Before filling out the full proposal application form you are requested to read the 'Explanation to the full proposal application form' which can be found on the NWO website or via the tab page 'documents' in ISAAC.

GENERAL INFORMATION

1. Main applicant

Main applicant: Prof.dr.ir. Alexander Verbraeck, TU Delft
Preference for correspondence in English: yes

2. Title of the proposal

Transport Self Organization through Network Integration and Collaboration (Trans-SONIC)

3. Summary of the proposed research *(max 250 words)* **Word count:** 222

This project will research the technical and organizational blockers and enablers, and their interaction, for providing integrated seamless multimodal transport services in the Netherlands. In such a system, a network of interdependent actors –on different transport modalities– have to work together and adapt in real time to changing demands of freight forwarders and shippers as well as changing availability of infrastructure and assets. We will research whether such services can emerge from the combination of social interactions between transport network organizations and novel, but already existing, technologies for sensing and for information exchange between partners. For the social interaction, simulation and gaming will be used as the main research instrument to study inter-organizational interactions as well as intervention and reward mechanisms that would lead to new types of services. Two issues play a central role in the research: lack of situational awareness about the current state of the system, and the low level of trust between transport partners Both are known to be major blockers for organizing multimodal or synchromodal transport. The project will therefore study the effects of utilizing sensor technology and new ways of information exchange between parties to (partly) overcome these issues. To develop and test the technological and organizational solutions, and their integration, a combination of simulation, gaming, data analysis and case studies in industry will be conducted.

4. Public summary *(max 50 words each)* **Word counts:** 49/47

English: The Trans-SONIC project will develop and test technological and organizational solutions for setting-up integrated, seamless multimodal transport services. These services are key for delivering goods between mainports and the hinterland in a sustainable way. Core innovations that will be researched are sensor and interaction technologies and incentives for self-organization.

Dutch: Het Trans-SONIC project richt zich op het ontwikkelen van technologische en organisatorische oplossingen voor het opzetten van geïntegreerde multimodale transportoplossingen, die noodzakelijk zijn om goederen duurzaam tussen mainports en achterland te vervoeren. Het project bestudeert het effect van nieuwe sensor- en interactietechnologieën en van incentives voor zelforganisatie.

5. Discipline code(s)

Main discipline	**40.50.00 Social and Organizational Psychology**
Other discipline(s)*	**16.20.00 Software, algorithms, control systems** **16.80.00 Computer Simulation** **11.70.00 Operations research**

6. Key words *(Max. 5)*

1) Transport
2) Self-Organisation
3) Situational Awareness
4) Network
5) Emergence

RESEARCH PROPOSAL

7. Description of the proposed research *(max 5000 words / 10 pages)* **Word count:** 3730

In the last two decades, the main European seaports have experienced a considerable increase in their container throughput (Notteboom & Rodrigue, 2009). Although this trend is significantly influenced by the financial crisis of 2009-2010, the growth in the container ports' throughput has been resumed afterwards to reach 651 million TEU in 2013, which is 5.58% higher than the global container throughput in 2012 (Rodrigue & Notteboom, 2013). As cargo volume continues to grow, inland transportation and hinterland accessibility are increasingly key factors. At the same time, growing environmental problems and congestion on many road networks calls for innovative solutions to further shift freight transport from roads to water and rail. At the same time, the efficient use of existing transportation capacity is crucial and is often less-costly comparing to new investments in capacity for hinterland transport. An **integrated self-organizing multimodal transport system** looks like a promising solution in this regard (Choi et al., 2001), as it relies on the power to regulate and stimulate itself. Self-organization in this sense means that the system – which includes a network of transport and transhipment service providers – is able to detect the changes and adapt the separated social and technical components into joined or integrated components (Helbing et al., 2009). This integrated service provision is a main element in a synchromodal freight transport system, considered as a spearhead in the top sector Logistics. Synchromodality is "the optimally flexible and sustainable deployment of different modes of transport in a network under the direction of a logistics service provider, so that the customer (shipper or forwarder) is offered an integrated solution for his (inland) transport"[1] (Tavasszy et al., 2015). This integrated multimodal transport system offers opportunities to benefit from the strengths of the various transport modes while avoiding their weaknesses. Of course, this integration would lead to a complex, interwoven, multi-level, multi-objective, and dynamic 'system of systems', in which technological systems as well as societal, financial, institutional, and legal systems interact (Helbing, 2012; Ulieru & Este, 2004). The system's functionality (for example the service level, flexibility, reliability, and robustness) emerges from the behaviour of individual components - both social and physical (e.g., smart containers, transport operators, etc.) - and their **interactions** at the micro-level (Holland, 1996). The emergent behaviour of this integrated system arises without any external influence but it is the result of interactions of local autonomous decision makers (Finnigan, 2005). This self-organization (Kauffman, 1993), self-governance (Berkes, 2006) or distributed decision making (Schneeweiss, 2003) is the main driving factor behind the operation and performance of an integrated multimodal transport system. A sustainable **transition from currently-fragmented** intermodal transport to an **integrated** (synchromodal) transport system calls for in-depth analysis of this self-organization and exploring the mechanisms to steer the self-organizing emergent behaviour in an intermodal Freight Transport system.

