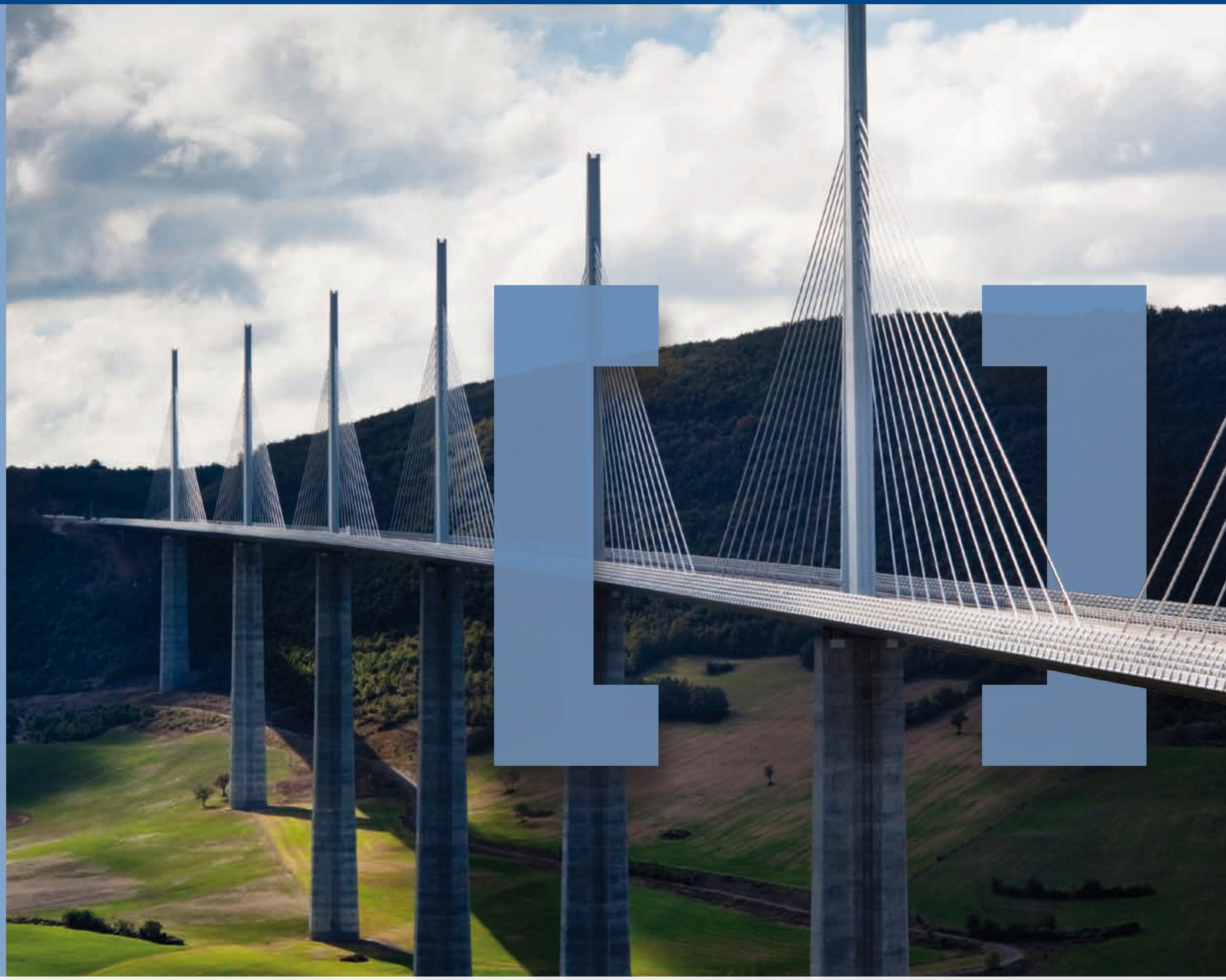
SeRoN – Security of Road Transport Networks



