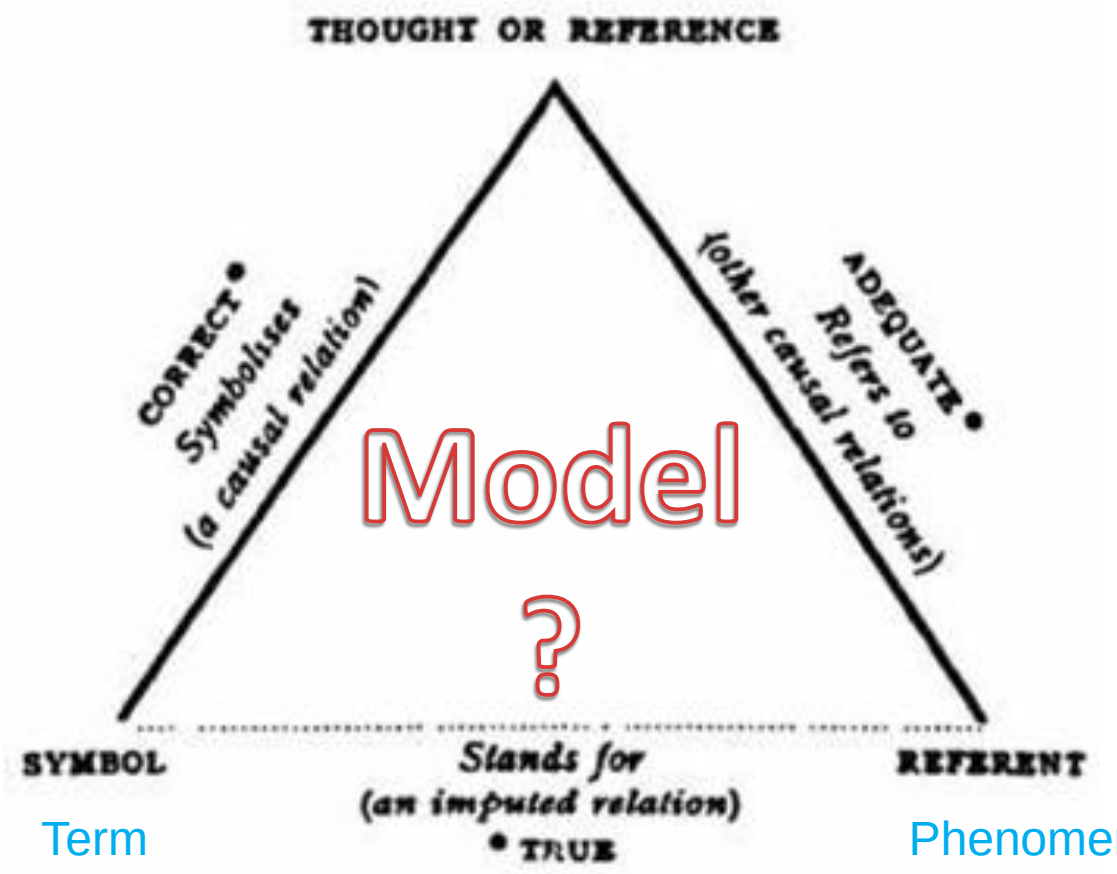
HEADS
Heterogenous and Distributed
Services for the Future Computing Continuum

What is Modeling?
Model Consistency

What's a Model?

Mathematics and Physics

Concept



Term

Phenomenon

UML1

Models@runtime

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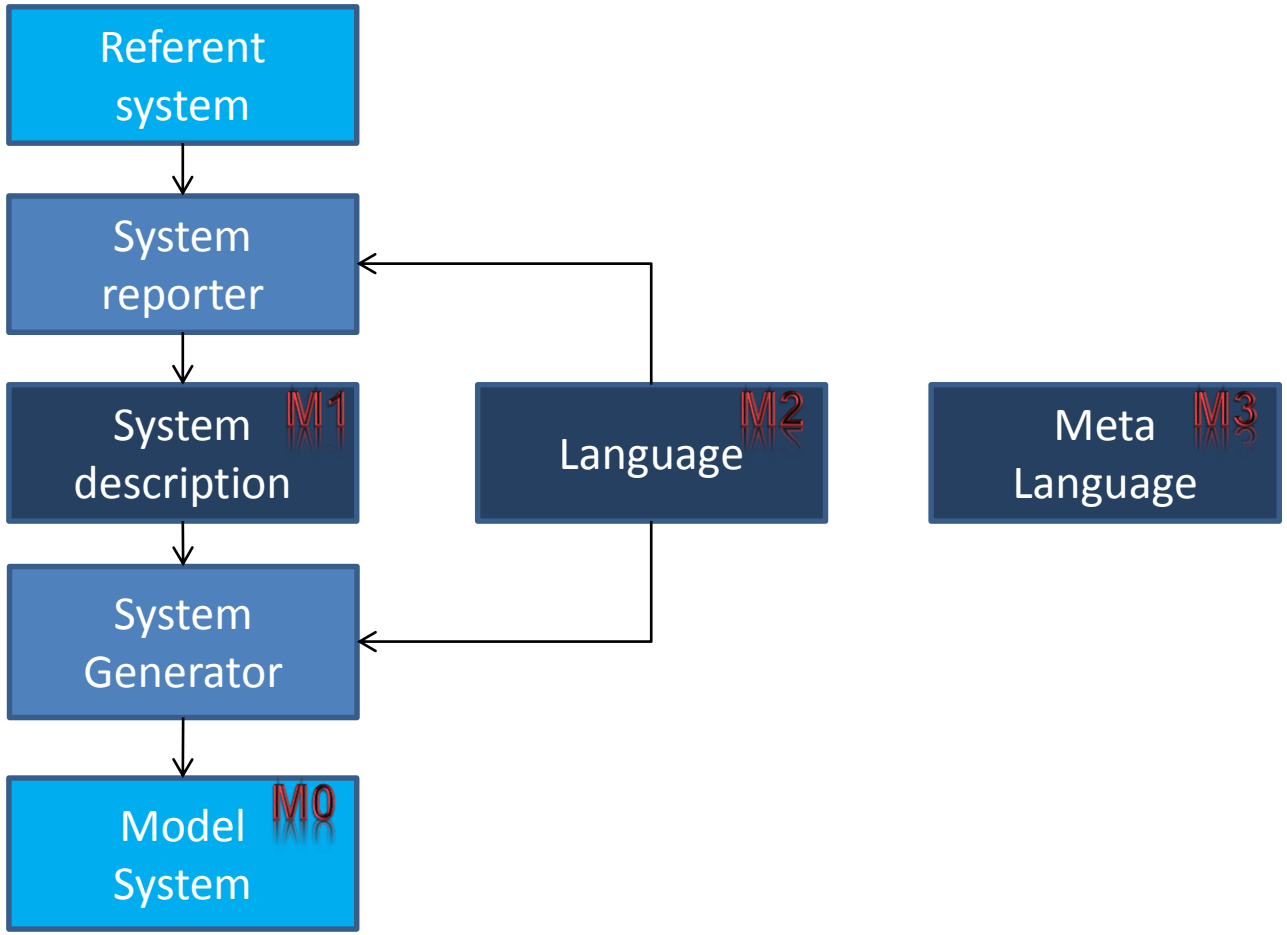
SEVENTH FRAMEWORK PROGRAMME

