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1 INTRODUCTION AND DESCRIPTION OF SCOPE

This report presents the results of the survey conducted in the context of work package 2 of the Road2SoS project. The survey aimed at identifying the needs, barriers, and opportunities regarding System of Systems approaches faced by the industrial sector. As set forth in the *Description of Work*, the survey targeted four industrial domains in which the System of Systems concept is thought to have a particularly high relevance and which are furthermore considered to be of strategic importance to the European society: *Multi-modal traffic control*, *Distributed Energy Generation and Smart Grids*, Integrated *Multi-site Production*, and *Emergency and Crisis Management*.

The questionnaire has been designed by partner 1 (SEZ) with inputs from the several partners (the questionnaire of the survey was provided in the deliverable D2.1, a representation of the updated questionnaire can also be found in the Annex of this report). Structurally, it contains two sets of questions. The first set being concerned with *System of Systems* aspects not specific to an industrial domain and the second consisting of questions specific to the above-mentioned four domains (Multi-modal traffic control, Distributed Energy Generation and Smart Grids, Integrated Multi-site Production, and Emergency and Crisis Management).

The survey has been conducted using an online questionnaire. The target group consisted of organizations in the four industrial domains with the overall target group size set to 200 organizations. Prior to conducting the survey, each partner had identified from their set of qualified contacts potential survey participants. Upon the beginning of the survey, these were contacted by the respective partner with an invitation to the survey including a link leading to the online questionnaire. Increasing the target group beyond the above-mentioned scope, each partner has further considered contacts from associations, networks, etc. Moreover, during the survey phase, potential participants to whom a direct contact was established in the context of an event were invited to participate in the survey.

The results gathered through this survey serve as a basis for further socio-economic analysis of the European market for Systems of Systems within the respective domains.

2 PARTICIPANT STRUCTURE

In the selection of participants for the survey, the aimed target group comprised companies as well as research centers, with a strong emphasis on participants from the industry. This selection is reflected in the respondent structure. The majority of respondents work for a company (75.0%). A smaller proportion described their organization as a research organization (19.2%). 5.8% of respondents describe themselves as independent experts.

In the emerging field of *Systems of Systems*, large companies are thought to be driving the development. The fact that a good part of respondents (63.3%) work for a large organization of over 250 employees thus constitutes an ideal target group for the purposes of this survey because the over-representation of large companies can be thought to be selective of survey participants particularly knowledgeable in the field of *Systems of Systems*. Indeed, 82% of respondents consider their organization as involved in systems engineering and 45.7% even as explicitly involved in *System of Systems engineering*.

Most of the respondents' organizations are developing information technology (71.7%) and the respondents themselves are mostly involved with research & technical development (68.6%*), systems design and architecture (37.3%*), system integration (27.5%*), or software development (29.4%*). * Selection of multiple items allowed.

All in all, the participant structure being characterized as described and the amount of responses received allows to derive a meaningful picture from the survey responses.

3 Overview of Survey Responses

The following provides an overview on responses to the several questions posed in the survey. Figure 1 shows the association of respondents to industrial domains, based on their self-assessment.

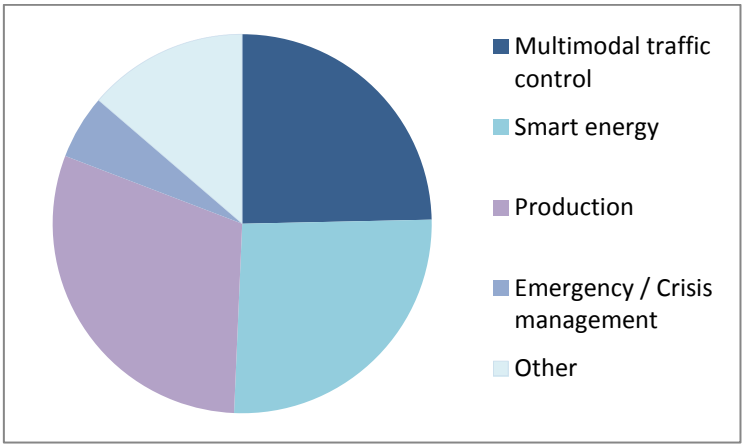


Fig. 1 – Distribution of respondents across domains (n = 73)

Benefits of a System of Systems approach

To identify the greatest benefits a *System of Systems* approach in the several industrial domains, respondents were presented a list of potential domain-specific aspects and were asked to rate them according to the relevance in their domain. The question posed was: "How relevant do you consider the following aspects to be for the domain of [multimodal traffic control / smart energy / production / emergency/crisis management]". Respondents were asked to assess each presented aspect according to its relevance in their domain on a 5-point scale ranging from 1 = "Not relevant" to 5 = "Highly relevant".

The figures 2-5 show the rating of the several presented aspects in each of the four domains.

Multi-modal Traffic Control

In the domain of Multi-modal Traffic Control, the received assessments suggest that a more controllable traffic system as a whole, more time-efficient transportation as well as a higher transport capacity are the main targets in the domain. The several items describing these aspects have been indicated to be *relevant* or *highly relevant* by over 80% of respondents (cf. figure 2). Further, over 50% of respondents have found aspects related to a greater ease of use for user of the traffic system as either *relevant* or *highly relevant* in the domain.

Interestingly, the received assessments in the survey suggest that, in the domain of Multi-modal Traffic Control, aspects regarding energy efficiency and the environmental impact of transport and traffic are not among the group of the most highly important aspects.
What motivates developments in Multi-modal Traffic Control thus seems to be rather the prospect of more time-efficient, more controllable traffic rather than greater energy efficiency or even higher cost efficiency (cf. figure 2).

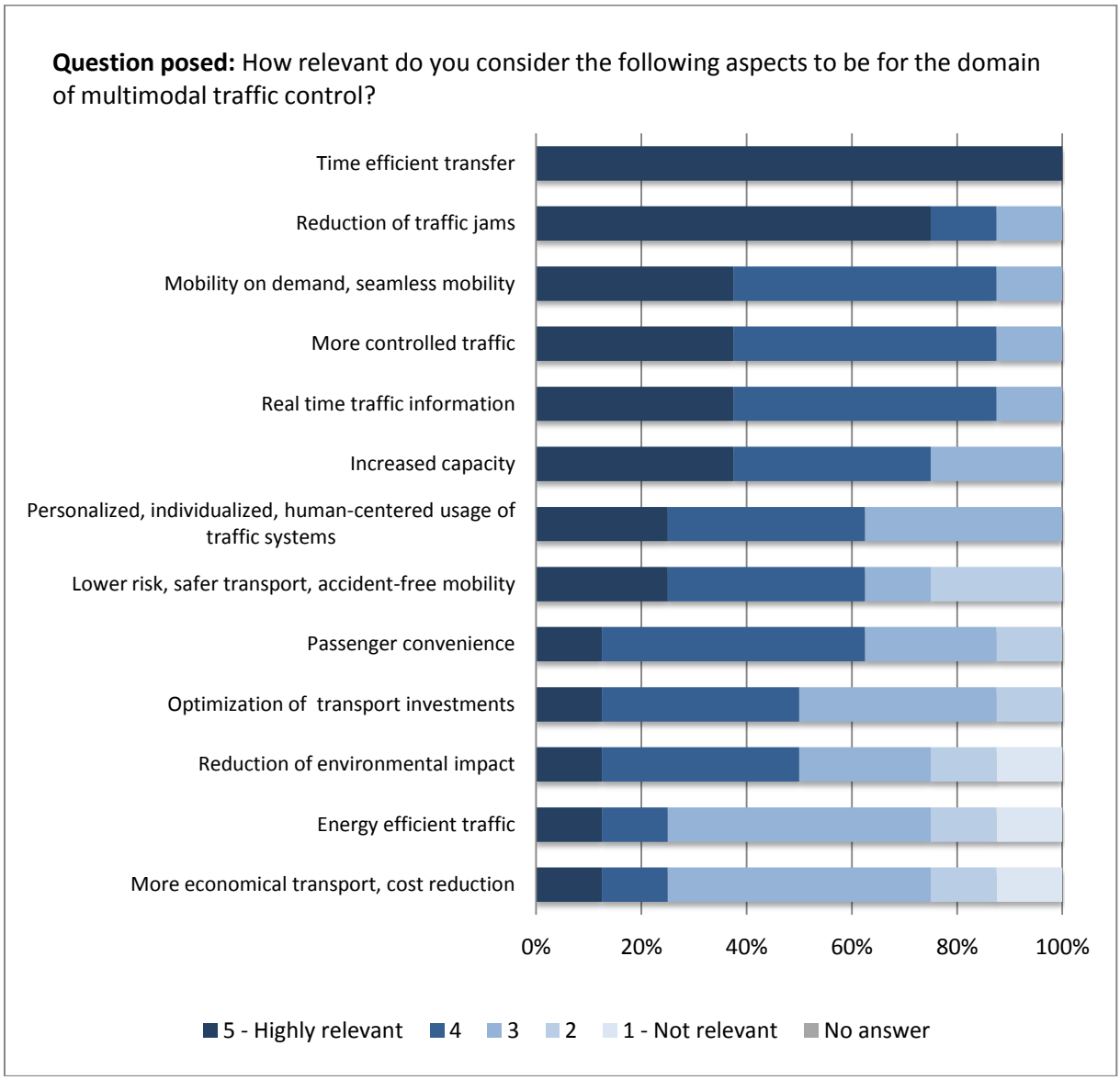


Fig. 2 – Most relevant aspects in the domain of Multi-modal Traffic Control (n = 8)

Distributed Energy Generation and Smart Grids

Just like the other examined domains, the domain termed *Distributed Energy Generation and Smart Grids* is not in existence today but rather a conception of tomorrow's energy system. In contrast to today's energy system, a smart grid is characterized as being a non-hierarchical, non-centric, undirected network for power distribution including a multitude of actors and a variety of energy sources. Not only will energy, in this system, be generated geographically distributed and from a variety of sources – it is also expected to be generated not only in specialized facilities but by users who appear on the energy market both as consumers and producers of energy (so-called "prosumers").

In transforming today's energy system to a smart grid, a variety of aspects become relevant. Thus, not unexpectedly, all aspects presented in the survey have been found to be *relevant* or *highly relevant* by over 60% of the respondents (cf. figure 3).

Firstly, the ability of the energy system to allow for energy generation to take place in a geographically distributed fashion is of course of prime importance. In this regard, several technologies become necessary, among them the storage of energy during times of high production and low energy demand. Also, management of these numerous sources becomes crucial in order for a smart grid to offer the supply stability of the classic power grid. Highly relevant in this regard is suitable forecasting of not only demand but also supply, which is dependent on exogenous factors such as the weather. Overall, the smart grid, being characterized as above, poses a control problem which requires the efficient processing of information from multiple information sources and thus an increased amount of information technology compared with today's energy system.

Tomorrow's energy system being as outlined above, the energy market is thought to change accordingly. With a great number of both consumers and producers, the price is becoming to fulfill an important signaling function and with demand of users being more responsive the energy market itself is becoming an important control mechanism for energy supply and demand the smart grid.

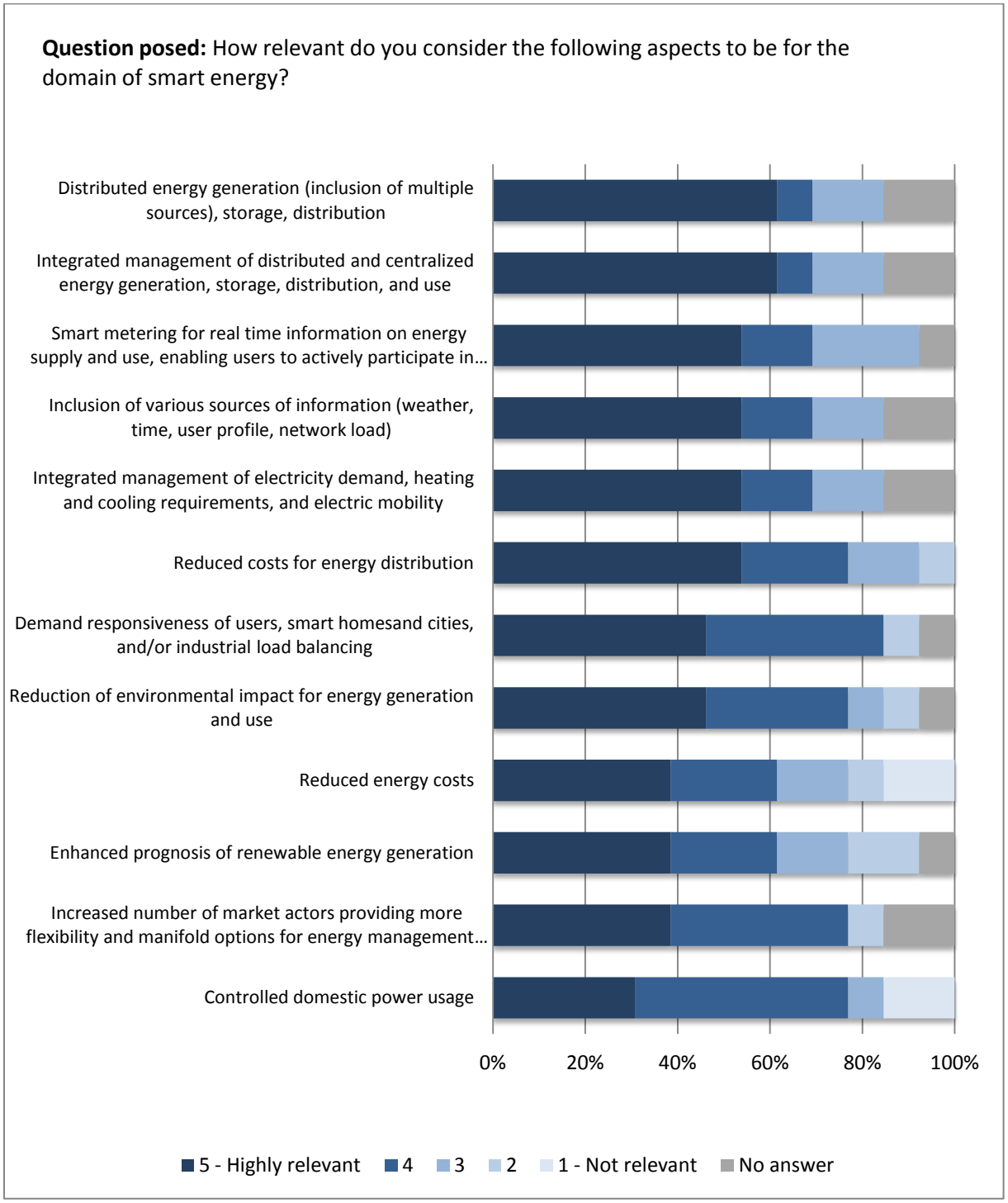


Fig. 3 - Most relevant aspects in the domain of *Distributed Energy Generation and Smart Grids* (n = 13)

Integrated Multi-site Production

In the domain of *Integrated Multi-site Production* nearly all presented aspects have been found to *relevant* or *highly relevant* in the domain by over half of the respondents (cf. figure 4).

