Delivering Europe's digital coupler

Testing of four prototype digital automatic coupler designs is underway as a deployment programme takes shape aimed at boosting the productivity and competitiveness of rail freight operations across Europe by 2030, but much remains to be done.

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Within the next few months, a decision is due to be taken on the preferred option for a Digital Automatic Coupler to be rolled out across the Single European Railway Area. Building on extensive research and development, four designs are currently on test, while plans are taking shape for a rapid migration strategy which could see close to half a million vehicles equipped by 2030.

Although railways on other continents adopted automatic couplers many decades ago, and they have been adopted for limited domestic applications in various countries, Europe's fragmented railway heritage has resulted in screw couplings remaining the interoperable standard for most domestic and all international freight trains. Staff on the ground must climb between wagons to hook and un-hook these couplings, a dangerous and physically challenging task in a hazardous environment and in all weather conditions. It is not surprising that workers are increasingly unwilling to perform this kind of work.

Moving to DAC would eliminate this manual effort and substantially accelerate the train formation process. Adding a digital capability that could support further automation is seen as a major step forward, differentiating the current initiative from previous abortive attempts to introduce an automatic coupler. Meanwhile, the growing imperative to counter the causes and effects of climate change has substantially increased support for rail freight from all stakeholders up to governmental level. Societal support for such a huge transformation was not simply not available in the 20th century, but now there is sufficient tailwind to make it happen.

Photo: DB AG / Patrick Kuschfeld

Prototype couplers have been fitted to a variety of DB Cargo wagons for testing under the DAC4EU project.

Wider societal benefits

The European Green Deal and the European Commission's Sustainable & Smart Mobility Strategy have set an ambitious target of cutting greenhouse gases from the transport sector by 55% by 2030. Modal shift of freight from road and air to rail is expected to be a major contributor to meeting that target. But more rail capacity will obviously be needed to accommodate the extra traffic, and to that end the Mobility Strategy sets an objective of increasing the capacity of rail freight across the EU by 50% over the coming decade.

Given that investment in additional infrastructure can be very costly and in some places physically difficult for lack of space, improving the efficiency of the existing network becomes key. DAC is seen as one of the few viable options for delivering a capacity increase on that scale, enabling the operation of longer, heavier and faster trains.

Reducing the time and cost of coupling and uncoupling trains will also increase productivity, helping to improve the overall competitiveness of rail freight. Offering a more attractive service to customers should encourage modal shift, while better asset utilisation will enable the railways to handle greater volumes of traffic with the same level of resources. At the same time, eliminating those hazardous manual processes will improve safety and ensure better working conditions for staff, making careers in rail more attractive and combatting the ongoing shortage of employees across the sector.

In terms of quality, the digital backbone will increase the flexibility and reliability of rail freight operations, supporting advanced telematics applications for enhanced customer service and fleet management.

Delivery programme

Open, close and efficient co-operation between all parties will be crucial to a successful and effective implementation. The European DAC Delivery Programme has therefore been

established under the leadership of Shift2Rail to provide a unified platform for collaboration. The EDDP is backed by a wide range of organisations — not just railway undertakings and wagon keepers, but also infrastructure managers, entities in charge of maintenance and the rail supply industry, as well as sector organisations, research centres and national and European political institutions. More than 50 entities across the continent are already involved, and the initiative is open to new participants.

The objective is to deliver a European DAC through an integrated programme, building on the pilot projects and ensuring that the necessary actions are taken to ensure a rapid roll-out that is both technically and economically feasible.

DAC deployment is aiming to address the three principal challenges facing the European rail freight sector today — capacity, productivity and quality. All of these are crucial to support a more efficient and modern rail freight system. However, the EDDP is not only for the rail sector; by helping to deliver the European Green Deal and creating additional economic value it will have a direct benefit for society and the wider environment.

Research and innovation

Development of the current generation of DAC technology was initially driven through Shift2Rail's Freight Innovation Programme, IP5. This began by looking at five types of coupler, in order to identify the most appropriate in terms of functionality and cost-benefit analysis. A basic Type 1 connects one wagon to another mechanically, while Type 2 includes a brake pipe connection and Type 3 adds an in-train power feed. Type 4 provides a data link, while Type 5 enables automatic uncoupling as well.

The FR8Rail project within IP5 undertook market surveys and business case analysis for different operational scenarios, looking at transport and logistics chains including wagonload and intermodal applications. These showed that there was a very positive business case in most scenarios, while none were negative. The cost:benefit ratio improved considerably when brake, power and data capabilities were included. This led to the selection of Type 4 as the best option — at least until the results of the EDDP analysis become available.

