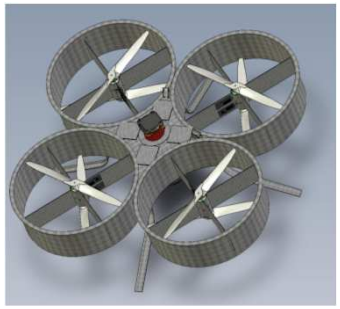
Collaborative Technology for Disaster Management

Mark Neerincx



TNO innovation for life

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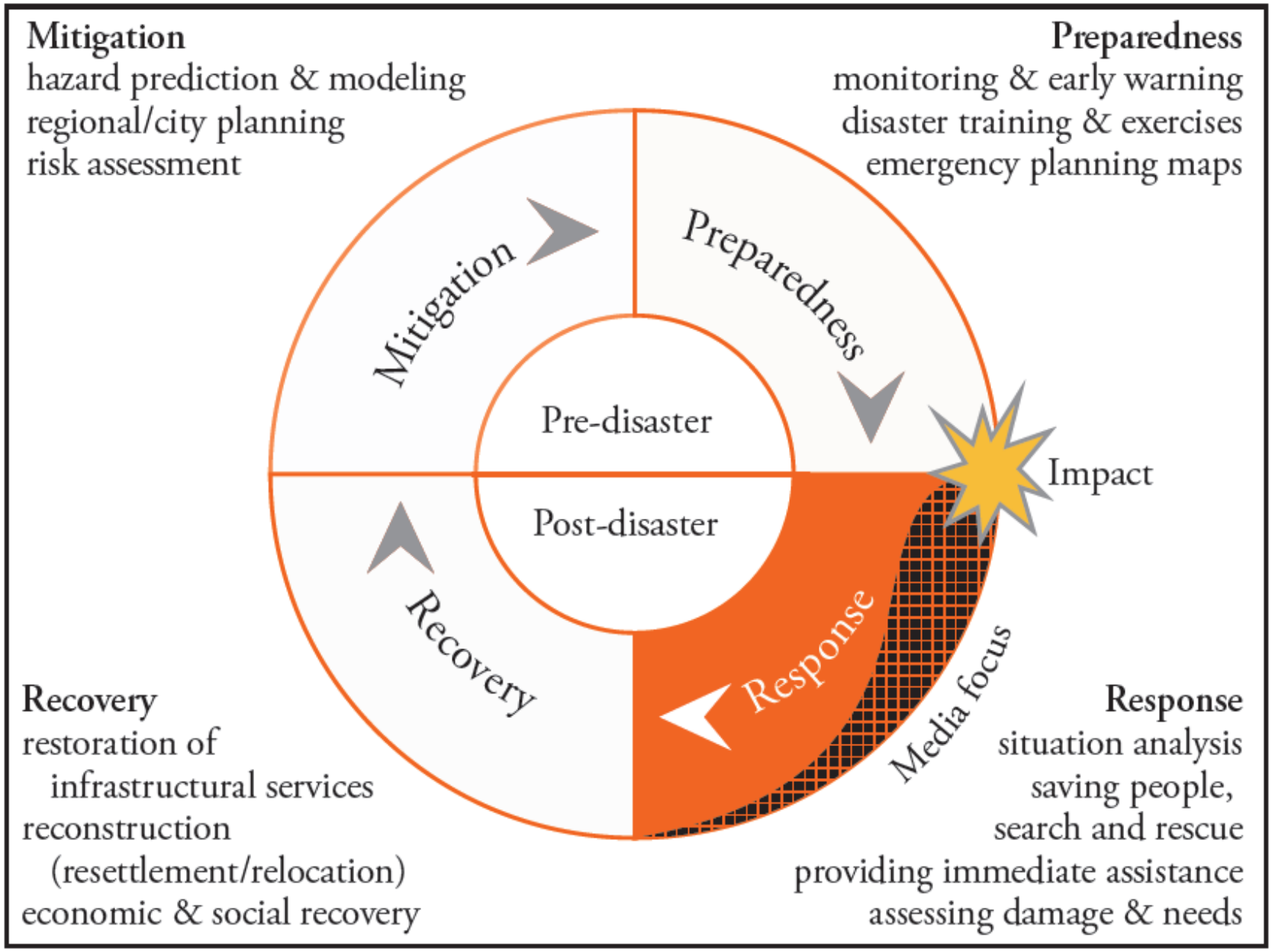
Disaster Management

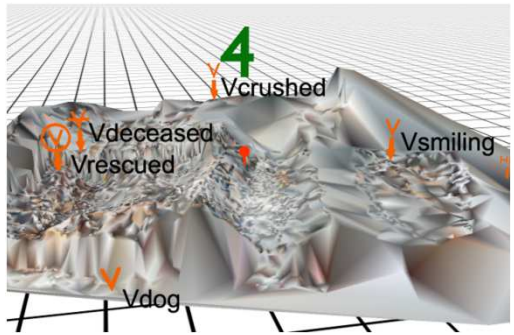


Collaboration during Disaster Response

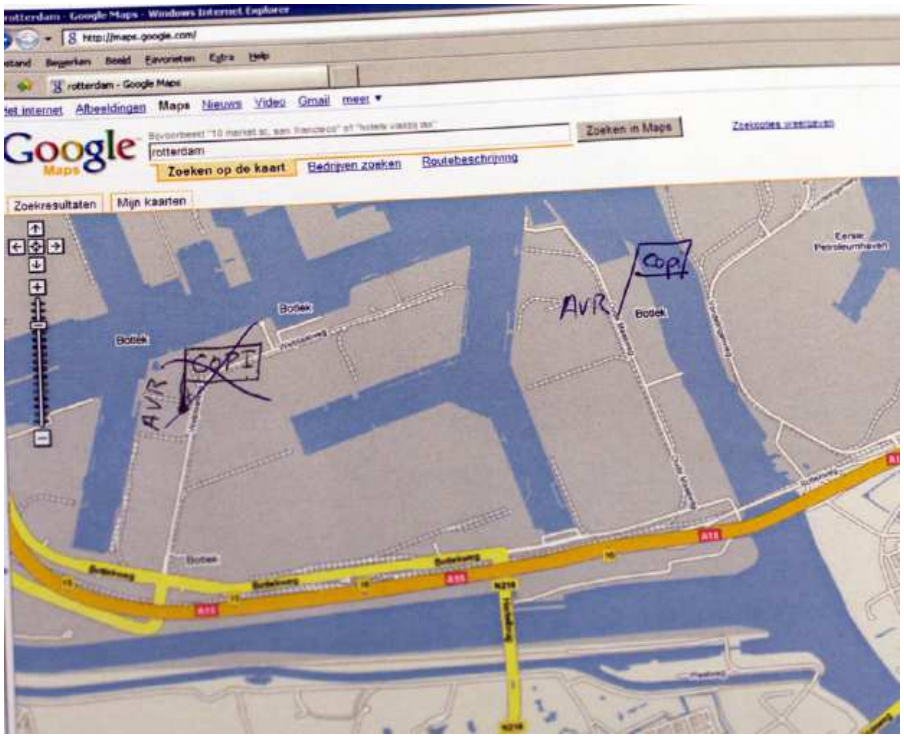
- Situated Collaboration:
  - Structural, prepared and managed by organizations
  - Ad-hoc, occurring by “coincidental” presence or remote involvement of persons

- Disaster Response:
  - rescue victims & save the environment
  - safeguard & coordinate persons’ actions
  - acquire (shared & complementary) situation awareness

- Collaborative Technology:
  - mobile network-based navigation support
  - distributed, mixed-initiative situation mapping
  - adaptive –ground and flying– robots that sense & act in dangerous & difficult-to-access environments.



