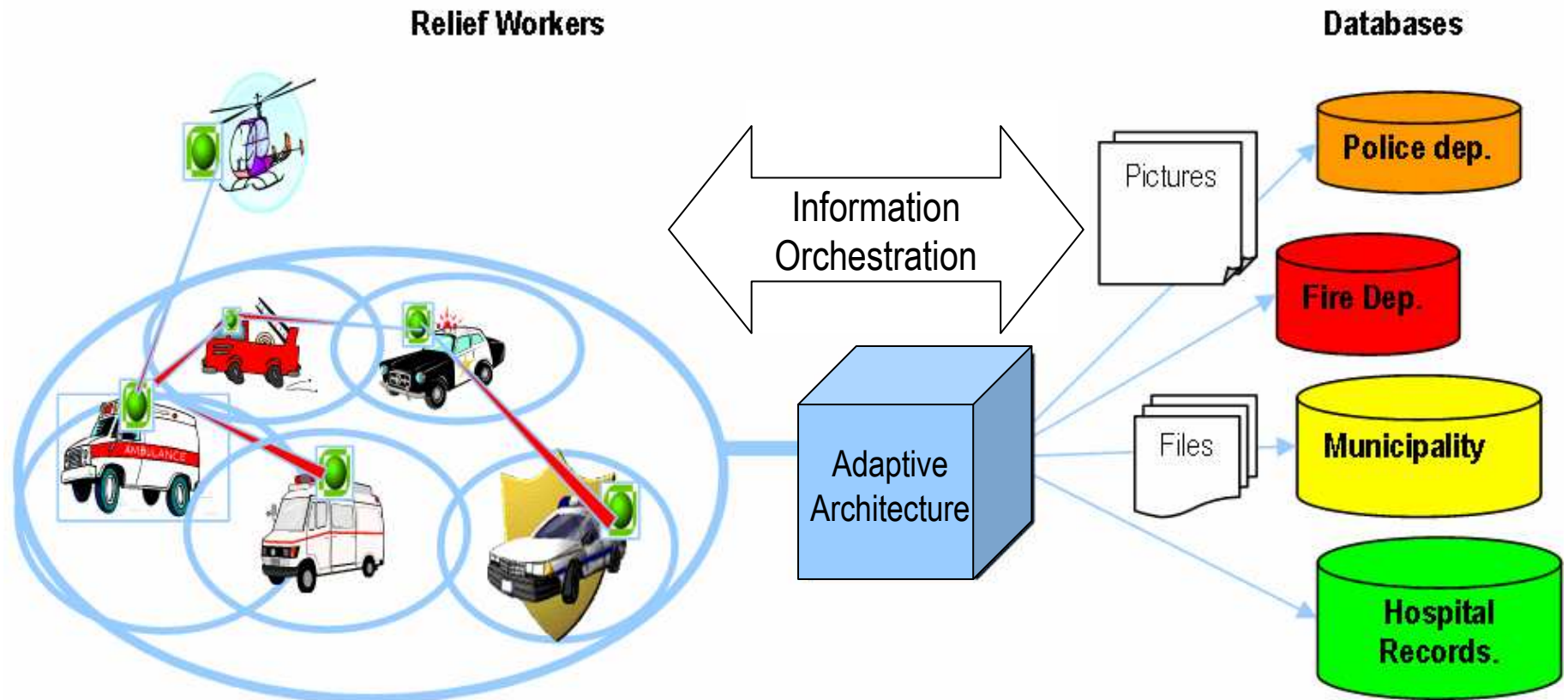


Adaptive Orchestration

**Designing an architecture for
adaptive information orchestration
during interagency crisis response**

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What does the title mean?



Today's Agenda

- Background
- Problem framing
- Related research
- Research objective and questions
- Plan of approach
- Theoretical lenses and concepts in use
- Progress and outlook

Background: poor information coordination

- Chernobyl (1986)
- Hercules (1999)
- Enschede (2000)
- New York (2001)
- Singapore (2003)
- Madrid (2004)
- Schiphol (2005)
- ...



