Cognitive Task Load Analysis

Specification and assessment of critical scenarios

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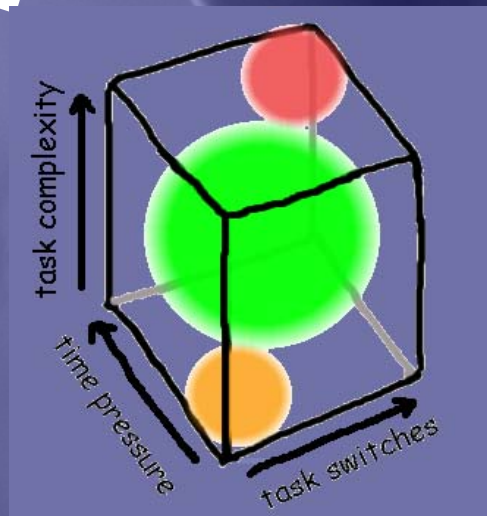
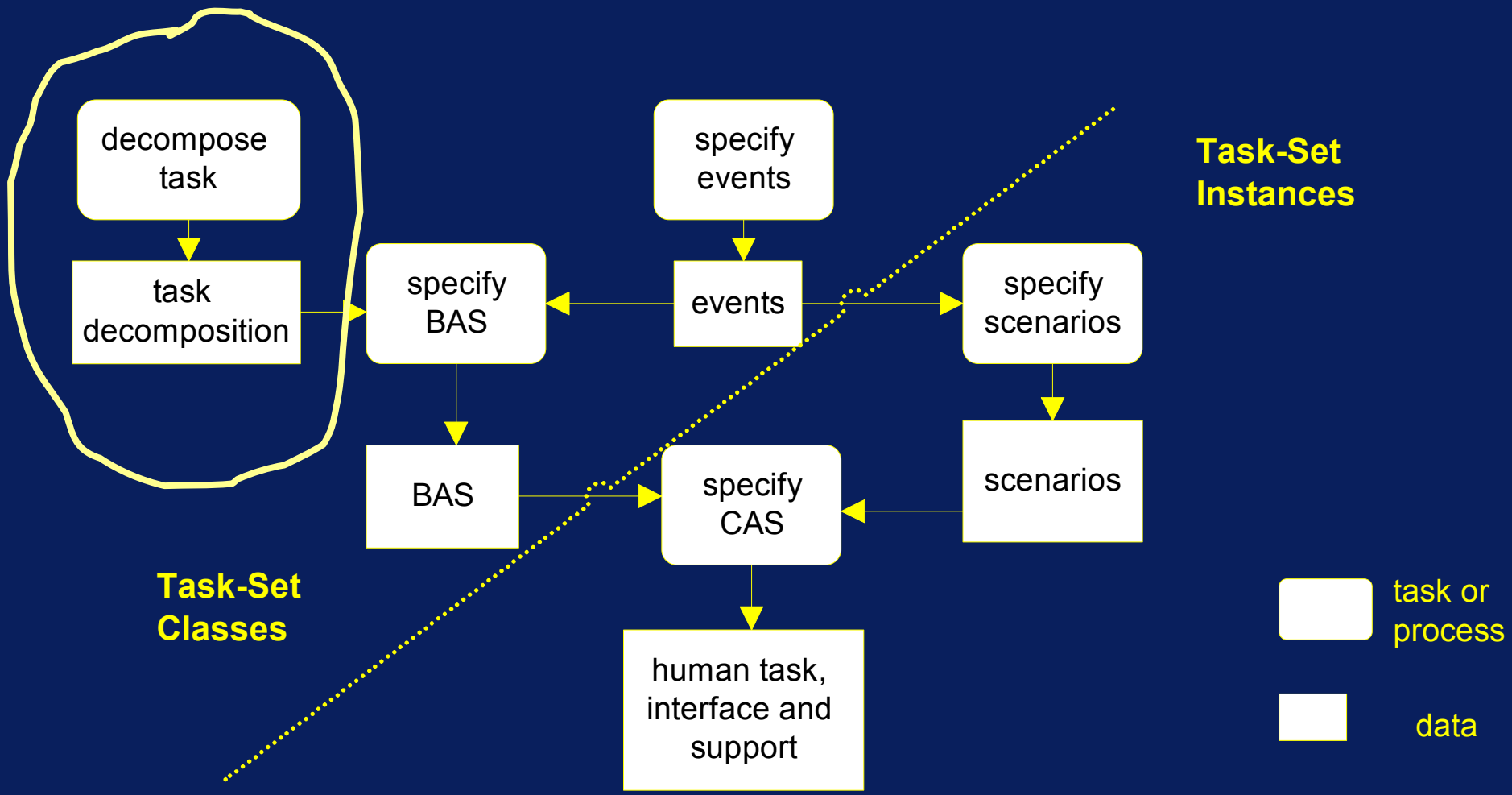
TNO Human Factors



