Call for Participation in a Workshop on

Inter-Infrastructure Risks Due to Natural Hazards

The National Telford Institute and the Scottish Informatics & Computer Science Alliance (SICSA)

Level 5, Sir Alwyn Williams Building, Department of Computing Science, Glasgow University.

Wednesday 8th and Thursday 9th September 2010.

Overview: UK critical infrastructures create a complex network of interdependent systems (e.g., transport, water supply and sewers, energy, communications). These interdependencies will increase through the integration of digital control into systems that range from the Microgrids that will help distribute renewable energy through to the SESAR proposals for European software integration in Air Traffic Management. Infrastructure also faces new challenges and increasing demands caused by changing climate, population growth and increased usage. At the same time, many existing infrastructure assets in Scotland are being extended well beyond their original design life. These factors increase the risks of failure across different critical infrastructures. Thus, it is essential to improve our understanding of interdependencies between different infrastructures under the impact of natural hazards.

Aims: This workshop will bring together researchers from different disciplines and other stakeholders (asset owners and operators, government agencies) in order to engage them into inter-disciplinary research on risk posed to Scottish (UK) infrastructure from natural hazards taking into account interdependencies and effects of changing climate.

Instructions: The first day will be used to present a series of keynotes and short talks on the topics listed above, while the second day will be mainly for further discussions and networking. In order to reserve your place please email the organisers at the addresses given below, to arrive no later than 1st September 2010.

For more information:
SICSA: Prof. Chris Johnson (Johnson@dcs.gla.ac.uk)
Telford: Dr. Dimitri Val (Val, Dimitry (D.Val@hw.ac.uk])

National Telford Institute | sicsa*

Wednesday 8th September 2010.

09.30	Coffee	
10.00	Welcome and Introduction	Chris Johnson and Dimitri Val
10.30	Climate Change, Damage Risks and Optimal Adaptation Strategies for Infrastructure	Mark Stewart University of Newcastle, Australia.
11.30	Coffee	
12.00	Preliminary Interdependency Analysis (PIA): A tool-supported method for carrying out qualitative and quantitative analysis of interdependency in critical infrastructures	Nick Chozos, Adelard.
12.30	Collaboration Infrastructures	Monika Buscher, Lancaster University Joseph Richard Pollack Crisis Training AS
13.00	Lunch	
14.00	Bayesian Networks for Modeling and Managing Risks of Natural Hazards	Prof Daniel Straub, TU Munich
15.00		Katie Owens Sarah Nodwell
15.30	Tea	
16.00	Mitigating Risk Through Stakeholder Involvement in Infrastructure Design: the case of tele-monitoring services	Jenny Ure, Edinburgh University
16.30	Learning Lessons from Previous Infrastructure Failures	Chris Johnson, University of Glasgow
17.00	Reception and networking	

Thursday 9th September 2010.

09.30-10.00	Coffee	
10.00-10.30		
10.30-11.30		
11.30-12.00	Coffee	
12.00-12.30		
12.30-13.00		
13.00-14.00	Lunch	
14.00-15.00		
15.00-15.30		
15.30-16.00	Tea	
16.00-16.30		
16.30-17.00		
17.00-19.00		

Collaboration Infrastructures

Monika Buscher, Centre for Mobilities Research, Lancaster University, UK
Joseph Richard Pollack, Crisis Training AS, Norway

Critical infrastructure failures often necessitate collaboration between multiple emergency response organizations as well as government authorities, non-governmental organizations, the media and the public. In this presentation we will present the BRIDGE project (EU FP7). BRIDGE: Bridging resources and agencies in large-scale emergency management is an effort to increase the security and safety of European citizens through improved multi-agency coordination in large-scale emergency management. The focus is on solutions to:

- **facilitate multi-agency collaboration** in large-scale emergency relief efforts;
- **enable data and system interoperability** in multi-agency collaborative efforts;
- **provide a common operational picture** for multi-agency emergency response operations.

The interdisciplinary team approaches the challenges of multi-agency collaboration from an integrated technical, organizational, and social practice level. On the technical level, BRIDGE will deliver:

- resilient ad-hoc network infrastructures founded on requirements evolved from emergency scenarios;
- generic, extensible middleware to support integration of data sources, networks, and systems;
- a context management system to foster data interoperability.

Technical interoperability is crucial for enabling multi-agency collaboration. However, the technology needs to be integrated into the workflows and communication processes of the respective agencies at the organizational level, so that they can work within a single command hierarchy rather than acting independently. To that end, BRIDGE will provide:

- methods and tools that support run-time intra- and inter-agency collaboration;
- a model-based automated support system built on a scenario-based training framework;
- an agent-based dynamic workflow composition and communication support system.