Considering the socio-technical nature of its complexity, the self-organization in intermodal transport can be studied from three different perspectives (see Fig. 1):

[1] http://www.synchromodaliteit.nl/nl/definitie/

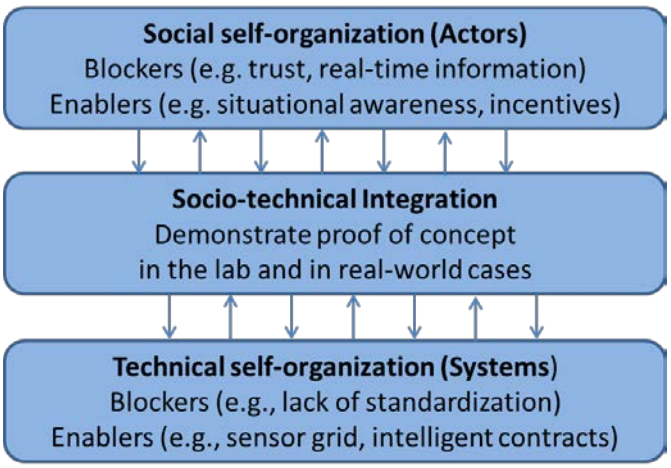

Fig 1. Three perspectives on self-organization in an Intermodal Freight Transport system

1) **Social self-organization** is about the collaboration between actors, for example, in a Synchromodal Community (Behdani et al, 2016). These actors – which include service providers, transport operators, and freight forwarders – have to work together. Their collaboration determines the overall performance of the network (Meyer, Campbell, Leach, & Coogan, 2005). Managing a transportation system in the most efficient and effective way means to maximize opportunities and revenue, committing to service providers, exploring investments from the perspective of mobility enhancement, and using designated information systems. Collaboration in the transportation system is not self-evident, mainly because of a high level of competition between the actors involved. Collaboration requires awareness for and understanding of the need for it, a need that should be clearly articulated (Meyer et al., 2005). In many cases, overcoming the hurdle of deciding that collaboration will benefit the own organization is a huge challenge already. As a result, incentives for self-organization are lacking. Even worse, the fragmentation in the multimodal transportation network asks for extra steps and extra processes to organize it, thereby asking for extra layers of information collecting, information provision, planning, and control. Many organizations earn money by not sharing their information with others, thereby blocking a better organization of the transport network. **Incentives** for **self-organization** will have to be created to overcome this problem. For this purpose, simulations and games will be developed as inclusive tools, highlighting the issues in the current transport system, and enabling actors to experience possible integrated, self-organizing synchromodal transport approaches. Such tools provide immediate feedback of decisions, e.g. changes to a different transport modality, and actions, e.g. a synchromodal transhipment of goods, to the actors. Based on simulated self-organization, actors are enabled to develop new approaches towards seamless intermodal freight-transportation. This asks for the development of agent-based simulation models (Macal & North, 2010) and games (Lukosch et al., 2016a, 2016b) that can be used to develop, test, and share possible network configurations, and discuss these with partners in the network (Veenstra et al., 2015; Veenstra & Zuidwijk, 2016). From the social perspective in the project, requirements will be posed for technological solutions that will be addressed in the technological perspective. Two of these requirements are already known, and will be used as a starting point in the project: overcoming lack of situational awareness by transport partners, and overcoming lack of trust between partners. The lack of situational awareness hampers self-organization: if the current state of the transport network is not known, partners are not able to proactively react on changes and disturbances. The lack of trust between partners also inhibits self-organization: withholding information from others and not providing early access to key data does not allow others to help overcome problems and keeps the system far away from optimal performance. Trust can be considered as “goodwill and reliability of and between partners of a cooperation” (Cummings & Bromiley, 1996). Moreover, trust has to be developed in a risky environment, where reluctance to accept risks exists (Meyer et al., 2005). The existence, or at least the feeling of power imbalances can also work negatively towards the development of trust in each other, and thus work counter-productive towards ‘true’ collaboration.

2) **Technical self-organization** is about smart and intelligent cargo and assets, as well as providing novel ways for technological partners to interact with each other. A pre-requisite for synchromodality is a flexible, shared, and comprehensive ICT layer to assign the best available service based on actual circumstances, e.g., traffic information and real-time availability of modalities (Hofman, 2014; Behdani,

et al., 2016). This ICT layer firstly supports a network operator to make real-time adjustments to handle an unexpected event, such as the late arrival of barges, order cancellations, or the late releasing of containers (Hülsmann et al., 2008). However, in the long-term the vision is going towards a **self-organizing intelligent transport** network – which is also a main enabler for the Physical Internet (Tavasszy et al., 2015). When locations of the goods and the available capacities of different modalities are made available in the actor network, it is expected that a new dynamics can emerge in which services can be offered that allow for seamless integration of transport and transhipment of the goods over multiple nodes and links in the network (Pathak et al., 2007; Venkatasubramanian et al., 2004). In addition, partners need to be able to share this information in a way where the trust issues can be overcome. Some examples of problems that have surfaced: sharing information about disturbances can be seen as negative by partners; sharing information about spare capacity can be misunderstood as a business problem; sharing price information can be used by competitors to offer better deals; sharing customer data can be misused to steal clients; etc.. To enable self-organization, a safe and secure way of communicating is needed where key information is exchanged to support a better organization of the network, without providing full access to all data (Poirier & Bauer, 2000). The project will research how new technologies like smart contracts (Kosba et al., 2016) can be used here to overcome this problem. The Trans-SONIC project will focus as much as possible in existing, yet innovative (information and communication) technologies. When organizations in the transport network would be enabled to use information made available by new technologies, it is expected that new service providers, harvesting new types of data and making new types information available as a service, will emerge. In that sense, the technological system will also self-evolve. The use and effects of new technologies on the self-organization of the technological system can be researched and evaluated with the use of simulations and games.