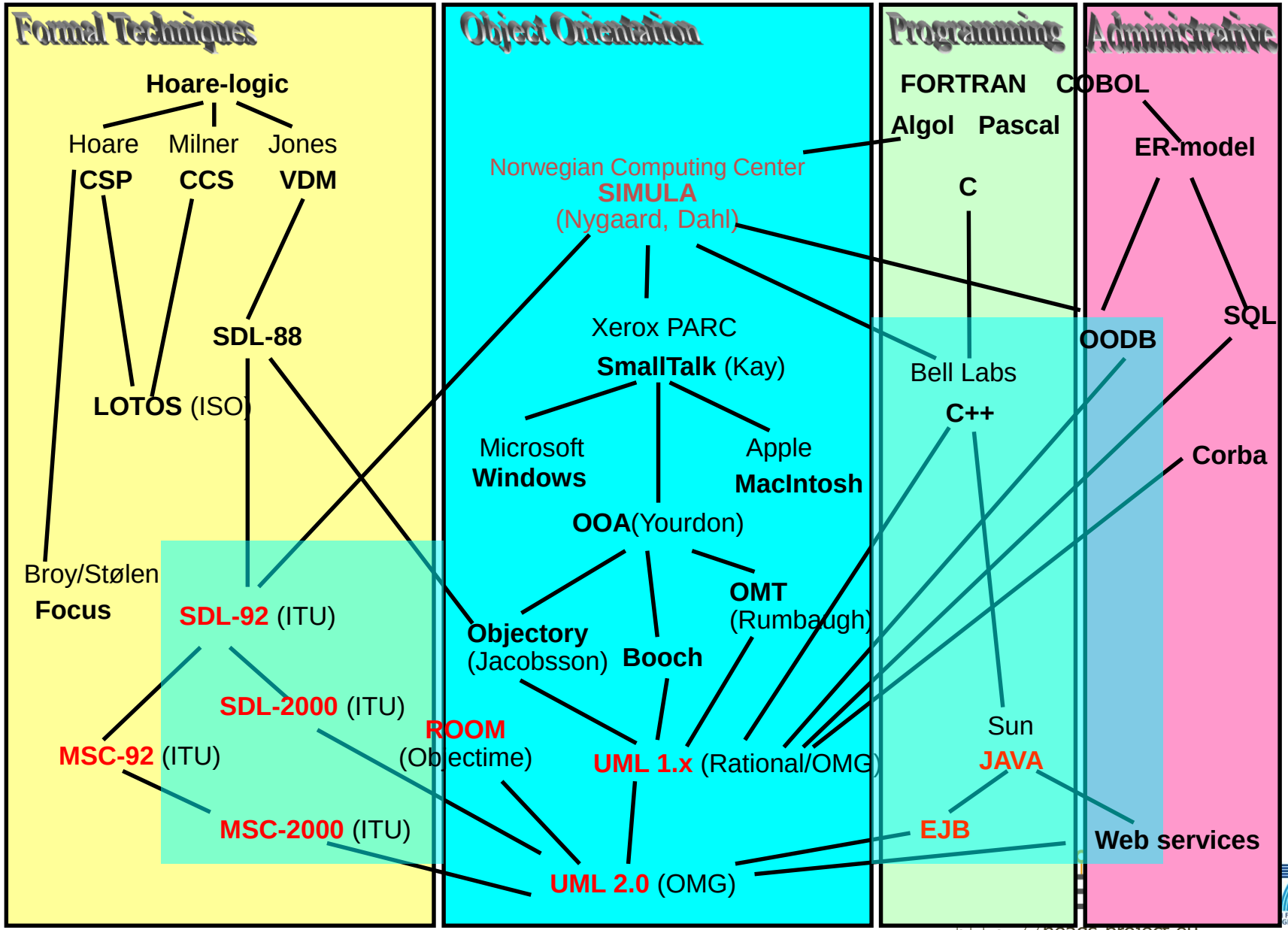
Modeling a system

- A system is a part of the world
  - which we choose to regard as a whole, separated from the rest of the world during some period of consideration, a whole which we choose to consider as containing a collection of components, each characterized by a selected set of associated data items and patterns, and by actions which may involve itself and other components
- Mental systems
  - Systems existing in the human mind, physically materialized as states of the cells of our brains
- Mental and manifest models
  - when a limited set of properties is selected from a system
- These definitions are from K. Nygaard and his DELTA team (in 1977)