Some of the most relevant aspects indicated by respondents refer to the ability to produce in a more flexible manner, more responsive to changing demand, to be able to realize the production of customized goods and also to be able to produce a diverse range of goods. Furthermore, any means allowing the reduction of costs are rated to be highly relevant – be it through a reduction of inventories, the achievement of new levels of manufacturing efficiency, increased automation, or reduced need for maintenance.

Lastly, achieving a more precise control over the production process in its entirety through better control of the several process parameters, scheduling, monitoring, tracking and tracing is attributed high importance in the domain.

Among further relevant aspects mentioned by respondents are:

- Advanced reliability engineering
- Advanced analytics forecasting
- Suitable management of complexity
- Increased control of product changes across supply chain
- Improved co-ordination of exceptional activities, such as recall &/or reworking products
- Coordinated Planning of all machines and Human resources
- Efficient transport and logistics
- Use of shared intelligent networks (information & physical networks). At present, the cost and development of these connecting/enabling networks is not being challenged (the big logistics providers (3PLs), and others, are setting the pattern/standards).

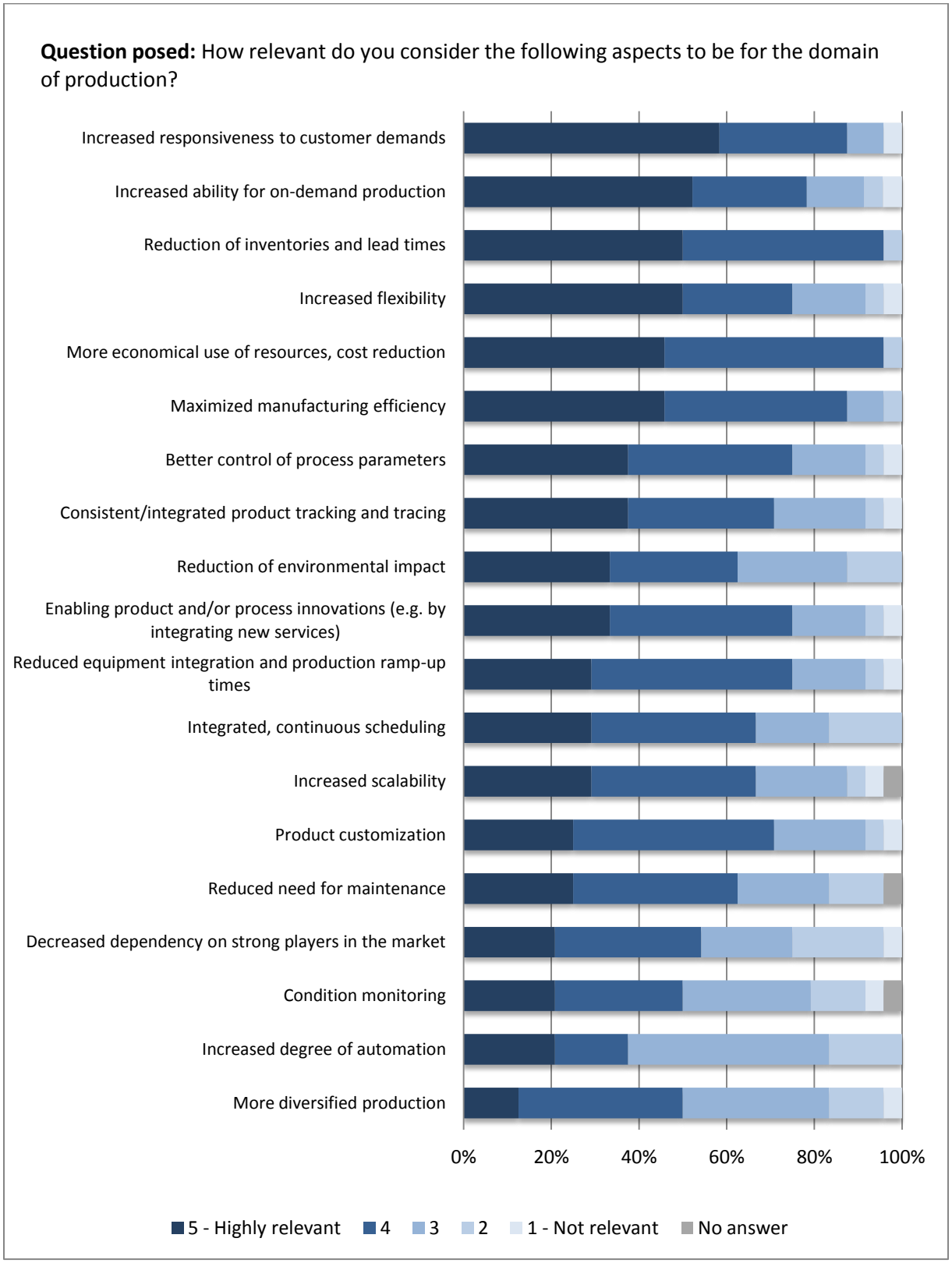


Fig. 4 - Most relevant aspects in the domain of *Integrated Multi-site Production* (n = 24)

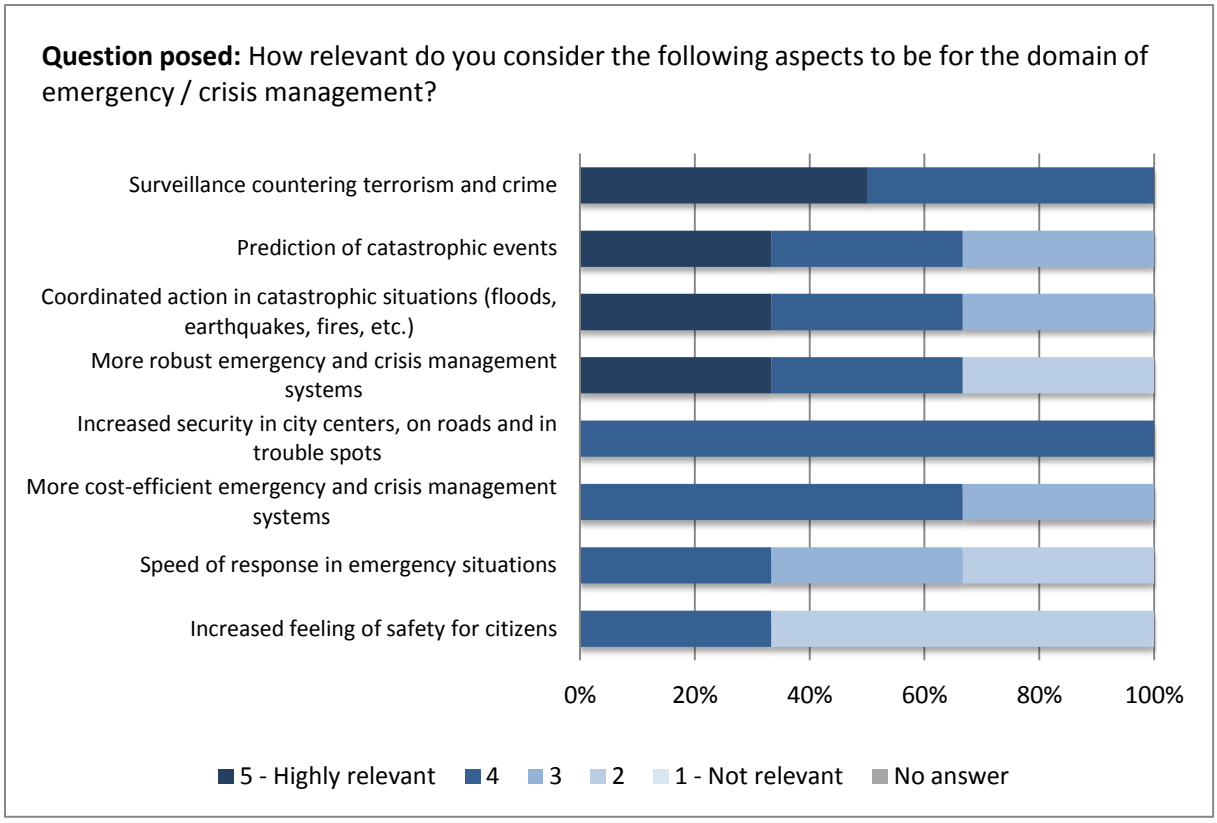


Fig. 5 - Most relevant aspects in the domain of *Emergency and Crisis Management* (n = 4)

Emergency and Crisis Management

In the domain of *Emergency and Crisis Management*, all of the respondents considered surveillance (as a means to combat terrorism and crime) as *relevant* or *highly relevant*. Survey respondents also attributed great importance to the prediction of disasters, as well as to a coordinated manner of action in these situations.

The systems employed both for coordination and prediction are required to provide robust operation. Accordingly, robustness of the systems involved in emergency and crisis management is considered *relevant* or *highly relevant* by most respondents.

On a smaller scale, security in urban centers and areas of conflict is considered important. While in these cases, incidents are not great in scale, they occur at great frequency (potentially daily). Bringing about improvement to such areas needs to not only be done in a cost-efficient way, but also in a profitable way. In the survey, over 60% of respondents considered these aspects *relevant* in the domain.

Improvement of the competitive position

To examine the concrete benefits associated with the introduction of a *System of Systems* approach from the point of view of individual companies, respondents were asked to select from a list those aspects in which a *System of Systems* approach could be advantageous to the competitive position of their company/organization.

Figure 6 shows the percentage of respondents who considered the respective aspect as potentially positively affecting the competitive position of their company/organization by implementing a *System of Systems* approach.

Across domains, a *System of Systems* approach is expected by many respondents to improve the competitive position of their company/organization by providing increased flexibility and also by increasing the range of services which can be offered to their company's or organization's users or customers. Also, usable capacity is thought to increase through the interconnection of existing systems into a greater System of Systems.

In the several domains, respondents considered a *System of Systems* approach to enhance the competitive position of their company/organization through the process innovations a *System of Systems* makes possible. Beyond process innovations, many respondents expect a *System of Systems* approach to even allow entirely new business models to emerge.

For the extent to which advantages were identified by respondents of the several domains, please refer to figure 6 on the following page.

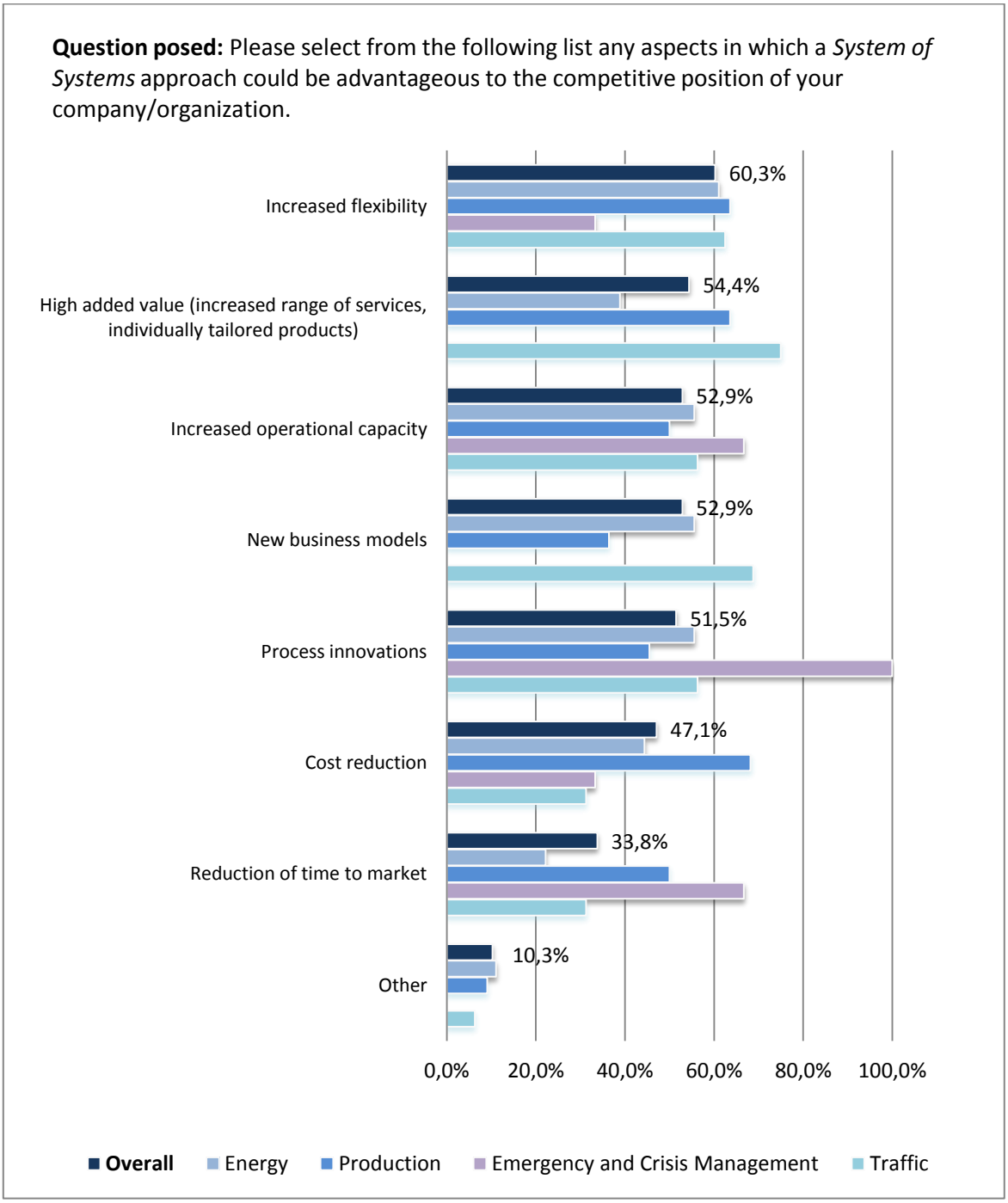


Fig. 6 – Advantageous impacts of Systems of Systems applications to the competitive position (n = 68, multiple answers allowed)

Scenarios and applications of *Systems of Systems*

Having investigated the aspects in which a *System of Systems* approach could be beneficial in the several domains and how it could yield advantages for individual companies, concreate application scenarios were elicited in the several domains.