Current Practice



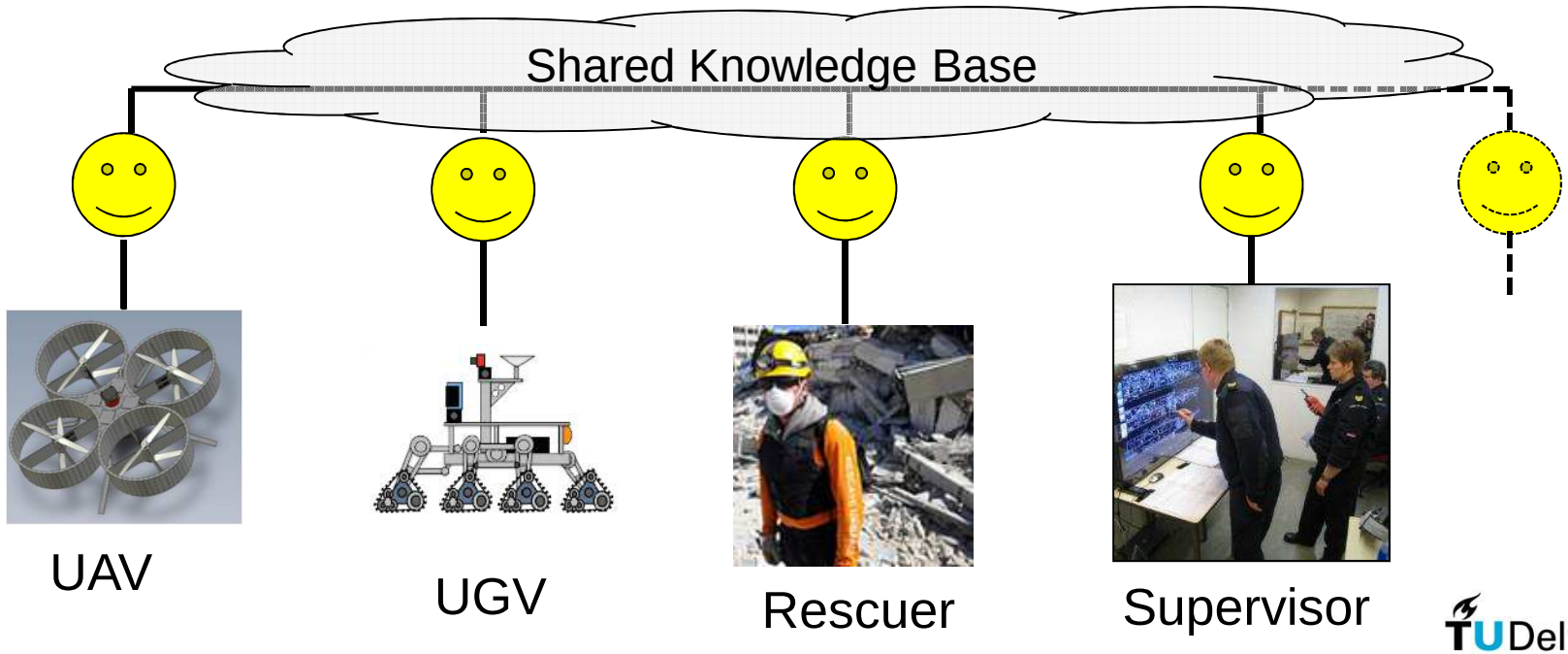
Human-Agent Teamwork

Vision: Agent-mediated human-robot team work

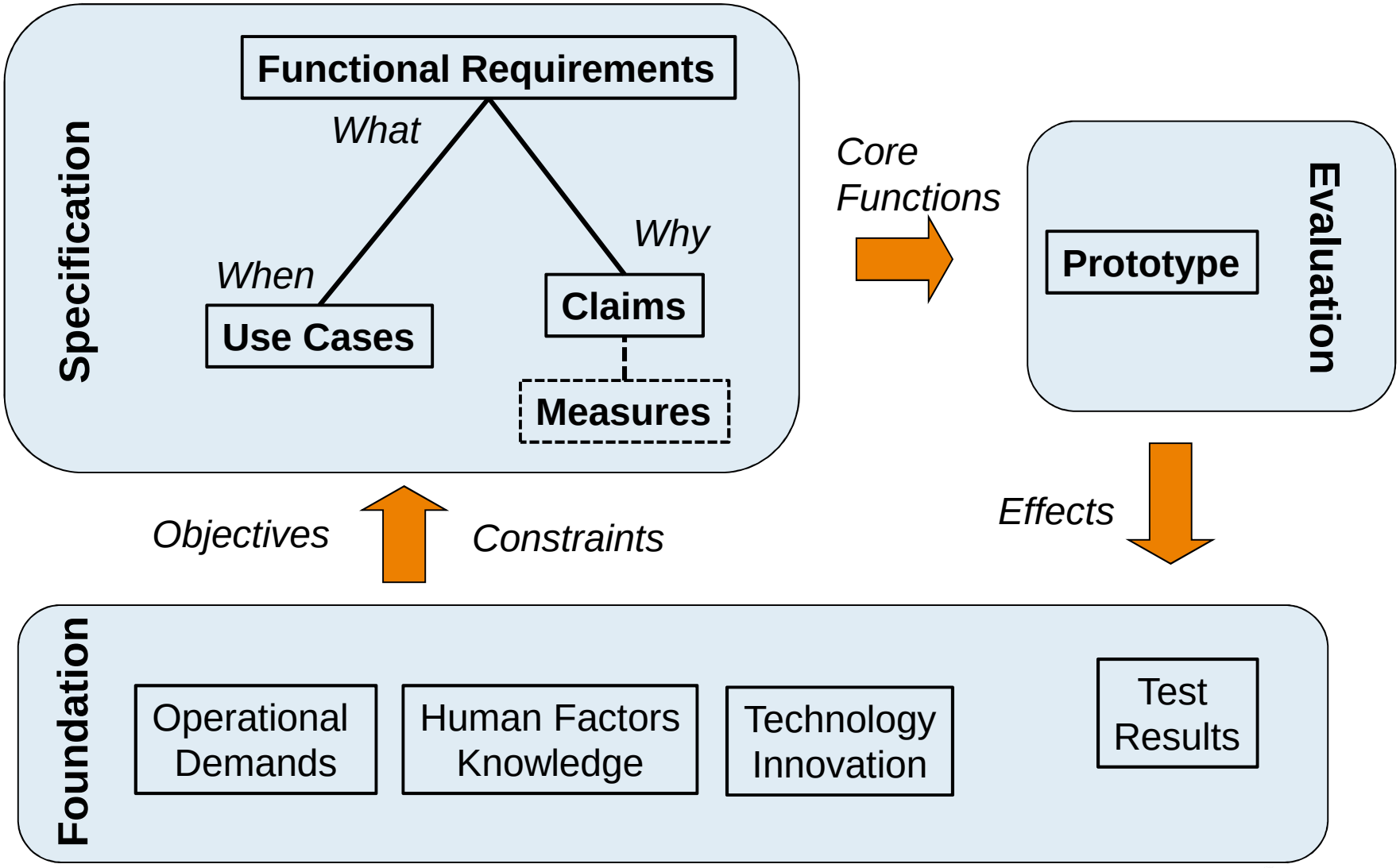
- Sharing information
- Balancing workload
- Adjusting robot autonomy

