

Overview of ECSS and Customer Supply Chain

Prof. Craig Underwood

**Emeritus Professor of Spacecraft Engineering
Surrey Space Centre, University of Surrey**

**With additional material from the late Dr. Angelo Grubisic
of the University of Southampton**



Bibliography

Key Text:

Fortescue, P., Stark, J. and Swinerd, G. (Eds) ***Spacecraft Systems Engineering*** (4th Ed). John Wiley & Sons, Chichester, 2011.

Other Recommended Reading:

Ley, W., Wittmann, K. and Hallmann, W. ***Handbook of Space Technology***, John Wiley & Sons, Chichester, UK, 2009.

Larson, W.J. and Wertz, J.R. (Eds) ***Space Mission Analysis and Design*** (3rd Ed), Space Technology Series, Kluwer Academic Publishers, 1999.

<https://ecss.nl/standards/> (Accessed 23-11-2020)

Learning Outcomes

1. Outline the purpose and structure of ECSS (European Cooperation for Space Standardisation).
2. Describe the provisions which ECSS sets out to allow the effective development and control of space systems.
3. Explain how a customer supply chain operates in terms of structure and responsibilities.
4. Describe the relative effort of requirements definition, design and manufacturing activities through a project lifecycle and therefore explain the importance of defining precise requirements engineering at the start of a project.
5. Relate a typical customer supply to the hierarchy of integrated architectures.

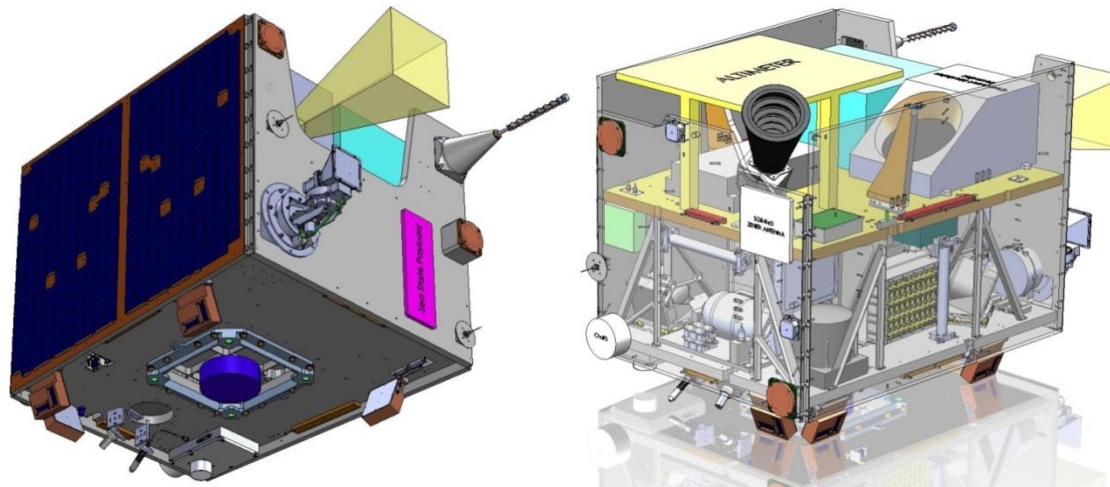
Spacecraft Systems Engineering

Spacecraft Systems Engineering involves techniques from a variety of scientific and engineering disciplines resulting in “**systems thinking**”.

“A **system** is a set of interrelated subsystems and components which interact with one another toward a common purpose”

“**Systems Engineering** is an interdisciplinary approach and is the means to enable the production of robust systems, on-time and on-budget.”

“The **European Cooperation for Space Standardisation (ECSS)** sets out the formal processes and standards by which this is achieved in a European space context.”



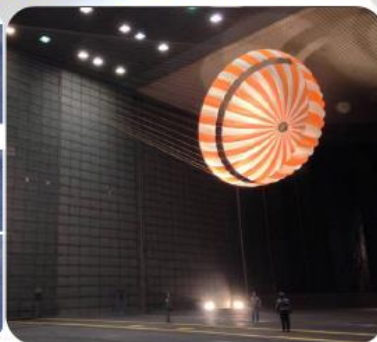
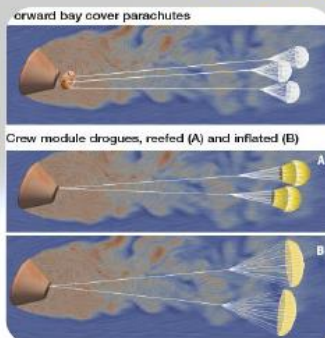
TechDemoSat-1
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Review of Systems Engineering

Systems Engineering Approach

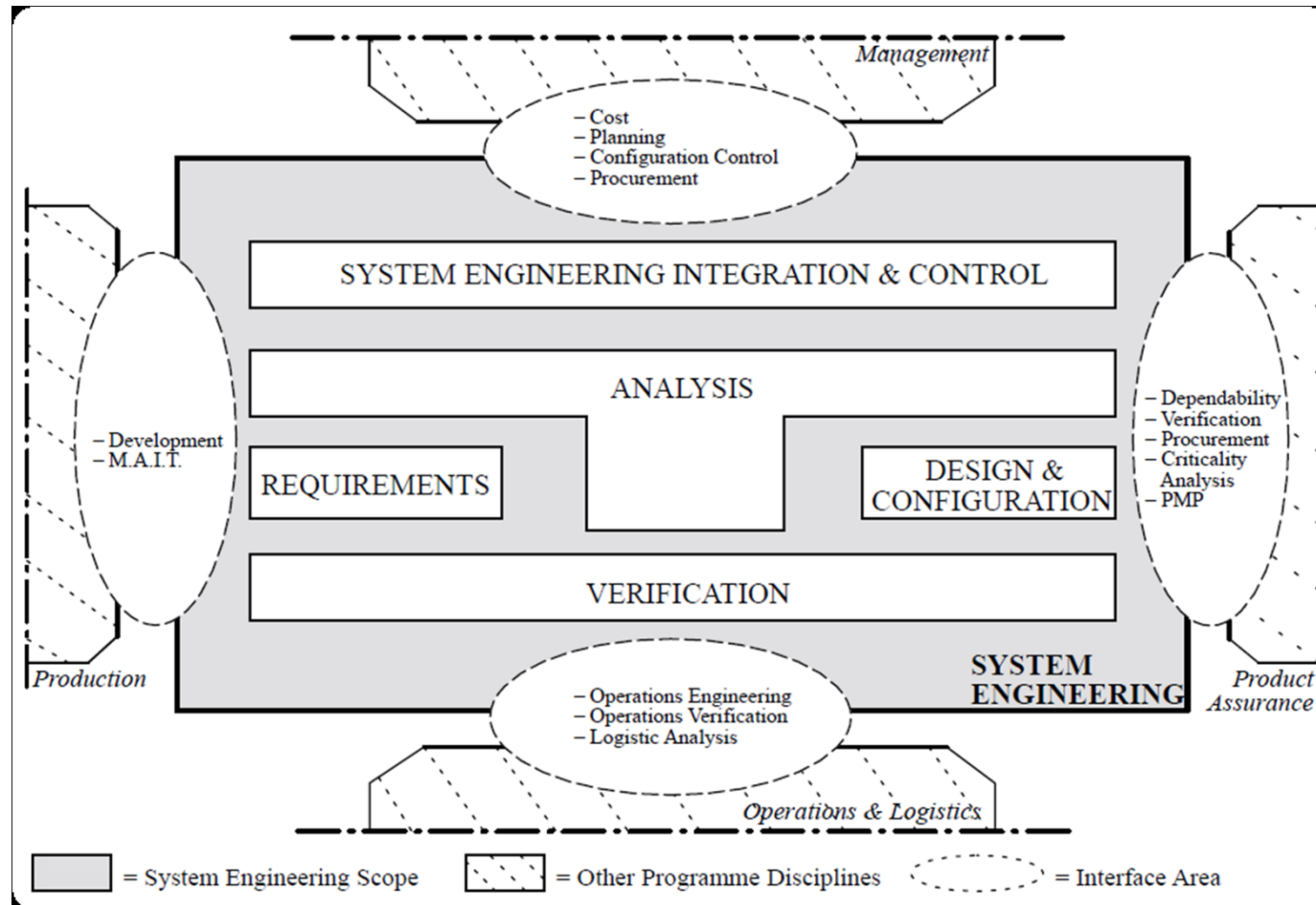
In simple terms, the systems engineering approach consists of:

- Identification and quantification of system goals
- Creation of alternative system design concepts
- Performance of design trades
- Selection and implementation of the best design
- Verification that the design is properly built and integrated
- Post implementation assessment of how well the system met the goals



