RCA Alpha – FAQ (frequently asked questions)

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1. Goals and direction

1.1. What is RCA?

RCA (= reference CCS[1] architecture) is an initiative by the members of EUG[2] and EULYNX to define a harmonized architecture for the future railway CCS, with the main goal to substantially increase the performance/TCO[3] ratio of CCS in comparison with today's implementations. Why RCA?
The reasons and main background for the RCA initiative are explained in the RCA white paper, accessible here: https://ertms.be/workgroups/ccs_architecture and here https://www.eulynx.eu/index.php/home2/37-reference-ccs-architecture-white-paper.

1.2. How will RCA help?

RCA…

- defines standardized, evolvable interfaces for all major components of the future railway CCS.
- defines a clean target architecture without legacy systems, while providing a migration path[4].
- brings in new technology and ensures that technological progress from other sectors reaches the railways.

Together this leads to substantial business cases (some railway companies have already calculated a case for an RCA-based systems).

1.3. What is the status of RCA Alpha?

The version RCA Alpha is the result of iteration 0 on the RCA performed by the RCA group in the second half of 2018 and provides a first, high-level draft of the RCA called release "alpha". RCA Alpha provides a starting point for:

- achieving the next level of understanding and commitment by the EUG and EULYNX members concerning RCA;
- organizing the next steps in the RCA development process (the RCA process is described separately) involving several working groups;
- continuing the discussion, allowing feedback, providing guidance with other stakeholders (industry, regulators, owners).

RCA Alpha is the first specification of RCA, and therefore not yet complete and precise. It is likely that the architecture will change/evolve in 2019, based on feedback we expect from within and from the outside of the RCA group.

1.4. Will RCA fully harmonize business processes of the railway companies?

RCA provides an architecture with well-defined "building-blocks". To be able to design useful building blocks, RCA will consider generic harmonized requirements. The building blocks of RCA can be used to support (according to the chosen equipment and configuration) different business processes. A (welcome) side effect may be some harmonization of business processes resulting from using the same "building-blocks". Full harmonization is not required however, as long as interoperability is warranted.

1.5. Is ATO in scope of the RCA?

Yes. RCA includes (but does not absolutely require) ATO. Different RCA target configurations will support Goa1, GoA2 and Goa3/Goa4.

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[1] CCS = command, control & signalling

[2] EUG = ERTMS Users Group

[3] TCO = total cost of ownership i.e. including initial procurement and lifecycle costs, as well as direct and indirect costs

[4] the migration path will, of course, include legacy systems in most cases

1.6. Are vehicles in scope of the RCA?

The component architecture of the vehicles with EVC, ATO, Localisation, … is part of the overall architecture the railway system must solve. So, the RCA scope includes modified functions on the vehicles and the corresponding interfaces to the vehicles. The scope of RCA does not include the architecture of the implementation of the components on the vehicles. A (separate) “reference vehicle architecture” initiative is needed to reduce the cost of bringing CCS functions to the vehicles. Currently several railways are preparing to start such an initiative (working title “OCORA” = Open CCS on-board reference architecture). And, as of 2019, Shift2Rail has a project on the railway architecture.

1.7. Are trackside assets in the scope of RCA?

The physical trackside assets per se are out of scope. For the interfaces to trackside assets RCA will reuse / build on material & processes of EULYNX.

1.8. Is a traffic management system (TMS) in the scope of RCA?

TMS is out scope, the interface to a TMS is part of RCA, especially the interface to the automatic route setting (ARS).

1.9. What is the deliverable of RCA?

The main deliverable is a set of interface specifications for the defined RCA subsystems. These specifications can be used as tender templates for companies (IMs) building / procuring an RCA-based system. Additional deliverables include supporting material for IVV (Integration, Verification and Validation) of the RCA subsystems. Also, part of RCA is material helping to plan for an RCA-based system (such as business case mechanics, supported target architectures etc.) and material helping to understand the decomposition of the RCA subsystems.

1.10. Is RCA a standard?

RCA is not a formal, “de iure” standard. RCA is a set of specifications. If the specification is credible and is used for substantial procurements, it creates a “de facto” standard or a “user standard”. This is the same approach as EULYNX. Maybe a formal standard for RCA may be helpful at a later time.

1.11. What is the relation between RCA and EULYNX?

RCA and EULYNX are coordinated and related in several ways:

- The EULYNX organization is (together with EUG) one of the governing bodies of RCA.
- The principle of railway companies harmonizing requirements to define standardized interface specification is the same.
- RCA will directly include specifications from EULYNX in its overall architecture.
- RCA will re-use methods (modelling) developed in EULYNX.

The main difference between RCA in EULYNX is the scope of the architecture, EULYNX is forming part of the RCA scope. Moreover, RCA targets a simplified “pure” future architecture of a CCS system and the migration to it, while EULYNX targets also today’s architecture and enables the migration to RCA.

1.12. What are the relations with other railway initiatives?

Several railways have announced/started substantial modernization programs (e.g. Digital Railway, Digitale Schiene Deutschland, smartrail 4.0 and others). The goal of RCA is use these programs as contributors to the development of RCA and to base these programs on RCA.

