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Agent Coordination Mechanisms in the COMBINED Systems First Aid Case

Patrick Storms • Y'all • Waalwijk, The Netherlands

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Combined Systems (1)

COMBINED Systems

- **C**haotic **O**pen world **M**ulti-agent **B**ased **I**ntelligently **NE**tworked **D**ecision support **Systems**
  - Large scale decision support systems in chaotic and complex environments
  - Early and improved situation awareness, decision making and action selection
  - Self-managing mechanisms and agent based techniques
  - And more…
- Demonstrator: crisis scenario in the Rotterdam Harbour

Combined Systems (2)

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- October 2002 – October 2006
- Decis Lab, Delft:
  - University of Amsterdam
  - Technical University Delft
  - TNO (contract research for companies, government bodies and public organizations)
  - Thales (multinational in defense, and communication systems)
  - Dutch SME subcontractors: Acklin, Y'All, Inology
- See http://combined.decis.nl

Case (part of Harbour Scenario)

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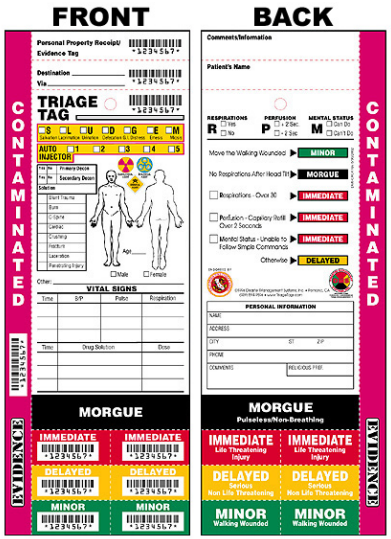
- Case: casualties in the Rotterdam Harbour
  - People get sick after inhaling toxic gases
  - People get hurt when crowd panics
- Jobs
  - Localize casualties
  - Prioritize (Triage)
  - Give medical attention
  - Evacuate



- Work needs to be allocated to emergency personnel, e.g. medics

Assumptions

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- Medics and casualties can communicate via PDAs
  - Cell phones (GSM/SMS, WAP, GPRS, UMTS)
  - Organizers (WiFi)
  - Active Triage Cards (RFID)

- Each medic and casualty is represented by a software agent
  - Agent executes on PDA
  - Agent interacts with other agents on PDAs
  - Network of agents that negotiate on medic-casualty assignment

- Benefits:
  - Medics are relieved from planning tasks
  - Casualties are sooner taken care of