Method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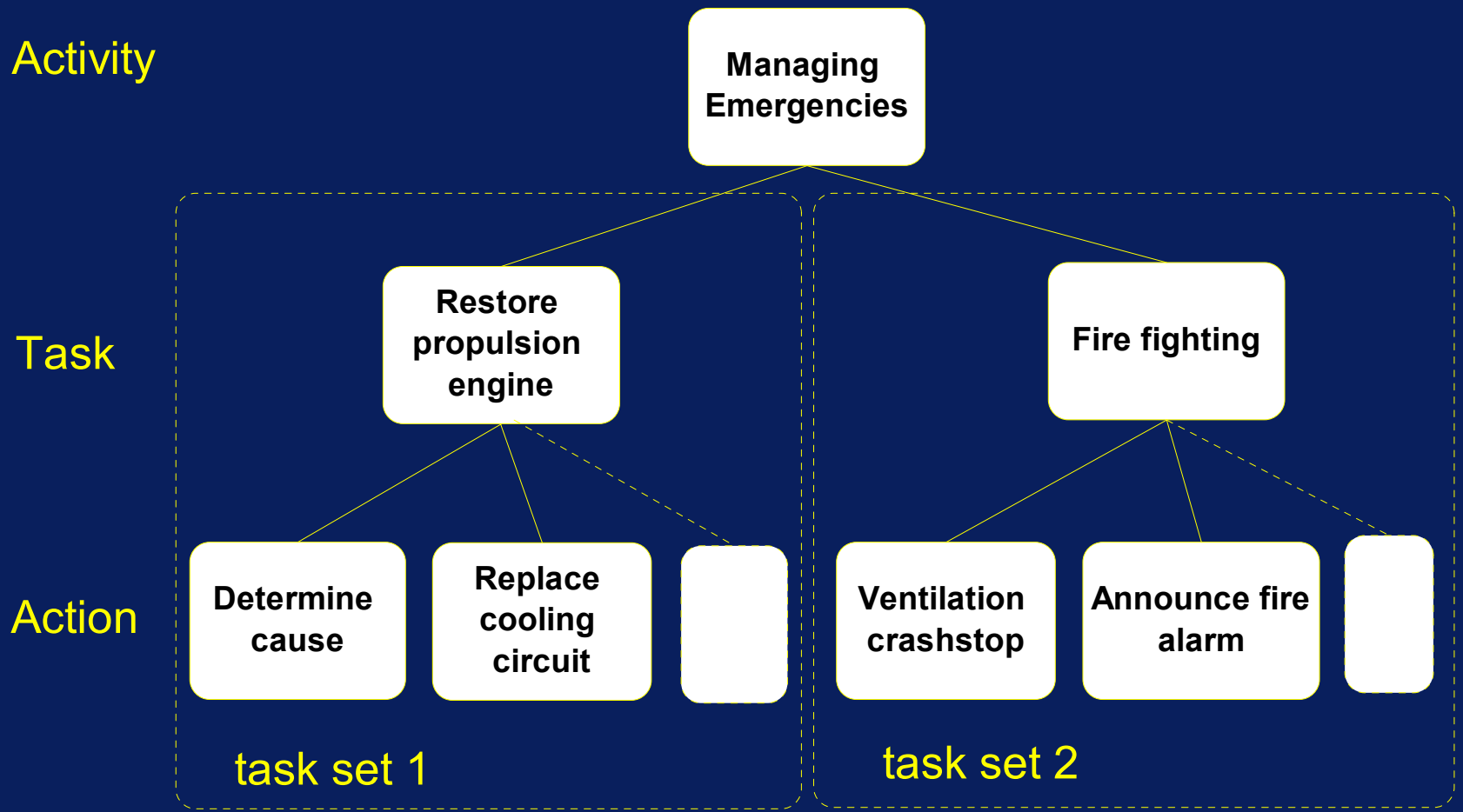
task decomposition
specify BAS
BAS
specify events
events
specify scenarios
scenarios
specify CAS
human task, interface and support
Task-Set Instances
Task-Set Classes
task or process
data