3) **Interaction between the social and technological self-organization**. Neither social self-organization, nor technological self-organization will address the problem fully. Social self-organization in this domain is fully dependent on situational awareness (e.g., provided by sensor fusion) and new ways of exchanging information that can overcome the trust barrier (e.g., provided by smart contracts). Unfortunately the problem of trust shifts when applying these solutions: instead of not trusting other partners, the question now becomes whether the organizations trust the technology itself. Demonstrations, simulations, games, and real-world cases are necessary to demonstrate and research with transportation partners whether and how these new technologies can help the partners in the network to effectively and efficiently (re)organize themselves to address challenges and uncertainties. Similarly, the implementation of the technological solutions is totally dependent on the requirements that the organizations pose for them. As technologies like sensor fusion and smart contracts (for example) are unknown to transport organizations, the requirements to successfully implement these in the system are also unknown. A technology push approach will certainly fail here (there is a very true saying: "unknown, unloved"...). An application pull does not work either: it is very hard to pose requirements for an unknown solution. Therefore, the only way forward is a tight interaction between the technological developments (creating simulations and proof-of-concept implementations of parts of the technology as demonstrators) and the self-organization from a social perspective (games to research new ways of working could provide clear indications like "in order to do X we would need to know Y"). This iterative approach, close to the transport clients, will be supported by simulations, games, workshops and case studies in the field.

a. Research questions

This is all comprised in the main research question:

> *Main question: What technological and social innovations enable self-organization to provide integrated, seamless multimodal transport services?*

This overarching question can be broken down into a number of sub-questions. Each of these will be addressed by a separate researcher, and by a part of the research consortium.

> *Sub-question 1: What are the main barriers and enablers from a social perspective for self-organization in a large multi-modal transport network involving multiple transport operators, asset owners and service providers?*

The first question within the project is to find the blockers and enablers for self-organization in complex multi-modal transport networks. From earlier research we already know that lack of situational awareness and lack of trust play a major role, but the root causes for these issues need to be researched further to address the root causes in this project rather than providing solutions that only scratch the surface. It is expected that lack of situational awareness and lack of trust for information exchange will

be researched as key blockers for social self-organization. PhD student 1 will focus on the first research question.

> *Sub-question 2: What are the main barriers and enablers from a technological perspective for self-organization in a large multi-modal transport network involving multiple transport operators, asset owners and service providers?*

The second question relates to the use of novel, but existing, technologies to overcome situational awareness and trust issues in the transport network. Examples are smart contracts and sensor networks, but potentially there are more. Issues that will be addressed in this part of the research are for instance: Which technologies are the main candidates to overcome issues as identified in research question 1? Which types of new service providers would emerge in the transport network if these technologies are used? What happens if these service providers start to compete and further fragmentation takes place? How can we overcome these problems? PhD student 2 will focus on research question 2.

> *Sub-question 3: Do new technologies such as sensor fusion and smart contracts, combined with social innovations such as new types of incentives and service providers for situational awareness, enable efficient self-organization in transport networks?*

The third research question addresses the relationship between the technological self-organization and the social self-organization, and studies the interaction between the technological and social perspectives on the research. A PostDoc who will start in year 2 when the first results of the research are known will address this research question.

In case the project will be awarded, TNO will seek funding with additional partners to answer a fourth research question for the proposal, which is an extension on RQ2. Note that RQ2 can be carried out independently of RQ4 in case TNO does not acquire the required co-funding or decides not to participate with a strategic budget in the project (see also the section on the motivation for the project budget).

> *Sub-question 4: How can block chain technology using data and smart contracts help to enable self-organization in transport networks?*

The fourth and final question relates to the use of block chain-technology to overcome trust issues in the transport network, especially relating to smart contracts running on block chain(s). One of the more socio-economic questions is what data one is willing to store in a block chain and what conditions have to be met to store this data. Another is the impact on behavior of individual actors with transparency of data. Block chain thus does not address all barriers, but overcomes the major technical ones, in case semantics of data for smart contracts is common in the chain. There are four different aspects that need to be researched in this project for the block chain, namely:

1. Robustness of smart contracts: currently, smart contracts are directly implemented. They may still have bugs, leading to weak spots in the complete block chain approach.
2. Smart contracts, their semantics and operations: robustness of block chains and easy configuration of (semantics) of smart contracts, potentially with standardized operations.
3. Consensus algorithms: support of different bundling strategies, optimization of process synchronization at hubs and corridors, etc.
4. Mining and business models: identifying the stakeholders trusted by all participants, where these stakeholders apply the consensus algorithms. These can be government agencies, port systems, etc.
5. Implementation architecture of block chains: although block chains are completely distributed databases, all (potential millions of) nodes always require not all logistics data and distributing all data would rapidly increase the Internet load. Innovative implementation architecture(s) are required.

TNO will focus on research question 4, in close co-operation with the PhD student who addresses RQ2, and new project partners for the proposal, including TransFollow and Portbase.

b. Objectives and Deliverables

A first objective of the project is to explore the (socio-technical) conditions for developing integrated self-organizing multimodal transport system. We also demonstrate the **potential effects of new technologies** on the ability to (self) organize the transport network. Project partners WUR, EUR, TUD and TNO will provide simulations that demonstrate the effect of real-time sensor fusion and information exchange on situational awareness of transport partners. The positive effects of real-time information for the ability to (self-)organize logistics have already been shown to work in supply chains (Boyson et al., 2004; Harrington et al., 2011), and are applied in this project to transportation networks. Smart

contracts can be used to share information and strategies, and to optimize the transport network in real time. Partners TNO and TransFollow will provide proof-of-concept implementations that can serve as a starting point for further rollout of the technology.