First Aid Problem Definition

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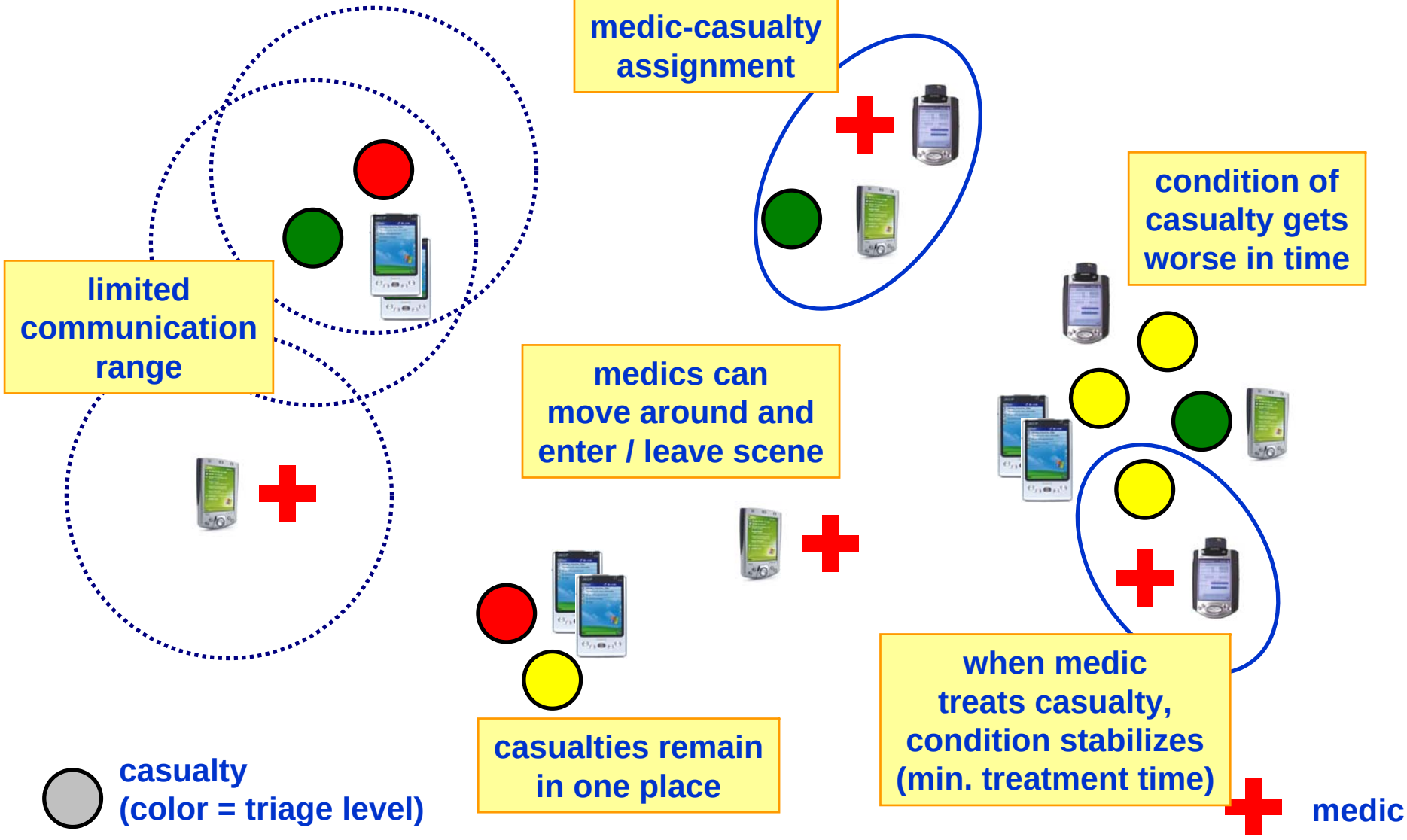

Testbed (Logical Architecture)

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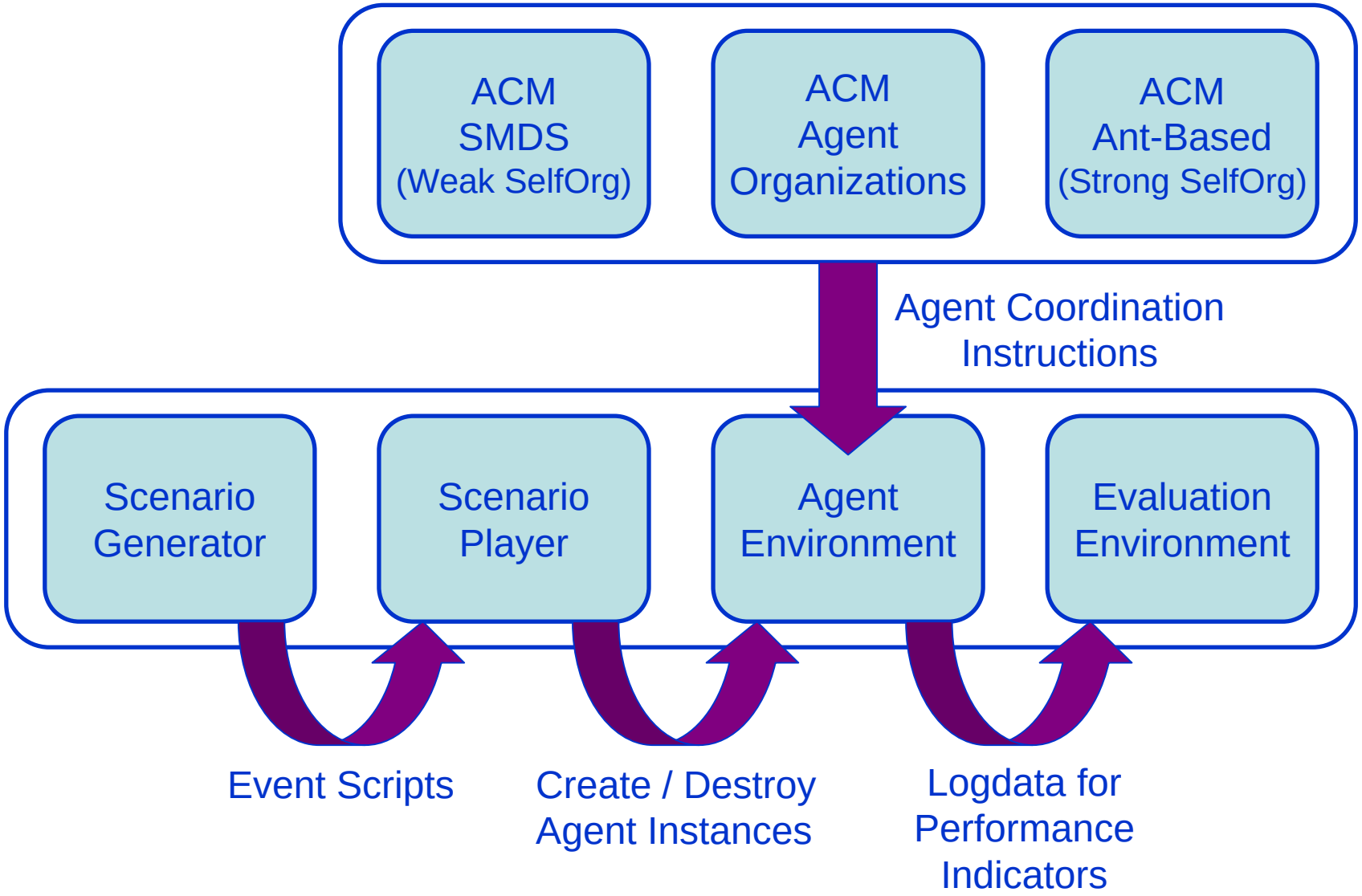