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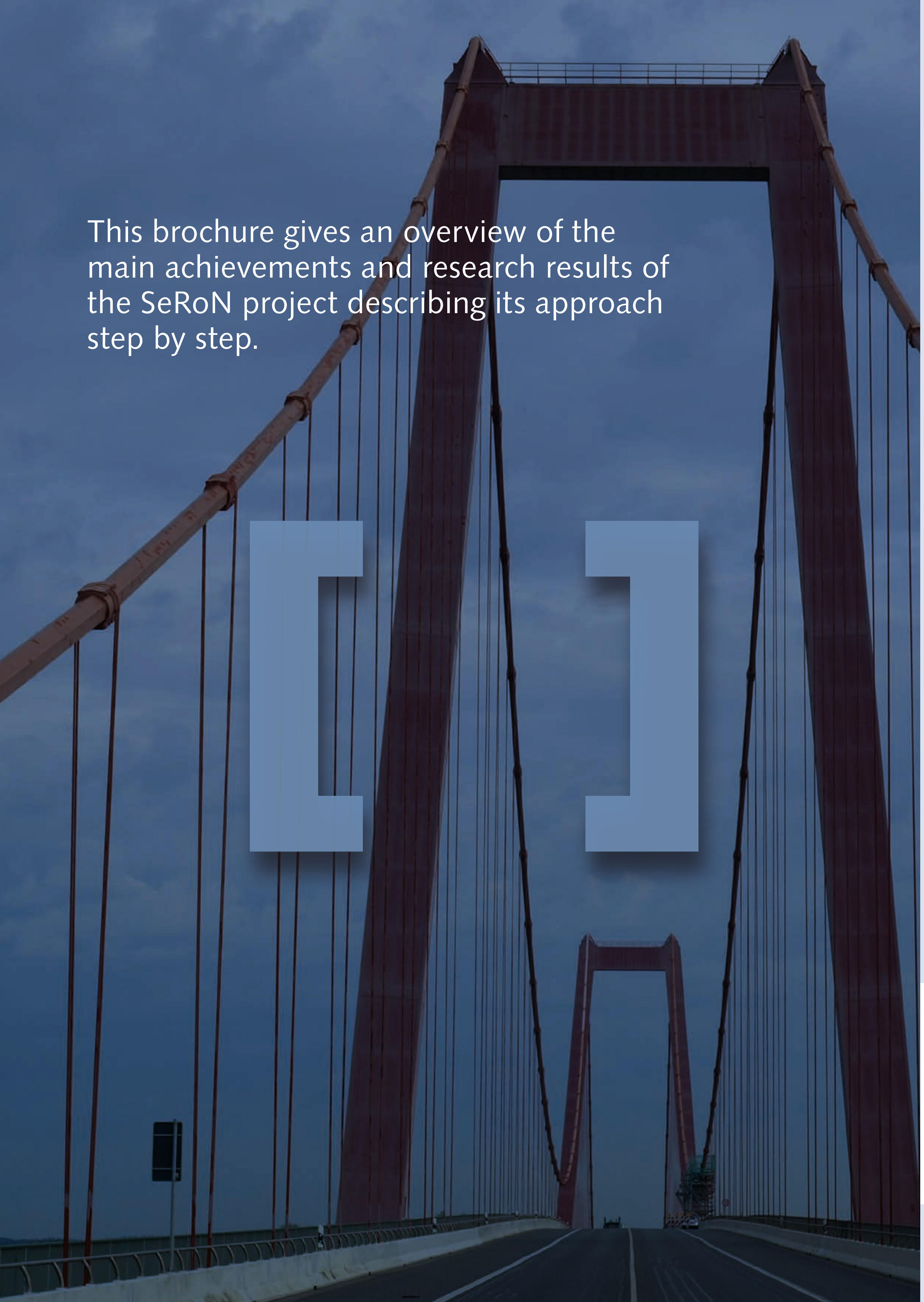
SEVENTH FRAMEWORK PROGRAMME



This brochure gives an overview of the main achievements and research results of the SeRoN project describing its approach step by step.

Contents

[ ] *Assessing the impacts of man-made hazards on road transport infrastructure, technical data from 46,000 bridges and 638 tunnels throughout Europe have been gathered and used within the SeRoN project.*

1 Introduction

»Europe has enjoyed a long consolidated, peaceful and prosperous period, but it has also become vulnerable to man-made hazards and natural disasters.

To make Europe more secure and resilient for its citizens the EU has launched the Seventh Framework Programme (FP7) and invested EUR 1.4 billion in security research between 2007 and 2013, promoting the cooperation between providers and end-users of security equipment, systems and knowledge, ensuring concerted use of available and evolving technologies and stimulating co-operation of providers and users for civil security solutions. Yet the evolving nature of security also implies many new challenges. Against the background of respecting fundamental human rights, including privacy, security research has to look into the preparedness and response of society to potential or actual threats and crises.

FP7 projects have covered the full range of security themes, including advanced research into the societal dimension of security, protection of citizens against all kinds of contamination (CBRN materials) or man-made and natural events, critical infrastructure protection, crisis management capabilities, intelligent maritime and land border surveillance, and the interoperability of systems. Key elements of the functioning of our societies, the vulnerabilities of such systems, equipment, services and processes and their resilience against threats are considered elementary for the security of the citizens in Europe. In response to the Council Directive 2008/114/EC on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection the focus was to make key infrastructures and utilities more secure, to protect them against all kinds of threats and to safeguard them against incidents, malfunctions and failures.

A competent European group of researchers have responded to the EU concerns regarding road infrastructures. In the SeRoN project they have brought in their expertise and collaborated to develop a methodology which presents an approach how the security of infrastructures can be enhanced by suitable protection measures, which are selected under cost-effectiveness aspects. The holistic approach addresses policy and decision makers as well as owners and operators of road transport infrastructures. It provides support in deciding how to make optimum use of the available financial means to protect transport infrastructures from threats for the benefit and the security of European citizens.

