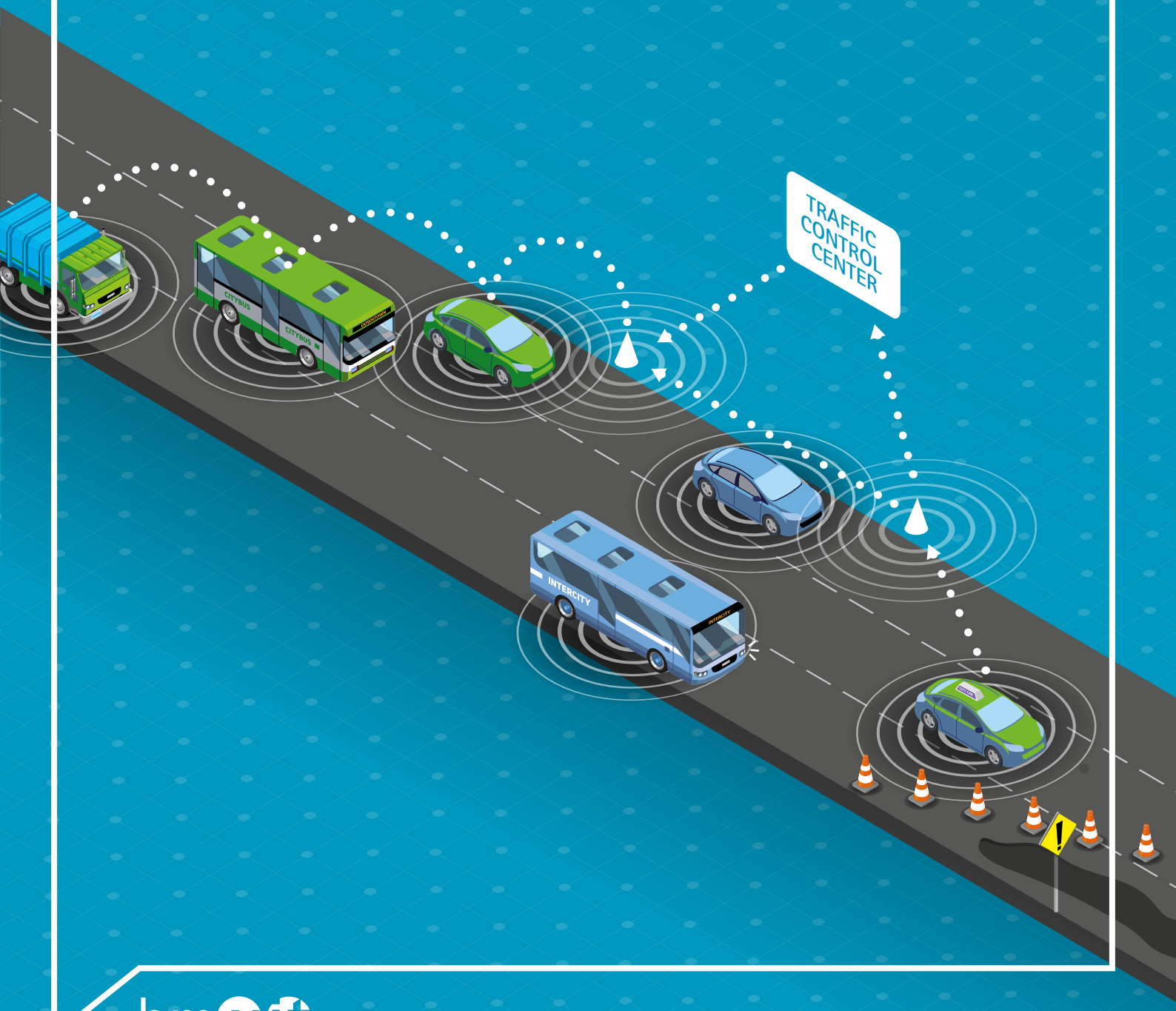
C-ITS Strategy Austria

Network Drivers, Promote Efficiency and Safety in Transport.
June 2016



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1. Foreword

Already today, the networking of intelligent transport systems contributes significantly to making transport safer, more efficient and sustainable. The possibilities offered by such cooperative systems, also known as C-ITS, are growing constantly. The C-ITS strategy for Austria summarises the key areas of action from the perspective of the bmvit and presents them in an international context. Thus, the basis for a deployment decision is provided for infrastructure operators as to how these new technologies can be deployed in the Austrian transport system by 2020. A further target group of this C-ITS strategy are the companies and organisations that will be involved in the deployment of C-ITS or will be affected by the deployment now or in the future.

C-ITS can significantly contribute to successfully, safely and permanently integrating automated driving into our mobility system. Cooperative systems have been tested over an extended period in various EU projects and national initiatives. This strategy also provides an overview of the current state of the applications and standards, as well as national and international projects in Europe, USA and Asia as well as possible deployment scenarios.

The joint deployment of C-ITS services is an important step in order to better network transport infrastructure and vehicles in the future and to coordinate the mutual exchange of data. An example for this is the Cooperative ITS Corridor from Rotterdam via Frankfurt to Vienna. In this project, importance is placed on both the deployment in the Austrian transport system, as well as the internationally coordinated deployment. Road infrastructure operators such as ASFINAG work together with other road operators, partners from industry and automotive manufacturers such as the "Car2Car Communication Consortium".

The next step will focus on the further development of C-ITS beyond the high level road. This strategy includes a vision of possible scenarios by 2020 and highlights concrete goals for the deployment of C-ITS in Austria, the necessary activities, the cooperation of the parties involved and an appropriate timetable for the deployment.

Other communication technologies have other strengths, such as the large data rates in cellular networks. As a first step until 2020, this strategy paper will only refer to C-ITS networking via ITS G5 because this standard is seen as the responsibility and domain of the public sector and this technology has been extensively tested and will soon be introduced to the market.

2. C-ITS – The Future of Transport

2.1 What is C-ITS?

ITS stands for "Intelligent Transport Systems". In Austria the abbreviation IVS (Intelligente Verkehrssysteme) is also often used.

According to the Austrian "Federal Act on the Deployment of Intelligent Transport Systems in Road Transport and Interfaces with Other Modes of Transport" (Section 1 §2.1 IVS-G - ITS Law)[1] the term "intelligent transport systems" is defined as follows:

"...'Intelligent Transport Systems' or 'ITS' systems in which information and communication technologies are applied in the field of road transport, including infrastructure, vehicles and drivers, as well as in traffic management and mobility management and for interfaces with other transport modes;" (Federal Chancellery of Austria 2015: Section 1 §2.1. IVS-G)

C-ITS stands for "Cooperative ITS"; in other words cooperative systems. These are ITS services that are based on networked data communication between vehicles and the infrastructure (communication between the individual vehicles, called V2V and between vehicles and the infrastructure, also called V2I).

V2X – vehicle to everything communication contains:

- V2I vehicle to infrastructure
- V2V vehicle to vehicle communication

C-ITS is defined even more broadly in the ISO and CEN standards[2], particularly with respect to the so-called "ITS stations", i.e. the hardware and software units installed in the vehicle or as a roadside unit on the road that perform various tasks in the entire network of the cooperative systems. Through the appropriate legal documents, the European Commission establishes a strong connection between road safety-relevant cooperative services and the radio frequencies in the 5.9 GHz range specially reserved for such purposes.

C-ITS Communication Technologies

Radio frequencies are strictly reserved for such applications and protected against other uses. The crucial document at the European level is the European Directive 2008/671/EC [3]. Furthermore, there is a relation to the ITS Directive[4], which in Section 4, Integration of Vehicles in Road Infrastructure, defines the individual issues regarding cooperative systems and thereby forms the basis for further measures. This is based on the mandate (M453) for common C-ITS standards for communication between transport infrastructure and vehicles in the EU. In addition, individual measures for the full development of cooperative systems and the development of a specific legal act on the implementation and deployment of C-ITS in the EU are necessary. In order to elaborate these topics further and to define the next steps for introducing C-ITS in Europe , the European Commission started the "European C-ITS platform" as an advisory expert group.