Respondents of each of the four domains were asked to describe scenarios and applications in which a System of Systems approach is applied or could be applied in the future yielding a desirable outcome. The following questions were posed relating to different points in time:

- Present time: "Are you aware of any scenarios/applications in your domain where a System of Systems approach is already implemented?"

- Near future: "Which scenarios/applications in your domain could benefit from the implementation in a System of Systems approach in the next 5 years?"

- Medium-term future: "Which scenarios/applications in your domain could benefit from the implementation in a System of Systems approach in 5 to 10 years?"

- Long-term future: "Which scenarios/applications in your domain could benefit from the implementation in a System of Systems approach in 10 to 15 years?"

The following tables summarize the scenarios and applications suggested by respondents in the several domains.

Present	Near future (“next 5 years”)	Medium-term future (“next 5 to 10 years”)	Long-term future (“in 10 to 15 years”)
Multi-modes of transport	Multi-modes of transport	Multi-modes of transport (at international level)	
	Applications for "full" multi-modal persons and goods transportation	Strategic policy tools covering all modi and socio-economic determinants	
Intelligent transport systems (ITS)		Shared transportation means	
	Delivering more services to our clients base	New business types	
	Continuous traveler information	Test and monitoring of instrumental frameworks on travellers behaviour and the transport system.	
Smart cities	Smart cities	Smart cities (at international level) Traffic in smarter cities	Smart city with connected traffic and energy control
Energy management coupled with transport	Energy management coupled with transport	Energy management coupled with transport (at international level)	
		Electrical vehicles and infrastructure for loading	
		Infrastructure-vehicle communication	
		Self-guided vehicles	Self-guided vehicles Autonomous driving
Air Traffic Management	Development of strategic and tactic scenario simulation software in air transport		
	In the railway domain: Rolling stock / infrastructure interaction, signaling	Signalling	
Navigation Systems			Network of low altitude satellites
Cooperation between several autonomous vehicles to perform a mission	Cooperation of several UAV, changing their goals in real time when they detect a new target	Flying drones in civil aero space	Transporting people and cargo by drone.
Collaboration of different kind of companies and institutions from several countries for the development of complex space instrumentation or systems, such as payloads, satellites, spacecrafts, probes, etc.		Payload for the Mars Environmental instrumentation for ground and atmosphere (http://metnet.fmi.fi)	

Table 1 – Scenarios in the domain of *Multi-modal Traffic Control*

Present	Near future (“next 5 years”)	Medium-term future (“next 5 to 10 years”)	Long-term future (“in 10 to 15 years”)
Global manufacturing footprint	Global manufacturing footprint	Global manufacturing and business footprint	Appropriate co-location of suppliers/manufacturers (cluster) to enable local production, also having linkage and coordination with the larger (Global/Regional Design / Manufacture / Repair / Recycle Network)
Product manufacturing	Produce anywhere short relocation of production facilities standardization of factories and equipment	Localization of emerging market based value streams	Integration of our end-to-end supply chains from consumer to R&D
System of Systems approach is currently implemented to provide a range of services to minimize plant upsets and trips	Global muti-site manufacturing	Integration of the expanding global network of independent associated companies in a manner that prevents us stifling current entrepreneurial culture	Design and Production localization globally
Supply network planning system (integration across manufacturers, trading companies, distribution centres & customers)	Better coordination of expanding external supply network	Increased linked to R&D and suppliers	Effective avoidance of only-one-source dependencies in critical components
The coming together of independent hauliers to construct their own industrial pallet delivery and collection networks (Pallex). Not a pure manufacturing example but interesting from the perspective of emerging 'business networks' and 'enabling infrastructure'.	Leadership and management of production technology competences (including resources) within a group (consisting of many production sites globally)	Common Standards	
	Materials planning (interconnected software & comms; shared data, information and visability; common planning rules / methods)		Integration of our end-to-end supply chains from consumer to R&D
	Fast Ramp up of MES (or IT in production in general)		
	Available and efficient materials transport between operations (shared carriers, durable packaging)		
	Building automation		

Table 2 – Scenarios in the domain of *Integrated Multi-site Production*

Present	Near future (“next 5 years”)	Medium-term future (“next 5 to 10 years”)	Long-term future (“in 10 to 15 years”)
In the Smart grid application the system of systems approach is exploiting synergies between different applications such as wind production, energy storage, active customers, electric vehicles etc,	Full scale intro of smart grid concept		
Interdependencies interactions between ICT and energy (power grid)	Intelligent demand follows offers in the energy market	Capacity virtualization: high and low loads on the grid can be predicted which enable utilities to propose in real-time tariff variations and spare capacity for large energy consumers to run their most energy consuming processes with optimal energy costs.	Decentralized electricity supply without necessity of BIG power plants for grid stability
Distributed Sensor Systems	Distribution automation + virtual power plants	Energy distribution of production and consuming	
Smart metering	Emergency demand response in the smart grid	Load balancing in local areas Environmental follow up systems	Reduction of transmission lines
	Management of grid stability during start-up-phase		
	Distributed energy generation by renewable energy plants.		Large scale offshore wind farms and ocean energy farms
	Self-energy consumption		
	Self healing networks, more or less automated		

Table 3 – Scenarios in the domain of Distributed Energy Generation and Smart Grids

Present	Near future (“next 5 years”)	Medium-term future (“next 5 to 10 years”)	Long-term future (“in 10 to 15 years”)
-	-	-	-

Table 4 – Scenarios in the domain of Emergency and Crisis Management

Barriers to the application of *Systems of Systems approaches*

Turning to the identification of potential barriers to the implementation of *System of Systems* approaches, respondents were asked to rate (and extend) lists of economical, social, and political and legal barriers. On a scale of 1 ("Not likely to be a barrier") to 5 ("Highly likely to be a barrier") respondents were asked to rate each of the presented potential barriers according to their likelihood of being an actual barrier to the implementation of a *System of Systems* approach.

Question posed: Please indicate to what extent you consider the following social aspects as being potential barriers to implementing a *System of Systems* approach.

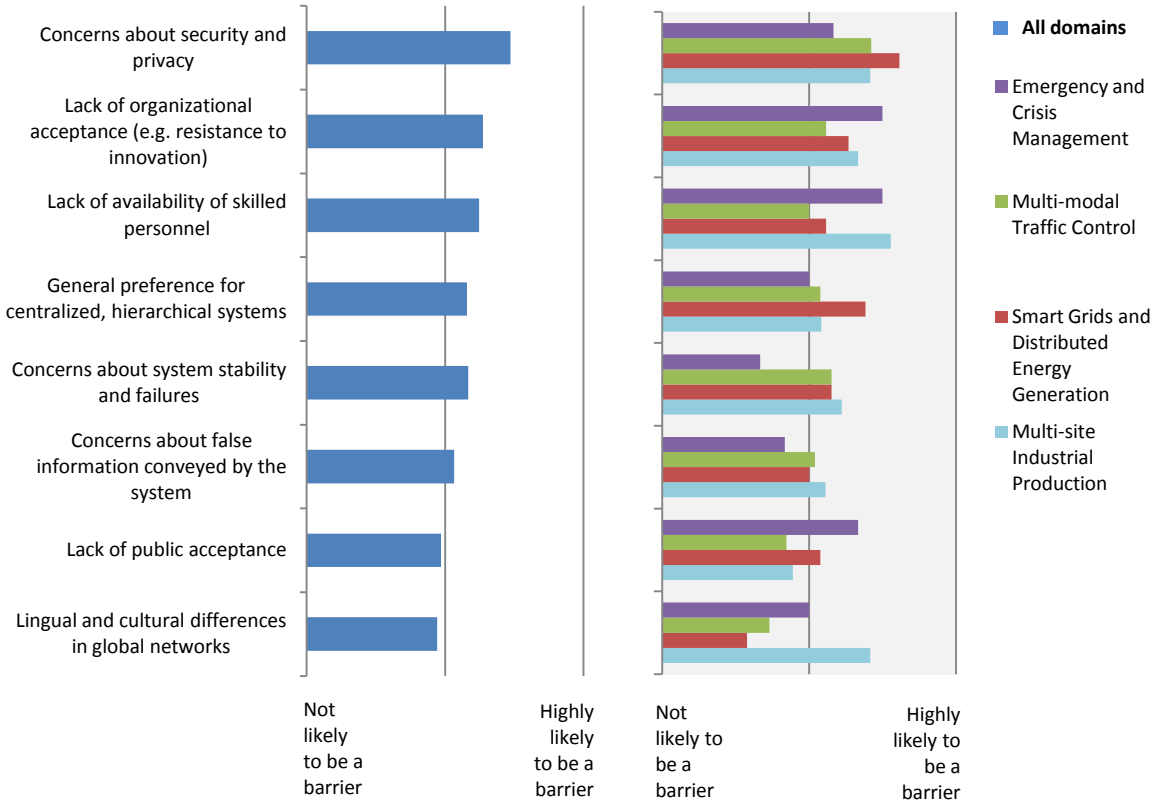


Fig. 7 – Most likely social barriers to *System of Systems* approaches (n = 55)

Among the presented social barriers, all were found by the respondents to be of some likelihood to indeed be a barrier to the implementation of a *System of Systems* approach (cf. figure 7). Across domains, concerns about security and privacy were considered most likely to pose a barrier. Also, the general resistance to innovation known to prevail in organizations and the general preference of people for hierarchical systems was seen by respondents as a likely barrier to the introduction of a *System of Systems* approach, which, by nature, is non-hierarchical and decentralized.

Further barriers considered as fairly likely to occur are concerns that may exist regarding the stability of the system of systems and also a lack of trust in the information conveyed by it.

Of particular concern in the domain of Integrated Multi-site Production, seem to be lingual and cultural differences among the human actors involved in the system of systems (cf. figure 7).

Further social barriers suggested by respondents were:

- The lack of a clear governance structure for the system of systems.
- Potential concerns about the impact of ever more extensive Systems of Systems on everyday life.
- Potential concerns about an increasing dependence on Systems of Systems
- Potential concerns about the devastating impact of the failure of the System of Systems in its entirety.

Among potential economic barriers, respondents considered the lack of appropriate business models a fairly likely barrier. Also, the high initial investment associated with the implementation of a System of Systems approach, a long or even unclear time to market, and the absence of demonstration was thought to deter stakeholders. Furthermore, that fact that individual action is highly risk fraught and that the risk-benefits ratio is unclear was considered a fairly likely barrier to the implementation as well (cf. figure 8).

A further economic barrier suggested was the static behavior of relevant economic agents (e.g. large energy companies).

Among potential political and legal barriers, issues arising from multiple ownership of the system of systems and also antitrust policies hindering necessary cooperation are thought to be fairly likely. Also, intellectual property issues are considered a fairly likely barrier. (In the domain of Integrated Multi-site Production all of the political and legal barriers are considered to be particularly likely. Cf. figure 9).

Question posed: Please indicate to what extent you consider the following economic aspects as being potential barriers to implementing a *System of Systems* approach.

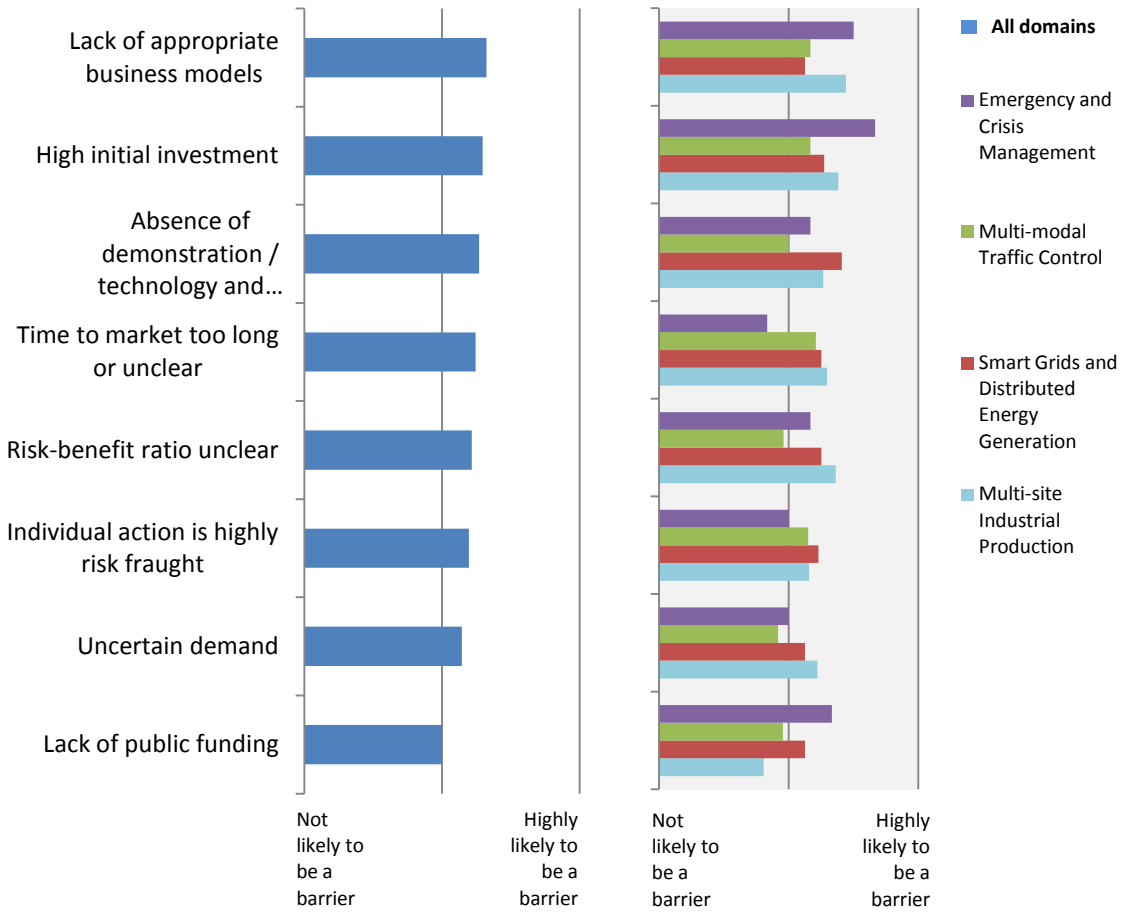


Fig. 8 – Most likely economic barriers to *System of Systems* approaches (n = 53)

Question posed: Please indicate to what extent you consider the following political and legal aspects as being potential barriers to implementing a *System of Systems* approach.

Fig. 9 – Most likely political and legal barriers to *System of Systems* approaches (n = 51)

Question posed: In the following list of IT and technological challenges, please tick those you consider to be of greatest importance for a *System of Systems* approach to be sucessfully implemented in your domain. Please tick five boxes.