(1) SMDS Approach

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- Self Managing Distributed Systems
  - Knowledge base system (KBS) for system resources, with formal descriptions of capabilities, dependencies and constraints
  - Plan for execution is inferred from KBS, based on a goal or information need
  - Plan is executed and monitored
  - Implementation: COMPASS (Thales)
- Continuously searching for an overall optimum

(2) Organizational Approach

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- Agents act using “social rules”, e.g.
  - Medics will ask for work when entering scene
  - Medics will handover jobs when leaving scene
  - Severe casualties have higher priority
  - Make 1-to-1 deals with other medics
- Organizational principle
  - Determine work (strategy)
  - Divide work (strategy)
  - Coordinate work (management)
  - Perform work (operation)
- Coordination approaches, inspired by human organizations (Mintzberg)

(3) Ant-based Approach

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- Ant-Based (similar to routing application)
  - No *a priori* assumptions on coordination
  - Agents interact through their environment (indirect)
  - Agents act according to simple behavioral rules
  - Coordination emerges
- Vehicle Routing with Time Windows
  - Medic Agents individually plan their task
  - Node = casualty
  - Time Window = time to next triage level

Current Challenges

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- Define overall performance indicators
  - Functional
    - “When are the agents doing a good job?”
    - Utility function
  - Non-functional
    - Response to sudden disruptions in environment
    - Predictability: do we get similar results over and over
    - Communication load, CPU load
- Model MARA problem for Organizational approach
  - What are the resources?
  - Who negotiates?
  - How to value resources?
  - etc.

Functional Performance Indicator

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- "When are the agents doing a good job?"

- Primary: penalty for transitions between triage levels, e.g.
  - After 25 minutes Green → Yellow: penalty = 1
  - After 15 minutes Yellow → Red: penalty = 5
  - After 10 minutes Red → Black: penalty = 25
  - Performance indicator = (sum of penalties) / (max penalty)
  - Discussion: penalty is arbitrary → what is a sensible choice?

- Secondary: minimize medic idle time
  - Medic is not idle when treating casualty
  - Medic is idle when in transit, or doing nothing
  - Performance indicator = (sum idle time) / (total time)

Agent Organization Approach

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- Casualties are tasks (= treatment)
  - discrete, indivisible, non-sharable
  - perishable & dynamic
  - multi-unit
- Medics negotiate on tasks
  - Medic is allocated a “job list” of treatment tasks
  - Simple 1-to-1 deals
  - Medic is “happy” with his job list when:
    - All tasks on job list can be handled in time…
    - …. with minimal penalty
    - … and minimal idle time
  - How to handle the dynamics in negotiation?

End

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Thank you for your attention

Contact:
Patrick Storms
Y'All B.V.
Grotestraat 182,
NL-5141HD Waalwijk,
The Netherlands
patrick@yall.nl