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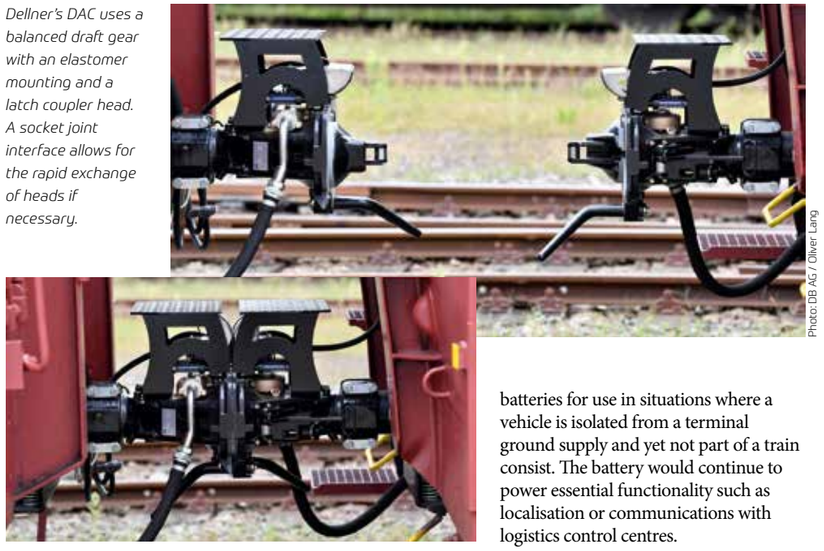
prototype couplers from three suppliers are being tested

Providing secure digital communication throughout the train allows a data exchange to reduce manual processes such as brake tests and train initialisation. It also unlocks the potential to incorporate further functionality, supporting telematics applications and rolling stock health-related functions such as condition monitoring for predictive maintenance.

DAC could also help to facilitate automated operation. Having a continuous digital connection provides a much-needed train integrity function for freight trains. The system checks continually that all wagons are still in the train and that nothing has become separated. Train integrity is a prerequisite for the deployment of ETCS Level 3, eliminating the need for fixed detection systems such as track circuits or axle counters and reducing the amount of costly lineside equipment to be installed and maintained. Level 3 in turn paves the way for moving block operation that could substantially increase network capacity.

A Type 4 DAC also provides a gateway for electrical power distribution, which is another significant development. This can provide a source of energy to power systems such as wagon door mechanisms or added-value services. However, each vehicle will need to be cabled to pass the energy from one to another. The DAC power specification anticipates that wagons would be fitted with onboard batteries for use in situations where a vehicle is isolated from a terminal ground supply and yet not part of a train consist. The battery would continue to power essential functionality such as localisation or communications with logistics control centres.



Dellner's DAC uses a balanced draft gear with an elastomer mounting and a latch coupler head. A socket joint interface allows for the rapid exchange of heads if necessary.

Photo: DB AG / Oliver Lang

Developing the technology

Once the preliminary choice of a Type 4 coupler had been agreed, detailed design and laboratory testing could begin under the FR8Rail II project within IP5. A CAF-led grouping including DB Cargo and Trafikverket undertook this project, producing a full-scale prototype to be tested up to Technology Readiness Level 6 by September 2020. The aim was to trial the coupler on various types of wagons under specific operational conditions, with a view to finalising an approved specification by the end of 2022.

Meanwhile, the initial work led to an increase in interest across the rail sector and the emergence of complementary initiatives. Under the auspices of the *Technischer Innovationskreis Schienengüterverkehr* (Technical Innovation Circle for Rail Freight), small batches of vehicles equipped with various types of DAC are already being deployed for testing across Austria, Germany and Switzerland (p00). In the meantime, Germany's Federal Ministry of Transport & Digital Infrastructure is funding the DAC4EU project to undertake extensive testing of initially four DAC concepts. The outputs from both the Shift2Rail work and these national initiatives will feed into the EDDP, enabling it to evaluate a range of coupler types and select the best option for a full scale roll-out.

> ‘DAC deployment is aiming to address the three principal challenges facing the European rail freight sector today — capacity, productivity and quality’

DAC4EU was launched in July 2020 and runs to December 2022. It is being led by a consortium that includes Deutsche Bahn, DB Cargo, SBB Cargo, Rail Cargo Austria and freight wagon leasing companies Ermewa, GATX Rail Europe and VTG.

