

Managing and Organising Self-* Networks *Perspectives on Critical Infrastructure Systems*

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Outline



– Introduction

- Motivation
- Critical Infrastructure Systems (CIS)
- Self-* Networks and ICT
- A new COST605 work item

– Self-* Networks and CIS

– Techno-economic aspects of CIS

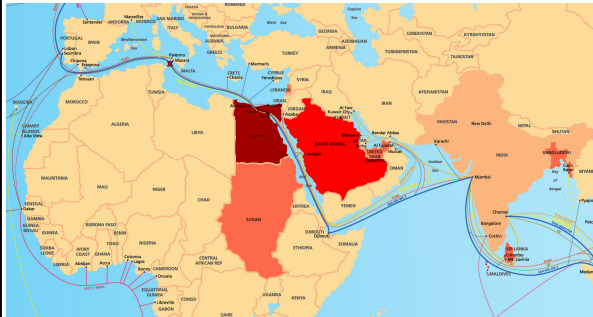
– Conclusions



Introduction

Motivation

- Quiz question: How much damage can a fisherman in the Mediterranean inflict on businesses in Dubai ???
 - *As it turns out ... Quite a lot !!!*



Source : <http://www.renesys.com>

- 30 Jan.2008 : 15% SA , 25% UAE (% network outage)
- 19 Dec.2008: 42% SA , 26% UAE (% network outage)

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Introduction

Motivation

- World Economic Forum estimates [2008]
 - In the next 10 years
 - **10-20% probability of a major CII breakdown**
 - CII: Critical Information Infrastructure
 - Potential global economic cost:
 - **Approx. 250 billion US\$ [~ €180 000 000 000]**
 - Source: Global Risks 2008 WEF Report
- CIS must be protected.
 - (Inter-)National Security assurance
 - Economic impact of breakdown
 - Maintain our living standards
 - **Protection of human lives**

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Introduction

Critical Infrastructure Systems (CIS)

- Commission Communication on **EPCIP** [COM(2005) 576]
 - **European Programme for Critical Infrastructure Protection**
 - “**Critical Infrastructure**” (CI) : an **asset, system or part thereof** located in Member States which is *essential for the maintenance of vital societal functions, health, safety, security, economic or social well-being of people*, and the **disruption or destruction** of which would have a significant impact in a Member State as a result of the *failure to maintain those functions*
 - Infrastructures are divided in Sectors
 - Sectors include **Products or Services**

I. Energy	VII. Public & Legal Order and Safety
II. ICT	VIII. Civil administration
III. Water	IX. Transport
IV. Food	X. Chemical and nuclear industry
V. Health	XI. Space and Research
VI. Financial	

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Introduction

Critical Infrastructure Systems (CIS)

- **EPCIP COM(2005) 576 (Annex 2)**

INDICATIVE LIST OF CRITICAL INFRASTRUCTURE SECTORS

Sector		Product or service	
II	Information, Communication Technologies, ICT	5	Information system and network protection
		6	Instrumentation automation and control systems (SCADA etc.)
		7	Internet
		8	Provision of fixed telecommunications
		9	Provision of mobile telecommunications
		10	Radio communication and navigation
		11	Satellite communication
		12	Broadcasting

- Commission Communication on **CIIP** [COM(2009)149]
 - **CIIP: Critical Information Infrastructure Protection**
 - “Protecting Europe from large scale cyber-attacks and disruptions: enhancing preparedness, security and resilience”

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Introduction

Self-* Networks and ICT

- Information & Communication Technologies
 - ICT Sector : CIIS / CIIP
 - Critical Information Infrastructure Systems / Protection
 - "the ability of a network or an information system to resist [...] **accidental events** or **malicious actions** that compromise its availability, authenticity, integrity and confidentiality [...]".
- Self-* Networks
 - Motivation → OPEX reduction
 - Through OSS/BSS automation
 - Reduce complexity + Increase revenues
 - Self-* capabilities
 - for automated network management and organisation
 - = configuration + optimisation + **protection** + **healing** + planning + discovery + **awareness** + ...