Finally, information and communications technology will mediate both the collaboration between agencies and the access they have to available data. All of the above efforts, then, must incorporate advanced techniques for collaboration and human-computer interaction – the level of social practice. BRIDGE will contribute here by developing:

- adaptive, multi-modal user interfaces;
- novel interaction techniques with fixed and mobile devices;
- tools for building and maintaining a scalable common operational picture.

To ensure success, the BRIDGE consortium brings together a team of academics from computing, social science, law and other disciplines, technology developers, domain experts, and end-user representatives. This presentation will describe the project from these different perspectives.

Technical area	**Established state-of-the-art**	**BRIDGE innovation**
Actor-Agent Networking: Emergency Management Support	Limited level of ambient cognition of Actor-Agent Networks	Forming a sound theory for Actor-Agent Teams (AAT) and Actor-Agent Communities (AAC) systems. Taking into account human cognition, social norms, culture and technological advancements across the different multi-agency emergency management organizations Implementing and testing related empirical

		(cognitive) AAT and AACmodels.
Actor-Agent Networking: Design Methodology	No methodology currently in use that addresses automation as 'intelligent interaction device' between human experts	Exploration of a structured approach starting at role and process descriptions for current organisations to define intraagency and inter-agency collaboration requirements
Actor-Agent Networking: Synergetics	Limited self-management and self-adaptation capabilities of actoragent networks in emergency C&C systems.	Introduction of Feedback-based methods, techniques and algorithms based on synergetics and renormalization.
Decision Support and collaboration in command and control	Limitations in current decision support systems to support sense making, and limited methods for multimodal interaction with data.	Focus on large-scale, multimodal, interactive visualizations of information in a common, scalable user interface.
Inter-agency training of collaboration	Inter-agency training is based on predefined procedural and prelearned operational capabilities and combinations. Training focuses on 'doing it right' aspects.	Bridge will introduce dynamic, ad-hoc composition of composed workflows based on run-time collaboration needs. Training techniques will focus on individual and agency behavioural and goal driven aspects.

Joseph Pollack is an employee at Crisis Training AS, Norway. CTAS is a company that supports its customers in planning, execution and evaluation of training exercises with the use of newly developed methods and technologies. The Norwegian Armed Forces, for example, have over the last 10 years used methods and technologies in their training of soldiers and organisations, and are recognized as one of the world leaders in this area. CTAS with their partners have developed these methods and technologies further to be used in the overall societal market. CTAS has experience in planning and execution of exercises but their main competence areas are related to methods and technologies in the preparation– and execution of the evaluation phase of exercises, tests and demonstrations. CTAS can integrate existing operational systems and components with the training equipment to assure an optimized real life situation for the customers exercise, test and/or demonstrations.

Monika Buscher is Senior Lecturer at the Centre for Mobilities Research at Lancaster University and co director of the mobilities.lab. Her role in the BRIDGE project is to undertake and co-coordinate ethnographic studies of existing and emergent future practices. She has undertaken ethnographic studies in the context of collaborative information technology design for the past 15 years (IST/FET funded). These studies have been folded into the design of support systems and computer architectures, including during the PalCom integrated project (http://www.ist-palcom.org). She is main author of a number of interdisciplinary publications, including publications at the *International Conference on Information Systems for Crisis Response and Management* (ISCRAM), the *International Journal of Emergency Management*, *International Journal of Information Systems for Crisis Response and Management*, the *Participatory Design Conference* (PDC), as well as high profile international social science journals such as *Environment and Planning* and *Sociological Research Online*. Her publications include four collaboratively edited books on participator design, design research and ethnographies of diagnostic work, which collects analyses of how a 'common operational picture' is achieved in different domains of work. She is on the conference committees for PDC and ISCRAM. She is editorial advisor for the *Journal of Computer Supported Cooperative Work*.

Preliminary Interdependency Analysis (PIA):

A tool-supported method for carrying out qualitative and quantitative analysis of interdependency in critical infrastructures

