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Railways Technology – the key lessons learnt from the Gotthard Base Tunnel project in Switzerland

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ABSTRACT: The major challenges to meet the milestones and to minimize or mitigate the risks for the customer (as well as for the general contractors) starts already with the preparation of the request of proposal (RFP). The customer's decision on how to separate the entire scope into lots and contracts will heavily predetermine the continuation of the project over the entire lifecycle and therefore marks a major step in the project, in order to guarantee a "smooth" execution of a long lasting infrastructure project. Based on the three big infrastructure project in Switzerland (Lötschberg-, Gotthard- and Ceneri Base Tunnel) we have analyzed the decisions by the customers to setup the lots and contracts. For the implementation of a multi-contract and multi-discipline project – such as most big and long lasting infrastructure projects – the key disciplines are a stringent Interface Management, a dedicated Quality & Process Management and a detailed Integration and Acceptance Plan which are all depending on the once chosen setup into lots. We therefore emphasize here on one of the initial tasks to setup the scope of the entire Railways Technology into lots and contracts.

1 Introduction

The major challenges to meet the milestones and to minimize or mitigate the risks for the customer (as well as for the general contractors) starts already with the preparation of the request of proposal (RFP).

In general, the more detailed and precise the RFP is, the better are the responses the customer gets. It should primarily be the basis for a good and fair "apple-to-apple" comparison. Many aspects have to be taken into consideration but one of the most important tasks is to combine the right scope into lots and contracts in order to **minimize the interfaces and consequently the risk and claiming potential**.

The customer's decision on how to separate the entire scope into lots and contracts will heavily predetermine the continuation of the project over the entire lifecycle and therefore marks a major step in the project, in order to guarantee a "smooth" execution of a long lasting infrastructure project.

For the general contractor, **finding the right partners is crucial**. This task has to take place way before the tendering process starts and has to anticipate the customer's decision on the lots building. The contractual setup with the partners has to be clearly defined and marks an important step in a long lasting partnership.

For the implementation of a multi-contract and multi-discipline project – such as most big and long lasting infrastructure projects – the key disciplines are a stringent Interface Management, a dedicated Quality & Process Management and a detailed Integration and Acceptance Plan which are a consequence of the once chosen setup into lots. We therefore emphasize in the following on one of the initial and major tasks of the project – *to setup the scope of the entire Railways Technology into lots and contracts*.

2 Project boundaries and functional Interfaces

The typical project boundaries in a Tunnel project are shown in Figure 1. Whereas in the example of the Gotthard Base Tunnel, AlpTransit Gotthard is the customer, Swiss Federal Railways the operator and Transtec Gotthard the consortium to deliver the turnkey solution for the entire Railway Technologies.

