Roadmap HCT road

As basis to the roadmap, there is a report, Asp, Åkesson & Wandel (2019), where the background to assumptions and sub targets can be found. Below, there are two pictures with HCT-vehicles combined with multimodal solutions.

Source: Skogforsk

Source: Volvo Trucks

Preface

As a task from Forum for the transport innovation (hereafter named Forum), CLOSER, in year 2013, developed a roadmap for High Capacity Transport (HCT) road. HCT is here defined as vehicles longer and/or heavier than allowed, which during the development of this roadmap means longer than 25,25 m or heavier than 64 tons. During 2018, CLOSER received a task from Forum where CLOSER was asked to develop an updated roadmap. In the task, it was also included to have an increased focus on multimodal solutions and clearer connections to electric roads, digitalization, and autonomous vehicles.

At the time of the completion, it was decided that Forum would be closed and the continued handling including the approval of the roadmap was transferred to the CLOSER board. Since CLOSER does not have the same task as Forum, an adjustment had to be made and a new version of the roadmap has been developed for decisions to be taken by the CLOSER board. The new version focuses on the part that has been conducted within CLOSER's themes. The purpose of the roadmap is to give different players basis for a continued active and coordinated implementation of HCT as an important part of the development towards a more efficient and more sustainable transport system. Here are for example priority of research and innovation projects an important part.

The work has been conducted as a project with a project group and a reference group. Included in the project group were Thomas Asp – CLOSER/Swedish Transport Administration (also project manager), Ulf Ceder – Scania, Stefan Grudemo – Swedish Transport Administration, Henrik von Hofsten - Skogforsk, Sogol Kharrazi - Swedish National Road and Transport Research Institute, Anders Johnson - RISE, Lena Larsson - Volvo, Jerker Sjögren - Jesjo Konsult, Sten Wandel - Lund University, Viktor Åkesson - DB Schenker Consulting (also coordinator). Jonas Sundberg – Sweco, have been an adjunct representative from Forum's board.

The members of the project group have participated actively in the development of the roadmap report. The reference group has given their comments on the report at a Skype meeting and thus contributed with valuable input. The once who have responded, including the participants via Skype were: DB Schenker, DHL, WSP, BIL Sweden, KTH Royal Institute of Technology, MOE/Tetraplan, Swedish Shippers' Council, RISE, Swedish Forest Industries, Swedish Shipowners' Association, The Swedish Association for Road Transport Companies, the Association of Swedish Engineering Industries, Swedish Transport Workers' union and Trivector.

Now that the work with the roadmap is closed, we note that the potential of HCT has been further strengthened compared to the roadmap of 2013. Several positive effects can be reached with a wide implementation of HCT – more efficient utilization of the road infrastructure, lower cost for transports, decreased energy usage and significant decrease of CO_2-emission and other emissions without increasing accidents or road wear.

In order to implement HCT on road, development is required within the logistic and intermodal transport setup based on HCT and the HCT vehicles including trailers. Also, some adjustments of the infrastructure are needed to manage the HCT vehicles, adjustments of laws and rules and systems for surveillance of the rules being followed are required. The relatively limited investments that are necessary in order to adjust the infrastructure for the HCT vehicles are considered to be very socioeconomically profitable.

Altogether, HCT will be able to contribute to necessary increase of efficiencies within the transport sector to reduce the energy usage per tonne-kilometre with 10% and therefore emissions of greenhouse gases. Additonally, at the same time contribute to strengthen the industry of Sweden and its competitiveness in two ways – partially by lower transport costs, partially by increased export of HCT vehicles and technology. However, further analysis of markets and system effects are required and a

proactive work regarding the development of legal frameworks and control of compliance is important here.

Research and demonstration projects are also required, especially in traffic safety, and for undivided roads, as support for a successive, safe and successful implementation of HCT as an integrated part of the entire transport system. Here, an international notion has been established, called SIAP (Smart Infrastructure Access Policy) covering optimization of the match between load, vehicle and infrastructure with connected vehicles etc. It is of the utmost importance that continued work with the development and implementation is done in close collaboration between all the involved players and stakeholders, and here the HCT program and CLOSER has a key role.

Gothenburg 29/5 2019
Thomas Asp Program manager for the HCT program at CLOSER

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Background and motive

Sweden, like the rest of the EU, is facing a major challenge. In year 2045 at the latest, Sweden shall not have any net emissions of greenhouse gases, according to the climate law from 2018. Further will the Swedish domestic transports (except for domestic flights) at the latest in 2030, reduce their emissions with 70% compared to the base year 2010 (The Swedish Government, 2018). A big part of the challenge is the fact that Sweden is a long and narrow peninsula of which up to 75% is sparsely populated, 1 000 km from the centre of Europe and has a transport-intensive base industry. Sweden is therefore more dependent of resource and cost-efficient transports, both domestic and international, than most other countries in order to secure a positive development. The prerequisites are similar in Finland, Australia and Canada which explains these countries', as Sweden's, interest in HCT for both road and railway.

The transport system is at the same time facing four large challenges: energy consumption, climate effects, capacity shortage and security for people, infrastructure, vehicles and freight. The road transport sector is responsible for a large part of the noise, emissions and traffic congestion that are experienced. As a part of facing these challenges, measures for reducing traffic and increasing resource efficiency are high up on the agendas of many decision makers.

