ECSS M-branch training course Q&A

Some questions have been edited for clarity and style.

1. **Sometimes there are projects/contracts to raise the TRL from, for example, 2 to 3, or 4 to 5. Is the same schedule organization (i.e. Phases A through F) used for these projects?**

   Maurizio's answer: [the answer to this question encompasses also the answer to questions Nr. 22 and Nr.23]

   In abstract terms, the technology development path and the project life follow two separate lines, i.e. a certain technology is developed by a technologist within the Technology Development world, moving from TRL 1 to TRL 5 – 6, when it could, but not necessarily, be taken on board a specific Project, whilst a Project typically stems from a Phase 0 Study (or Pre-Phase A) and evolves up to the point is formally approved and financed. At this point, the Project may decide to take on-board that specific technology, assuming it is assessed having achieved the required TRL. In practice, things may go slightly different. Project Directorates often, but not necessary always, establish a direct connection with the development of technologies of their interest and systematically review formally the progress on TRL at the Study/Project Reviews. This approach is highly beneficial in ensuring that the technology development is in tune with the Study/Project progress, such to have achieved the needed TRL at the moment the Project is formally approved and the technology can be taken on-board. It has to be said, however, that the formal responsibility of the technology development progress remains with the Directorate financing the technology, unless the technology development responsibility (i.e. the financial responsibility) is already within the Project Directorate, as part of Project Directorate's own Technology Development Programme. The level of coordination Project-Technology is probably higher in case of "enabling technologies, i.e. the innovative / break-through technologies that are assessed to have the capability to enable a specific mission.

2. **In the V-shape model, how are the schedule and time balanced? The first part of the V is just a preliminary phase, the second part is critical and should take more time. It is somewhere around 50/50 or closer to 20/80%?**

   Maurizio's answer: The time allocated, and later-on actually spent, to the two branches of the V-shape model does not obey to any theoretical formula. The length of the two

branches could be, and often is, very different. Examples are varying significantly, depending on the Project history and evolution.

3. **[Question unclear]**

4. **How are the requirements for each TRL level defined by ESA? How/when do you know you have reached a specific milestone? Especially for new technology I reckon there is not a standard set of requirements, hence the question.**

   Maurizio's answer: The TRL definition is contained in a document agreed upon after years long negotiation by representatives of major international Space key players. ESA has summarised its position on the TRLs in the "Technology Readiness Levels Handbook for Space Application", latest updated in 2008. The definition of the different levels is very clear in the Handbook. As far as I am aware of, considering that I left ESA a couple of years ago, the TRL is assigned by the Technologist him/her-self and/or by a small team encompassing his/her line management. Although the point has been lengthy debated, I am not aware of an independent and self-standing Body tasked with the Authority to assigned TRL's achievement. However, it has to be noted that it is relatively easy, and might be not too controversial, to assign TRL's achievement at lower levels, but this is not of so much interest. It is much more interesting to formally assign higher level TRLs (e.g. 5-6), but this does not make any sense in absolute terms, i.e. not related to a Project. Actually, different Projects imply different operational environments and TRL can only be related to a specific operational environment.

5. **Question regarding TRL: Can TRL be assess for ground segment devices (MGSE/EGSE) [editor's note: MGSE and EGSE are part of the space segment, not the ground segment] or it is not applicable for them?**

   Maurizio's answer: Typically, the TRL is related to the Flight Segment. In principle, it might be conceived the idea that a very innovative technology needs an equally innovative and critical ground segment to be operated. In such, a bit extreme, case it could be said that the technology is not ready unless it can be operated.

6. **Where do you think the ECSS M-branch standards fall short and in what ways do you think the standards should evolve to be futureproof?**

   Maurizio's answer: I share the answer below

   ECSS Executive Secretariat answer: ECSS is working on a review of the M-branch standards as part of the ECSS 4.0 initiative. The review aims to classify all requirements

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as *core* or *non-core*, to simplify the application of the standards in different types of projects.

7. **Is there a standardized / defined way of working together with other disciplines - especially product assurance? Given that all participants should contribute to risk management, are there requirements for the PM to integrate certain people, departments, or disciplines at certain times, i.e. to pass a certain phase gate?**

   Maurizio's answer: The Project Team's composition is the prerogative of the Project Manager and his/her Management Line, as per any other team composition in ESA. Traditionally, all the key functions are part of the Project Team, either embedded in the Project or made available as need be. Everybody, then, of the Project Team contributes to the different facets of Project life, as per his/her own responsibility.

8. **Why do you use a PBS (product breakdown structure / product tree) and a WBS? The *who* can be associated with each piece of *product* in a PBS?**

   Maurizio's answer: Answer to 8, 9 and 12. The Product Tree is the "what". In a "who does what" logic, the function tree is the "who", the WBS is the "does". In other words: the definition of the single tasks. E.g.: the stress analysis specialists [who] (name, or name or the responsible person) of a certain Company of the Industrial Consortium (Prime, the same Sub that is responsible for the subsystem structure, or another Sub or even a Company specialised in stress analysis) performs [does] the stress analysis [what] of a certain structure or piece of structure.