In other regions of the world as well, particularly in the USA and in Asia (e.g. Japan, Korea and China), this range of radio frequencies has also been reserved for cooperative services so that C-ITS services can be offered worldwide. Furthermore, in the USA, the United States Department of Transportation (DoT/NHTSA) stated in its decision on V2V in ANPNR[5] from August 2014, that with a planned start date of 1.1.2019, all newly registered vehicles will be required to be able to send cooperative messages in the form of "Basic Safety Message" (very similar to the CAM - Cooperative Awareness Message in the EU). This requirement will apply to all vehicle manufacturers in the USA and will thus have a strong international influence.

The standard CAM

"Cooperative Awareness Message" is one of the standardised messages of the C-ITS for the high frequency (in milliseconds) exchange of traffic data between vehicles. The message itself contains, among other data, the current position, speed and direction of movement.

2.2 What Purpose does C-ITS serve?

C-ITS has a positive influence on road safety because it allows precise warnings to be sent directly to drivers quickly and efficiently. Road safety is increased through the rapid identification of traffic disruptions (at the C-ITS stations), and the targeted warning of all drivers approaching a danger situation. On the one hand, this particularly concerns road sections associated with mobile service and maintenance work, as well as infrastructure sections that are often affected by adverse weather conditions and weather alerts and where other means for providing drivers with information are not quick enough.

The direct connection to the traffic control centre is only given for C-ITS. Therefore, the drivers can be provided information more quickly and accurately than through other means of communication such as mobile applications on smart phones or the traditional traffic reports on the radio. It is currently not yet possible with any other media to provide all the drivers on a section of road with the complete traffic information in such very short intervals.

Through this information, C-ITS can improve the overall driving comfort because well-informed drivers are more relaxed on the road. Dangerous situations can be avoided by adjusting the driving style based on information in advance. It can not yet be quantitatively determined to what extent C-ITS will contribute to a reduction in accidents since sufficient installations and vehicles are not currently available in order to evaluate this for an entire infrastructure network. Depending on the type of accident, it is currently estimated that if all cars were equipped with C-ITS systems, their use could lead to a reduction of accidents between 8% (in the highway environment) and 60% - 80% (in collisions at intersections in urban areas).

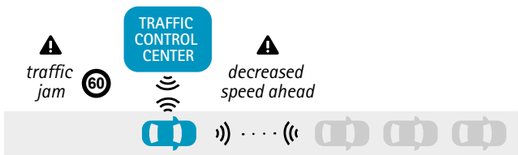
2.3 Developments in Austria

Austria began very early with the first C-ITS activities. From 2006 to 2010 the first cooperative services were developed and tested in the project COOPERS under the direction of AustriaTech with strong participation from ASFINAG. This project was one of the fundamental EU projects in the field of V2I communications.

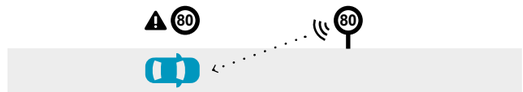
The findings were refined further in the national project "Testbed Telematik". In this project funded by the KLIEN (Federal Climate and Energy Fund), a consortium of research, industry and public companies tested how cooperative services should be designed and implemented in order to optimally contribute to increased safety, efficiency and sustainable mobility in the transport network, and how to best meet the requirements and needs of the users. The focus was on the communication between the infrastructure and the vehicle (traffic control centre, roadside units, receiving unit in the vehicle).

The next step is the cross-border implementation of C-ITS applications. To achieve this, Austria is working together with the Netherlands and Germany to implement C-ITS services along a corridor from Rotterdam via Frankfurt/Main to Vienna. The Austrian part of this corridor will be defined in the project ECo-AT ("European Corridor – Austrian Testbed for Cooperative Systems"). In the first phase of this project a complete system specification will be developed, tested and approved. This specification is the basis for subsequent tenders for C-ITS units on Austrian motorways. As a result of the roll-out, the defined "Day 1 applications" should be available along the corridor. Based on the current planning status, these applications will be "Roadworks Warning", "In-Vehicle Information", "Probe Vehicle Data", "SPAT / MAP applications" and certain "DENM applications" and will provide drivers with the following information:

Traffic Jam Warning
Drivers are informed about upcoming construction sites and their relevant data as well as any obstacles (e.g. closed lanes).



In-Vehicle Information (IVI)
Drivers receive information about speed limits



CAM, DENM Aggregation
The collection of anonymous vehicle data (mobile ITS stations) will considerably expand the basic data for traffic management.

Intersection Safety (ISS):
Cooperative traffic light systems provide information on the status of their signal phase (SPAT - Signal Phase and Timing).

Figure 1: Use Cases for Day 1 applications

Example: A frequent accident on high level roads is the collision of a vehicle with markers and safety barriers for construction sites. By transmitting the relevant information about upcoming construction sites and the related lane changes directly to the vehicle ahead of time, these accidents can be reduced.

Overall, the C-ITS technology has now been well researched and will soon be ready for use in series production. All that remains is the clarification of individual aspects that will also require research approaches and projects in the future that will be coordinated with the FTI Roadmap of the bmvit.

2.4 Integration brings Benefits

To take advantage of the full potential of C-ITS, it will be crucial to optimally integrate C-ITS applications and services into the traffic management. Therefore, in the projects described above (COOPERS, Testbed Telematik, ECo-AT) data from the traffic management were and are the basis for the C-ITS services offered. A decisive factor will also be the networking of traffic management facilities of different road operators (ASFINAG, provinces, cities and municipalities), otherwise it will only be possible to provide services locally and not throughout Austria (e.g. to connect the high level road network and adjoining urban areas and set up an automatic information exchange). These local solutions are still certainly also useful for a start in the implementation (Day 1 – high level road network). For subsequent steps of evolution (state roads, cities) however, further networking efforts must also be made to make the benefits of C-ITS effective for the entire transport network.

The solutions strived for should encompass not only road traffic, but also public transport. An example of this is the prioritization of public transport at traffic lights. In this case, if needed the public transport could request priority at traffic lights and thus help to keep the public transport on schedule.

Since many drivers use navigation devices or applications for route planning and to display traffic information, the exchange between road infrastructure operators and providers of information services (navigation, traffic information) can open up additional opportunities. Thus, providers of mobility services have direct access to their customers and also information about their destinations and preferences. This allows existing traffic information to be personalized. Road infrastructure operators in turn have information for example on planned events or the expected duration of necessary short term road closures and can significantly improve the quality of the traffic information given with the help of providers of information services. Currently, the ERTICO "Platform Traffic Management 2.0" is working on networking these two groups.

2.5 Cooperative Vehicles on the Road

In 2012, the members of the Car2Car Communication Consortium (C2C CC) signed a Memorandum of Understanding (MoU)[6] which stated their intention to work together to deploy C-ITS services on Europe's roads. Since then, the development of the foundations for C-ITS services and their standardization has been driven forward. It is expected that the development will include everything from warning messages to cooperative driving (such as Lane-Merge Assistance) all the way to fully automated driving[7]. C-ITS is an essential basis for achieving all this.

In November 2015, the C2C CC also published an update to the MoU in which the series production of vehicles equipped with C-ITS by vehicle manufacturers that are members of the C2C CC are specified. In this document the members agree to introduce production vehicles equipped with C-ITS by 2019. The condition is that the currently existing open issues such as data security for the C-ITS units and data privacy are fully addressed beforehand. These issues should be taken into consideration in the development process of production vehicles. Several manufacturers have already announced that they will have production vehicles with C-ITS on board even before 2019.