One of these reducing and efficiency measures, HCT, refers to the introduction of vehicles with higher capacity (longer and/or heavier vehicles) than what are used today. HCT implies a better match between freight, vehicles and road for increased resource efficiency. By using HCT in a smart way, existing capacity in the infrastructure can be utilized better, which is in line with the four step model of the Swedish Transport Administration (Swedish Transport Administration, 2018). If PBS (Performance Based Standard, functional requirements on the vehicles instead of precise dimensions and technical design) and IAC (Intelligent Access Control which means that the vehicles are connected in order to steer the vehicles in an optimized way in time and space) are added together, it is called SIAP.

This roadmap for HCT road has been developed through a great commitment from many players within CLOSER and aims mainly to describe the direction for the continued innovation work in different parts that the partners of the HCT program consider as important to continue working with. The HCT program aims to enable the usage of different vehicle combinations of HCT and loading units in the transport system. **Fel! Hittar inte referenskälla.** below presents the national HCT program and its work packages with responsible organisations.

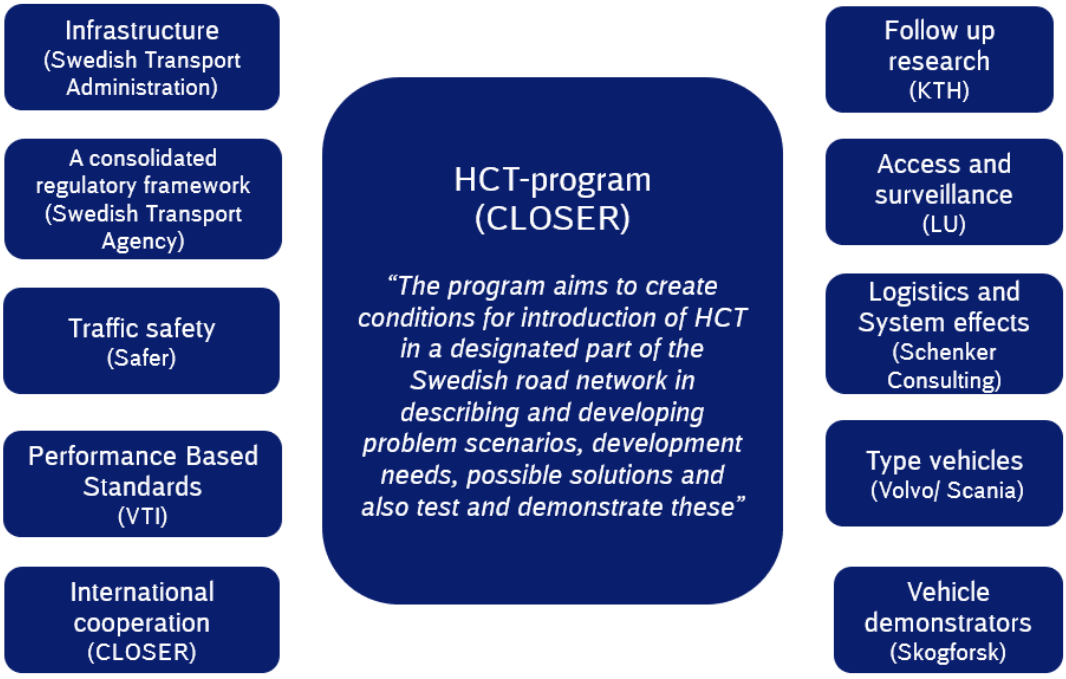

Figure 1: The Swedish national HCT-program

HCT has a significant potential to reduce the costs for road transports, reduce the environmental impact, reduce the need of capacity investments and at the same time strengthen the competitiveness of Sweden by being a future sector of export for Swedish automotive industry. ERTRAC (2019) also emphasize HCT as an important piece in its strategic roadmap for long distance freight transports. The national HCT program started as an environmental project, with the start of the ETT project in 2007, where one saw the possibility of reducing the fuel consumption per tonne-kilometre by adding more payload.

Since the last roadmap from 2013, a legal framework for bearing capacity class 4 (BCC4) has been decided and the first BCC4 roads that allows 74 tons/25.25m were opened in 2018-07-01. Something else that has had a great impact is the fact that Finland introduced 76 tons as max gross weight in 2013, and in January 2019 34.5 m were also introduced on the entire road network. There are though, both limiting bridges (considering 76 tons) and junctions etc (considering the length 34.5 m). Unlike the roadmap of 2013, the targets for 2030 are more aggressively set and back-casting is used where the steps that must be taken to reach these targets are planned backwards, instead of forecasting the most likely development.

In the national plan for the upcoming 12 years period, 10 billion SEK are allocated to strengthen the most important roads to bearing capacity class 4 standard. HCT results in an increment of productivity and a lower energy consumption per tonne-kilometre/m^3-kilometre and consequently reducing emissions of mainly carbon dioxide but also other emissions.

Direction 2030

Target

The roadmap describes measures and sub targets to achieve a desired state in 2030 that is based on the targets of the national transport politics, mainly climate oriented, and the targets of adjacent roadmaps. Through back casting, the sub targets for the time horizon 2025 was firstly set and afterwards was the sub targets for 2020 set. There are a lot of ways to contribute to the targets, for example electric roads, autonomous/connected vehicles, alternative fuel and intermodal solutions. Though, this roadmap, which focuses on HCT, mainly handles the parts where they are directly related to HCT on road. Generally, we see that all these also can be used for HCT vehicles and when it comes to multimodal solutions, it's rather an advantage. The target below is developed by the project group and harmonized with the reference group:

The overall target for 2030 is to give prerequisites resulting in that 80 % of the freight transport work on road is executed by HCT vehicles (target for 2020 is 5 % and 45 % for 2025) and that it leads to the energy consumption being 10 % lower per tonne-kilometre than in 2018.