This brochure, which is a pleasure for me to introduce, describes the developed SeRoN approach, explains its practical application and presents the project findings and results. Hopefully its reading will be of interest to the target audience and the SeRoN approach will find consideration at the relevant bodies.

Finally I would like to thank all SeRoN project partners for their cooperation and their valuable contributions, our EC Project Officer, Patricio Ortiz de la Torre, for his guidance and support, and Carlo Polidori for his valuable comments when reviewing the SeRoN project. Special thanks go to the authorities, road infrastructure owners and operators and institutions that supported our research work. «

Dr. Georg Mayer,
SeRoN Project Coordinator

[ ] *The 27 Member States of the EU comprise 5,000,000 km of paved roads, 65,100 km of which are TEN-T motorways. The overall traffic between the Member States is growing and is expected to double by 2020 requiring new investments into road infrastructure and additional safety and security measures.*

2 Security of road transport networks

An effective and secure road network is essential to the European society and economy providing access to employment, essential services such as health care and education and providing businesses with links to their supply chains.

Bridges and tunnels in particular are key elements of the road transport network. Their non-availability in case of a disruption may lead to intense traffic interferences on the surrounding road network resulting in negative impacts on the road user, high economic follow-up costs and negative environmental impacts. Having a bottleneck function, they play a crucial role also for the interconnection of vital transport routes of the EU, the so-called Trans-European Transport Network (TEN-T).

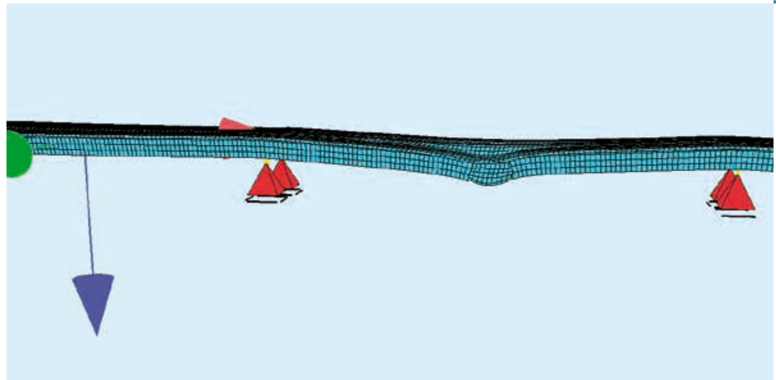
During the past few years and increasingly in the light of recent events the security of infrastructure has become a major challenge for the EU and its Member States. With the EPCIP directive issued in 2008 on the identification and designation of European critical infrastructure and the assessment of the need to improve their protection the EU expressed the need for urgent action. The threats to civil security in general and infrastructure security in particular range from terrorist and criminal activities to intensifying natural hazards, per se being of transboundary nature. The interconnected European Single Market and the still increasing interconnection of transport routes and corridors in the TEN-T require innovative procedures and methodologies that can be applied EU-wide.