9. **Is it possible to better explain the link between the product and function trees, and the WBS?**

   Maurizio's answer: See point 8 above

10. **Is there any intention to reflect agile way of working in the next/future updates to standards? ECSS published an agile software development handbook in 2020.**

    Maurizio's answer: Similar answer of point 6 above. It is worth noting that key-player of commercial space activities are pushing to get to a more agile definition of requirements and standards. A bit of risk is there to cut some corners short.

11. **On the right side of the V-model, is the CDR at each level typically formally dependent not only on a CDR but also a QR and an AR in the levels below? For example, 1st level CDR typically not conducted until not only the CDR but also the QR and the AR are performed at level 2, and so on?**

Maurizio's answer: In the V-model the acronyms CDR and AR appear repeatedly at the same levels on the right side. A clarification in this respect is needed. Along the same lines that requirements are progressively broken down from higher to lower levels in the contract ladder (Prime, Sub, lower level Sub, … , component Supplier), similarly, the requirements are accepted and subsequently verified in inverted order. This logic also leads to a sequence of Acceptance Reviews which are necessarily ahead of time wrt their corresponding higher-level Reviews. In other words: a component (off-the-shelf or tailor-made) is accepted for subsequent integration in an equipment, which is aimed at being later-on accepted for further integration in a sub-system, and so on, up to system level or fully integrated satellite. Each higher-level Review builds upon lower-level ones. At a certain point in the process, the acceptance of simpler elements precedes the acceptance of more complex ones.

12. **Is there a more formal way to link the product tree, WBS and function tree? Logically speaking, it is clear that there is a link, but is a link between the structures (for instance WP10000 should be linked to PT10000 and F10000) also needed?**

   Maurizio's answer: See reply at point 8 above.

13. **Are there templates for creating a RID table?**

   Maurizio's answer: The Standards provide also standard template. In principle, this could, up to a certain extent, be adapted to Project's needs. The way to handle the RIDs is Project prerogative, although at the end most of the Projects adopt the same scheme.

14. **Is there a link between the Configuration Item number given by ESA (or Prime) and the part number to be assigned to the item (or sub-items)?**

   Maurizio's answer: The part number assigned by the Vendor is a commercial tool which has a meaning within Vendor's organisation. The configuration item number in a Project Configuration Management system is a tool functional to Project's organisation. Rarely the two needs coincide. An item bearing a certain part number of Vendor's Catalogue may, and de facto will, bear another number as configuration item identifier.

15. **Is the risk policy a project specific document, or a company-wide document?**

   Maurizio's answer: The Project Risk Policy is a Project specific document. This is aimed at assessing, and possibly successfully control, Project's identified risks. Companies may have their own risk policy (after all the delivery of a product by a

Company is, somehow, a Project on its own). In principle the two "Policies" are different. It could be, for very specific cases, that the Project Policy takes into account the Company Policy of a very critical component, but only as an extra monitoring tool, not to import it inside the Project Policy itself.

16. **[Question unclear]**

17. **For the risk matrix, can a different scaling (e.g. 1-4 instead of 1-5 and A-D instead of A-E) be used?**

    Maurizio's answer: In principle, the Standards could be tailored to the Project's needs, typically simplified in case of very simple Projects. Besides that, the merit of twisting Standards is not so evident and this practice should be discouraged.

18. **How does the detectability of a risk come into play in filling in the risk matrix?**

    Maurizio's answer: Each risk is identified and subsequently assessed on the basis of Project Team's experience and skills. Nobody has the crystal ball. Forecasts and predictions are the ingredients determining both the criticality of consequences and likelihood of occurrence. The entire exercise is to anticipate the risks and take the necessary steps to prevent them from occurring. Once risks materialise, and therefore can be detected, it might be a bit too late.

19. **Are there any guidelines in ECSS – based on lessons learnt – to identify the typical risks one may encounter in a project?**

    Maurizio's answer: See point 18 above.

20. **Is the project manager/project team setting the percentage values in the risk severity classification table?**

    Maurizio's answer: Yes, based on their experience and wisdom. And their assessment is to be discussed with, and agreed by, the Industrial Consortium.

21. **Where can templates (e.g. risk assessment, RID) be found?**

    Maurizio's answer: Agreed with the answer below.

    ECSS Executive Secretariat answer: Templates can be found in the normative annexes (DRDs) in the M-branch standards.

22. **Linking between the TRL and project Phases (A-F): If a tender has objective to raise the TRL of a software from 2 to 5, with several expected outputs and progress meetings (PMs), how this could be linked to project Phases? Should the**

PMs be associated to reviews?

Maurizio's answer: See reply at point 1 above.

23. **Who gives the final approval on the TRL achieved? Does ESA give you a certificate with *this technology is now TRL5*?**

Maurizio's answer: See reply at point 1 above.