Task Decomposition and Allocation

Abstraction Level



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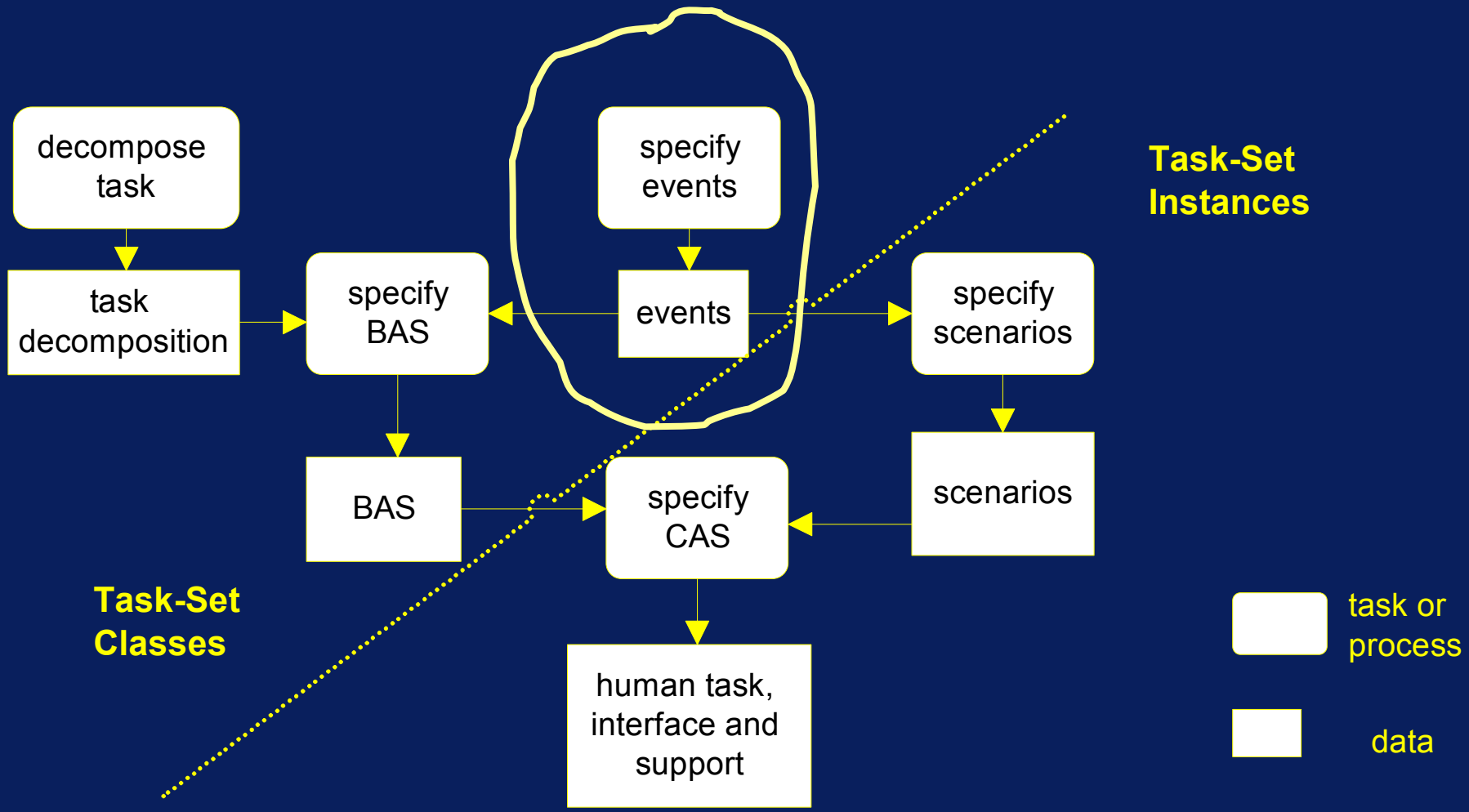
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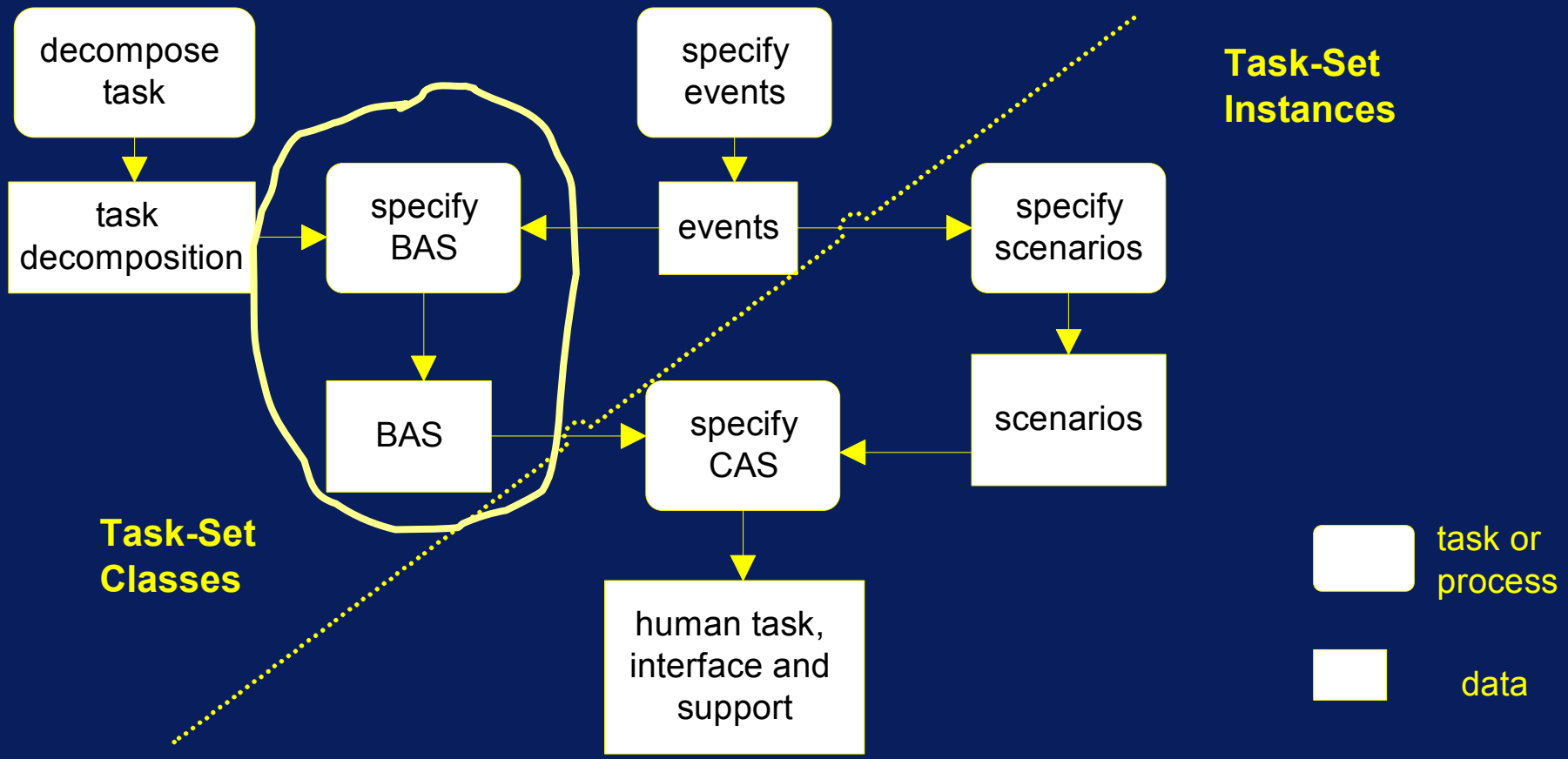
Event List