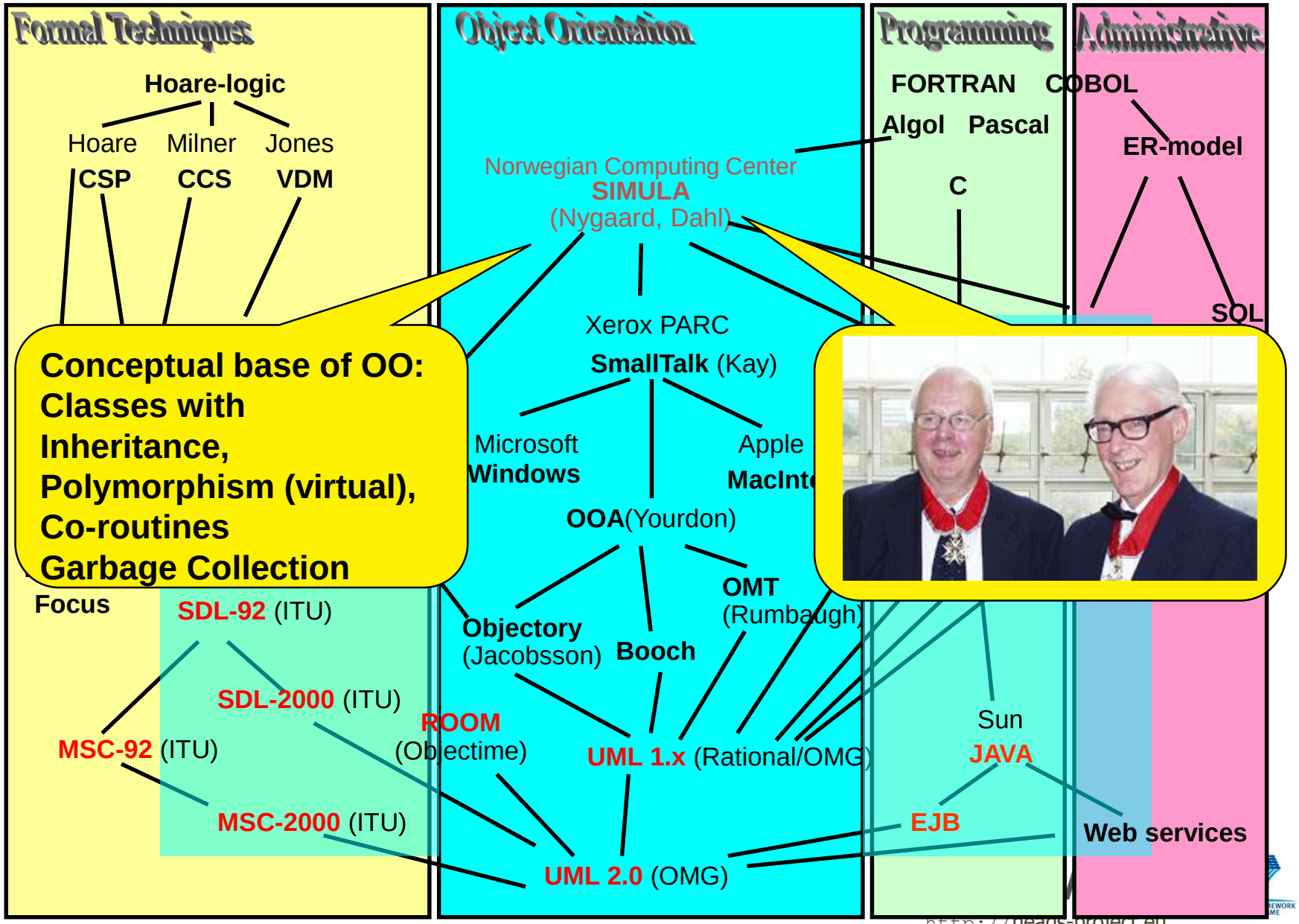
Modeling levels revisited



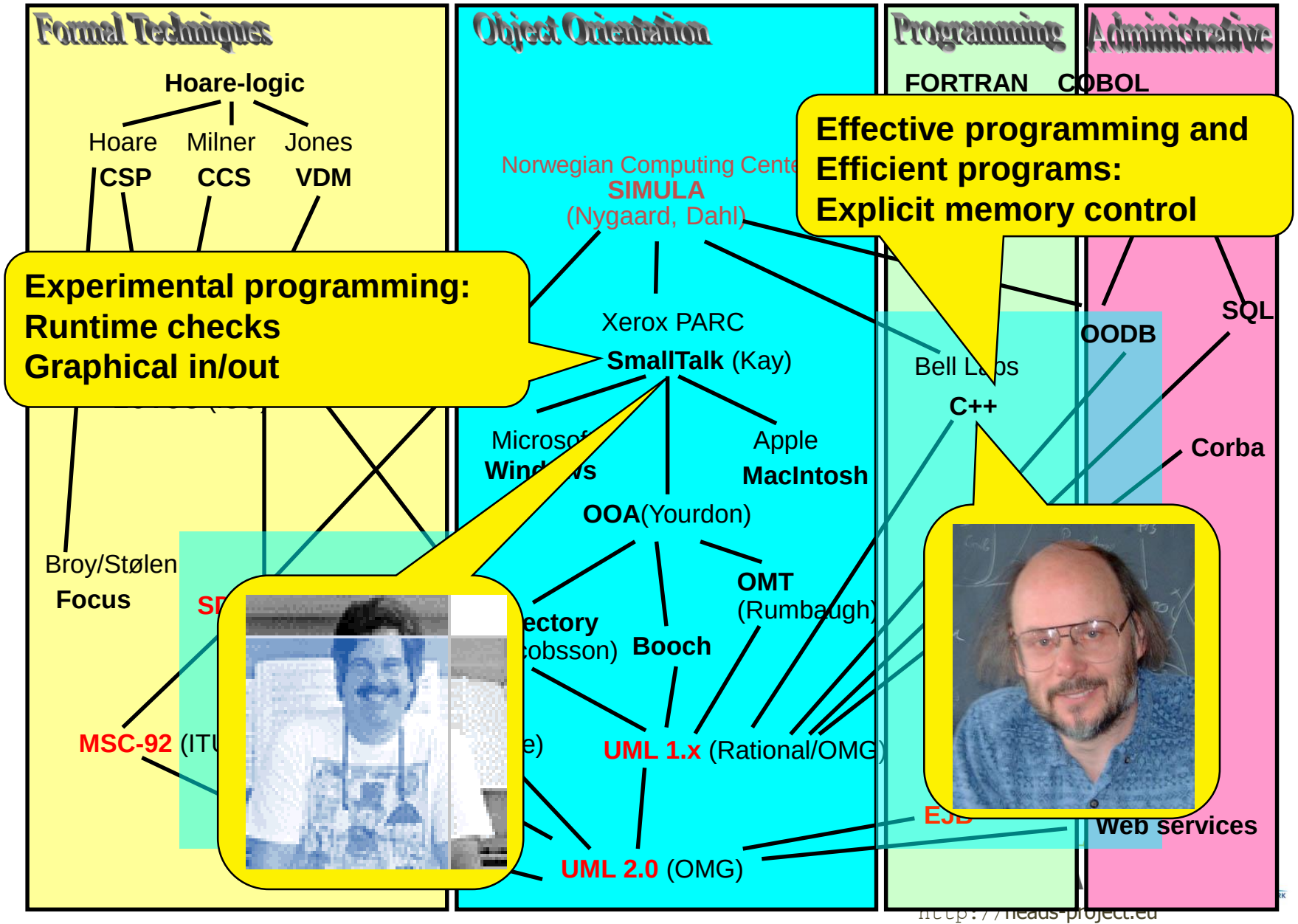
A history of modeling languages



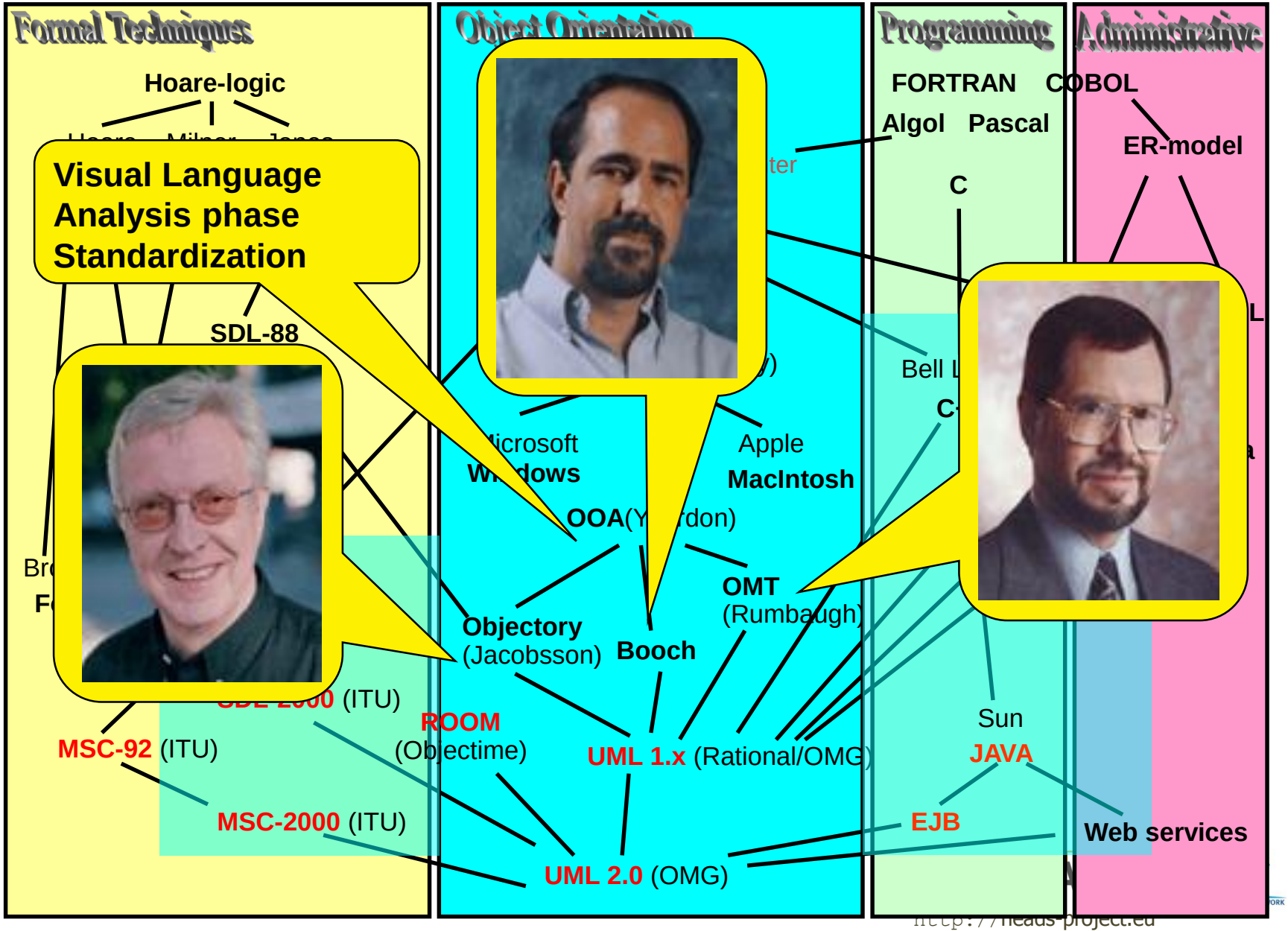
The founding fathers



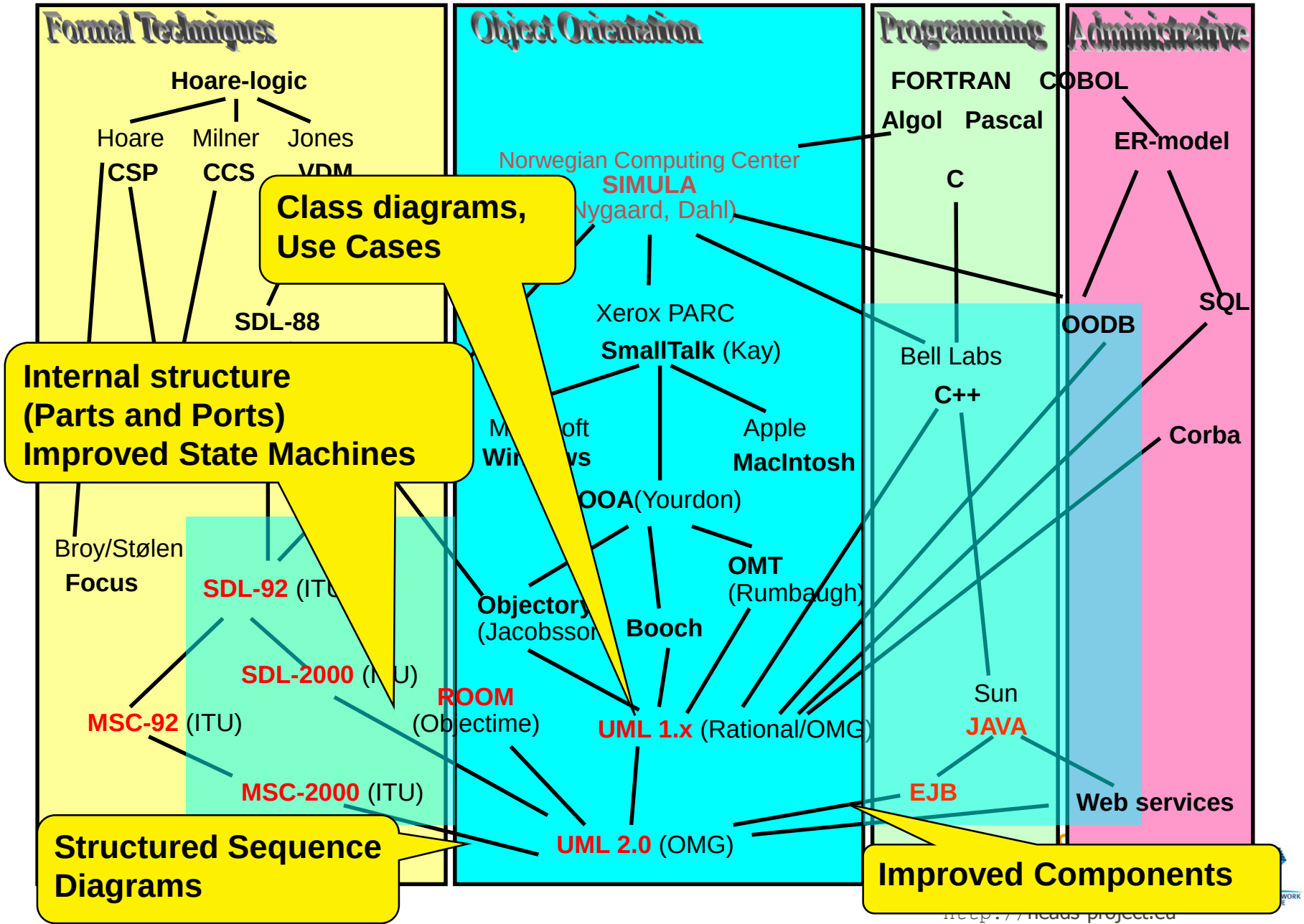
Making OO Popular and Commercial



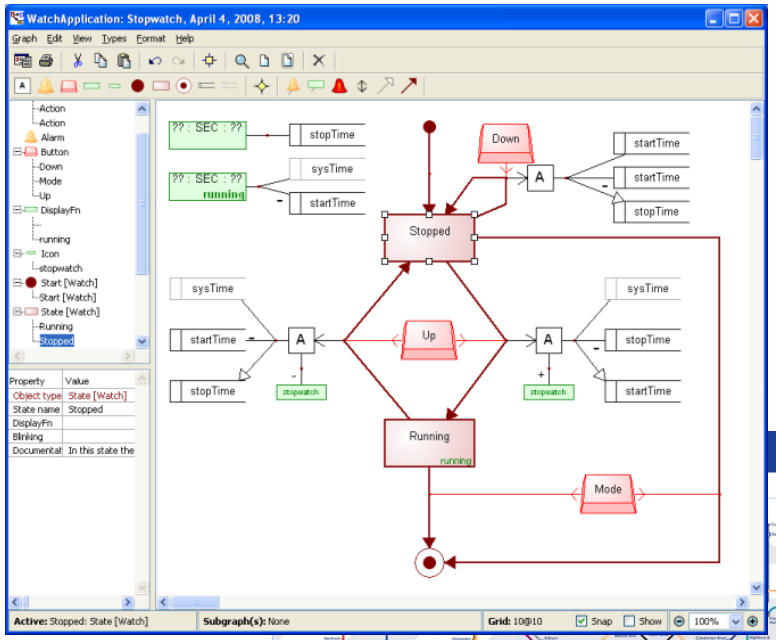
The Three Amigos

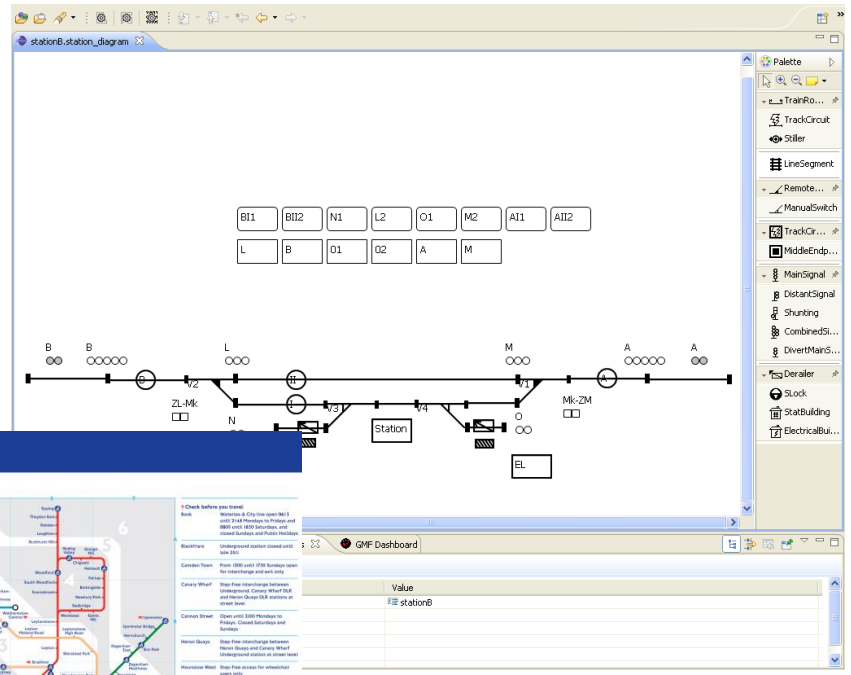


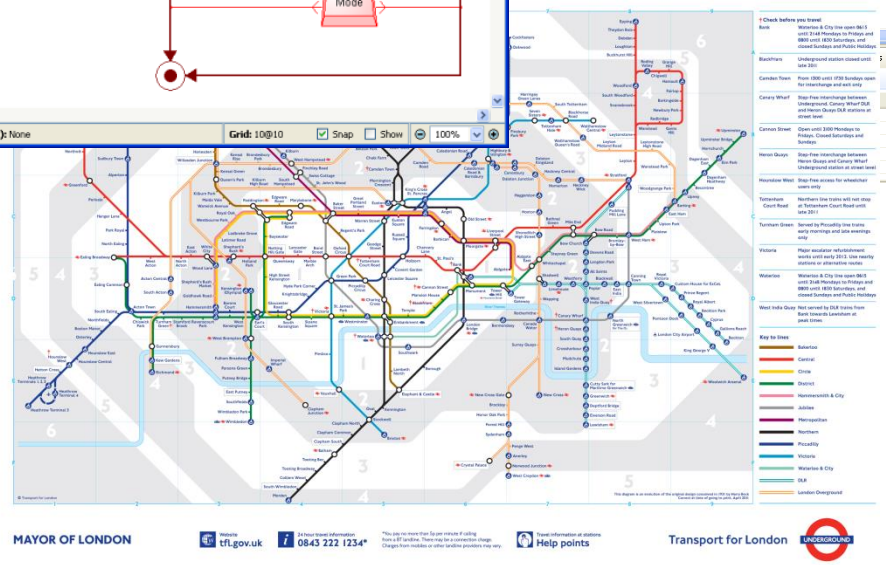
Influences on UML 2.0



Why make a language?








```
statechart PIM_behavior init Init {
        state Init {
                transition -> Init
                event snsr:get_sensor?sensorinfo
                action do
                        human_output!sensorinfo(snsr.model,snsr.proto,snsr.sid,snsr.dataTypes,snsr.temperature,snsr.humidity,snsr.timeStamp
                        )
                end
                transition -> Init
                event dvcs:get_sensor?deviceinfo