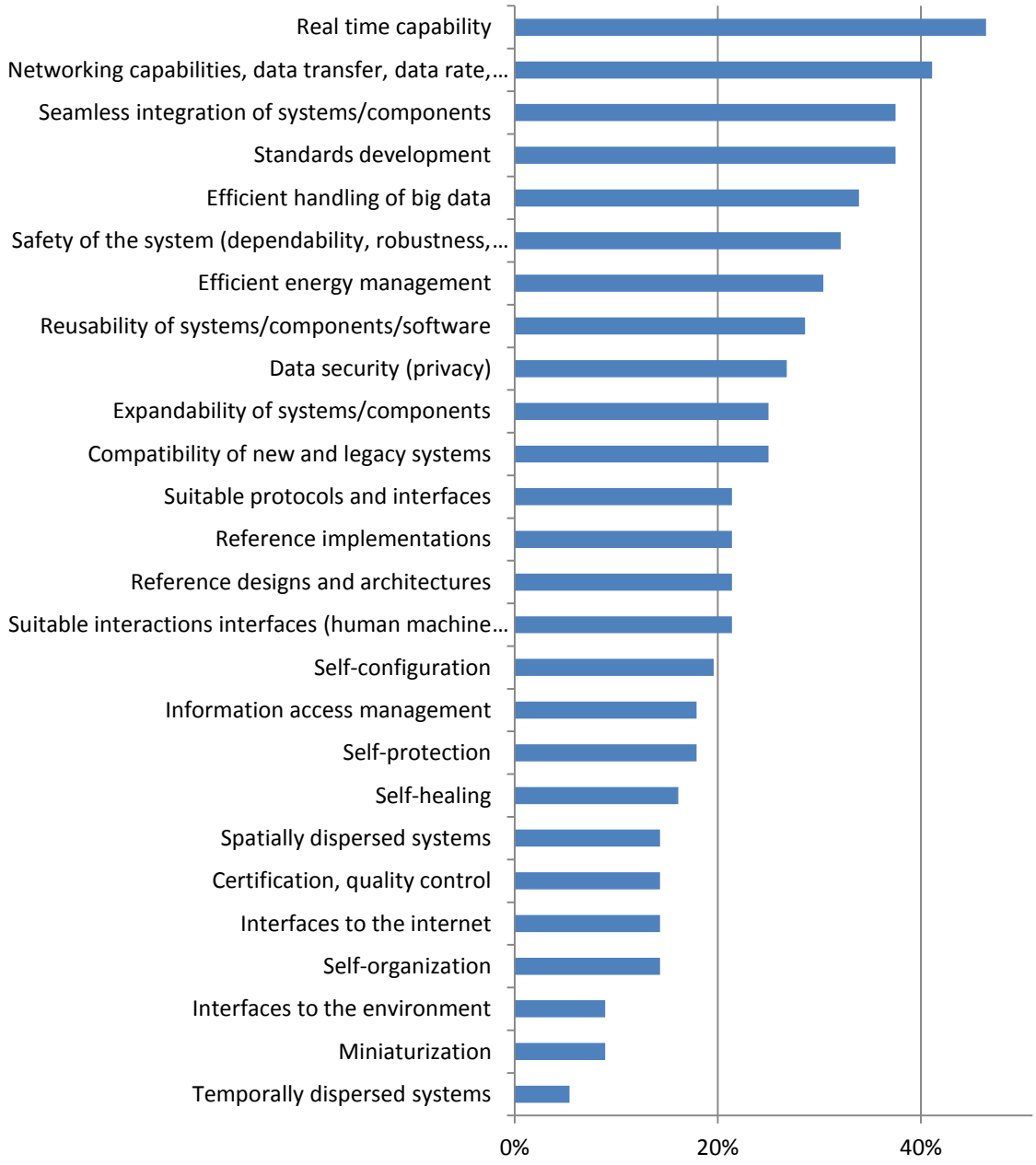


Fig. 9 – IT and technological challenges of greatest importance for the implementation of System of Systems approaches (n = 56)

Most pressing research IT & technological challenges

To identify the most important research topics regarding Systems of Systems, respondents were presented an extensive list of IT and technological challenges and were asked to indicate among them the five most important ones. Figure 9 provides an overview of the items presented and displays the percentage of respondents who considered the respective aspect among the top five IT and technological challenges regarding the introduction of a *System of Systems* approach.

Endowing systems with capabilities which in fact enable them to communicate and effectively work together in the System of Systems constitutes some of the top challenges. Among these challenges is not only the endowment of the systems with networking capabilities, but also providing that the systems operate in real-time, and are able to exchange sufficiently large amounts of data at a sufficiently high data rate.

Also, the development of standards, interfaces, and protocols is of course key to enable systems to participate in a system of systems. Developing these interfaces and protocols, however, particularly challenging design criteria need to be met. Not only need the protocols and interfaces be suitable for a great variety of systems to communicate, they also need to allow for the interconnection of new systems and legacy systems. The design criteria are not less demanding for the systems themselves, their components, and any software running on these. The greater the extent to which they are reusable and expandable, the greater the ease at which a system of systems can work.

Another highly challenging point, in its relevance not limited to system of systems, is the handling of *big data*. Among the major advantages of the *System of Systems* approach is the fact that relevant information from multiple sources is available to be used in a meaningful way. However, the computing power required to treat and interpret available data can easily exceed available computational capacity, even in fairly limited systems of systems. Thus, an interconnection of systems may only yield benefits with efficient methods at hand to deal with the large quantities of data offered. Consequently, the handling of big data is among the top challenges to successfully implementing a *Systems of Systems* approach.

Lastly, in accordance with commonly existing concerns about data security and system stability, the providing of data security and safe, secure, and dependable systems are considered top challenges.

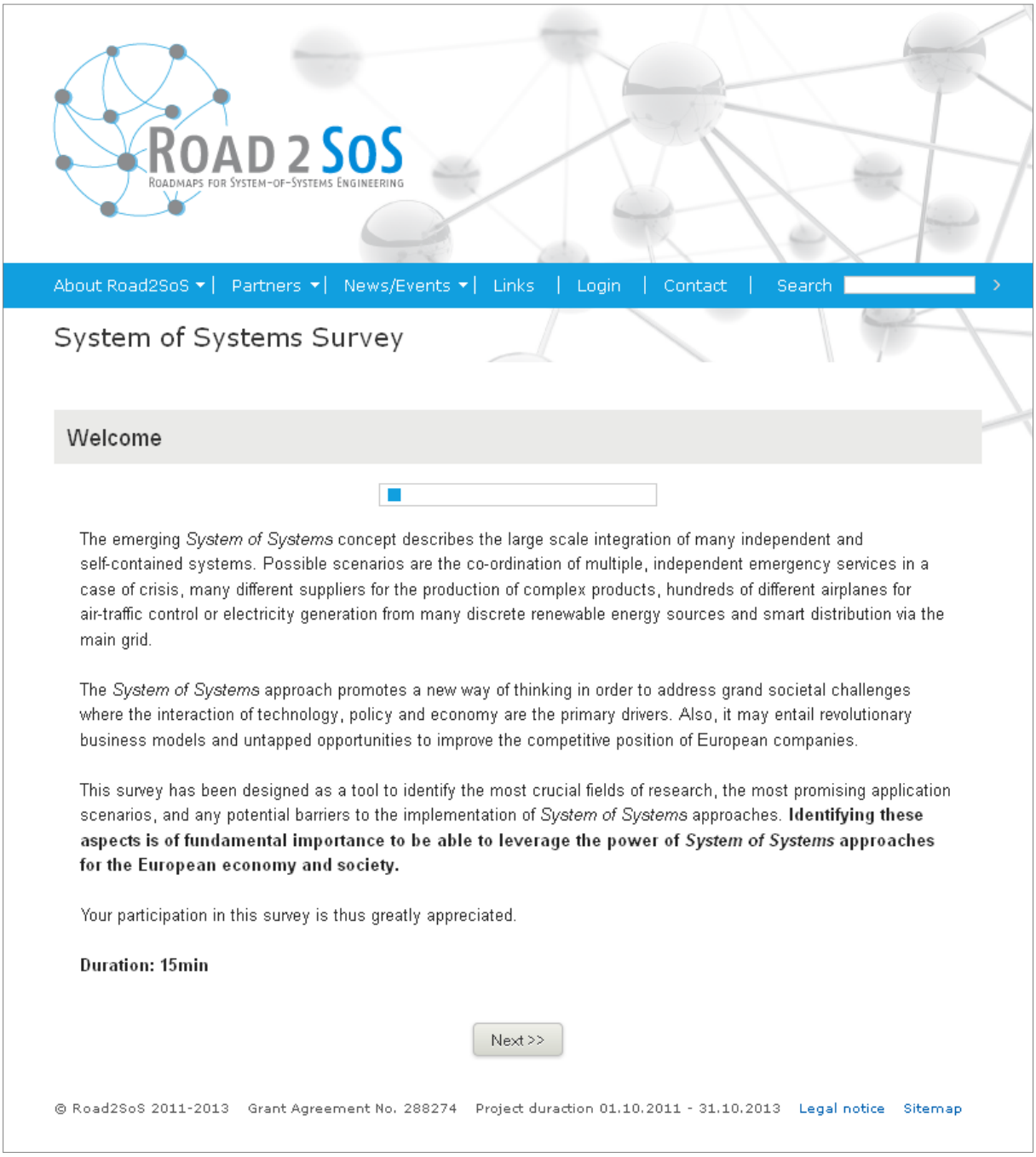
For the investigated domains, table 5 contains the top five IT and technological challenges identified by respondents in the respective domain.

Multi-modal Traffic Control	1. Standards development 2. Reusability of systems /components /software 3. Efficient handling of big data 4. Suitable interaction interfaces 5. Safety of the system
Integrated Multi-site Production	1. Real time capability 2. Networking capabilities, data transfer, data rate, … 3. Seamless integration of systems/components 4. Standards development 5. Expandability of systems/components
Distributed Energy Generation and Smart Grids	1. Real time capability 2. Data security (privacy) 3. Self-healing 4. Suitable protocols and interfaces 5. Self protection
Emergency and Crisis Management	1. Networking capabilities, data transfer, data rate, … 2. Efficient handling of big data 3. Safety of the system 4. Efficient energy management 5. Real time capabilities

Table 5 – Top five IT and technological challenges in the four domains

4 ANNEX

Screenshots of online survey



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System of Systems Survey

Welcome

The emerging *System of Systems* concept describes the large scale integration of many independent and self-contained systems. Possible scenarios are the co-ordination of multiple, independent emergency services in a case of crisis, many different suppliers for the production of complex products, hundreds of different airplanes for air-traffic control or electricity generation from many discrete renewable energy sources and smart distribution via the main grid.

The *System of Systems* approach promotes a new way of thinking in order to address grand societal challenges where the interaction of technology, policy and economy are the primary drivers. Also, it may entail revolutionary business models and untapped opportunities to improve the competitive position of European companies.

This survey has been designed as a tool to identify the most crucial fields of research, the most promising application scenarios, and any potential barriers to the implementation of *System of Systems* approaches. **Identifying these aspects is of fundamental importance to be able to leverage the power of *System of Systems* approaches for the European economy and society.**

Your participation in this survey is thus greatly appreciated.

Duration: 15min

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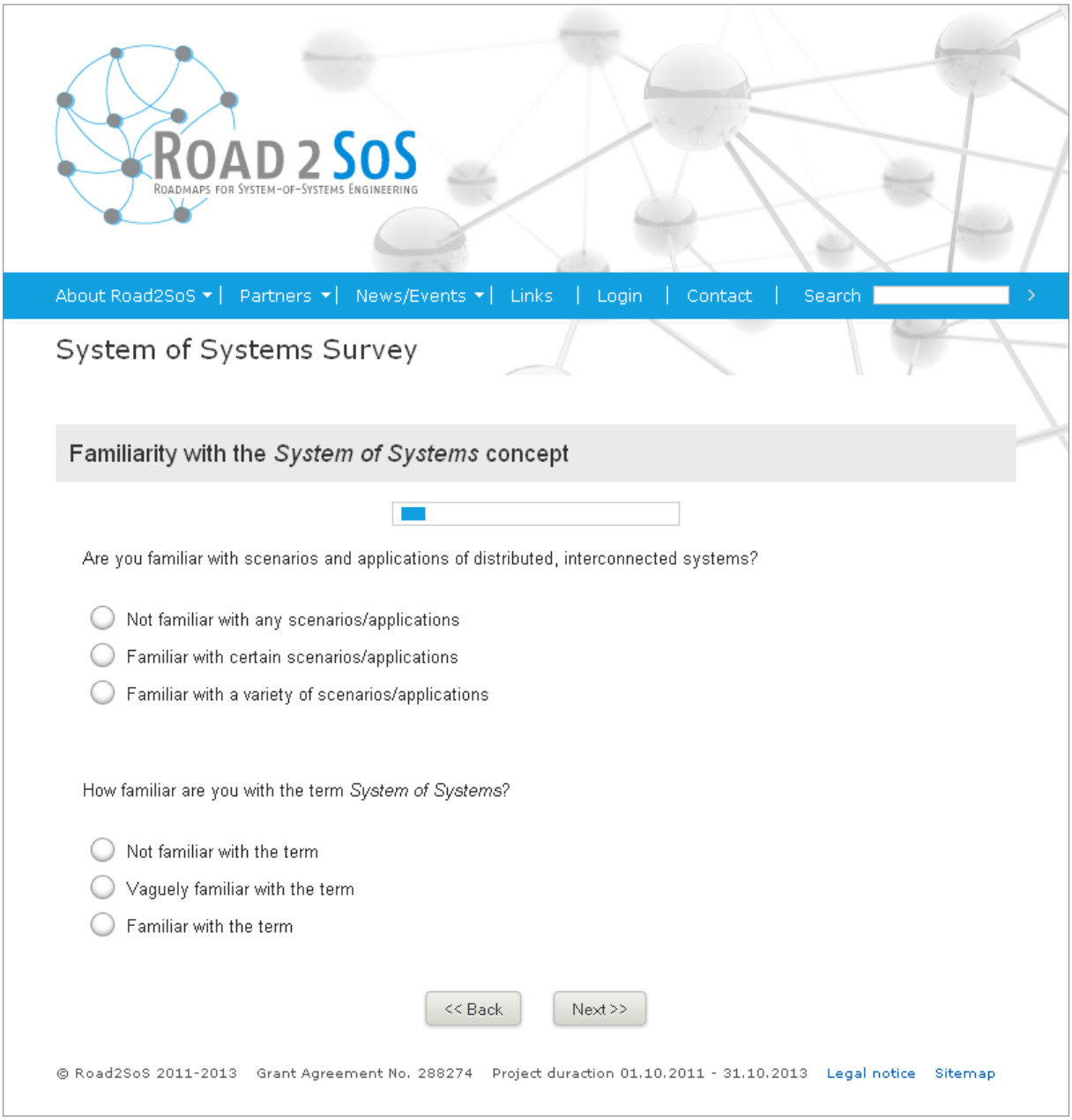

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System of Systems Survey

Familiarity with the *System of Systems* concept

Are you familiar with scenarios and applications of distributed, interconnected systems?