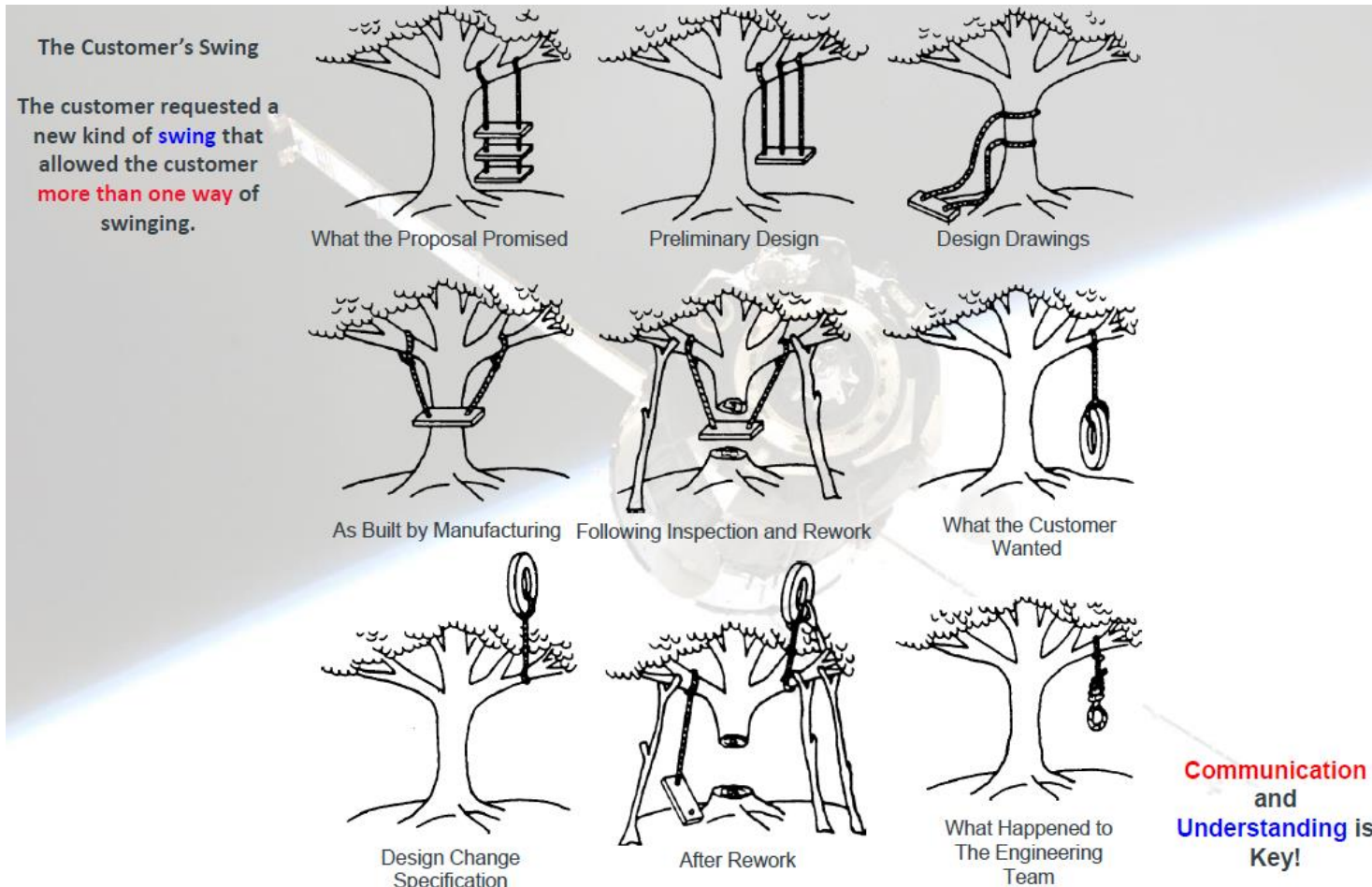
Review of Systems Engineering

Systems Engineering Functions



Review of Systems Engineering

Systems Engineering Failure



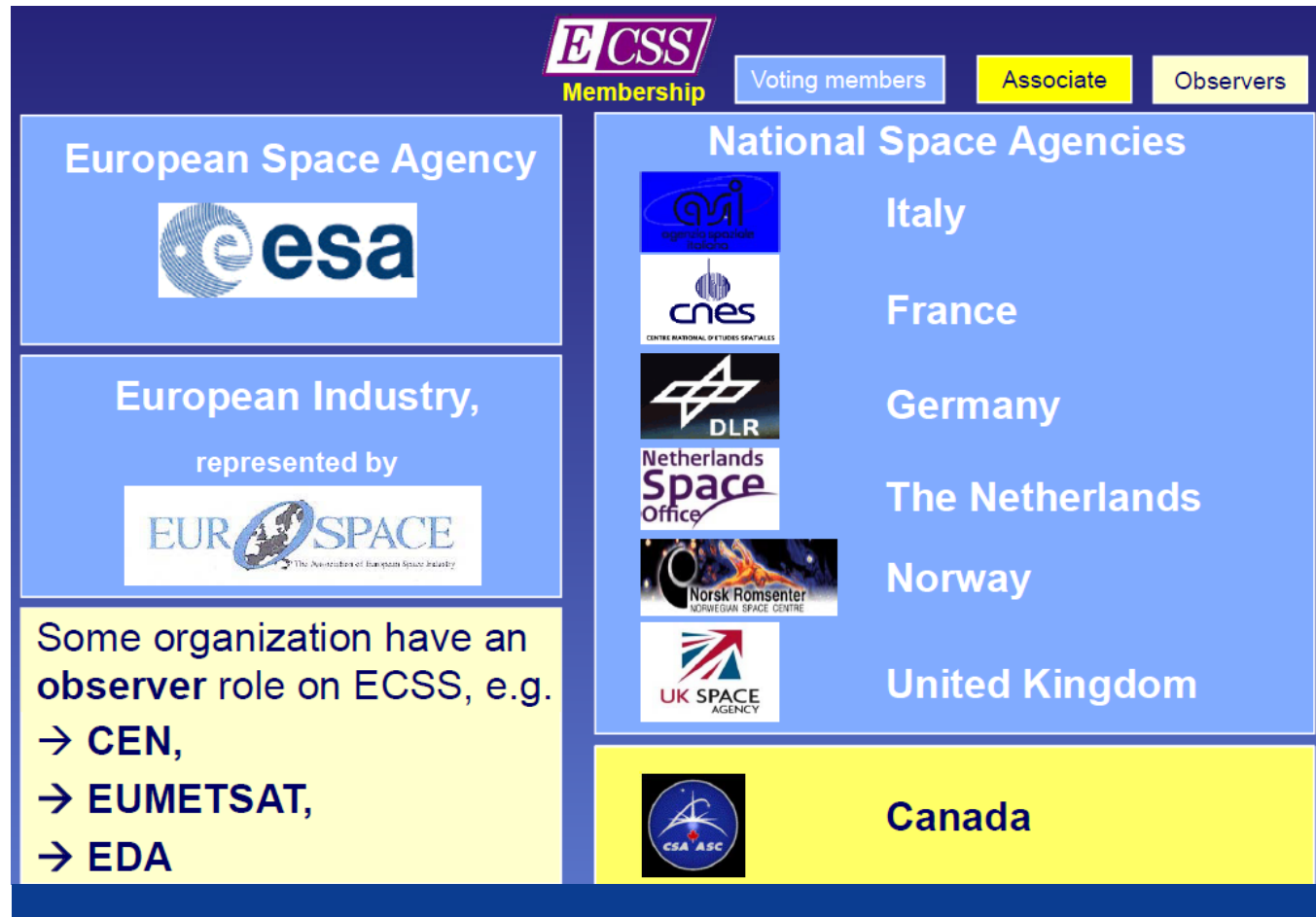
Space Standards

The Need for Space Standards

- **Competitiveness**
Standards have an important economic and social role for enabling our industry to remain competitive on the market and to conquer new markets.
- **Efficiency**
Standards contribute to making the development, manufacturing and supply of products and services more efficient, reliable, safer and cleaner.
- **Trading facilitation**
Standards allow trading between organizations to progress easier and fairer.
- **Knowledge transfer**
Standards aid in transferring knowledge and enhancing engineering capabilities to smaller or developing organizations.
- **Education**
Finally, Standards participate to the education of today's and future engineers when conforming to standards is secured, thus, for instance, avoiding designers "reinventing the wheel".

Overview of ECSS

European Cooperation for Space Standardization - ECSS



Overview of ECSS

ECSS Types of Documents

	ecss types of documents
standards	for direct use in invitation to tender and business agreements
handbooks	non-normative documents providing guidelines and/or collection of data
technical memoranda	non-normative documents providing useful info or data not yet mature for a standard or handbook

Must be compliant with

more WIP help documents

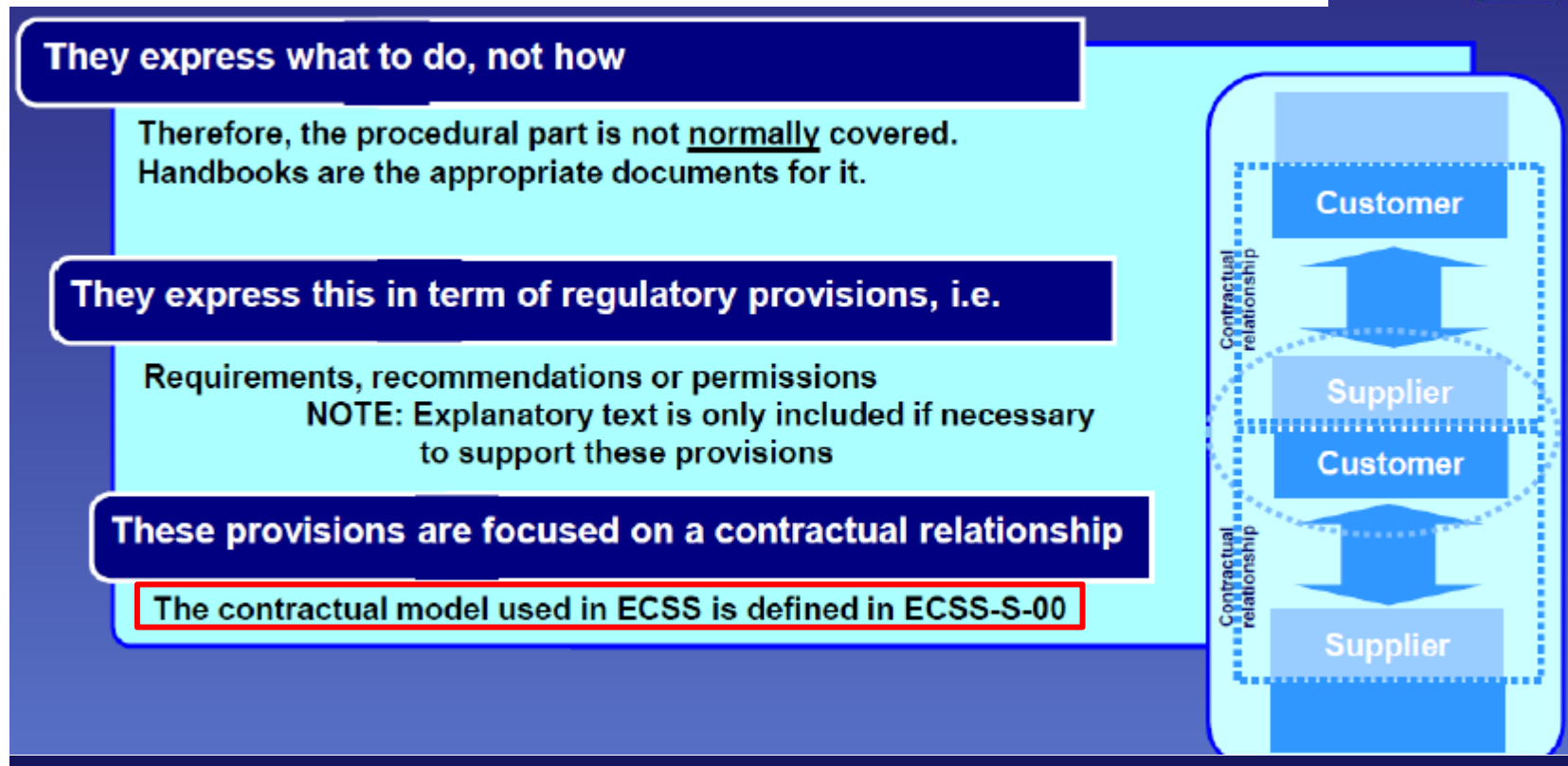
for useful reference on implementation

WIP version of

Overview of ECSS

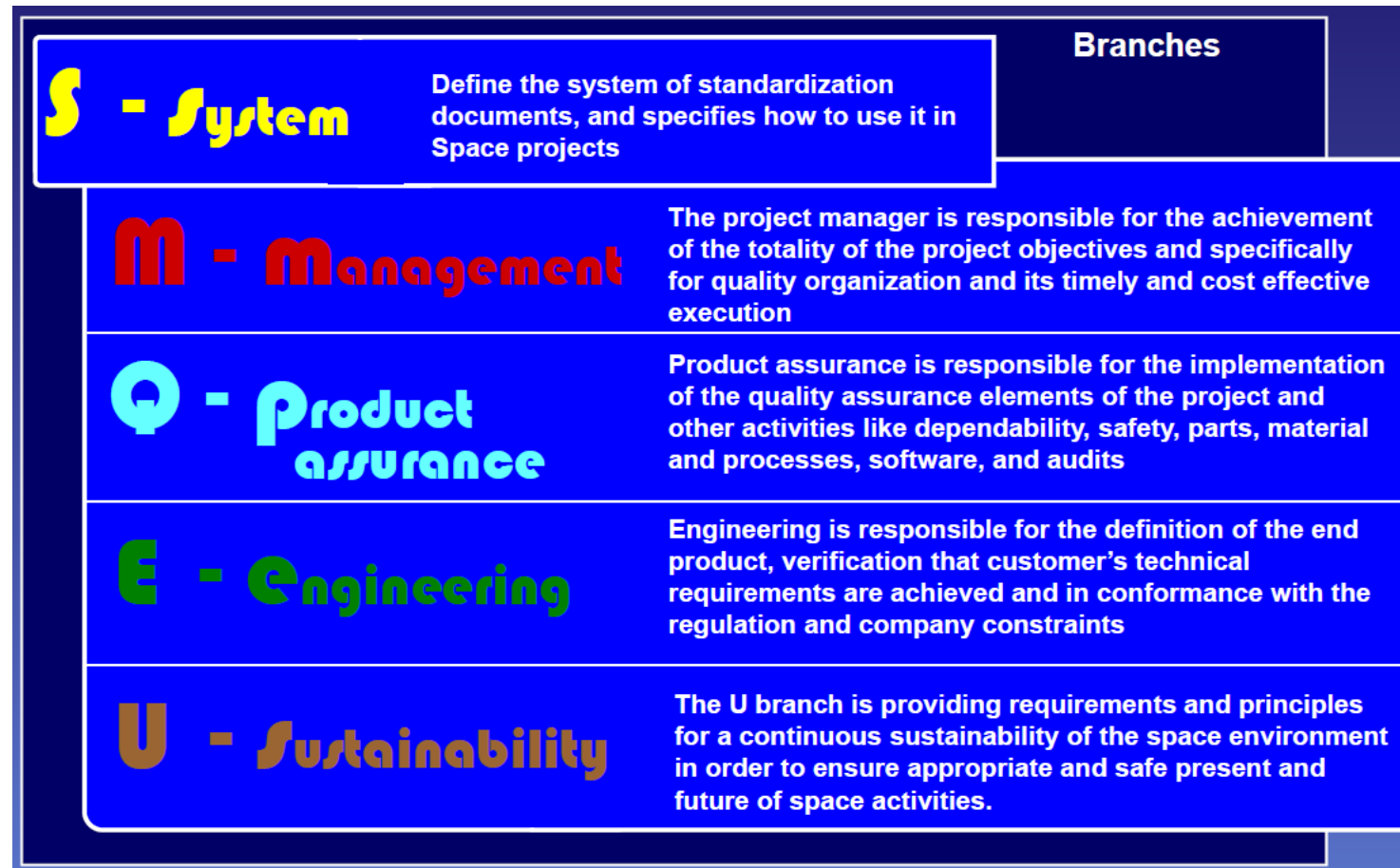
ECSS Standards – <https://ecss.nl/standards/>