2. Target architecture

2.1. What is the foundation of the target architecture of RCA?

RCA is radio-based ETCS cab-signaling including all elements needed for this.

2.2. Is RCA the same thing as ERTMS, totally different or a competition?

The RCA is a generic CCS architecture, that uses the ERTMS standards (TSI CCS) for the interfaces to the vehicle. The protocols of ETCS are useful and important for interoperability. RCA implements advanced CCS functions like moving block, full supervision for shunting, high quality mobile localization etc. and adds interface specifications, that have not been necessary for interoperability, but which are crucial for evolvability and integrability. To fully use RCA, some change requests to the TSI will be necessary, which will be submitted in due form.

2.3. Does RCA include ERTMS "game changers"?

Some of the game-changers frequently mentioned[5] are: automatic train operation,
full moving block, train-borne localization (sometimes called satellite positioning, which is misleading) and the next generation telecommunications system. RCA implements all these game changers and additionally some innovations concerning interlockings and migration technologies. For localization no particular technology (i.e. satellites) yet is favored or believed to fulfill all needs, it will be an open architecture in which different technologies can be combined.

2.4. Is there only one target architecture for RCA?

No. First, RCA-based system can choose different functional target configurations, without jeopardizing interoperability. Possible variants in target architecture include: ATO (none – GoA2 - GoA3 – GoA4), the choice/mix of localization technology, physical deployment (centralization/regionalization) and others. Second, an RCA-based system can exist in different physical/deployment configurations. A system is RCA-based, if it's components implement the RCA interfaces.

2.5. How are needs for innovation and for stability balanced in RCA?

An MoU between ERA and different stakeholders describes the need for stability in the ERTMS specification. At the same time, it is clear that the sector needs innovation and that the current form of implementation of CCS can (and must) be improved. RCA on one hand brings a push for innovation[6] and brings in changes. But these changes happen in the technologies and used products, while in the TSI CCS only smaller changes are necessary. The focus on well-defined, evolvable interfaces will help stabilize the system, by making changes more local (limited impact) or by allowing fast upgrades (reducing complexity).

2.6. What are the interoperability effects of RCA?

For RCA an interoperable railway system is a design target. New features in RCA (e.g. localization) may require changes to the current ERTMS specifications.

3. Migration

3.1. Are migration issues part of RCA?

Yes. Migration is a central aspect of RCA. Several mechanisms in the architecture support migration. Examples of migration paths are part of the RCA documentation.

3.2. Will RCA require a certain migration strategy?

RCA will analyse the current starting point of railways and design a small set of migration paths leading to the target architecture. This set of migration strategies will be used as a driver/requirement for the architecture. While RCA describes some migration "patterns", each IM will have to choose their own specific migration strategy.

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[5] For some background: see http://www.unife.org/component/attachments/attachments.html?id=785

[6] innovations include for example localization technology or the degree of automation (not only for driving) but also for planning, command & control.

3.3. How do (on-going/planned) ETCS L2 rollout programs fit with RCA?

Not only are today's ETCS L2 implementation limited in their performance/TCO-ratio, more importantly they are not easy to evolve. Therefore, the RCA is deemed time critical, the earlier the new (RCA based) ERTMS implementations are available the sooner we have systems installed that can be easily adapted and grown cost effectively.

4. How to use RCA / Effects of using RCA for railways

4.1. Will the architecture lead to identical business processes among railways?

Not necessarily, see question "Will RCA harmonize business process of the railway companies?"

4.2. Will the architecture lead to identical equipment of the IMs?

No. The goal is standardization / modularization on important interfaces for the "building block". So, firstly the building block can be implemented by competing companies. Secondly different railways may use different configurations / system designs of the building blocks.

4.3. How is the architecture going to have an impact "in the real world"?

To have an effect, the architecture and its specifications must become a requirement in tenders from the IMs (same model as EULYNX).

4.4. Who can use the RCA?

The specifications of RCA interfaces will be freely available, under EUPL or similar.

4.5. When can I use RCA?

For IMs: You can prepare a business case and IM-internal lobbying for an RCA-based system now.
For RUs: you can get information on the initiative regarding vehicle architecture (OCORA) and decide if you want to participate.
For Suppliers: you can provide feedback to the architecture and start planning technical demonstrators and adaptions to your product line now.
By the end of 2019 a Version 1.0 of the RCA will be ready.

5. How to contribute to RCA

5.1. Who can contribute to RCA?

Anybody (IM, S2R, supplier, researcher….) can contribute a specification or concept to the RCA.

5.2. Are there any rules for RCA contributions?

To be included in the RCA, proposals will go through a formal Change control board (CCB). Important requirements for contributions are (in addition of an overall fit with the architecture):

- interface specifications to a level of precision to allow exchangeable components;
- interfaces designed to maximize upward-compatibility;
- interface specifications free of IPR that may be an obstacle to the exchangeability or upgradability of components (products or component implementations may, of course, still be protected by IPR).