Target outcome: performance and resilience

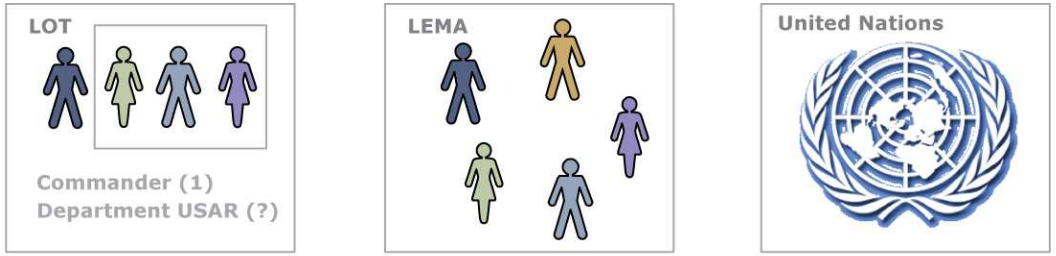
- Effective and efficient human-robot operations,
- Attuned to human, robot and situational constraints



situated Cognitive Engineering

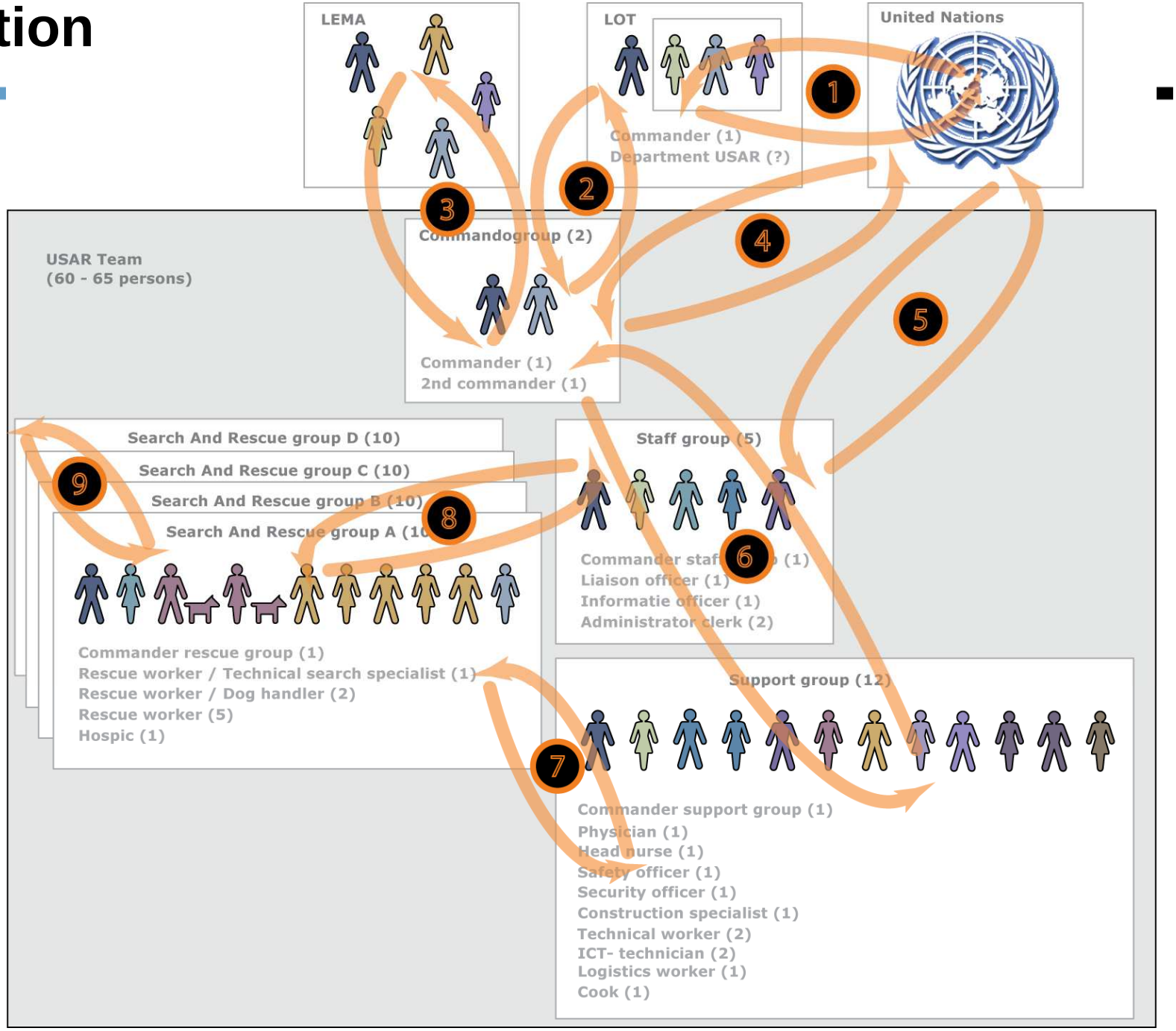


Foundation


LOT
Commander (1)
Department USAR (?)
LEMA
United Nations


USAR Team
(60 - 65 persons)
Commandogroup (2)
Commander (1)
2nd commander (1)
Search And Rescue group D (10)
Search And Rescue group C (10)
Search And Rescue group B (10)
Search And Rescue group A (10)
Commander rescue group (1)
Rescue worker / Technical search specialist (1)
Rescue worker / Dog handler (2)
Rescue worker (5)
Hospic (1)
Staff group (5)
Commander staff group (1)
Liaison officer (1)
Informatie officer (1)
Administrator clerk (2)
Support group (12)
Commander support group (1)
Physician (1)
Head nurse (1)
Safety officer (1)
Security officer (1)
Construction specialist (1)
Technical worker (2)
ICT- technician (2)
Logistics worker (1)
Cook (1)

Foundation


LEMA
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8
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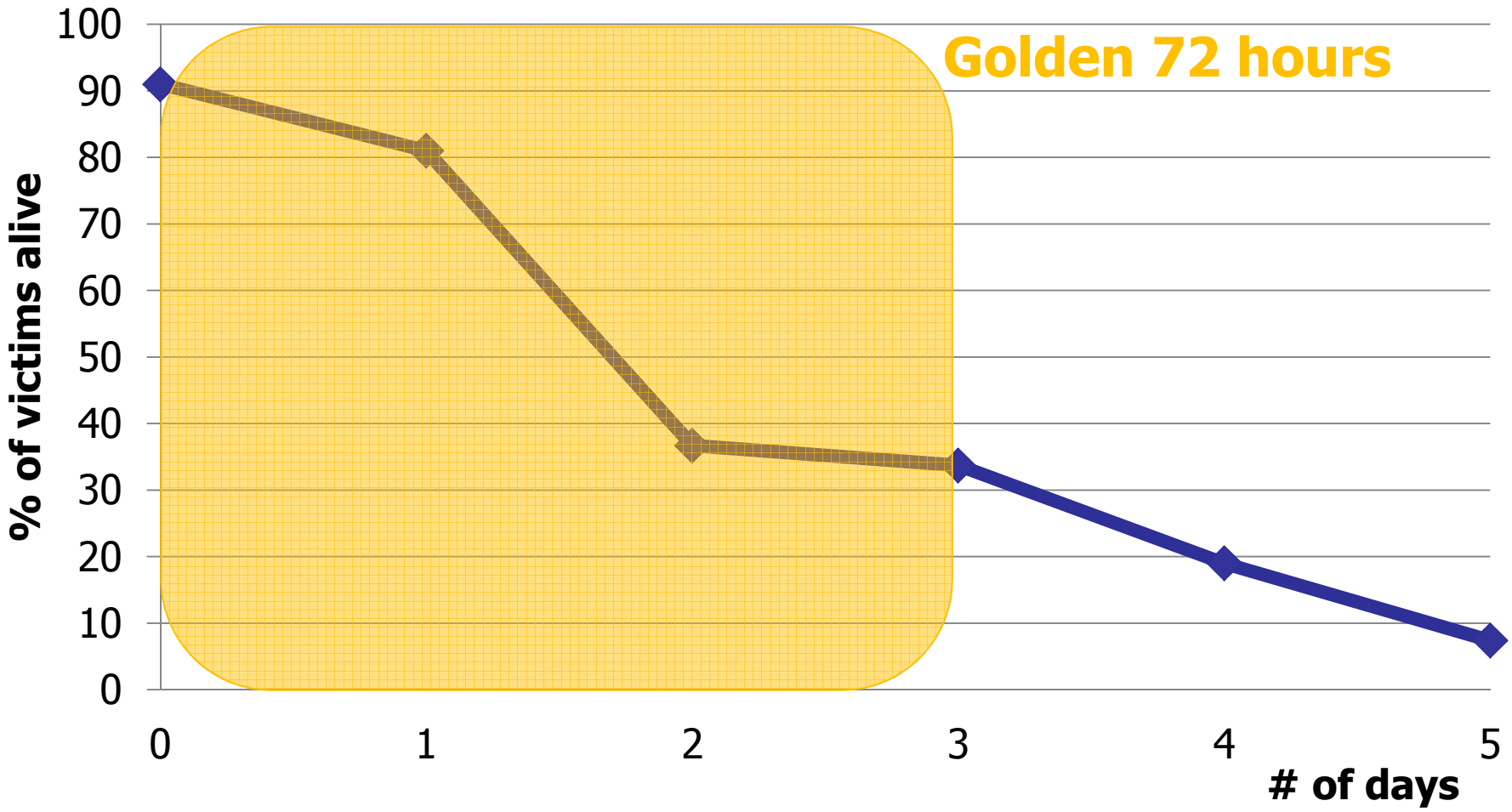
Foundation


