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System Concept_CCS - Granularity Concepts and Principles - Case Study EAL



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1 Document History

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2 Current draft Traffic CS Architecture

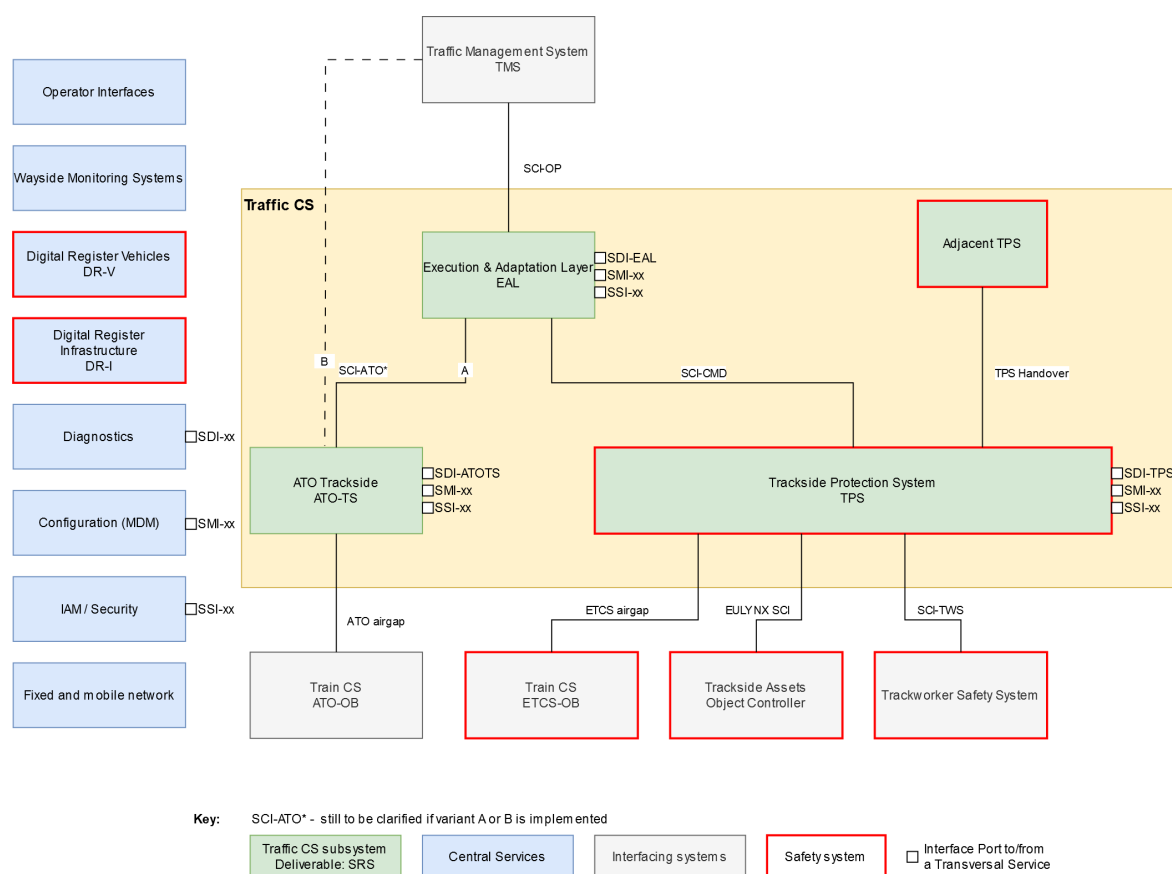


Figure 1 - Traffic CS Operational Data Flow

Source of Figure 1: See SPT2TRAFFIC-4457, Figure 3 (SPT2TRAFFIC-4815).
[SPT2ARC-2340]

In this document the Granularity concepts and principles document is exemplarily applied for Execution & Adaption Layer (EAL) for analysing

- 1.) definition of EAL as a subsystem
- 2.) standardisation of SCI-OP and SCI-CMD

with which level of standardisation. The interface SCI-ATO shall be analysed in another case study for ATO-TS. [SPT2ARC-2343]

In this case study the following three alternatives are in the scope:

- Option 1: EAL is a separate subsystem and the interface EAL/TPS is harmonised
- Option 2: EAL is a separate subsystem and the interface EAL/TPS is not harmonised
- Option 3: EAL and TPS are integrated in the same subsystem but with non-functional requirements which are sufficient to develop a subsystem compliant with CBO

In all cases the interface to TMS SCI-OP is taken also into account but the interface to ATO TS SCI-ATO is not in the focus. [SPT2ARC-2687]

In all options EAL shall be for the target architecture a harmonised subsystem or part of a harmonised subsystem in option 3. For a migration phase a partial harmonisation is assumed, so that in a first step only the EAL-TPS interface is fully harmonised. [SPT2ARC-2914]

In the analysis the reference to these three alternatives is done with:

- Option 1: Harmonised SCI-CMD
- Option 2: Non-harmonised SCI-CMD
- Option 3: Only one Subsystem

[SPT2ARC-2688]

In the analyses it is assumed that Option 1 is the objective which is compared with the other two options for the different criteria. [SPT2ARC-2686]


The description of the EAL sub-system can be found here: [SPT2TRAFFIC-5418 - Plan Execution System \(PES\)](#).