                action do
                        human_output!deviceinfo(dvcs.did,dvcs.name,dvcs.model,dvcs.proto, dvcs.ttype,dvcs.meth,dvcs.lastCmd,dvcs.lastValue)
                end
                transition -> Running // adding the first thermometer will start the normal operation
                event addt:human_input?add_thermometer
                action do
                        request_sensor!add_thermometer(addt.id,addt.txt)
                        // we do some bookkeeping on thermometers both at the PSM and at the PIM
                        thermometers[last_thermo]=addt.id
                        thermotext[last_thermo]=addt.txt
                        thermoval[last_thermo]=66.66 //to indicate no temperature has been received
                        last_thermo=last_thermo+1 //increasing the number of thermometers in our set
                end
}
```

Domain Specific Language characteristics

- A language is a precise and well-defined way to describe an area of concern
  - We have a long tradition for making languages and for making supporting tools and frameworks for that
- There are domain specific languages wherever you turn
  - like the London metro map pioneered by Beck in 1931
  - like architectural drawings of buildings and train stations
- “Make everything as simple as possible, but not simpler”
  - General languages are just too much of everything

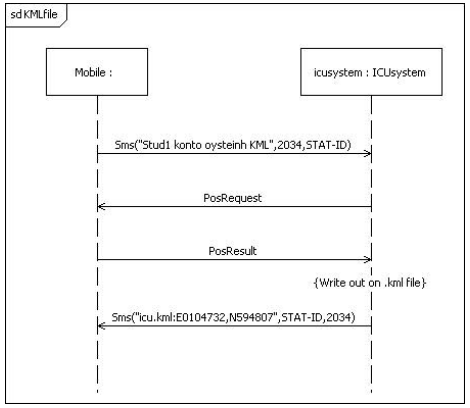
The business case for DSLs

- “Small is beautiful”
  - You have full control and rely on nobody
- Much easier to make code generation that can produce 100% of the code
  - because there are few elements and they are all well known to you
- Well documented company-wide understanding
  - good for bringing new employees into the company

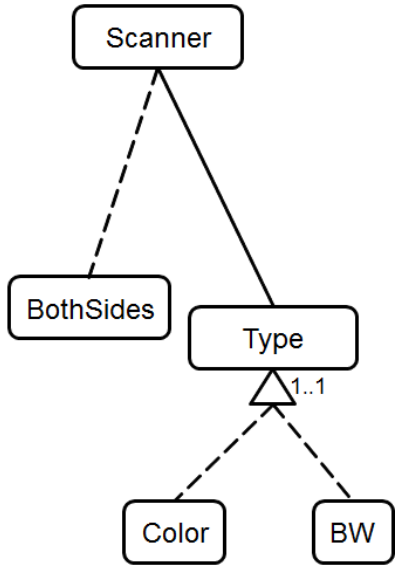
Why use a general standardized language?