Space Project Management (red); Space Product Assurance (blue); Space Engineering (green).



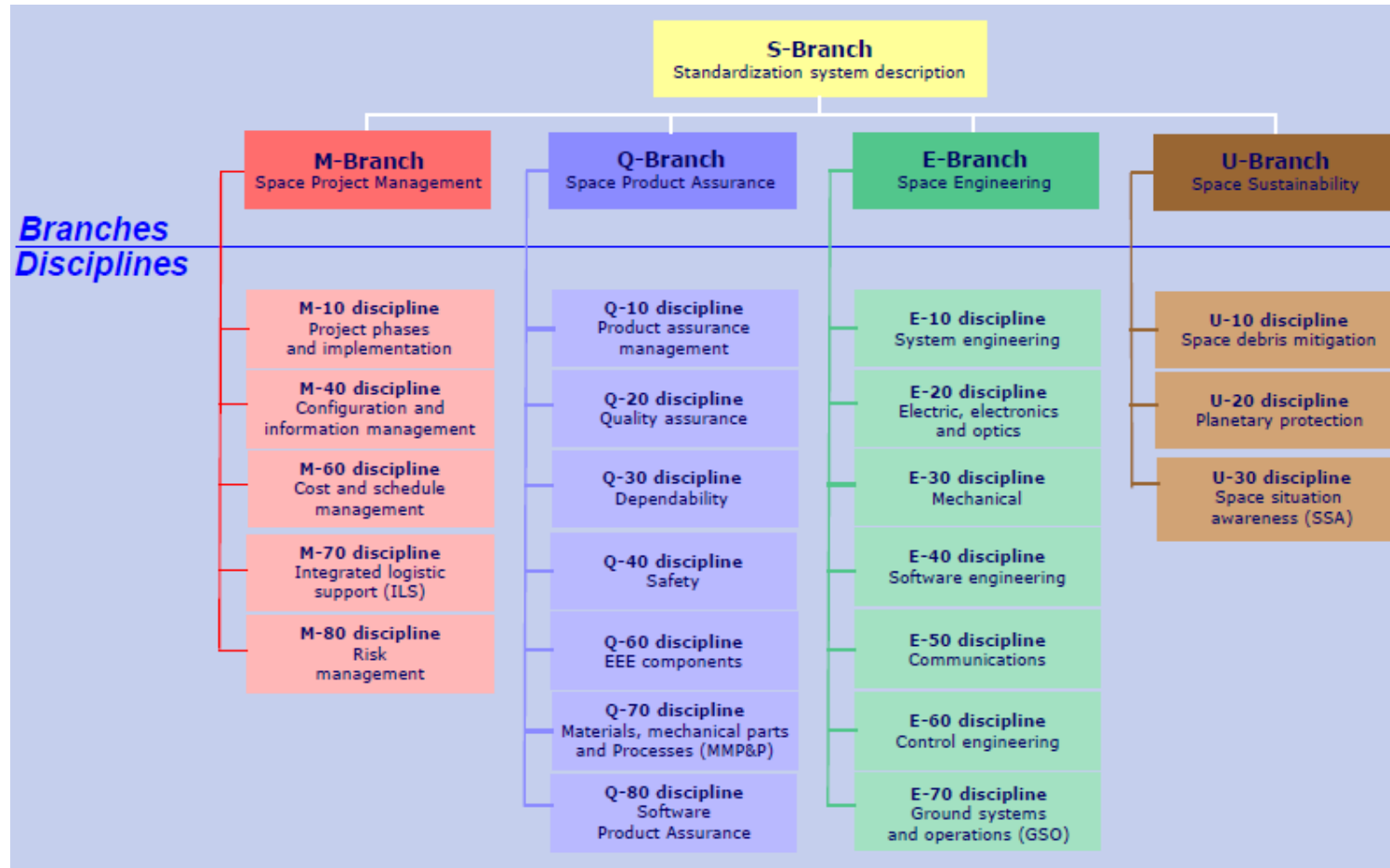
Overview of ECSS

ECSS Documentation Structure



Overview of ECSS

ECSS Documentation Structure



Overview of ECSS

- Naming structure

ECSS Documentation Structure

- ❑ ECSS documents are named as

$$\text{ECSS} - \left\{ \begin{matrix} \text{S} \\ \text{M} \\ \text{Q} \\ \text{E} \\ \text{U} \end{matrix} \right\} - \left\{ \begin{matrix} \text{ST} \\ \text{AS} \\ \text{HB} \\ \text{AH} \\ \text{TM} \end{matrix} \right\} - \langle \text{number} \rangle \langle \text{version} \rangle$$

- ❑ <S, M, Q, E or U> represents the branch

- ✧ S for ECSS system, the top level document that gives a general introduction into ECSS and the use of ECSS documents
- ✧ M for Management, Q for Product assurance, E for engineering, and U for Sustainability

- ❑ <ST, AS, HB, AH or TM> is the type of document

- ✧ ST for standard, AS for adopted as standard, HB for handbook, AH for adopted as handbook, and TM for technical memo

- ❑ <Number> is one or two groups of two digits each

- ✧ one group of two digits to identify those documents with more generic requirements
- ✧ two groups of two digits to identify those with more specific requirements
- ✧ the difference is not to indicate higher relevance of some standards with respect to others.

- ❑ <version> is a letter from A onwards, representing the issue. It may include also a Rev index, from 1 onwards.

Example:

S-ST-00C

ECSS system
(standard)

E-ST-50C

Communications
(standard)



E-ST-50-05C

Radio frequency
and modulation
(standard)

E-HB-50A

Communications
(handbook)

Overview of ECSS

The ECSS Website: www.ecss.nl

The screenshot shows the ECSS website interface. The navigation menu on the left includes links for HOME, ORGANIZATION, STANDARDS, Publications and TMs, ECSS Terms and definitions, ECSS Related Issues, and ENR. The main content area is titled "Active Product Assurance standards" and lists 10 standards that can be downloaded in PDF or MS Word format. The standards are:

1. ECSS-Q-ST-10-04C – Critical item control (31 July 2008)
2. ECSS-Q-ST-10-09C – Nonconformance control system (31 July 2008)
3. ECSS-Q-ST-10C Rev.1 – Product assurance management (15 March 2016)
4. ECSS-Q-ST-20-07C – Quality and safety assurance for space test centres (1 October 2014)
5. ECSS-Q-ST-20-08C – Storage, handling and transportation of spacecraft hardware (1 October 2014)
6. ECSS-Q-ST-20-10C – Off-the-shelf items utilization in space systems (8 October 2010)
7. ECSS-Q-ST-20C Rev.1 – Quality assurance (1 March 2013)
8. ECSS-Q-ST-30-02C – Failure modes, effects (and criticality) analysis (FMEA/FMECA) – (6 March 2009)
9. ECSS-Q-ST-30-09C – Availability analysis (31 July 2008)
10. ECSS-Q-ST-30-11C Rev.1 – Derating – EEE components (4 October 2011)

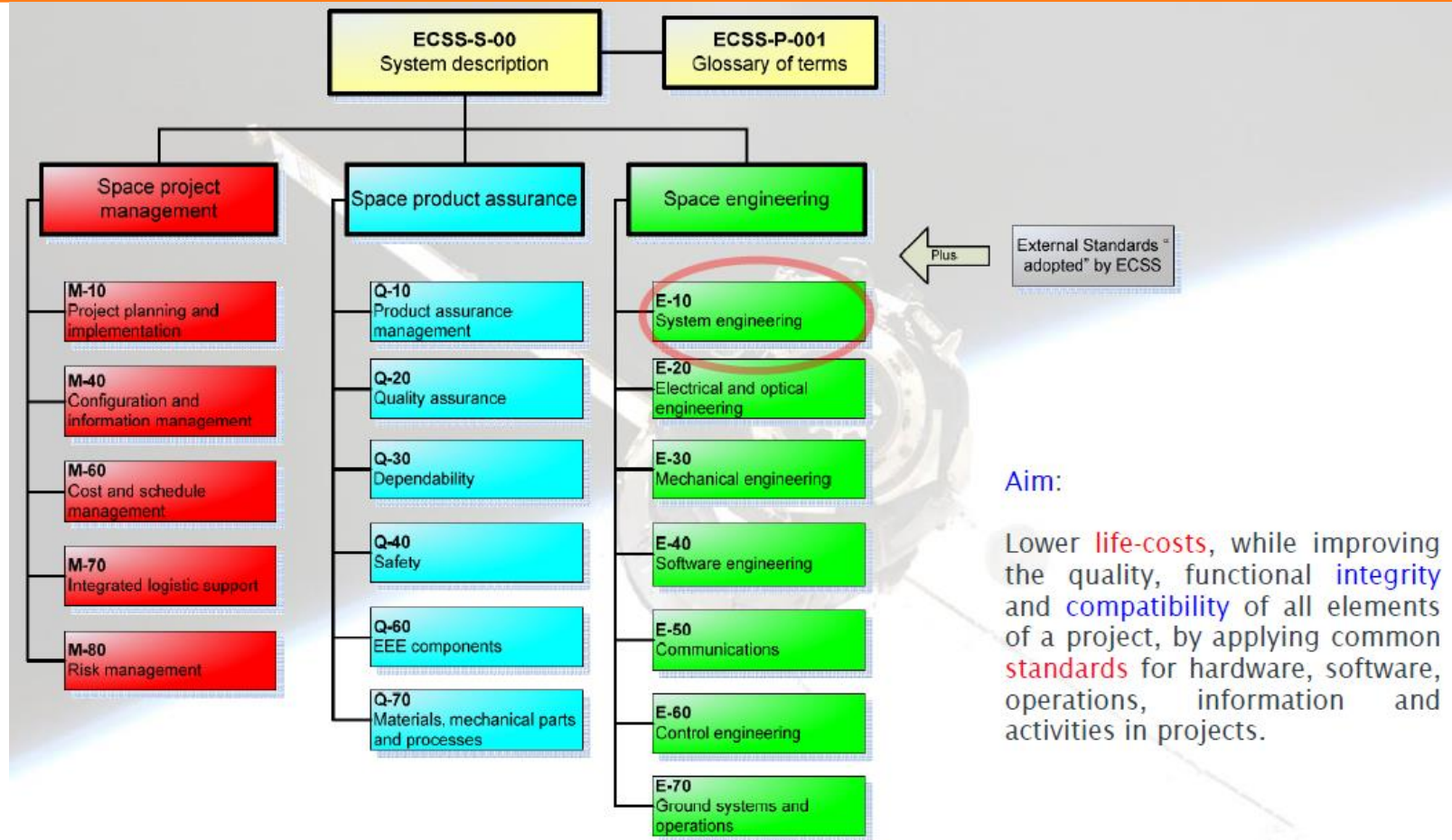
Below the list, there is a section for "Latest published ECSS documents" and "Ongoing reviews". The "Latest published ECSS documents" section lists 10 documents, including ECSS-E-H-21-03A – Thermal analysis handbook (19 November 2016), ECSS-Q-ST-20-14C – Corrosion (1 November 2016), ECSS-Q-HR-60-00A – Techniques for radiation effects mitigation in ASICs and FPGA handbook (1 September 2016), ECSS-E-ST-20-41C – Telemetry and telecommand packet utilization (15 April 2016), ECSS-E-HR-20-20A – Guidelines for electrical design and interface requirements for power supply (15 April 2016), ECSS-E-ST-20-20C – Electrical design and interface requirements for power supply (15 April 2016), and ECSS-Q-ST-10C Rev.1 – Product assurance management (15 March 2016).