[SPT2ARC-2341]

3 Example on how to Apply the Template for the Qualitative Analysis


Sub-system name	Execution & Adaption Layer (EAL)
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[SPT2ARC-2344]


Objective	 SPT2ARC-942 - Interoperability for cross border operation / open network access
• Applicability	Taking into account that there is a high dependency between EAL and TPS, at least a relevancy of EAL for interoperability is expected.
• Specific benefits	EAL is not directly relevant for interoperability but separation from interoperability constituents is beneficial. By using a partly harmonized interface towards TMS, national specific TMS solutions can be supported without impacting TPS. The national specific TMS would not need to be adapted based on the EAL adaptation function.
• Specific risks	Changes to harmonised EAL functions or interfaces need to be agreed across the sector.
• Comparison of the options	<p><i>Option 1: Harmonised SCI-CMD:</i> EAL is clearly separated from interoperability constituents like TPS which helps to reduce cost for NoBo certification.</p> <p><i>Option 2: Non-harmonised SCI-CMD:</i> EAL is clearly separated from interoperability constituents like TPS which helps to reduce cost for NoBo certification but it maybe needs more argumentation. Without harmonised interface, market specific or project specific interfaces have to be developed, tested and accepted which implies</p>


Objective	 SPT2ARC-942 - Interoperability for cross border operation / open network access
	<p>additional costs.</p> <p><i>Option 3: Only one Subsystem:</i> Increased costs for NoBo certification expected if interoperability constituents like TPS is not clearly separated from e.g. EAL.</p>

[SPT2ARC-2323]


Objective	 SPT2ARC-941 - Cost Reduction at the LCC level
• Applicability	Yes, but the objective SPT2ARC-941 is in the focus of the CBA and will be analysed more in detail in the CBS.
• Specific benefits	Cost reduction can only come from larger volumes per supplier.
• Specific risks	Sub-systems with additional harmonised interfaces are more costly to harmonise, develop, certify, and also to produce.
• Comparison of the options	<p><i>Option 1: Harmonised SCI-CMD:</i> Initial harmonisation is expensive and changes need agreements and time. An European market helps to share the costs.</p> <p><i>Option 2: Non-harmonised SCI-CMD:</i> It is assumed that some Infrastructure Managers need to introduce a market specific standard interface which will not allow the suppliers to apply their best fit existing interface, i.e. variation needs to be supported and costs related to variation is not shared in whole Europe.</p> <p><i>Option 3: Only one Subsystem:</i> Initial harmonisation of non-functional requirements is expensive but assumed to be cheaper than full harmonisation. Suppliers are able to use their best fit internal solution.</p>


[SPT2ARC-2689]

Objective	 SPT2ARC-958 - Creating open markets for sub-systems and ensure competition
• Applicability	Yes
• Specific benefits	Standardised EAL creates a market for EAL which is independent to the safety core Trackside Protection System market and to the TMS market.
• Specific risks	<p>There is not a big volume for EAL which would lead to a real cost reduction.</p> <p>It might not be fully possible to specify the EAL independent from the TPS. This depends on the level of harmonization of the safety logic.</p> <p>Another risk is that ATO-TS will probably be less demanded than TPS. If we make the interface SCI-ATO mandatory, an EAL needed only for TPS operation would be more expensive than really needed. If we make it optional, the incentive of developing a full blown EAL could be very small.</p> <p>Harmonised, aligned specifications of the subsystems TPS and EAL is</p>


Objective	 SPT2ARC-958 - Creating open markets for sub-systems and ensure competition
	needed which might be difficult to achieve.
<ul style="list-style-type: none"> • Comparison of the options 	<p>Cost reduction can only come from larger volumes per supplier in case of harmonised products. Sub-systems with additional harmonised interfaces are more costly to harmonise, develop, certify, and also to produce.</p> <p><i>Option 1: Harmonised SCI-CMD:</i> EAL with standardised interfaces creates in principle a market for EAL which is independent to the safety core Trackside Protection System market and to the TMS market. There is not a big volume for EAL which would lead to a real cost reduction. It might not be fully possible to specify the EAL independent from the TPS. This depends on the level of harmonization of the safety logic.</p> <p><i>Option 2:</i> Without harmonised interface, market specific or project specific interfaces have to be developed, tested and accepted which would be needed for an open market.</p> <p><i>Option 3: Only one Subsystem:</i> EAL and TPS functionality is provided by one supplier as an entity.</p>

[SPT2ARC-2322]


Objective	 SPT2ARC-957 - Create broader supplier base
<ul style="list-style-type: none"> • Applicability 	Yes
<ul style="list-style-type: none"> • Specific benefits 	EAL with Basic Integrity (or with a lower safety integrity level as TPS - to be further analysed) will allow a broader supplier base whose core competence is not how to provide a safety case.
<ul style="list-style-type: none"> • Specific risks 	<p>There might be no separate / additional EAL suppliers because the volumes are limited so that only the established suppliers will provide solutions, who will offer a combined solution with TPS.</p> <p>Another risk is that ATO-TS will probably be less demanded than TPS. If we make the interface SCI-ATO mandatory, an EAL needed only for TPS operation would be more expensive than really needed. If we make it optional, the incentive of developing a full blown EAL could be very small.</p>
<ul style="list-style-type: none"> • Comparison of the options 	<p>Larger volumes are required to increase number of suppliers, conditions must be attractive to suppliers.</p> <p><i>Option 1: Harmonised SCI-CMD:</i> EAL with Basic Integrity will allow a broader supplier base whose core competence is not how to provide a safety case. There might be no separate / additional EAL suppliers because the volumes are limited so that only the established suppliers will provide solutions, who will offer TPS and EAL with the harmonised interface.</p> <p><i>Option 2: Non-harmonised SCI-CMD:</i> An EAL supplier need to support variants of EAL-TPS interface to different TPS.</p> <p><i>Option 3: Only one Subsystem:</i> EAL and TPS functionality is provided by</p>


Objective	 SPT2ARC-957 - Create broader supplier base
	one supplier as an entity.