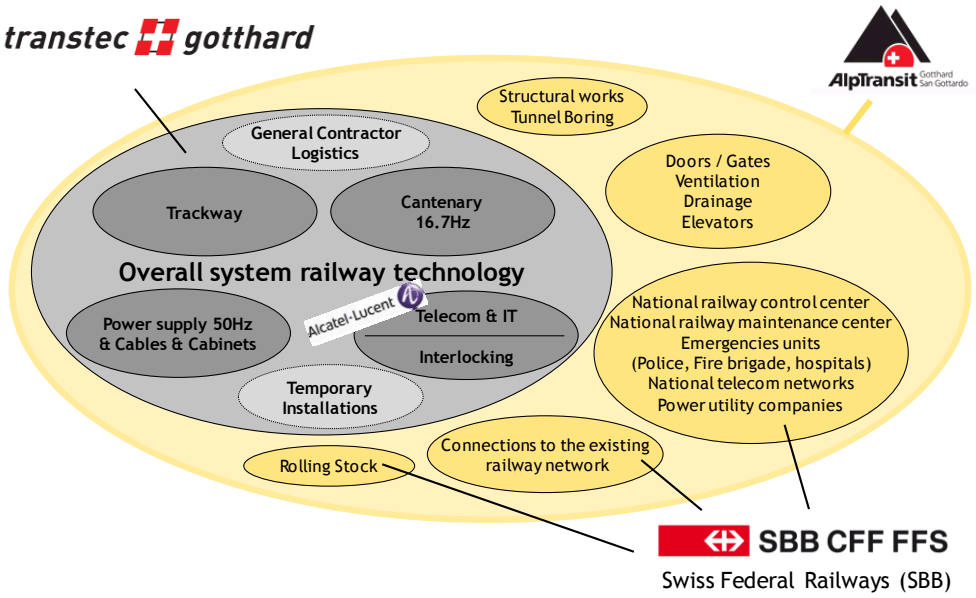

Figure 1. Typical boundaries in a railway tunnel project

The major functional interfaces are shown in Figure 2. The numbers represent the interfaces identified, clearly defined and documented during the offering phase, grouped into total number of interfaces within a group of lots, between the group of lots and the total number of each discipline, including the interfaces (342) outside the scope of the Railways Technology.

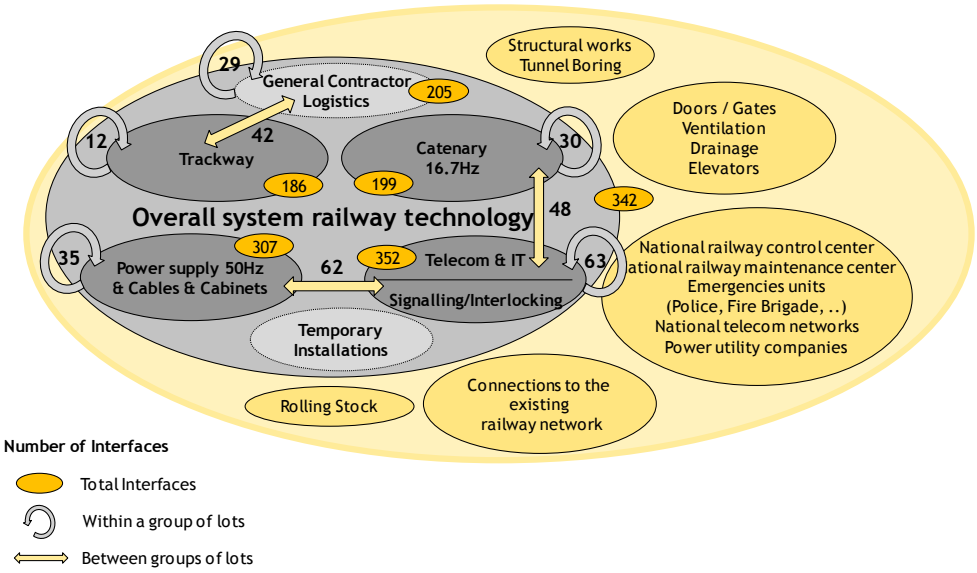

Figure 2. Identified and documented interfaces during offering phase

All the interfaces entirely within the overall system for Railways Technology are under the responsibility of Transtec Gotthard – only (but still) 342 interfaces are managed between the customer and Transtec Gotthard.

Not all the interfaces are equally important, Figure 3. shows a relevance ranking. As all the technical interfaces of all disciplines in such projects are carried over the Telecom Data Backbone Network and presented/managed in the Tunnel Control Centre, it is not a surprise that the ICT domain plays an important role as the pivotal point. This not only for the overall Interface Management task but as well as for the overall integration and acceptance of the Railways Technology.