The "Ongoing reviews" section lists 1 document: ECSS-Q-ST-20C Rev.2 DRI: Start of Public Review (Extended until: 9 January 2017).

The "Previous reviews" section lists 4 documents: ECSS-E-ST-21-02C Rev.1 DRI: Start of Public Review (Due: 22 July 2016), ECSS-E-ST-21-01C Rev.1 DRI: Start of Public Review (Due: 30 June 2016), ECSS-E-HR-11A DRI: Start of Public Review (Due: 27 April 2016), and ECSS-E-ST-10C Rev.1 DRI: Extension of Public Review (New due date: 24 June 2016).

At the bottom of the page, there is a copyright notice: "© 2016 by the European Space Agency for the members of ECSS".

ECSS and Systems Engineering



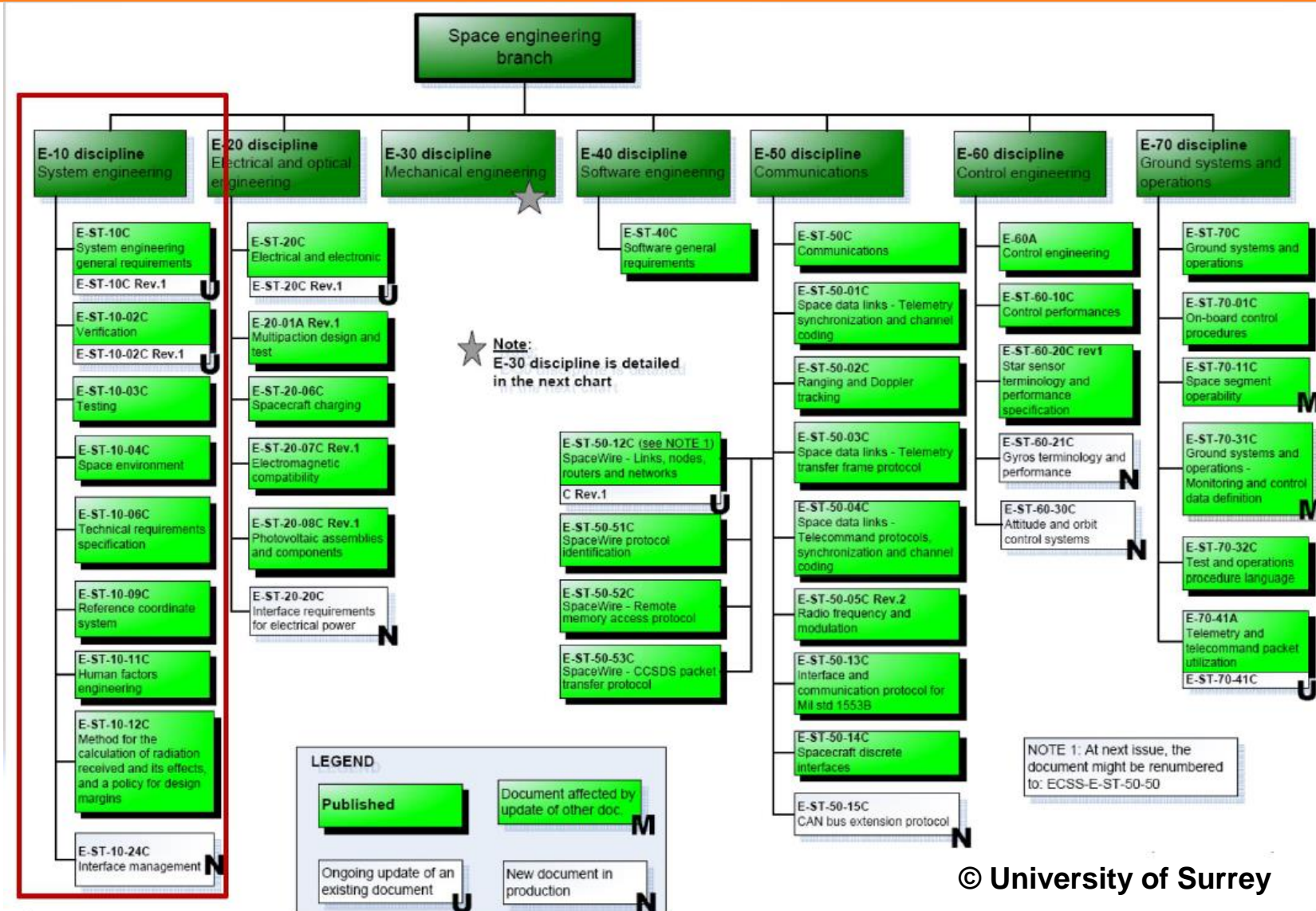
Aim:

Lower **life-costs**, while improving the quality, functional **integrity** and **compatibility** of all elements of a project, by applying common **standards** for hardware, software, operations, information and activities in projects.

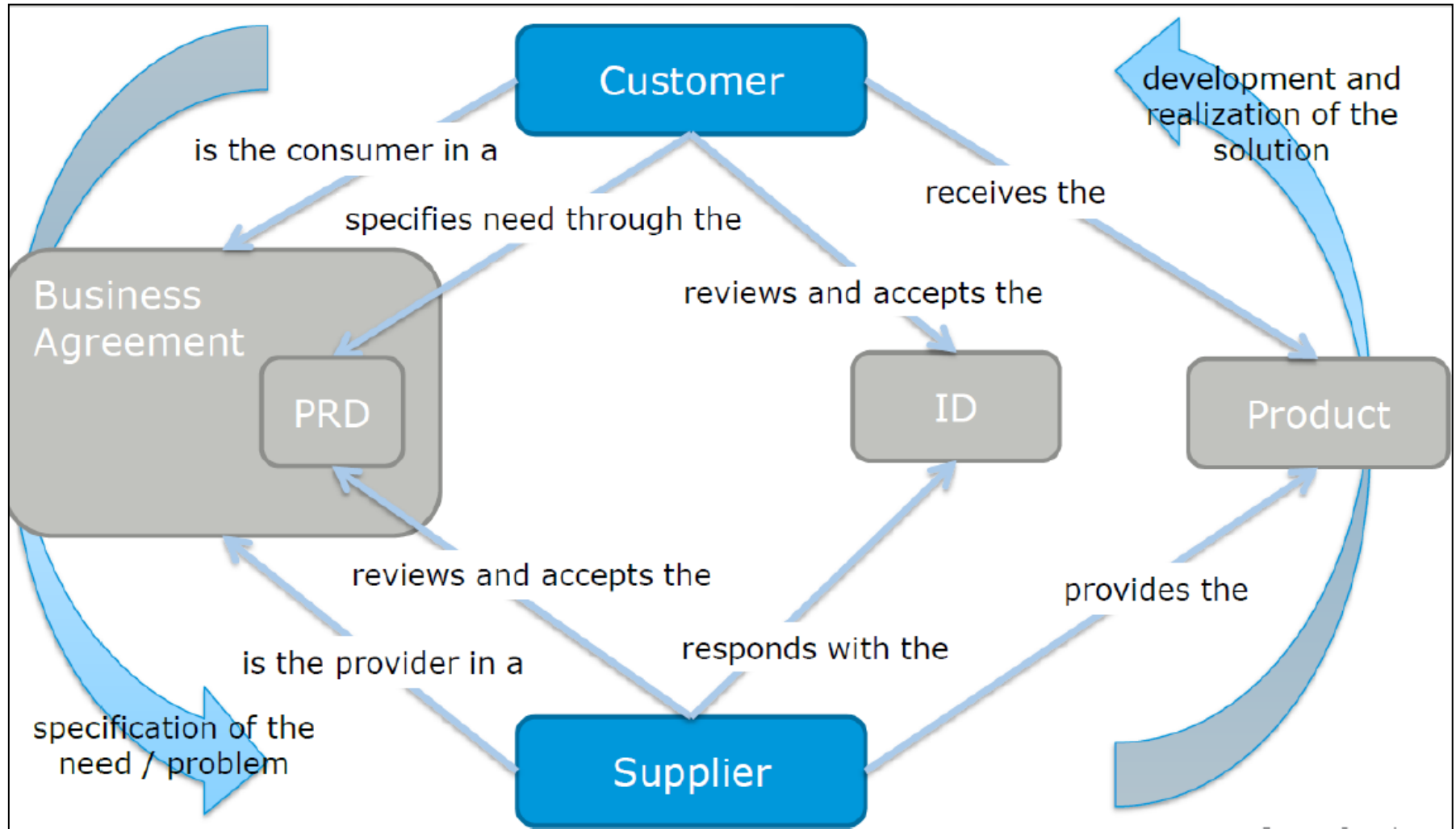
ECSS provides baseline **working practices** for systems engineering in line with ESA/EU/**industry requirements** and **recommendations**