- Common terms and interpretation
  - across persons, teams, companies and cultures
    - Experience SISU project
      - Very large SDL specification ported from Alcatel to Kongsberg
    - Experience MSC
      - We have a Korean translation of MSC 2000
  - across computers! portability
    - Experience Simula
      - We ported the exact same code on at least 5 machines without changing a single line of code around 1980
- Common teaching material
- Common libraries
- Common and open reviewing process

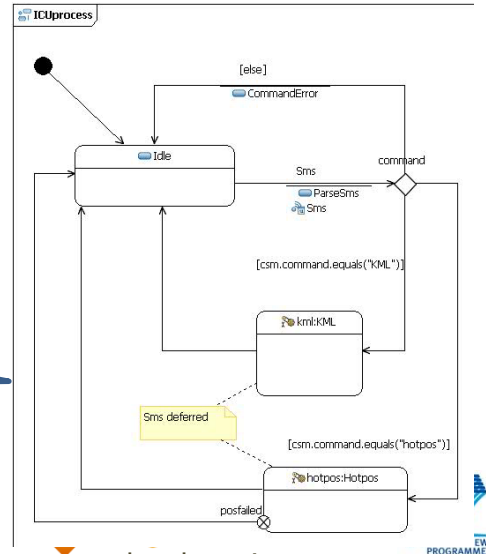
We will apply modeling for several purposes



Behavioral Requirements of Interaction



Product Lines (Variability)



Executable models

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The CPS Modeling Methodolody

Agile modeling

- ”agile”
  - = having a quick resourceful and adaptable character
- executable models!
- very stepwise approach
  - each step will have its specification and executable model
  - each step should be tested
- We shall use one example throughout the course
  - with many steps
  - intended to be mirrored by the project exercise model
- Every week a working program!

Manifesto for Agile Software Development

- We are uncovering better ways of developing software by doing it and helping others do it.
- Through this work we have come to value:
  - Individuals and interactions over processes and tools
  - Working software over comprehensive documentation
  - Customer collaboration over contract negotiation
  - Responding to change over following a plan
- That is, while there is value in the items on the right, we value the items on the left more.

Dialectic Software Development

- Software Development is a process of learning
  - once you have totally understood the system you are building, it is done
- Learning is best achieved through conflict, not harmony
  - discussions reveal problematic points
  - silence hides critical errors
- By applying different perspectives to the system to be designed
  - inconsistencies may appear
  - and they must be harmonized
- Inconsistencies are not always errors!
  - difference of opinion
  - difference of understanding
  - misunderstanding each other
  - a result of partial knowledge
- Reliable systems are those that have already met challenges

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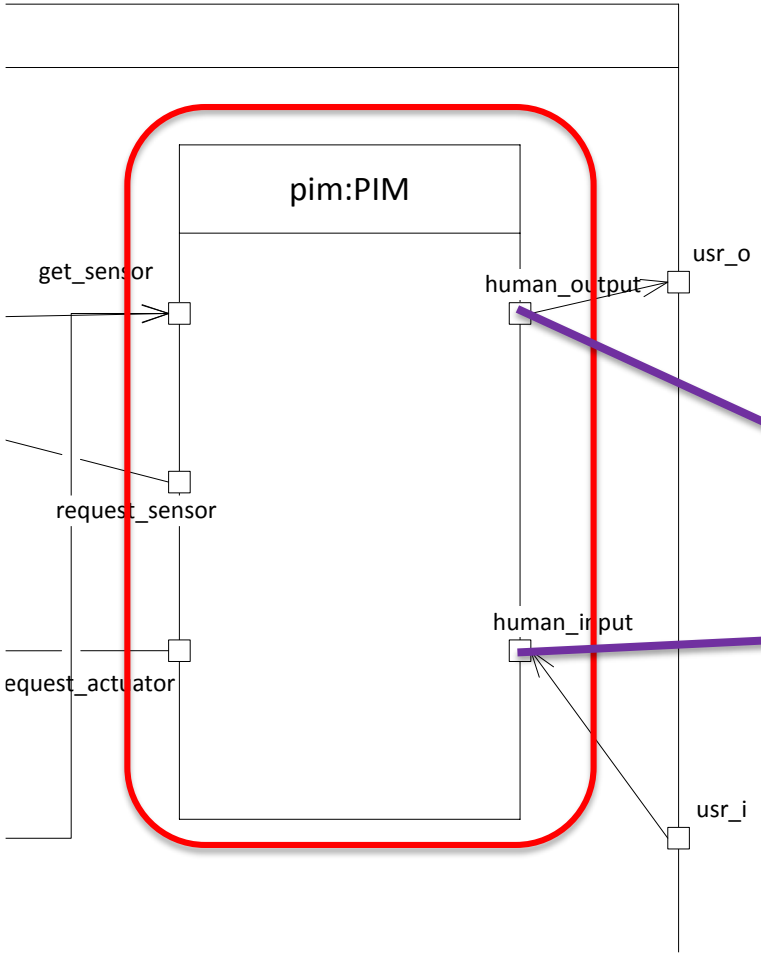
Consistency