The circumstances to how the sub targets above has been developed can be read in the background report, Asp, Åkesson & Wandel (2019).

Energy consumption is considered as the energy that is used to create power between wheels and road, which is needed to drive the vehicles. In this roadmap, the energy consumption is assumed to be proportional to the diesel consumption. This energy saving is fully in line with IEA's (IEA 2017) on 9-20%, which is presented in Figure 2 and Table 1. IEA and this roadmap have identified PBS (Performance Based Standard) and IAC (Intelligent Access Control) as enablers for HCT. As can be seen in Figure 2, the difficulty of a wide and fast roll out of HCT is classified as medium because there are obstacles. The blue colour means that individual companies can implement it, while the green shows that external cooperation is required, for example horizontally. A purpose with the roadmap is to analyse and remove those obstacles that both IEA and the experiences in Sweden has shown.

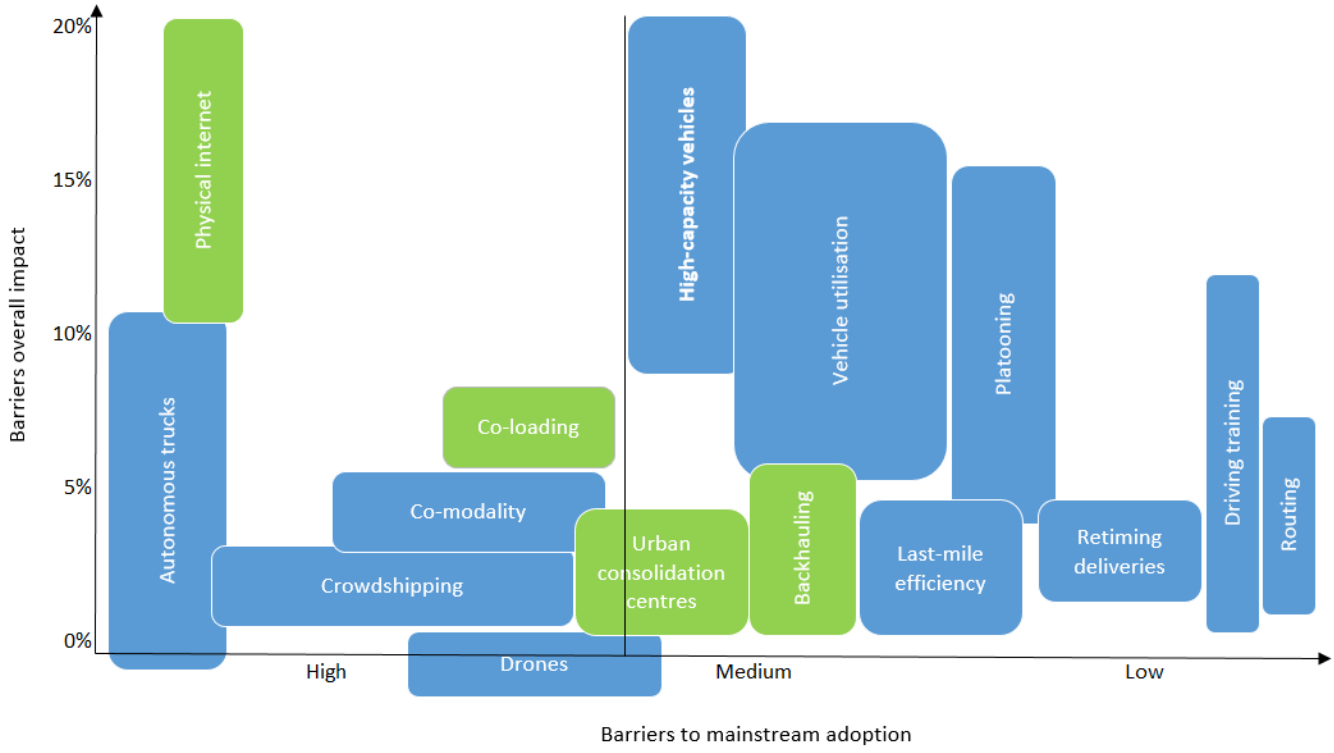

Figure 2: Measures to reduce fuel consumption and the carbon dioxide emissions, adapted from IEA (2017)

Table 1: Measures to improve the efficiency of the system of road freight with low implementation barriers (IEA, 2017)