ECSS and Systems Engineering

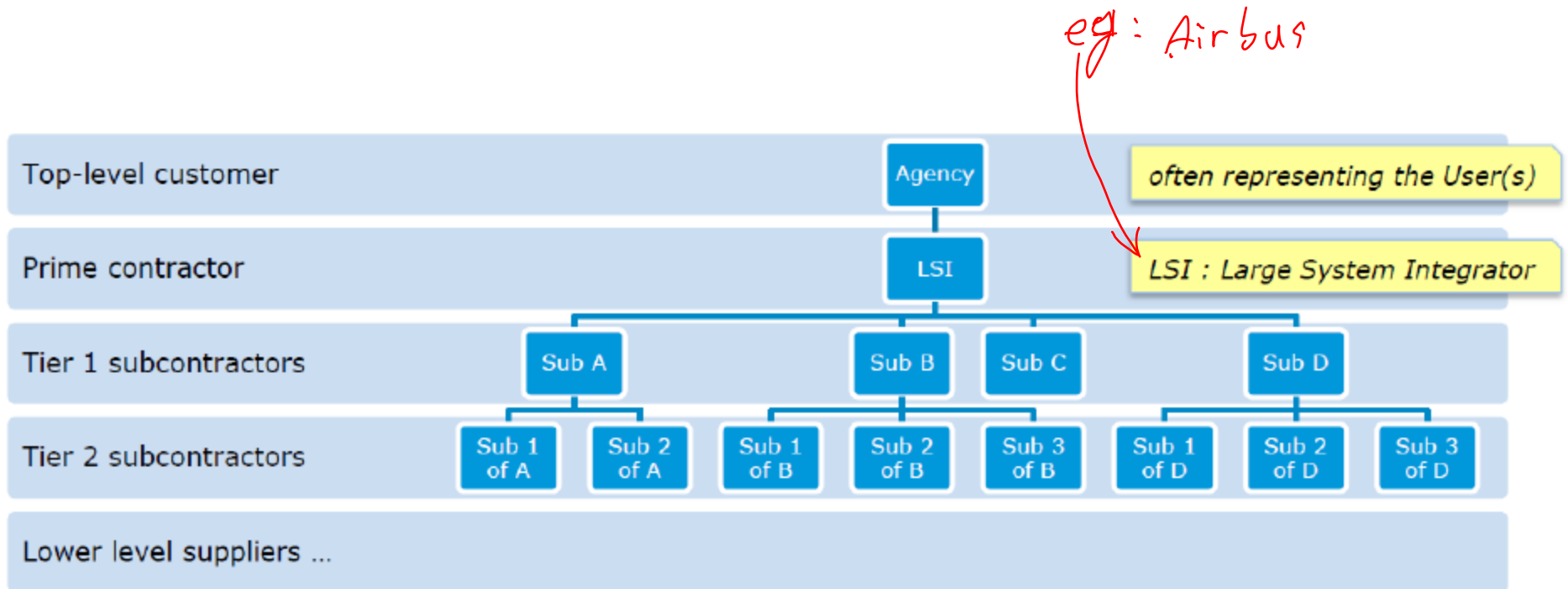
E-10 Discipline – Systems Engineering



Customer-Supplier Model

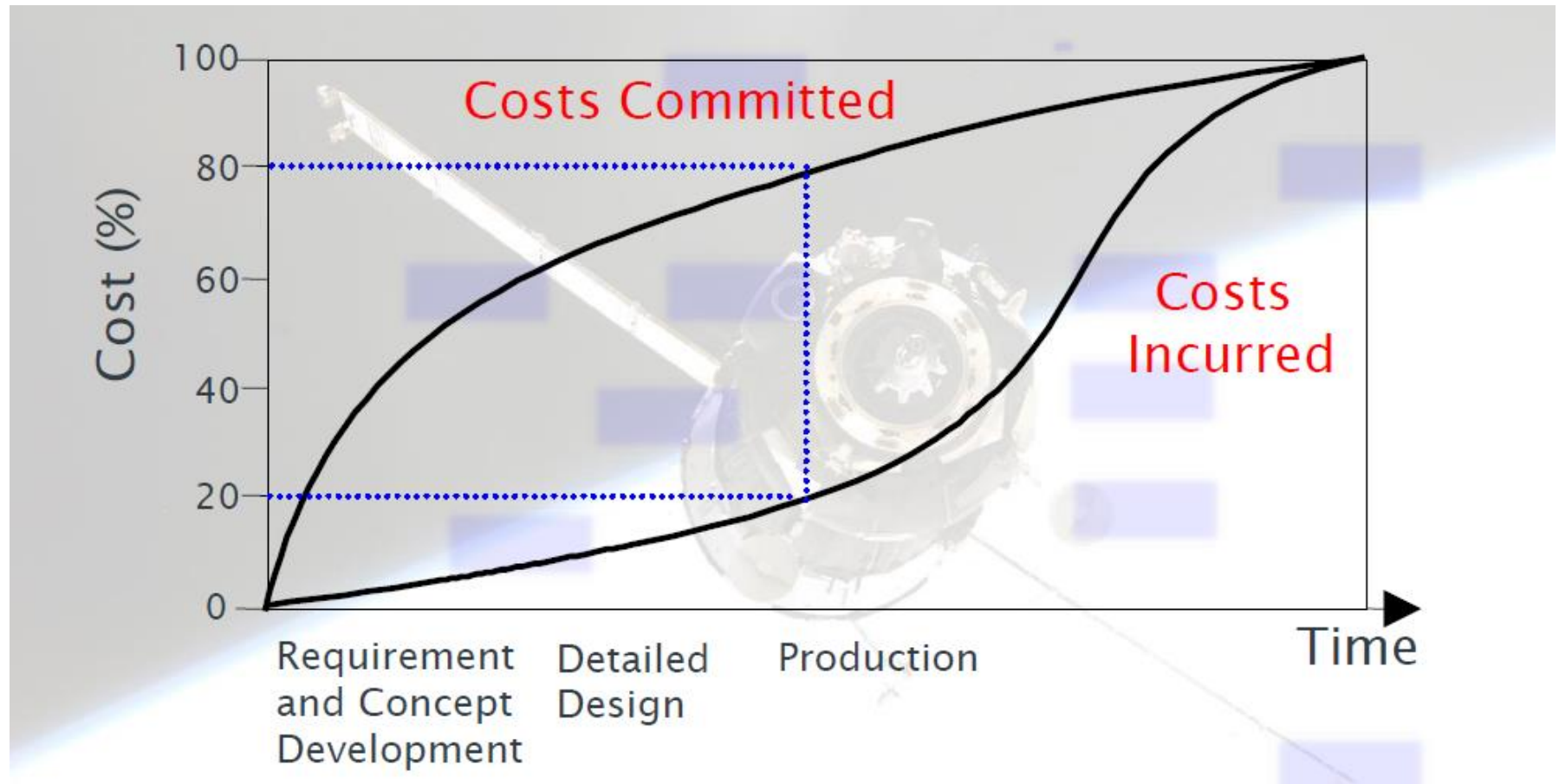


Customer-Supply Chain



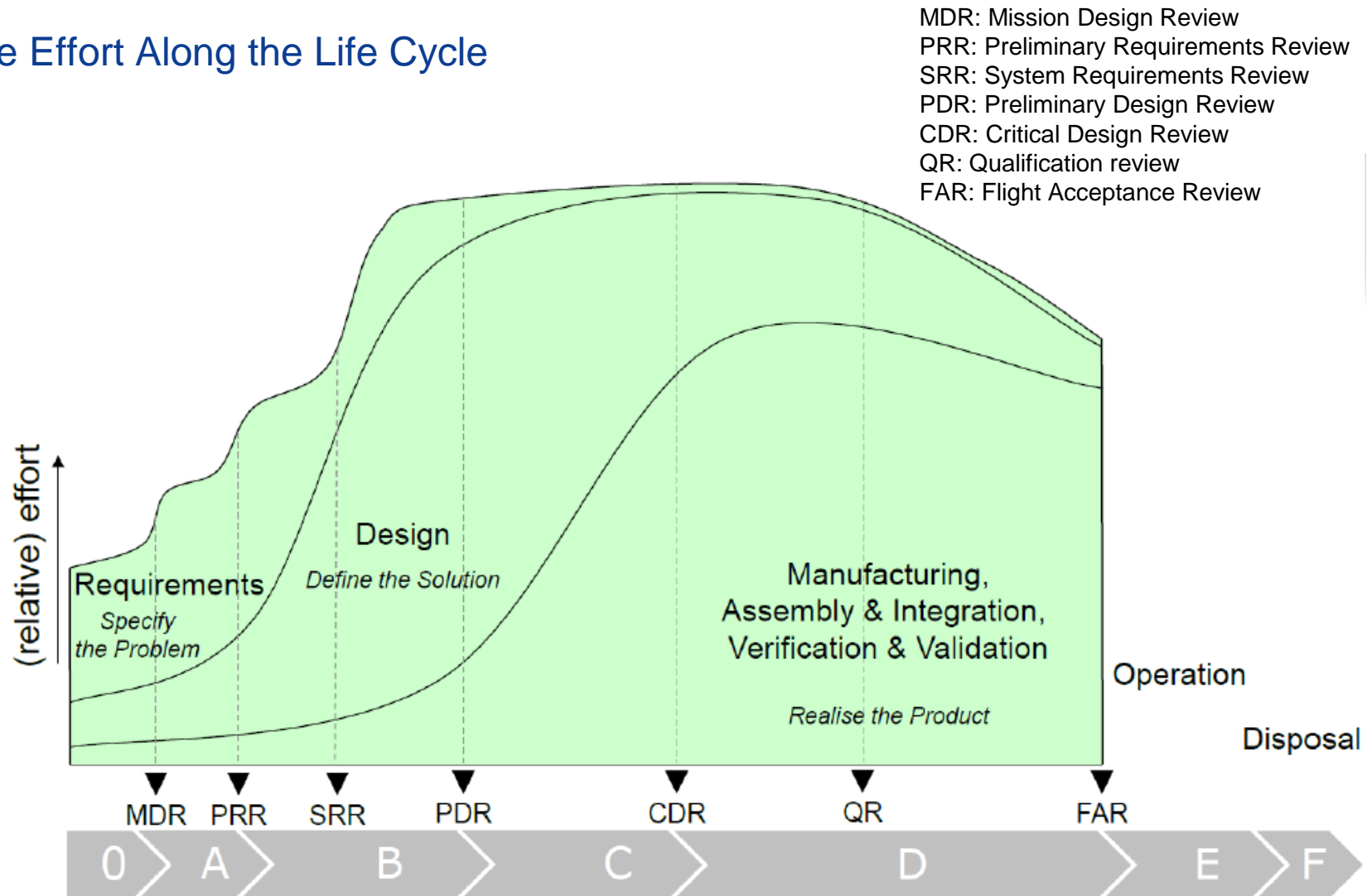
Importance of Precise Requirements Definition

Impact of Systems Engineering on Cost Schedule



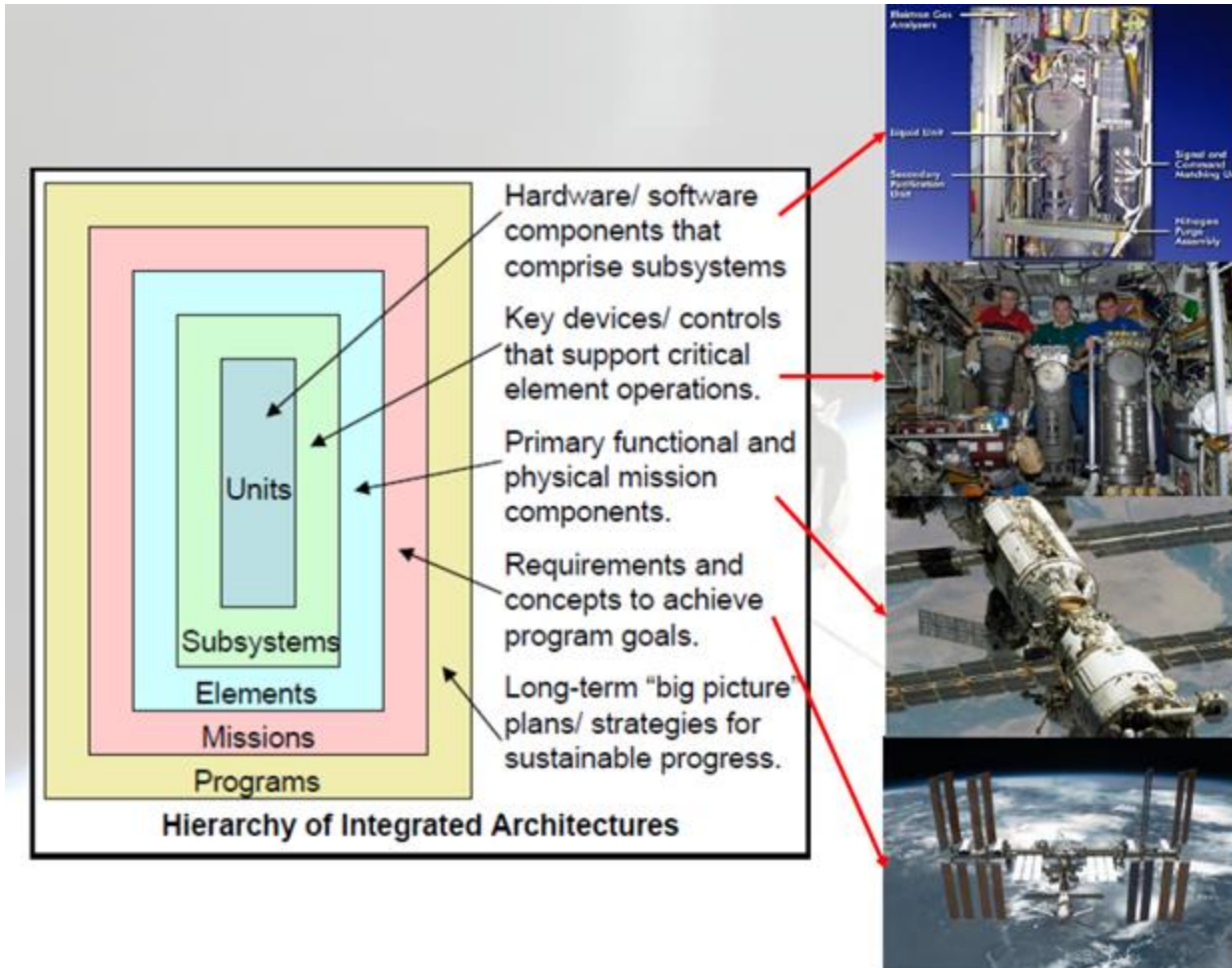
Effort vs. Timeline to FAR (typically ~ 5-20 years for ESA)