- Not familiar with any scenarios/applications
- Familiar with certain scenarios/applications
- Familiar with a variety of scenarios/applications

How familiar are you with the term *System of Systems*?

- Not familiar with the term
- Vaguely familiar with the term
- Familiar with the term

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System of Systems Survey
Your domain
In which of the following domains are you active?
Multimodal traffic control
Smart energy
Production
Emergency / Crisis management
Other (please specify)
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System of Systems Survey

Identification of greatest benefits of a *System of Systems* implementation

How relevant do you consider the following aspects to be for the domain of multimodal traffic control?

	Not relevant 1	2	3	4	Highly relevant 5	No answer
Time efficient transfer	○	○	○	○	○	○
Increased capacity	○	○	○	○	○	○
More controlled traffic	○	○	○	○	○	○
Reduction of traffic jams	○	○	○	○	○	○
Lower risk, safer transport, accident-free mobility	○	○	○	○	○	○
Passenger convenience	○	○	○	○	○	○
Personalized, individualized, human-centered usage of traffic systems	○	○	○	○	○	○
Mobility on demand, seamless mobility	○	○	○	○	○	○
More economical transport, cost reduction	○	○	○	○	○	○
Reduction of environmental impact	○	○	○	○	○	○
Real time traffic information	○	○	○	○	○	○
Energy efficient traffic	○	○	○	○	○	○
Optimization of transport investments	○	○	○	○	○	○

Can you think of any further aspects?

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System of Systems Survey

Identification of greatest benefits of a *System of Systems* implementation

How relevant do you consider the following aspects to be for the domain of smart energy?

	Not relevant 1	2	3	4	Highly relevant 5	No answer
Reduced energy costs	○	○	○	○	○	○
Reduced costs for energy distribution	○	○	○	○	○	○
Demand responsiveness of users, smart homesand cities, and/or industrial load balancing	○	○	○	○	○	○
Controlled domestic power usage	○	○	○	○	○	○
Smart metering for real time information on energy supply and use, enabling users to actively participate in the market	○	○	○	○	○	○
Distributed energy generation (inclusion of multiple sources), storage, distribution	○	○	○	○	○	○
Inclusion of various sources of information (weather, time, user profile, network load)	○	○	○	○	○	○
Integrated management of distributed and centralized energy generation, storage, distribution, and use	○	○	○	○	○	○
Integrated management of electricity demand, heating and cooling requirements, and electric mobility	○	○	○	○	○	○
Increased number of market actors providing more flexibility and manifold options for energy management and grid stabilization	○	○	○	○	○	○
Enhanced prognosis of renewable energy generation	○	○	○	○	○	○
Reduction of environmental impact for energy generation and use	○	○	○	○	○	○

Can you think of any further aspects?

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System of Systems Survey

Identification of greatest benefits of a *System of Systems* implementation

How relevant do you consider the following aspects to be for the domain of production?

	Not relevant 1	2	3	4	Highly relevant 5	No answer
More economical use of resources, cost reduction	○	○	○	○	○	○
Maximized manufacturing efficiency	○	○	○	○	○	○
Increased degree of automation	○	○	○	○	○	○
Increased scalability	○	○	○	○	○	○
Increased ability for on-demand production	○	○	○	○	○	○
Consistent/integrated product tracking and tracing	○	○	○	○	○	○
Reduced need for maintenance	○	○	○	○	○	○
Condition monitoring	○	○	○	○	○	○
Better control of process parameters	○	○	○	○	○	○
Reduction of inventories and lead times	○	○	○	○	○	○
Reduced equipment integration and production ramp-up times	○	○	○	○	○	○
Integrated, continuous scheduling	○	○	○	○	○	○
Increased flexibility	○	○	○	○	○	○
More diversified production	○	○	○	○	○	○
Greater number of product variants	○	○	○	○	○	○
Product customization	○	○	○	○	○	○
Increased responsiveness to customer demands	○	○	○	○	○	○
Enabling product and/or process innovations (e.g. by integrating new services)	○	○	○	○	○	○
Reduction of environmental impact	○	○	○	○	○	○
Decreased dependency on strong players in the market	○	○	○	○	○	○

Can you think of any further aspects?

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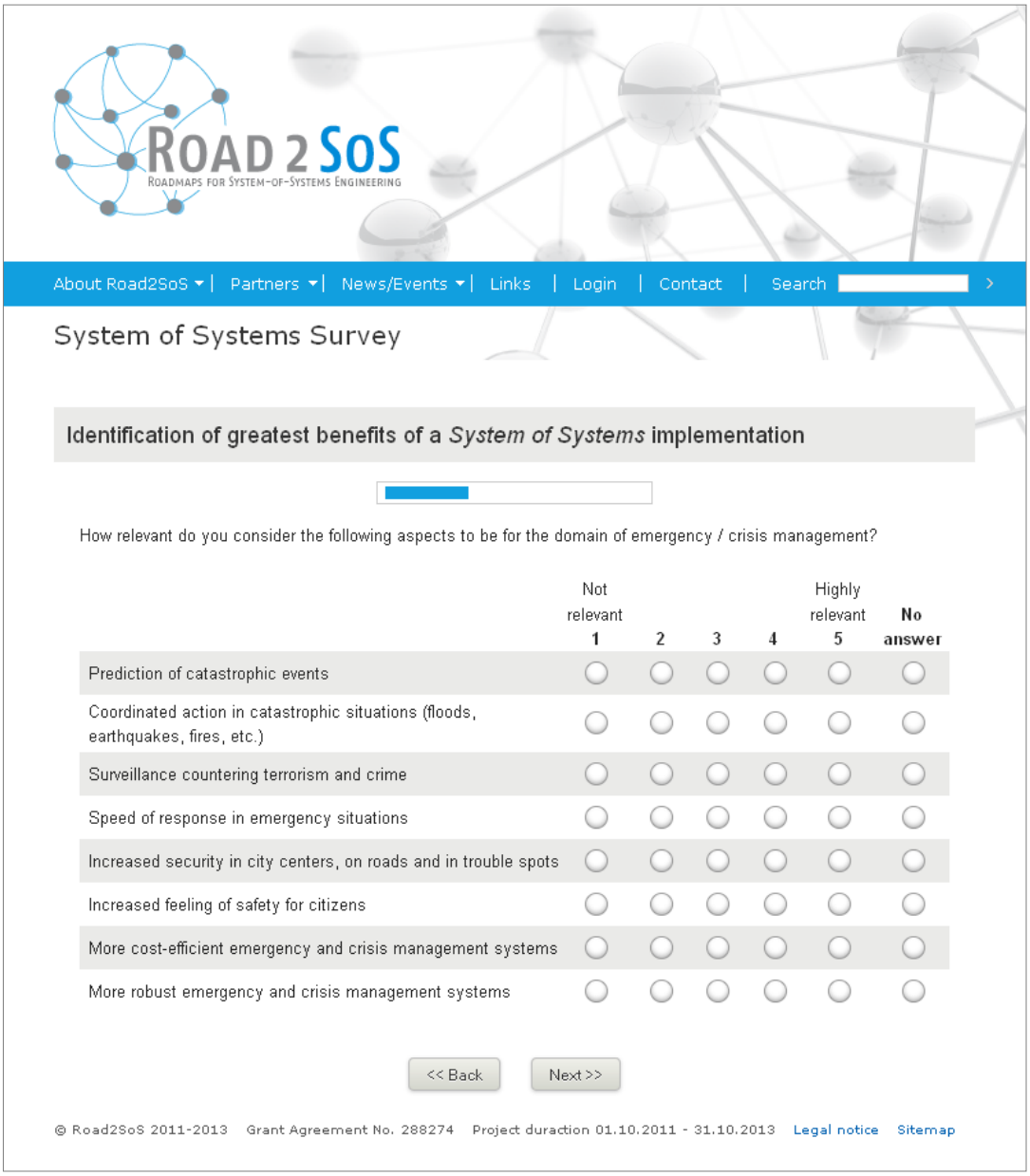

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Identification of greatest benefits of a *System of Systems* implementation

How relevant do you consider the following aspects to be for the domain of emergency / crisis management?

	Not relevant 1	2	3	4	Highly relevant 5	No answer
Prediction of catastrophic events	○	○	○	○	○	○
Coordinated action in catastrophic situations (floods, earthquakes, fires, etc.)	○	○	○	○	○	○
Surveillance countering terrorism and crime	○	○	○	○	○	○
Speed of response in emergency situations	○	○	○	○	○	○
Increased security in city centers, on roads and in trouble spots	○	○	○	○	○	○
Increased feeling of safety for citizens	○	○	○	○	○	○
More cost-efficient emergency and crisis management systems	○	○	○	○	○	○
More robust emergency and crisis management systems	○	○	○	○	○	○

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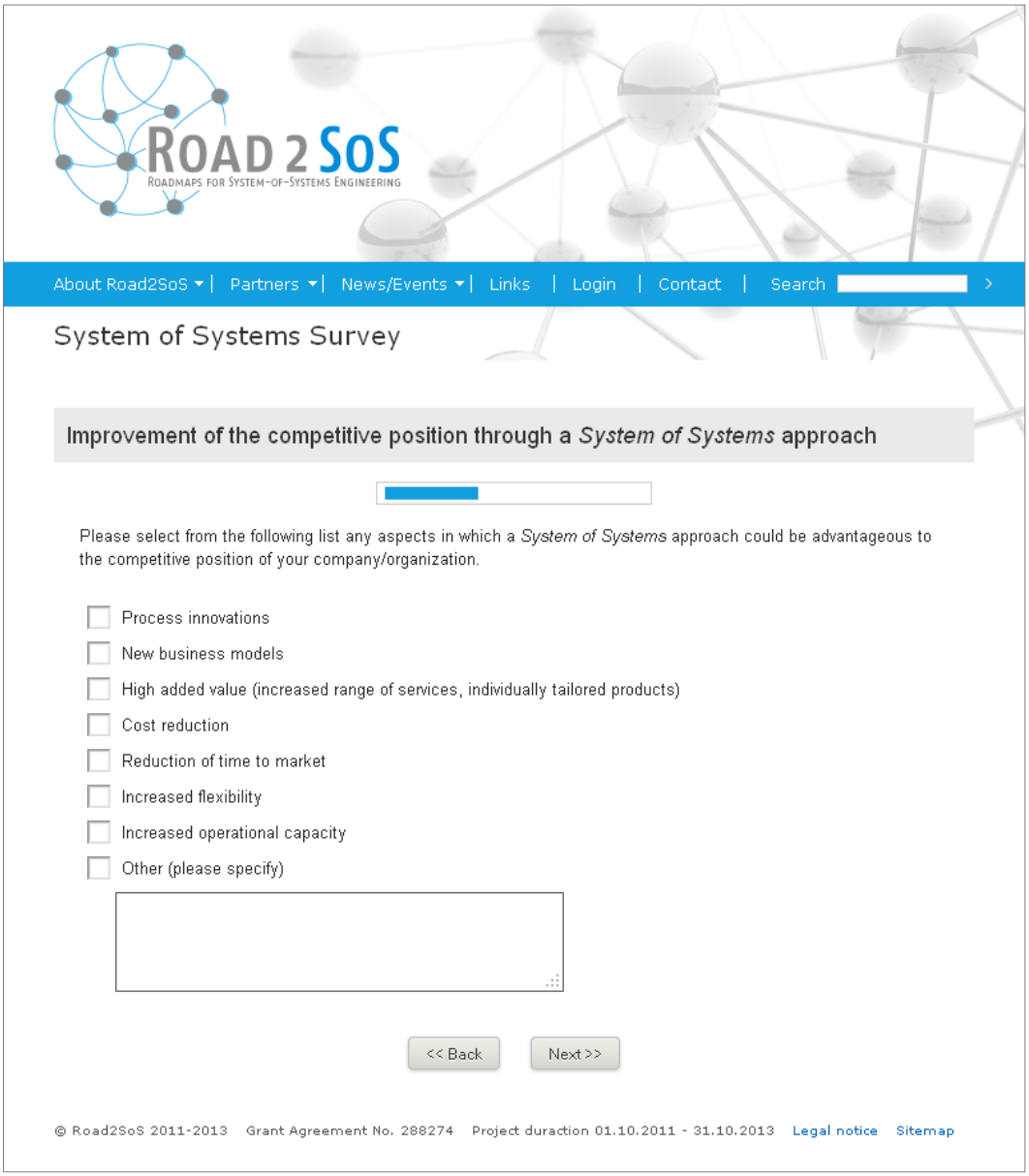

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System of Systems Survey

Improvement of the competitive position through a *System of Systems* approach

Please select from the following list any aspects in which a *System of Systems* approach could be advantageous to the competitive position of your company/organization.