Golden 72 hours
% of victims alive
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
# of days

Foundation:

Observations in Dubai and Czech Republic

Foundation

Figure 3.4. The group commander started to draw the map of the building and locations of victims found

Figure 3.5. The group commander briefed his group on how to best rescue the victims

Figure 3.6. The rescue operation

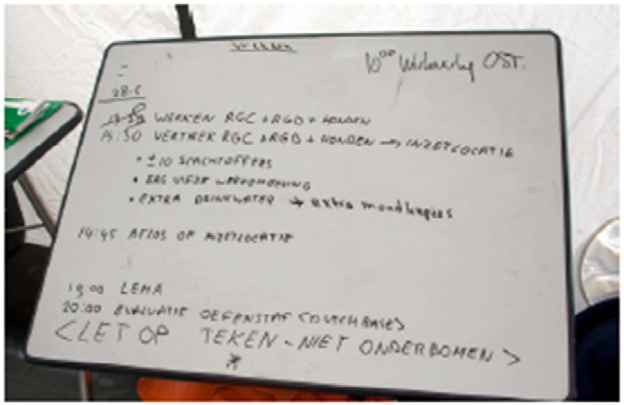


Figure 3.7. The situation board at the command post

Figure 3.8. The more complete map of the building developing over time

Figure 3.9. The group commander explaining the situation to the new team who arrived at the

Problem Scenario 1

- Setting: Rescue team is digging towards a victim under extreme temperatures (40+ degrees Celsius). Water supply is running out….
- Lack of observability between staff at the base camp and rescue team leads to suboptimal operations.

Lack of Observability

Problem Scenario 2

- Setting: Rescue team has been working for a long time to excavate a victim.
- Lack of observability between the base-camp and the rescue team leads to unnecessary early wake-up of the other recue team to take over their job.

Problem Scenario 3

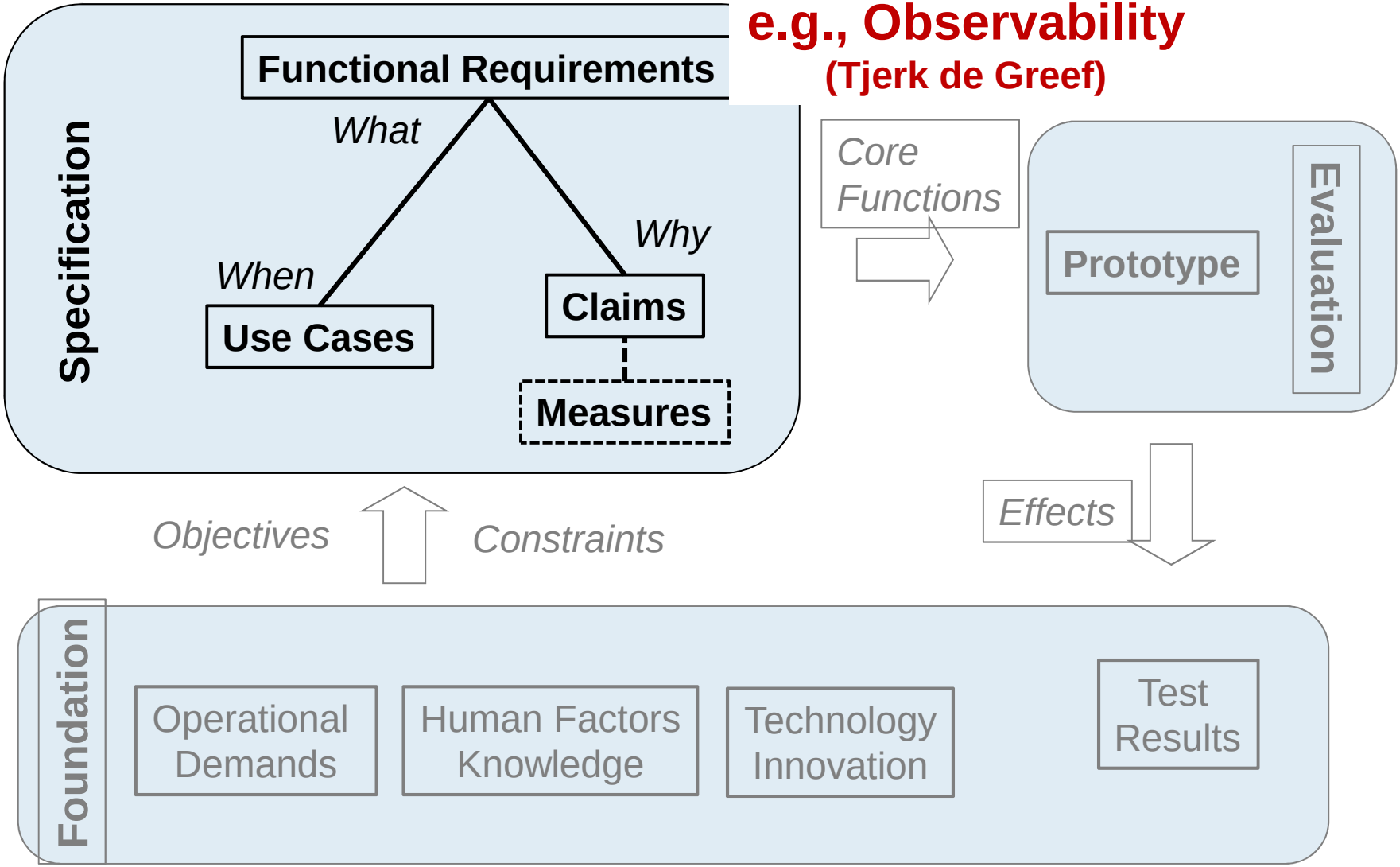
- Setting: the commander of USAR.nl enters the staff tent and wants to know where each team is, what they are doing, and how well they are doing.

- Lack of observability requires the commander to make interrupting phone calls to each rescue team

Problem Scenario 4

- Setting: Rescue team needs water in order to drill a hole through a 50 cm wide wall.
- Lack of observability over time between rescue teams leads to suboptimal operations.