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Introduction

A new COST605 work item

- Techno-economic aspects of CIS (CIIS/CIIP)
 - Inter-dependencies Management
 - Economic CIS Management
 - Self-* CIS Feasibility Study
 - Risk Assessment
 - Game Theory
 - Policy Issues
 - ?
- Complementary to COST IC0806 IntelliCIS
 - Intelligent Monitoring, Control and Security of CIS

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Outline

- Introduction
- **Self-* Networks and CIS**
 - Self-Management vs. Self-Organisation
 - Critical Information Infrastructure Systems
 - Research Outlook
- Techno-economic aspects of CIS
- Conclusions

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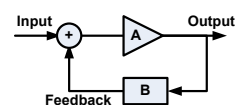
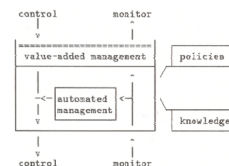
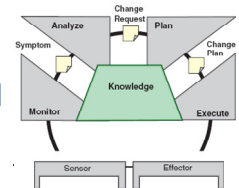
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Self-* Networks and CIS

Self-Management vs. Self-Organisation

- Different focus
 - Self-Managing Autonomic Networks (AN)
 - IT automation: Internet [Core/Enterprise Network]
 - Self-Organising Networks (SON)
 - Telco automation: Mobile [3GPP LTE RAN]
- Share the same self-* capabilities
 - *Share* \equiv “would benefit from” !
- Same underlying concept
 - Control Theory for Network/Systems Mgt.
 - **Closing the management loop!**
 - L.Fehskens [IFIP/IM 1989]
 - IBM's Autonomic Vision [2000]



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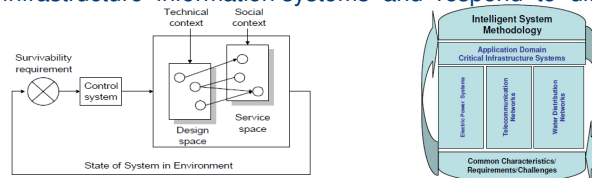
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Self-* Networks and CIS

Critical Information Infrastructure Systems

- Control Theory for CIIP
 - K. Sullivan et al, “**Information survivability control systems**”, Int. Conf. Software Engineering, USA, May 1999.
 - distributed, hierarchical, discrete state control systems to monitor infrastructure information systems and respond to disruptions



- M.M. Polycarpou, “**Fault Diagnostics and Security of Critical Infrastructure Systems**”, 7th IFAC Int. Symp. on Fault Detection, Supervision & Safety of Technical Processes, SAFEPROCESS'09
 - Fault Detection/Isolation (FDI) : use of networked intelligent agent systems provides a fundamental framework for intelligent monitoring, control, fault diagnosis and security of critical infrastructures
- COST IC0806 “IntelliCIS” www.intellicis.eu

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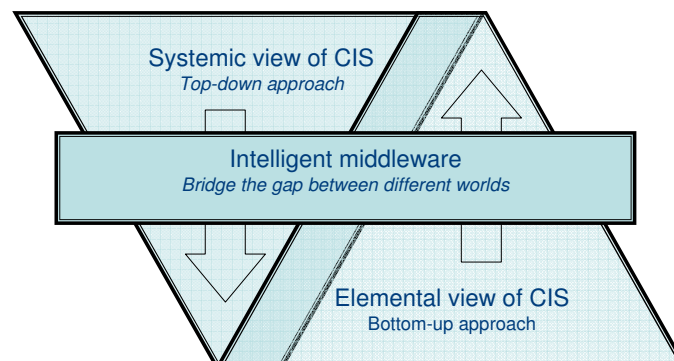
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Self-* Networks and CIS

Research Outlook



- Intelligent systems approaches for CIS
 - Reliable management & control of telecommunication networks

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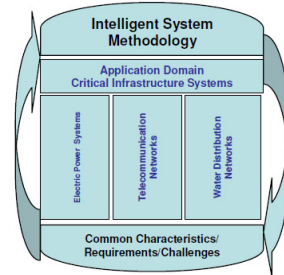
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Self-* Networks and CIS *Research Outlook*