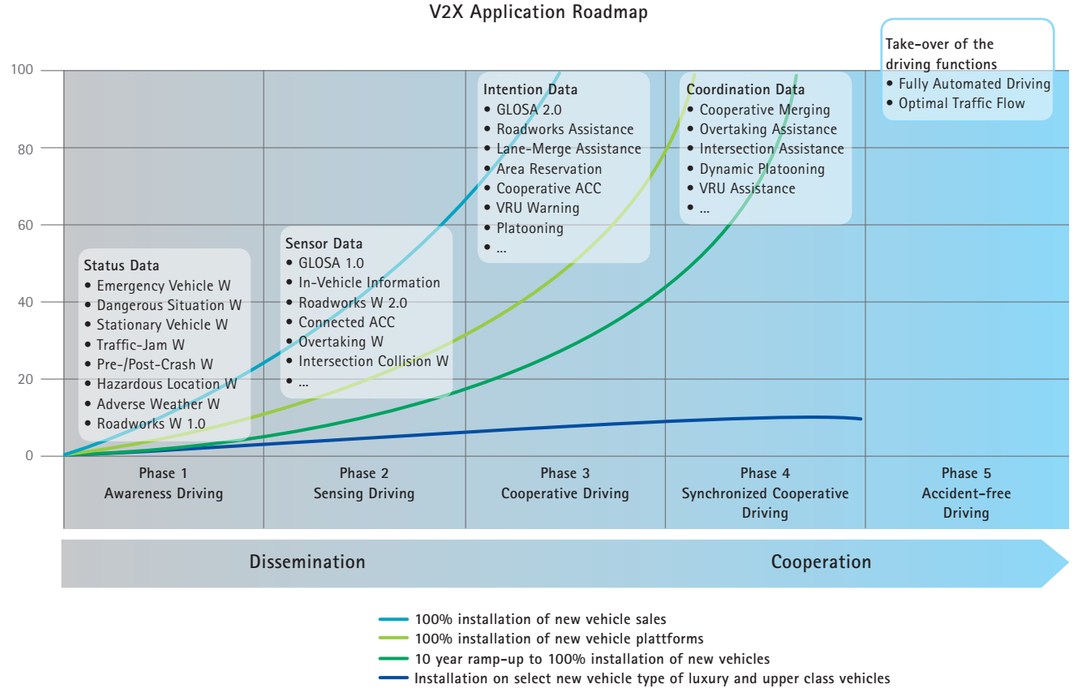


Figure 2: V2X applications from the perspective of the C2C Communication Consortium, based on the SAE graphic.

Side note: Automated driving

Efficient automated driving in mixed traffic (automated and non-automated vehicles) can only achieve an optimum through continuous coordination with traffic management. The traffic management can specify requirements for example to maintain the traffic flow or to approve existing requirements for automated driving. Thus, for example, a lane could be dynamically released for automated driving with precise specifications for speed and distance between vehicles.

In general, the networking of the vehicles with one another and with the infrastructure is a decisive factor in making a comprehensive, forward-looking and detailed perception of the environment possible for the individual vehicles. With the appropriate networking for example, accurate information about the current speed limits can be reliably transmitted directly to the vehicle. Only in this way can the safe operation of autonomous vehicles be guaranteed.

3. C-ITS in Practice

A first step for the implementation of C-ITS services lies in the definition of so-called Day 1 applications. These applications include those safety-related notifications that are to be given priority and are to be implemented in the first phase. To do so, applications were defined at a European level in the fields of "hazardous location notifications" and "signage applications".

3.1 Deployment Scenarios – "Day 1 Applications"

"Day 1 applications" refer to those applications that are to be realized in the first step. These were already worked on several times in numerous projects and also edited and confirmed again in the working groups of the "EU C-ITS Deployment Platform"[8b] in 2015. The final report from this platform was published on 20th January 2016. The current corridor project will reveal which applications are actually seen as useful by the road operators and the automotive industry and should be implemented first. These applications are on the one hand warning systems that alert drivers of dangers on the road, and on the other hand applications that electronically display static and dynamic traffic signs directly in the vehicle, thereby making them more easily recognisable for drivers. The entire list of applications is defined as follows:

Application / Service	C-ITS Message Basis	Supported by Deployment and Specification Activity	Further Key Technology Building Blocks	V2V / V2I
Hazardous location notifications:				
Slow or stationary vehicle(s), Traffic jam ahead warning	DENM	SCOOP@F Car2Car-CC MoU		V2V V2V
Road works warning	DENM	C-ITS Corridor, ECo-AT SCOOP@F Car2Car-CC MoU	Interfaces on infrastructure to trailer / Centre	V2I
Weather conditions	DENM	SCOOP@F	Interfaces on infrastructure to Centre; evtl. roadside weather station	V2I
Emergency brake light	DENM	SCOOP@F Car2Car-CC MoU		V2V
Emergency vehicle approaching	DENM	Car2Car-CC MoU		V2V

Application / Service	C-ITS Message Basis	Supported by Deployment and Specification Activity	Further Key Technology Building Blocks	V2V / V2I
Signage applications:				
In-vehicle signage	IVI / IVS	C-ITS Corridor, ECo-AT SCOOP@F Car2Car-CC MoU		V2I
In-vehicle speed limits	IVI	C-ITS Corridor, ECo-AT SCOOP@F Car2Car-CC MoU		V2I
Signal violation / Intersection Safety	SPAT/ MAP	C-ITS Corridor Car2Car-CC MoU		V2I
Traffic signal priority request by designated vehicles	SPAT/ MAP	Infrastructure Industry; Cities; PT organisations		V2I
Green Light Optimal Speed Advisory (GLOSA)	SPAT/ MAP	Car2Car-CC MoU	Forecast required	V2I
Probe vehicle data: CAM aggregation	CAM	C-ITS Corridor (ECo-AT) SCOOP@F	CAM evaluation logic at infrastructure for detection of traffic related events	V2I

Table 1: List of C-ITS "Day 1 Applications" as of 12/2015

These applications should be the first to be implemented in the EU by 2020. Others will follow on this basis and be used in various areas of transport.

3.2 Mobile Traffic Information and Networks

In just three to five years, many new vehicles will be networked with the infrastructure or other IT services and exchange data on a regular basis. This data is required by both the drivers on board as well as the traffic managers. The technical basis of the network connection between vehicle and infrastructure is an element of the so-called "cloud services" that in future will provide mobile users with traffic information and other content (e.g. points of interest at the destination). These services are either offered via the network of a telecom provider, a vehicle-based cloud service or an independent third party service provider via the Internet. The users will be able to select and use the service they prefer. These developments reinforce the existing trend of remaining well informed even when on the go, and has many positive implications for the deployment of C-ITS.

This results in an increased need for the traffic management to generate sufficiently detailed and high quality traffic information in the management centres and to distribute it via the technically available channels so that it can best reach the drivers. With its standardised traffic notifications, the C-ITS communication network is the best suited means for ensuring drivers are provided with accurate information extremely quickly.

3.3 Goal: Efficiency and Consistent Traffic Flow

Through the use of C-ITS Day 1 applications, the technical basis is created in the transport infrastructure and the vehicles for the implementation of C-ITS services and applications and for further subsequent deployment. The Day 1 applications described in this paper are used primarily to keep traffic flowing and thus contribute to lower emission levels and to warn vehicles of dangerous situations ahead.