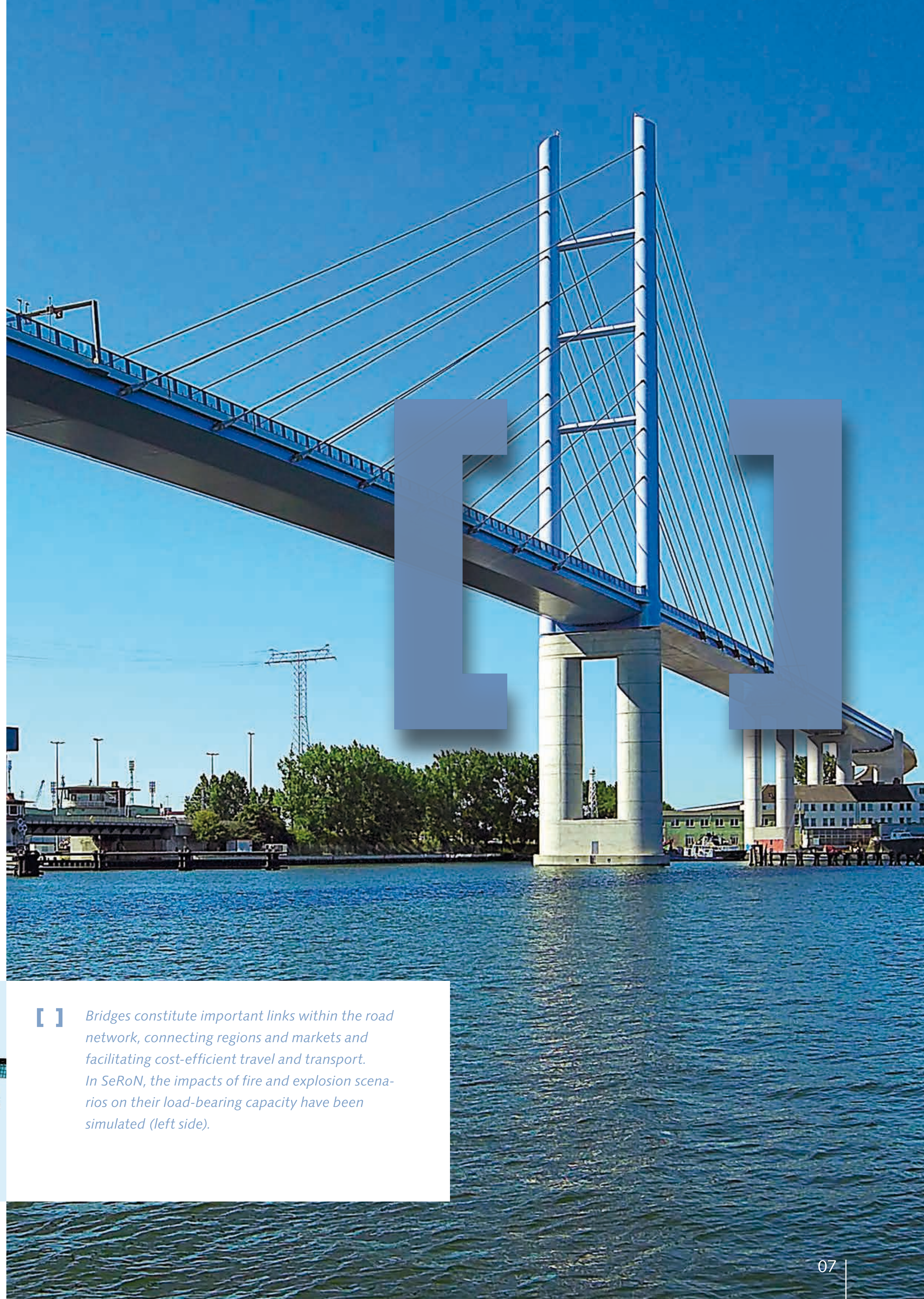
The SeRoN (Security of Road Transport Networks) research project which was funded by the EC Seventh Framework Programme (FP7/2007-2013) responded to this challenge by investigating the impacts of possible terrorist attacks on the transport network. In particular, it focused on the resulting regional and supra-regional impacts on transport links and their economic impacts. Within SeRoN an innovative methodology has been developed to analyse and assess road networks and their infrastructure elements. This methodology provides owners and operators with a holistic procedure to identify critical road infrastructure objects and evaluate cost-effective protection measures to enhance the security and robustness of their infrastructure. At the same time, it increases the overall resilience of the transport network in Europe.

SeRoN lasted from 2009 to 2012.

The project consortium consisted of seven project partners coming from six European countries: PTV AG (project coordinator) (DE), NIRAS (DK), Ernst Basler + Partner (CH), Federal Highway Research Institute (DE), Traficon (BE), TU Graz, (A) and Parsons Brinckerhoff (UK).

SeRoN was funded by the EC with 2.25 million Euro.





[ ] *Bridges constitute important links within the road network, connecting regions and markets and facilitating cost-efficient travel and transport. In SeRoN, the impacts of fire and explosion scenarios on their load-bearing capacity have been simulated (left side).*

3 The SeRoN methodology

The SeRoN methodology is an innovative approach that allows for the analysis and assessment of road networks and their infrastructure elements with regard to their sensitivity to man-made hazards such as terrorism and criminal activities. It has been conceptualised for owners and operators of road infrastructure in Europe and provides a valuable basis for protecting road networks EU-wide.

The SeRoN approach considers both the object and network criticality of road infrastructure. On the one hand, objects can be vulnerable to specific hazards, for instance, its structural prerequisites may not resist an explosion. On the other hand, an infrastructure object may have a vital function in the wider transport network. In this case, the non-availability of a given bridge or tunnel might have extraordinary consequences to the overall traffic flow and result in socio-economic follow-up costs.