- [ ] Process innovations
- [ ] New business models
- [ ] High added value (increased range of services, individually tailored products)
- [ ] Cost reduction
- [ ] Reduction of time to market
- [ ] Increased flexibility
- [ ] Increased operational capacity
- [ ] Other (please specify)

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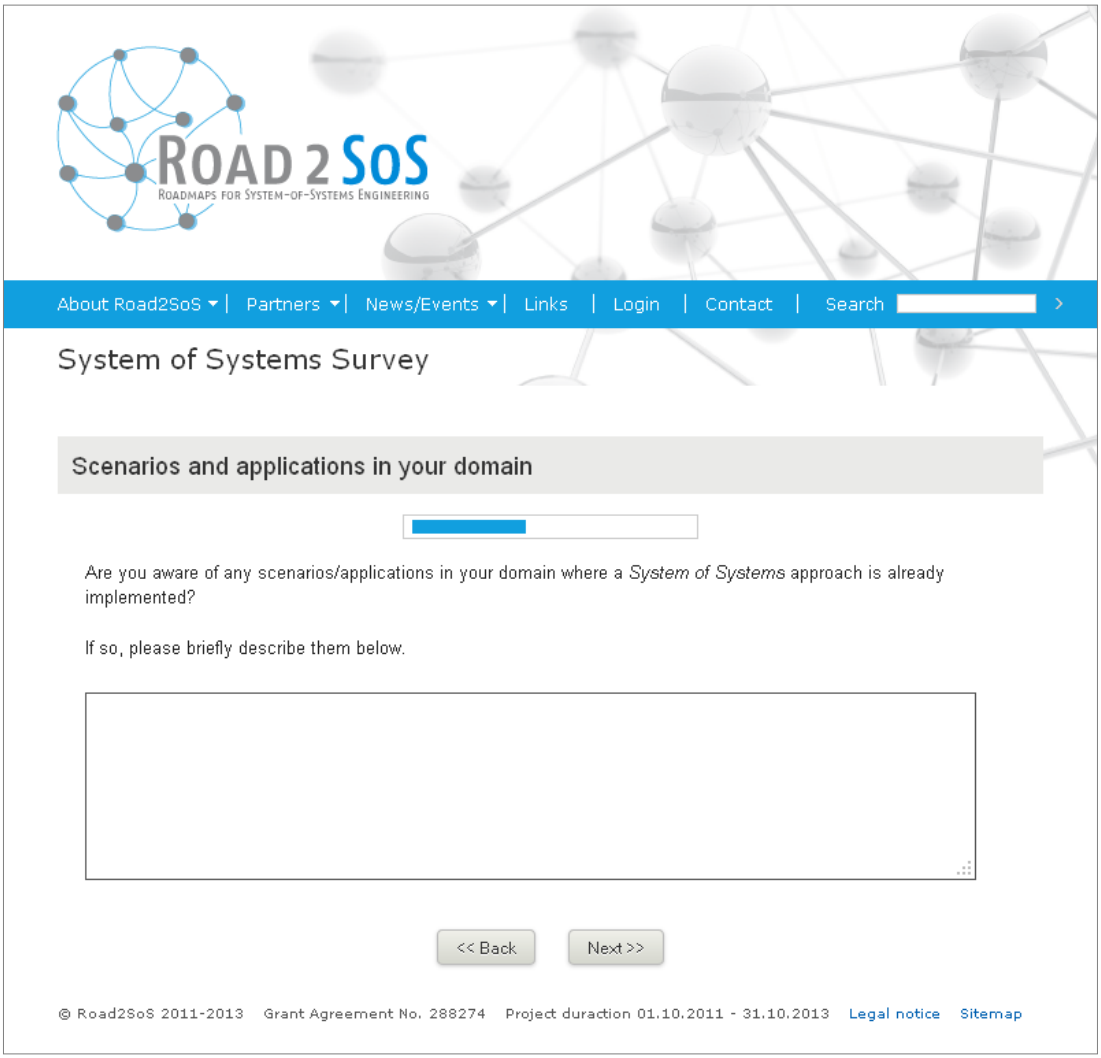
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Scenarios and applications in your domain
Are you aware of any scenarios/applications in your domain where a System of Systems approach is already implemented?
If so, please briefly describe them below.
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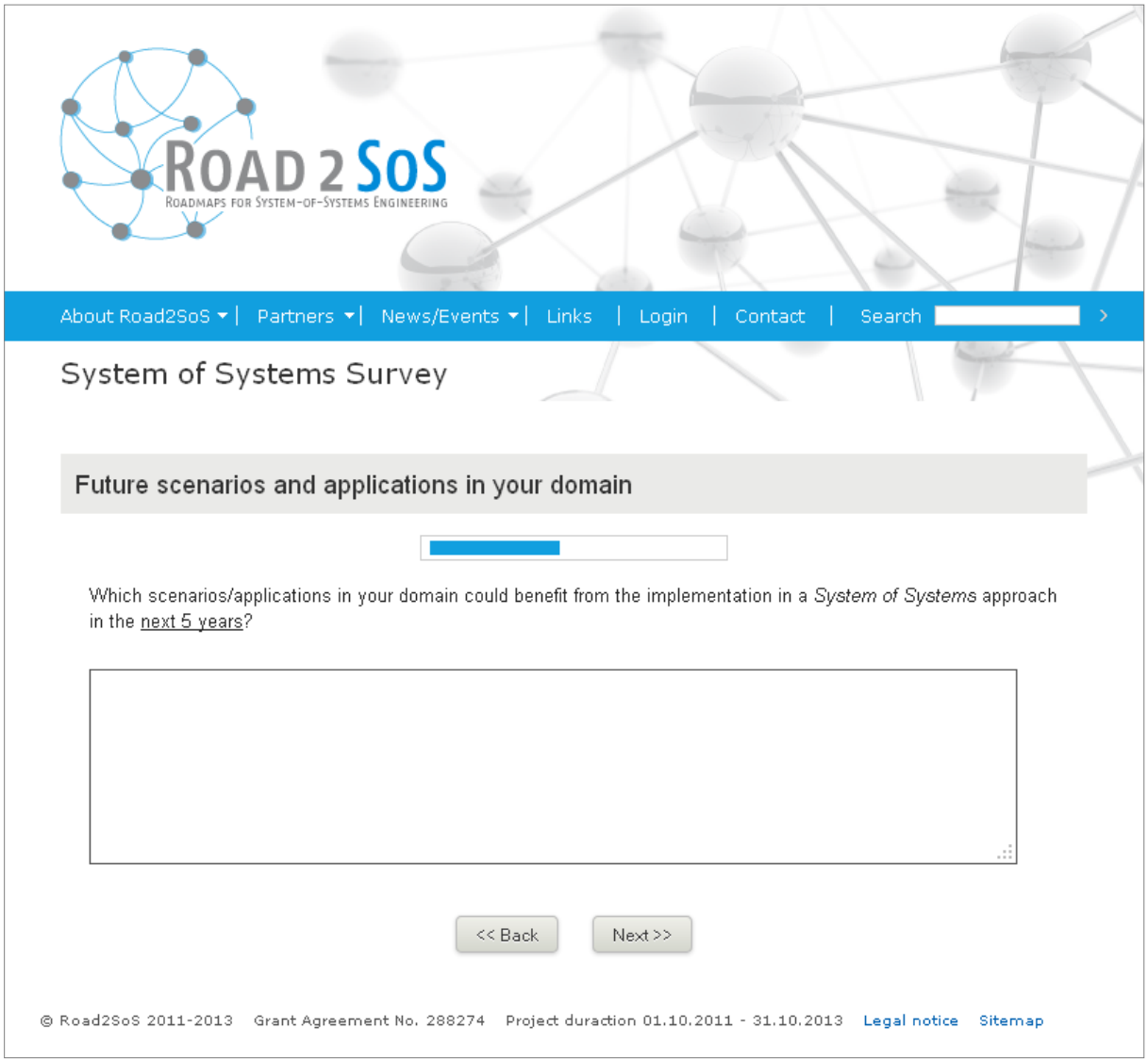
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Future scenarios and applications in your domain
Which scenarios/applications in your domain could benefit from the implementation in a System of Systems approach in the next 5 years?
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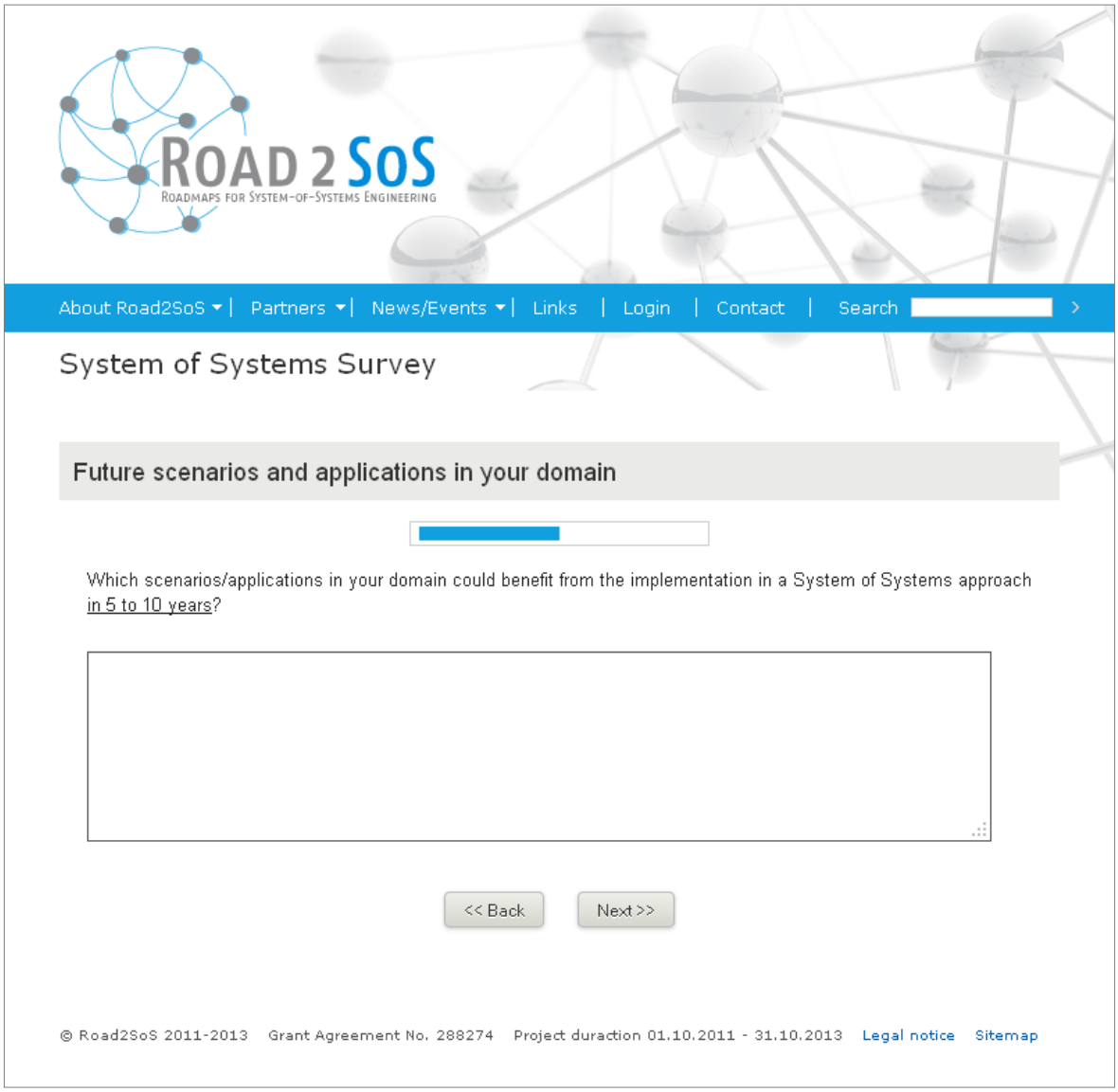
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Future scenarios and applications in your domain
Which scenarios/applications in your domain could benefit from the implementation in a System of Systems approach in 5 to 10 years?
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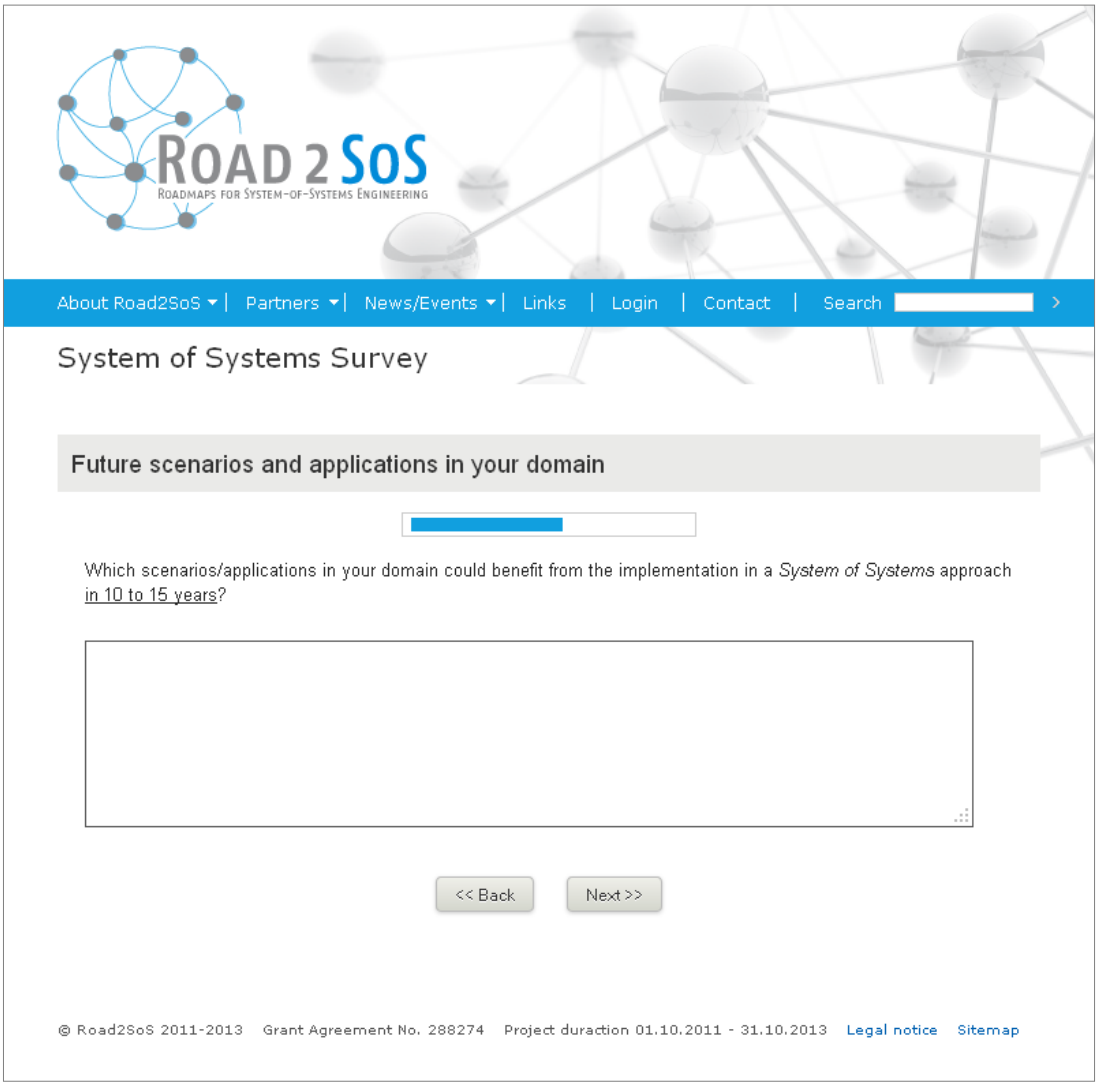
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Future scenarios and applications in your domain
Which scenarios/applications in your domain could benefit from the implementation in a System of Systems approach in 10 to 15 years?
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System of Systems Survey

Identification of the most pressing IT & technological challenges

In the following list of IT and technological challenges, please tick those you consider to be of greatest importance for a *System of Systems* approach to be sucessfully implemented in your domain.