We further demonstrate the **ability to self-organize** a transport network in two case studies. One case study will be carried out in the Amsterdam region with the Port of Amsterdam, and the other case study will be carried out with SmartPort for the hinterland of the Port of Rotterdam. Data from many earlier studies is available, see e.g. Zhang & Pel (2016a, 2016b), and real-time data will be made available by project partner ECORYS on the basis of their Links database that will be available to the project partners for the duration of the project. Project partners TUD, EUR and TNO have good access to data in the Rotterdam region. The Port of Amsterdam and SmartPort can provide access to data for the agent-based simulations and organizations to participate in the gaming sessions. Data availability in the Amsterdam region benefits very much from the AMS initiative in which project partners TUD and WUR participate. Additionally, the TKI/Dinalog SynchroGaming project that is carried out by, amongst others, TUD and TNO, provides direct access to input from multimodal hinterland transportation from both the Amsterdam and Rotterdam ports. The gaming experience that is used to test the ability to self-organize is provided by TUD, supported by the other partners in the consortium. The games developed will be made available during and after the project for others to experience self-organization in transport networks.

The interaction between the different aspects of the project is illustrated in Fig. 2.

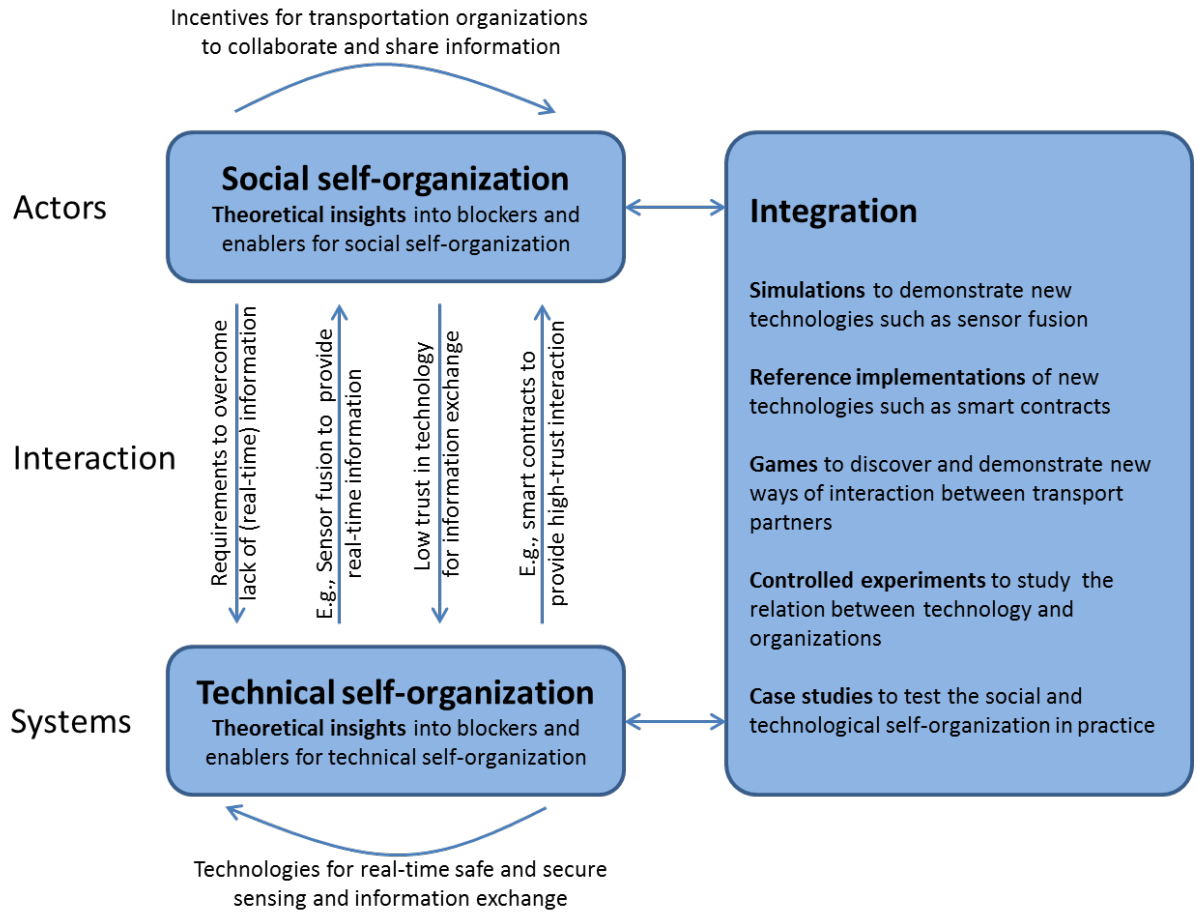

Fig. 2. Interaction between different aspects of the Trans-SONIC project

c. Methodology

The project will use a rich set of research methods to answer the research questions. PhD student 1, answering RQ1, the social science research question, will use a mixed methods approach where both games (as a research instrument) and controlled experiments will be used to answer the question under

which conditions social self-organization in transport networks will take place. PhD student 2 (RQ2) and TNO (RQ4) will rely more on simulations and reference implementations of new technology to test the implementations under controlled conditions. The postdoc addressing RQ3 will use in-depth case studies with project partners that will be proposed by Port of Amsterdam and SmartPort.

d. Project structure

The project includes 2 PhD students and 1 Postdoc, as well as researchers from the knowledge partners. Each of the PhDs will focus on one aspect of the self-organization; the Postdoc research will study the alignment between the social subsystem and the technological subsystem, and thereby help in the integration of the research of these two PhDs. TNO will address RQ4 from a more practical point of view, closely aligning with PhD student 2, EUR, and TransFollow.

SmartPort (Rotterdam) and Port of Amsterdam will help to seek partners in the hinterland transportation network who will participate in game sessions and case studies. A network of interested partners will be formed in Year 1 of the project. Participants in previous projects of the knowledge partners (SALOMO, IDVV, SynchroGaming, etc.) will also be approached to participate in the network.

e. Valorization and knowledge utilization

The project aims at providing working versions and **reference implementations** of software, which will be made available for companies to use. The partners in the project will be the first ones to benefit from the newly developed solutions, but these will not be exclusive.