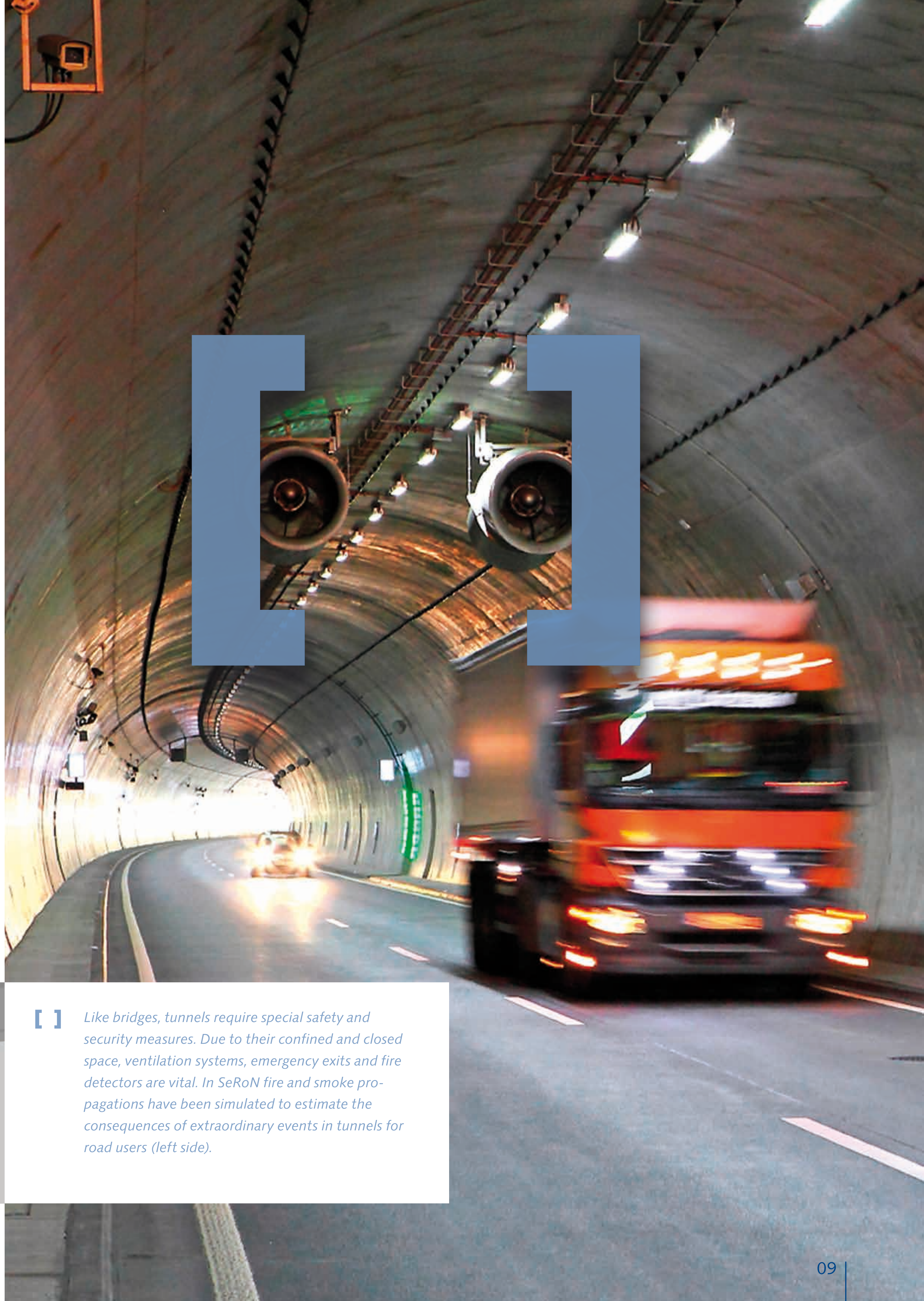
Taking into account both object and network criticality, the SeRoN project developed an innovative **four-step approach** for owners and operators of critical road infrastructure:

Step 1: Road corridor selection and identification of potentially critical infrastructure objects

Step 2: Calculation of network importance

Step 3: Risk analysis (without protection measures)

Step 4: Measure analysis



[ ] *Like bridges, tunnels require special safety and security measures. Due to their confined and closed space, ventilation systems, emergency exits and fire detectors are vital. In SeRoN fire and smoke propagations have been simulated to estimate the consequences of extraordinary events in tunnels for road users (left side).*

4 The four-step approach

The four-step approach can be used on a modular basis. This means, the owner or operator using the approach may opt to use single steps or decide to apply all steps.