Please tick five boxes.

- [ ] Reference designs and architectures
- [ ] Reference implementations
- [ ] Standards development
- [ ] Compatibility of new and legacy systems
- [ ] Reusability of systems/components/software
- [ ] Expandability of systems/components
- [ ] Seamless integration of systems/components
- [ ] Suitable protocols and interfaces
- [ ] Self-configuration
- [ ] Self-organization
- [ ] Self-healing
- [ ] Self-protection
- [ ] Networking capabilities, data transfer, data rate, response time, availability
- [ ] Efficient handling of big data
- [ ] Real time capability
- [ ] Efficient energy management
- [ ] Miniaturization
- [ ] Interfaces to the environment
- [ ] Interfaces to the internet
- [ ] Suitable interactions interfaces (human machine interfaces), user software,
- [ ] Safety of the system (dependability, robustness, reliability, stability)
- [ ] Data security (privacy)
- [ ] Information access management
- [ ] Certification, quality control
- [ ] Spatially dispersed systems
- [ ] Temporally dispersed systems
- [ ] Other (please specify)

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System of Systems Survey

Social barriers to the implementation of Systems of Systems approaches

Please indicate to what extent you consider the following social aspects as being potential barriers to implementing a *System of Systems* approach.

	Not likely to be a barrier 1	2	3	4	Highly likely to be a barrier 5	No answer
Lingual and cultural differences in global networks	○	○	○	○	○	○
Lack of public acceptance	○	○	○	○	○	○
Lack of organizational acceptance (e.g. resistance to innovation)	○	○	○	○	○	○
Concerns about system stability and failures	○	○	○	○	○	○
Concerns about false information conveyed by the system	○	○	○	○	○	○
Concerns about security and privacy	○	○	○	○	○	○
General preference for centralized, hierarchical systems	○	○	○	○	○	○
Lack of availability of skilled personnel	○	○	○	○	○	○

Can you think of any further aspects?

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System of Systems Survey

Economic barriers to the implementation of Systems of Systems approaches

Please indicate to what extent you consider the following economic aspects as being potential barriers to implementing a *System of Systems* approach.

	Not likely to be a barrier 1	2	3	4	Highly likely to be a barrier 5	No answer
Risk-benefit ratio unclear	○	○	○	○	○	○
Time to market too long or unclear	○	○	○	○	○	○
Uncertain demand	○	○	○	○	○	○
High initial investment	○	○	○	○	○	○
Lack of public funding	○	○	○	○	○	○
Lack of appropriate business models	○	○	○	○	○	○
Individual action is highly risk fraught	○	○	○	○	○	○
Absence of demonstration / technology and approach insufficiently tested	○	○	○	○	○	○

Can you think of any further aspects?

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Political and legal barriers to the implementation of Systems of Systems approaches

Please indicate to what extent you consider the following political and legal aspects as being potential barriers to implementing a *System of Systems* approach.

	Not likely to be a barrier 1	2	3	4	Highly likely to be a barrier 5	No answer
Intellectual property issues	○	○	○	○	○	○
Problems related to multiple ownership	○	○	○	○	○	○
Antitrust policies hindering cooperation of companies establishing System of Systems implementations	○	○	○	○	○	○
Certification	○	○	○	○	○	○
Regulartory issues	○	○	○	○	○	○
Software licensing	○	○	○	○	○	○

Can you think of any further aspects?

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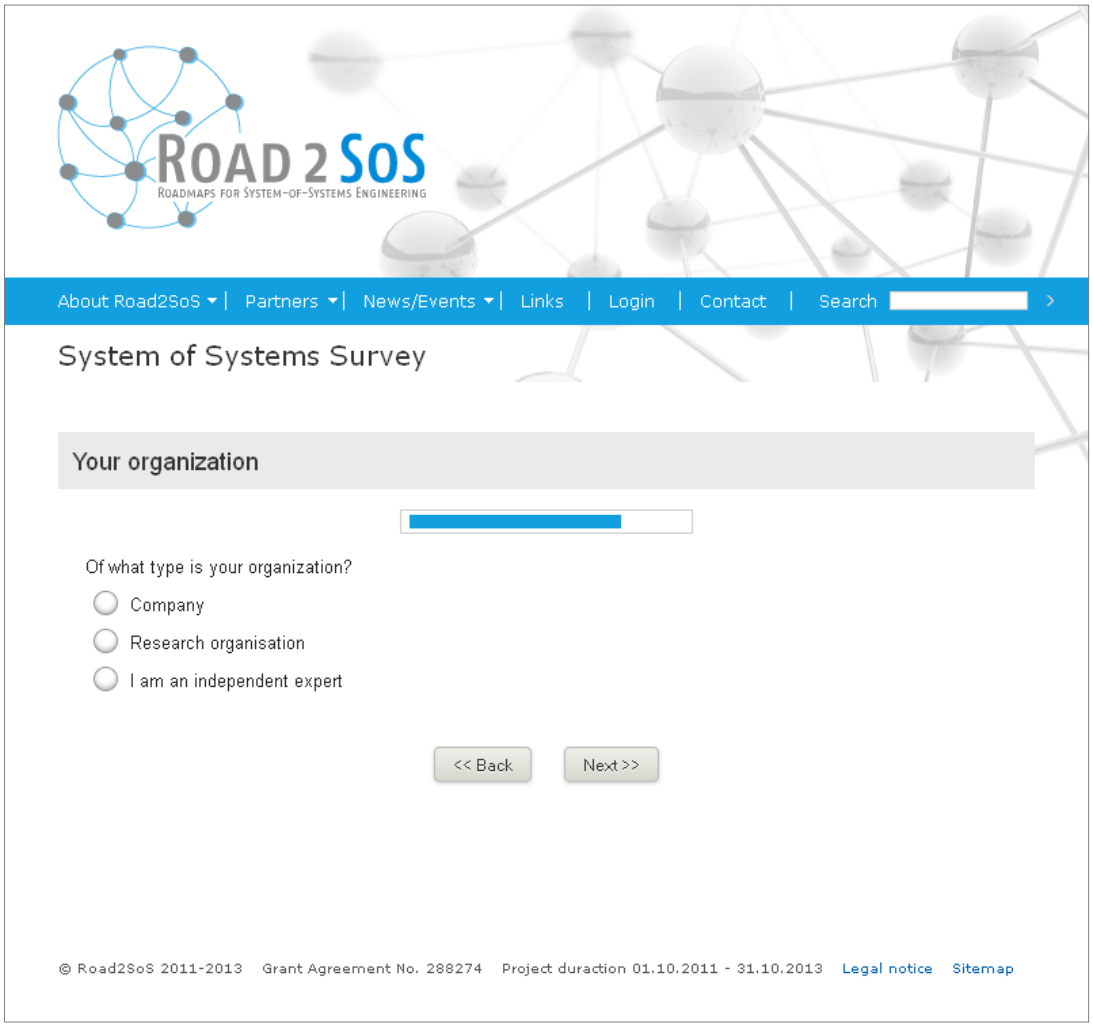
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Your organization
Of what type is your organization?
Company
Research organisation
I am an independent expert
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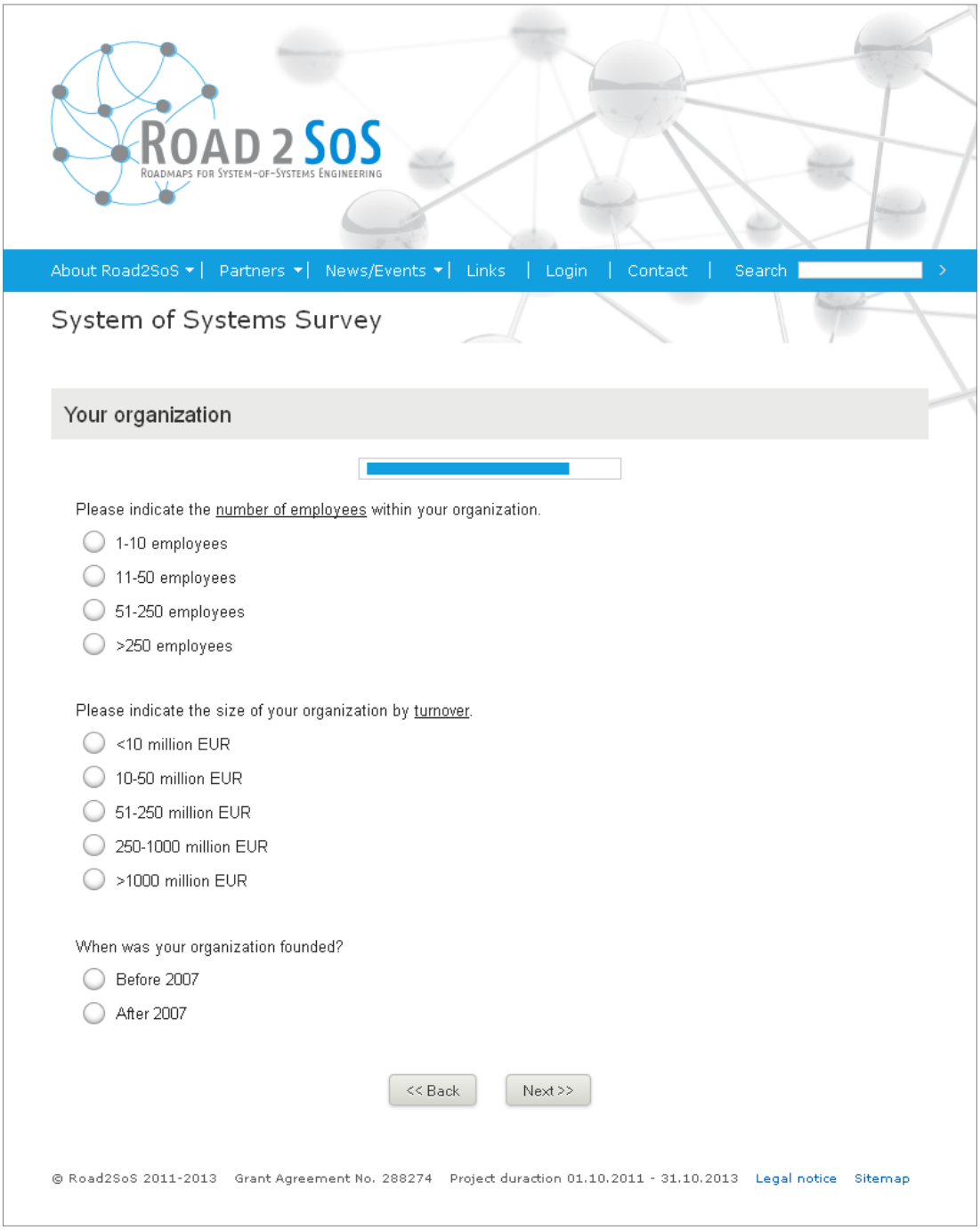

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Your organization

Please indicate the number of employees within your organization.

- 1-10 employees
- 11-50 employees
- 51-250 employees
- >250 employees

Please indicate the size of your organization by turnover.

- <10 million EUR
- 10-50 million EUR
- 51-250 million EUR
- 250-1000 million EUR
- >1000 million EUR

When was your organization founded?

- Before 2007
- After 2007

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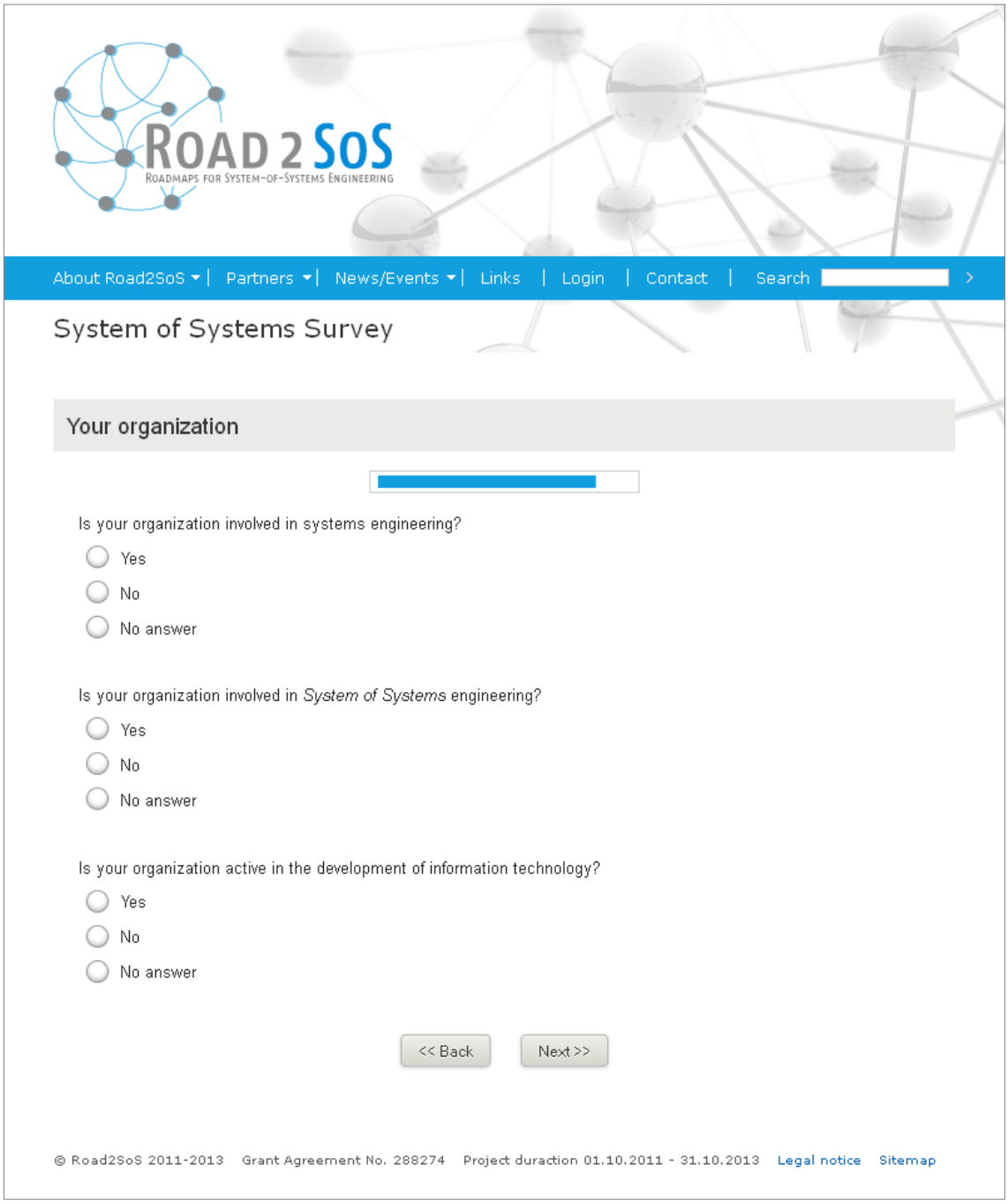

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Your organization

Is your organization involved in systems engineering?