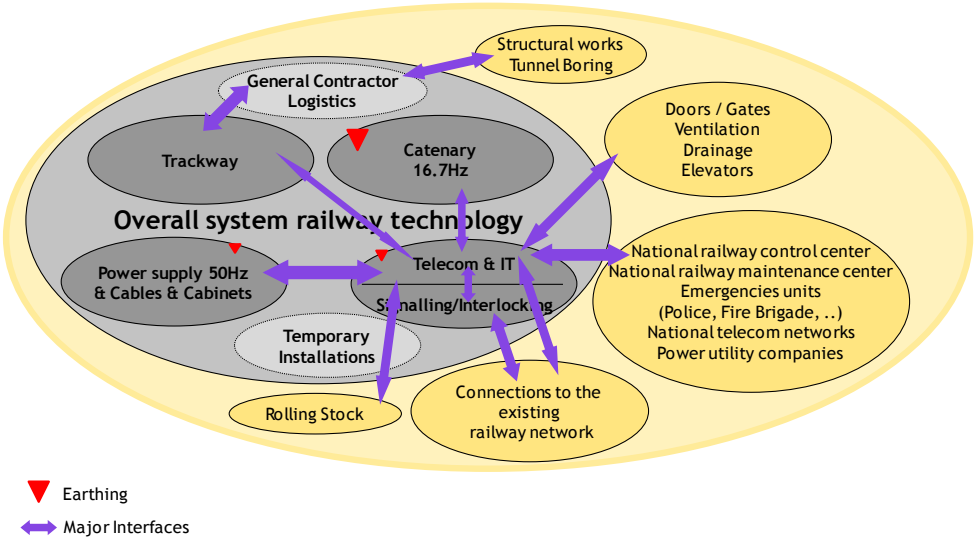

Figure 3. Functional interfaces (relevance ranking)

Additionally and worth to mention is also the complex and difficult topic of “earthing”. Usually, the lead is within the 16.7Hz team but 50Hz and ICT are also heavily involved and affected.

3 Lots building and Contract separation

3.1 Comparison between 3 major Tunnel projects in Switzerland

Based on the three big infrastructure project in Switzerland (Lötschberg-, Gotthard- and Ceneri Base Tunnel) we have analyzed the decisions by the customers to setup the lots and contracts. An overview is shown in Figure 4.

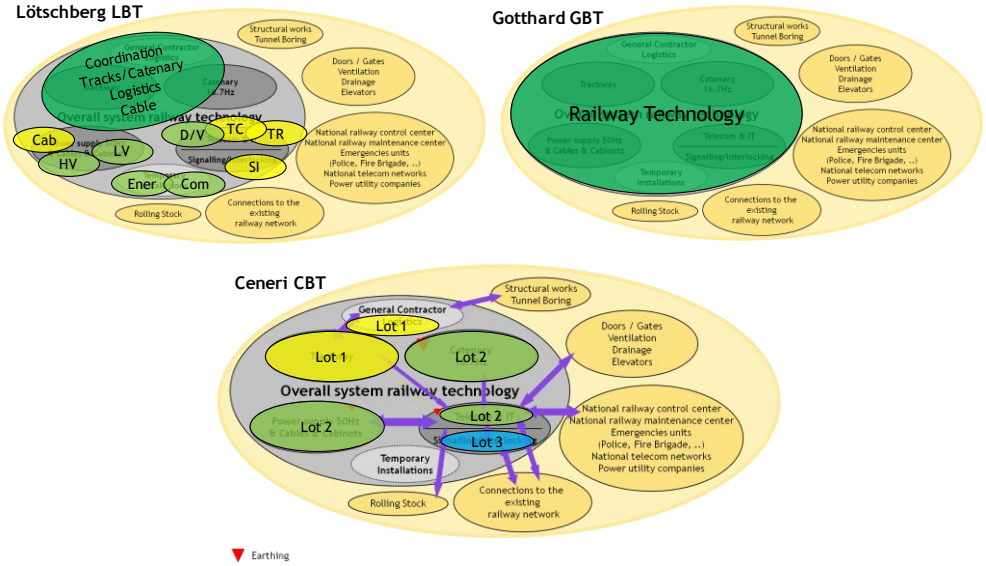

Figure 4. Lots building and contract separation in the major 3 Tunnel projects in Switzerland

In the **Lötschberg Base Tunnel** (35km, RFP for Railways Technology issued early 2000, operational since 2007) a setup with many contracts have been chosen, with an enormous coordination effort for the customer. Consequently with a big claiming potential which results in a huge risk exposure on time and cost for the customer.