Event category			Basic event	Example event	Example consequence
Extern	Weather	…	…	Storm approaching	Deviation from route
	Sea state	Current	…	…	…
		Traffic	Vessel passing ahead	…	none
			Vessel gives way	Vessel approaching from port gives way.	…
			Vessel changes to collision course	Vessel approaching from port changes to collision course	A collision occurs
Intern	Cargo		Gas-leak	Release of toxic fumes	…
	System Failure	Propulsion	Engine shutdown	A temperature rise caused the engine to automatically shutdown	Ship can not maintain it's current speed.
			Max. temp.	Engine temperature exceeds set point	Engine speed is limited
			Max. level.	…	…
		Collision Avoidance	…	Collision avoidance sensor malfunction	A collision occurs
		Navigation	…	Ship off course	Ship can't arrive at ETA
		Electric	Short circuit	Short circuit in cooling pump	Malfunctioning cooling circuit of the engine
	Fire			Fire in the engine room	Engine speed is limited

Method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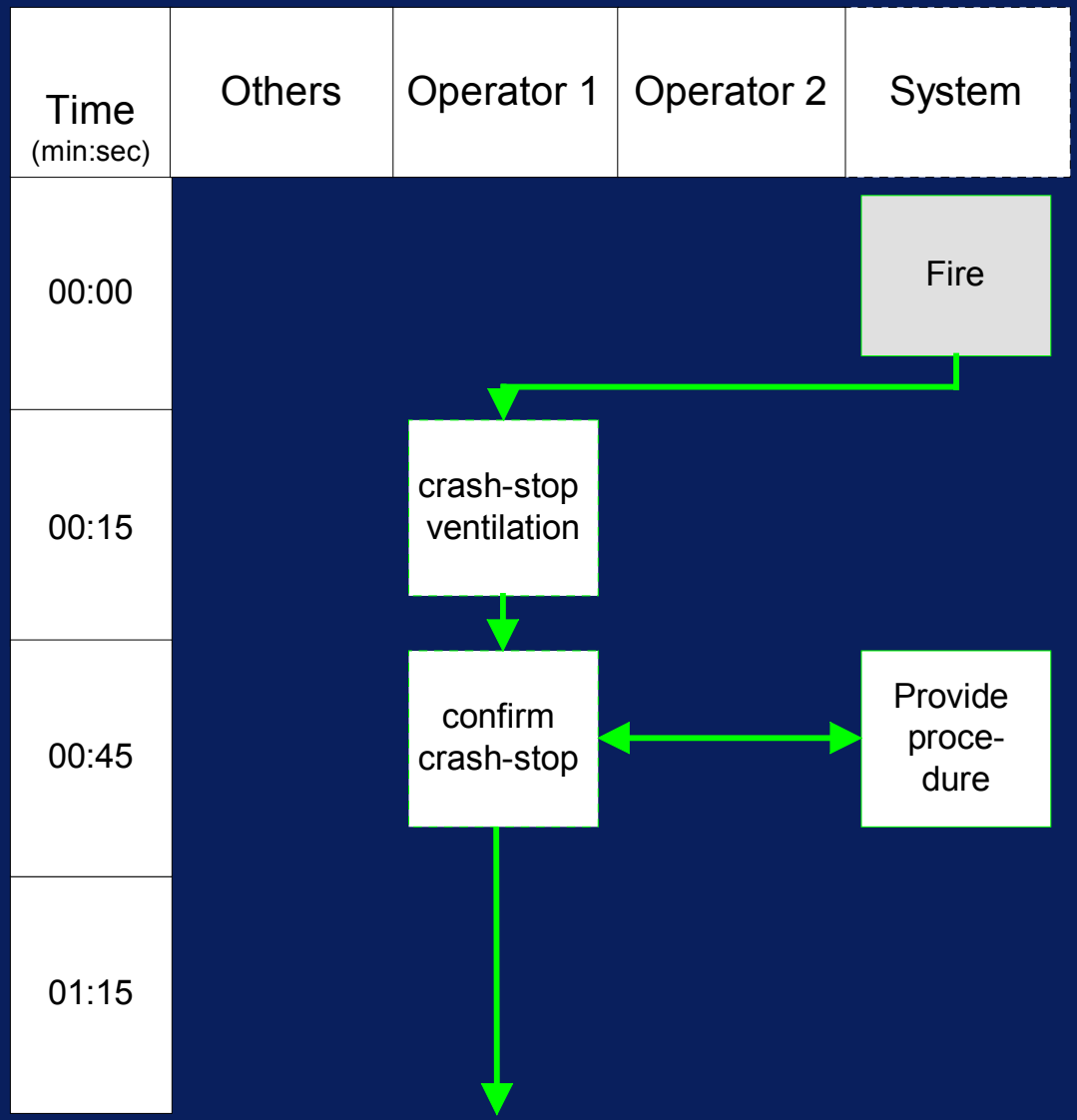
Basic Action Sequence