- The early and accurate localization of problem areas, obstacles etc. is essential for sending warnings to following vehicles. Thus, dangerous situations can be avoided and an overall consistent traffic flow can be maintained even in dense traffic.
- At construction sites, speed funnels are crucial for reducing vehicle speed before the construction site in order to keep traffic moving smoothly and to influence the traffic density. Through the use of C-ITS, warnings are precisely defined and transmitted to the vehicles.
- The same applies to weather warnings which concern dangerous and often very dynamic situations: The warnings must be quickly transmitted to the concerned vehicles in order to influence the driving behaviour.
- The applications mentioned so far are warnings that are created by the infrastructure operators and sent first to motorways and expressways. At the same time, vehicles equipped with C-ITS also exchange information directly between each other, for example sending and receiving warnings if they abruptly slow down or are approaching the end of a traffic jam. These types of applications will also be available in the first series production vehicles equipped with C-ITS.
- For urban areas, there are currently two largely standardized applications for C-ITS. These applications concern traffic signals and signal phases with driving privileges for the respective lanes. In technical terms, these standards for message formats are referred to as "SPAT/MAP"[2].
- Further fields of application for information from C-ITS traffic lights are: Vehicles can be warned if another vehicle disregards the traffic light signals ("red light violation"). Furthermore, based on the SPAT information from consecutive traffic lights, the optimal speed for a so-called "green wave" can be calculated ("Green Light Optimum Speed Advisory – GLOSA").

Another application of C-ITS is the prioritization of emergency vehicles at intersections. In this case, the traffic lights can be changed accordingly on the one hand, and on the other hand vehicles that are already at the crossing can be informed in order to clear a lane for the emergency vehicle. The prioritization of public transport (PT) at intersections is also possible on the basis of C-ITS. In this case, vehicles of the public transport fleet are equipped with an active C-ITS unit that, depending on the current parameters in the vehicle, such as occupancy rate and time schedule, can request a suitable signal phase so they can drive straight through. This decreases emissions and increases the attractiveness of public transport.

3.4 Goal: Higher Traffic Safety

C-ITS applications that are based on the exchange of data between vehicles have a positive influence on road safety. International estimates, for instance from the USA, predict a reduction in the number of accidents by up to 30% when all vehicles are equipped with C-ITS[5]. The specific and precise warnings of the transport infrastructure in the vehicle help on the one hand to avoid critical driving situations and on the other hand to reduce the severity of accidents. This is especially true for the electronic warning upon abrupt braking as well as at intersections and warnings when emergency vehicles are approaching.

Depending on the C-ITS service, as well as the penetration in the vehicle fleet and in the transport infrastructure, the contributions of the individual services will either be more in the area of efficiency or the area of road safety. The precise and rapidly transmitted warnings by the transport authorities or transport infrastructure operators are an essential starting point for the developments. At the beginning of the deployment, when few vehicles are equipped with C-ITS, an appropriate distribution of C-ITS units on certain sections of the transport infrastructure can help ensure a positive experience and consequent acceptance among users.

4. C-ITS International

This section will present international projects that further detail the transition between research and development projects and the first use of C-ITS in everyday traffic. The different international approaches to the deployment of C-ITS will also be presented. The projects presented can provide interesting experiences for the deployment in Europe.

4.1 Europe and the Cooperative ITS Corridor

In connection with the Cooperative ITS Corridor Rotterdam-Frankfurt-Vienna, it was decided by a MoU of the Transport Ministers involved on 10 June 2013 to introduce C-ITS in an international corridor and together with the automotive industry to take a first step towards deploying this technology on a major transport corridor. The three participating countries, the Netherlands, Germany and Austria, have each started national projects to finance the activities and at the same time set up coordination at the strategic and project level. Together with industry, the deployment is targeted for approximately 2019, when the first production vehicles will be introduced. The coordination along the corridor is supported by the working groups of "Amsterdam Group"[9], the motorway operators, road authorities, automotive industry and representatives of cities and public institutions that are all involved in the deployment of C-ITS.

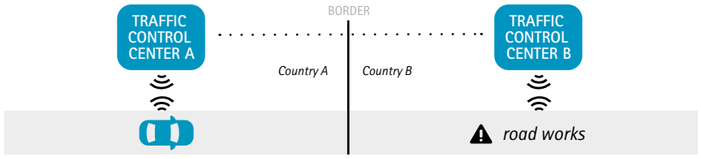


Figure 3: C-ITS for crossborder traffic data exchange

In Austria, the project ECo-AT[10] was launched under the consortium management of ASFINAG. Operators, industrial companies and research institutions are working on the deployment of C-ITS along the corresponding corridor. In Phase 1 of the project, the specifications of the individual elements of C-ITS will be developed and tested and the development of the necessary products will be promoted. The detailed specifications of the individual components, such as Road Side Units (RSU) have already been published in a total of four cycles to get and incorporate feedback from external institutions. The documents were first published on 12/2014, 04/2015 and 07/2015. The start of Phase 2, the implementation of the project, is planned after a positive deployment decision by ASFINAG taking into account the conditions of the European Commission as well as the current implementation plans of the vehicle manufacturers (OEMs).

Of the C-ITS services mentioned, in ECo-AT the following three services will be deployed along the corridor based on the ITS G5 communication technology:

- Road Works Warning (RWW)
- Probe Vehicle Data (PVD)
- and Cooperative Awareness Message (CAM) Aggregation.

The positive impact on road safety and the improvement of the collection of transport data compared to the status quo were the main reasons for deciding to deploy these C-ITS services first for the transport infrastructure and vehicles in Europe. The RWW service will already have a positive influence on road safety even if only a low number of vehicles are equipped with C-ITS. Since accidents are particularly common at mobile construction sites (daily and mobile roadworks), the employees of the road operator can also be better protected by the local warnings sent to vehicles. Due to the additional data provided by the vehicles through the PVD service or CAM aggregation, infrastructure operators are in a better position than ever before to recognise irregular situations and generate and transmit more precise warnings.

A key task of the Cooperative ITS Corridor is the testing and validation of the C-ITS units. This should help ensure the same functionality everywhere along the corridor itself and also in other countries in Europe as well as for all vehicle brands to guarantee full interoperability. To accomplish this, a "Living Lab" will be established in the ECo-AT project where the industrial companies can test and validate the C-ITS units they develop against the existing specifications. This test and validation phase of the ECo-AT project will ensure a know-how transfer and provide sound information for public organisations and institutions about the possible applications on highways or in urban traffic environments. Other projects related to the Cooperative ITS Corridor, some of which are bound to the coordination of the Amsterdam Group, will be presented in the following sections.

4.2 France and SCOOP

In France there have also been a number of national R & D projects that have explored the technical basis of C-ITS and have thus demonstrated its functionality. Worth mentioning are above all the field operational test "SCORE@F", with the participation of the carmakers Renault and PSA (Peugeot and Citroen), and the follow-up projects SCOOP@F[11] and SCOOP@EU, which is currently being worked on. The project is financed in part nationally and in part by the EU. SCOOP should make the transition between R & D and a first series production of C-ITS in five demonstration areas in France possible. These test sites are on the one hand highway corridors around Paris, as well sections from Paris to Strasbourg much like the Cooperative ITS Corridor. In addition, the test sites also include smaller cities in rural areas such as in Brittany and the city of Bordeaux. The following illustration shows the five demonstration areas and their extensions.