In the **Gotthard Base Tunnel** (57km, RFP for Railways Technology issued in 2005, operational in 2016) a setup with one General Contractor with a turnkey solution has been chosen. This setup has reduced the risk exposure and the claiming potential for the customer tremendously. On the other side of the medal, only two consortiums have been able to respond to the RFP.

In the **Ceneri Base Tunnel** (16km, RFP for Railways Technology issued in 2012, operational in 2019) a setup with 3 major lots has been chosen. This setup will increase the competition and compromises on minimizing the number of interfaces, which have to be managed by the customer, as much as possible.

3.2 Conclusions and lessons learnt

This is now the view and interpretation of a general contractor, one should ask the involved customers to understand exactly the reasoning behind the different approaches. Of course, also politics and many other aspects play very often an important role in the decisions, but looking from "outside" we come to the following lessons learnt over the last 10 years:

- Keep the lots and contracts as big as possible, minimizing the number of interfaces and consequently minimize risk exposure and claiming potential

but …

- Compromise on lots separation where you expect higher competition
- Separate the lots where you limit the number of competitors, due to restriction or regulations

With the setup of **one General Contractor** in the case of the Gotthard Base Tunnel project, two additional advantages are worth to be mentioned:

- Negotiations with one single partner (this setup made it possible to move the commercial operation one year ahead of original schedule)
- RAMS calculations for the entire system out of one hand

4 Implementation of the Railways Technology

For the implementation of a **multi-contract and multi-discipline project** – such as most big and long lasting infrastructure projects – the key disciplines are a stringent Interface Management, a dedicated Quality & Process Management and a detailed Integration and Acceptance Plan, which are of course depending on the once chosen setup into lots.

4.1 A stringent Interface Management

A clear definition and documentation of the boundaries/scope between the different lots as well as within the lots is crucial to minimize „finger pointing / claiming" and risk during project implementation.

Far more than 1000 interfaces have been identified in the Gotthard Project, close to 900 of relevance and already documented within the consortium in details during offering phase.

With the Interface Matrix shown in Figure 5. each and every functional interface has been identified and documented with the following content:

- ONE responsible Interface Manager
- Scope and involved partners
- Definition and boundaries, experience out of a similar project (if applicable)
- Requirements and implications on technical / time / place
- Mutual acknowledgment and signature (where possible)

Even documents with "no interfaces identified" have been established and mutually signed between the parties.

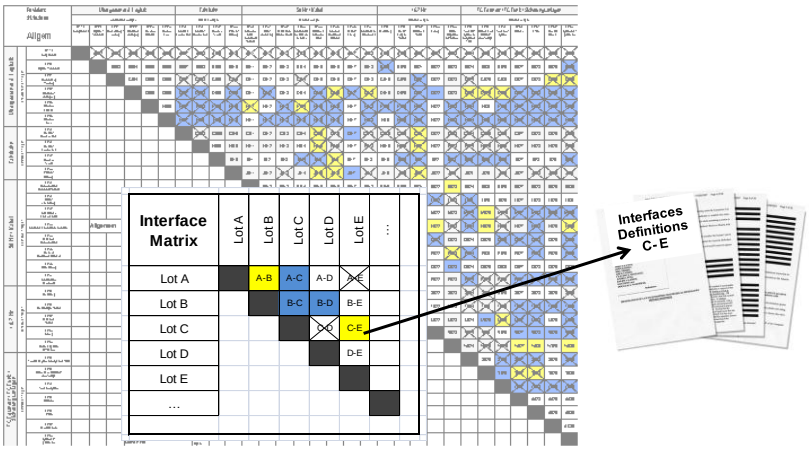

Figure 5. Interface Matrix between all involved parties – the methodology

4.2 A dedicated Quality & Process Management

Defined and implemented on consortium level, everyone involved has to speak the same language.

The Process Management is preferably based on EN 50126 (RAMS), the safety management system, as the process guideline to be strictly followed.

All involved consortia members and the many subcontractors are obliged to strictly follow the major processes and RAMS phases described in the Project Management Handbook (see major processes in Figure 6).

