced by the System Engineer. However, Function tree is a DRD in E-ST-10 "System engineering" (in the E branch), and Product tree is a DRD in M-ST-10 "Project Planning and implementation" (in the M branch).
WHY?

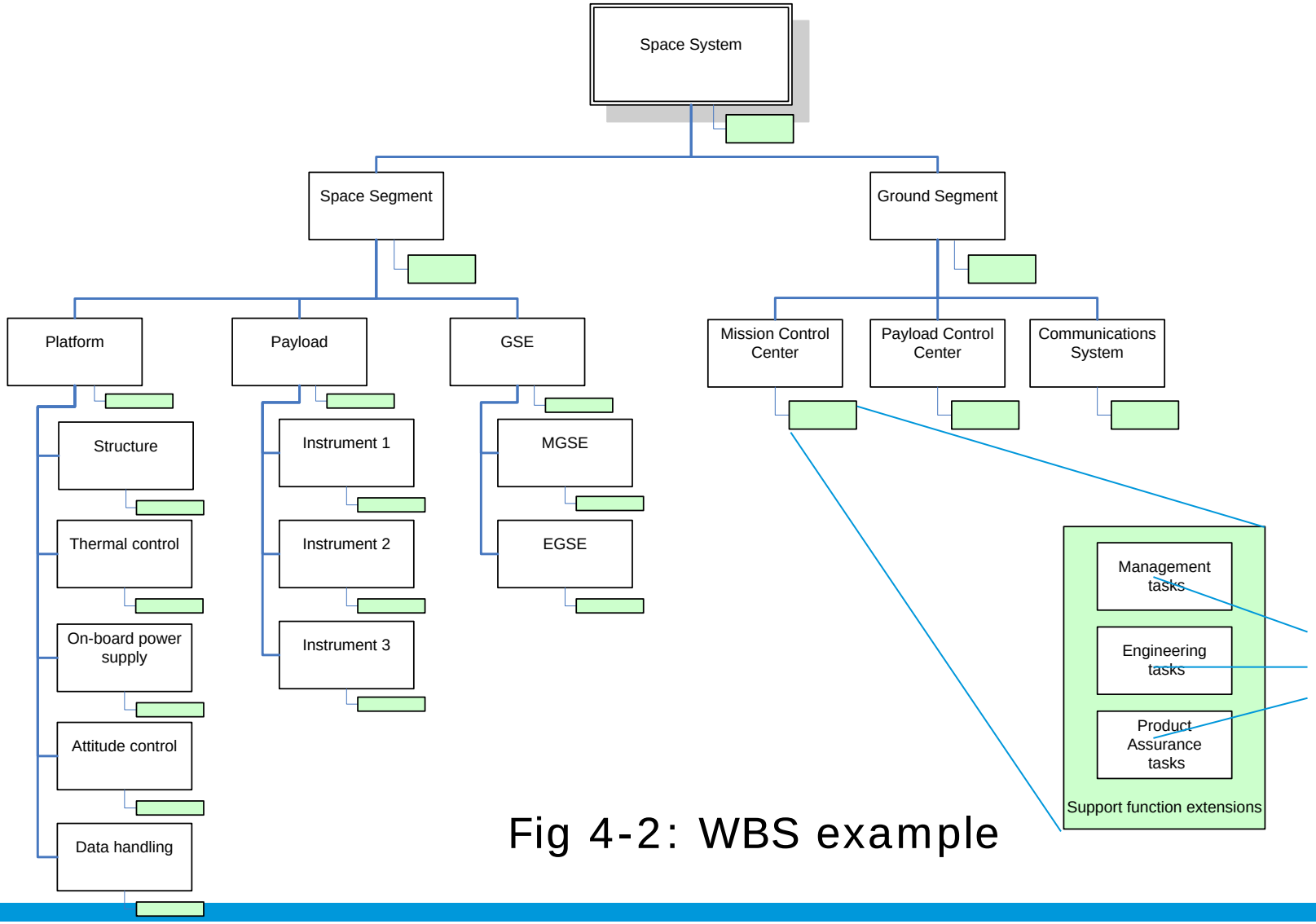


Fig 4-2: WBS example

4 - ECSS M-standards content
M-ST-10 (supporting material)
Project Planning & Implementation

REVIEWS

MDR=Mission Definition

PRR=Preliminary req.

SRR=System req.

PDR=Preliminary design

CDR=Critical design

QR=Qualification

AR=Acceptance

ORR=Operational readiness

FRR=Flight readiness

LRR=Launch readiness

CRR=Commissioning result

ELR=End-of-life

MCR=Mission close-out

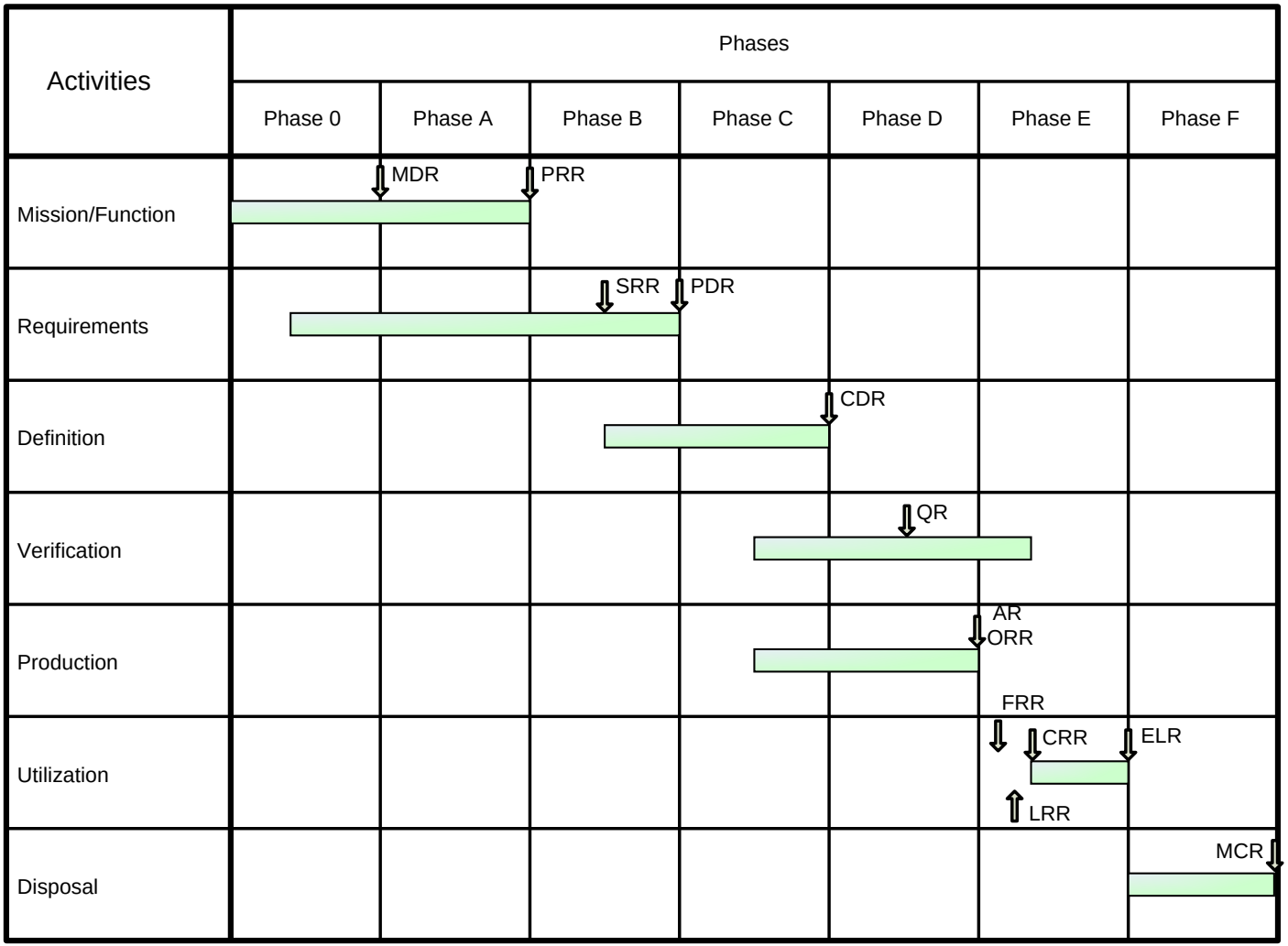


Fig 4-3: Typical project life-cycle

4 - ECSS M-standards content
M-ST-10 (supporting material)
Project Planning & Implementation

Annex F is a very interesting informative annex
It covers the MAIN DRDs in the M branch

Table F-1: Management documents delivery per review

Document Title	Phase													DRD ref.
	0	A	B		C	D		E					F	
	MDR	PRR	SRR	PDR	CDR	QR	AR	ORR	FRR	LRR	CRR	ELR	MCR	
Project management plan		X	X	X										ECSS-M-ST-10, Annex A
Product tree		X	X	X	X	X	X							ECSS-M-ST-10, Annex B
Work breakdown structure		X	X	X										ECSS-M-ST-10, Annex C
Work package description		X	X	X										ECSS-M-ST-10, Annex D
Schedule	X	X	X	X	X	X	X	X	X					ECSS-M-ST-60, Annex B
Cost estimate report		X	X	X										ECSS-M-ST-60, Annex G
Configuration management plan		X	X	X										ECSS-M-ST-40, Annex A
Configuration item list				X	X									ECSS-M-ST-40, Annex B
Configuration item data list				X	X	X	X							ECSS-M-ST-40, Annex C
As-built configuration list						X	X							ECSS-M-ST-40, Annex D
Software configuration file				X	X	X	X							ECSS-M-ST-40, Annex E
Configuration status accounting reports				X	X	X	X							ECSS-M-ST-40, Annex F
Risk management policy document	X	X	X	X										ECSS-M-ST-80, Annex A
Risk management plan	X	X	X	X										ECSS-M-ST-80, Annex B
Risk assessment report		X	X	X	X	X	X	X	X					ECSS-M-ST-80, Annex C

4 - ECSS M-standards content
M-ST-10-01
Organization & conduct of reviews

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Clause & Req	Topic (what reqs are addressing)	DRD (Annex)
5.1 General – customer responsibilities, objective & coverage documentation		
5.2 Review bodies – Review authority (consumer), review team, project team (customer & supplier)		
5.3 Roles & tasks		
5.3.1	**Review authority (RA)**: Approve procedure, endorse team recomm, make recomm to customer report findings	D (Review Authority Report)
5.3.2	**Customer**: Propose procedure, event organization, data management system	A (Review Procedure)
5.3.3	**Supplier:** Support the customer for: logistics, documentation, and RID responses/action schedule	
5.3.5	**Review team (RT):** Review doc, produce RIDs, assess RIDs responses, help with the report	B (RID content)
5.3.4	**Review team leader (RTL):** Confirm prerequisite, approve RIDs & dispo, produce the report	C (Review team report)
5.4 Prerequisite conditions – defined in the procedure by the customer, and agreed by supplier		
5.5 Review meetings		
5.5.1	**Prerequisite key point** - See above	
5.5.2	**K.O. meeting** – All bodies, for present the docs and authorize review	
5.5.3	**Coordination meeting** – As defined by RTL, for review inputs, release RIDs	
5.5.4	**Collocation meeting:** As defined by the RTL, for review RIDs, agree dispo, identify actions/dates	
5.5.5	**RT close-out meeting**: As defined by the RTL, for results, inputs to report, and major issues	
5.5.6	**RA meeting**: RA & RT, for "blessing" the review, endorse team recomm, make decisions, issue RA report	
5.6 RID processing and A.I. follow-up – Major & minor RIDs, originators informed, RID closed = dispo/action agreed, open RIDs to be dispo by RA INFO IN ANNEX E (Logic diagram for RID processing)		