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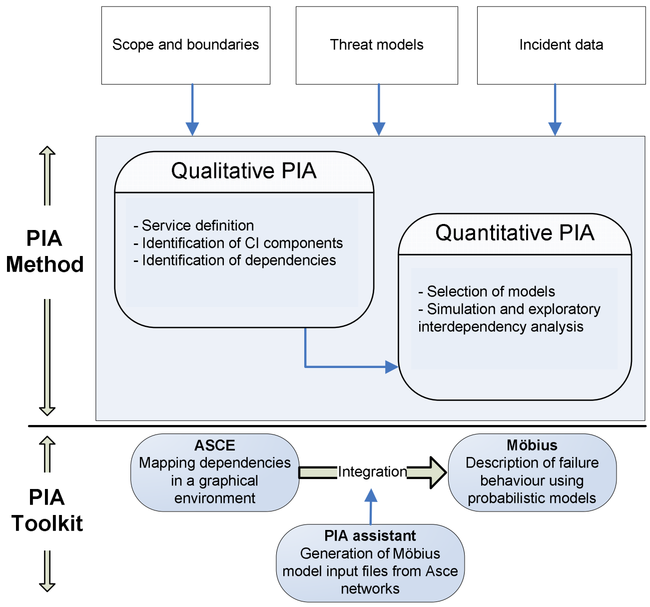
Abstract: We are developing a method for infrastructure modelling and analysis of dependencies in complex systems, focusing on intra- and inter- infrastructure systems. The method—Preliminary Interdependency Analysis (PIA)—is supported by a software toolkit: with this toolkit, analysts can carry out infrastructure modelling in a dynamic graphical environment, defining infrastructure physical and intangible components and different kinds of associations among them, eventually performing simulations to explore probabilistic aspects of cascade failure among elements of the modelled system. PIA is a flexible, adaptable approach, which can be used to model not only engineering aspects of critical infrastructures, but also other aspects such as risks associated with geographical position and weather, or examine softer elements such as trust and reputation. PIA is designed to be deployed fairly quickly, not only for national infrastructure, but also by SME's for their business continuity planning. This paper will present the current status of the PIA method and toolkit, and discuss two case studies where PIA is currently being applied. This work is funded by the Technology Strategy Board's "Information Infrastructure Protection: Managing complexity, risk and resilience, 2009" innovation platform.



Learning Lessons from the Previous failures in National Critical Infrastructures

Prof. Chris Johnson,

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Abstract: This paper argues that we must learn as much as possible from the previous failures in national critical infrastructures. In particular, accident investigation techniques can be used to determine how environmental and meteorological conditions have combined to expose flaws in the design and operation of complex systems. For national critical infrastructures, this combination of natural and human factors creates a dangerous mix that undermines existing contingency plans. From this it follows that it is important not just to study the causes of previous failures but also to learn lessons from the response. Unfortunately, there are few mechanisms to support this learning process. Insights from previous floods are seldom documented in a form that can be used by a wide range of stakeholders both within the regions affected but also more widely by other countries that share common vulnerabilities. The paper closes by drawing parallels between the vulnerability of national critical infrastructures and the elaborate information sharing systems that support safety-critical systems engineering in domains as diverse as transportation and healthcare.

Climate Change, Damage Risks and Optimal Adaptation Strategies for Infrastructure

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The time and spatially dependent uncertainties and variabilities associated with climate change impact and adaptation lends itself to stochastic modelling of infrastructure performance. This presentation will show the utility of probabilistic risk assessment by assessing the impact and adaptation assessment of (i) safety and reliability of carbonation-induced corrosion caused by enhanced greenhouse gas (CO_2) emissions and (ii) cyclone damage risks in North Queensland due to climate change.

Increases in wind damage are expected if the intensity and/or frequency of tropical cyclones increase due to enhanced greenhouse conditions. The presentation estimates cyclone damage risks and fragility curves due to enhanced greenhouse conditions for residential construction in North Queensland, and then assesses the economic viability of several climate adaptation (hazard mitigation) strategies. The effect of regional changes to building inventory over time and space, rate of retrofitting, cost of retrofit, reduction in vulnerability and discount rate will be considered. The risk-cost-benefit analysis considering temporal changes in wind hazard and building vulnerability can be used to help optimize the timing and extent of climate adaptation strategies. Atmospheric CO_2 is a major cause of reinforcement corrosion in bridges, buildings, wharves, and other concrete infrastructure in Australia, United States, United Kingdom and most other countries. Moreover, corrosion rates will increase by up to 25% if temperature increases by 2°C. Clearly, the impact of climate change on existing and new infrastructure is considerable, as corrosion damage is disruptive to society and costly to repair. The presentation describes a probabilistic and reliability-based approach that predicts the probability of corrosion initiation and damage for concrete infrastructure subjected to corrosion. The effect of various adaptation measures is also considered. It was found that damage risks increase by up to a few hundred percent over a time period to 2100, and that the results vary for different cities and regions in Australia. Increases in design cover for new infrastructure designed in Australia are recommended to ameliorate the effects of climate change. The use of galvanised and stainless steel reinforcement reduced damage risks to negligible values, but at the expense of significant additional construction costs.

Mark G. Stewart is Professor of Civil Engineering and Director of the Centre for Infrastructure Performance and Reliability at The University of Newcastle in Australia. He is the author, with R.E. Melchers, of *Probabilistic Risk Assessment of Engineering Systems* (Chapman & Hall, 1997), as well as more than 300 technical papers and reports. He has more than 25 years of experience in probabilistic risk assessment of infrastructure systems, particularly studying the time-dependent safety and reliability of concrete structures subject to corrosion. He has also developed risk-based approaches to assessing the risk acceptability and cost-effectiveness of protective measures for infrastructure for natural and man-made (terrorism) hazards. Professor Stewart is currently an advisor to the Australian Department of Climate Change on the effect of global warming on corrosion and damage risks to infrastructure.