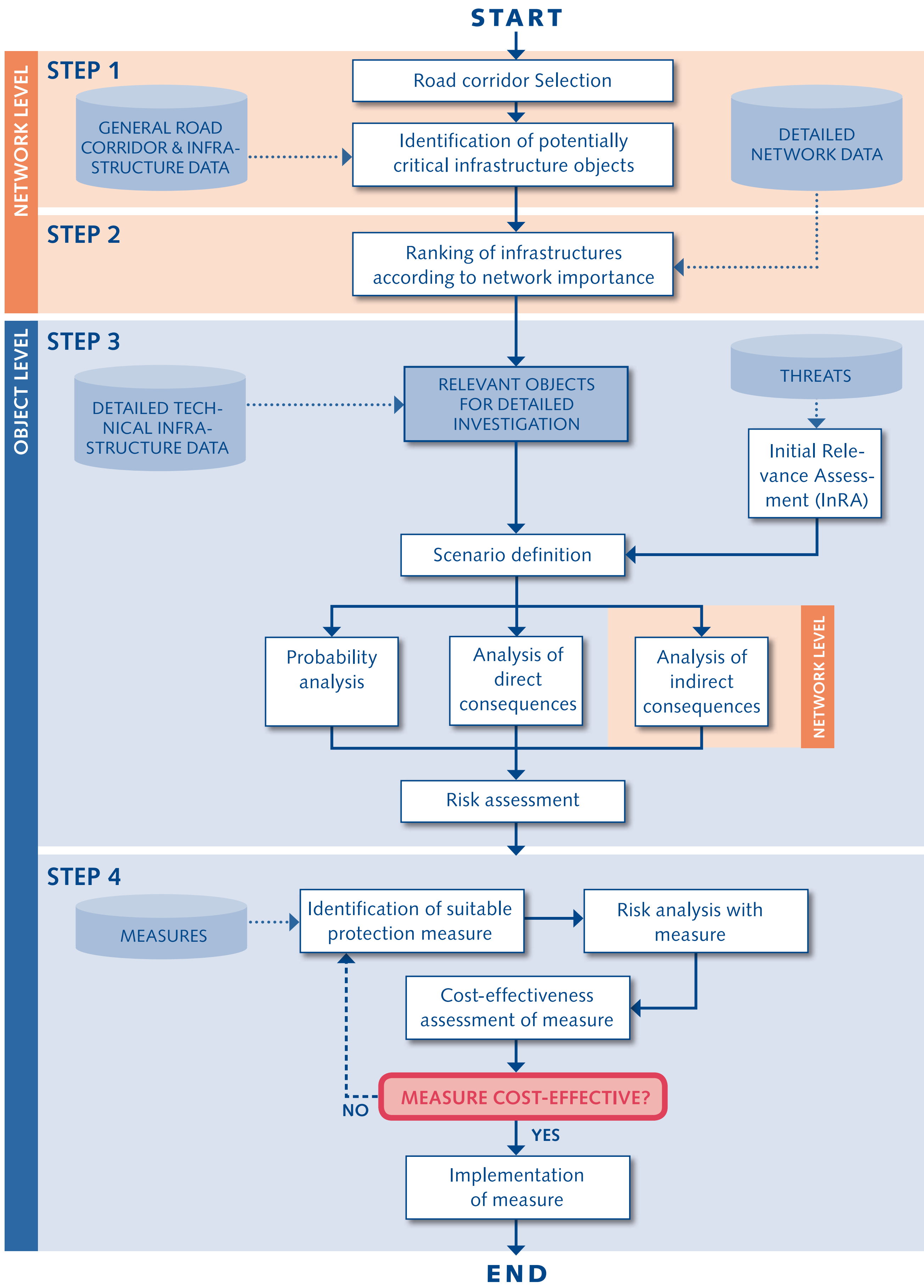
Step 1 is used to carry out a "rough" assessment and classification of its infrastructure stock regarding potentially critical infrastructure objects. By applying Step 2 the owner or operator considers the network criticality of a given object. To identify cost-effective protection measures additionally he can also apply Step 3 and 4 and carry out a detailed risk and measure analysis.

Application of the four-step approach on a modular basis includes:

- to carry out a quick assessment (overview) of a given infrastructure stock by applying Step 1 only, or,
- given that the network criticality of infrastructure objects is to be investigated, to apply Step 2 only, or,
- combine Step 1 and 2 to get to a more detailed assessment and ranking of the most critical infrastructure objects, or,
- to carry out a detailed risk analysis by applying Step 3 only, or,
- if protection measures should be assessed for an already selected infrastructure object, to carry out Step 3 and 4 only.

Users of the SeRoN methodology can use the Knowledge Database for executing the above described steps. The Database was developed by the project partners as a template for collecting relevant road network and infrastructure data. The data used such as Average Daily Traffic (ADT) or length and span of infrastructure objects are used as variables for assessing critical infrastructure objects within the road network. As can be seen from the flowchart on the right side this data is needed as a basic prerequisite for executing steps 1, 2 and 3.

→ The flowchart illustrates the four steps integrated in the overall approach to give an overview of the needed prerequisites for the application of the SeRoN methodology.



4 The four-step approach

Step 1:
Road corridor selection and identification of potentially critical infrastructure objects

The aim of Step 1 is to identify the potentially critical infrastructure objects and rank them according to their degree of criticality.

The road operators or owners select a road corridor they want to investigate. This could be any road corridor for which they are responsible, e.g. a TEN-T corridor which has a vital function in the overall road network of a country or within the EU.

After that, the relevant technical data of the infrastructure objects along the selected corridor and the traffic data of the corridor have to be collected. This includes general technical data of bridges and tunnels such as the length, type of construction or material used. The road network data used is Average Daily Traffic (ADT) and Heavy Goods Vehicle (HGV) percentage.

All infrastructure objects on the selected road corridor are investigated according to their potential criticality.

Step 2:
Calculation of network importance

In Step 2, the objects selected in Step 1 are ranked according to their network importance. For this step, detailed road network data are required and a specific traffic and transport model should be applied.

The network importance is defined as the benefit which arises from the prevented non-availability of a certain infrastructure object. The network importance of a road infrastructure object is not only reflected by the consequences of its non-availability for road transport, but by any kind of socio-economic effects. Therefore, the developed assessment procedure takes into account that road users, traffic flow, the infrastructure object itself as well as the surrounding regional economy may also be affected by the non-availability of infrastructure objects. Resulting consequences are quantified, monetised and summed up to a final importance value. This importance value describes the benefit resulting from the prevented non-availability.

From a network point of view the top-ranked infrastructure objects among those previously identified as critical (Step 1) on the object level are then taken to be further investigated in detail (Step 3 and 4).