RID = Review item discrepancy

4 - ECSS M-standards content
M-ST-10-01
Organization and conduct of reviews

1. Clause 5 contains all requirements related to Project Reviews. These cover:
    a. General
    b. Review Bodies
    c. Roles and tasks (Review authority, customer, supplier, review team leader, and review team)
    d. Prerequisites for holding a review
    e. Review meetings (prerequisite key point, Kick-off meeting, co-ordination meeting, collocation meeting, review team closeout meeting, and review authority meeting)
    f. RID processing

RID = Review item discrepancy

4 - ECSS M-standards content
M-ST-40
Configuration and information management

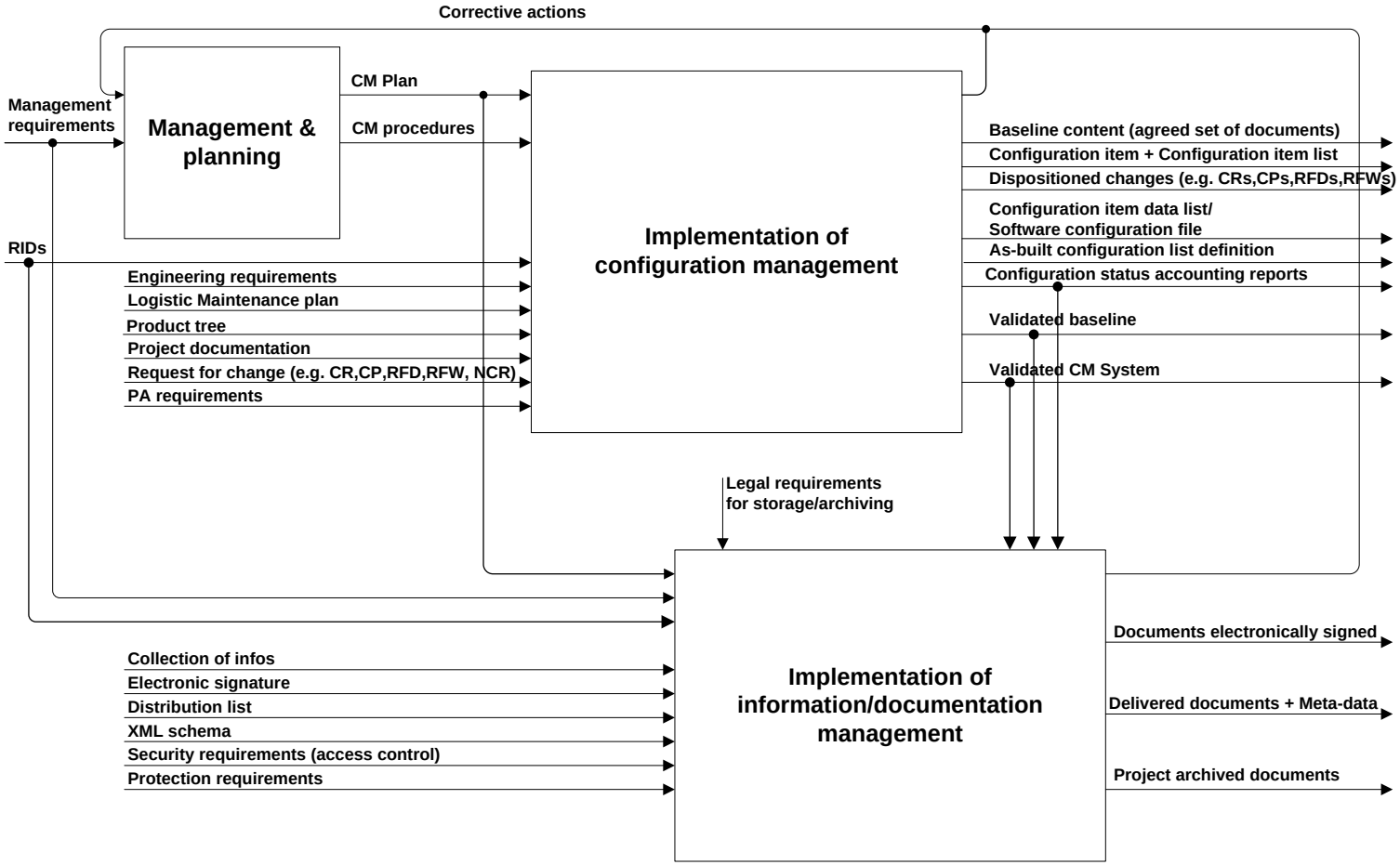
Standardization training program
Space Project Management

NOTE 1: For general process descriptions see Figures 4-1, 4-4, 4-5, 4-7, and 4-8

Clause & Req	Topic (and what reqs. are addressing)	DRD (Annex)	Provided information (Clause 4)
5.2 Configuration Management(CM) planning			
5.2.1	**CM plan (CMP)** - (incl. info security & classification)	A	General guidelines in 4.1.2
5.2.2	**CM interfaces** - (with Proj mng, Eng, PA, Inf/DocMngmnt, …)	-	4.2.2 
5.3 Configuration management (CM) implementation			
5.3.1	**Configuration identification** - (C.I. def, selection, baseline, marking, …)	**Part of CMP**	4.3.2 & Annex K (C.I. Selection) 
	Configuration Item List (CIL)	B	
5.3.2	**Configuration control** - (Change proc, classif, dispo, …)	**Part of CMP**	4.3.3 (change proc, classif, CCB…)
	Change request	G	
	Change proposal	H	
	RFD & RFW	I & J	
5.3.3	**Configuration status accounting (record, store & retrieve data)**	**Part of CMP**	General guidelines in 4.3.4 (incl as-designed and as-build data lists)
	Conf. Status accounting report (incl. Docs, Drawings, RFW, RFD, CRs, …)	F	
As designed	Conf Item Data List (CIDL)	C	
As designed	SW Conf File (SCF)	E	
	As-build Conf. List	D	
5.3.4	**Configuration verification** - (AsBuilt<->AsDesign @ various reviews)	**Part of CMP**	
5.3.5	**Audits of the CM system**		
5.3.6	**C.M. for operational phases** – (Activities during phases E & F)		
5.3.7	**Implementation of info/doc management** (incl. creation, review, delivery, archiving, retrieval)		4.3.8 (including TDP) & Annex L (Tech data) Annex M (Digital Sign.) 

IDM = Info & Doc management **CCB = Conf. Control Board** **TDP = Technical data package**

4 - ECSS M-standards content
M-ST-40 (supporting material)
Configuration and information management



NOTE to Fig 4-1: Corrective actions are improvements on the process itself as a consequence of lessons learned and any feedback provided on the project

Fig 4-1: Configuration management

4 - ECSS M-standards content
M-ST-40 (supporting material)
Configuration and information management

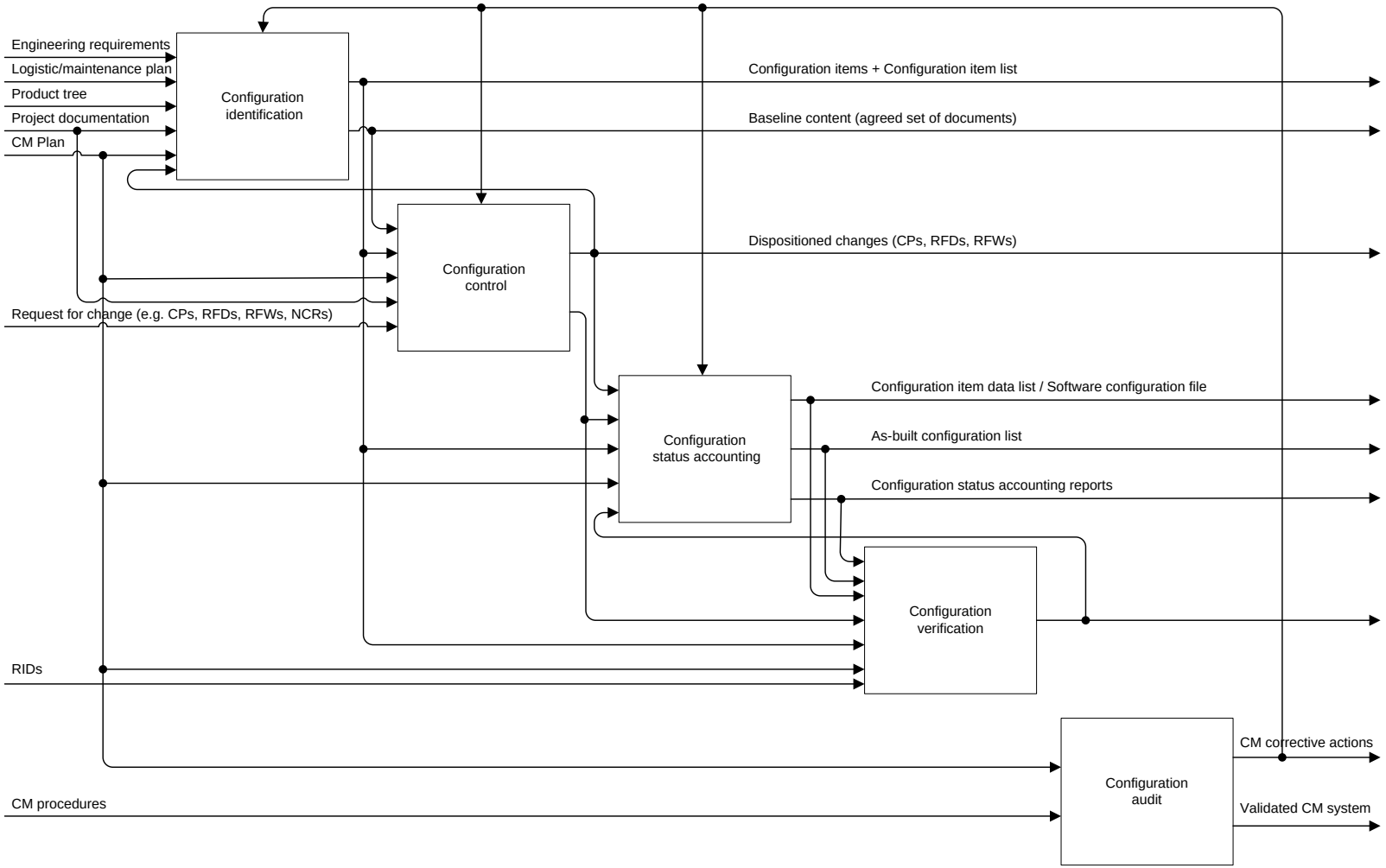


Fig 4-4: Implementation of configuration management

4 - ECSS M-standards content
M-ST-40 (supporting material)
Configuration and information management