The project is also expected to generate extensive **scientific insights** into self-organization. Publications in journals, conference presentations, and PhD theses will help in the knowledge dissemination.

The **game sessions** that will be organized as part of RQ1 and the **case studies** that are part of RQ3, will allow the project participants to disseminate the knowledge to a wide set of partners. When partners are interested in adopting the technology, the reference implementations will help them to quickly utilize the deliverables from the Trans-SONIC project. TransFollow will play an important role here for the "smart contract" aspect of the project.

f. Relation with other projects

The Trans-SONIC research project will build on a number of initiatives and projects that have been carried out in recent years, or that are currently running:

Get-Service EU project. This project (led by TUE) worked with several partners along different corridors to study possibilities for better organization of multi-modal transport with the availability of real-time information. ICT solutions provided by this project will be used as a basis for the technical self-organization.

IDVV. Work package 3.4 and 3.5 of the IDVV project studied collaborative approaches for transport organization for container transport via inland waterways. Project partners TNO/TUD created the simulations and carried out the gaming sessions.

Salomo. Supported by Dinalog, in which the complex system of a container terminal as crucial node in the supply chain has been studied. Several systems have been developed by TUD and its project partners, such as a risk identification tool, a safety game, and a number of Microgames, to increase awareness and support actors in the complex system.

Ultimate, supported by Dinalog, in which project partner EUR participated, studied the concept of an extended gate to streamline hinterland transportation.

Synchro-Gaming. This project (led by TNO) from TKI-Logistics in which project partners TUD and SmartPort (a.o.) participate for developing simulation and gaming looks at the network infrastructure provider level (Ports, RWS, ProRail) in relation to the possibility to provide intermodal transport services on top of these infrastructures.

The Trans-SONIC project will build on top of these earlier projects but use a completely different approach. Instead of designing solutions for ICT (Get-Service), focus on the network and developments of the network over the next decades (Ultimate, Synchro Gaming), focus on one modality at a time

(IDVV), or focus on the Port system only (Salomo), Trans-SONIC will study the ability for the transport system to self-organize, and under which conditions and supported by which technologies a seamless multi-modal transport system emerges. This will be tested in two case studies for two port regions with their hinterland connections. Furthermore, reference implementations of the developed technologies as well as the simulation and games used to design and study social self-organization will be handed over as deliverables of the project.

g. Connections to Topsector Logistics Roadmap

The aim of this project is to strengthen the competitive position of the business community, and the Netherlands in the global supply chains by supporting the development of an integrated seamless multimodal transport system. Therefore, there is a strong connection with synchromodality and service logistics in Topsector Logistics Roadmap. Furthermore, the project supports the development of Cross Chain Control Centres (4C); chains jointly coordinated and orchestrated with the latest technology and software concepts and the new schemes for cooperation.

8. Planning of the proposed research

Envisaged start date: 1-1-2017

Envisaged end date: 31-12-2021

9. Work plan of the proposed research

The research phasing will be as follows:

Year	PhD student 1: social (RQ 1)	PhD student 2: technical (RQ 2)	PostDoc: Integration (RQ 3)	TNO (with partners) (RQ 4)
1	Literature study and interviews on blockers and enablers for social self-organization	Literature study and interviews on blockers and enablers for technical self-organization		Developing prototypes of block chains and smart contracts for logistics use cases
2	Organizing game-supported workshops with stakeholders for in-depth analyse of blockers and enablers	Creating agent-based simulation models to study the effect of information provision on self-organization	Setting up case studies for the Port of Rotterdam and Port of Amsterdam networks	Analysing and developing capabilities of generating smart contracts: semantics and operations
3	Developing supportive actions and determining do's and don'ts for social-self organization	Developing principles and requirements for information provision to enable technical self-organization	Case-studies in Amsterdam region and Rotterdam region with project partners to test the developed approaches	Analysing and developing data governance issues: selectively making data available to others using block chains
4	Feedback of findings of case studies in game-supported workshops to stakeholders; writing dissertation	Testing of findings of case studies in agent-based simulation models; writing dissertation		Governance structure of block chains for logistics: mining, consensus algorithms, and implementation architecture

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CONSORTIUM

You are requested to include a short CV (1/2 A4) of the main applicant, co-applicant(s) and other consortium members at the end of the application.

11. Main applicant

Name, title(s):	Alexander Verbraeck, Prof.dr.ir	Male
PhD date:	28-11-1991	
Position:	Full professor	
End date contract**:	indefinite	
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Department:	Multi-Actor Systems	
Postal Address:	Jaffalaan 5	
Zipcode/City:	2628 BX Delft	
E-mail	a.verbraeck@tudelft.nl	
Phone:	+31 15 2783805 / +31 6 51089019	
Website:	http://tudelft.nl/averbraeck	

12. Co-applicant(s)*

Name, title(s):	Heide K. Lukosch, dr. rer. soc.	Female
PhD date:	23-10-2008	
Position:	Assistant professor	
End date contract**:	indefinite	
University:	Delft University of Technology	
Department:	Multi-Actor Systems	
Postal Address:	Jaffalaan 5	
Zipcode/City:	2628 BX Delft	
E-mail:	h.k.lukosch@tudelft.nl	
Phone:	+31 15 2783211	
Website:	http://www.tudelft.nl/hklukosch	

Name, title(s):	Behzad Behdani, dr.ir.	Male
PhD date:	22-01-2013	
Position:	Assistant professor	
End date contract**:	19-1-2018	
University:	Wageningen University	
Department:	Social Sciences	
Postal Address:	Hollandseweg 1	
Zipcode/City:	6706 KN Wageningen	
E-mail:	behzad.behdani@wur.nl	
Phone:	+31 317 48 44 60	
Website:	http://www.wur.nl	

Name, title(s):	Rob A. Zuidwijk, prof.dr.	Male
PhD date:	20-10-1994	
Position:	Full professor	
End date contract**:	indefinite	
University:	Erasmus University Rotterdam	
Department:	Rotterdam School of Management	
Postal Address:	Burgemeester Oudlaan 50	
Zipcode/City:	3062 PA Rotterdam	

E-mail:	rzuidwijk@rsm.nl
Phone:	+31 10 408 2235
Website:	http://www.rsm.nl

*Please copy and paste the table for each co-applicant.
** Please note that for each applicant whose contract term is shorter than the duration of the envisaged research a guarantee letter of the employer needs to be uploaded in ISAAC. This letter needs to guarantee the continuity of the research and supervision of the PhD's/post docs/PDEng researchers in case the contract of the person concerned will not be renewed.