[SPT2ARC-2319]



Objective	 SPT2ARC-956 - Support integration of new systems into existing environments
• Applicability	Yes
• Specific benefits	EAL supports the integration of Trackside Protection System into TMS environment with some national specifics (when adding or modifying TMS there is no need to update the TPS, only update EAL). Assumption: "national specifics" have only impact on EAL and TMS but have no impact on TPS. So the integration of standard TPS with existing TMS is supported by EAL.
• Specific risks	Introduction of EAL with adaptation functionality increases the risk for non-harmonisation of TMS/Traffic CS interface if the adapter is misused. There might be high integration efforts between EAL and TMS.
• CBA results	Tbd
• Comparison of the options	Support of existing TMS is seen as a valid migration scenario. All options can have an adaptation function to existing TMS. <i>Option 1: Harmonised SCI-CMD:</i> An adapter for a specific existing TMS can be used via harmonised interface to TPS by different TPS. For options 2 and 3 there is nothing specific to be highlighted.

[SPT2ARC-2318]


Objective	 SPT2ARC-953 - Support Migration
• Applicability	Yes
• Specific benefits	It is an adapter towards TMS so that the current TMS solutions could be used for longer time while the TPS part is already modernized for the SP target architecture. As a consequence there is no need to update the TMS, only EAL has to be updated when adding or modifying TPS. The relation of TMS to Traffic CS is "1 to n". So single Traffic CS areas part of one TMS could be already migrated so that a step-wise migration is possible.
• Specific risks	EAL has to be adapted for national specifics and not the complete interface EAL/TMS can be harmonized as long as there is no fully harmonized TMS solution. The current IXL and RBC solutions might be used only with higher integration efforts when introducing an EAL (an adapter or a change


Objective	 SPT2ARC-953 - Support Migration
	interface would be needed most probably). Migrating current command-control systems towards EAL implies a migration of IXL/RBC towards TPS.
<ul style="list-style-type: none"> • Comparison of the options 	<p>Support of existing TMS is seen as a valid migration scenario. All options can have an adaptation function to existing TMS.</p> <p><i>Option 1: Harmonised SCI-CMD:</i> A specific existing TMS can be used for different TPS by using an adapter which has a harmonised interface to TPS.</p> <p><i>Option 1 and 2:</i> For countries where automatic route setting subsystems are already deployed the following strategy for the migration to TPS could be applied: You upgrade the existing subsystems to include EAL functionalities and interfaces so that they can interface with the TPS. Therefore it allows a step-wise migration from IXL to TPS.</p> <p>For option 3 there is nothing specific to be highlighted.</p>

[SPT2ARC-2321]


Objective	 SPT2ARC-951 - Long term sustainment of the service /  SPT2ARC-949 - Manage different lifecycles of systems
<ul style="list-style-type: none"> • Applicability 	Yes
<ul style="list-style-type: none"> • Specific benefits 	Decompose operational plan into granular and very stable TPS commands decouples life span of TMS and TPS. As a consequence, in most cases there is no need to update the TMS, only EAL has to be updated when adding or modifying TPS.
<ul style="list-style-type: none"> • Specific risks 	EAL is not sufficiently independent from TPS commands to allow less frequent updates of TPS.
<ul style="list-style-type: none"> • CBA results 	Tbd
<ul style="list-style-type: none"> • Comparison of the options 	Options with separate subsystem allow decoupling of EAL and TPS which probably have different lifespans. TMS is anyway decoupled.

[SPT2ARC-2320]


Objective	 SPT2ARC-947 - Interchangeability
<ul style="list-style-type: none"> • Applicability 	Yes
<ul style="list-style-type: none"> • Specific benefits 	For a target architecture with a fully harmonized TMS and TPS the interfaces can be fully harmonised allowing interchangeability so that EAL provides the possibility for non-safety related updates (basic

Objective	 SPT2ARC-947 - Interchangeability
	integrity EAL functions are independent from TPS)
• Specific risks	<p>Also with fully harmonised EAL intergration and cdrtification efforts are expected so that exchangeability will be achieved but not interchangeability.</p> <p>EAL is an adapter so that no interchangeability can be achieved. As long as TMS has national specifics with implications on the interface interchanageability is not achieved.</p> <p>If EAL is a means for migration with national specific TMS the interchangeability is not achieved.</p> <p>So far, TPS is seen as simple safety logical (accepting or rejecting commands for EAL). To achieve interchangeability for TPS-EAL interface, it might constraint EAL to include the same logic as TPS.</p>
• Comparison of the options	<p><i>Option 1: Harmonised SCI-CMD:</i> Fully harmonised EAL can be interchanged but there is a high risk to not achieve this.</p> <p><i>Option 3: Only one Subsystem:</i> If EAL is delivered with TPS, only the complete subsystem can be interchanged.</p> <p>For option 2 there is nothing specific to be highlighted.</p>


[SPT2ARC-2303]