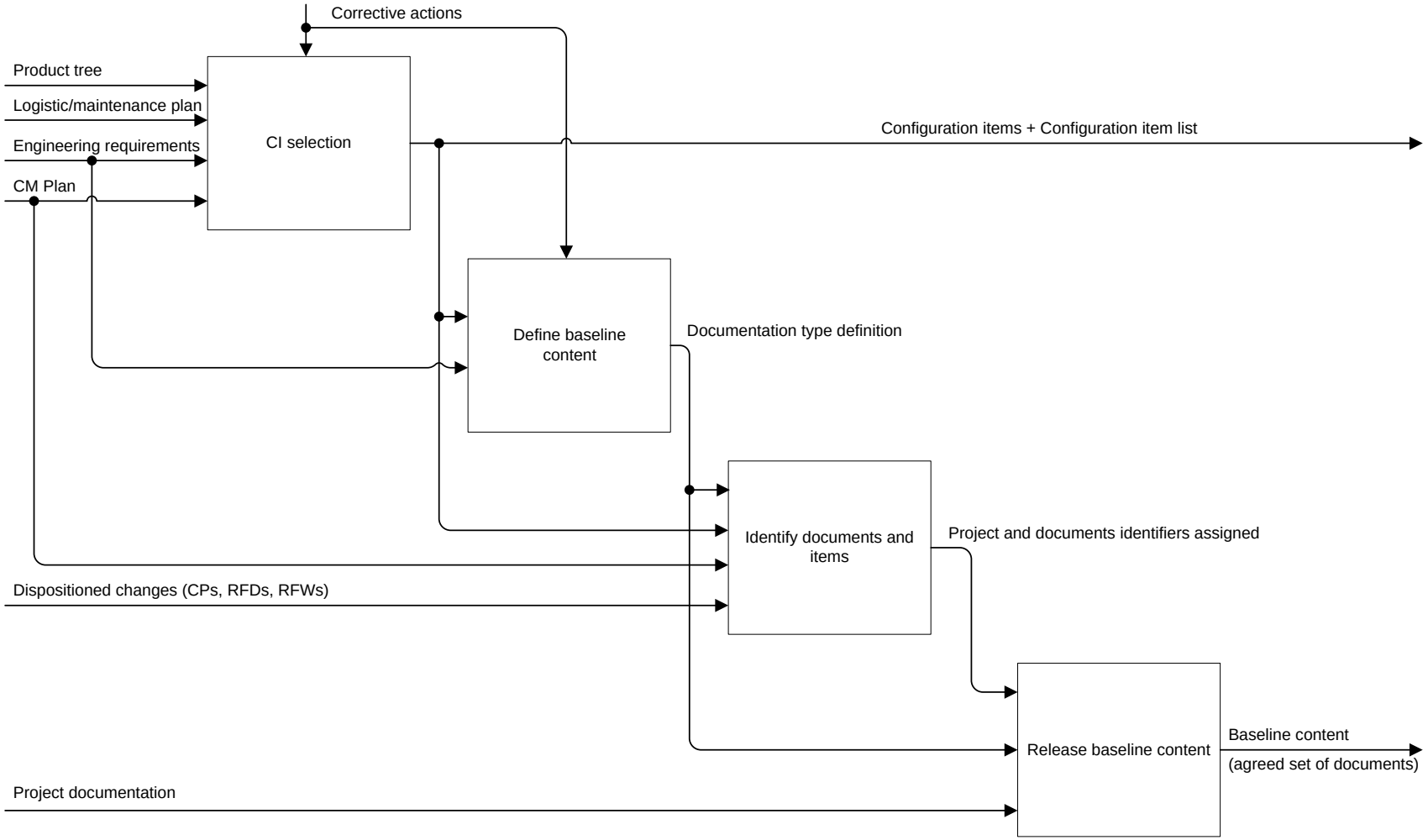


Fig 4-5: Configuration identification

4 - ECSS M-standards content
M-ST-40 (supporting material)
Configuration and information management

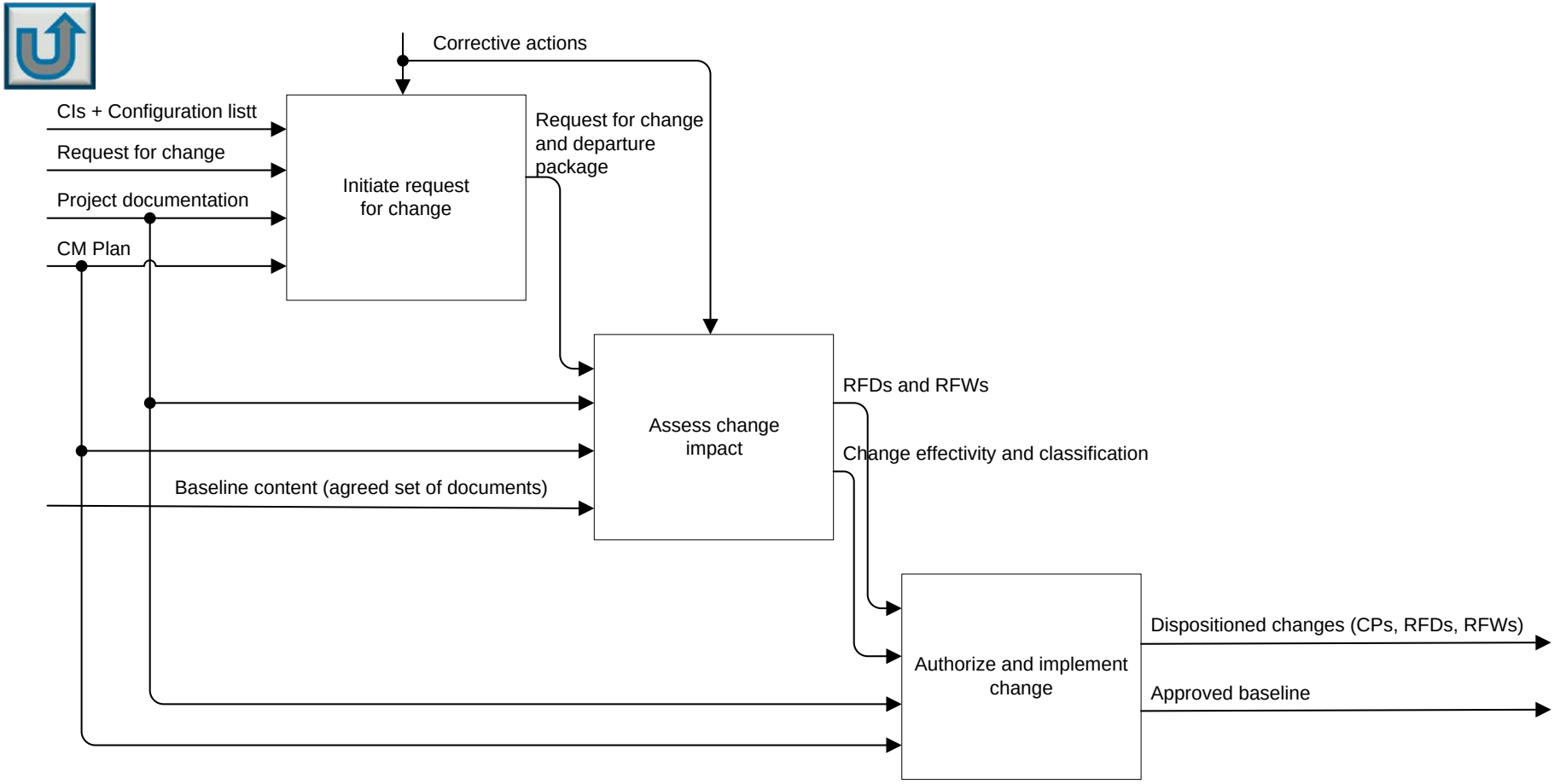


Fig 4-7: Configuration control

4 - ECSS M-standards content
M-ST-40 (supporting material)
Configuration and information management

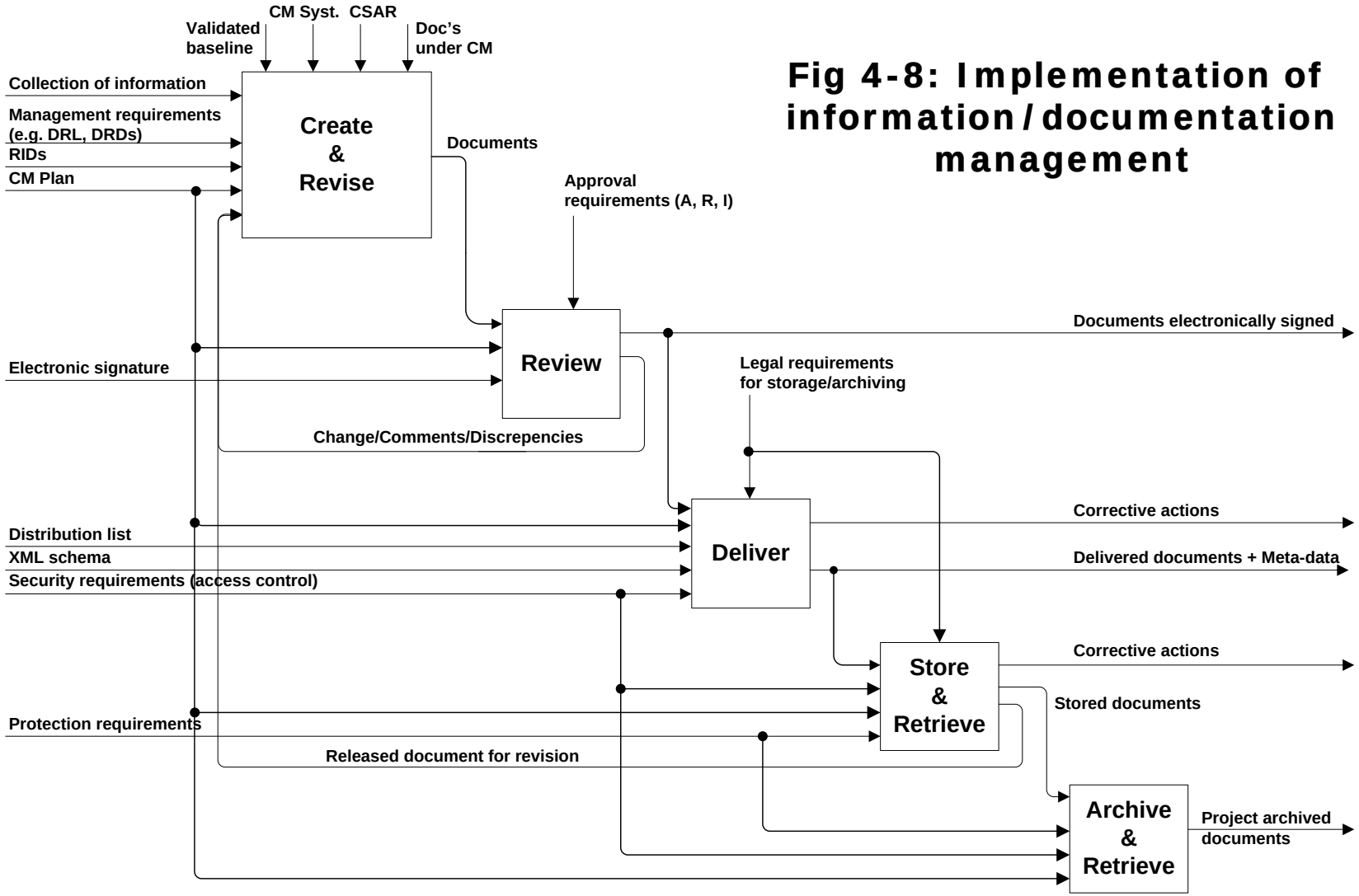


Fig 4-8: Implementation of information/documentation management

4 - ECSS M-standards content
M-ST-40 (supporting material)
Configuration and information management