Many causes for poor coordination

- Psychological factors
 - Human cognition (Farazmand, 2001).
 - Group memory (Liebowitz, 2003)
 - Emotional Stress (Smith, 1997)
- Ad-hoc group decision making environment (Smart, 1997)
- Hierarchical governance structure (Davis, 2002; Denis, 1997)
- **Information:**
 - low quality (Liebowitz, 1999)
 - overload (Hale, 2005)
 - no multimedia and real time data exchange (Robinson, 2005)
 - dynamics (Huberman, 2004)
 - no access to third party information (Dawes et al, 2003)
 - changing and unexpected information needs (Arens, 2003)

Some related research

Project	Institutes	Focus	References
GeoVista (US)	Penn State University	Geo-visualization	(Cai, 2006)
ICS/NIMS (USA)	University of Missouri-Columbia	Interagency templates	(Hannestad, 2005)
OASIS (EU)	EURORISK Consortium & Consultancy firms	European WS standards development	eu-orchestra.org
COMBINED (NL)	DECIS: TNO, Thales, UVA and TU Delft	Intelligent applications development	(Storms, 2004) (Burghardt, 2004)
DERMIS (US)	New Jersey Institute of Technology & Rutgers University	Principles for crisis communication systems	(Turoff, 2004)
COSMOA (UK)	Oxford University	Ontology description	(Bloodsworth, 2005)
CRUE (US)	California Information Science Institute	Sensor networks	(Arens, 2003)
RESCUE (USA)	Brigham Young University, University of California, University of Maryland.	Information networks	(Mehrortra, 2004)
TAID (NL)	University of Amsterdam Twente University	Adaptive workflow systems	Netten et al (2006)

Conclusions explorative case study

- Low IT-readiness of relief workers
- Dependence on human information filtering
- High reliance on predefined procedures and protocols in order to deal with uncertainty
- No emergent, only pre-structured coordination
- Information needs cannot be predicted
- Need for adaptivity: centralized information orchestration according to the rapidly changing information needs

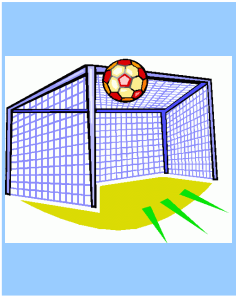
SEPAM* View

- Information coordination problem is ill-structured (multiple problem aspects, vague objectives, multiple solution spaces)
- Solving problems in complex technological systems require both an technological design and an institutional design (Goodin, 1996; Nelson & Sampat, 2001; Kiser and Ostrom, 1982)
- Designing these systems not only has a technological (substantive) dimension, but it also pre-supposes coordination of the behavior of parties necessary to make the system function.
- This coordination is organized through institutional arrangements that regulate the positions and relations between parties (Groenewegen, 2005)

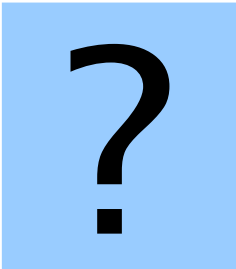
Propositions

- Specific features of an advanced information systems (e.g. filtering, sensing, self reconfiguration) can help solve difficult coordination problems (Argyres, 1999)
- Providing task specific information to individual team members will improve coordination and decision-making (Sperling, 2005)
- In order to support emergent coordination the system needs to be adaptive
- While decision-making should be kept decentralized, the coordination of information should be centralized
- A broader architectural view is required to identify the adaptivity requirements.

Goal and Central Question



Design and evaluate architectures prescribing the elements that allow adaptive information orchestration during interagency crisis response



What are the needs for adaptive information orchestration in crisis response and which socio-technical elements in architectures support the need of adaptivity?

Sub questions and approach

1. What is the need for adaptivity in crisis management?
2. Which institutional elements enable adaptivity?
3. Which information systems elements enable adaptivity?
4. Which elements of adaptive architectures can we evaluate using workshops and surveys?