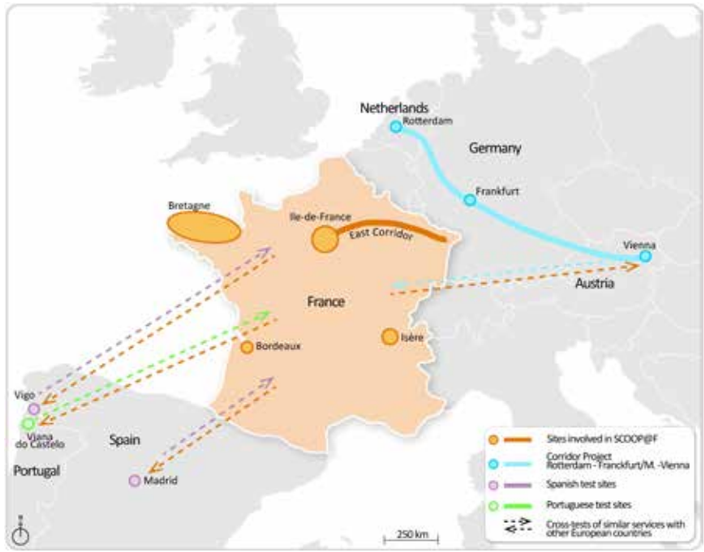


Figure 4: SCOOP@F overview map and demonstration sites involved

The five C-ITS services of SCOOP are based on the same ISO/CEN and ETSI standards as those for the Cooperative ITS Corridor. However, in addition to the transmission technology "ITS G5", the partners in SCOOP are also testing the transmission in the vehicle by means of telecommunications networks (e.g. LTE or in the future 5G). Overall, the goal is to equip up to 3,000 vehicles for use in the demonstration test. The goal of the SCOOP@F project is on the one hand to demonstrate the user acceptance of the services, and on the other hand to examine the coexistence with existing transport systems in more detail. Another important point in the SCOOP@F project is the activity of the "cross-site testing" with the Cooperative ITS Corridor to ensure full interoperability of cooperative systems in the EU. This is being done in coordination with the "Amsterdam Group" and the working groups set up for the aspect "Testing and Validation of C-ITS".

Other countries in the EU are also conducting projects to prepare for the deployment of C-ITS and have submitted these projects to the European Commission for co-financing. At present, they are mainly Scandinavian countries with the project "Nordic Way", but Poland, Hungary, UK, Spain and the Czech Republic also have C-ITS projects underway. Examples of international projects from outside Europe will be presented in the next section.

4.3 USA: Vehicle Infrastructure Integration (VII)

In the USA several attempts have already been started for the deployment of C-ITS in the transport system. An attempt was made to organise a cooperation between private companies from the automotive industry and the technology sector and public institutions and organisations with the help of stakeholder groups. An example is "Vehicle Infrastruc-

ture Integration (VII)". From the beginning, the introduction of cooperative systems and the contribution of public institutions was justified in the USA solely with the goal of improving road safety. Therefore, they focused on C-ITS applications based on V2V warnings that can have a positive impact on rear-end collisions and collisions at intersections.[12]

Since 2001, the cooperation of the automotive industry in a research program called "Collision Avoidance Metrics" (CAMP) has been promoted with the aim of researching the settings and conditions of V2V warnings and laying a foundation for the development of series products for the individual automobile manufacturers. Series products launched around 2005 and by 2011 had been adopted by other international manufacturers such as Honda, Toyota and Daimler. In the R & D phase, the prototypes were used by manufacturers in series of up to 20 vehicles to research communication scenarios with a higher number of participants and mutual influence.

An initiative on the basis of the research was "Vehicle Infrastructure Integration (VII)"[13] from 2006 to 2010, a national program of the US Department of Transportation (DoT) that mainly researched the communication technology DSRC, a variant of the wireless standards (802.11XX) and developed about 20 different applications for vehicle to vehicle communication. These technologies were demonstrated together with US and international automobile manufacturers in Ann Arbor, Michigan and in California, where further testing projects took place. The most important findings of VII are:

- The detailed definition of communication standards and protocols/messages between vehicles is not sufficient to be able to respond to the messages from other vehicles in safety critical situations. For this reason it was necessary to start the CAMP initiative and define and parameterize the specific communication profiles and trigger conditions for V2V warnings together with all the automobile manufacturers.
- By defining the C-ITS applications that positively influence road safety through V2V warnings, the introduction of the technology in the overall transport system is more difficult to present because the respective positive impact on the number of accidents can only be achieved with a high penetration of the vehicle market. To achieve installation rates of over 80% of the vehicle fleet, however, a period of 20 to 30 years is certainly realistic. Therefore, the public institutions in the USA have repeatedly pointed out in recent years that C-ITS applications that influence traffic flow and efficiency can also make an important contribution. Deployment initiatives by DoT's have been announced for corridors and individual states, such as Michigan, with a high number of C-ITS equipped vehicles.
- Last but not least, the NHTSA, National Authority for Road Safety on Highways, announced in August 2014 that with the introduction of C-ITS it will be mandatory to equip all new vehicles with C-ITS as of 01/01/2019. Vehicles must then be able to send the Basic Safety Message (BSM - the US equivalent of CAM in Europe) for the purpose of improving road safety[5]. This also provides further impetus for the introduction of C-ITS in the USA.

4.4 Asia and Oceania

Of the many extensive ITS projects in Asia and Oceania, two examples will be presented here that also allow a comparison with the situation in Europe and also include interesting aspects. These are the C-ITS in Japan and the "Intelligent Access Program" (IAP) from "Transport Certification Australia" (TCA) in Australia.

It is noteworthy in Japan that for C-ITS projects and their deployment the government manages with strategic vision to attract industrial companies to collaborate on technology programs and these programs are also continued all the way up to the introduction into series production, e.g. in vehicles. Thus, in an international comparison, Japan has the highest number of networked vehicles equipped with C-ITS on the road in everyday traffic (about 20 million vehicles). They use traffic alerts, dynamic message signs and other C-ITS applications in vehicles.

Another interesting example of the use of C-ITS is the "Intelligent Access Program" of the Australian government and the authority TCA. The program was introduced in order to allow an exchange of information between vehicles and infrastructure in freight transport and to thus better coordinate public and private interests[14]. To achieve this, various public (e.g. emergency call function similar to eCall) and private applications (e.g. navigation and fleet management) are used on a common on-board unit. However, the unit completely separates the data and information into the two areas. In addition, the public applications from different vendors can be certified as modules and used in vehicles with different on-board units. The program has been running since 2006 and is currently widely used in freight transport with an increasing number of applications. In the context of C-ITS, the use in freight transport is of particular interest since it is precisely here that the regulations from the government and the requirements of the transporters are increasingly difficult to reconcile. An involvement of the freight transport operators in Europe comparable to that in Australia has so far been unsuccessful. Such a move however, could significantly expand the range of C-ITS applications and promote acceptance.

5. C-ITS – Vision and Goals

This section will present the basic goals of the C-ITS strategy in Austria. The detailed plans for Phase 1 (Day 1) and subsequent phases (deployment) will also be presented, such as the concrete plans until 2020.

5.1 Vision and Mission Statement for the Transport System

The use of C-ITS affects the entire transport system in the street area, beginning with the high level road network and its interfaces to the secondary networks. The road network of the provinces, the cities and municipalities are affected as well.

The basic goals for the deployment (Day 1) of C-ITS in Austria are:

- The users receive improved traffic information and can drive more safely with more foresight.
- Anonymised vehicle data and user generated data will be used to supplement or replace the current traffic management sensors.
- Existing information and data from the road infrastructure will be supplemented and validated.
- C-ITS services will also be offered to drivers in the subordinate network with the help of mobile networks.

It in no way concerns the collection of personal data for further evaluation and use for law enforcement purposes. The "privacy by design" principle will be followed for the deployment of C-ITS services!

Other goals for later phases (Day 2 and more):

- The roll-out strategy for the secondary network will be coordinated and decided together with the infrastructure operators.
- The roll-out strategy for Day 2 and Day 3 applications will be developed and coordinated with stakeholders. For this purpose, the entire chain of information all the way to the display of traffic information in vehicles on different devices with different service providers will be analysed.
- The legal liability for the display of do's and don'ts in digital form in the car or on mobile devices, such as a speed restriction on a VMS (e.g. overhead display) should be ensured for Day 2 and Day 3 applications.