Category	Enablers	Barriers	Potential energy saving	Examples / Notes
Use of high-capacity vehicles (HCVs)	Performance-based standards Intelligent Access Program as in Australia	Concerns about safety and road infrastructure impacts; potential for "reverse" mode shift (away from freight rail); increased demand for just-in-time delivery	Direct savings may be upwards of 20%, but actual savings may be lower, depending on the extent of activity rebound and of modal shift from rail.	Regulations allow for the operation of HCVs at the national or regional level in Australia, Brazil, Canada, Finland, Mexico, South Africa and Sweden.
Route optimisation	Geographic information system real-time routing data Relaxing delivery time constraints	Increased demand for just-in-time delivery	From 5%-10% for intra-city trucking, but closer to only 1% for long-haul missions.	UPS ORION, which in 2017 began its global rollout.
Platooning*	Vehicle communication and automation technologies	Traffic congestion, and mixed traffic; road capacity limitations. Need to ensure safety	From 5% to 15% for a three-truck platoon traveling at 80 km/h (depending on gap distance).**	Japan's "Energy ITS" (2008); the California PATH programme (2011); the European Commission's SARTRE project (2017).
Driver training and feedback	Rewards programmes in mid- to large fleets	Lack of consolidation among carriers (many small owner-operators)	Immediate savings of between 3% and 9% (the latter in long-haul operations).	FleetSmart, Canada, as well as many examples among Finnish, German, US and other carriers.
Improved vehicle utilisation (including backhauling)	Better data collection (as enabled by ICT) Collaboration and on-line exchanges alliances among carriers and logistics service providers (LSPs)	Legal frameworks that restrict anti-competitive behaviour (and thereby impede co-ordination among carriers, shippers, and LSPs). Lack of industry consolidation among carriers.	Potentially substantial, but difficult to quantify. Savings are enabled by better tracking basic freight operational parameters and adopting industry best practices in logistics.	The European Union's CO3 Project on horizontal supply chain collaboration. Online freight exchanges co-ordinate a large fraction of road freight movements in the United States and the United Kingdom.
Last-mile efficiency measures	Prediction of dynamic demand Increased competition, including market entry of LSPs	Increased demand for just-in-time delivery Urban traffic congestion	Likely in the range of 1-5%.	Delivery service plans developed by Transport for London; Binnenstadt service in 11 towns in the Netherlands.
Re-timing urban deliveries	Incentives to shipment receivers to accept the insurance and logistical impacts of shifting to early morning and off-hour deliveries	Concerns from local citizens about noise Customer concerns with product quality and condition upon delivery Constraints imposed by just-in-time delivery	Very difficult to estimate and generalise. Across the urban truck fleet as a whole, fuel- and GHG emission reductions are estimated in the range of 10%-15%.	A complete shift to off-hour deliveries led to a reduction in local pollutants in the range of 45-67% in New York, Bogotá and São Paulo. Pilots include POLIS (European Union) and PIEK (the Netherlands).
Urban consolidation centres (UCCs)	City regulatory policies to reduce congestion and promote air quality	Design is highly city-specific, making dissemination of best practices difficult Fiscal sustainability challenges in the absence of a dedicated public funding stream or viable business model	Vehicle activity, fuel use and CO_2 emissions within urban centres can be reduced by 20-50%.	UCCs group shipments from multiple shippers and consolidate these onto a single truck for delivery to a given geographic region. Various global cities, most of which are located in Europe, and Japan.

* Platooning refers to the practice of driving heavy-duty trucks (primarily tractor-trailers or rigid trucks) in a single line with small gaps between them to reduce drag and thereby save fuel during highway operations. Vehicle-to-vehicle and vehicle-to-infrastructure (V2V and V2I) communication technologies can enable trucks to drive in very close proximity without sacrificing safety or manoeuverability.

** According to Tsugawa, Jeschke and Shladovers (2016), the average fuel saving for three trucks driving at 80 km/hr with a 10-m gap is about 8%, and 15% with a 4-m gap. High levels of vehicle autonomy would be needed to safely operate trucks with a 4-m gap.

Sources: Browne, Allen and Leonardi (2011); Wiki4City (2014); Holguín-Veras (2016); McKinnon (2016b); Wallenburg and Raue (2011).

The most important targets for year 2030:

Below are conclusions of some of the most important sub targets for the path towards the target in 2030:

- Legal and institutional legal frameworks are in place for all HCT concepts according to A-E below and they are harmonized with the rest of Europe.
- The parts of the bearing capacity class 1 road network that has been appointed by the industry and the most important roads for first/last-mile allow 74 tons, i.e. bearing capacity class 4.
- The road network with dense goods traffic including other important routes, such as to and from ports and terminals, allows 34.5 meters where some parts also allow vehicles over 74 tons.
- Taxes and incentives are designed to promote the transition to a wide utilization of HCT
- Active collaboration with nearby research areas such as electric roads and autonomous/connected vehicles
- Produce multimodal solutions with the rest of the transport modes

Proposed forms of access for HCT

HCT vehicles can access the infrastructure in several different ways and that needs to be more utilized in Sweden. International experiences show that among others the following forms of access can be used:

A. New road class on a limited appointed road network for specific HCT vehicles. An example is bearing capacity class 4 for 74 tons/25.25 m which was introduced July 1 in 2018. Finland does not yet have different bearing capacity classes, meanwhile Norway and Australia have more than Sweden's four.

B. Specific permanent permit to drive one or more specific HCT vehicles on specific roads. Heavy mobile cranes, ore transports in Pajala and Australia and PBS certified vehicles are some examples.

C. Specific time limited permit to drive specific HCT vehicles on specific roads for research purpose. Ongoing HCT demonstrators are just that.

D. Situation adapted permanent permit or restrictions that are dynamically adjusted to changed conditions, for example ground frost, thawing of frozen ground, weather, low traffic, powertrain and type of goods.

E. Exemption for a specific purpose to drive a specific HCT vehicle on a specific route. This has for a long time been possible for vehicles with non-dividable load and could be used by HCT vehicles for access on specific roads during a certain period of time or for a certain amount of passages at for example larger construction projects, when waiting for the road or bridge to be strengthened, redirections during road repairs or when harvesting a certain forest area, that for example only occurs every fifty years. Those exemptions can be combined with fees for compensating for the extra costs of wear and administration.

Up till now, the above has only been implemented to some extent in Sweden. These more differentiated forms of access for HCT would mean that the load, vehicle and the road can be matched more situation specifically than by dividing the roads into general bearing capacity classes. The innovations PBS, IAC and digital route guidance facilitate and are in some cases a prerequisite for implementing the above forms of access.