13. Other members of the consortium*

Research partners (from other research institutes that are not eligible for NWO funding), private and/or (semi-)public partners, process manager, etc.

Name, title(s):	Wout J. Hofman, PhD	Male
Organization/company	TNO, Technical Sciences – Business and Information Systems	
Discipline/position:	Senior Research Scientist	
Country:	The Netherlands	
Postal Address:	Stieltjesweg 1	
Zipcode/City:	2628 CK Delft	
E-mail:	wout.hofman@tno.nl	
Phone:	+31 6 22 499 890	
Website:	http://www.tno.nl	
Personal website	-	

Name, title(s):	Pim Steenhuis	Male
Organization/company	Port of Amsterdam	
Discipline/position:	Projectmanager Spoorgoederenvervoer en Binnenvaart Marketing & Projectmanagement	
Country:	The Netherlands	
Postal Address:	De Ruijterkade 7	
Zipcode/City:	1013 AA Amsterdam	
E-mail:	pim.steenhuis@portofamsterdam.nl	
Phone:	+31 20 523 4583	
Website:	http://www.portofamsterdam.com	
Personal website	-	

Name, title(s):	Michiel Jak, dr.ir.	Male
Organization/company	SmartPort	
Discipline/position:	Managing Director	
Country:	The Netherlands	
Postal Address:	PO Box 54200	
Zipcode/City:	3008 JE Rotterdam	
E-mail:	smartport@deltalinqs.nl	
Phone:	+31 10 4020343	
Website:	http://smart-port.nl/en/	
Personal website	-	

Name, title(s):	Jeroen Bozuwa	Male
Organization/company	ECORYS / Intermodal Links	
Discipline/position:	Principal Consultant	
Country:	The Netherlands	

Postal Address:	Postbus 4174
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Website:	www.ecorys.com / www.intermodallinks.com
Personal website	-

Name, title(s):	Rene Bruijne	Male
Organization/company	TransFollow	
Discipline/position:	Chairman	
Country:	The Netherlands	
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Zipcode/City:	2490 AA Den Haag	
E-mail:	info@TransFollow.org	
Phone:	+31 88 55 22 164	
Website:	https://www.transfollow.nl/	
Personal website	-	

*Please copy and paste the table for each consortium member

14. Description of the consortium *(max 500 words)* **Word count:** 219

The research parties in this project (TUD, WUR and EUR) all three have extended experience with multi-modal transportation, and a track record of earlier projects in which transport organization has been addressed. The project balances social sciences / organization on the one hand and ICT / engineering on the other hand, and key researchers in the project come from a social science background as well as from a technical background. The model methods used (simulation, gaming, case studies) have been extensively applied in earlier projects by the project partners. Examples are SALOMO, Synchro-Gaming, IDVV, and Ultimate. TNO has been approached to help with the ICT services that are needed to provide real-time insight into the status of the transport network, transport means, and goods. The consortium is complemented by a number of industry partners who have expressed their willingness to help with the challenges from an application perspective. SmartPort, bringing together the partners in the Port of Rotterdam, provides an excellent network in the Rotterdam Port region and its hinterland connections, whereas The Port of Amsterdam provides an excellent network and a wealth of data in the Amsterdam region. Real-time data to feed the simulations and games is made available by ECORYS through their Links database. Thereby, we have access to both partners and data through the consortium composition.

15. Supervision

Please indicate who will act as supervisor(s) for the requested PhD students/PDEng trainees/post docs.

Requested position	Supervisor(s)
PhD 1 (social)	Dr. H.K. Lukosch & Prof.dr.ir. A. Verbraeck
PhD 2 (technical)	Prof.dr. R.A. Zuidwijk
PostDoc (integration)	Dr. B. Behdani

FINANCIAL DETAILS

16. Project budget

STAFF COSTS

A) Funding requested from NWO (A1)				B) Co-financing from consortium partners (B1)			
Description	**fte**	**# months**	**Amount (€)**	**Name partner**	**in kind**	**cash**	**Amount (€)**
PhD 4 years	1	48	189,201	*SmartPort*		20,000	20,000
PhD 4 years	1	48	143,201	*TransFollow*		66,000	66,000
PostDoc 2 years	1	24	137,042				
Total A1 (Staff costs)			**469,444**	**Total B1 (Staff costs)**			**86,000**

BENCHFEE

Allocated by NWO (A2)		*Not applicable*
PhDs: *number* x €5.000	10,000	
PDEng: *number* x € 5.000		
Postdocs: *number* x € 5.000	5,000	
Total A2 (Bench Fee)	**15,000**	

MATERIAL COSTS

Funding requested from NWO (A3)		Co-financing of consortium partners (B3)			
Description	**Amount (€)**	**Name partner**	**in kind**	**cash**	**Amount (€)**
Gaming sessions with partners	10,000	*Port of A'dam*	P.M.		P.M.
Intermodal links database	5,000	*ECORYS*	15,000	20,000	35,000
Total A3 (Material costs)	**15,000**	**Total B3 (Material costs)**			**35,000**