- Yes
- No
- No answer

Is your organization involved in *System of Systems* engineering?

- Yes
- No
- No answer

Is your organization active in the development of information technology?

- Yes
- No
- No answer

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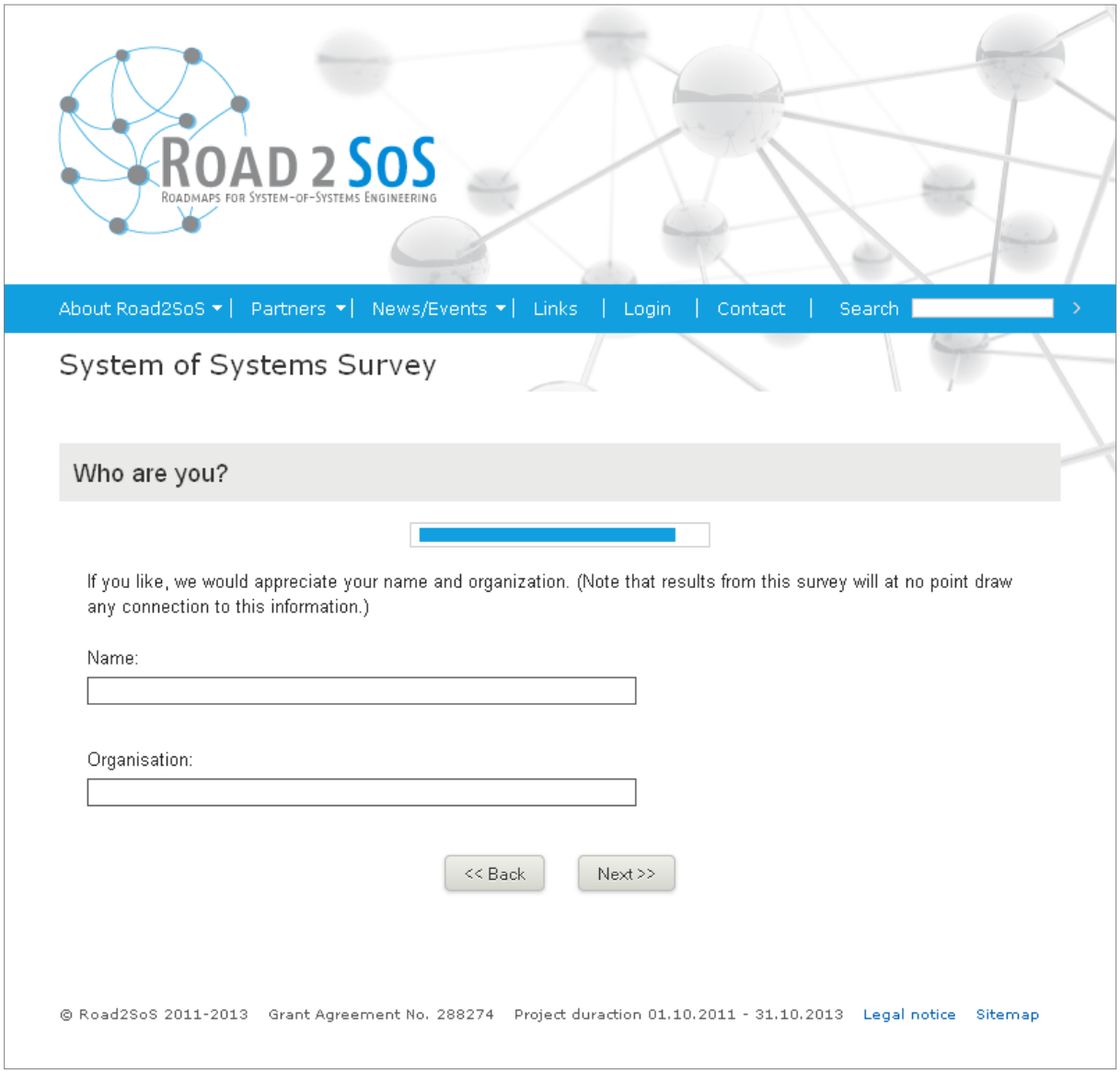
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Who are you?
If you like, we would appreciate your name and organization. (Note that results from this survey will at no point draw any connection to this information.)
Name:
Organisation:
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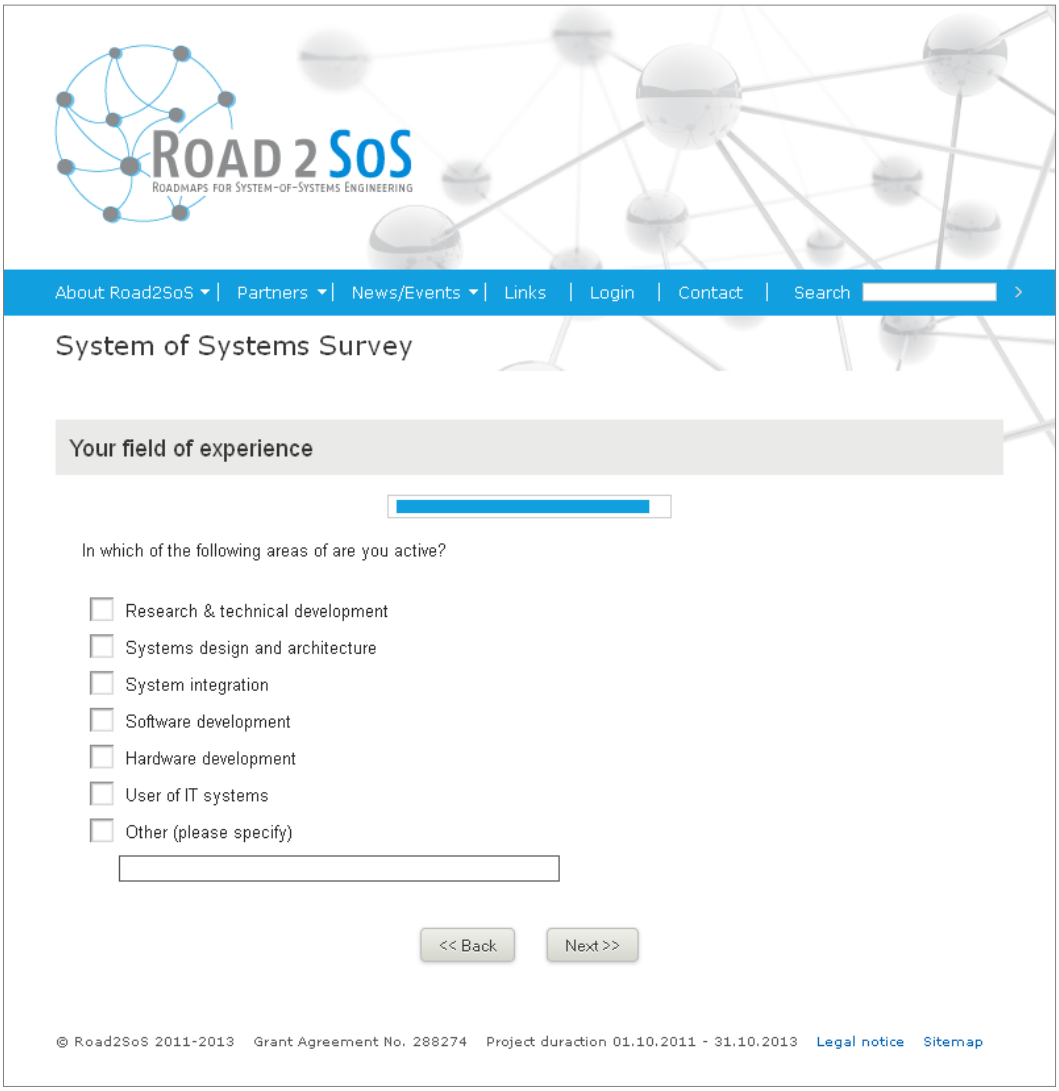
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Your field of experience
In which of the following areas of are you active?
Research & technical development
Systems design and architecture
System integration
Software development
Hardware development
User of IT systems
Other (please specify)
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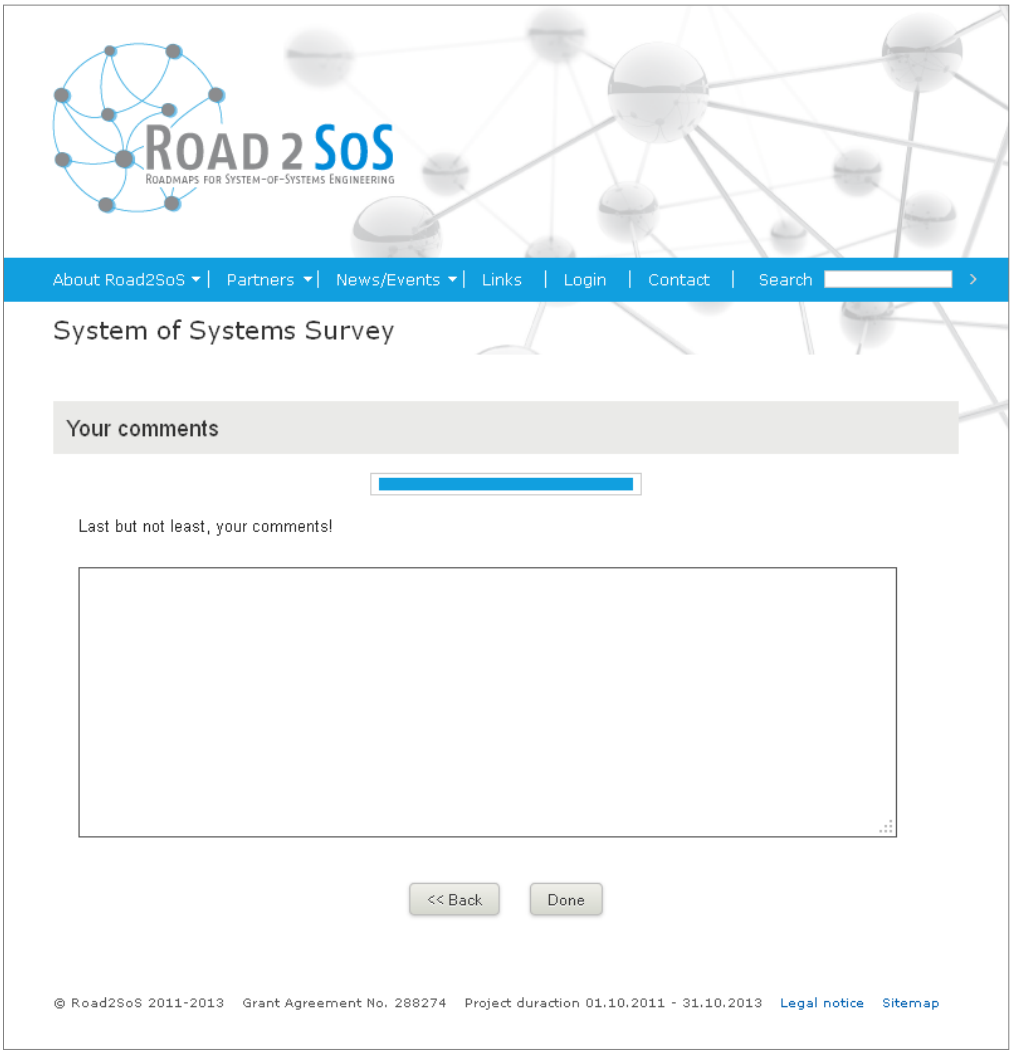
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Your comments
Last but not least, your comments!
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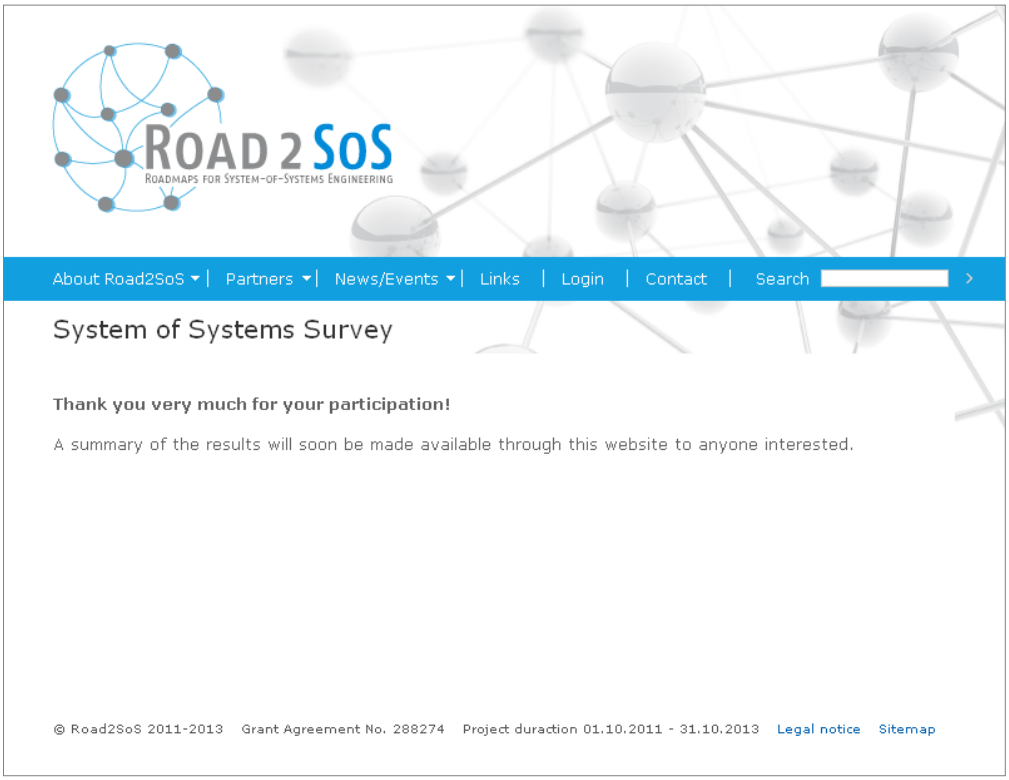
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Thank you very much for your participation!
A summary of the results will soon be made available through this website to anyone interested.
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