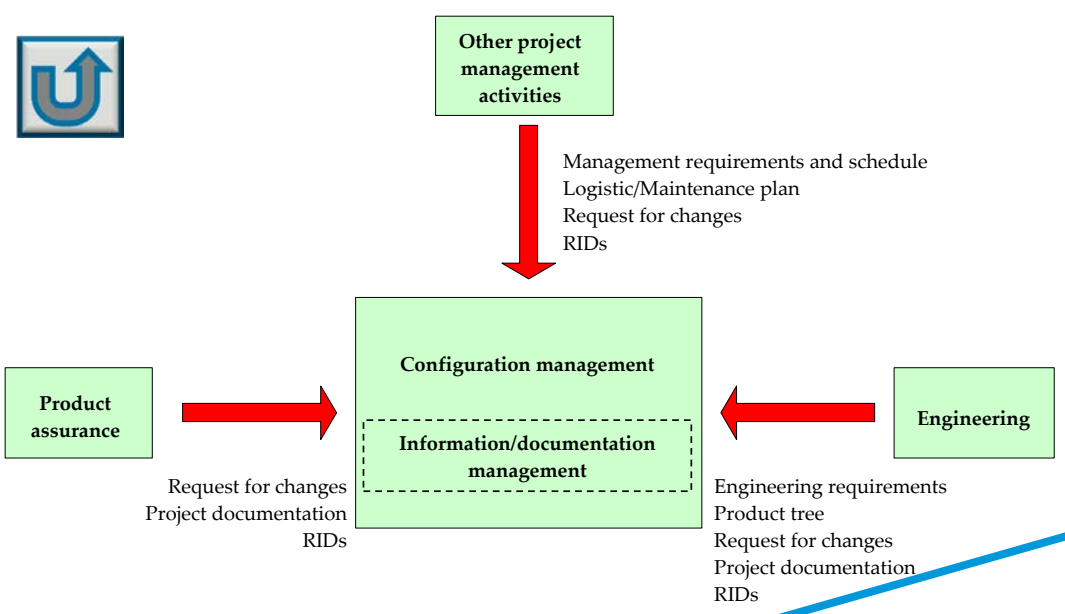


Fig 4-2:
C.M. interfaces (inputs)

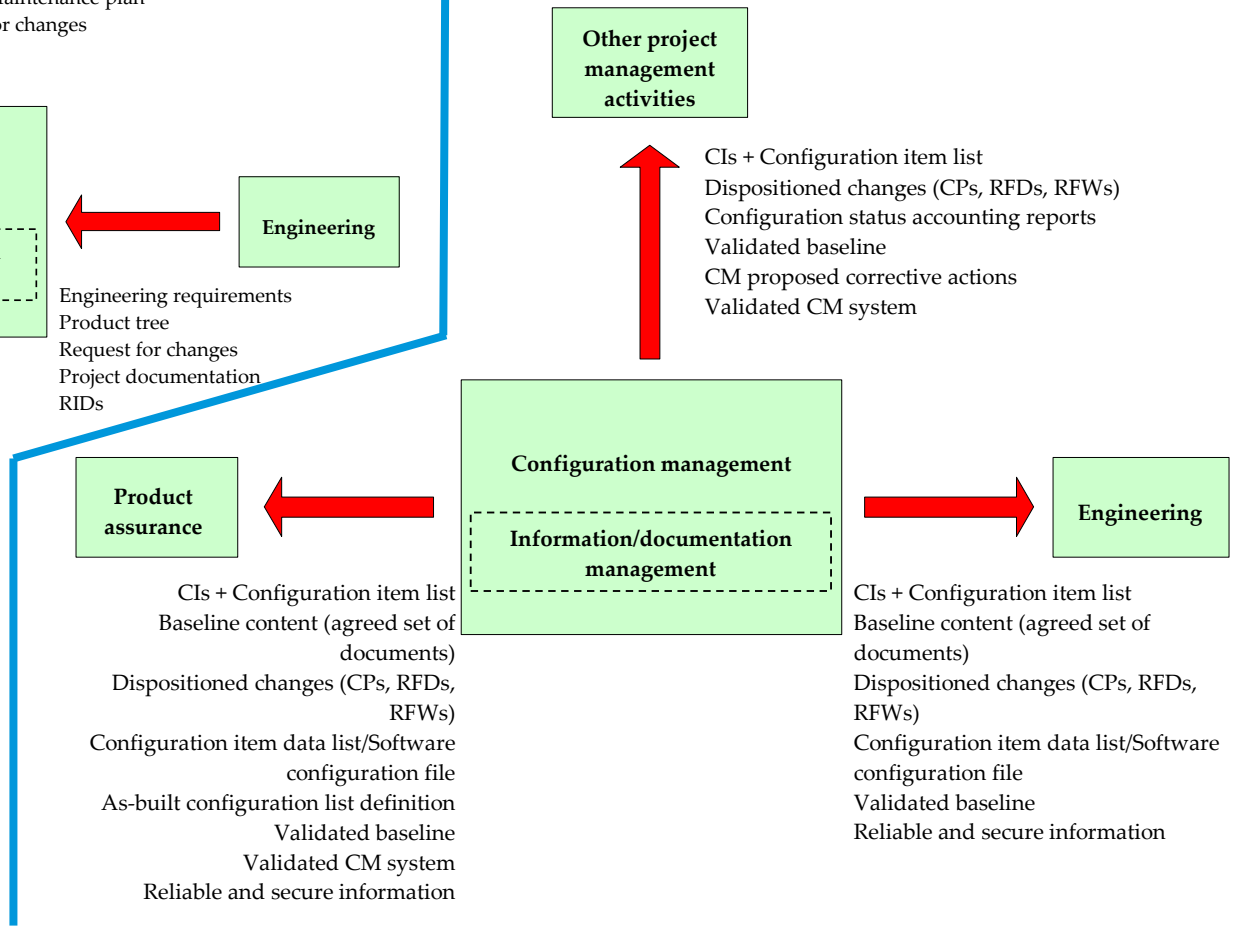


Fig 4-3:
C.M. interfaces (outputs)

4 - ECSS M-standards content
M-ST-40 (supporting material)
Configuration and information management

Derived from Product Tree
C.I. identification, by the customer
Trade-off C.M. ←→ cost
Annex K contains guidelines

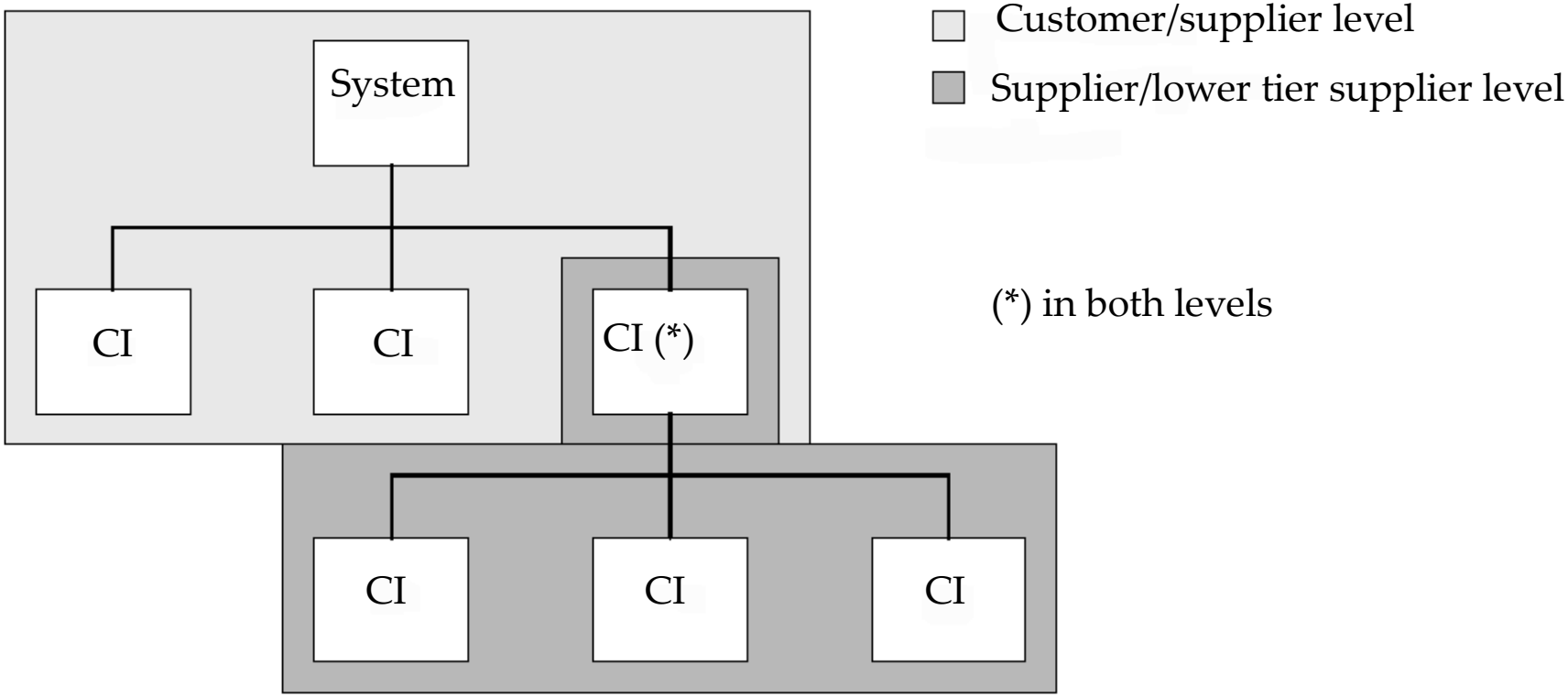


Fig 4-6: C.I. product tree structure

4 - ECSS M-standards content
M-ST-40 (supporting material)
Configuration and information management

TDP format defines the way to exchange content files and their related metadata and the way to structure them within folders