SUMMARY

Funding requested from NWO		Co-financing consortium partners	
Staff costs (Total A1)	469,444	Staff costs (Total B1)	86,000
Bench fee (Total A2)	15,000	*Not applicable*	--------
Material costs (Total A3)	15,000	Material costs (Total B3)	35,000
Total funding request from NWO (A4)	**499,444**	**Total co-financing (B4)**	**121,000**

D) CONTRIBUTION BY UNIVERSTIES (OF APPLIED SCIENCE), TO2 INSTITUTES (if applicable)

Description	**Name institute**	**in kind**	**cash**	**Amount (€)**
Support by TNO for smart contracts	*TNO*	15,000		15,000
Smart Contract reference implementation	*TransFollow*	60,000	9,000	69,000
Other partners to be selected by TNO	*TBD*		P.M.	P.M.
Total contribution by universities (of applied science) and / or TO2 institutes (D)				**84,000**

TOTAL PROJECT BUDGET

A	Funding requested from NWO (A4)	499,444 €	81%	Total co-financing (B; cash and in-kind together) should be at least 15% of the project budget (C) but must not exceed 50% of the project budget. Contributions by universities (of applied science) and Large Technological (TO2) Institutes (including TNO) (D) do not count towards the required co-financing.
B	Co-financing consortium partners(B4)	121,000 €	19%	
C	**Project budget (A4+B4)**	620,444 €	100%	
D	Contribution by universities (of applied science and TO institutes) (if applicable)	84,000 €		
E	**Total project budget (C+D)**	704,444 €		

17. Motivation for the project budget

As indicated in the research description, the project will be executed by two PhD students for RQ1 and RQ2, and one Postdoc for RQ3. SmartPort (for the Port of Rotterdam), Port of Amsterdam, ECORYS (for participating and making available their Links database with hinterland connections), and TransFollow (for the reference implementation of the smart contracts to the market) participate in the project in a co-financing role. As the letter of the Port of Amsterdam for their co-financing is not in yet, we put it as PM in the budget. When they commit, the in-kind co-financing will be increased. A budget is allocated for carrying out a number of interactive sessions with partners, as indicated in Figure 2. The bench fee will cover the equipment and travel costs of the PhD students. Costs for the researchers from TUD, EUR and WUR will be carried by the universities.
If the project gets funded, TNO want to participate on a larger scale in the project, answering RQ4 that has been introduced in section 7c of this research proposal. At that moment TNO will call on two to three parties for co-funding (Portbase, TransFollow, and an IT provider) and connect the research to TU Delft's blockchain-lab. TNO will make a strategic investment in the project, doubling the co-funding of the parties, and thereby making a significant contribution to the project. Neither TNO, nor the partners can reserve the full budget at this moment, however, given the fact that the outcome of the selection is still uncertain. As soon as project award takes place, TNO and TUD will get in contact with NWO to see how the addition of TO financing under category "D" in the project proposal can take place. Part of the TransFollow budget is already allocated for this purpose under "D".

18. Other grant applications for this project or idea

☒ Not applicable

☐ Yes

Title proposal:		
Applicant(s):		
Funding agency / budget applied for:		
Date of submission / date of decision:		

Statements and signature

19. Letters of commitment

Please tick the box.

☒ I hereby declare that the obligatory letters of commitment of the consortium partners have been uploaded separately in ISAAC.

*Note: due to the holiday period in which final decisions had to be made, not all **letters** were in yet. We have oral confirmation of the Port of Amsterdam for a 20 k€ in-kind contribution, and expect their letter to be submitted within a few days after the submission date. We will make the letter available immediately to NWO when it comes in. Please note that in order to make the project proposal complete, we did not include any contribution(s) in the budget from partners that did not send in a letter yet. Therefore all letters relating to in cash and in kind support were uploaded.*

20. Guarantee letters

If applicable, please tick the box.

☒ I hereby declare that the obligatory guarantee letters for each applicant whose contract term is shorter than the duration of the envisaged research have been uploaded separately in ISAAC.

A guarantee letter for Dr. Behzad Behdani from WUR has been unloaded to ISAAC.

21. Netherlands Code of Conduct for Scientific Practice 2012

Please tick the box.

☒ By submitting this form I declare that I satisfy the nationally and internationally accepted standards for scientific conduct as stated in the Netherlands Code of Conduct for Scientific Practice 2012 (Association of Universities in the Netherlands).

22. Signature

Main applicant: Prof.dr.ir. A. Verbraeck
Place: Delft
Date: 8 September 2016

Before you submit the full application in ISAAC you will be asked to sign the application electronically.

Deadline for submitting the application: September 8, 2016, 14:00 hours CEST.

Attachments: CV

You are requested to include here a short CV (1/2 A4) of each consortium member (main applicant, co-applicant(s) and consortium partners).

Delft University of Technology: prof.dr.ir. Alexander Verbraeck

Alexander Verbraeck is a professor in Systems and Simulation at Delft University of Technology, Faculty of Technology, Policy and Management. His research focuses on modeling, simulation and gaming, especially in heavily distributed environments and using real-time data. Examples of research on these types of simulations are real-time decision making, interactive gaming using simulations, and the use of 3D virtual and augmented reality environments in training simulations. The major application domains for research are logistics and transportation, and safety and security. Alexander chairs the Freight Transport and Logistics domain in the interdisciplinary TU Delft Transport Institute, and is a Fellow in the Research School TRAIL for Transport, Infrastructure and logistics. In addition Alexander has a position as adjunct professor at the R.H. Smith School of Business at the University of Maryland, USA. Here, he applies the modeling and simulation research for studying real-time supply chains.