Step 3:
Risk analysis (without protection measures)

In Step 3, a risk assessment is carried out for the highest ranked infrastructure objects of Step 2. For this risk assessment, a scenario is used in order to estimate the consequences of an event. An example of a scenario would be a truck fire (threat) in the middle section of a tunnel (object). Relevant threats for developing the scenarios are assessed by considering the following criteria:

- feasibility of attack,
- damage potential,
- shock effect, and
- symbolic relevance.

Fire and explosion scenarios have been identified as the most relevant threats to road infrastructure taking into account man-made hazards.

For each scenario, the consequences (impact) on the analysed object as well as the surrounding traffic network are taken into account. Thereby, risk is understood as the product of the likelihood (that a threat occurs) and the (expected/calculated) consequences if the threat occurs.

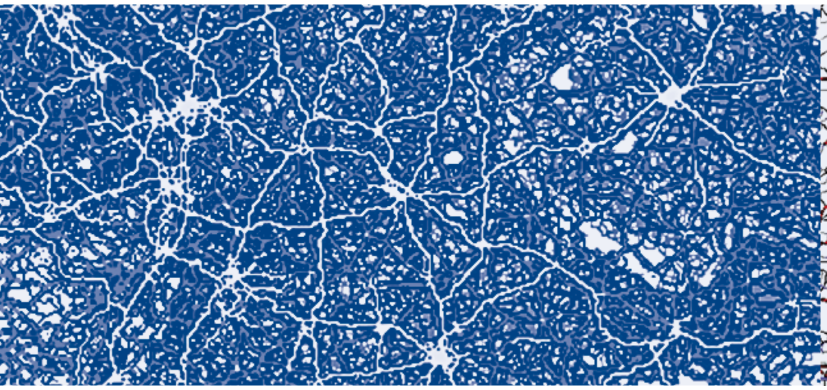
Consequences can be differentiated in direct (i.e. fatalities and structural damage to the infrastructure) and indirect consequences (i.e. economic costs, additional travel time, etc.).

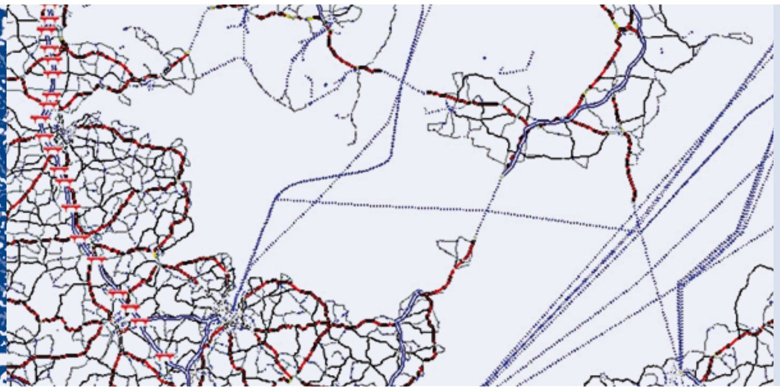
The result of Step 3 is the monetised risk (risk expressed in monetary terms) for the used scenario without considering the potential effect of protection measures.

Step 4:
Measure analysis

In Step 4, the effects of appropriate protection measures for the used scenarios are determined by applying cost-benefit analysis. For the measure analysis, different protection measures are included in the risk assessment calculation. For each scenario, the monetised risk is calculated without the implementation of a certain protection measure (done in Step 3) and after the 'hypothetical' implementation of the selected protection measure.

Based on the risk reduction and the cost of the selected protection measure the break-even frequency of the considered scenario is calculated. This break-even frequency defines the point at which a particular protection measure is or "gets" cost-effective. This objective procedure allows for comparing and assessing suitable protection measures. Thus, infrastructure owners and operators are provided with a good basis for decision-making in order to make best use of the available budget and the knowledge which measures to implement in order to improve the robustness of a critical infrastructure object.





[ ] *The SeRoN approach considers both the vulnerability of the object itself resulting from its individual characteristics and its position in the wider road network. For the analysis, vital road corridors were selected (left side), critical objects identified and suitable protection measures for the most relevant scenarios evaluated (right side).*

5 Experiences and recommendations

When using and validating the SeRoN methodology, the project consortium made some practical experiences which any user of the methodology should consider.

The most important experiences and facts to keep in mind are:

- An owner or operator using the SeRoN approach may opt to use Step 1 only to do a "rough" assessment and classification of its infrastructure stock regarding potentially critical infrastructure objects, or, he may apply Step 2 to consider the network criticality of a given object, and identify cost-effective protection measures additionally (Step 3 and 4) by carrying out a detailed risk assessment.