The testing programme began in October 2020 to assess four prototype couplers manufactured by three suppliers (Fig 1). These are an SA-3 type from Dellner, a Schwab type coupler from Wabtec-Faiveley and two Scharfenberg types from Dellner and Voith. Each of the couplers is being subjected to 440 individual tests with a range of test scenarios to assess the various technical requirements. Most of the testing has been undertaken at the TÜV Süd test centre in Görlitz, although winter testing took place at Green Cargo facilities in Sweden. However, the SA-3 design has since been withdrawn from the programme as a result of technical issues.

Representatives from the European Transport Workers' Federation, along with the trade unions Vida (Austria), EVG (Germany) and SEV (Switzerland), visited Görlitz on June 9-10 2020, giving the project team an opportunity to garner experience from railway workers to assist with the evaluation. This group included shunting staff, train drivers and wagon masters, all of whose daily work would be affected significantly. The union representatives and EDDP programme managers all expressed their satisfaction with the progress being made.

The results of the initial tests were processed during the summer and made available to EDDP to inform the final technology selection. At the same time, a demonstrator train is being fitted with all of the coupler types; this will be operated throughout Europe to gain more practical experience and to familiarise different companies in the transport sector with the new technology. Meanwhile, testing is continuing. The process will help to determine the best design and concept for the EU DAC, enabling EDDP to take a final decision by the end of 2021, based on the trial results and an evaluation of the life-cycle costs.

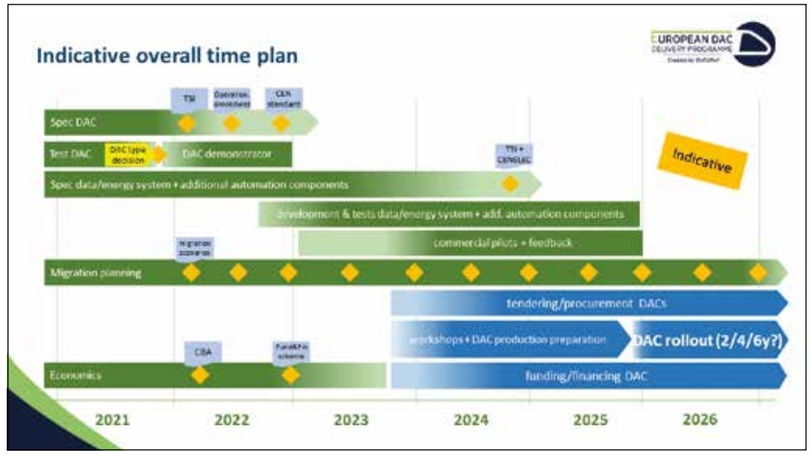


Fig 1. The EDDP indicative time plan envisages finalisation of the specification by the end of 2022 and commercial trials over the next three years, leading to a prouction roll-out from 2026.

Once a decision has been made, EDDP will work with the various standardisation committees to define the final EU-wide interfaces, while the suppliers who have provided the various prototypes will work together to develop a mature series product. The aim is to have a finished DAC authorised and ready for deployment in 2025-26. Meanwhile, the lead suppliers are expected to work with other manufacturers to ensure that deployable series products are available. Co-operation will be crucial, given the very large scale of the project. Retrofitting DAC to between 450 000 and 500 000 vehicles by 2030 means up to a million couplings will have to be manufactured and installed over a relatively short time to be defined in the migration planning.

A digital variant of the Voith CargoFlex coupler (p00) is one of the three types being tested under the DAC4EU project.

Photo: DB AG / Oliver Lang

European DAC Delivery Programme

The vision is for DAC to become the backbone for all freight trains across Europe. But for rail freight to remain competitive and efficient, it is essential to ensure that the technology is fully interoperable and functions in a seamless and integrated way, being well tested and authorised across the whole of the Single European Railway Area. Hence the establishment of EDDP.

The programme has two decision-making bodies — a Supervisory Board and a Programme Board. The Supervisory Board ensures sectoral alignment and political support at European level, as well as providing oversight. The Programme Board is responsible for preparing and implementing decisions, bringing together senior managers from the participating entities, along with Shift2Rail Executive Director Carlo Borghini.