Delft University of Technology: dr. rer. soc. Heide K. Lukosch

Heide Lukosch is an assistant professor in Simulation Gaming at Delft University of Technology, Faculty of Technology, Policy and Management with a background in social and media sciences. Her research focuses on the design, use and effects of emerging technologies like (augmented/virtual reality) simulation games to create situational awareness in complex, socio-technical systems. She explores design requirements for effective simulation games, which can be used to empower people to participate in complex (work) situations and systems. With her research, Heide aims at a deeper understanding of simulation game fidelity, and how simulation games can provide the adequate information to support the process of developing situational awareness in domains such as health, logistics, and safety & security. Heide is a board member of ISAGA, and scientific advisor of SAGSAGA. She teaches game design for complex systems on a master level.

Wageningen University: dr. Behzad Behdani

Behzad Behdani is assistant Professor in Logistics and Operations Research at Wageningen University. He got his Ph.D. in 2013 from the Faculty of Technology Policy and Management at Delft University of Technology. Following his PhD, Behzad was also working as a researcher in the Transport & Planning Department at Delft University of Technology University. During this period, he has been involved in Cargo-driven Intermodal Transportation and Synchromodality projects at TU Delft. Behzad is also involved in the NWO-funded project EURECA (Effective Use of Reefer Containers for conditioned products through the Port of Rotterdam). Additionally, he is managing the Work Package 2 in project i-Flow (Intelligent Flowers & Plants Pricing and Logistics). The main goal of this project is to investigate innovative solutions that improve the commercial process and logistics process of the daily trade in floricultural supply chains.

Erasmus University Rotterdam: prof.dr. Rob Zuidwijk

Rob Zuidwijk is Trust Fund Endowed Professor “Ports in Global Networks" at Rotterdam School of Management, Erasmus University, he acts as trail blazer of the SmartPort roadmap “Smart Logistics”, and as trail blazer Leiden Delft Erasmus center “Metropolis and Mainport”. He focuses on three topics: synchronizing transportation networks, connecting the port to global supply chains, and coordinating global supply chains for sustainability. His work has been published in journals like California Management Review, Transportation Science, Manufacturing & Service Operations Management, Communications of the ACM, and Production and Operations Management. He has participated and coordinated funded research projects in the area of international logistics and container transport, and he

continues doing so. He teaches freight transport systems, intermodal transportation, international logistics and supply chain management, and inter-organizational systems in logistics to BSc, MSc, and PhD students, and he is also involved in post-experience courses.

TNO: dr. Wout Hofman
Wout Hofman is a senior research scientist in Data Science with a specialization of interoperability in global trade facilitation, supply, and logistics. He has a Ph.D. Informatics at TU/e and Erasmus University (1994) in developing an innovative IT system for business transaction management, currently known as 'Control Tower'. Wout is and has been responsible for IT coordination in various EU funded projects like EU FP7 Cassandra and – CORE (both on seamless, compliant goods flows), EU FP7 iCargo (applying linked data concepts in supply and logistics), EU FP7 Logicon (developing innovative platforms for SMEs), and H2020 SmartRail (interoperability in the rail sector). Wout also provides consultancy to EC DG Move (e.g. policy impact assessment, support of the Digital Transport and Logistics Forum (DTLF), and feasibility of an architecture for the Digital Inland Navigation Area (DINA)).

Port of Amsterdam: Pim Steenhuis
Pim Steenhuis is manager of Freight Rail and Inland Waterways Marketing & Project Management at Port of Amsterdam. Port of Amsterdam manages, operates and develops the port. The main aim of PoA is stimulating economic activity and employment in the entire Amsterdam port region. Port of Amsterdam seeks to be a smart port adding value for clients and the environment in a sustainable and innovative manner. PoA actively participates with TU Delft and TNO in the TKI Logistics call Synchro-Gaming, which has relations with this proposal.

SmartPort: dr.ir. Michiel Jak
Michiel Jak is Business Director Mobility & Logistics at TNO and Managing Director of SmartPort. SmartPort is a global institute representing the Erasmus University Rotterdam, Delft University of Technology, Port of Rotterdam Authority, Port of Rotterdam business association Deltalinqs and the City of Rotterdam. The aim of Smart Port is actively developing, bundling and investing in knowledge that is important for the port to take advantage of the opportunities offered by international developments. Smart Port also plays an integrating and stimulating role in the cooperation needed to address the complex challenges of the port area.

ECORYS: Jeroen Bozuwa
Jeroen Bozuwa (1965) joined ECORYS (former NEI) after his study Transportation and Logistics at the Polytechnics of Tilburg. He has a wide experience in the field of freight transport and logistics, with emphasis on the inland transport modes and intermodal transport. His key experience is in the field of research into macro economic effects of trends and policy measures related to freight transport, especially freight transport by road, inland waterways and rail. Moreover he was and is involved in (inter)national corridor studies; modal shift studies; studies into efficiency improvements in freight transport; construction of freight transport databases; and freight logistics studies. He has a professional experience of 25 years, and is / has been involved, a.o., in the following projects: Intermodal Links: intermodal planner East-West Corridor (EU ITS Platform), the BESTFACT project for interfacing set up of a community based TSD data base, and Intermodal Planner Port of Amsterdam.

TransFollow: Rene Bruijne
Rene Bruijne is Chairman of TransFollow. Rene started his professional career with Stichting Uniform Transport Code (1991) in supporting logistics businesses in implementing interoperability, move to a function as CEO of Beurtvaartadres B.V. (2001), fully owned by Transport and Logistics Netherlands, EVO, and NRBB, and is currently CEO of TransFollow (2016), fully owned by the International Road Union. TransFollow is raised as an initiative of Beurtvaartadres with the objective of supporting electronic

transport documents accompanying goods transport in Europe, thus replacing the paper documents originally sold by Beurtvaartadres. Applying innovative technology in logistics operations has always been a topic of large interest of Rene.