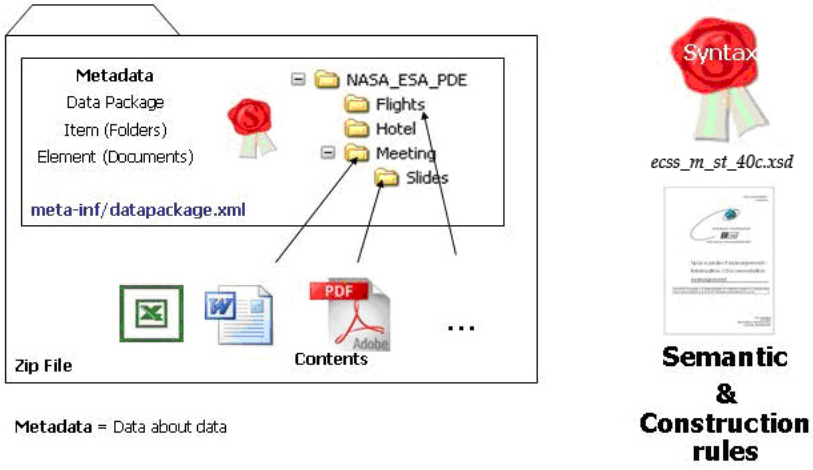


Fig 4-9: Technical Data Package (TDP) contents

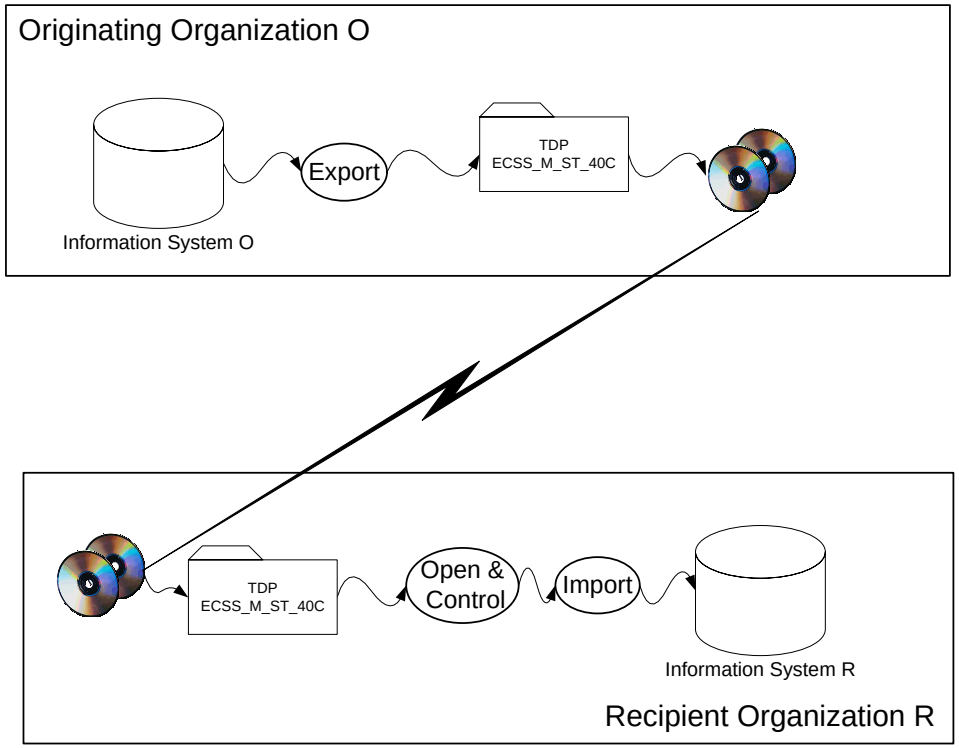


Fig 4-10: Delivery process for TDP

4 - ECSS M-standards content
M-ST-60 [1/2]
Cost and schedule (C&S) management

Standardization training program
Space Project Management

NOTE 1: For general process descriptions see Figure 4-1

Clause & Req	Topic (and what requirements are addressed)		DRD (Annex)	Provided information (Clause 4)	
7 - Cost & schedule management common requirements					
7.1	**Project structure**				
	7.1.1 Cost breakdown structure (CBS) – Cost categories		A	Info in the DRD itself	
	7.1.2 Business agreement structure (BAS)	Both covering all elements of the WBS (see ECSS-M-10 Annex C)	-	Clause 4.2.3	See business agreement types in 4.3
	7.1.3 Country/Company structure (CCS)		-	Normally combined with the BAS	
7.2	**Risk management** - C&S contribution to Risk management (ECSS-M-80)		-		
8 – Schedule management requirements					
8.1	**Schedule definition** – Schedule, critical path, dependencies, calendar, KIP, MIP		-	Clause 5.1	
8.2	**Schedule control** – Baseline and actual schedule, performance measurement & evaluation, trends		B	Clause 5.2	
8.3	**Schedule reporting**		C		

Business agreement types

Fixed price		Cost reimbursement
Firm	Possibility of ceiling price	Cost + fixed price
With variation		Cost + incentive price
Fix unit price		Time & material

M/KIP = Main/Key inspection point

4 - ECSS M-standards content
M-ST-60 [2/2]
Cost and schedule (C&S) management

Standardization training program
Space Project Management

Clause & Req	Topic (and what requirements are addressed)	DRD (Annex)	Provided information (Clause 4)
9 – Cost management requirements			
9.1	**Contractual and financial interfaces**		
	9.1.1 Audited rates and cost structure – Approved and audited by national authority	-	Some info in 6.2 EC defined in 3.2.5 as "reference period of time during which a set of financial elements are applicable
	9.1.2 Economic conditions (EC) – Cost info to be referred to the EC defined by customer	-	
	9.1.3 Currency & exchange rates	-	
	9.1.4 Contract change procedure - CCNs	O	Some info in 6.2.3
9.2	**Cost estimating and planning**		
	9.2.1 Cost estimating - Plan (Annex F) and Report (Annex G), proprietary data	F & G	Info in 6.3.1
	9.2.2 Project financial info – Company price breakdown form (CPBF)	D	
	9.2.3 Development cost plan (DCP) – based on Product Tree, WBS, CBS & CPBF	-	Some info in 6.3.2
	9.2.4 Milestone payment plan	H	Some info in 6.3.3
	9.2.5 Price variation mechanism – Supplier proposes, customer approves	-	Info in 6.3.4
	9.2.6 Geographic distribution – meeting the customer geog. distri. constraints	E	Some info in 6.3.5
9.3	**Cost control**		
	9.3.1 Original BCP (baseline cost plan) – BCP for cost reimbursement & Fixed price	K & L	Some info in 6.4.1
	9.3.2 Current baseline cost plan (CBCP) – Report on the update the OBCP	K & L	
	9.3.3 EstAC & EstTC – Report for cost reimb. (Annex M) and Fixed Price (Annex N)	M & N	Some info in 6.4.2
	9.3.4 Price variation mechanism control – Report on computation of 9.2.5	-	Some info in 6.4.3
	9.3.5 Geographical distribution control – Report on Actual distribution (see 9.2.6)	E	Some info in 6.4.4
	9.3.6 Inventory control – Inventory control plan	-	Info in 6.3.6 and 6.4.5
	9.3.7 Financial audits (for cost reimbursement) – Customer right to audit supplier	-	Some info in 6.4.6
	9.3.8 Payment milestone achievement – Way to certify & document payment	-	Some info in 6.4.7
9.4	**Cost management reporting**		
	9.4.1 Cost & manpower report (for cost reimbursement)	J	
	9.4.2 Inventory report	I	

4 - ECSS M-standards content
M-ST-60 [Supporting material]
Cost and schedule (C&S) management

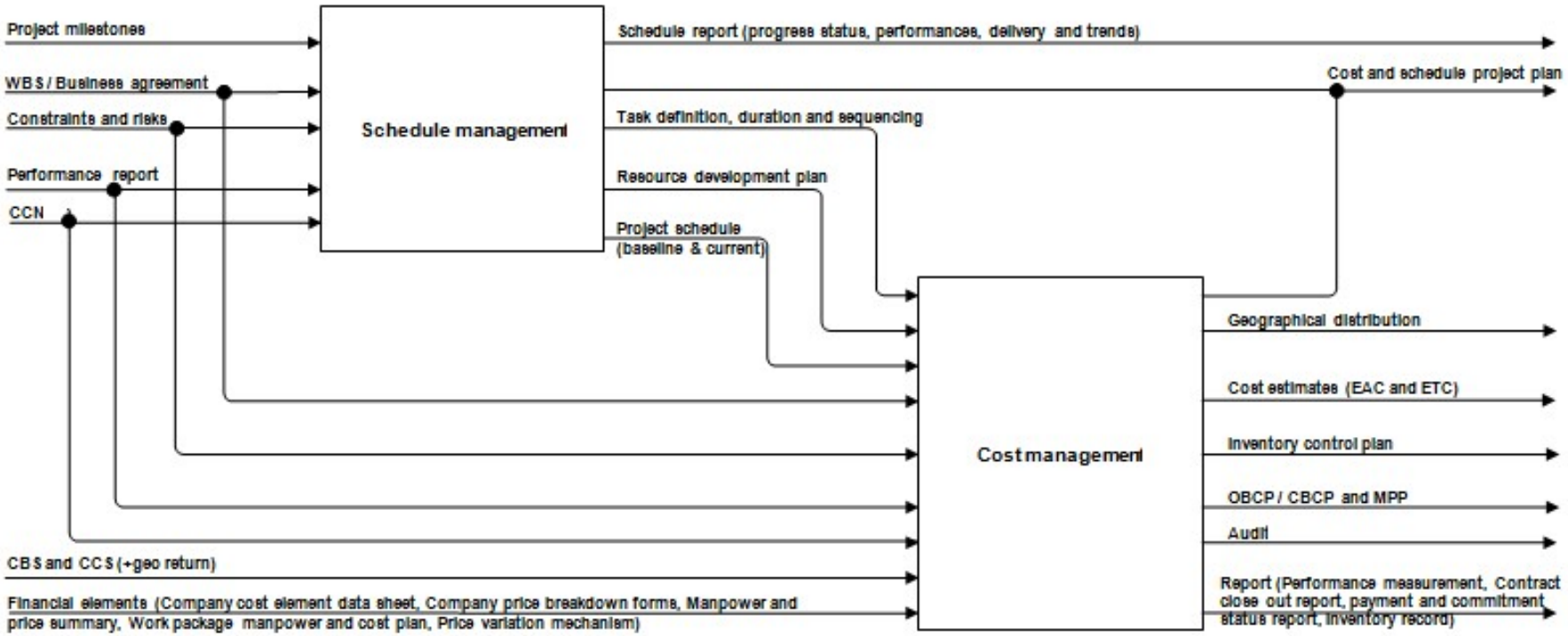


Fig 4-1:
C&S overall functional analysis

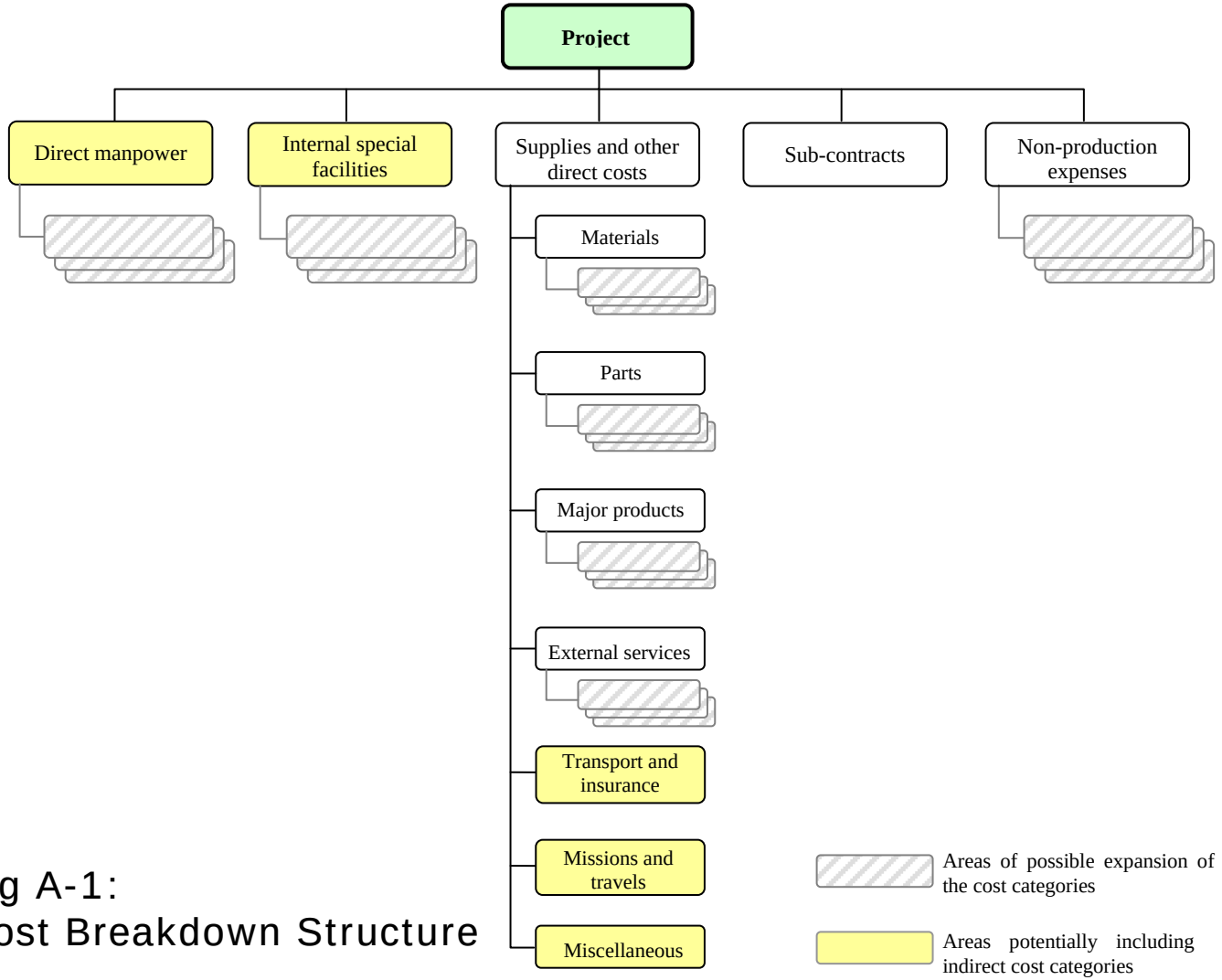


Fig A-1:
Cost Breakdown Structure

4 - ECSS M-standards content
M-ST-60 [Supporting material]
Cost and schedule (C&S) management