Relative Effort Along the Life Cycle

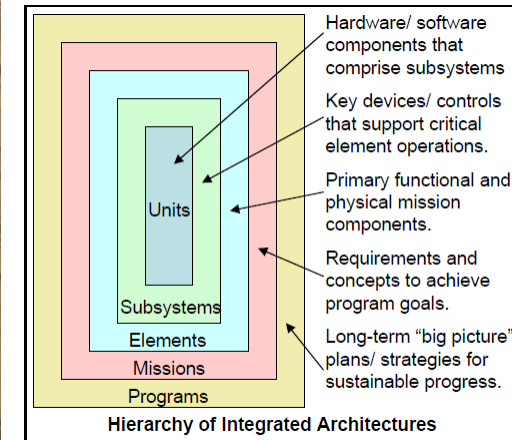


Hierarchy of Systems Architectures

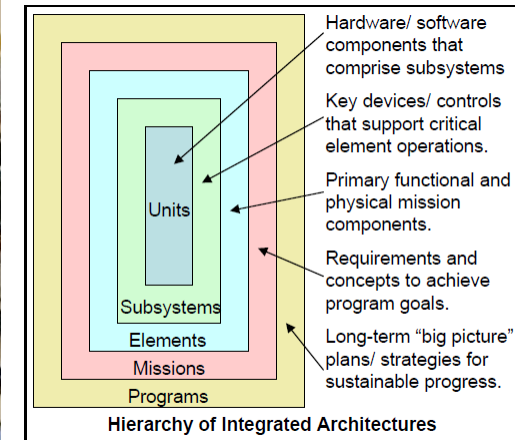
Hierarchy of Integrated Architectures



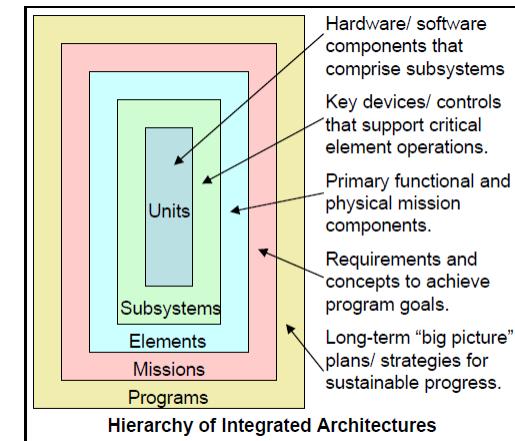
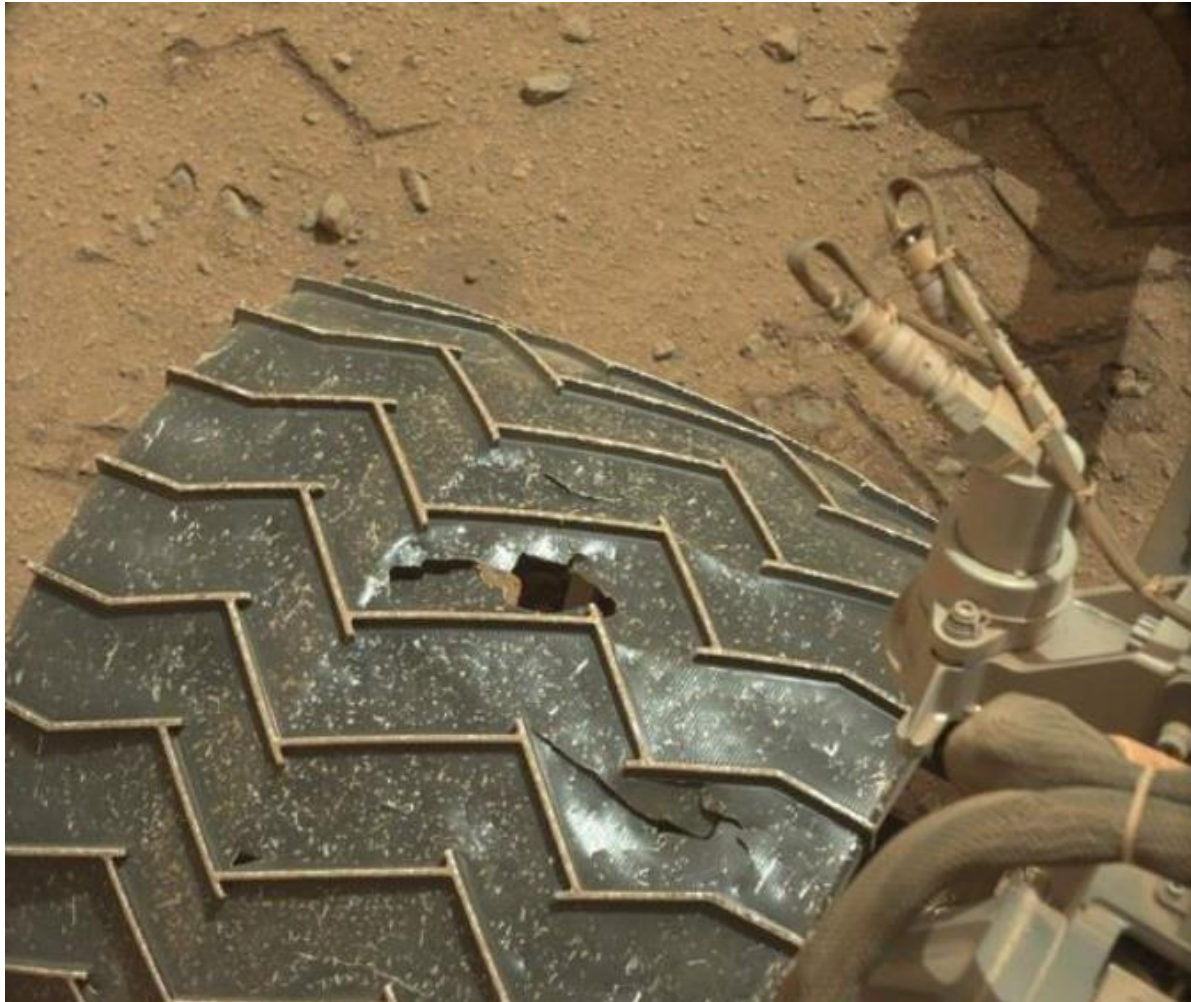
Example System – Curiosity Rover