Objective	 SPT2ARC-1632 - Exchangeability
• Applicability	Yes
• Specific benefits	For a target architecture with a harmonized TMS and TPS the interfaces can be fully harmonised allowing exchangeability so that EAL provides the possibility for non-safety related updates (basic integrity EAL functions are independent from TPS)
• Specific risks	For achieving exchangeability first a harmonization of TMS and TPS must be achieved. It assumed that TPS is harmonised before a harmonisation of TMS can be reached. So there is a risk for exchangeability of EAL as long as TMS is not fully harmonised.
• Comparison of the options	<p><i>Option 1: Harmonised SCI-CMD:</i> Fully harmonised EAL can be exchanged but there is the risk to achieve this only on a long term perspective.</p> <p><i>Option 3: Only one Subsystem:</i> If EAL is delivered with TPS, only complete subsystem can be exchanged.</p> <p>For option 2 there is nothing specific to be highlighted.</p>


[SPT2ARC-2335]

Objective	 SPT2ARC-945 - Independent changeability for non-safe and safe sub-systems
• Applicability	Yes
• Specific benefits	The decomposition of EAL from TPS separates components that contain safety critical functions (TPS) from components that contain only non-safety critical functions (EAL). No authorisation is needed for the non-safety critical parts. EAL can be updated independently or more frequently. Designs can be simpler for EAL and changes less costly. EAL clusters non-safety logic. This facilitates that this subsystem concentrates on timetable&infrastructure optimisation, independent from the safety logic. This decoupling of business logic from safety logic simplifies the safety assurance process of single subsystems.
• Specific risks	EAL is not sufficiently independent from TPS commands to allow less frequent updates of TPS. It might not be fully possible to specify the EAL independent from the TPS. This depends on the level of harmonization of the safety logic.
• Comparison of the options	No difference between options for the assessment. <i>Option 3: Only one Subsystem:</i> Ensured by non functional requirements for the subsystem under responsibility of one supplier. For options 1 and 2 there is nothing specific to be highlighted.


[SPT2ARC-2337]

Objective	 SPT2ARC-943 - Different Performance or RAM requirements of sub-systems
• Applicability	Yes
• Specific benefits	A failure of TPS is immediately critical in relation to PRAM requirements while a failure of EAL would be critical only after a certain time (all trains can operate until EoA is reached). For RAM-related requirements there is no difference for the three options.
• Specific risks	-
• Comparison of the options	No difference between options for the assessment. <i>Option 3: Only one Subsystem:</i> Ensured by non functional requirements for the subsystem under responsibility of one supplier. For options 1 and 2 there is nothing specific to be highlighted.



[SPT2ARC-2333]


Objective	 SPT2ARC-959 - Independent changeability of shared functionality
• Applicability	N/A, providing shared functionality is not the target of the EAL
• Comparison of the options	<p><i>Option 3: Only one Subsystem:</i> Supplier has the possibility to create a solution with shared functionality between EAL and TPS.</p> <p>For options 1 and 2 there is nothing specific to be highlighted.</p>

[SPT2ARC-2330]


Objective	 SPT2ARC-1028 - Maintain and upgrade legacy systems not supported by the original supplier
• Applicability	Yes
• Specific benefits	One objective of EAL is to support legacy TMS and to modernize the TPS independent from TMS towards the target system.
• Specific risks	EAL has to be adapted for national specifics and not the complete interface EAL/TMS can be harmonized as long as there is no fully harmonized TMS solution.
• Comparison of the options	<p>EAL could be exchanged even without original EAL supplier under the assumption that new EAL needs to be compatible with the TPS legacy system.</p> <p><i>Option 3: Only one Subsystem:</i> If EAL is delivered with TPS, only complete subsystem can be replaced.</p> <p>For options 1 and 2 there is nothing specific to be highlighted.</p>

[SPT2ARC-2328]



Rule	 SPT2ARC-1283 - Interface only with justifiable data
• Applicability	Yes
• Specific benefits	<ul style="list-style-type: none"> • SCI-CMD • SCI-OP • SCI-ATO <p>Description of the data, see  SPT2TRAFFIC-4457, chapters 3.2.1, 4.5.1 “SCI-CMD”, 4.5.2 “SCI-ATO” and 4.6.2 “SCI-OP”</p>
• Specific risks	<p>Overspecification of interfaces. Interfaces with the same content but different format.</p> <p>In case that EAL is used as an adapter there are national specific</p>


Rule	 SPT2ARC-1283 - Interface only with justifiable data
	applications for SCI-OP.
• Remarks	SCI-ATO could go directly to TMS without EAL. This depends on the architecture decisions for ATO-TS.
• Comparison of the options	<p><i>Option 1: Harmonised SCI-CMD:</i> High risk to not achieve needed harmonisation on this level and to include more then necessary into the interface as a compromise.</p> <p>For options 2 and 3 there is nothing specific to be highlighted.</p>

[SPT2ARC-2326]



Rule	 SPT2ARC-1282 - Avoid mixing functions of different quality attributes
• Applicability	Yes
• Specific benefits	<p>EAL contains functions with Basic Integrity which are for that reason separated from TPS.</p> <p>A failure of TPS is immediately critical while a failure of EAL would be critical only after a certain time (all trains can operate until EoA is reached).</p> <p>Remark: For Maintainability requirements there is not difference.</p>
• Specific risks	EAL is not sufficiently independent from TPS commands
• Comparison of the options	No difference between options in the assessment.

[SPT2ARC-2325]


Rule	 SPT2ARC-1279 - Isolate optional functions
• Applicability	Yes
• Specific benefits	<p>EAL is an adapter which is optional to legacy TMS.</p> <p>EAL might have some optional functions for optimization purposes (e.g. sequence and timings of commands to TPS like points staggering).</p>
• Specific risks	See  SPT2ARC-2328
• Comparison of the options	<i>Option 3:</i> There is the risk that a supplier does not separate non-safety-related functionality to another sub-system so that relevant functions are not isolated.