Bayesian Networks for Modeling and Managing Risks of Natural Hazards

Prof Daniel Straub, TU Munich

Abstract: Bayesian Networks (BNs) are becoming increasingly popular as a modeling tool in risk analysis and assessment. Form many types of risks, they enable the efficient representations of the (complex) interdependences among the system elements and the hazard phenomena. Not least they enable the calculation of the risk conditional on monitoring data and other types of observations, thus facilitating optimization of mitigation actions in near-real-time. The presentation will provide a brief introduction to BNs, present an overview on a number of applications of BN for natural hazards risk assessment from the speaker's experience and will end with a discussion on the potential and limitations of the methodology.

Mitigating Risk Through Stakeholder Involvement in Infrastructure Design: the case of tele-monitoring services

Jenny Ure, Edinburgh University

Scottish telecare strategy anticipates home tele-monitoring services being an integral part of national healthcare infrastructure by 2015. This will re-align a range of distributed health, community and housing services more cost-effectively around the needs of older patients at home and is intended to cut the costs of hospital services at a time where demand is rising and resources are shrinking.

Our experience of evaluating the risks and benefits of regional pilot services changed perceptions of both the nature of the risks and how these might be anticipated and mediated by users themselves. Collaborative action research in the pilot studies flagged risks to effective implementation that were not anticipated at the outset, particularly in relation to the alignment of the digital process of data triage and intervention with the real requirements (and costs)of diagnosis and clinical intervention on the ground.

Mitigating Risks in Technical infrastructure

Many of the technical risks associated with working across interdependent systems were related to issues of interoperability, scalability and harmonisation, in addition to the availability of bandwidth, the cost of connection in some regions, and the impact of failure at any point in this extended supply chain on data. However a number were invisible by means other than triaging interviews with different users, and many were likely to be subject to change when providers of systems or services upgraded or changed the services they provided. More evident than the risks of alignment with other IT systems however were the more socio-technical issues in aligning the digital process of triage and decision support, with the real world process of diagnosis and intervention.

Mitigating Risks in Process infrastructure

Tele-monitoring brings digital and human infrastructure together in new ways, with a range of possible scenarios for the coordination of care by distributed teams. Each scenario invokes a different configuration of risks, roles and resource allocation for users. The speed of change in the technology itself also means that the potential risks and benefits are in constant flux.

The changing scenarios for data triage and care provision in one tele-monitoring pilot are used to illustrate this point. Patients used digital monitoring peripherals at home to monitor chronic pulmonary problems, and symptom measures were sent via a secure database to a call centre, and based on a protocol, GPs were alerted and patients contacted.

Scenario 1 was based on automated decision support based using data triage to identify at risk patients early, alerting GPs when scores went outwith agreed parameters. In practice, standard benchmarks did not reliably differentiate at risk patients from others without further input, thus risking over or under-treating patients in a high risk category.

Scenario 2 was a two stage process combining automated decision support based on data triage, with local input from patients and nurses to interpret scores and agree on care options. This was very effective, and was regarded by patients and care staff as significantly improving the quality of care, however there was a high cost in terms of additional practitioner workload, and care staff in the practice took more responsibility for the decision to intervene. In addition, there was now a very transparent digital audit trail, where delays in response at any stage were also more visible and attributable in the case of an adverse event. The workload implications also meant this would not be scalable to large patient numbers without additional resource.

Scenario 3 devolved the responsibility for decision-making to patients again. They were expected to use their scores themselves as a basis for an informed decision about accessing services, and managing self-care. This was a low cost option, but crucially, raised the risk of unreported problems, which is one of the issues that the intervention was meant to address at the outset. Unsurprisingly, many patients felt that this would negate any of the benefits of monitoring, and indicated that they would not use such as system.

In each scenario also, users (patients and practitioners) appropriated the system for their own ends in unexpected ways, from the manipulation of scores by patients to facilitate or avoid intervention, to the manipulation of triage scenarios to minimise perceived risks, should delays in response lead to an adverse event. These are risks that are often only evident from evaluation in practice, and can only be mitigated by and with stakeholders.

Harnessing local knowledge and agency

Neither the technical nor the human actors in this interplay are constant, and we argue that risk mitigation in this context is about providing a vehicle for facilitating ongoing exploration of these new digitally enhanced territories in practice, and negotiating their appropriation in ways that optimise value and minimise cost and risk in transparent and accountable ways.

If, like economic markets, complex systems are highly interdependent, and performative, then risk mitigating solutions must harness rather than ignore this. Collaborative action research and the many analogous process of iterative user engagement are arguably useful sandpits for shaping what cannot be predicted and managed a priori.

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