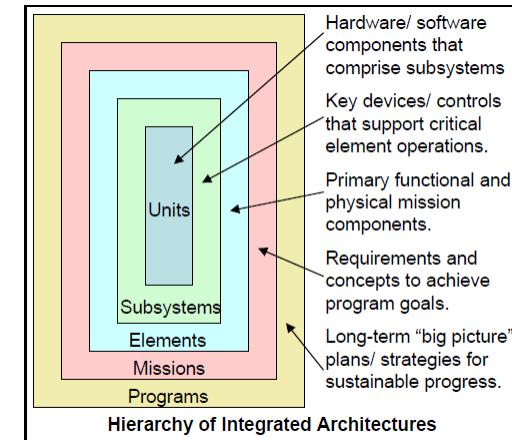
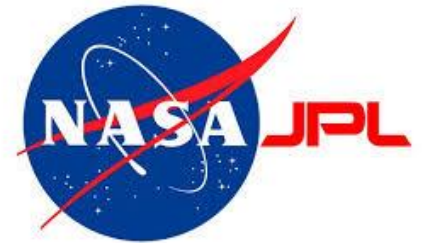
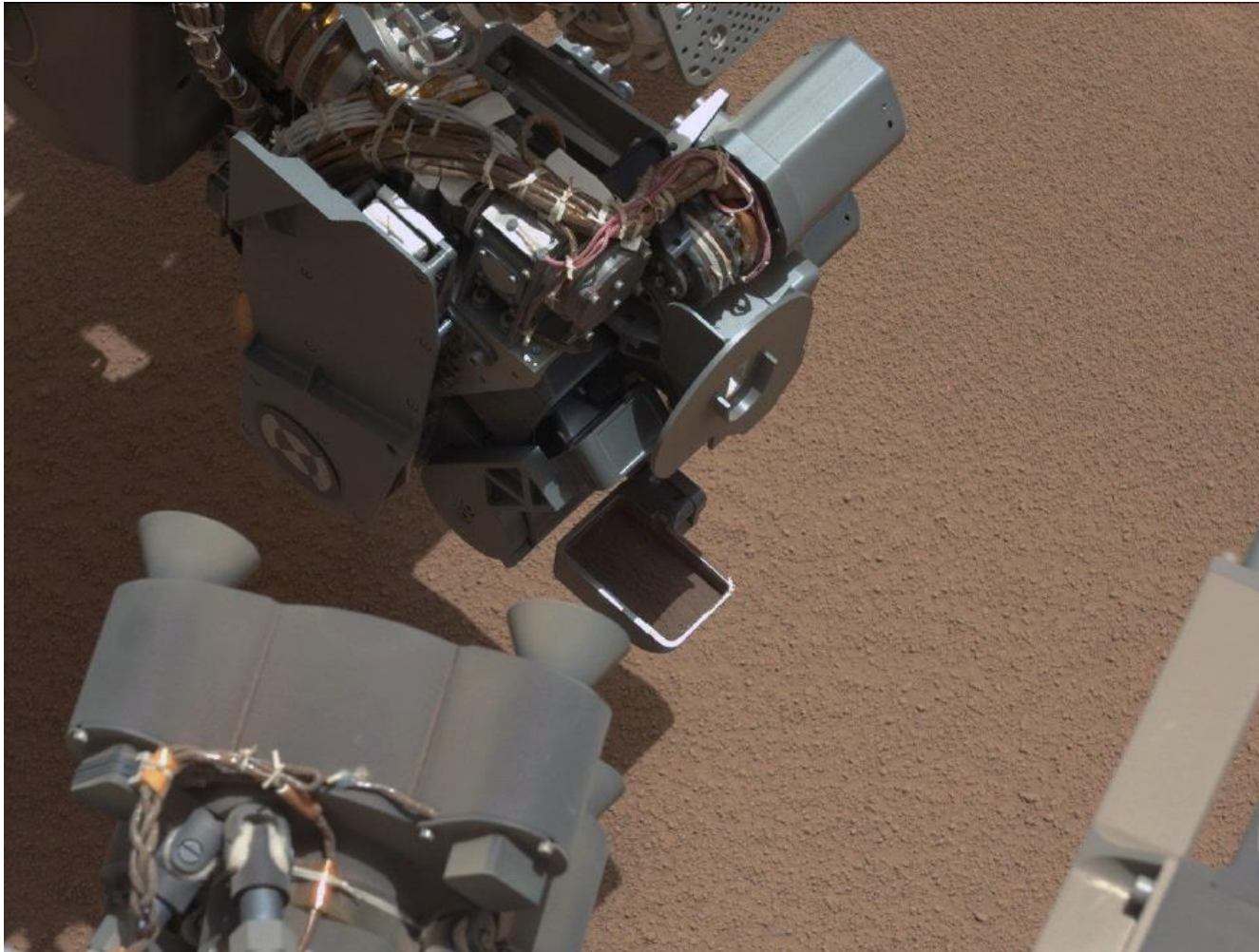
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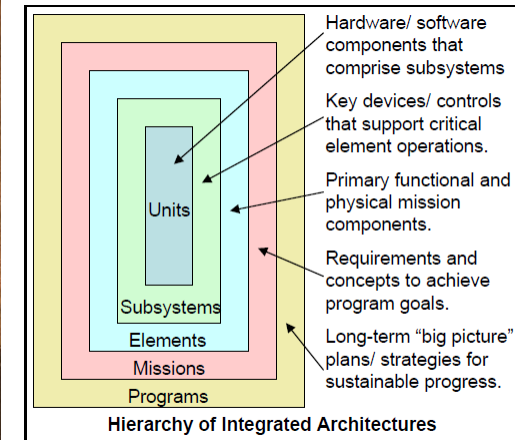
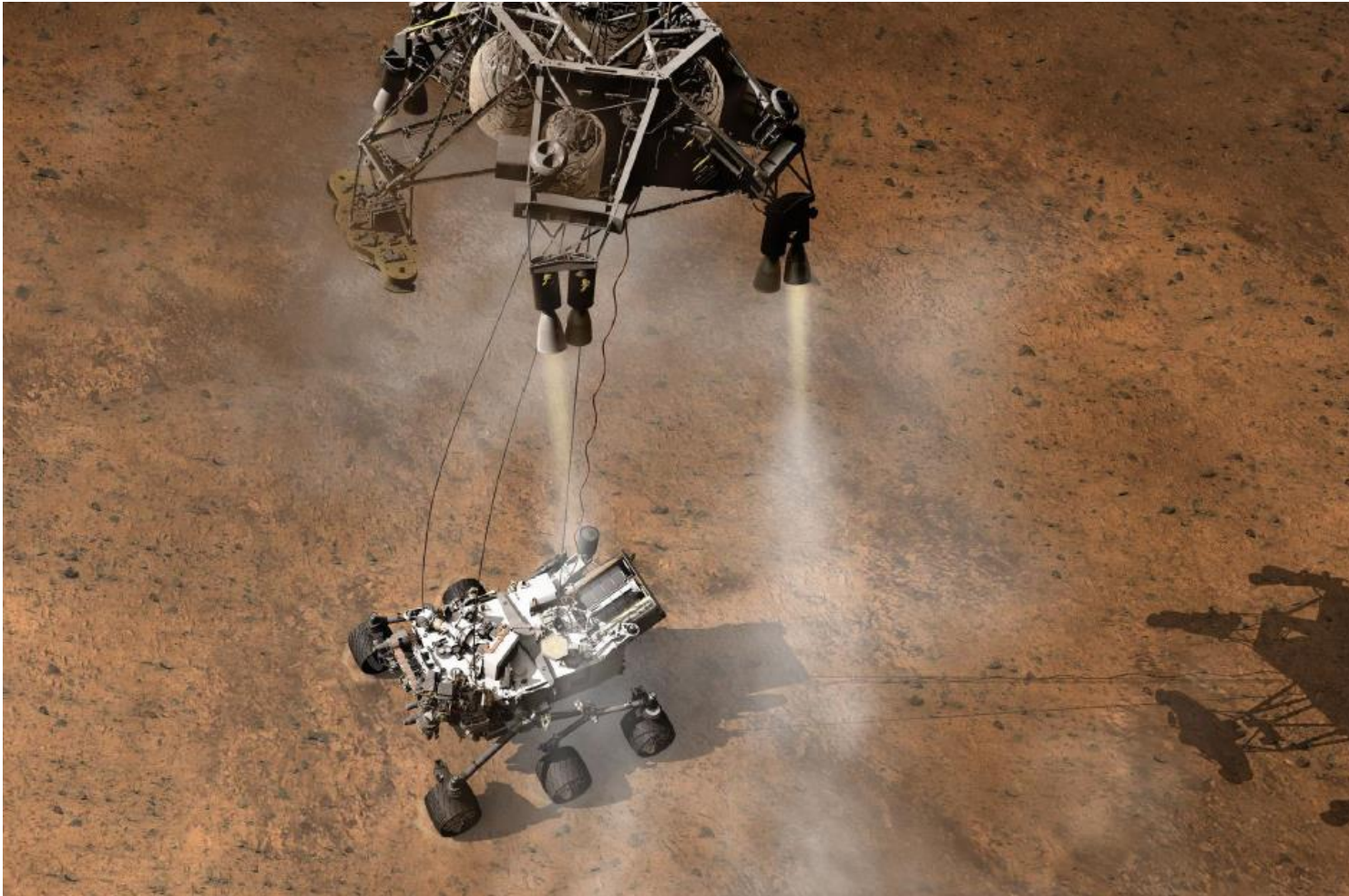
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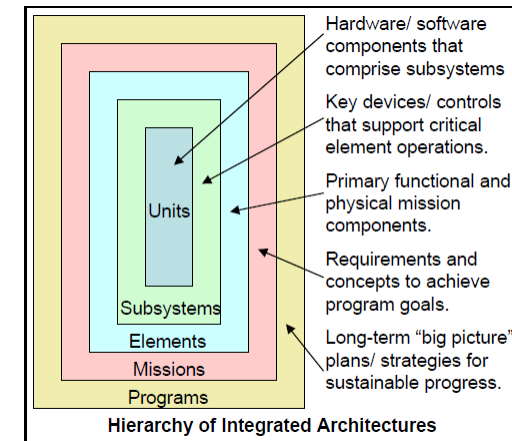
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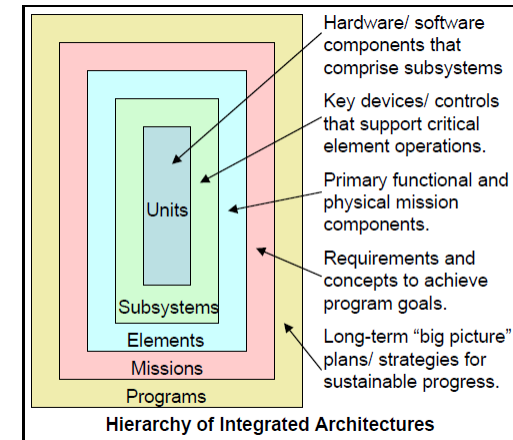
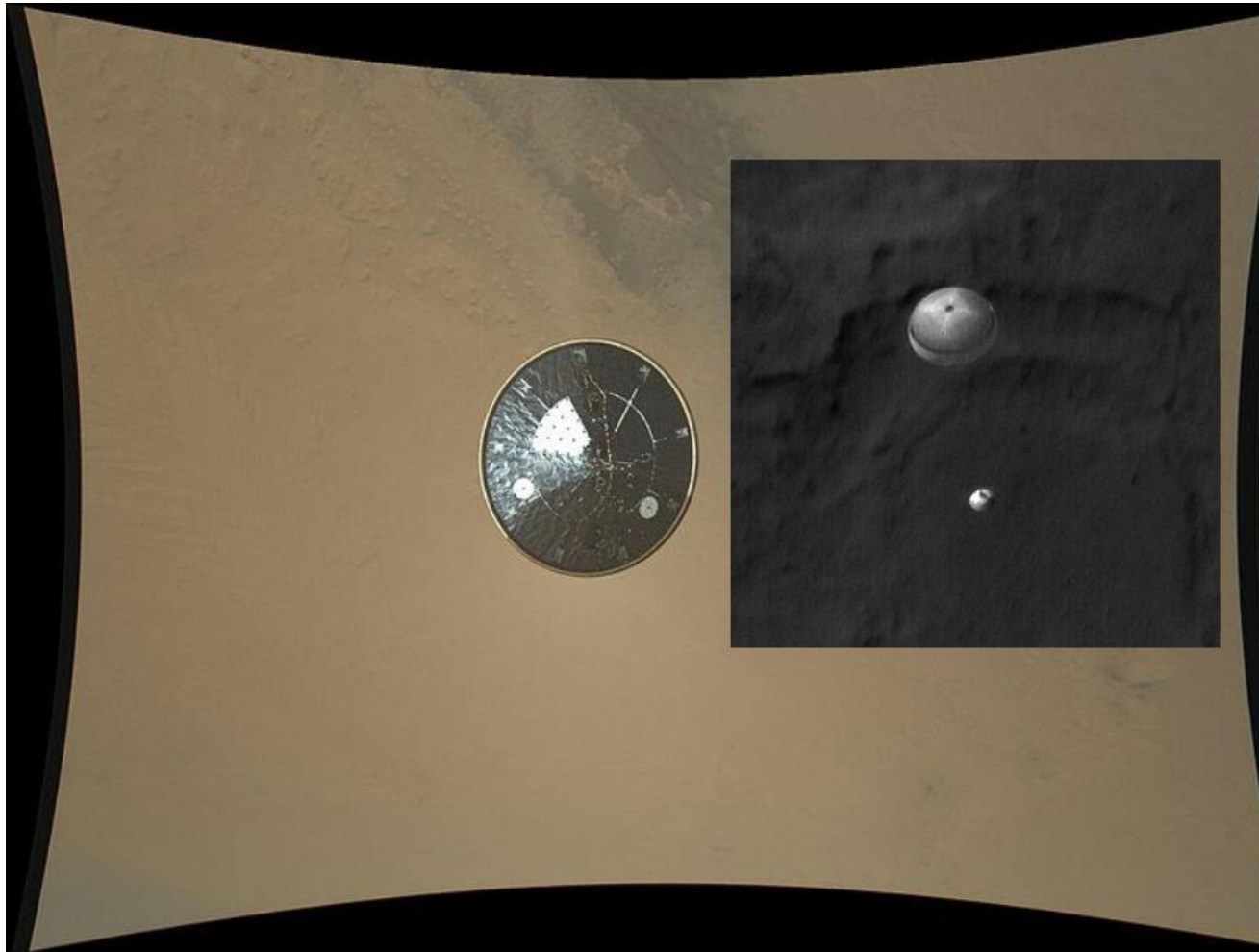
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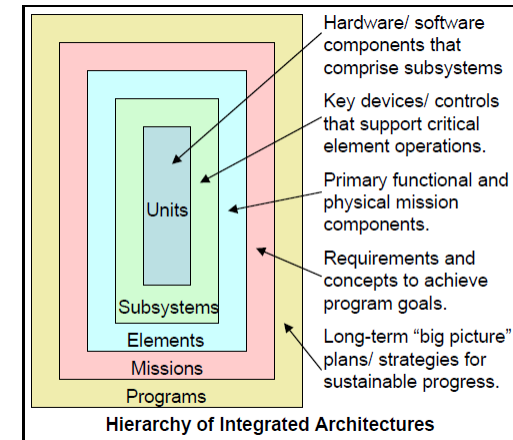
Example System – Curiosity Rover