- COST Action IC0806 **IntelliCIS** (ICT Domain)
Intelligent Monitoring, Control, and Security of CIS
 - Main objective: to develop innovative intelligent monitoring, control and safety methodologies for CIS
 - electric power systems, telco networks, water distribution systems
 - an exciting area of research with direct benefits to the social and economic welfare of people worldwide
 - >50 researchers from 29 signatory countries
 - KIOS Research Center for Intelligent Systems and Networks (kios.org.cy)
 - Non-profit organisation (UCY)
 - Cyprus Strategic Infrastructure Center
 - Multidisciplinary team of faculty and researchers from UCY and industry



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- **Techno-economic aspects of CIS**
- Conclusions

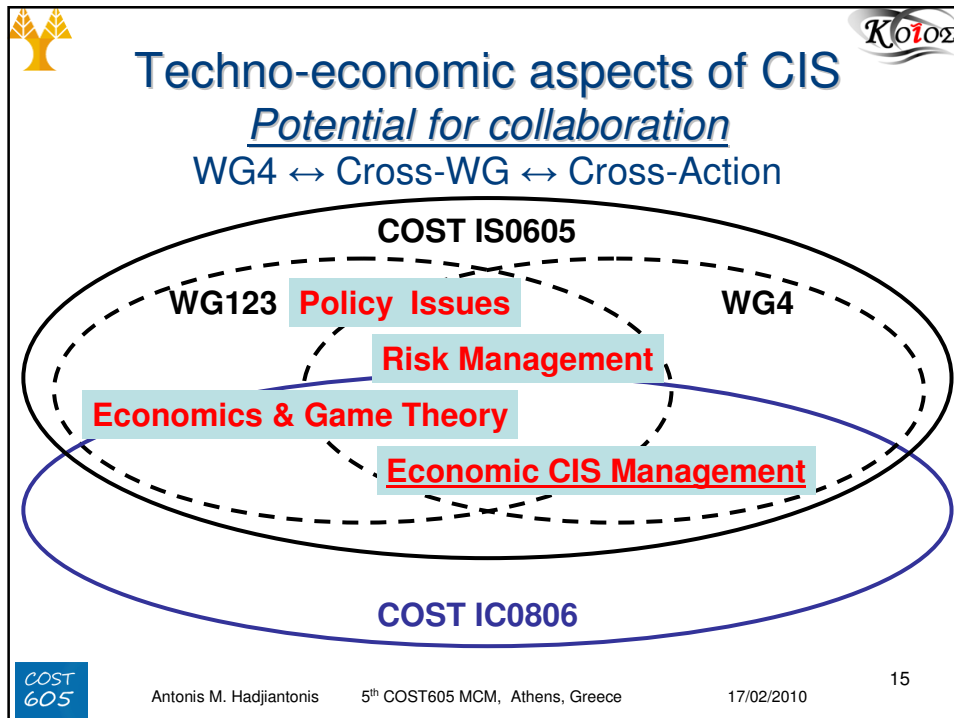
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- Techno-economic aspects of CIS**
A new COST605 work item
- **Economic CIS Management**
 - Information sharing and overheads
 - Inter-dependencies Management
 - Self-* CIS Feasibility Study
 - Add your COST605 interest here!
 - **Economics and Game Theory**
 - Leontief's Input-Output model
 - Finding Nash equilibria: Cournot/Stackelberg
 - Add your COST605 interest here!
 - **Risk Management**
 - Probabilistic Risk Assessment
 - Infrastructure Insurance
 - Add your COST605 interest here!
 - **Policy Issues**
 - Information sharing agreements
 - Competition and cooperation
 - Add your COST605 interest here!
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Outline

- Introduction
- Self-* Networks and CIS
- Techno-economic aspects of CIS
- **Conclusions**
 - Summary
 - Questions and Discussion



Conclusions

Summary

- CIS must be protected
 - Energy, Water, ICT networks
 - Critical Information Infrastructure Protection
- Self-* capabilities highly desirable
 - Automated network management and organisation
 - Self-healing, self-protecting, self-organising
- Knowledge transfer from Control Theory
 - Intelligent Systems approach
 - E.g. Fault Detection/Isolation (FDI)
- Techno-economic aspects of CIS
 - A new COST605 work item
 - Significant collaboration potential
 - E.g. Economic CIS Management