6. Organization of RCA processes

6.1. Who governs the RCA process?

RCA was started by a white paper and Memorandum of Understanding between EUG and EULYNX. See https://ertms.be/workgroups/ccs_architecture. So, the governing bodies of RCA are EUG and EULYNX.

6.2. What is the relation of RCA to Shift2Rail?

RCA is harmonizing architectural user requirements for the future railway system as a stable basis for industrial developments. It is led by the Infrastructure Managers who are members of the ERTMS Users Group and EULYNX. Shift2rail is "the first European rail initiative to seek focused research and innovation (R&I) and market-driven solutions by accelerating the integration of new and advanced technologies into innovative rail product solutions". We plan to have substantial interactions between RCA and Shift2Rail. In particular, RCA will provide inputs to the S2R strategy and architecture work (a S2R project on railway system architecture starts in 2019), and S2R may contribute with specification work and demonstrators to RCA. Many members of the ERTMS Users Group and EULYNX are also Founding Member or Associated Member of Shift2Rail and require RCA and the work in Shift2Rail to be aligned.

6.3. What is the role of industry / suppliers in RCA?

As with the EULYNX initiative, RCA raises questions about the impact on the relation of railway (customers) and industry (suppliers). What does not change with RCA is that railways (IMs) will purchase components / systems from suppliers. What does change are the following elements:

- Railways harmonize requirements and define architecture. This leads to reduced variability in components;
- Exchangeable components. This leads to more competition and allows faster renewals;
- Smaller components (note: it's the buyer's decision how procurements bundle components). This may allow new market entrants and to the need for additional integration services;
- Separating of function (software) and box (runtime environment). This may allow new market entrants.

The consequences of these changes must be understood and acted upon by both sides. This will need discussions and mutual feedback.

6.4. Is RCA a "win-lose" proposition for railway industry?

The story of RCA is to increase the performance/TCO-ratio of our CCS systems. For some this is equivalent to "railways pay less – industry earns less". This is not the complete picture since standardized architectures make it possible to sell a single component in the same form in much more countries. So, the market for a single component gets much larger and the ROI of a development is better. But of course, this may lead to increased competition.

There are several upside potentials for industry:

- Better performance/TCO-ratio will make equipping/renewals attractive that today are simply not economical, this may lead to bigger overall market;
- Reduction of development risks (market acceptance, product variability);
- Better evolvability may lead to more frequent renewals;
- Better overall performance/TCO of the railway system ensures customer money and public funds will be available in the long-term i.e. it is a key enabler for national programs and helps to release the funding, so it is a win/win situation for suppliers and railways;

6.5. Risks: what could go wrong?

The white paper contains a description of the most important risks regarding the success of the RCA initiative. The list includes: 1. Disagreement between members. 2. Challenge on Life Cycle Cost (LCC) reductions. 3. Lack of resources to do the work. 4. Lack of funding. 5. Opposition from Railway Undertakings. 6. Lack of support of suppliers. 7. Lack of support at EU level. 8. Delay of national ERTMS roll out projects. 9. RCA will be too late.

7. Architectural decisions

7.1. Where is the interlocking (IXL)?

RCA defines a new structure (architecture) for the interlocking logic. To avoid confusion, a new name was chosen: the APS (advanced protection system) roughly covers the purpose of today's interlockings. The core of the protection logic has been assigned to the components named SL (safety logic) and SM (safety manager).

7.2. Why does RCA put so much intelligence on the infrastructure side?

Or, the other way around: why not just put additional intelligence on the vehicles (e.g. ATO initiative by SNCF)?

While the vehicle side is important, it only partially drives important goals such as cost, reliability, capacity and safety. The business case mechanics of RCA show that reducing the complexity of the track-side systems, while providing them state-of-the art technology has large impact on the overall case. An impact not attainable by acting only on the vehicle-side or shifting systems from wayside to onboard.

7.3. Why does RCA plan for largely centralized trackside systems?

The TMS and Protection System (Interlocking) seem to be centralized in RCA, why not plan for totally decentralized (swarm) intelligence on the vehicles?

Vehicles are going to be more "intelligent" with RCA. Functions such as (Auto-)localization and ATO will simplify the trackside and put more requirements on the vehicles (a process already started with ETCS L1 and L2). Complete distribution of the logic for planning, dispatching and controlling trains (and omitting all centralized/trackside logic) is not sound from an engineering point of view:

- Safe movements of trains are only possible with knowledge of movements of other trains, other track occupations and allocation (locking) of switches. While in principle a distributed system (with each train being a decentralized datacenter) is possible, it would be an order of magnitude more complex than using a centralized, "single point of truth";
- The scarce resource is in many cases the physical track. Only logic covering a large part of the network (knowing the state and plan for trains and able to control them) will be able to optimize this scarce resource;
- The interaction with RUs (vehicle and personnel planning) and customers (traffic information) will need centralized hubs anyway;
- The central approach helps to make decisions based on the prediction of impact for the full network instead of local optimization.