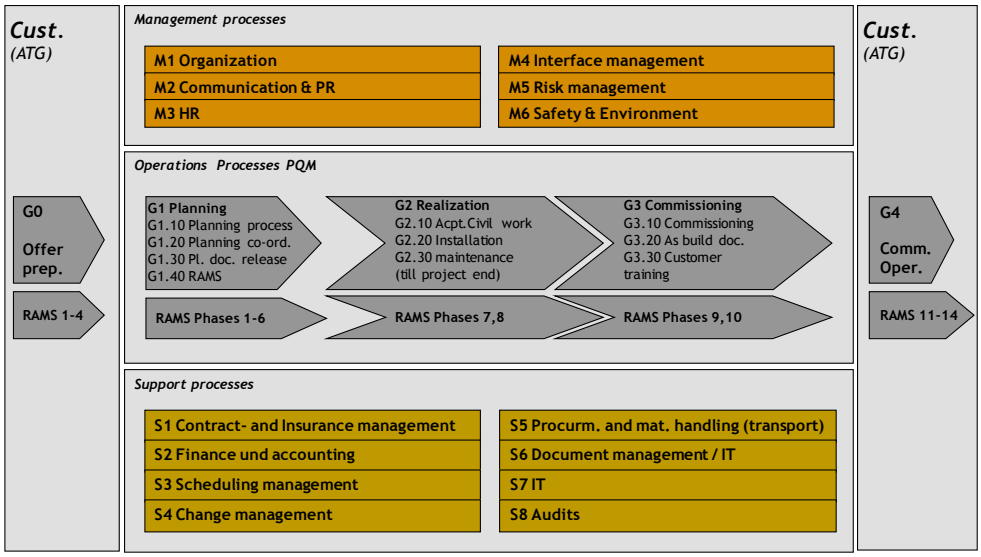

Figure 6. The organization – Management-, Operations- and Support Processes

This handbook has been created specifically for the implementation/execution of the Gotthard Tunnel, in order to have one common understanding and spirit of Project Management over all involved parties (client, consortia partners and subcontractors).

4.3 A detailed Commissioning, Integration and Acceptance Plan

A multi-vendor and multi-disciplined task, where the ICT domain plays an important role as the pivotal point and often takes over the overall responsibility for the entire Railways Technology:

Inspection, Testing, validation, verification, etc. is executed according the RAMS phases specified in SE EN50126.

Goal of the inspection and testing is to demonstrate (control and validate) that the realized systems fulfill all the given and contractually agreed requirements (RAMS Phase 4-6).

Several documents are defined to support the overall integration process:

- Validation plan (overall and lot specific)
- Control Plan (overall and lot specific)
- Factory Acceptance Test (FAT)
- Site Acceptance Test (SAT)

Figure 7. shows an overview on how inspection and testing is done in the Gotthard Base Tunnel project:

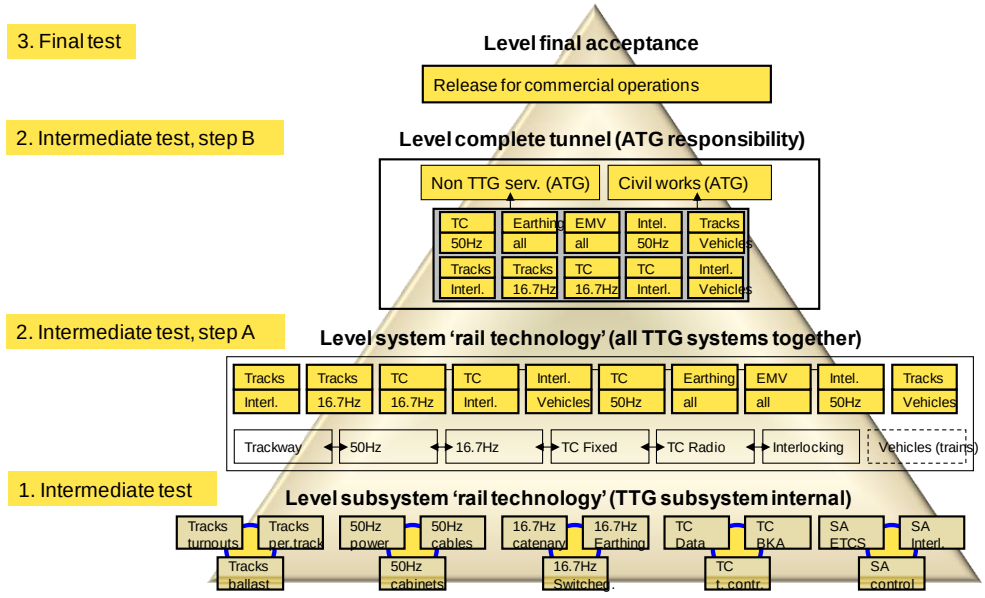

Figure 7. Multi-vendor and multi-disciplined Commissioning, Integration and Acceptance

1: System / Lots tests – Lead Transtec Gotthard (Alcatel-Lucent for their lots)

In this phase all lots (subsystems) are doing their own FAT and SAT. There are several phases according to the implementation phase in the tunnel. Several sections (east tube, west tube) are tested separately. Finally all "single" systems are tested and validated.

All results are documented and signed in a clear defined structure and stored.

2: Intermediate test, step A - Lead Transtec Gotthard (Alcatel-Lucent for their lots)

Base for this phase is a successful execution and approval of all FAT and SAT of all involved disciplines.

A first time inspection and testing is done interdisciplinary over all involved lots by tunnel section. After successful execution and approval of all tunnel sections, an overall inspection and test is executed. All results are documented and signed in a clear defined structure and stored.

2: Intermediate test, step B – Lead customer AlpTransit Gotthard together with Transtec Gotthard (Swiss Federal Railways participating)

Base for this phase is a successful execution and approval of all intermediate tests, step A.

In this phase also non Transtec Gotthard lots like civil work, rolling stock, national railway infrastructure etc. becomes part of the inspection and testing. Also in that phase all results are documented and signed in a clear defined structure.

3: Final test – lead customer AlpTransit Gotthard together with Swiss Federal Railways (Transtec Gotthard participating and supporting)

This step is in fact the final acceptance of the overall Gotthard Base tunnel and is running over several months under commercial railway conditions.

4.4 Partner approach

Selecting and legally binding the right partner at the right time (before start of the RFP) is crucial. Clear rules, open books and back-to-back agreements between all involved parties are the major pillars to build up a high confidence level and constructive culture, this even more needed with partners who are competitors in other projects.

Changes (organizational, legal, products) within Alcatel-Lucent and client/partners/subcontractors are normal for such long lasting projects and each project manager has to deal with it. A strict Resource Planning and Skill Management on both sides help to cope with fluctuation (know-how drain) during project implementation. A special emphasis should also be on how to deal with technology change.

5 Conclusion

These lessons learnt are based on our experience on the implementation of the Railways Technology for the Gotthard Base Tunnel, where Alcatel-Lucent is a member of the consortium Transtec Gotthard and responsible for the overall Telecom and IT solutions in this complex and fascinating project.

Over the course of the Gotthard project so far (start 2005, end 2016), the above mentioned measures have been implemented, adopted and successfully put into practice by all consortium and team members. A culture of confidence between client, supplier and all involved subcontractors is the result and the successful implementation (on time and on budget) of the first section of the tunnel (15km) the proof.

While working on a infrastructure project of such magnitude is a very challenging and demanding undertaking, it does have its rewards. Everyone working on this project feels an enormous sense of pride at playing their part in building what will be the world’s longest tunnel and a true engineering landmark.

6 Acknowledgements

Many thanks to all involved in this project, the Alcatel-Lucent project team with its partners, the consortium members of Transtec Gotthard and the customer AlpTransit Gotthard, for the many discussions, thoughts and inputs necessary to create this paper.

7 References

No direct references but many discussions and thoughts from our partners as well as the customer AlpTransit Gotthard and Swiss Federal Railways.