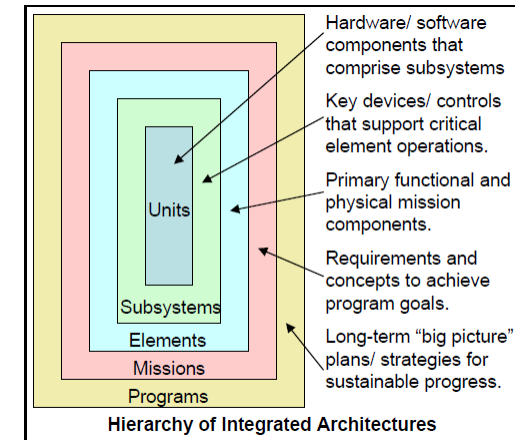
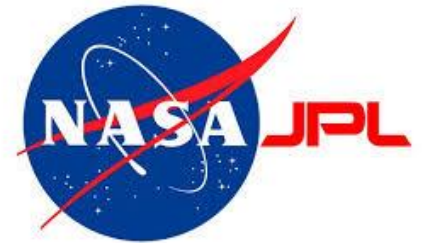
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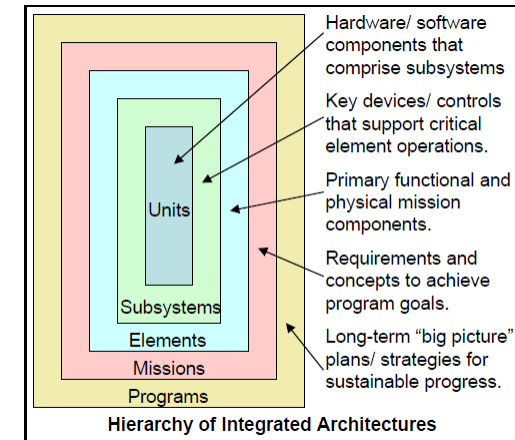
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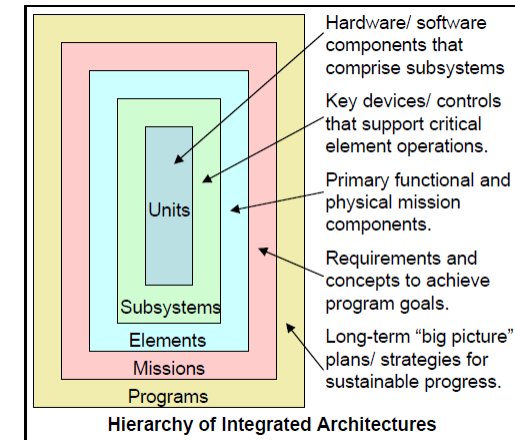
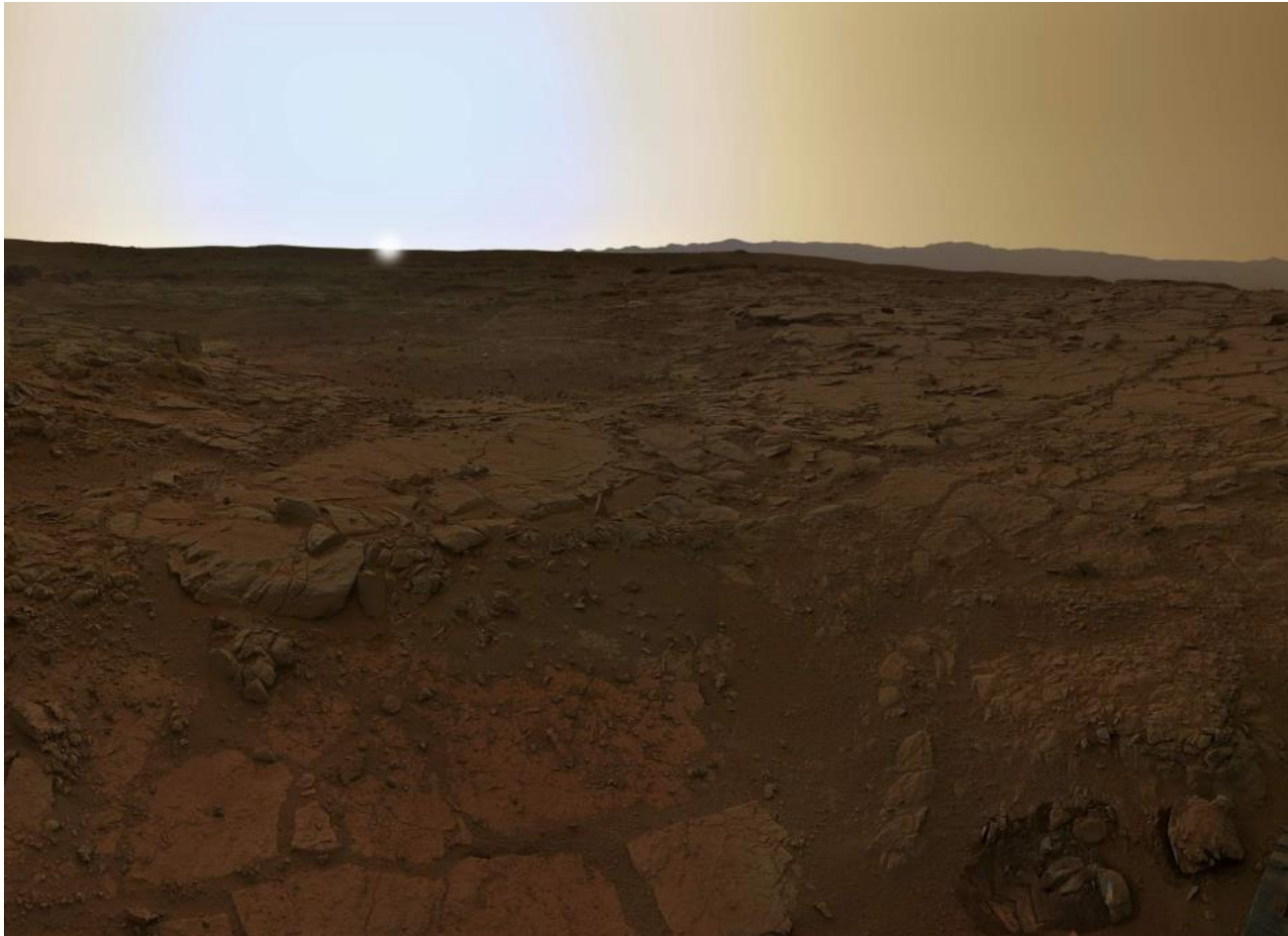
Example System = Curiosity Rover



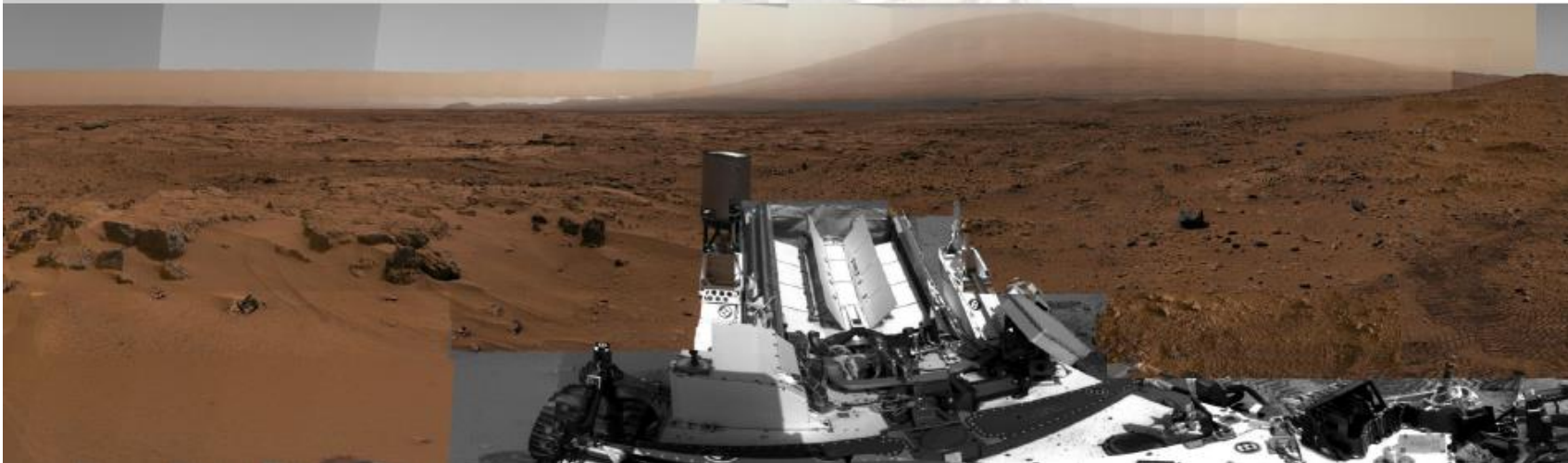
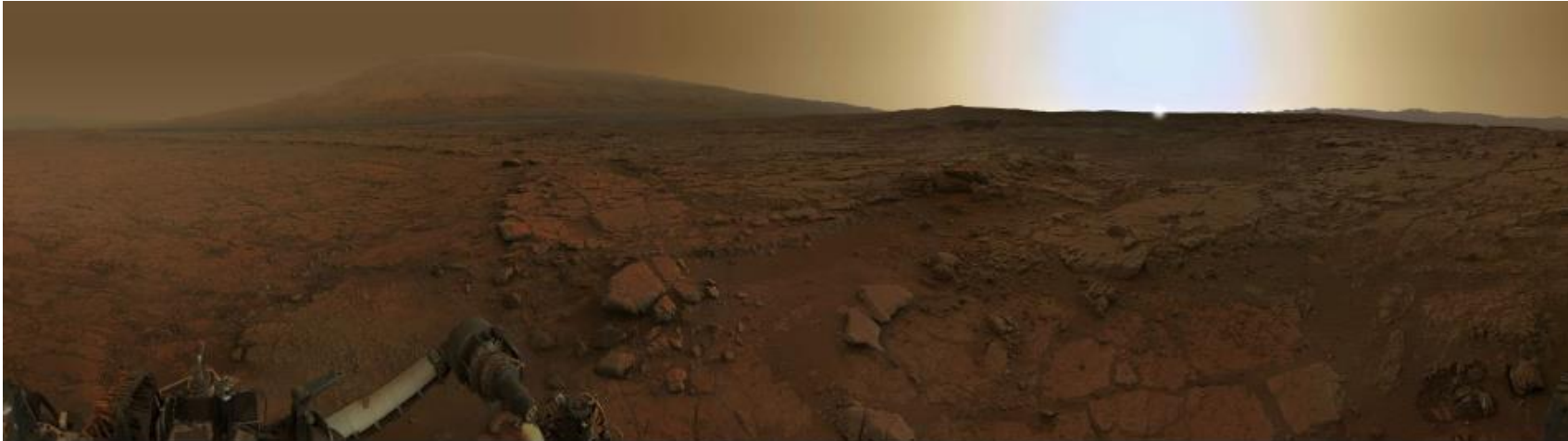
Example System – Curiosity Rover



Example System – Curiosity Rover



Example System – Curiosity Rover



ECSS and the Customer Supply Chain

- What you should know/understand:
 - The purpose and structure of ECSS (European Cooperation for Space Standardisation).
 - The rôle of ECSS in defining procedures and standards which allow the effective development and control of space systems.
 - How a customer supply chain operates in terms of structure, relationships and responsibilities.
 - The relative effort of requirements definition, design and manufacturing activities through a project lifecycle and be able to explain the importance of defining precise requirements at the start of a project.
 - The hierarchical nature of integrated system architectures.