The roles of different players

The roadmap was developed by players within CLOSER with focus on the HCT program. It is important to point out that CLOSER's role is about initiating projects and to transfer knowledge. A lot of the work will then have to be done within each organization/company during the implementation phase. Table 2 below describes examples for each innovation domain, what each group of players are expected to: be responsible for, contribute with and benefit from. All players are also expected to: participate in tests and projects, contribute with data and information, cooperate, transfer knowledge and to push for rapid implementation. The innovation domains are the same as the work packages in Figure 1.

Table 2: Responsibilities and benefits of players

Group of players / Innovation domain	Goods' owner	Carrier: - forwarders - Hauliers	Manufacturer of: - motor vehicle - trailers	Infrastructure owners	Responsible for: - policy - legal frameworks - supervision	Other players: - authorities -researchers/ consultants
Logistic with multimodal solutions	Adjust the loading units, shipping size, duration of transport Contract to share risks Horizontal collaboration Initiate tests	Adjust terminals, structures, logistic setups, loading units Contract to share risks Amodal forwarders Horizontal collaboration Initiate tests	Develop multimodal loading units Provide with technical expertise and analyses	Adjust train terminals, ports, airports, traffic control Support last mile access Initiate tests	Facilitate tests and implementations on a wider basis Multimodal corridors	Investigate possibilities of: - Digitization - Transport as a service
System effects	Support with calculations when choosing logistic setups Input for cost and benefit calculation	Support with calculations when investing in vehicles, choice of vehicle for task Input for cost and benefit calculation	Input for cost and benefit calculation	Calculations for different pace of implementation, geographical and industry sector priorities, types of HCT vehicles and measures to increase the compliance	Use the knowledge of socio-economic calculations for political priorities and legal frameworks	Develop IT based models Big data and AI Research for system analysis calculations
Performance Based Standards (PBS)	Make demands on PBS when procuring logistic services	Invest in HCT and PBS related equipment for all new vehicles	Include vehicle requirements in PBS	Include infrastructure requirements from all transport modes adjusted to PBS	Speed up the development of legal frameworks adjusted to PBS	Provide with funding for more rapid acceptance and introduction to the market
Demonstrators	Initiate sector specific demonstrators	Initiate large scale demonstrators for entire cargo system	Initiate tests to evaluate new technology and vehicle configurations	Initiate demonstrators that include chains of several transport modes	Facilitate tests and implementations on a wider basis	Provide with initiation of tests on a wider basis, knowledge transfer, active pressure for rapid introduction
Type vehicles	Initiate utilization of new types of HCT vehicles	Structure of knowledge and investment in new HCT vehicles for more rapid implementation	Investigate the vehicles of the future in collaboration with Finland, knowledge transfer about performance etc for different HCT technologies including PBS	Guide the sector and player-wide coordination for the type vehicles of the future incl. fossil free	Include new type vehicles in the legal frameworks	Provide with funding, knowledge transfer Initiate development and implementation of fossil free energy provisioning for HCT vehicles
Infrastructure	Adjust their own infrastructure Make demands on others	Adjust their own infrastructure Make demands on others	Develop vehicles adjusted for different road network incl. electric roads and autonomous vehicles	Expand the road network for the different HCT types at a faster rate and get everyone (ports, railway terminals, airports) involved in the process of adjusting to HCT	Legal frameworks that enables creative procurement of investments and operation	Adjust gas stations, lay-bys, intermodal terminals etc
Traffic safety	Invest in safety system for HCT transports Security requirements in procurements	Invest in safety system for HCT transports among others IAC Drivers' education Self-monitoring	Develop and market equipment for enhanced traffic safety Knowledge transfer	Adjust road design so that the vehicles can be driven safely, among others stronger road rails	Adjust legal frameworks so that traffic safe vehicles get benefits	Support development of know-how at control authorities and others regarding benefits that new technological equipment give in a traffic safety perspective
Access control and compliance	IAC as requirement when procuring logistic services	Invest in different IAC technologies and self-monitoring	Ensure that required data is also open for other players	Make demands on IAC to get to drive HCT vehicles. Provide road data Traffic management at disruptions	Develop legal frameworks and standards for eco-systems for IAC and similar.	Knowledge structure of the benefits of this new technology Testing and certification
Legal frameworks	Participate in the development of HCT legal frameworks Knowledge support for involved authorities	Participate in the development of HCT legal framework Knowledge support for involved authorities	Participate in the development of HCT legal framework Knowledge support for involved authorities	Develop legal frameworks for different forms of access	Speed up the regulatory work of the implementation of new ways to increase the efficiency of the utilization of the infrastructure	Knowledge support for involved authorities Testing and certification

Identified sub targets

Table 3 below summarizes the sub targets that were identified within innovation domains for this roadmap. The responsible players and identified barriers to enable measures are presented. The background colours in the table mainly mark the time horizon of the sub targets. There is one exception though, for year 2020 where green represents sub targets that are most likely to be finished until the time horizon, and yellow represents the sub targets that are more difficult to predict when, for example, political decisions are required. The targets are in alphabetical order (for innovation domains) for each time horizon i.e. not priority order.

Background and explanation of why the targets have been chosen can be found in the background report Asp, Åkesson & Wandel (2019).