5.2 Specific Objectives for C-ITS until 2020

5.2.1 Quantitative Goals:

- ASFINAG records 50% of the events generated by C-ITS equipped vehicles on the primary road network.
- C-ITS traffic information is available in real time in the vehicle for at least 10% of the ASFINAG network.
- The time from when a C-ITS equipped vehicle is notified of a traffic event by Decentralised Environmental Notification Message (DENM's) until the message is sent to the next surrounding vehicle is less than 180 seconds.
- The RWW warning for mobile construction sites is sent locally after setting up the construction site within 30 seconds of activating the appropriate C-ITS unit.
- All construction sites in the Austrian deployment area of the Cooperative ITS Corridor, that have an impact on the traffic (e.g. narrowed lanes or changed lane markings), are equipped with C-ITS and send correct and complete RWW messages to passing vehicles.
- At least five C-ITS services are available on the equipped network, are regularly offered by ASFINAG and used by the C-ITS equipment industry and service providers.

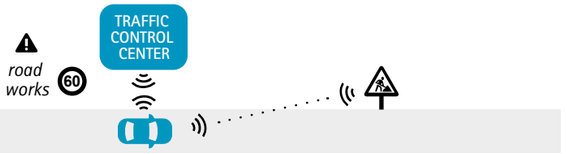


Figure 5: Road Works Warning: Drivers are informed about upcoming construction sites and their relevant data as well as any obstacles (e.g. closed lanes).

5.2.2 Qualitative Goals:

- Improved time and location information for 20% more informed drivers on the road.
- The coordinated Day 1 applications are available on the equipped corridor, are regularly used and accepted.
- C-ITS networks and nodes of all participants (e.g. road stations, vehicles) are operated with a high and proven security standard for the users.
- Through improved traffic information, a more uniform velocity distribution of the vehicles is achieved on individual infrastructure sections.
- The international coordination and European developments are to be taken into consideration and prepared together with the main partners in the next deployment phase.
- The regular use of anonymised vehicle data for the core tasks of road operators, particularly in traffic management, is introduced and will be expanded.
- Access and use of the Living Lab for validating and testing of C-ITS applications in the context of the deployment is also ensured for external partners.

- The R & D needs for Day 2 and Day 3 C-ITS applications and later applications will be defined as a topic on the basis of existing activities in the deployment and will be validated and tested within the context of the Living Lab.

5.3 Basis of the C-ITS Strategy

In order to optimally coordinate the exchange of data between the transport infrastructure and the vehicles and to ensure the organisational coordination between the public and private companies and organisations involved is managed as well as possible during the deployment phase, an improved cooperation among all the parties involved in the deployment of C-ITS in Austria is necessary.

6. C-ITS – Further Deployment Steps

For the on-going coordination, it is planned to hold regular information meetings with the participants so that the next steps in the implementation can be clarified and the experiences in the individual phases can be shared to make mutual learning possible. The following sections are intended to explain this cooperation and present the roles and responsibilities of the organisations in association with C-ITS. This division of tasks and forms of cooperation can also serve to shape and positively influence future developments, such as the automation of traffic, in terms of road safety and energy efficiency.

6.1 International Commitment

To facilitate a harmonised deployment of C-ITS, the activities of other countries must be taken into consideration already during the planning phase. Cross-border projects are an important step in this direction.

This includes, as already stated, the international coordination of the C-ITS development goals with the neighbouring countries and the EU at the project level, in particular along the Cooperative ITS Corridor with the Netherlands and Germany. This can take place in European platforms such as the Amsterdam Group, as well as in other appropriate working groups and projects. Particular emphasis is placed on the areas of security, privacy and interoperability.

6.2 One Platform for all Partners

Just as important as the coordination for the deployment is the on-going exchange of information on an international and national level.

Such exchanges could include cooperation with France in the project SCOOP, as well as with the Scandinavian countries in the project Nordic Way and any other interested countries. The adaptation of the services takes place through the common definition and through a coordinated validation in the deployment phase. The bmvit coordinates the national involvement.

6.3 Technical Tests and Validation

For the implementation of the C-ITS strategy, a number of activities for the validation and safeguarding of the deployment are currently planned.

In addition, joint projects are to be initiated with the active countries and partners in the EU in the field of C-ITS application of validation and coordination actions are to be taken. The goal is to achieve interoperability of C-ITS services in the EU and beyond.

In the field of C-ITS Security, a joint solution in the EU by means of a public "Public Key Infrastructure" (PKI)[8] is strived for and will be incorporated in the testing and validation in the deployment phase.

PKI (Public Key Infrastructure)
= public IT infrastructure, which serves to manage secure keys for communication between vehicles and the infrastructure securely and efficiently.

The cooperation of public organisations with industrial partners must be promoted and must be open in order to gain experience with the new technology in Austria early on and to jointly determine the next steps. This procedure has already proven positive for cooperation in the ECo-AT project.

This coordination not only serves the so-called "Day 1 applications", but also the preparation for the deployment of further C-ITS applications due to jointly coordinated roadmaps and decisions by the transport infrastructure operators and vehicle manufacturers.

6.4 Communication

Communication with the general public during the deployment phase of a new technology is a complex task that is best acknowledged by all the partners and carried out on various levels. A consistent public relations approach for all the public and private organisations involved in the deployment of C-ITS is important for raising awareness on the subject. In addition, it is also important to present individual technical issues in an understandable manner and to communicate progress as compared to the status quo.

Critical issues should be anticipated and consciously addressed, for example data protection, the issue of IT security or the additional security of the IT systems and networks used in transport, in order to support a proactive approach.

7. C-ITS in Austria

7.1 Joint Responsibilities of the Partners

The C-ITS deployment in Austria will succeed if there is effective cooperation between the public and private institutions with active contributions from both sides. The contributions are traffic information and clearly communicated strategic decisions of the traffic control, quick and accurate (anonymous) driver feedback from the vehicles and mobile applications for purposes of traffic management. The willingness of the parties to coordinate their activities is the basis for cooperation and will be essential in the future.

7.2 Digital Information

ASFINAG has long been actively involved in the definition, technical development and the distribution of traffic information services to mobile users. They see the development of C-ITS as a building block in the context of traffic information on the entire network. Other aspects of these services were revised and implemented in the projects of VAO – Verkehrsauskunft Österreich (Traffic Information Austria) and other projects. The development status of these services can be found in the Transport Telematics Reports published annually in accordance with the IVS-G (ITS Law) under www.bmvit.gv.at. Since the VAO itself is an essential element of these services, its current status will be presented here briefly.

7.2.1 Verkehrsauskunft Österreich (VAO)

Since going live on 16 December 2013, Verkehrsauskunft Österreich (VAO) VAO services (clients) have continuously been put into operation for VAO partners. Since June 2015, eleven web applications based on VAO are now available to drivers on the Austrian transport network (AnachB, ASFINAG, bmvit, Land Salzburg, ÖAMTC, Pendlerrechner, Salzburger Verkehrsverbund, Verkehrsverbund Oberösterreich, Verkehrsverbund Ostregion, Verkehrsverbund Tirol, Verkehrsverbund Vorarlberg). Furthermore, seven smartphone apps for Android, iOS and BlackBerry are also available (AnachB/VOR, ASFINAG, ÖAMTC, Salzburger Verkehrsverbund, Verkehrsverbund Oberösterreich, Verkehrsverbund Tirol, Verkehrsverbund Vorarlberg). Several research projects also use the routing services of VAO. In 2015, the first smartphone apps for urban transport companies were migrated to the VAO backend.