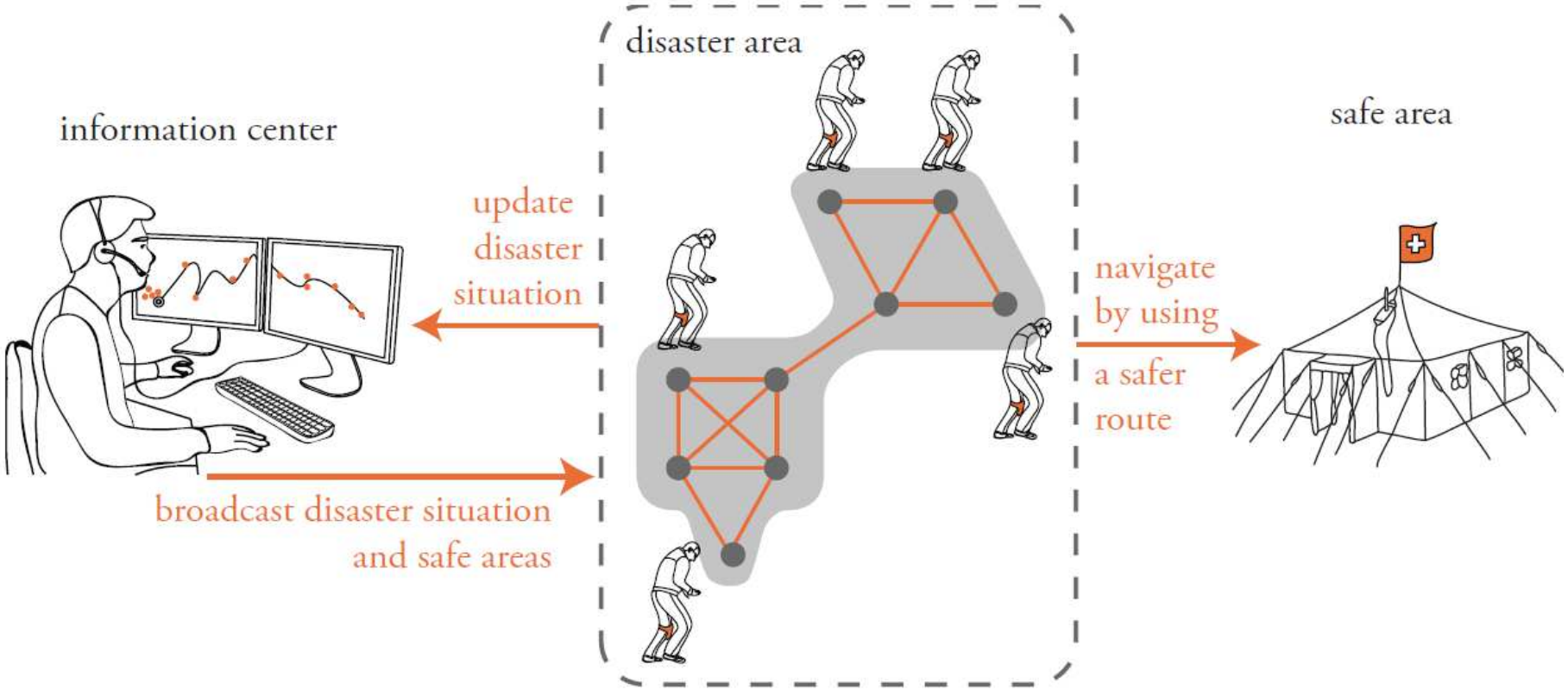
situated Cognitive Engineering



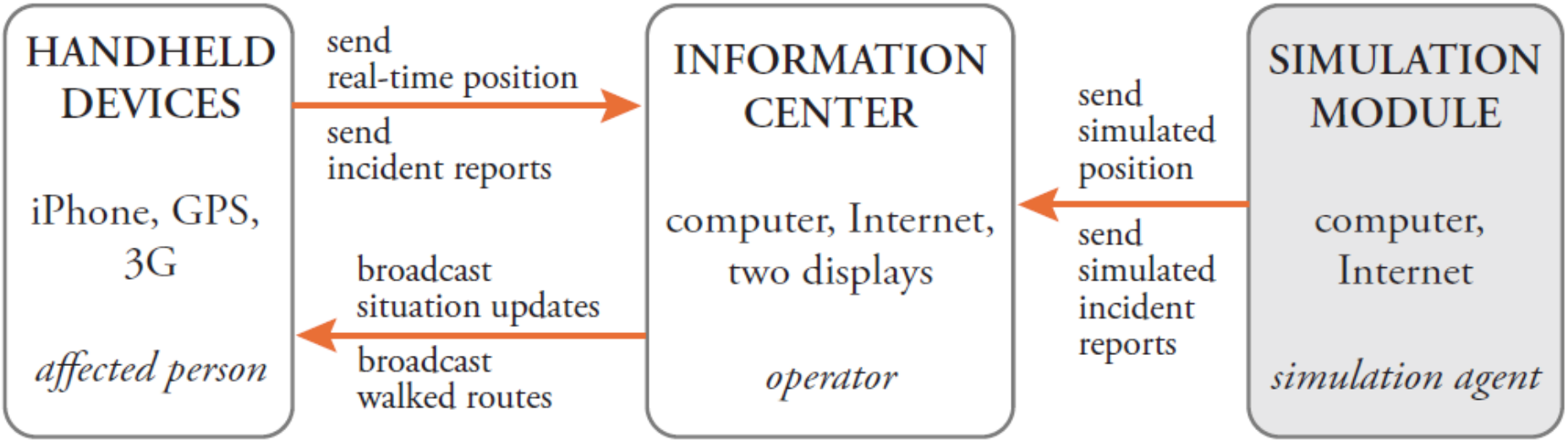
Specification Example (simplified)

Req01	The observability module shall show the work progress of all distributed rescue teams to each other.	
Claim	Observability improves the activity awareness and communication efficiency, resulting into adequate coordination and fast operations, with minimal costs of workload and micro-management	
	+	Improves activity awareness (questionnaire) Improves coordination (resource deployment) Communication efficiency (time for communication) Fast operations (time per area explored)
	-	Increases workload (questionnaire) Increases micro management (attention allocation)
Use-Cases	UC01, UC02, UC10	

Prototyping (Nike Gunawan)



Prototyping



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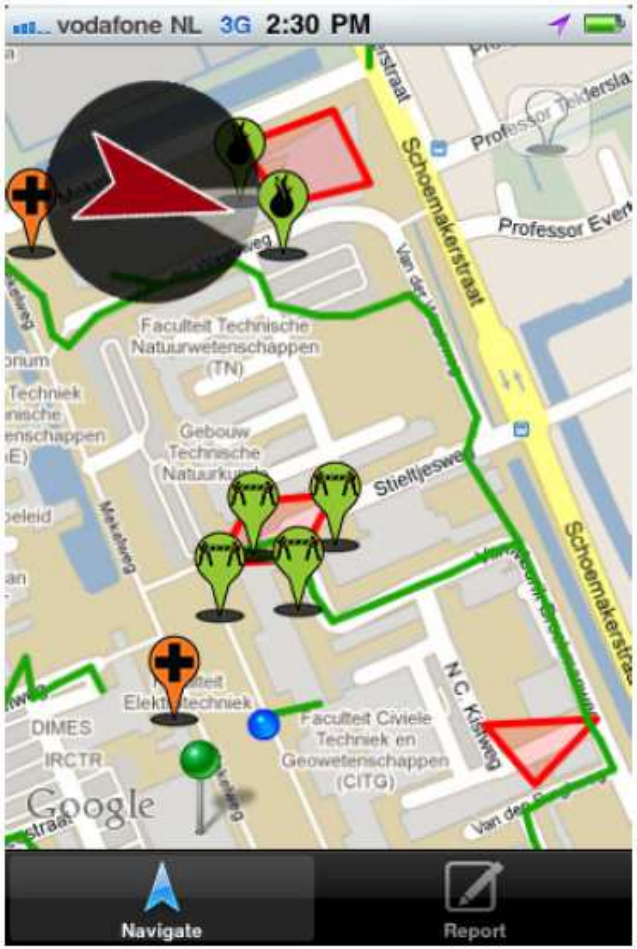