Table 3: Proposal of sub targets

Innovation domain	Time horizon	Sub targets	Responsible players	Barriers
Demonstrators	2020	About twenty vehicles that are heavier than 74 tons, but not longer, have been put into operation within among others mining industry and for steel transports.	Vehicle manufacturers, goods owners, haulage contractors and researchers	Permit & legal frameworks Funding of the tests with related research
Infrastructure	2020	There is an appointed road network for longer vehicles (24.5 m) which probably mainly consists of divided roads. This road network has also been reviewed regarding the prerequisites that are required, for example, length of the left turn lane, space at petrol stations, shunting locations and lay-bys.	Swedish Transport Administration, municipalities, private players	
Infrastructure	2020	The dialog with the other infrastructure owners, mainly municipalities, have a functioning process and the 100 most important nodes/routes are listed and partially fixed. Last mile access and measures to facilitate multimodal solutions are highly prioritized.	Swedish Transport Administration, Municipalities	
Infrastructure	2020	Tests with autonomous HCT vehicles are ongoing.	Swedish Transport Administration, The Swedish Transport Agency, private players	Lack of legal frameworks and permit

Infrastructure/Access control and compliance	2020	Ongoing investigation of the possibility for the road owners to lower the safety factor for bridges because the vehicle's weights are known through the IAC system and overweight are thus minimized.	Swedish Transport Administration	
International collaboration	2020	Both within EU and within the framework of Nordic cooperation, a work is introduced to harmonize the legal frameworks for HCT vehicles. It concerns among others cross-border transports, the durability of bridges, PBS and IT based systems for access control.	Swedish Transport Administration, The Swedish Transport Agency	
Logistic with multimodal solutions	2020	Sector and product group-specific multimodal demonstration projects have been initiated	Carriers, forwarders, goods owners, Swedish Transport Administration, The Swedish Transport Agency and research institute.	Spreading information and issuing permits
PBS/Infrastructure/ Traffic safety	2020	A Swedish PBS system including a Beta version of the support program for HCT vehicles exists in Sweden and connects the vehicles' characteristics to different traffic safety factors and the infrastructure	The Swedish Transport Agency, Research institute.	Lack of funding and collaboration between involved stakeholders.
Legal frameworks	2020	Work is in progress on how fees, taxes and other instruments that support increased efficiency and CO2 reduction within the freight transport system should be designed and mainly focused on HCT	The Swedish Transport Agency, Swedish Transport Administration, Government	
Legal framework/Traffic safety	2020	Investigations are done concerning if it is possible and if there are needs of having special qualifications to drive the HCT vehicles, mainly concerning 34.5 m vehicles	The Swedish Transport Agency, Swedish Transport Administration, Swedish National Road and Transport Research Institute	
Access control and compliance	2020	HCT-related IAC-services exist on the market, both for fixed telematic units and for mobile phones for rare users, for example foreign vehicles	Telematic suppliers, i.e. OEM and FM suppliers	Requires political decisions and legal assistance
Traffic safety	2020	Ongoing research concerning direct and indirect traffic safety effects at different degrees of penetration of HCT	Researchers	
Traffic safety	2020	Pre-studies are in progress on whether a higher degree of control and supervision of HCT leads to higher compliance and	Researchers	

		thus a higher traffic safety in Sweden compare to conventional vehicles.		
Traffic safety	2020	Execute studies of the traffic safety in undivided road network	Researchers	
Type vehicles	2020	The first report of HCT type vehicles is published and publicly available	Automotive industry	Funding
Type vehicles	2020	The work with combinations of type vehicles that can be used cross borders is initiated, for example regarding which axles that should be steered, lifted, and be driven individually or combined	Automotive industry and The Swedish Transport Agency	Funding Nordic cooperation
Type vehicles	2020	Accessibility for longer vehicles in the traffic system has been simulated and tests in traffic have been initiated	Automotive industry and researchers	Funding
Type vehicles	2020	Intermodal long combinations have been designed and simulated	Automotive industry, forwarders and researchers	Funding
Demonstrators	2020	At least 10 long test vehicles are driven outside of the highways. At least one of the vehicles has yet untested vehicle configuration.	Vehicle manufacturers, hauliers and researchers	Permit & legal frameworks. Finance of the tests related to research
Infrastructure	2020	Decisions are made on introducing longer vehicles (34.5 m) with maximum gross weight of 74 tons.	Government, The Swedish Transport Agency, Swedish Transport Administration	Political will
Infrastructure	2020	Develop socio-economical cost-benefit calculations for different rates of implementation, geographical and sector priorities, types of HCT vehicles and for alternative measures to increase the compliance	Swedish Transport Administration	Lack of input
Infrastructure	2020	Investigation is in progress if the weight curve for bearing capacity class 1 can be extended by increasing the distance from the first to the last axle beyond 20.0 m for gross weights over 64 tons and in that way get more weight with the same load per metre road	Swedish Transport Administration, The Swedish Transport Agency	Different opinions about the possibility to execute this
Logistic with multimodal solutions	2020	Several demonstrations with longer vehicles and multimodal concepts have been initiated, for example combined sequential combi and parallel combi and where the players have shared the risks with other types of contracts than what is common today.	Carriers, forwarders, goods owners, Swedish Transport Administration and research institute	Spreading information and issuing permits
Logistic with multimodal solutions	2020	A pilot terminal for fully automatic horizontal transfer of containers is tested and for automatic handling of separated loading units	Carriers, forwarders, goods owners, Swedish Transport	Lack of funding and cooperation between involved stakeholders