Rule	 SPT2ARC-1279 - Isolate optional functions
	For options 1 and 2 there is nothing specific to be highlighted.


[SPT2ARC-2324]

Rule	 SPT2ARC-1278 - Ensure independent life-cycles
• Applicability	Yes
• Specific benefits	Stable TPS shall be protected with an EAL which could be adapted more frequently according to the needs of the national specifics of TMSs.
• Specific risks	See  SPT2ARC-2337 : EAL is not sufficiently independent from TPS commands to allow less frequent updates of TPS. It might not be fully possible to specify the EAL independent from the TPS. This depends on the level of harmonization of the safety logic.
• Comparison of the options	<i>Option 3:</i> There is the risk that a supplier does not separate non-safety-related functionality to another sub-system so that relevant functions are not isolated. For options 1 and 2 there is nothing specific to be highlighted.


[SPT2ARC-2314]

Rule	 SPT2ARC-1276 - Aim at realizing functions in software
• Applicability	Yes
• Specific benefits	By extracting the basic integrity functions it is supported to run EAL in a virtual environment.
• Specific risks	-
• Comparison of the options	No difference between options in the assessment.


[SPT2ARC-2312]

Rule	 SPT2ARC-1275 - Aim for balanced integration effort
• Applicability	Yes
• Specific benefits	No specific benefit. Remark for SCI-ATO: integration effort is the same if it is a separate interface of Traffic CS (that means direct interface between TMS and ATO-TS) or if it is integrated in SCI-OP.
• Specific risks	For SCI-CMD there is the risk of a high dependency between both sub-systems (there might be the need for EAL to know the safety logic); pre-condition: harmonized safety logic. Double engineering work, if the aim is that TPS and EAL are operated by different suppliers in the same area, the effort of the engineering work will be duplicated. Each supplier will need to deal with the specific track layout characteristics.
• Comparison of the options	<i>Option 2: Non-harmonised SCI-CMD:</i> Integration effort increases for new variants of the interface between EAL and TPS. <i>Option 3: Only one Subsystem:</i> Supplier of subsystem is responsible to integrate EAL and TPS in one subsystem. For option 1 there is nothing specific to be highlighted.

[SPT2ARC-2310]

Rule	 SPT2ARC-1270 - Aim for balanced certification effort
• Applicability	Yes
• Specific benefits	With the introduction of EAL there is one additional interface between EAL and TPS but for certification there is also the benefit that basic integrity functions are separated from the safety system for which in any case should be less requirements for certification.
• Specific risks	Non-functional requirements assigned to specific functions could also result in a balanced certification effort.
• Comparison of the options	<i>Option 1: Harmonised SCI-CMD:</i> There is the risk to not achieve needed harmonisation on this level but if it is reached certification should be easier following aligned rules. <i>Option 2: Non-harmonised SCI-CMD:</i> Certification of a new variant will need some additional effort. <i>Option 3: Only one Subsystem:</i> Supplier of subsystem is responsible to have a clear split between safety-critical and non-safety critical functionality and a clear split between interoperability and non-interoperability related functionality.


[SPT2ARC-2295]

Rule	 SPT2ARC-1271 - Aim for balanced maintenance effort
• Applicability	Yes
• Specific benefits	Stable TPS shall be protected with an EAL which could be adapted more frequently according to the needs of the national specifics of TMSs. It is easier to maintain separately the EAL (non safe, national specific) and the TPS (safe, harmonized).
• Specific risks	<p>If the interface SCI-CMD is not harmonized it would allow a higher flexibility for innovation related to safety logic and optimizations between TPS and EAL.</p> <p>Non-functional requirements assigned to specific functions could also result in a balanced maintenance effort.</p> <p>In case of technical incident, the diagnosis might be more difficult especially if SCI-CMD is not harmonized.</p> <p>New harmonised interface means more maintenance efforts for interface specifications.</p>
• Comparison of the options	<p><i>Option 1: Harmonised SCI-CMD:</i> It is easier to maintain separately the EAL (non safe, national specific) and the TPS (safe, harmonized). New harmonised interface means more maintenance efforts for interface specifications which means less efforts compared with the maintenance of all the national interfaces if this interface is not harmonised. Stable TPS shall be protected with an EAL which could be adapted more frequently according to the needs of the national specifics of TMSs.</p> <p><i>Option 2: Non-harmonised SCI-CMD:</i> In case of technical incident, the diagnosis might be more difficult especially if SCI-CMD is not harmonized.</p> <p><i>Option 3: Only one Subsystem:</i> Non-functional requirements assigned to specific functions could also result to a separation in a specific subsystem and therefore result in a balanced maintenance effort.</p>




[SPT2ARC-2308]

Rule	SPT2ARC-1272 - Aim for a strict separation of hardware and software
• Applicability	Yes
• Specific benefits	EAL has no special HW needs. Separation rules are followed.
• Specific risks	-
• Comparison of the options	No difference between options in the assessment.


[SPT2ARC-2306]

Rule	 SPT2ARC-1281 - Effort of changing products only for harmonisation
• Applicability	Yes
• Specific benefits	EAL supports the integration of Trackside Protection System into TMS environment with some national specifics. Different kind of TPS systems can be supported with an EAL.
• Specific risks	Normally the introduction of EAL is different to today's architectures with RBC and Interlocking. So with EAL it requires more effort to use today's products.
• Comparison of the options	Less harmonisation at the interface between EAL and TPS could allow suppliers to re-use better existing solutions.