Approach: Design based research: requires literature review and theory generation, uses formative evaluation as a research method, and analysis methods widely used in quantitative and qualitative research (Orill, Hannafin & Glazer, 2003)

Plan of approach

Phase of research	Activities (following the design science approach by Hevner et al)	Main methods used
1 (2006)	Exploration Problem Formulation Definition of key concepts	<ul style="list-style-type: none">• Theory selection/ Archival analysis• Explorative case studies (multiple cases)
2 (2007)	Description of information exchange based on current technology	<ul style="list-style-type: none">• Conceptualization (objects, variables)• Statistical analysis (Conjunct)• Semi-structured interviews with field experts
3 (2008)	Design of an adaptive architecture	<ul style="list-style-type: none">• Modeling (specification)• Structured interviews with field experts
4 (2009)	Evaluation of the design	<ul style="list-style-type: none">• Test case/ (quasi) experiment• Facilitation of workshops

Theoretical lenses in use (ongoing)

- Organization theory (Simon, 1958)
- Complexity theory (Gell-Manm, 1995)
- Institutional Theory (Williamson, 1998)
- Complex Adaptive Systems (Waldrop, 1992)
- Multi-Agent Systems (Wooldridge, 2002)

Key Concept: Adaptivity

- Ill defined concept in literature (Evans, 2001)
- A system's capacity to adjust to changes in the environment without endangering its essential organization (Heylighen, 1997)
- Umbrella term entailing multiple infrastructure and organizational attributes: flexibility, agility, interactivity, changeability, robustness, resilience, anticipation, versatility, hedging
- Supposedly implies a high level of sensing, self reconfiguring and learning
- Multidimensional concept
 - Required in & between all of the architecture layers to cope with volatility and uncertainty

Key concept: Architecture

- “The fundamental organization of a system embodied in its components, their relationships to each other and to the environment and the principles guiding its design and evolution” (*IEEE standard 1471*)
- “Architecture is the organizing logic for applications, data, and infrastructure technologies, as captured in a set of policies and technical choices that form unifying principles and practice across projects and lines of business in the enterprise” (*Ross, 2003*)

Coordination VS Orchestration

- “The additional information processing performed when multiple, connected actors pursue goals that a single actor pursuing the same goals would not perform” (Malone, 1988)
- Orchestration implies some form of centralized coordination in a network of resources
 - Can be process, event or information driven
 - Different from familiar concepts such as collaboration, automation and governance

Progress & Outlook

- Explorative case study completed
- Sub-Questions refined
- Theoretical fundament laid down
- Some key concepts defined
- Construction of conceptual model in progress
- Archival analysis/ surveys and conjunct analysis
- Final touches on research proposal
- Two in-depth case studies planned (2008)