			Administration and research institute.	
Legal frameworks	2020	Complete proposal in the Swedish PBS and IAC systems are developed and tests are in progress	The Swedish Transport Agency, Swedish Transport Administration, Government	
Access control and compliance	2020	The entire IAC is finished and the legal frameworks for IAC become valid and IAC becomes compulsory in order to drive all types of HCT vehicles, including the bearing capacity class 4 vehicles, 2021-01-01	The Swedish Transport Agency, Swedish Transport Administration	Requires operative participation by legal expertise in the development and that IAC is politically prioritized.
Type vehicles/PBS	2020	Tire configuration optimization for different type vehicles and load characteristics are investigated.	Automotive industry and researchers	Funding of the tests and access to test combinations for verification
Demonstrators	2025	A sufficient number of long vehicles have also been used on undivided roads to get a good basis for evaluating the effects on the traffic safety	Vehicle manufacturers, truck body manufacturers, hauliers and researchers	Permit & legal frameworks
Demonstrators	2025	Technically, have enough knowledge been obtained to get a better understanding of which types of configurations that are best suited for different transport tasks incl multimodal setups.	Vehicle manufacturers, truck body manufacturers, hauliers and researchers	Research funding and access to expertise within the area
Demonstrators/ Logistic with multimodal solutions	2025	Several HCT vehicle combinations are in use in cross border traffic.	Goods owners, hauliers and researchers	A harmonized legal framework within the Nordic countries
Demonstrators/Infrastructure/ Type vehicles	2025	At least 30 tests are in progress with a length up to 34.5 meters including some that are heavier than 74 tons	Vehicle manufacturers, hauliers and researchers	Access to road network Funding of the tests regarding research
Infrastructure	2025	50 % of the bearing capacity class 1 road network that the industry has appointed is allowed for bearing capacity class 4.	Swedish Transport Administration	Budget restrictions
Infrastructure	2025	Longer vehicles (24.5 m) are allowed on appointed road networks and this road network is adjusted, i.e., left turn lane, lay-bys etc have been addressed.	Government, The Swedish Transport Agency, Swedish	

			Transport Administration, municipalities, private players	
Infrastructure	2025	Construction rules are adjusted for longer vehicles and also for vehicles heavier than 74 tons.	Swedish Transport Administration	
Infrastructure	2025	There are continuous dialogs with the rest of the infrastructure owners and the industry regarding which measures that are needed and hereby continued focus on the multimodal solutions.	Swedish Transport Administration, municipalities, industry	
International cooperation	2025	Expertise of HCT has been established as a part of the Swedish aid to decrease the climate impact that the fast growing transports, in particularly Africa, are feared to lead to.	The government SIDA	Time and commitment
Logistic with multimodal solutions	2025	Forwarding companies and the goods owners have adjusted their terminals and warehouse structures as well as traffic planning for HCT, especially for carriages with two or more trailers or empty loading units.	Forwarders Goods owners	Turning radius within existing terminals. Adjustments of existing operations and structures
Logistic with multimodal solutions	2025	Horizontal collaborations between several different goods owners, forwarders and operators to ensure high and even filling rate.	Carriers, forwarders and goods owners.	Competitive factors
Logistic with multimodal solutions	2025	Offer for transport in corridor where the freight is divided over transport modes and operators for system optimization. Requires a kind of corridor forwarders.	Carriers, forwarders and goods owners.	A harmonized legal framework within EU, infrastructure and finance
PBS	2025	The Swedish PBS system is evaluated and improved with several factors considered, such as choice of tires.	The Swedish Transport Agency, research institute	Lack of funding and collaboration between involved stakeholders
PBS	2025	The truck calculator has been complemented with requirements for longer HCT vehicles based on PBS	The Swedish Transport Agency, research institute	
Legal frameworks	2025	A new Swedish authority or department at existing authority has been established to certify hardware, software and processes for connected vehicles and all related back-end and cloud systems.	The government	Unclear division of responsibilities between the authorities
Legal frameworks	2025	A cross border legal framework for HCT, including PBS and IAC, within the Nordic countries is established and is in progress for Europe.	The Swedish Transport Agency, Swedish Transport Administration, the government	National specific interests

Access control and compliance	2025	The IAC platform is also used for exemption transports and transports of dangerous freights and also as a part of fulfilling the EU requirement 96/53 regarding weighing of vehicles which will be introduced in 2021.	The Swedish Transport Agency Swedish Transport Administration	Requires operative participation by legal expertise in the development and that IAC is politically decided.
Access control and compliance	2025	IAC2 has been introduced where the registration of gross weights, axle weights and trailers are executed entirely automatically. Manual registration occurs only in emergencies.	OEM, sub-supplier, Telematic suppliers	Standards are not developed
Access control and compliance	2025	IAC3 is introduced where all process and hardware have been certified so that registered weights, positions and vehicle configurations can be used directly for prosecution and sanctions.	Responsible authorities	
Access control and compliance	2025	The police and the Swedish Transport Agency use IAC data for their risk management system, i.e. for selection of who will be stopped for control and for data request from tachograph and from the IAC server.	The Swedish Transport Agency and the police	Requires political decisions and legal participation
Traffic safety	2025	A follow-up and immerse of types of accidents and trends for conventional heavy vehicles which have been identified in previous studies	Researchers	
Traffic safety	2025	Requirements for visibility and space in junctions and roundabouts for conventional heavy vehicles and HCT (space requirements are handled in the work package PBS) including hidden angles and risks for unprotected road users	Researchers	
Traffic safety	2025	Traffic safety risks related to tunnels and rails among others to develop basis for strategies for the increment of the collision capacity of road and bridge rails	Researchers	
Type vehicle	2025	Development and definition of the new vehicle units, for example, wagon and double link	Vehicle manufactures, truck body manufacturers, hauliers and researchers The Swedish Transport Agency	Funding of tests and access to test combinations for verification
Type vehicle	2025	Coordination between Sweden, Finland and Norway for cross border transports is in progress concerning for example steering, lifting and driving different axles.	Vehicle manufacturer, truck body manufacturers, hauliers and researchers	Funding Nordic cooperation Access to test combinations