Verkehrsauskunft Österreich (http://www.verkehrsauskunft.at) was created within the framework of an implementation project funded by the Klima- und Energiefonds (Climate and Energy Fund) and under the direction of ASFINAG with several project partners. In the project, organisational, technical and legal steps were taken for implementing an Austria-wide, intermodal, traffic information service on the basis of target data authorised by the transport infrastructure, transportation and transport reporting operators. The GIP from VAO is used as a traffic graph and the base map is used as a background map. The

services are based on other data from the operating partners (e.g. PT data, POIs, traffic-LOS-data, traffic reports). The project was successfully completed in the fall of 2013 and the project results were transferred to the interim VAO operation that guarantees the professional and technical operation of transport information for all clients. Since 2014, the ÖBB Holding is also an operating partner in the VAO interim operation. The operating team includes eight employees who ensure the smooth operation of Verkehrsauskunft Österreich at the headquarters in Bahnhof City Wien West.

At the same time, the project "Verkehrsauskunft Österreich Phase 2" (VAO 2) was launched, which focuses on the supply of real-time data in public transport and the expansion of the VAO services and has already implemented expansions. Thus, a basis for smartphone apps based on VAO services was created and an interface for research projects was defined. The information is continuously being expanded throughout Austria with additional traffic information such as short-term parking and bicycle stations, and the quality of all the base data is being improved through defined feedback processes with the data owners. In addition, the project VAO 2 - Expansion (VAO 2-E) was started in Q2 2015, and is concerned with the integration of the ÖBB in the processes and data supply to the VAO as well as with the quality management of all the data and the transmission in a process-oriented operation.

Finally, another core content of the VAO 2 project is creating the legal and organisational framework to enable a transition from the VAO interim operation to a VAO full operation. In this way the long-term operation and financing for the Verkehrsauskunft Österreich can be secured. The coordination for the transfer of the VAO to a controlled full operation started in mid-2014 and was completed by July, 2015. The interim operation of VAO was transferred to VAO GmbH in the second half of 2015, which acts as a public authority and service provider for the operating partners and is responsible for the future operation of the intermodal Austria-wide information.

Figure 6: The VAO currently records approximately 2.7 million route queries per month (July 2015).

In this context, the evolution of C-ITS is another strong element in improving the traffic information for mobile users on the transport network in the coming years. Above all, in order to more accurately record the vehicle flows on the high level road and improve the quality of the related warnings for traffic obstructions.

7.3 The Next Steps

In 2017, work will begin on the following actions/measures:

- In the ECo-AT project phase 1, the detailed specifications for the first C-ITS applications will be developed and made publicly available. Thus, both the project partners and other companies will take these specifications into account in their developments and fully implement them in order ensure a European-wide coordination of the applications. The aspects of the C-ITS security in communication and also the privacy regulations for a first use of C-ITS in the EU should be defined and specified together in the EU C-ITS Platform taking the ECo-AT project results into consideration, thus making a simple harmonised start in the EU possible.
- The testing and validation of the C-ITS applications as well as individual components will begin under intensive cooperation with several other countries in Europe. The goal is to deploy interoperable systems. The establishment of a Living Lab to enable testing and validation of C-ITS applications that will also be openly available to third partners and institutions to support these efforts.

7.4 The Core Actors

7.4.1 Responsibilities of the bmvit

- The coordination of the strategy along the Cooperative ITS Corridor and cooperation with other partner countries to promote the coordination with the stakeholders on a national level.
- The position of the C-ITS security and implementation of a trust model, in particular for the coordination of infrastructure-based C-ITS stations in Austria.
- Support for the deployment of C-ITS and development of a medium-term solution for the equipping of mobile C-ITS stations for use in safety and emergency services.
- Collaboration in the definition of the relevant European frameworks for the use of C-ITS.
- Coordination of all processes, where necessary, with other ministries, promotion of international cooperation and involvement of cities in the project.

The most important aspect for all of the above is the introduction of fully interoperable first C-ITS services in the EU in order to quickly achieve a critical mass among users and to acquire infrastructure equipment to contribute to the positive experience of the users.

7.4.2 Responsibilities of ASFINAG

- The coordination of the project ECo-AT and the pushing of coordination along the Cooperative ITS Corridor.
- The methodical and structured collection of traffic information and ensuring the technical channels for the distribution of traffic information are available.
- To take advantage of the Amsterdam Group for a harmonised deployment of C-ITS services in Europe and to push coordination with both the ASECAP members and in the CEDR to secure the own investments.
- The medium to long term development of mobile sensors and the association with improved traffic information and the increased integration in traffic services.
- The preparation of the next steps in the hybrid communication of traffic information (i.e. under the parallel use of different communication technologies such as ITS G5 and telecommunications networks).

7.4.3 Responsibilities of AustriaTech

- The testing and validation of C-ITS stations and applications and the international, coordination, cooperation with projects and activities for the deployment of interoperable C-ITS solutions in the EU.
- Involvement in the ITS G5 security solution and support in the prototype phase in the validation and deployment.
- To take into consideration the specific requirements of public institutions such as police and rescue services as well as municipal services during the testing and validating of C-ITS stations and the integration of these requirements in the deployment.

7.4.4 Supporting Communication

C-ITS Strategy Austria		
C-ITS Austria deployment: Discussion, coordination and decision on the next steps for the use of C-ITS	**ITS Austria:** Exchange of information between industry, research institutions and public bodies	**Awareness building:** Addressing the general public to increase acceptance for the deployment as well as engaging in discussions about more critical aspects.

7.5 Organisational Requirements

For the implementation of the C-ITS strategy by 2020, it is important to set up regular cooperation between the partners in a "platform of core partners". This could be one of the first tasks of the ITS Advisory Board in accordance with IVS-G to concretely acknowledge the following responsibilities:

- To organise the cooperation between public and private institutions in C-ITS. To inform the infrastructure operators and cities. To define the exchange of information and coordinate measures with the public.

7.6 Technical Requirements

From a technical standpoint, the essential specifications for C-ITS were determined in the standards for "release 1" for EU mandate 453 until February, 2013. These were and will be applied in the drafting of the specifications for C-ITS for ECo-AT for use in Austria. This is a solid basis for the deployment that will now be expanded step by step and must be supplemented with operational experience in the deployment and operation phases. Therefore, the following activities are required:

- Set up testing and validation for the first C-ITS applications. Determine and validate the security solution for the "C-ITS Day 1 applications" and coordinate with public institutions in the EU.
- Set up testing and validation for international interoperability and allow open access for third parties.
- Publish the processes and procedures for testing and validation and communicate test-results and milestones for the deployment.
- Develop further procedures for comparable presentation of "hybrid communication solutions" for C-ITS and the associated test methods.
- Make experience from testing and validation steps in the area of C-ITS also available for the "Automation in Transportation" and involve more companies in the communication and collaboration on projects.

7.7 Legal Requirements

From a legal perspective, the preparations for the deployment of C-ITS in Europe is embedded in the ITS Directive[4], and is defined in Section 4. In addition, further concrete legislative measures were presented during the initial preparation activities for an EU regulation, which may include the following aspects:

- Definition and coordination with the EU for the authorisation to operate C-ITS components (e.g. for security and PKI, data privacy).
- Enable operation and coordination of radio frequencies between C-ITS and electronic toll collection systems.
- Analyse necessary changes in the road traffic regulations for the introduction of C-ITS and in particular examine the operational processes for public institutions (e.g. emergency services and their additional requirements in the security policy).

7.8 Commitment of the Partners

The main partners in C-ITS are the bmvit, road infrastructure operators for the high level road (ASFINAG), for state roads (the provinces) and the cities and municipalities as well as industry and research institutions.

In order to implement the C-ITS strategy by 2020, a strong commitment is required from all the core partners. This commitment of the main partners, infrastructure operators and vehicle manufacturers, on the basis of the Memorandum of Understanding (MoU) of the C2C Communication Consortium and the MoU for the Cooperative ITS Corridor of the three countries the Netherlands, Germany and Austria, is to be further strengthened and coordinated and linked with other initiatives.