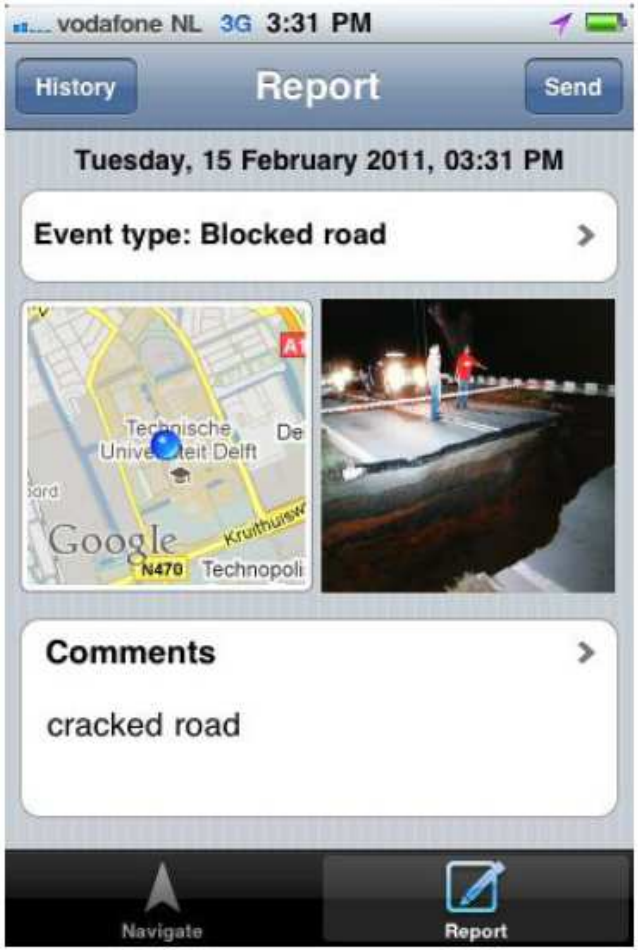

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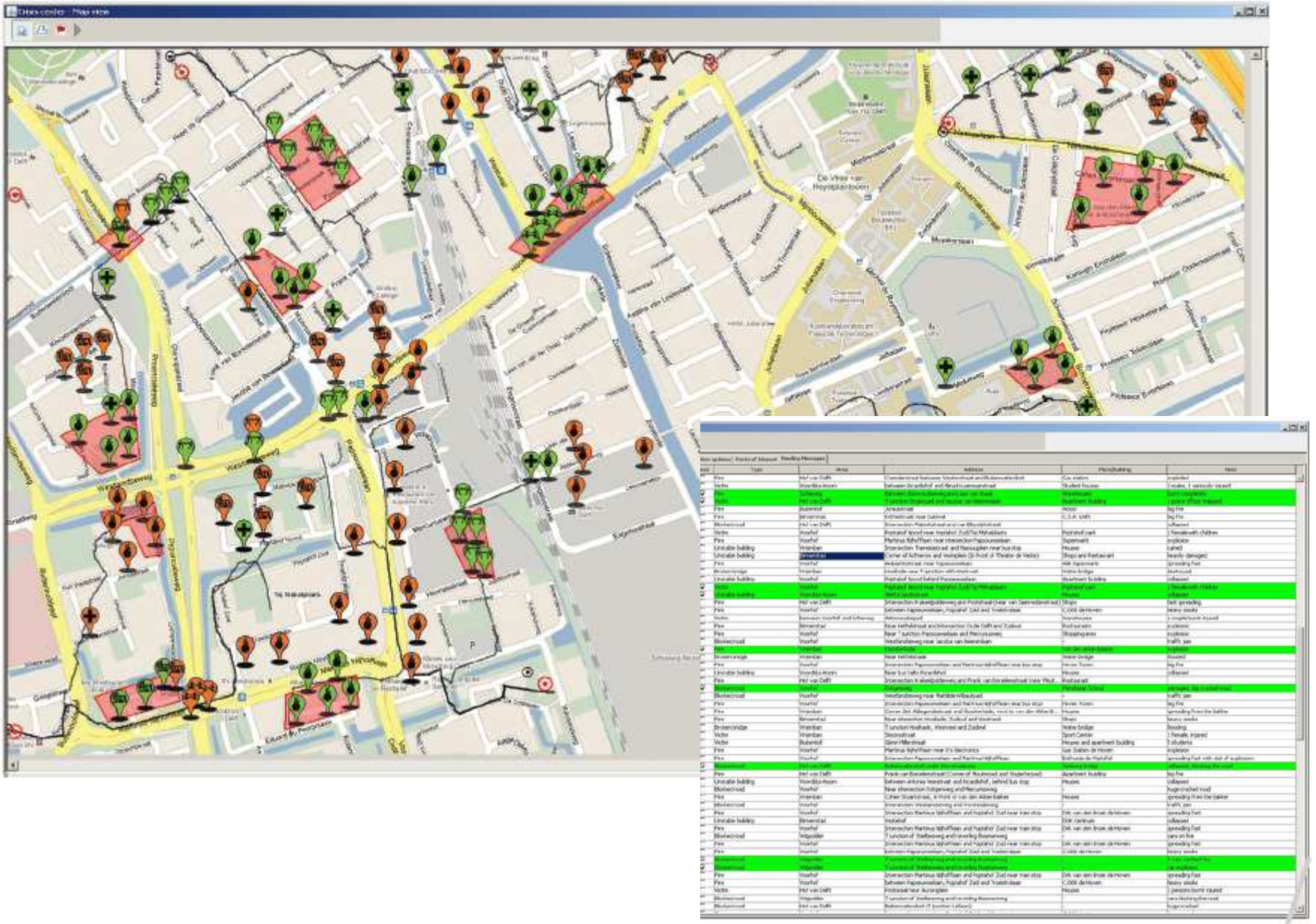

Evaluation

The collaboration

- Without adequate collaboration, a joint map can be less accurate than the underlying individual maps
  - Accommodate individual input
  - Facilitate the provision of confidence information

The integrated support system

- Improved Situation Awareness
  - Improved definition of dangerous areas
  - Improved registration of observation reports
- Safer Navigation
- Lower workload
- Improved prioritization of rescue efforts
- Improved usability

Integrating robots in the disaster response NIFTi, *EU FP7 project*

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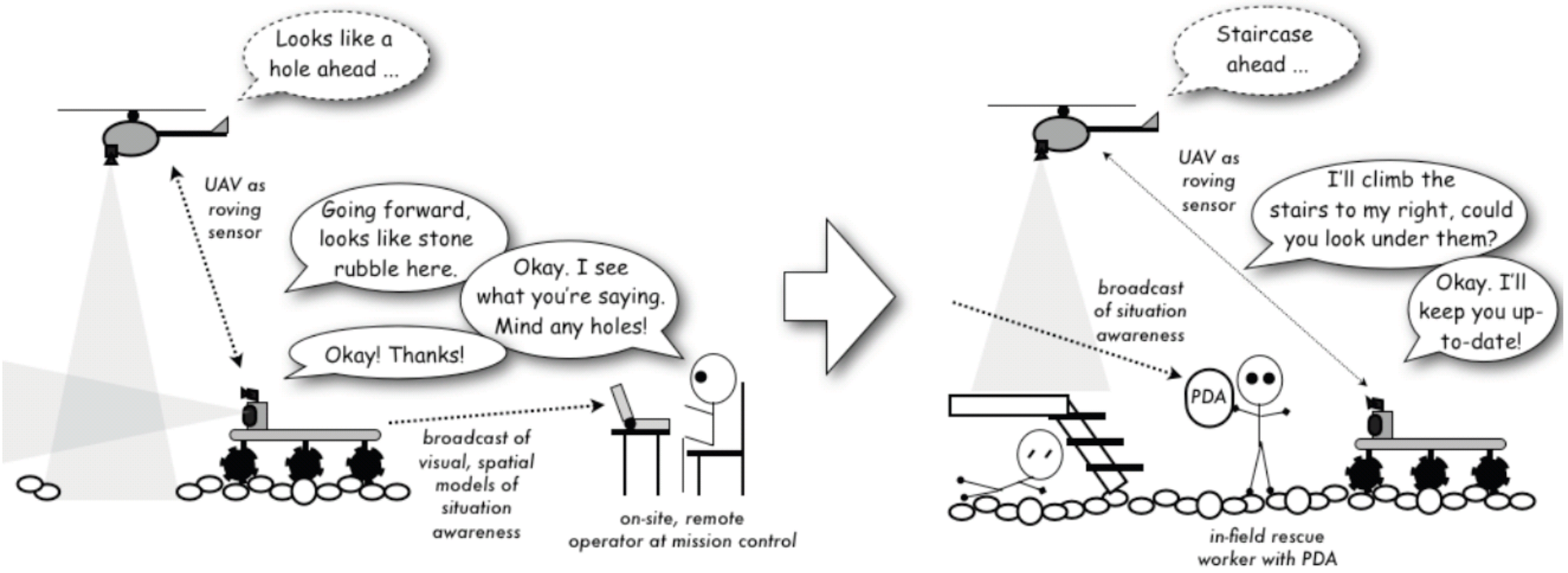