Consistency 1: Ports



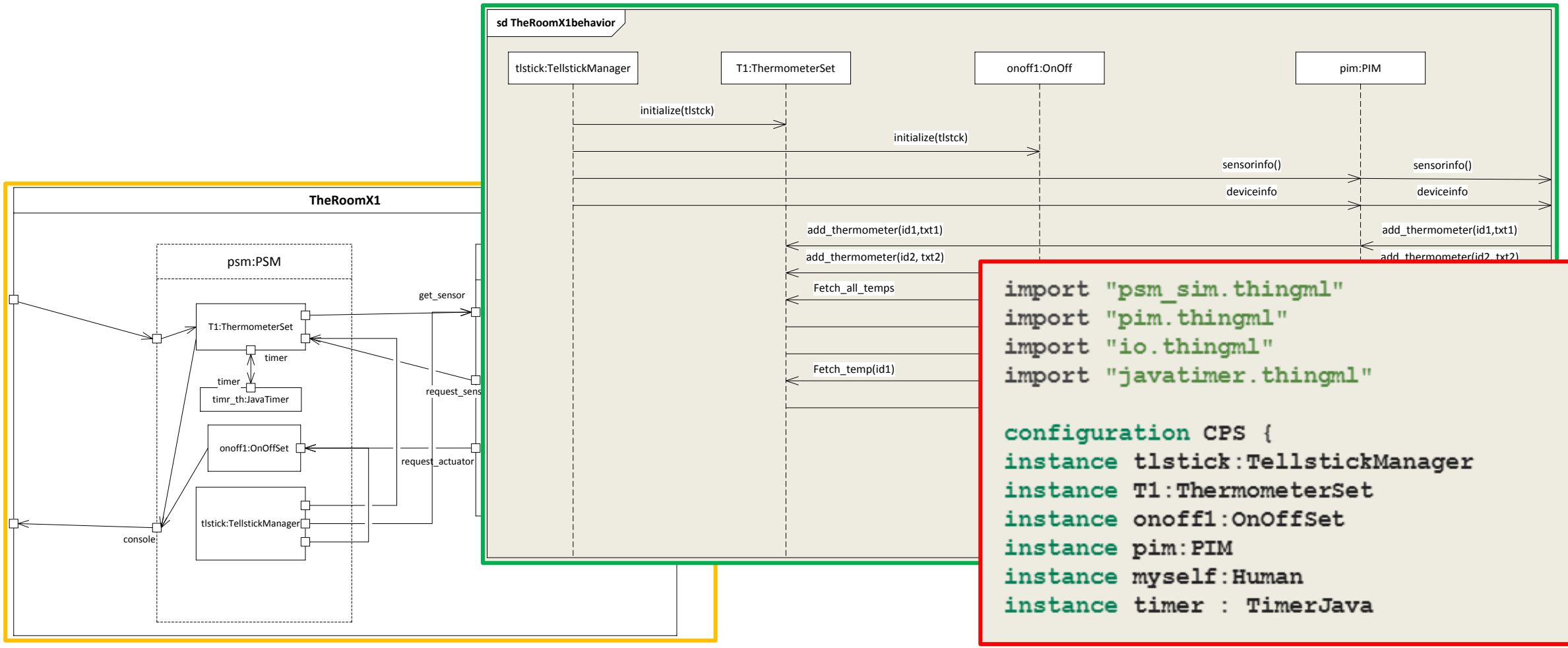

```
thing PIM includes GeneralMsg, TemperatureMsg, OnOffMsg {
      provided port get_sensor {
            receives temperature, sensorinfo, deviceinfo
      }
      required port request_sensor {
            sends add_thermometer
      }
      required port request_actuator{
            sends add_device, SwitchOn, SwitchOff
      }
      provided port human_input {
            receives add_thermometer, add_device, fetch_temp, fetch_
      }
      required port human_output {
            sends temperature,  sensorinfo, deviceinfo
      }
```

Consistency 2: Messages

```
thing PIM includes GeneralMsg, TemperatureMsg, OnOffMsg {
	provided port get_sensor {
		receives temperature, sensorinfo, deviceinfo
	}
	required port request_sensor {
		sends add_thermometer
	}
	required port request_actuator{
		sends add_device, SwitchOn, SwitchOff
	}
	provided port human_input {
		receives add_thermometer, add_device, fetch_temp, fetch_all_temps, SwitchOn, SwitchOff
	}
	required port human_output {
		sends temperature,  sensorinfo, deviceinfo
	}
```

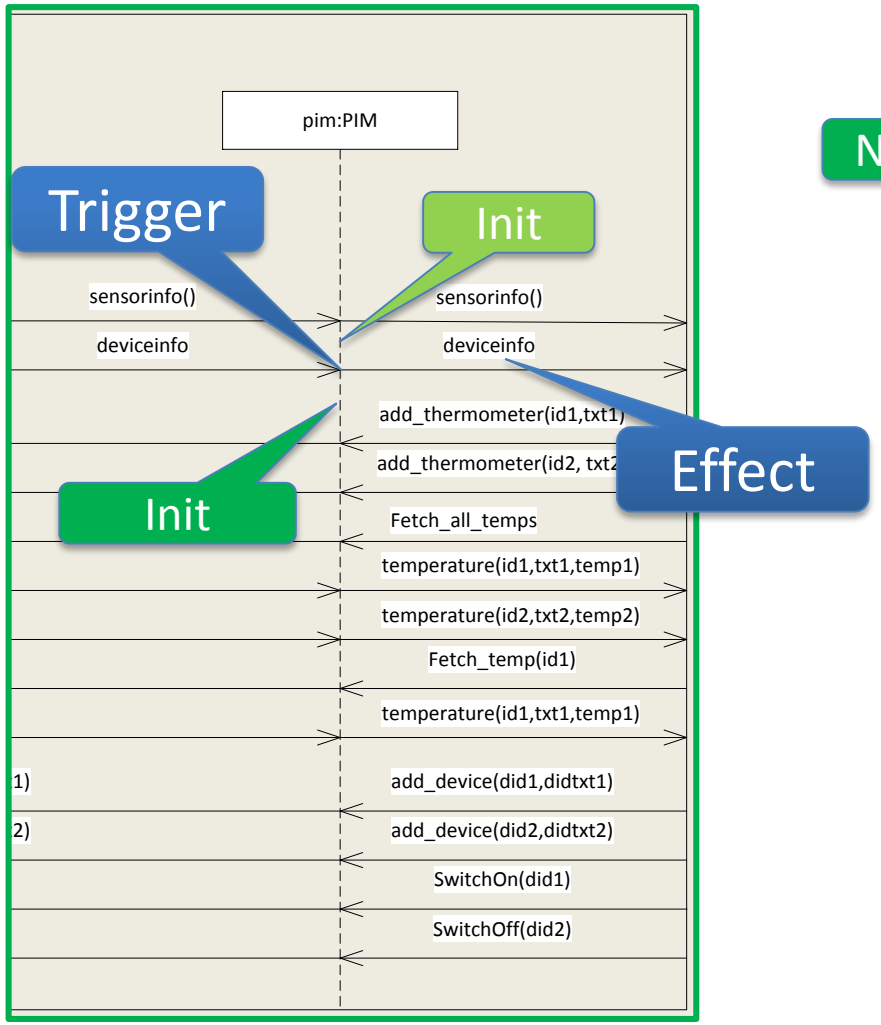
```
statechart PIM_behavior init Init {
	state Init {
		transition -> Init
		event snsr:get_sensor?sensorinfo
		action do
			human_output!sensorinfo(snsr.model,snsr.proto,snsr.sid,snsr.dataTypes,snsr.temperature,snsr.humidity,snsr.timeStamp)
		end
		transition -> Init
		event dvcs:get_sensor?deviceinfo
		action do
			human_output!deviceinfo(dvcs.did,dvcs.name,dvcs.model,dvcs.proto, dvcs.ttype,dvcs.meth,dvcs.lastCmd,dvcs.lastValue)
		end
```