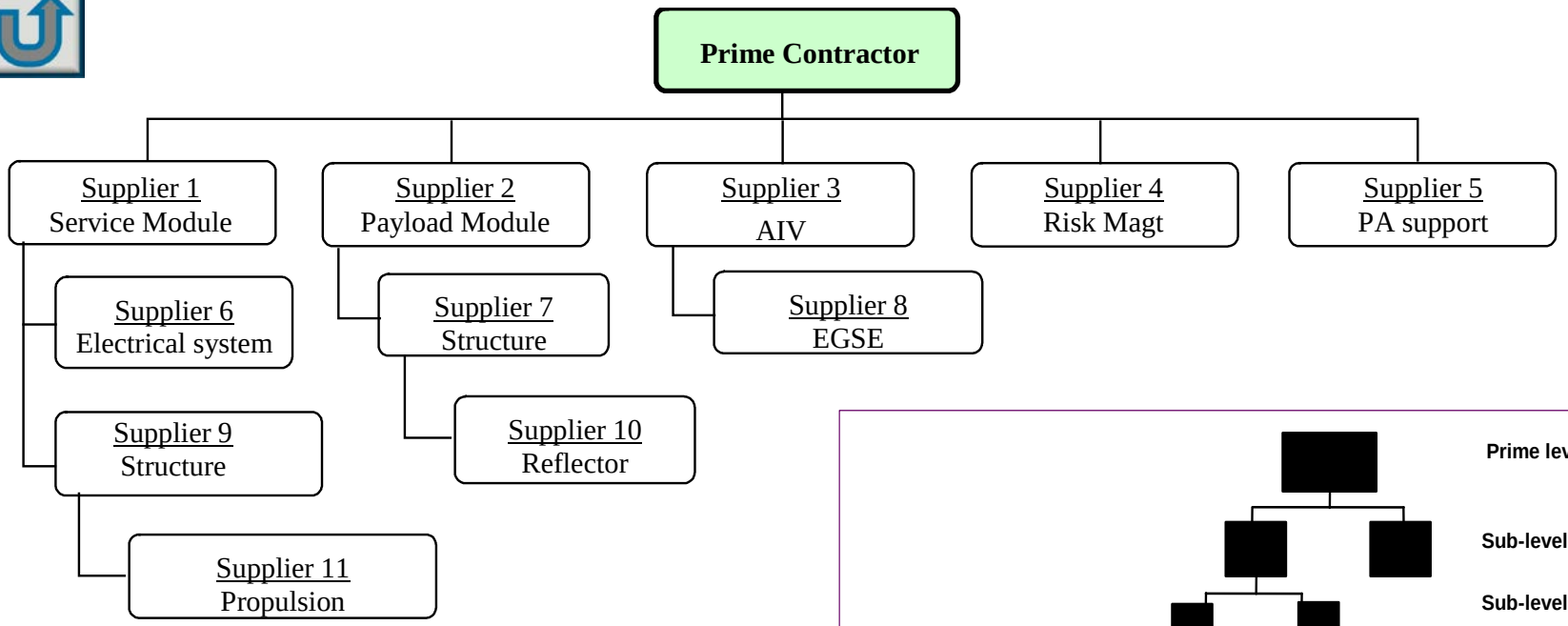


Fig 4-2:
Business agreement structure example

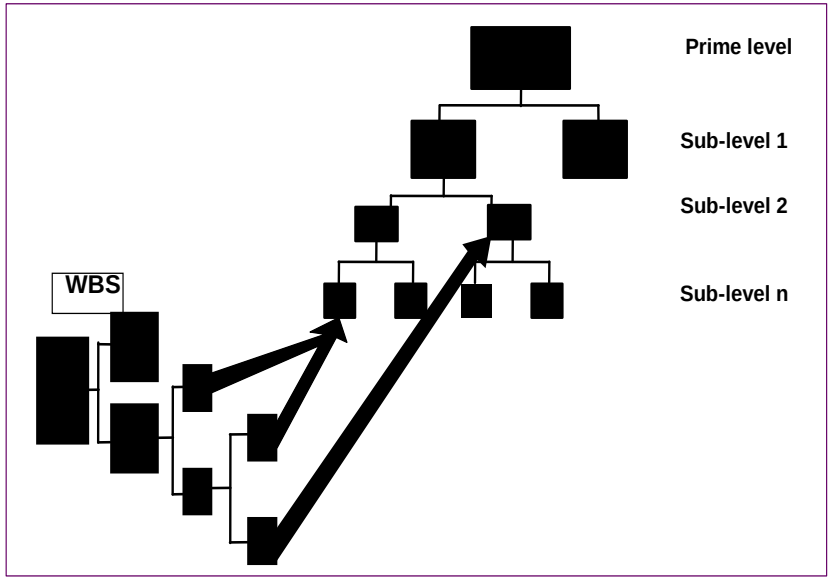


Fig 4-3:
Business agreement structure schematic

ID	Task Name	Duration	Start	Finish	% Complete	Predecessors
1	**Solar Array Project (5 panels per wing)**	**414 days**	**Mon 03-11-03**	**Mon 30-05-05**	**67%**	
2						
3	**ENGINEERING**	**190 days**	**Mon 03-11-03**	**Tue 20-07-04**	**100%**	
4	**MS#01 Kick-Off Meeting Completion**	**2 days**	**Mon 03-11-03**	**Tue 04-11-03**	100%	
5	**DVT activities**	**75 days**	**Wed 05-11-03**	**Mon 16-02-04**	**100%**	**4**
6	Prelimin. DVT lay-out def. + Drawing Substrate	75 days	Wed 05-11-03	Mon 16-02-04	100%	4
7	DVT Interface Drawing Cells & Wiring	5 wks	Tue 13-01-04	Mon 16-02-04	100%	6FS-5 wks
8	Cup/Cone for DVT Sample	3 wks	Wed 24-12-03	Tue 13-01-04	100%	6FS-2 wks
9	**PDR Phase**	**124 days**	**Wed 05-11-03**	**Thu 22-04-04**	**100%**	
10	Prel.Design & Analyses + PDR Datapackage	17 wks	Wed 05-11-03	Mon 01-03-04	100%	4
11	Substrate production drawings	69 days	Tue 20-01-04	Thu 22-04-04	100%	6FS-4 wks
12	**MS#04 Preliminary Design Review (PDR)**	**2 days**	**Thu 18-03-04**	**Fri 19-03-04**	100%	52FS+3 days;10FS+2 wks
13	**CDR Phase**	**89 days**	**Mon 22-03-04**	**Tue 20-07-04**	**100%**	
14	Detailed Design & Analyses + CDR Datapackage	82 days	Mon 22-03-04	Fri 09-07-04	100%	12
15	Review Datapackage CDR	2 wks	Mon 28-06-04	Fri 09-07-04	100%	14FS-10 days
16	**MS#09 Critical Design Review (CDR)**	**2 days**	**Mon 19-07-04**	**Tue 20-07-04**	100%	15FS+5 days;55FS+5 days
17						

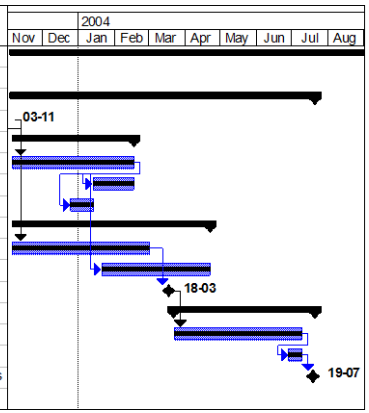


Fig 5-1: Gantt char example (for performance evaluation)

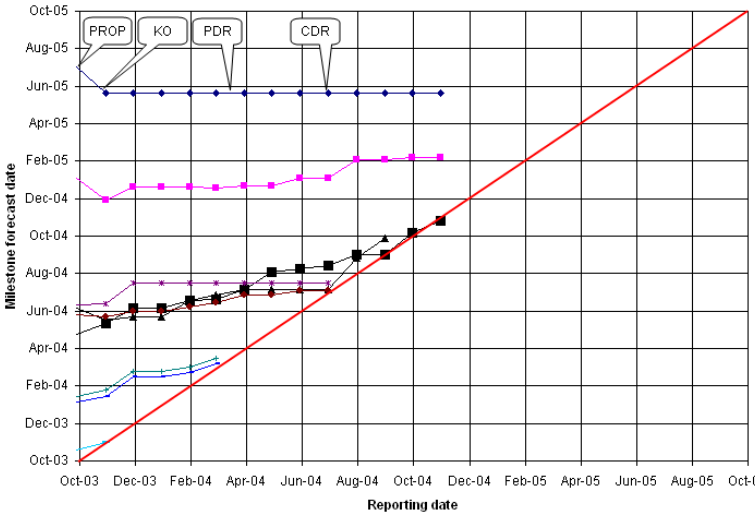


Fig 5-2:
Milestone trend chart example

Milestone	Baseline	Current	
Finish of development	1/ Jun 04	8/ Jun 04	
Design review	1/ Nov 04	10/ Oct 04	
Start manufacturing	1/ Feb 05	25/ Jan 05	
Delivery	1/ Jul 05	20/ Aug 05	

Fig 5-3: Milestone list example

4 - ECSS M-standards content
M-70A
Integrated Logistic Support (ILS)

1. This ECSS **issue A** standard provides the guidelines and requirements to prepare for, and support, the operation and maintenance of a product during its operational life

2. The need for an integrated logistics system is usually associated with human spaceflight projects and projects involving reusable and/or production spacecraft where human intervention can be used to upgrade and maintain the space element(s) of the system.