[SPT2ARC-2304]

Rule	 SPT2ARC-1280 - Evolution vs. stability of interfaces
• Applicability	Yes
• Specific benefits	EAL is not backwards compatible but as the basic integrity functions are separated from the safety subsystem it helps for the stability of the safe subsystem and allows more agile changes for basic integrity functions for which a less restrict certification process is applicable. EAL supports the backwards compatibility for existing TMS.
• Specific risks	As long as the target architecture with TMS is not available there might be extensive project specific parts for TMS / EAL interface. But if there is no EAL there will be extensive project specific parts of the TPS interfaces. See  SPT2ARC-2328 and  SPT2ARC-2335 .
• Comparison of the options	<i>Option 1: Harmonised SCI-CMD:</i> Harmonised interface between EAL and TPS hinders evolution since it takes longer to introduce changes and changes often impact backwards compatibility <i>Option 2: Non-harmonised SCI-CMD:</i> Evolution/innovation easier for the supplier. <i>Option 3: Only one Subsystem:</i> Evolution/innovation easier for the supplier.


[SPT2ARC-2302]

Rule	 SPT2ARC-1274 - Consider current granularity specifications
• Applicability	N/A. There are no existing harmonised European specifications.
• Comparison of the options	No difference between options in the assessment.


[SPT2ARC-2300]


Rule	 SPT2ARC-1273 - New major enhancements as separate sub-system
• Applicability	N/A – it is not the target of EAL to isolate functionalities of major enhancements in a new subsystem
• Comparison of the options	Options are not affected by major enhancements.

[SPT2ARC-2299]


Rule	 SPT2ARC-1603 - Avoidance to decompose sub-systems for already established sub-systems retrospectively
• Applicability	N/A – there are no harmonised, already established sub-systems
• Comparison of the options	

[SPT2ARC-2298]



Rule	 SPT2ARC-1277 - Critical mass of a sub-system
• Applicability	Yes
• Specific benefits	EAL with Basic Integrity will allow a broader supplier base whose core topic is not how to provide a safety case.
• Specific risks	The critical mass might not be achieved so that there are no additional suppliers who provide EAL without a combined solution with TPS.
• Comparison of the options	<i>Option 1: Harmonised SCI-CMD:</i> There is the risk that there is no critical mass achieved.

Rule	 SPT2ARC-1277 - Critical mass of a sub-system
	For options 2 and 3 there is nothing specific to be highlighted.




[SPT2ARC-2339]

Rule	 SPT2ARC-1289 - Evaluation to use parametrisation
• Applicability	Yes
• Specific benefits	With EAL as an adapter it is avoided that there different TPS solutions are needed for different TMS including national specifics.
• Specific risks	-
• Comparison of the options	No difference between options in the assessment.



[SPT2ARC-2338]

Rule	 SPT2ARC-1288 - Avoidance of options
• Applicability	Yes
• Specific benefits	Options are limited to not fully harmonised TMS and different kind of TPS.
• Specific risks	See  SPT2ARC-2318 A reasonable option would be to provide or not the ATO-related part (the SCI-ATO interface), as it will probably much less demanded than the TPS-related part. This option might hamper the market for full-blown EALs.
• Comparison of the options	No difference between options in the assessment.


[SPT2ARC-2336]


Rule	 SPT2ARC-1287 - Ontologies to define semantics
• Applicability	Yes
• Specific benefits	Ontologies should define the semantics of data exchange and expected behaviour of sub-systems of Traffic CS domain architecture. To be done by Traffic CS domain, see  SPT2TRAFFIC-4457
• Specific risks	See  SPT2ARC-2318
• Comparison of the options	Less defined semantics needed with less interfaces.

[SPT2ARC-2296]


Rule	 SPT2ARC-1607 - Harmonisation for functional apportionment
• Applicability	Yes
• Specific benefits	Harmonisation for functional apportionment is needed for interface to TMS.
• Specific risks	See  SPT2ARC-2318
• Comparison of the options	

[SPT2ARC-2334]


Rule	 SPT2ARC-1606 - Independent changeability of interfaces
• Applicability	Yes
• Specific benefits	EAL is the adapter which enables independent changeability of TPS and TMS and independent interfaces <ul style="list-style-type: none"> • SCI-CMD • SCI-OP • SCI-ATO (interface candidate)

Rule	 SPT2ARC-1606 - Independent changeability of interfaces
• Specific risks	It might not be fully possible to specify the EAL independent from the TPS.
• Comparison of the options	<p><i>Option 1: Harmonised SCI-CMD:</i> There is a high dependency between EAL and TPS functionality related to the Safety Logic. Even having an harmonised interface between them, changes could impact both and additionally the interface.</p> <p>For options 2 and 3 there is nothing specific to be highlighted.</p>


[SPT2ARC-2332]

Rule	 SPT2ARC-1605 - Decomposition only if linked to a harmonisation level
• Applicability	Yes
• Specific benefits	The definition of EAL separates basic integrity functions from safety functions of TPS and is at least related to functional apportionment.
• Specific risks	-
• Comparison of the options	Assessment depends on agreed harmonisation level and related benefits/drawbacks.