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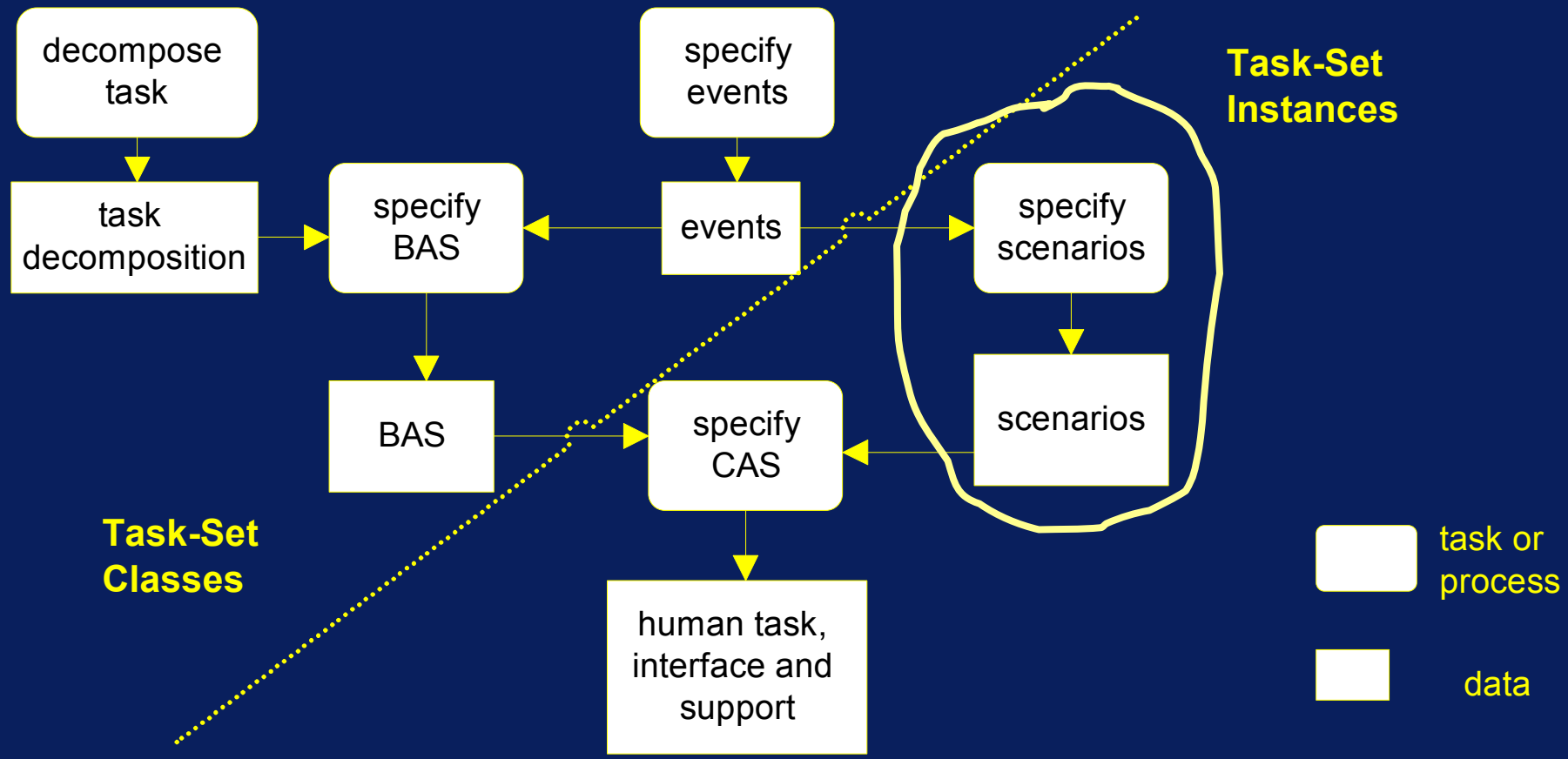
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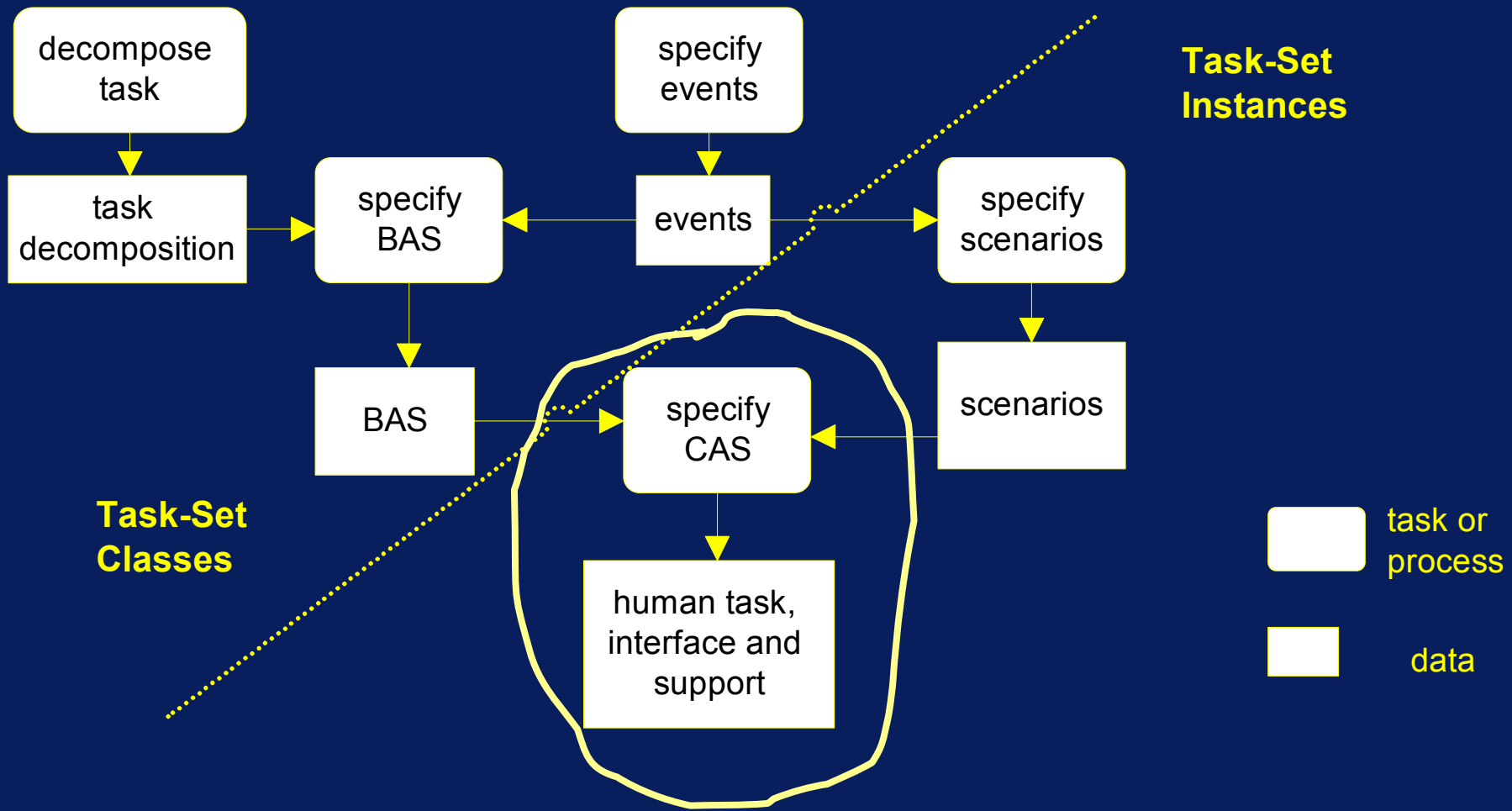
Scenario