3. The requirements provided are mainly covering:
    a. Logistics analysis
    b. Spares provisioning
    c. Maintenance planning

Note: *Need is identified to update the standard (some preliminary activities are on-going) => the document is mostly used as a guideline*

4 - ECSS M-standards content
M-ST-80
Risk management

Standardization training program
Space Project Management

Clause & Req	Topic (and what requirements are addressed)	DRD (Annex)	Provided information (Clause 4)
7 – Risk management requirements			
7.2	**Risk management process**		
	7.2.1 Risk policy	A	
	- Resources, goals & constraints		Info in 5.1
	- Strategy, approach and goal ranking		Info in 5.1 and 5.2.1
	- Risk scoring and index scheme, and action criteria		Info in 5.2.1 and 5.2.2
	- Decision		Info in 5.2.3
	- Communication and monitorization		Info in 5.2.4
	7.2.2 Risk management plan (RMP)	B	
	- Organization and responsibilities		Info and guidelines in 6.2 and 6.3
	- Decision, criteria and tools		Info in 6.4
	- Documentation and processes		Info in 6.5
	7.2.3 to 7.2.5 Risk scenarios – To be identified, assessed & analized for acceptability		Risk register example in Annex D
	7.2.6 Risk reduction – i.a.w. the risk policy in Annex A		
	7.2.7 Determination of reduced risk – To understand the impact of mitigation actions		
	7.2.8 Resolved, acceptable & overall risk assessment – i.a.w. RMP (Annex B)		
	7.2.9 Unresolved risk – Disposed as in the RMP (Annex B)		
	7.2.10 Residual risk – Accepted/disposed as in the RMP (Annex B)		
	7.2.11 Risk report	C	
7.3	**Risk management implementation**		
	7.3.1 Risk implementation (at any level customer-supplier) and integration		Summary: Implement your RMP
	7.3.2 Cost effective, at project level		
	9.3.3 Risk management process - to be monitored		
	9.3.5 Lessons Learnt on Risk management - to be performed		

4 - ECSS M-standards content
M-ST-80 [Support material]
Risk management

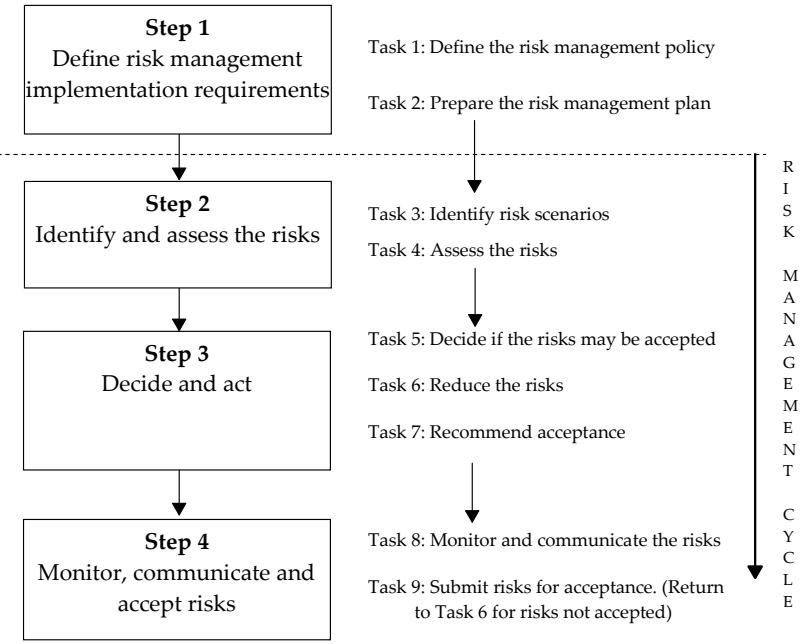


Fig 5-2:
Task associated to the steps

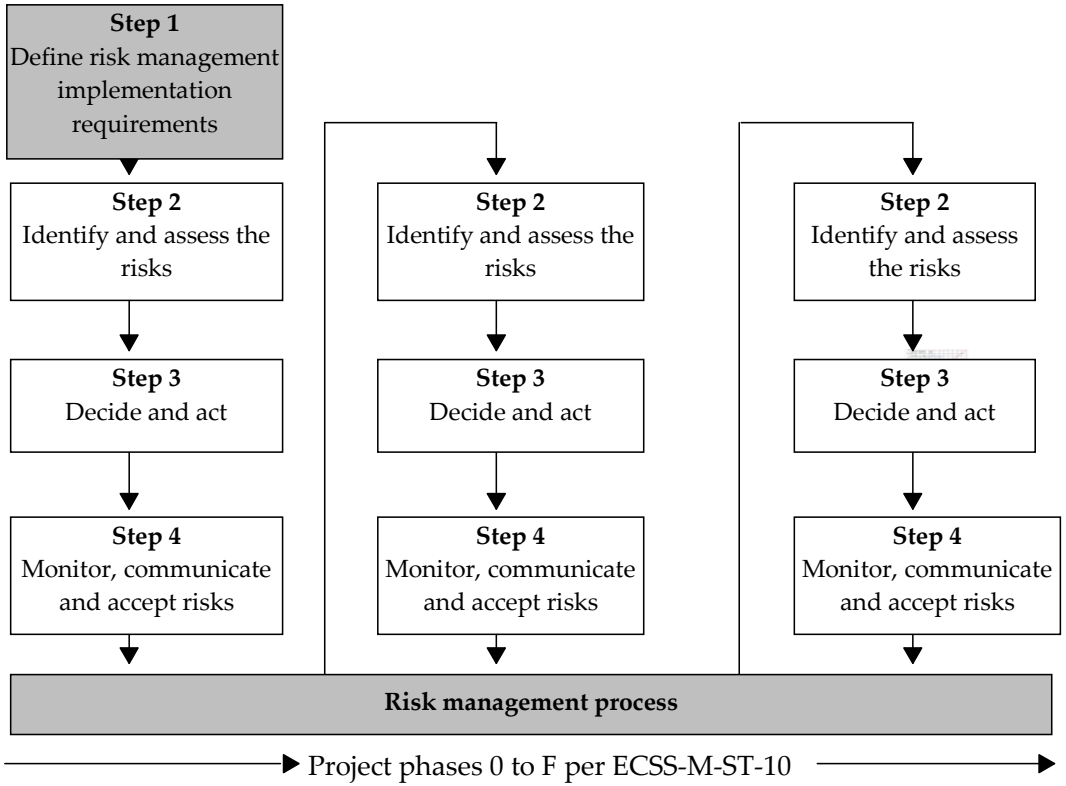


Fig 5-1:
Steps & cycles in the risk management process

4 - ECSS M-standards content
M-ST-80 [Support material]
Risk management

Score	Severity	Severity of consequence: impact on (for example) cost
5	Catastrophic	Leads to termination of the project
4	Critical	Project cost increase > tbd %
3	Major	Project cost increase > tbd %
2	Significant	Project cost increase < tbd %
1	Negligible	Minimal or no impact

Fig 5-3:
Example of a severity-of-consequence scoring scheme

Score	Likelihood	Likelihood of occurrence
E	Maximum	Certain to occur, will occur one or more times per project
D	High	Will occur frequently, about 1 in 10 projects
C	Medium	Will occur sometimes, about 1 in 100 projects
B	Low	Will seldom occur, about 1 in 1000 projects
A	Minimum	Will almost never occur, 1 of 10 000 or more projects

Fig 5-4:
Example of likelihood scoring scheme

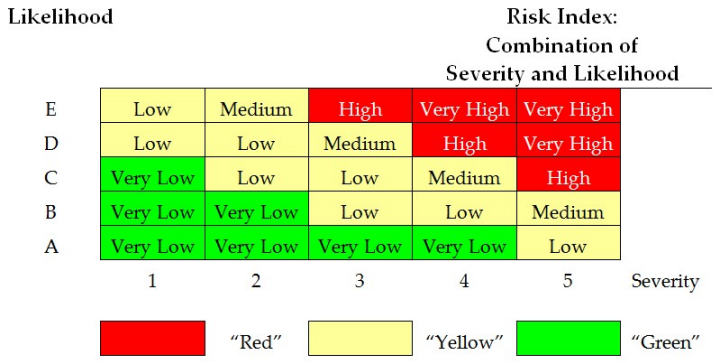


Fig 5-5:
Example of risk index & magnitude scheme

Risk index	Risk magnitude	Proposed actions
E4, E5, D5	Very High risk	Unacceptable risk: implement new team process or change baseline – seek project management attention at appropriate high management level as defined in the risk management plan.
E3, D4, C5	High risk	Unacceptable risk: see above.
E2, D3, C4, B5	Medium risk	Unacceptable risk: aggressively manage, consider alternative team process or baseline – seek attention at appropriate management level as defined in the risk management plan.
E1, D1, D2, C2, C3, B3, B4, A5	Low risk	Acceptable risk: control, monitor – seek responsible work package management attention.
C1, B1, A1, B2, A2, A3, A4	Very Low risk	Acceptable risk: see above.

Fig 5-6: Example of risk magnitude designation & proposed actions for individual risks

4 - ECSS M-standards content
M-ST-80 [Support material]
Risk management

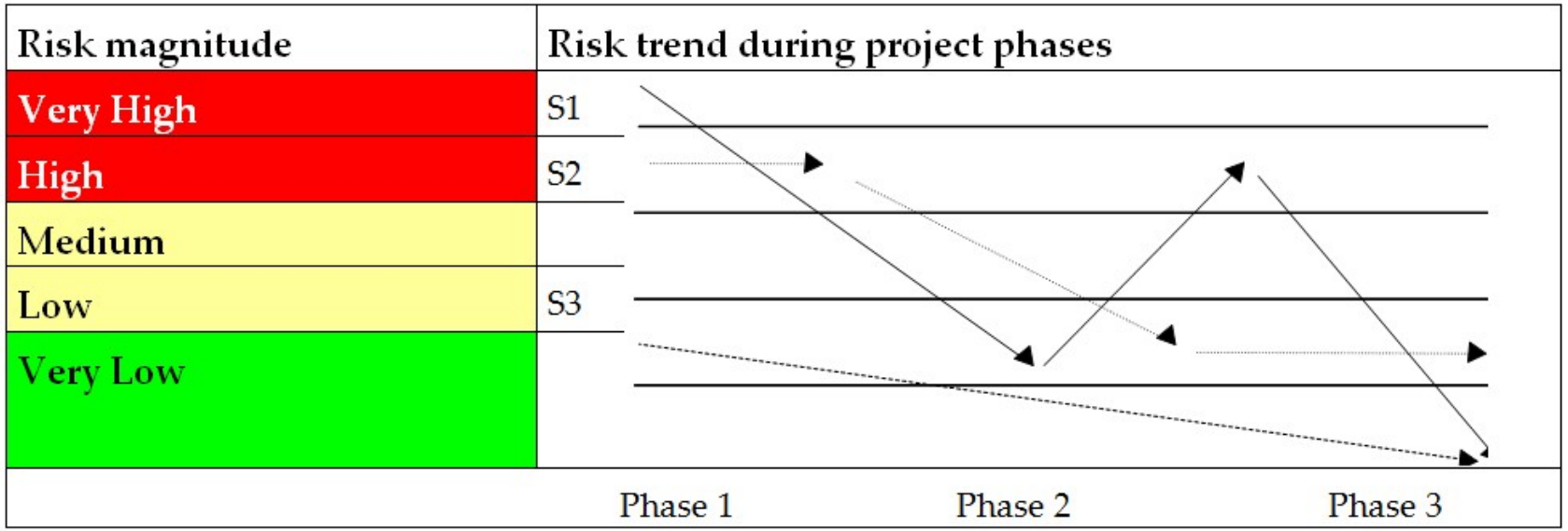


Fig 5-7: Example of a risk trend

4 - ECSS M-standards content
M-ST-80 [Support material]
Risk management

RISK REGISTER (Example)			
Project: WBS Ref.:	Organization:	Source: Controlled by: Supported by:	Date: Issue:

RISK SCENARIO and MAGNITUDE	
No.	Risk scenario title:
Cause and consequence:	

Severity (S)					Likelihood (L)					Risk index	RED	YELLOW	GREEN	Risk domain
Negligible 1	Significant 2	Major 3	Critical 4	Catastrophic 5	Minimum A	Low B	Medium C	High D	Maximum E		(*)	(*)	(*)	(**)

RISK DECISION and ACTION		
Accept risk ❑	Reduce risk ❑	
Risk reduction measures:	Verification means:	Expected risk reduction (severity, likelihood, risk index):
Action:	Status:	
Agreed by project management: Name: Signature: Date:		Risk rank:

Project:	Organization:	Date: Issue:

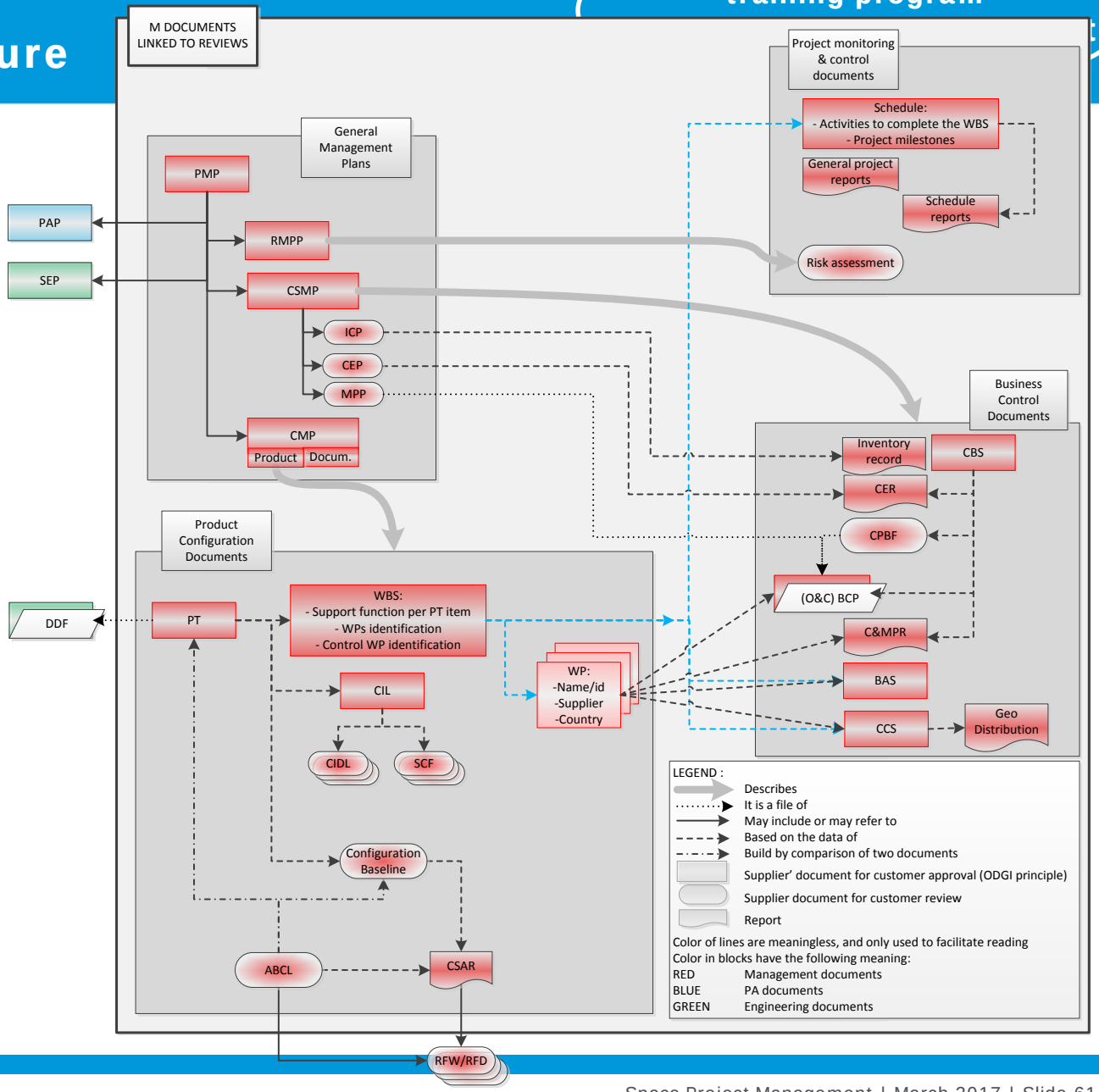
Rank	No.	Risk scenario title	Red	Yellow	Green	Risk domain	Actions and status
			(*)	(*)	(*)	(**)	

Annex D:
Example of
risk register

4 - ECSS M-standards content

DRDs General picture

ABCL – As-built configuration list
BAS – Business agreement structure
BCP – Baseline cost plan
C&MPR – Cost & manpower report
CBS – Cost breakdown structures
CCS – Company/country structure
CEP – Cost estimation plan
CER – Cost estimate report
CIDL – Configuration item data list
CIL – Configuration item list
CMP – Configuration management plan
CPBF – Company price breakdown form
CSAR – Configuration status accounting report
CSMP – Cost & schedule management plan
DDF – Design definition file
ICP – Inventory control plan
MPP – Milestone payment plan
O&C – Original and current
PAP – Product assurance plan
PMP – Project management plan
PT – Product tree
RFD – Request for deviation
RFW – Request for waiver
RMPP - Risk management policy & plan
SCF – SW configuration file
SEP – System engineering plan
WBS – Work breakdown structures
WP – Work package



4 - ECSS M-standards content

DRDs General picture

a. The General management plans, including:

1. The PMP "Project Management Plan", which is the highest M deliverable, and includes:

a) General management issues:

1) Objectives and constrains of the project
2) Project organization, including project manager, key personnel, specialists, authority and hierarchy, roles and responsibilities, interface with suppliers and other projects.
3) Project breakdown structures, describing the approach to define the project WBS, and pointing the document describing the WBS themselves.
4) A description of the ILS approach

b) Interfaces with other management areas, including the following documents or pointers them: the Configuration management Plan (CMP, see 2 below), the Cost and schedule management plan (CSMP, see 3 below), ILS approach (see 4 below), the Risk management and plan (RMPP, see 5 below).

c) Interfaces with other project areas, including the following documents or pointers to them: the Product Assurance Plan (PAP) and the System Engineering Plan (SEP).

2. The CMP, or Configuration management plan, describing how all the configuration management activities, both for the product and for the documentation and information, will be performed.

3. The CSMP, or Cost & Schedule management Plan, describing the approach used to ensure cost and schedule management. It may include or point to the following documents:

a) The CEP or Cost estimating plan, explaining the organization and processes for cost estimation
b) The MPP or Milestone payment plan, defining the plan for payment events.

4. The ILS approach, defining the approach use for ILS.

5. The RMPP or Risk management Policy and Plan composed of two documents which can be released together or independently:

a) The Risk management policy, defining the resources, goals, strategy, margins, ranking/scoring/index schemes, action/acceptance criteria and communication approach.
b) The Risk management plan, describing the processes and metrics to apply the risk management policy.

4 - ECSS M-standards content

DRDs General picture

b. The Product Configuration documents, including:

1. **The Product Tree** (PT), is a description of the hierarchical partitioning of a deliverable product down to an agreed level. Important remarks are:
   a) Each item in the tree is identified by its name, an identification code, the supplier and the applicable spec.
   b) Items may include HW or SW.
   c) All the items of the PT selected to be under configuration control are so identified (see 4 below)
   d) All items which are recurrent products are so identified.
2. **The WBS**, that:
   a) For each of the items in the PT, includes a sub-tree with the support functions defined by the customer, and the necessary services and tasks to produce the deliverables. For example, defining for each item in the PT the management, the PA and engineering tasks.
   b) Identifies the Work packages (WP) by referring the items in the WBS in each WP, ensuring that that the WPs cover the total work scope. Detailed description of each WP is not done here (see 3 below).
3. The description of each **Work Packages** identified in the WBS (see 2.b above), including among others the name of the package, manager in charge, supplier and supplier country, description of the included (and excluded) tasks, deliverables, location and start and end dates.
4. The **Configuration item list** (CIL), listing the items (HW or SW) of the PT which have been identified to be under configuration control [see b.1.(b) above]., with name, code, quantity, supplier and applicable specification.
5. Each item in the CIL is described in a **Configuration Item Data List** (CIDL), listing all the relevant data of the item under configuration control.
6. Each item SW in the CIL is described in the **SW configuration file** (SCF)
7. **The configuration baseline** (CB), is a set of documents, to be agreed between customer and supplier, reflecting the actual configuration of the product. The initial CB refers to the “as-design” product, but it will need to be updated to refer to the “as-built” product when the latter differs from the former.
8. The **As-built configuration list** (ABCL), reflecting the actual status of the product “as-built”, listing the differences with the “as design”, and justifying these differences by making reference to the corresponding RFW/RFD.
9. The **Configuration status accounting report** (CSAR), collecting and summarizing the necessary information to support a meaningful configuration management.

4 - ECSS M-standards content

DRDs General picture

c. The **Business control documents**, including:

1. The **Cost breakdown structure** (CBS), that is the breakdown of all the cost concepts of the project to categories to be used for cost management, with clear differentiation between direct and indirect costs. Figure in Slide 51 shows an example.

2. **The CPBF** (Company price breakdown forms), which shows the manpower and cost data broken down according to the categories defined in the CBS.

3. **The BAS** (Business Agreement Structure) [called Contract Structure in ESA/REG/001 Annex IV], is a breakdown structure of the of suppliers indicating their reporting lines and the WPs assigned to each supplier. An example is in Slide 52 (top). It has to be completely mapped to the WBS as shown in Slide 52 (bottom), and fully consistent with the defined Work packages (since the WP also contain information on suppliers).

4. **The CCS** (Country/Company structure), which shows the relationship between suppliers in the BAS and the country where the work is performed. If this relationship is simple, the CCS is normally combined with the BAS in a single document.

5. The **Cost estimate report**, which reports, for each of the cost items identified in the CBS, the estimation method, quality of the estimate, hypothesis, sensitivity analysis (influence to the total cost), cost risk analysis, and recommendations.

6. The actual **Cost and Manpower report** is only necessary for cost reimbursement contracts. It gives a detailed status on the expenses incurred by the supplier.

7. The **Baseline Cost Plans** (BCP) document the contractually agreed cost and manpower.

4 - ECSS M-standards content

DRDs General picture

d. The **Project Monitoring, schedule and control** documents, including:

1. The **Project Schedule**, which consist on a timed network of activities (showing their interdependencies) against defined milestones, preferably in a Gant-Chart, and identifying the critical path:
   a) The network of activities are derived from the **WBS**.
   b) The milestones depend on the project, but typically include the start and end of each phase and the project reviews (see **PMP**), production/test/delivery reviews (see **PMP**), payment milestones (see **payment plan**), and CFE delivery dates.

2. The progress reports (not relevant for the contract), including:
   a) General Project **Progress reports**,
   b) The **Schedule Progress report**, including the work actually performed against the original Project Schedule, trend analysis for the milestones, justification of deviations, remedy actions and status of deliverable items.

3. **Risk assessment report**, explaining how the **risk policy and plan** has been applied and followed for the identification and mitigation of risks, and listing all the registered risks, with their rank, rating and trend.

5 - M-standards application & tailoring

General tailoring basic principles

- All disciplines and associated requirements addressed by the management standards are basically applicable to all suppliers within the customer/supplier chain of a project.

- Appropriate tailoring of the standards by the top level customer to match project needs is essential so that a coherent management approach is achieved at all project levels.

- However, for M standard, due to their generality, is very likely that tailoring will be minimum.

5 - M-standards application & tailoring

Tailoring practices in ESA

- M requirements are generic enough to justify a “generic pre-tailoring for all ESA projects”, covered in a document called the “ESA MaRD (Management Requirement Document) template”

- The ESA MaRD template needs to be finally tailored for the specificities of a particular project. The result of this exercise will be the “Project MARD”. It is expected that this final tailoring will be minimum.

- Documents to be delivered are specified in a separate Document Requirement List (DRL), including the DRDs and project specific documents.

5 - M-standards application & tailoring

Feedback

- The major input for maintaining & improving ECSS standards is the feedback from projects that have used tailoring these standards to comply with their project needs
- Feedback from some ESA projects has been provided within ESA, and to the ECSS secretariat as an input for possible updates to the ECSS standards, or for use to build pre-tailored standards for future use by the Agency
- Feedback received so far from ESA, from the tailoring of ECSS management standards, has been provided by several projects: Sentinel, MTG, SOL, Euclide, Proba and Metop SG (in the form of MARDs and DRDs)
  - Some apply the tailoring process described before 
  - Some documents are self contained (rewrite of most of the requirements) 

5 - M-standards application & tailoring

Feedback

- This and future feedback will be used as an input for the periodic update of the MARD.

- The template approach at organization level is a useful tool, when consolidated, for tailoring ECSS standards.

Thanks for your attention