[SPT2ARC-2331]

Rule	 SPT2ARC-1593 - Avoidance of SRACS
• Applicability	Yes
• Specific benefits	Currently, no SRACs are foreseen.
• Specific risks	-
• Comparison of the options	<p><i>Option 3:</i> SRACs are not shared between EAL and TPS supplier since there is only one supplier so that the SRACs handling is easier.</p> <p>For options 1 and 2 there is nothing specific to be highlighted.</p>



[SPT2ARC-2329]

Rule	 SPT2ARC-1594 - Separation of shared functionality
• Applicability	N/A, providing shared functionality is not the target of the EAL
• Comparison of the options	


[SPT2ARC-2327]


Rule	 SPT2ARC-1595 - Consideration of proven in use solutions
• Applicability	N/A, there is no common proven in use solution to be taken into account.
• Comparison of the options	No difference between options in the assessment.

[SPT2ARC-2317]



Rule	 SPT2ARC-1598 - Reduce railway specific requirements
• Applicability	Yes
• Specific benefits	The EAL contain basic integrity functions so that not safety case according to railway safety standards is needed.
• Specific risks	See  SPT2ARC-2319
• Comparison of the options	<p><i>Option 3:</i> The suppliers might not separate non-safety related functions to a separate subsystem so that the specific benefit is not achieved.</p> <p>For options 1 and 2 there is nothing specific to be highlighted.</p>

[SPT2ARC-2316]



Rule	 SPT2ARC-1597 - Reduce interfaces between safety relevant subsystems
• Applicability	Yes
• Specific benefits	The safety relevant functions are only in TPS and are not spread over different subsystems (including EAL).

Rule	 SPT2ARC-1597 - Reduce interfaces between safety relevant subsystems
• Specific risks	-
• Comparison of the options	No difference between options in the assessment.




[SPT2ARC-2315]

Rule	 SPT2ARC-1599 - Adapt the environment or existing sub-systems for newly defined interfaces
• Applicability	Yes
• Specific benefits	EAL is the subsystem which is the adapter between TMS and TPS, so EAL prepares the environment/existing TMS subsystems for a newly defined TPS.
• Specific risks	See  SPT2ARC-2318
• Comparison of the options	<p><i>Option 3:</i> The suppliers might not separate EAL related functions to a separate subsystem so that the specific benefit is not achieved.</p> <p>For options 1 and 2 there is nothing specific to be highlighted.</p>



[SPT2ARC-2313]

Rule	 SPT2ARC-1602 - Harmonised requirements
• Applicability	Yes
• Specific benefits	EAL helps to have no national requirements for TPS
• Specific risks	See  SPT2ARC-2318
• Comparison of the options	<p><i>Option 2: Non-harmonised SCI-CMD:</i> It is assumed that some Infrastructure Managers will introduce a market specific standard interface which will not allow the suppliers to apply their best fit existing interface. I.e. variation needs to be supported and costs related to variation is not shared in whole Europe and suppliers only offer their imperfect interface.</p> <p>For options 2 and 3 there is nothing specific to be highlighted.</p>








[SPT2ARC-2311]

Rule	 SPT2ARC-1627 - Intermediate step for migration
• Applicability	Yes
• Specific benefits	See  SPT2ARC-2321
• Specific risks	See  SPT2ARC-2321
• Comparison of the options	<p>Support of existing TMS is seen as a valid migration scenario. All options can have an adaptation function to existing TMS.</p> <p><i>Option 1: Harmonised SCI-CMD:</i> An adapter for a specific existing TMS can be used via harmonised interface to TPS by different TPS.</p> <p>For options 2 and 3 there is nothing specific to be highlighted.</p>

[SPT2ARC-2309]

Rule	 SPT2ARC-1626 - Common ontology for data element in a domain architecture
• Applicability	Yes
• Specific benefits	<p>All data elements of Traffic CS domain architecture should use a common semantic dictionary, i.e. all data elements should be defined in a common ontology.</p> <p>To be done by Traffic CS domain, see  SPT2TRAFFIC-4457</p>
• Specific risks	-
• Comparison of the options	Less defined semantics needed when less interfaces.

[SPT2ARC-2297]

<p>Additional consideration of advantages and disadvantages which are explained in  SPT2ARC-415 - Problem statement but which have not been considered sufficiently in the analysis so far</p>	<p> SPT2ARC-1237 Limitation for innovations /</p> <p> SPT2ARC-1236 Obstacle for innovations: Option 3 gives more freedom for innovation than the other both options. Option 1 has the highest limitation for innovation with the full standardised interface. In the assessment it is sufficiently considered with  SPT2ARC-2308 and  SPT2ARC-2302.</p> <p> SPT2ARC-1244 Maintenance of specifications: Covered with  SPT2ARC-2308.</p> <p>There is the risk of option 2 that interfaces will be specified on</p>
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national level in different ways.

[SPT2ARC-2695]

As basis for a conclusion a summary of the argumentations including a weighting is given here: [Annex for EAL Case Study - Summary and Weighting](#). In total option 1 "EAL is a separate subsystem and the interface EAL/TPS is harmonised" is assessed better than the other two options.

[SPT2ARC-2690]

Conclusion for introducing a new subsystem

[remark: This is only a draft and therefore marked in yellow and shall show a possible conclusion]

In total the benefits in relation to

- separate EAL with basic integrity functions from safe TPS and
- the migration benefits of EAL as an adapter solution

weight higher than the risk that there might be no new suppliers offering EAL who does not offer a combined solution with TPS.

A final analysis can be done only based on the full specification of the functionality. The current case study is based on the assumptions on the functionality in the system concept.

[SPT2ARC-2307]

Conclusion for introducing new interfaces

[remark: This is only a draft and therefore marked in yellow and shall show a possible conclusion]

EAL needs interface specification towards TMS, ATO-TS and TPS:

- SCI-CMD
- SCI-OP
- SCI-ATO (interface candidate)


For a migration period SCI-OP interface can be only partly harmonised.