7.9 Resources

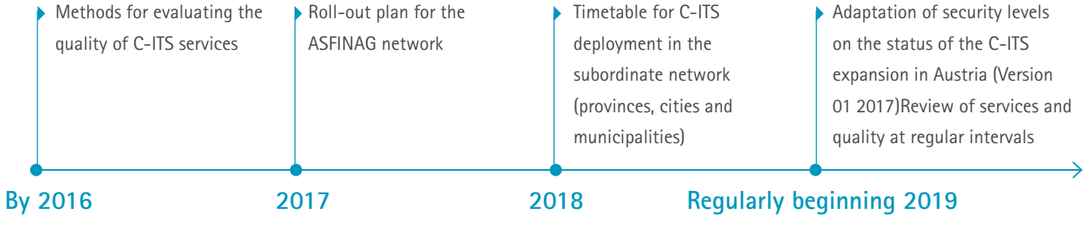
During the deployment phase of C-ITS, resources for the partners are needed for a range of activities that can only be estimated at present, but will certainly be defined more concretely during the work on the first steps. The following activities are necessary and must be financed:

- Testing and validation in the deployment phase of C-ITS. Work on and clarification of the open items: security, data privacy, interoperability and international coordination in the EU and beyond.
- Preparation of the roll-out plan for the core network of ASFINAG.
- Preparation of the roll-out plan (Phase2) for the extended road network and cities.
- Expansion of C-ITS to the entire transport infrastructure network and validation of the quality of the C-ITS services.

8. Outlook

Based on the proceeding analysis and the defined responsibilities of the partners for the deployment of C-ITS, the following conclusions on the implementation of the C-ITS strategy in Austria become apparent, however, this section will only present the next immediate steps.

8.1 Roadmap for C-ITS Deployment



8.2 Remarks

[1] IVS Gesetz Österreich (ITS Law Austria)

[2] CEN/ISO TS 19091, Intelligent Transport Systems - Cooperative ITS - Using V2I and I2 Communications for Applications Related to Signalized Intersections (SPaT, MAP, SRM, SSM)

[3] (2008/671/EC - on the harmonised use of radio spectrum in the 5 875-5 905 MHz frequency band for safety-related applications of Intelligent Transport Systems (ITS)

[4] EU ITS Directive 2010/40/EU

[5] US DOT/NITSA Decision on V2V, Advance Notice of Proposed Rulemaking (ANPRM) published Aug. 2014, www.nhtsa.gov/staticfiles/rule-making/pdf/V"V/V"V-ANPRM 081514.pdf

[6] https://www.car-2-car.org/index.php?id=231 and https://www.car-2-car.org/index.php?id=214

[7] V2X Applications Roadmap, Car2Car Communication Consortium, Präsentation Teodor Buburuzan, 25th March 2015

[8] EU C-ITS platform, final report and annexes - results from the work groups, http://ec.europa.eu/transport/themes/its/doc/c-its-platform-final-report-january-2016.pdf / last accessed 29.01.2016

[8b] EU C-ITS platform, final report and annexes - results from the work groups, http://ec.europa.eu/transport/themes/its/doc/c-its-platform-final-report-january-2016.pdf / last accessed 29.01.2016, page 24.

[9] http://www.amsterdamgroup.eu/ last accessed 12.06.2015

[10] http://www.eco-at.info/home.html/ last accessed 29.01.2016

[11] http://www.developpement-durable.gouv.fr/IMG/pdf/49b_DGITM_scoop_GB_2p_def_web.pdf

[12] http://www.nhtsa.gov/Research/Crash+Avoidance/Office+of+Crash+Avoidance+Research+Technical+Publications

[13] http://www.vehicle-infrastructure.org/

[14] http://www.tca.gov.au/certified-services/iap

[15] EU C-ITS Platform: WG5 security – report: **Trust models for Cooperative - Intelligent Transport System (C-ITS)** An analysis of the possible options for the design of the C-ITS trust model based on Public Key Infrastructure in Europe included as Annex to [8]

9. Glossary

Abbreviation	Explanation
5G	The fifth generation mobile phone standard
ADS	Automated Driving Systems
ANPR	Automatic Number Plate Recognition
ASFINAG	*Autobahnen- und Schnellstraßen-Finanzierungs-Aktiengesellschaf*t
AT	Austria
BMVIT	*Bundesministerium für Verkehr, Innovation & Technik* (Federal Ministry for Transport, Innovation & Technology)
BSM	Basic Safety Message
C2C CC	Car2Car Communication Consortium
CAM	Cooperative Awareness Messages
CAMP	Collision Avoidance Metrics Project
Car2Car	Vehicle to vehicle communication
CEDR	Conference of European Directors of Roads
CEF	Connecting Europe Facility
CEN	European Committee for Standardisation
C-ITS	Cooperative Intelligent Transport Systems
COOPERS	CO-OPerative SystEms for Intelligent Road Safety
DE	Germany
DENM	Decentralised Environmental Notification Message
DSRC	Dedicated Short Range Communication
eCall	Abbreviation for emergency call, scheduled automatic emergency call system for motor vehicles
ECo-AT	European Corridor – Austrian Testbed for Cooperative Systems
ERTICO	ERTICO - ITS Europe is a partnership of around 100 companies and institutions involved in the production of Intelligent Transport Systems (ITS).
ETSI	European Telecommunications Standards Institute
R & D	Research and Development
FTI	*Forschung, Technologie & Innovation* (Research, Technology & Innovation)
GHz	Gigahertz
GIP	Graph Integration Platform
GLOSA	Green Light Optimum Speed Advisory
IAP	Intelligent Access Program
ICT	Information and Communication Technology
ISO	International Standardisation Organisation
ISS	Intersection Safety
IT	Information Technology
ITS	Intelligent Transport Systems
ITS-G5	Similar to wireless communication technology

IVI	In Vehicle Information
IVS	Intelligente Verkehrssysteme (Intelligent Transport Systems)
IVS-G	IVS-Gesetz (ITS Law)
KLIEN	Klima- und Energiefonds (Climate and Energy Fund)
LOS	Level of Service
LTE	Long Term Evolution (fourth generation mobile standard)
MAP	Intersection Topology
MoU	Memorandum of Understanding
NHTSA	National Highway Traffic Safety Administration
NL	Netherlands
ÖBB	*Österreichische Bundesbahnen* (Austrian Federal Railways)
OEM	Original Equipment Manufacturer
ÖV	*Öffentlicher Verkehr* (Public Transport)
PKI	Public Key Infrastructure
POI	Point of Interest
PT	Public Transport
PVD	Probe Vehicle Data
RSU	Road Side Units
RWW	Road Works Warning
SCOOP	Cooperative ITS Setup EU Pilot Project
SCORE@F	*Système Coopératif Routier Expérimental @ France* (Experimental Cooperative Road System @ France)
SPAT	Signal Phase and Timing
STVO	*Straßenverkehrsordnung* (Road Traffic Regulations)
TCA	Transport Certification Australia
TEN-T	Trans-European Transport Network
TM2.0	Traffic Management 2.0
US DoT	United States Department of Transportation
V2I	Data Communication between Vehicle and Infrastructure
V2V	Data Communication between Vehicle and Vehicle
V2X	Data Communication between Vehicles and other ITS stations
VAO	*Verkehrsauskunft Österreich* (Traffic Information Austria)
VII	Vehicle Infrastructure Integration
VMS	Variable Message Sign
VOR	*Verkehrsbund Ost-Region* (Transport Authority for the Eastern Region, Vienna)
W-LAN	Wireless Local Area Network