Initial state Ship is en route to Hamburg; there are two operators present on the bridge.			
Time	Event		
21.54	Short circuit	Location	Cooling- pump of engine in engine room
		Details	Short circuit causes a fire in the pump, which is located in the cooling system of the engine.
		Consequences	Cooling system will not work and the engine temperature will increase.
		Source	None (event is not detected by system)
22.03	Fire	Location	Engine room
		Details	A pump in the engine room is on fire
		Consequences	Unknown
		Source	Smoke detector of Fire Control System
22.06	Max. temp. engine	Location	Engine room
		Details	The temperature of the engine increased beyond the set point.
		Consequences	The engine shuts down after a period of high temperature.
		Source	Propulsion management system
22.08	Engine shutdown	Location	Engine room
		Details	The temperature was too high for the critical period.
		Consequences	The vessel cannot maintain its current speed.
		Source	Propulsion management system

Method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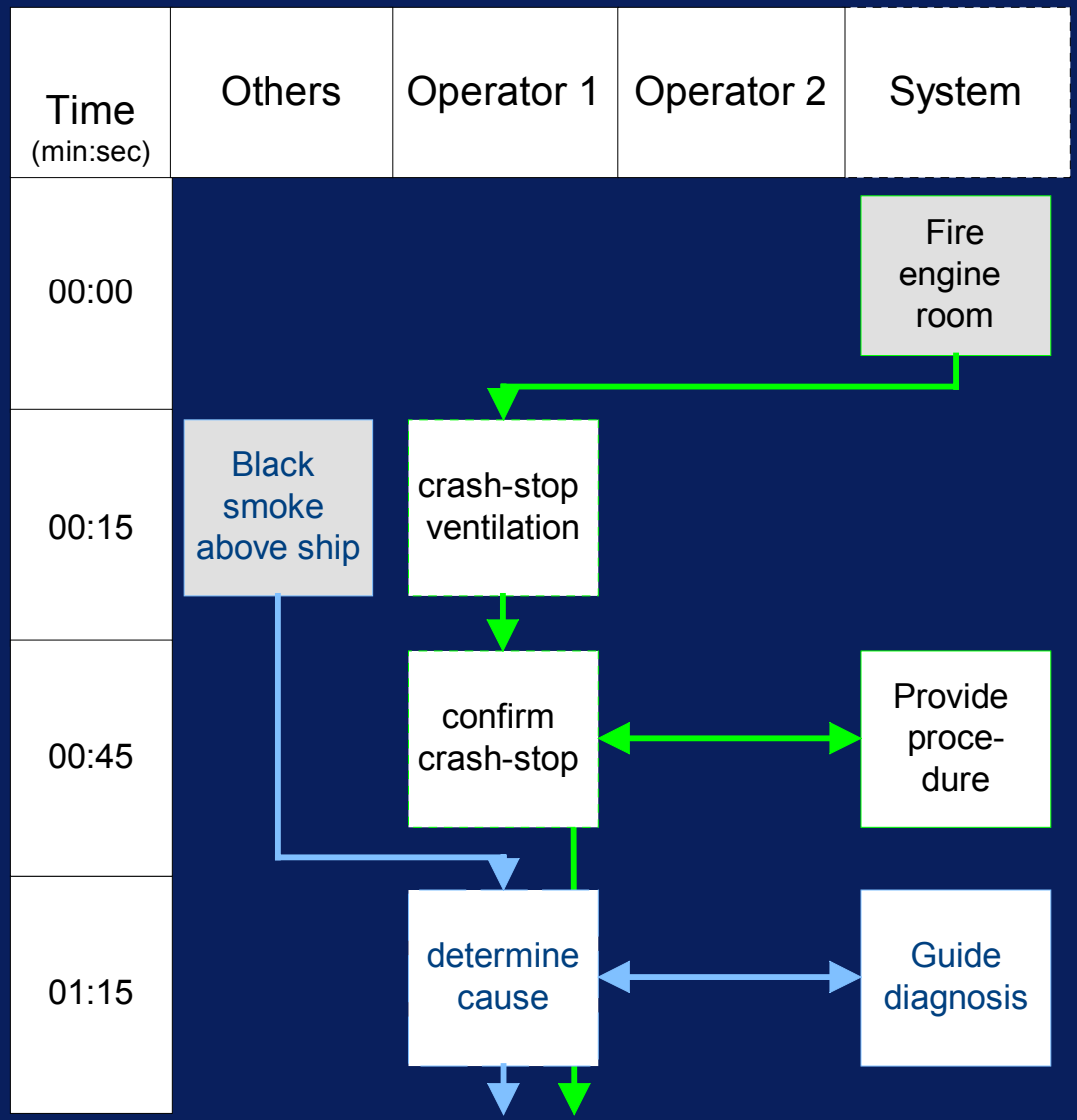
Compound Action Sequence