human-assisted exploration

sharing situation awareness

human-instructed exploration

In-field joint exploration planning

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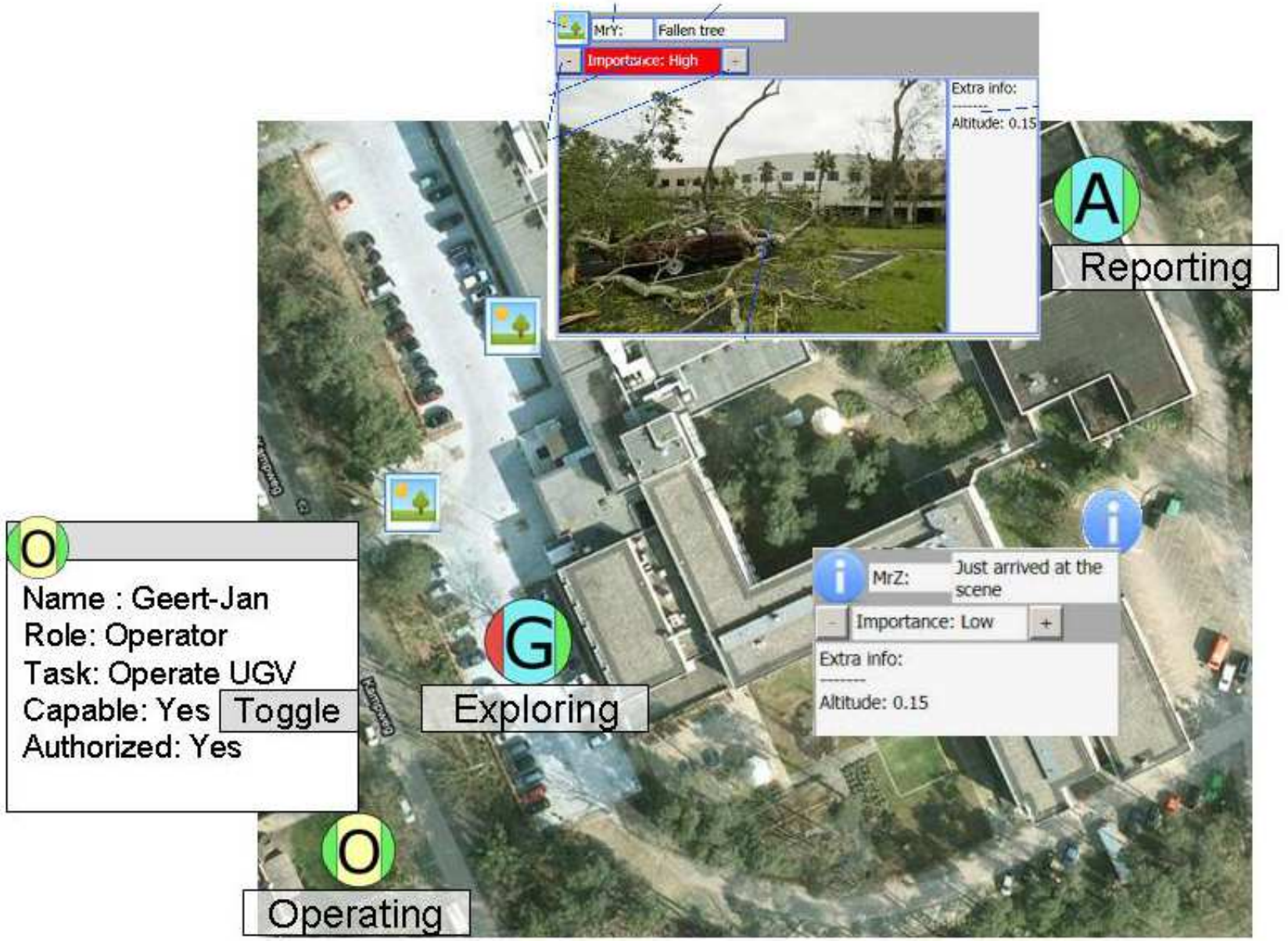
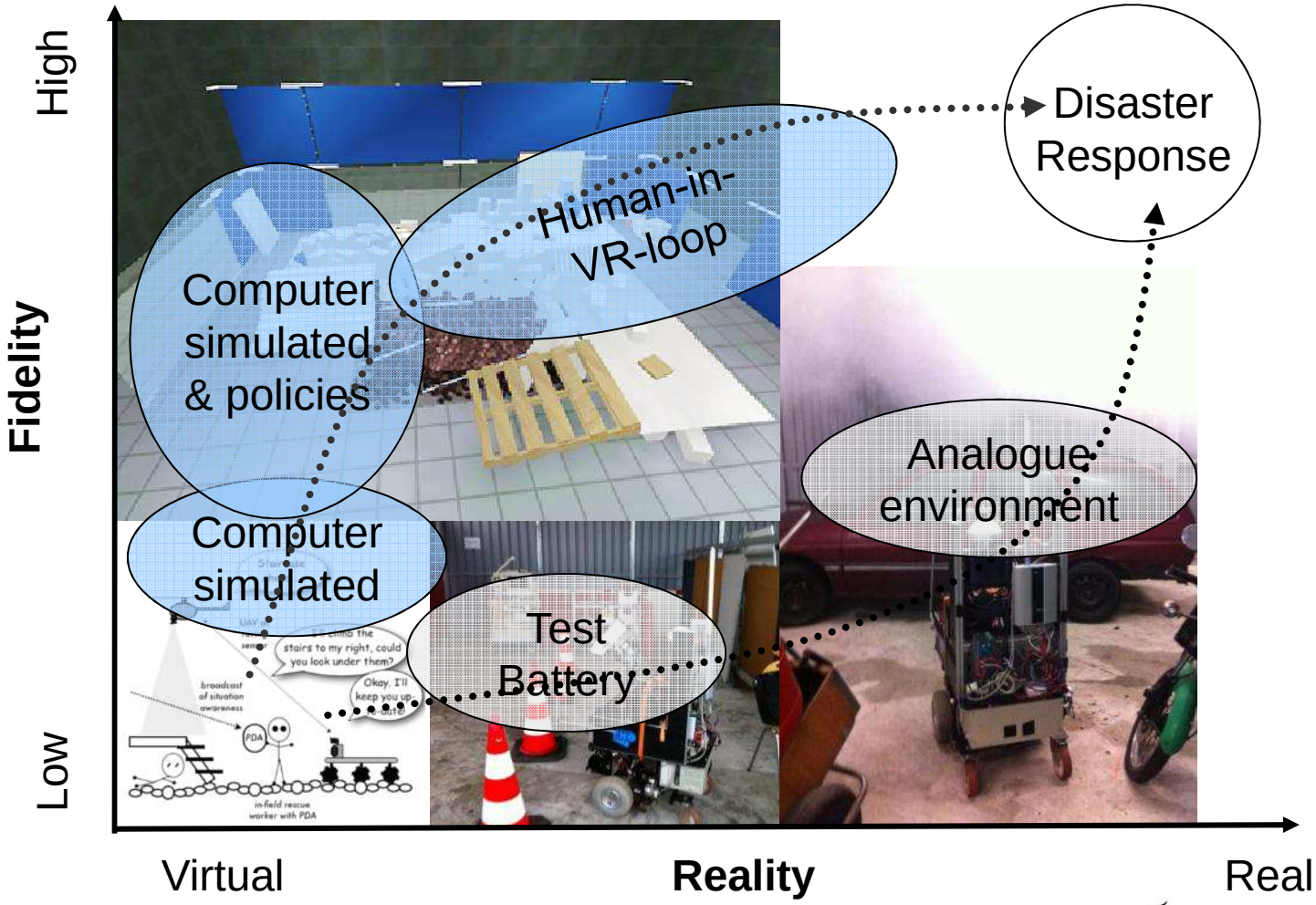
Movie

Situation and Team Awareness



Evaluations to refine and validate reqs



Development of Collaborative Technology

- Theoretical and empirical foundation
  - Improving the design rationale
  - Crossing domains