Only in a final target architecture the interfaces of EAL can be fully harmonised on FFFIS level.

A final analysis can be done only based on the full specification of the functionality. The current case study is based on the assumptions on the functionality in the system concept.

[SPT2ARC-2305]


4 Example for the Quantitative Analysis (CBA)

The step 2 of the granularity trade-off process defined in  SPT2ARC-2666 is fulfilled by the CBA provided by Blue Arches and the following deliverable : [ARC Mirror Group - Review of July 2024 - Tous les documents \(sharepoint.com\)](#). [SPT2ARC-2902]


The step 3 of the granularity trade-off process defined in  SPT2ARC-2666 is the object of the present chapter which is mainly a digest of the CBA deliverable **ARC Mirror Group - Review of July 2024 - Tous les documents (sharepoint.com)**. [SPT2ARC-2901]

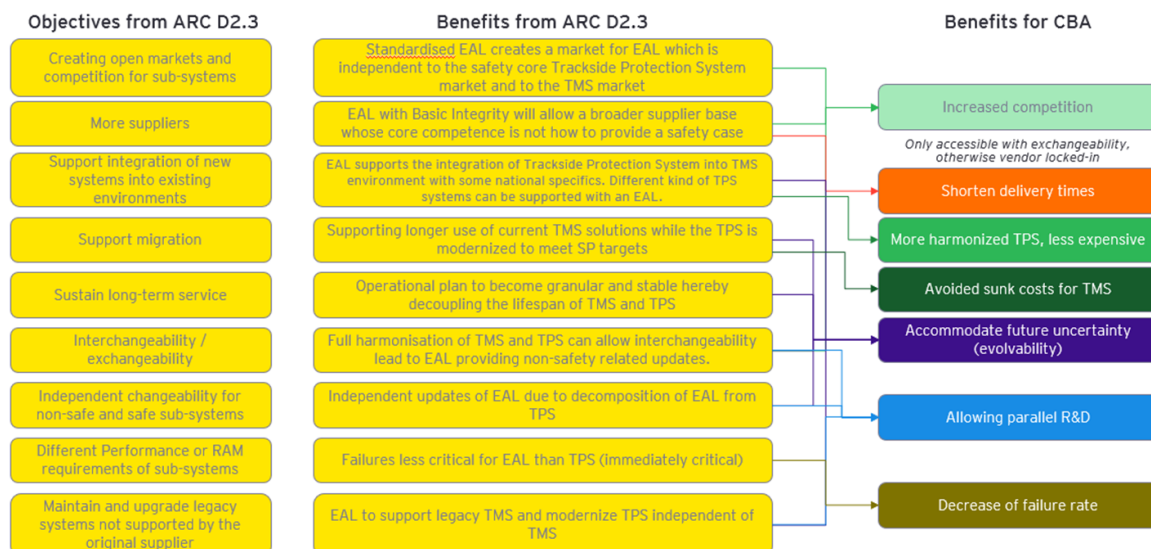
4.1 Mapping between the Granularity objectives and the CBA KPI

The following figure extracted from **ARC Mirror Group - Review of July 2024 - Tous les documents (sharepoint.com)** shows the correspondance between the granularity trade-off template and the CBA analysis :

1. The first column is a recap of the granularity objectives defined in  SPT2ARC-422 - Granularization Objectives and Principles
2. The second column is an instantiation of the granularity objectives on the specific case of the EAL
3. The third column is made of the KPI of the CBA analysis.

[SPT2ARC-2897]

The arrows between column 2 and column 3 achieve a mapping between the granularity objectives and the KPI of the CBA. This mapping is the proof that the CBA analysis can be integrated into the granularity trade-off analysis such as defined by  SPT2ARC-2665 - The process of integration of a CBA in a granularity assessment and decision is... [SPT2ARC-2895]



[SPT2ARC-2900]

4.2 Overview of the CBA

4.2.1 Method

The subsystem EAL has been created to :

- Facilitate the rollout of the TPS without modifying the existing TMS
- Separate the SIL4 functions (TPS) from the basic safety level functions (EAL)

[SPT2ARC-2899]

Therefore several upgrades of the EAL are to be forecasted all along its life-cycle for the following reasons :

- Upgrade/replacement of the TMS without any modifications of the TPS
- Improvement of the EAL without any modifications of the TPS

[SPT2ARC-2892]

As a consequence, the CBA analysis focused on the EAL upgrade scenarios. The analysis has taken into account the TPS rollout scenarios on different types of countries depending on their achievement status in the digitalization of the IXL. [SPT2ARC-2891]

4.2.2 Achievements and Limitations

The assessment of the EAL upgrade scenarios has given the possibility to take into account the following benefits :

1. Increased competition
2. Accomodate future uncertainty (evolvability)
3. Allowing parallel R&D
4. More harmonized TPS, less expensive

[SPT2ARC-2893]

The objectives "Avoided sunk costs for TMS" and "Decrease of failure rate" were not quantified because of the lack of input data. [SPT2ARC-2898]

4.3 Findings

The main finding of the CBA study is that it fits the granularity trade-off process. [SPT2ARC-2896]

Moreover, keeping in mind the limitations mentioned in the previous paragraph, the CBA analysis conclusion is that the architecture where the EAL is a separate subsystem with an harmonized interface with the TPS is the best architecture option.

[SPT2ARC-2894]