			The Swedish Transport Agency	
Infrastructure	2030	The entire bearing capacity class 1 road network that is appointed by the industry, has been upgraded to bearing capacity class 4.	Swedish Transport Administration	Budget restrictions
Infrastructure	2030	The road network for 34.5 meter and 74 tons has been expanded with additional routes that are critical for the industry.	Swedish Transport Administration, municipalities, private road owners	Budget restrictions
Infrastructure	2030	In addition to previous level for HCT vehicles, there is a level for more than 74 tons and/or up to a length of 34.5 meters. The vehicles are driven on separated routes and with special permits	Government, the Swedish Transport Agency, Swedish Transport Administration	
Infrastructure	2030	Appointed system of green multimodal corridors for all transport modes is established.	Swedish Transport Administration	
Infrastructure	2030	HCT vehicles are adjusted to the development within autonomous vehicles and electric roads in order to take advantage of the benefits.	Swedish Transport Administration, the Swedish Transport Agency	
International cooperation/Legal frameworks/Access control and compliance	2030	A harmonized legal framework is finalised within EU. Concerns among others PBS, SIAP and IT-based systems for access control and automatic control of compliance.	European traffic authorities	Lack of cooperation National specific interests
Logistic with multimodal solutions	2030	A few autonomous HCT vehicles are driven on the roads	Carriers, forwarders, goods owners, Swedish Transport Administration, the Swedish Transport Agency and truck manufacturer	Legal frameworks Technology adoption
Logistic with multimodal solutions	2030	A few HCT vehicles are driven also on electric roads	Carriers, forwarders, goods owners, Swedish Transport Administration, the Swedish Transport Agency and truck manufacturers.	Legal frameworks Technology adoption

PBS	2030	A European system for SIAP (Smart Infrastructure Access Policy) exists, which implies optimization of the matching of vehicles ⇔ infrastructure	The Swedish Transport Agency, research players	Lack of funding and cooperation between involved stakeholders
Legal frameworks	2030	A global legal framework exists to certify hardware, software and processes for connected vehicles and all related back-end and cloud systems	Governments	Specific interests
Access control and compliance	2030	The previous separated boxes for the different authority applications within Europe, such as tachograph, tolls, e-cal etc. are replaced successively by apps in the telematic platforms.	Responsible authority	Special interests, concerns about cheating
Access control and compliance	2030	Access control is used for most of the road vehicles to individually control access in time and space and dynamically adjusted to the specific combination of vehicle characteristics, road characteristics, weather and traffic.	Road owners	Stakeholders does not want access to be restricted or charged.
Traffic safety	2030	A follow-up and immerse of accident types and trends for conventional heavy vehicles which have been identified in previous studies	Researchers	
Traffic safety	2030	In 2030 is the risk of accidents with the HCT vehicles half of what it was in 2018 due to PBS, IAC and other safety enhancing technologies and special education.	Researchers	

Recommendations and next step

This roadmap is based on a desired state in year 2030 and through back casting, sub targets for year 2025 and 2020 have been determined.

The most important stakeholders need to adopt this roadmap and based on it, develop their strategies, investment plans and budgets. This involves all the stakeholders in the small system, which is described in the base report, i.e. goods owners, forwarders, hauliers, road owners, vehicle manufacturers, IT-suppliers and especially legislator and authorities. The understanding of the system and stakeholder model in the background report Asp, Åkesson & Wandel (2019) becomes important when a communication plan is established. Here, collaboration platforms have a big role (such as CLOSER) when the players cooperate to establish this roadmap in order to reach the targets of 2030.

The quarterly meetings in the HCT steering group with active representatives from the most important players and the annual Nordic HCT conference, are examples of meeting points between stakeholders and need to be continued. This goes hand in hand with the need to continue to execute demonstrations and pilot projects regarding multimodal and sector-specific logistic setups, which requires collaboration with other transport modes.

It is important that legal expertise is included from the start in the operative development process of HCT in order to guide the development and facilitate when going from development project to changing laws and a broad implementation. The necessary international cooperation shall continue in order to avoid duplication of work and to harmonize legal frameworks and technical requirements for both cross border transports and the vehicle development

Research has proven that it is socioeconomically profitable to quickly implement HCT widely. In Sweden we have enough knowledge for starting immediately. Though, so far, some stakeholders and political groups have been doubtful and shown knowledge gaps and therefore slowed down the implementation. A purpose with the new roadmap is to fill these knowledge gaps and thus increase the acceptance. Unique for this roadmap is that, for each sub target, both responsible and expected barriers have been identified to facilitate reaching the sub targets.

In order to link to the above, it is important to develop a clear communication plan with individual plans for two-way communication with the different groups of stakeholders. Cooperation and communication are very important to ensure that the targets of the roadmap of 2030 are reached. The roadmap will never be stronger than the commitment of each participant and what the remaining barriers allow.

Henceforth, CLOSER will be an important cohesive link and driving force in order to immediately start the activities that are required in order to reach the targets.

Finally, it is recommended that the roadmap becomes a living document and that it is revised in year 2020 considering the rapid ongoing development.

References

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