At the beginning of 2020, the Supervisory Board appointed two programme managers to take responsibility for day-to-day management in conjunction with the Programme Board and the Shift2Rail

Photo: DB AG / Patrick Kuschfeld

Modification of the test wagons and installation of the prototype couplers was undertaken DB workshops in Mannheim.

programme office. Mark Topal is Chief Technical Officer of ÖBB, while railiable founder Jens Engelmann is a former Head of Unit at the EU Agency for Railways.

EDDP has been structured into seven work packages:

1. Technology, Regulation & Standardisation, Operations;
2. Test, Demonstrator & Pilot Projects;
3. Migration Strategy;
4. Rail System Capacity and ERTMS;
5. Business Cases and Financing;
6. Communication & Dissemination;
7. Intelligent Freight Train.

EDDP is currently reviewing the factors that will shape the deployment of DAC in Europe, and the necessary conditions that need to be put in place. We are assessing the available technologies and clarifying the interfaces with other programmes. Of the seven work packages, the testing, demonstrator and pilot projects are well underway. And in parallel another workstream is looking at establishing the appropriate regulatory environment.

Looking at the need for further research, related technology such as Automatic Train Operation will need to be harmonised with the DAC digital backbone to ensure full compatibility. Whilst various automation components are available today, these are still mostly stand-alone items. Work will be required to bring them together as part of the data/energy backbone and achieve the highest Technology Readiness Level. The aim is to achieve a unified technology framework for full digital freight train operations, including a well-managed interface and system integration.

In terms of implementation, a smart migration in a shortest period possible would limit the implications for operators. The EDDP is looking at various options to shorten the migration period, in order to minimise the risk of any negative impact on performance during the period in which both old and new coupling procedures are in use. The aim is to complete the development of feasible EU-wide migration scenarios by early 2022.

Meanwhile, the programme team is looking to explain to the various players what is at stake. We are looking to emphasise what the different stakeholders can gain from a rapid migration to DAC, while seeking to understand and allay any doubts and concerns. Support from the European institutions and national policymakers for the rail freight sector will be essential during the migration period.

Who pays, who gains?

Support may also be needed in terms of funding and finance. EDDP is currently developing a business case to demonstrate to European policy makers and the EU member states how sustainable rail freight transport can be achieved in the most affordable way. The cost of rolling out DAC is expected to be significantly less than that for building alternative infrastructure or the external costs of other modes which would persist and potentially increase if freight transport does not shift to rail.

Initial estimates suggest that the cost of equipping between 450 000 and 500 000 wagons with DAC will be around €8bn. On top of this would be the costs for any further automation components yet to be developed. Investment would also be needed to ensure interoperability and integration with various locomotive fleets.

To cover the up-front investment and ensure successful implementation, EDDP envisages that significant European support would be combined with national instruments to create the incentives and capacity to keep the transition phase as short as possible.

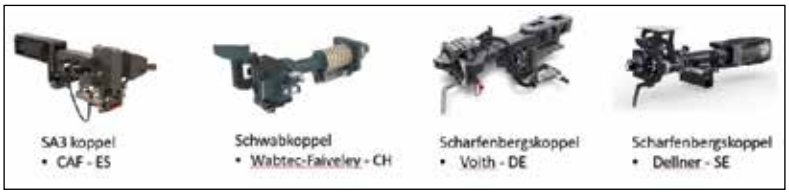
Compensation may be needed to cover such things as operational difficulties during migration, and to minimise any negative effects on rail freight transport during this period. Measures may also be needed to ensure a level playing field for retrofitting throughout Europe, requiring selective financing models at both European and national levels.

Outreach has been identified as another key success factor. The success of the rollout programme depends on having a single, harmonised, European system. While some countries understand what is at stake, and are already well informed about progress, the game-changing potential of DAC still needs to be highlighted and disseminated to other member states.

We now have a clear picture of the target. However, there is still much to do, and the sector stakeholders have agreed that the most effective framework within which to take the project forward will be the upcoming Europe's Rail Joint Undertaking, as successor to Shift2Rail.

A unique window of opportunity is opening up over the next few years. All European stakeholders must be ready to seize the chance, so that we can unite forces to focus on the development of fully digital freight train operations that would finally bring the sector into the 21st century.

Below right: Fig 2. Four types of digital automatic coupler were tested in winter conditions by Green Cargo in Sweden as part of Shift2Rail's FR8RAIL project.



Below: Consigned to the past? Railways are finding it hard to recruit staff to couple and uncouple wagons using traditional screw couplers.

Photo: DB AG / Patrick Kuschfeld