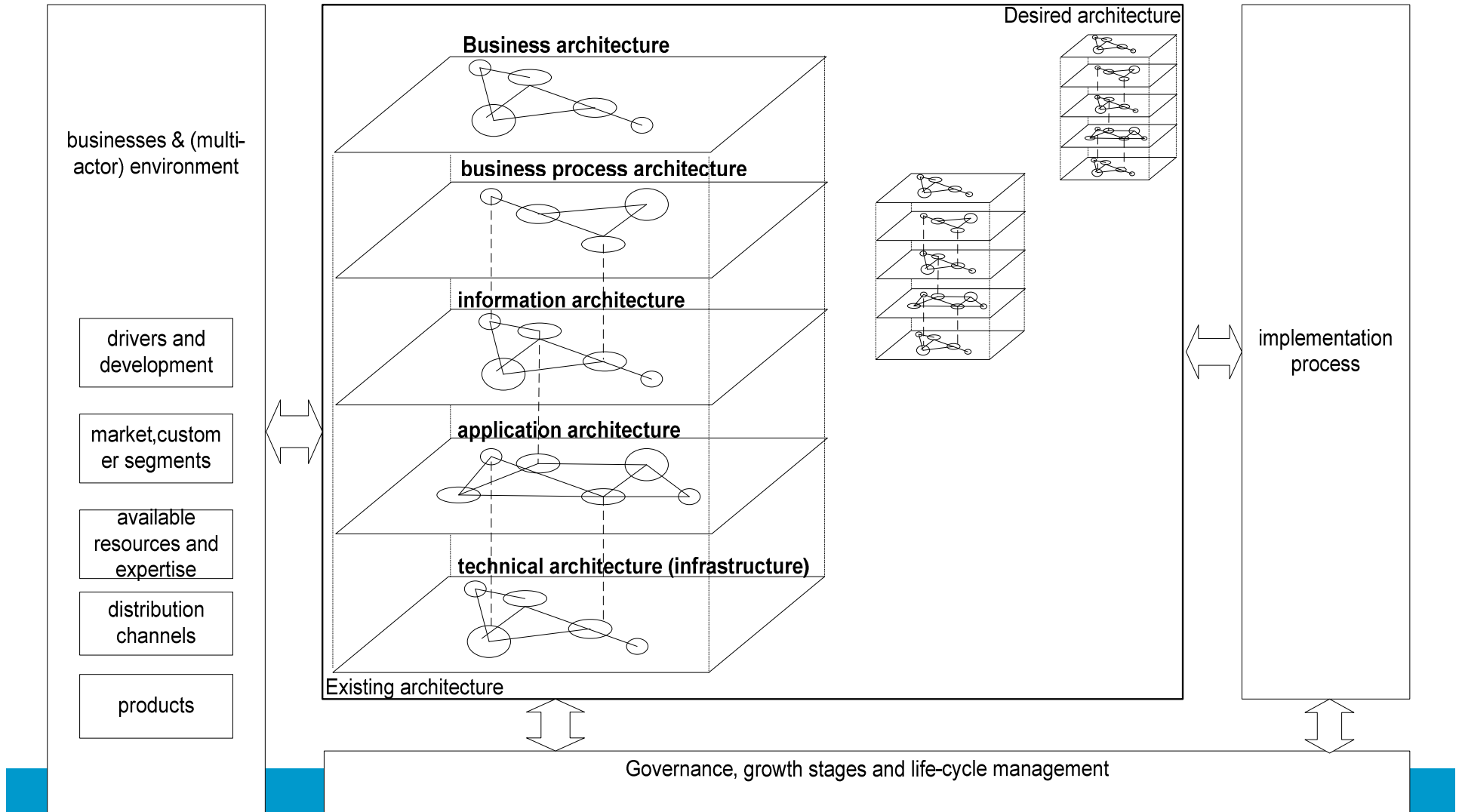
Discussion

Backup slides

Architecture purposes

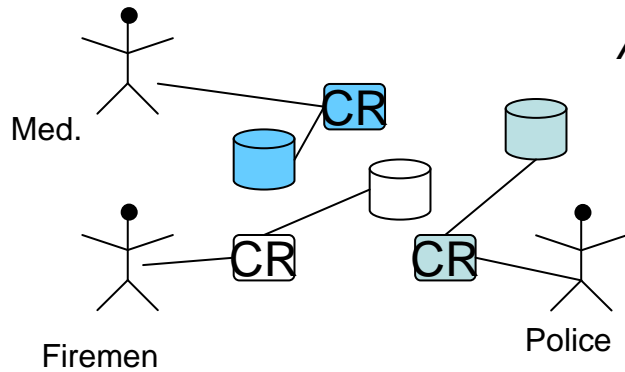
	Ex-ante	Ex-post
Descriptive	Communication instrument	Evaluation instrument
Prescriptive	Design instrument	Redesign instrument

Architecture framework



A Gap Analysis

Current CM Information Systems

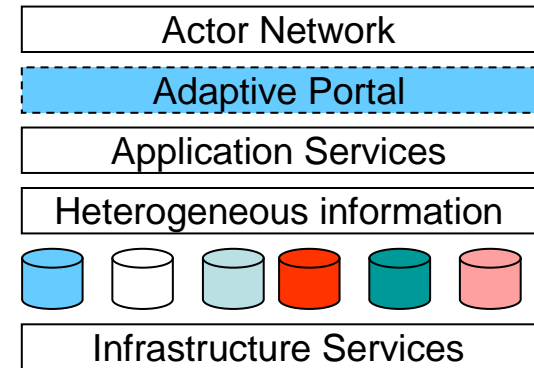


- Fragmented IT Landscape
- Low flexibility & high failure rate
- Technology orientation
- Silo's/centralized architecture
- Voice communication
- Pre-structured coordination support

Architectural Requirements?

↑
 Higher SA?
 Quality?
 Intelligence?
 Flexibility?
 Robustness?
 ↓

Desired CM Information Systems



- Intelligent/context aware
- Flexible & Robust
- User centric
- Inter-organizational use
- Multimedia info exchange
- Emergent coordination support

Selection Criteria for Case Studies

- *Multi Actor Environment*
- *High Information intensity*
- *Source Distribution*
- *Distributed expertise*
- *Source Heterogeneity*
- *Time Pressure*
- *High uncertainty/failure cost*
- *Need for adaptivity*

Conceptual Model

Variables of an adaptive CMS Measures of an adaptive CMS