- Incremental development
  - Modular (e.g., observability display & navigation support)
  - Addressing key human factors (e.g., situation awareness & workload)
  - Iterative refinement process; moving rapidly between foundation, specification, prototyping and evaluation

- Multi-disciplinary collaborative activity

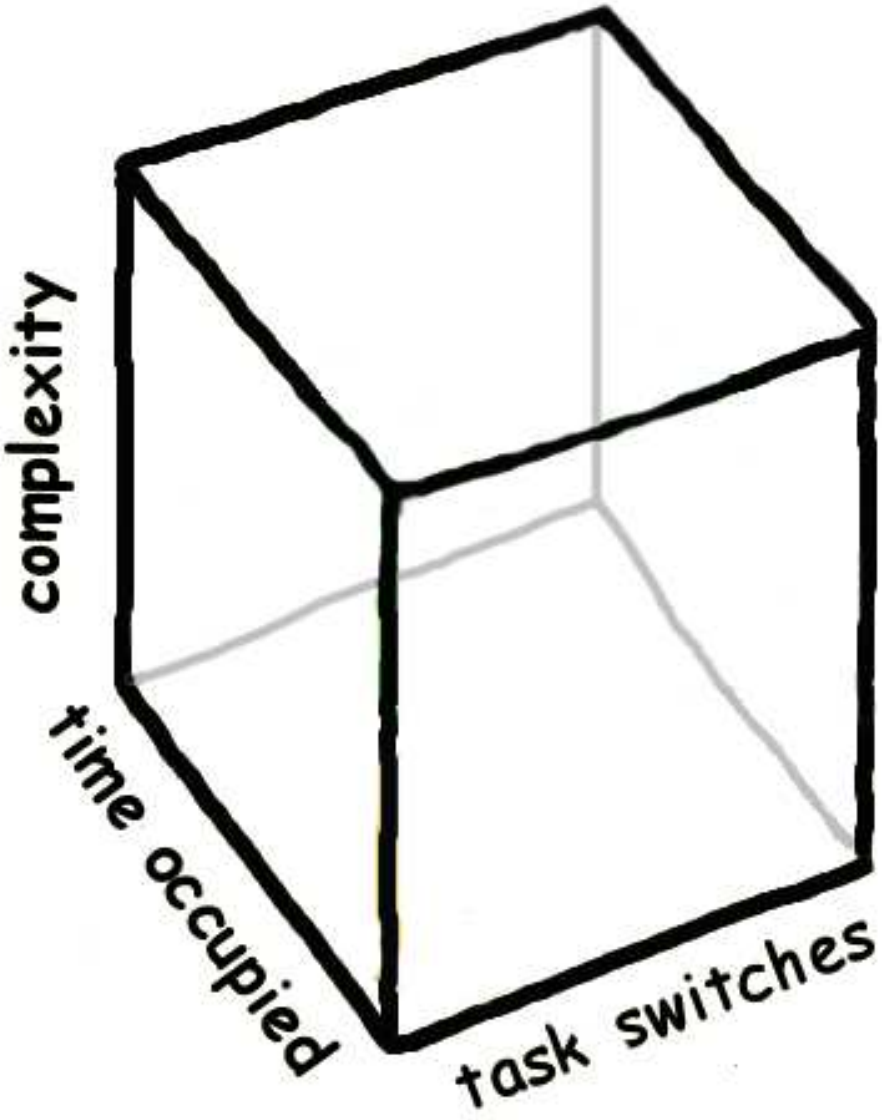
- situated Cognitive Engineering Tool (sCET), www.scetool.nl

Questions?

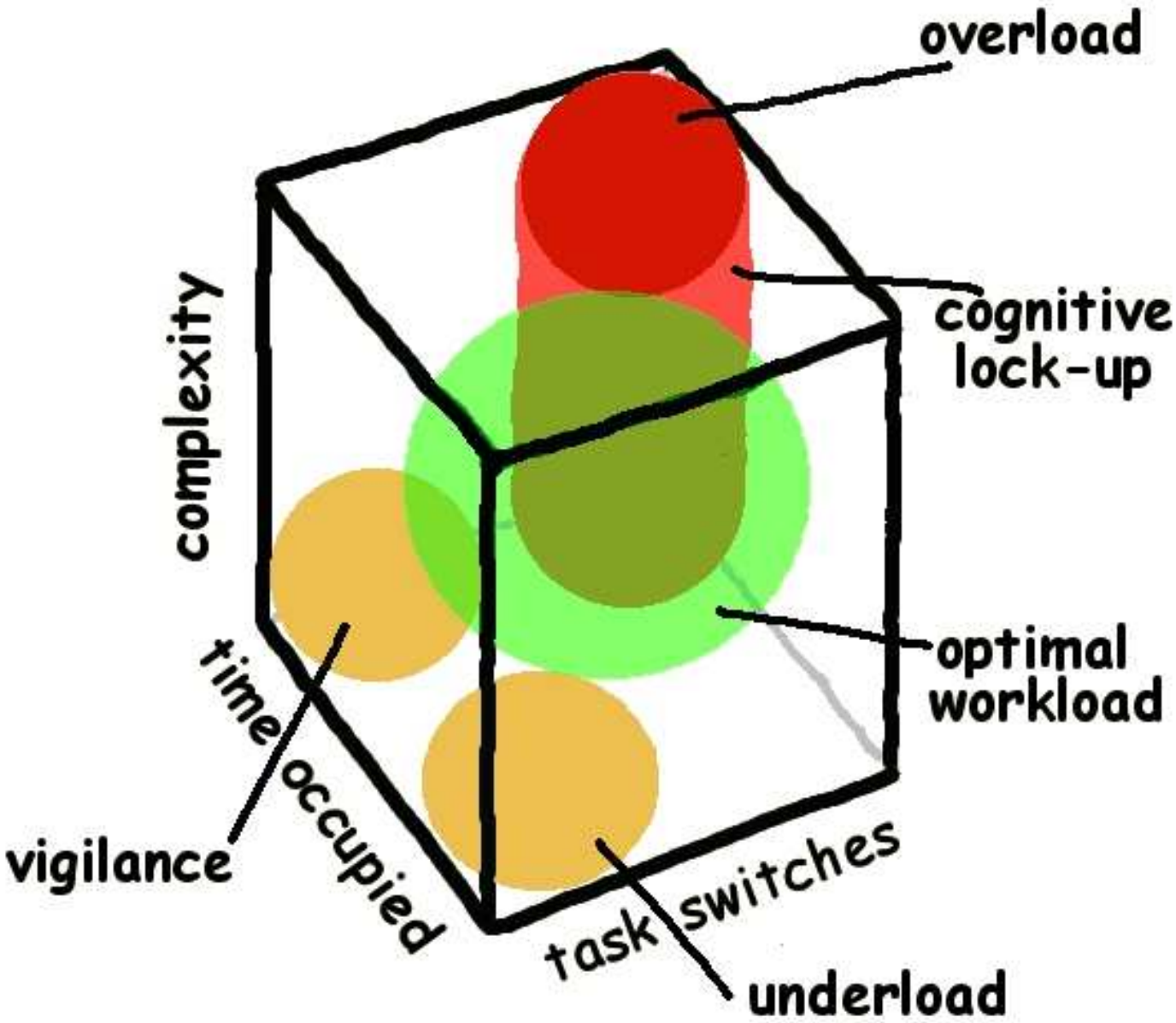
Urban Search and Rescue - USAR.NL

- Heavy team (1 out of 11), founded in 2002, 65 persons
- To find, rescue, and assist people in disaster areas
- Fully self-supporting up to ten days
- Fast response and deployment within a 5000 km radius
- Complex and dynamic operations:
  - Gathering and transporting people and resources
  - Settling at location and coordination with other teams
  - Info exchange in distributed and extreme environments
  - Establishing priorities and up-to-date shared work plan

Team Awareness: Task Allocation



Cognitive Task Load (CTL) Model



Cognitive Load *and* Emotional State