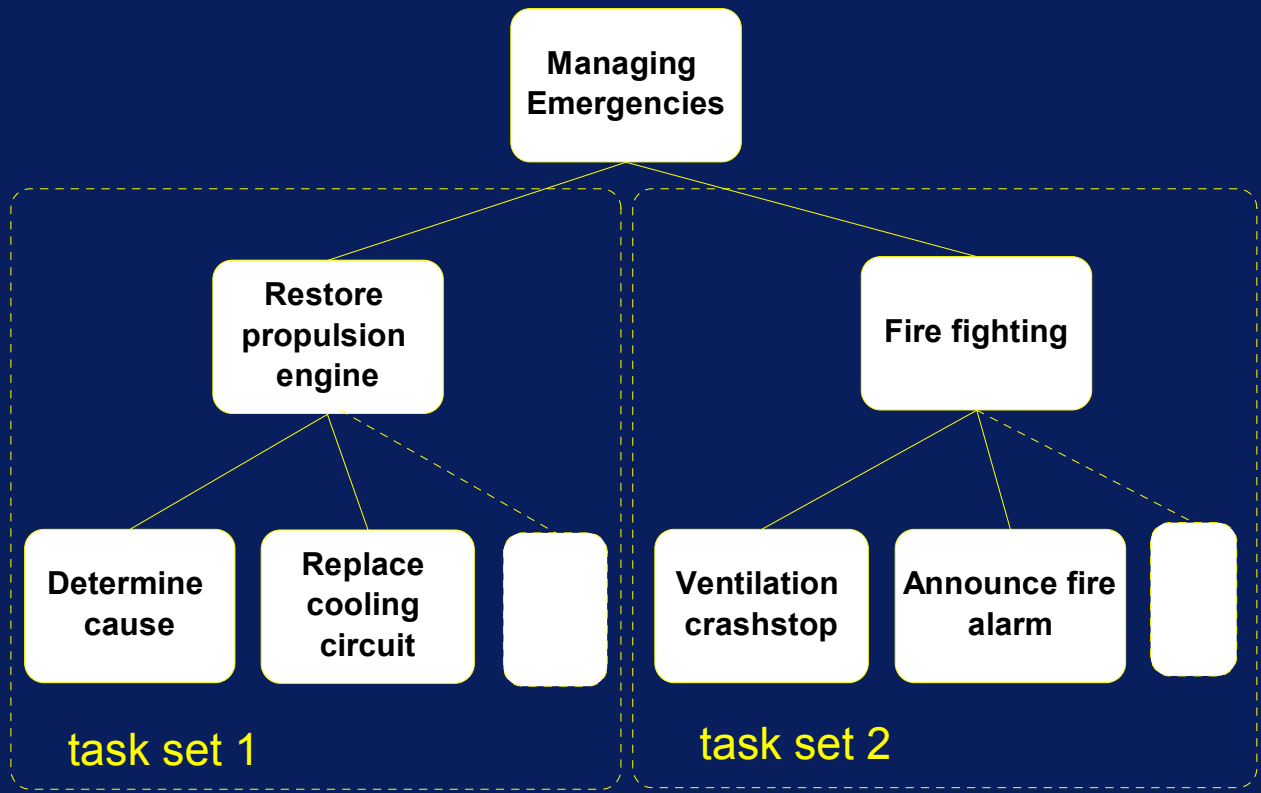
Overview of specifications

Abstraction Level

Activity

Task

Action



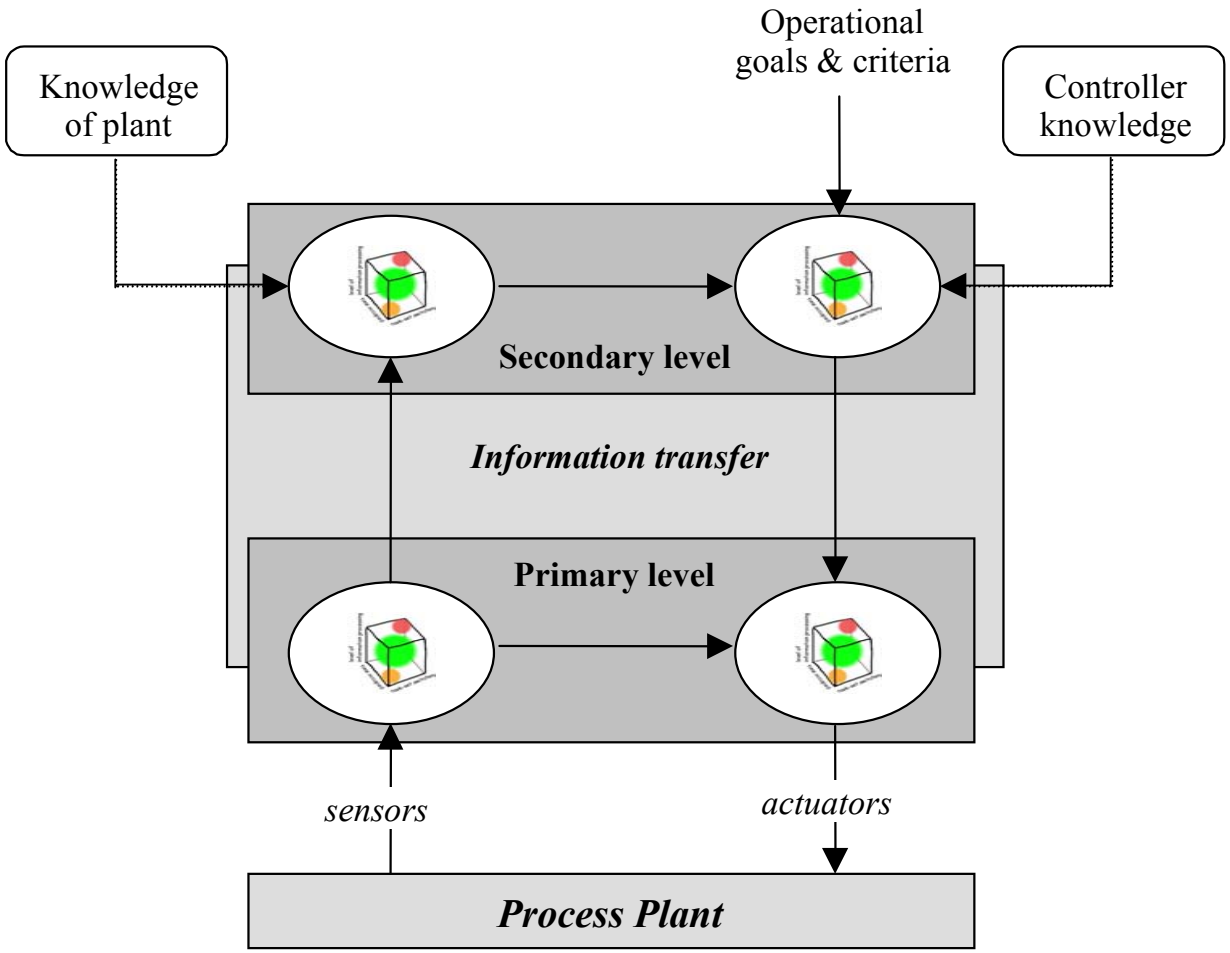
External Triggers

Scenario
-ship to Hamburg
-two bridge operators
...

Event
-engine shutdown
-fire deck A
...

Process state
-c.circuit replaced
-ventilation on/off
...

Workshop to elicit task demands:
Identifying critical load factors and functions



Specifying task load factors

Tasks: distinguish functional *and* contextual elements

- **Situation Awareness**
- **Disturbance Assessment**
- **Decision Making**
- **Direction & Control**

Task Load

- **Time occupied**
- **Level of information processing**
- **Task-set switches**

Elicitation of bottlenecks

Indicators, such as

- expert opinions
- (near) incidents
- practitioner's reports
- observations/analyses of task performances

Causes

- task demands do not match human capacities
- context provides the specific conditions for the appearance of this mismatch

Time-occupied bottlenecks

Possible indicators

- **work overtime**
- **work not finished**
- **insufficient interim, brief rests**

Causes?

- **task**
- **context**

Level of info processing bottlenecks

Possible indicators

- hardly time for concurrent actions like conversation
- extensive use of manuals, help systems, etc.
- need for advise or assistance
- occurrence of non-routine situations for which
  - the critical elements are hard to identify
  - it is not immediately clear what actions to perform

Causes?

- task
- context

Task-set switching bottlenecks

Possible indicators

- **interruptions from the environment (e.g. phone calls)**
- **occurrences of several problems or task assignments that have to be handled “simultaneously”**

Causes?

- **task**
- **context**

Workshop Envisioning High-demand Situations

- Individuals generate instances of bottlenecks for
  - task and context, and
  - the four functions and three load factors
- Each group structures the bottlenecks according to the load and functional framework
- Each group presents the results to the other groups for discussion

In the next phase, critical scenarios will be derived from the workshop results