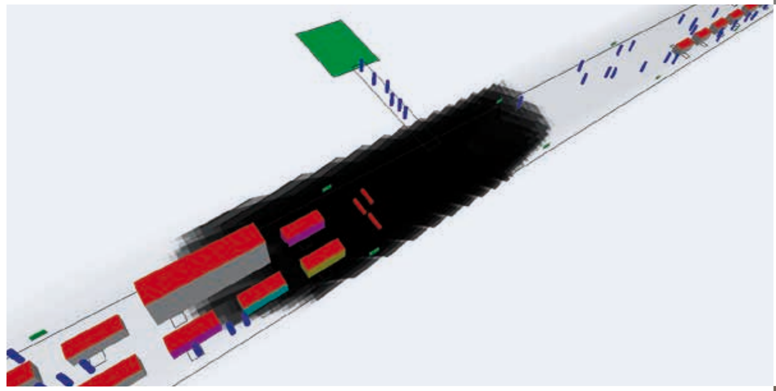
- Regarding the cost-effectiveness of measures it turned out that less expensive measures are more cost-effective when applied to thwart terrorist attacks. This impact is even raised for protection measures that may be relevant and therefore can be applied to multiple scenarios, for instance, video detection that might have a protective effect against a terrorist attack (security) and accidents (safety) as well.

- The SeRoN methodology is able to integrate both security and safety aspects within a broader resilience context. This means, it can be used as a universally applicable tool to identify critical infrastructure objects, rank them, and determine effective protection measures to strengthen the overall resilience of the European road transport network.

Allowing for universal application, the SeRoN methodology can be

- applied to different geographical and political contexts,
- modified to include other hazard focuses, for instance, natural hazards,
- modified to be applied to other modes of transport (rail, inland waterways and maritime transport).

Supporting the application of the SeRoN approach, the consortium offers to download the Knowledge Database from the project website under **http://www.seron-project.eu/index.php?p=tools** free of charge. The Knowledge Database can be used by every owner and operator as a template for collecting their respective infrastructure data and assessing the criticality of objects which are part of their infrastructure stock.



[ ] *The psychology of road users is a key component when considering their behaviour in case of an extreme event with fire and smoke propagation in tunnels. In SeRoN, special tools have been used to simulate the evacuation behaviour of road users.*

6 Consortium

The SeRoN Consortium consisted of seven partners from six European countries and brought together interdisciplinary expertise from universities, traffic simulation and automatic incident detection, risk analysis and cost-benefit analysis, and end-user specific knowledge.

SeRoN Consortium October 2012, London, UK
IET Conference Infrastructure Risk and Resilience

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D-76131 Karlsruhe, Germany
http://www.ptvgroup.com

Role in the Consortium: PTV was responsible for the project management and coordination. They also provided expertise to traffic simulation analysing the direct and indirect consequences of traffic flow disruption. Furthermore, PTV contributed their knowledge in terms of risk analyses and the assessment of direct consequences on road users by applying fire and evacuation simulations.

BASt
Bundesanstalt für Straßenwesen
(Federal Highway Research Institute)
Bruederstr. 53,
D-51427 Bergisch Gladbach,
Germany
www.bast.de

Role in the Consortium: BASt developed a method for the preselection of potentially critical road infrastructure, contributing with their expertise in infrastructure security and as end-user on behalf of the German Federal Ministry of Transport. BASt was also responsible for the organisation of the two SeRoN Workshops that were held by the Consortium.

Parsons Brinckerhoff
Borough Road,
Westbrook Mills,
Godalming GU7 2AZ,
United Kingdom
www.pbworld.com

Role in the Consortium: PB contributed their expertise in bridge and tunnel security and design. They were also responsible for organising the SeRoN Conference "Infrastructure Risk and Resilience" in London, UK.

NIRAS
Sortemosevej 19,
DK-3450 Alleroed, Denmark
www.niras.com

Role in the Consortium: NIRAS was responsible for calculating blast pressures on infrastructure objects and carried out the risk assessment and measure analysis.

Traficon
Flamingstraat 19,
B-8560 Wevelgem, Belgium
www.traficon.com

Role in the Consortium: Traficon, as experienced provider of security solutions and automatic incident detection systems, brought in their expertise for the implementation of effective protection measures.

Institute for Structural Analysis, TU Graz
Rechbauerstr. 12,
A-8010 Graz, Austria
www.tugraz.at

Role in the Consortium: TU Graz put in their expertise for the simulation and calculation of blast and fire impacts on infrastructure statics.

Ernst Basler + Partner
Zollikerstr. 65,
CH-8702 Zollikon, Switzerland
www.ebp.ch

Role in the Consortium: EBP contributed expertise especially in road safety and security, the methodological background of risk analysis and evaluation as well as the cost-effectiveness assessment of protection measures.

For the application of the SeRoN methodology the partners offer

- Assistance to start the implementation of the SeRoN methodology
- Guidance to the Knowledge Database
- Guide to Risk Assessment

If you have further questions on how to apply the SeRoN methodology, please contact the consortium leader. Or, if you have specific questions regarding single steps or topics, please contact the relevant project partner.

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[ ] *Heavy Goods Vehicle (HGV) transport makes up a major amount of goods transport in Europe and is likely to increase even more in the future. Innovative safety and security measures are required to improve the security of the road user, the economy and society.*