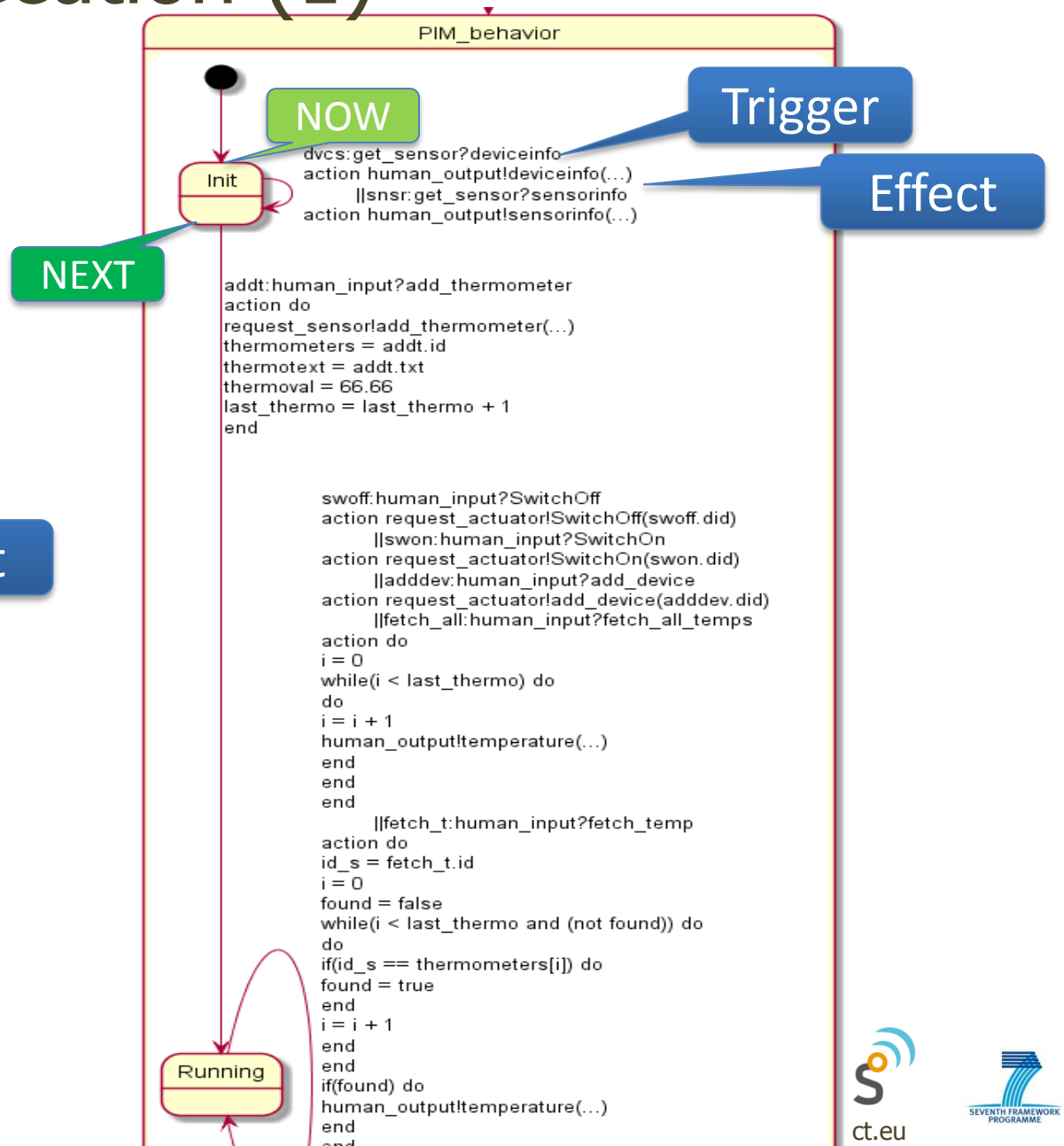
Consistency 3: Parts/instances and Lifelines (+connect)



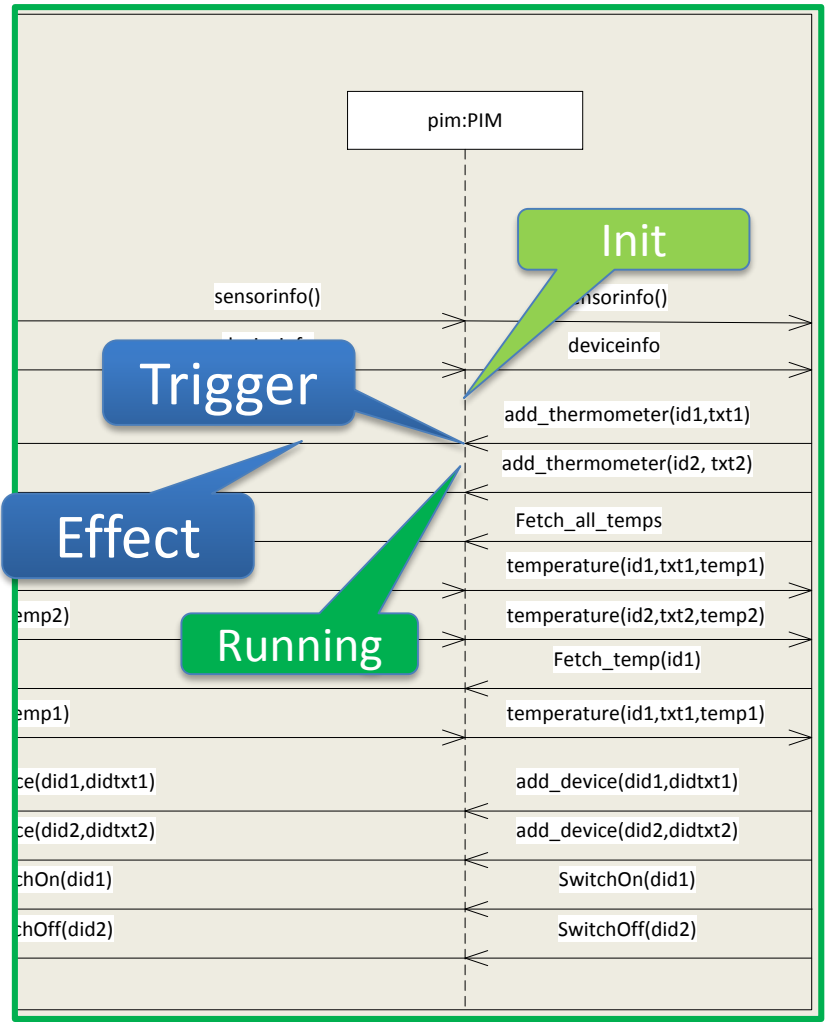

```
import "psm_sim.thingml"
import "pim.thingml"
import "io.thingml"
import "javatimer.thingml"

configuration CPS {
instance tlstick:TellstickManager
instance T1:ThermometerSet
instance onoff1:OnOffSet
instance pim:PIM
instance myself:Human
instance timer : TimerJava
```

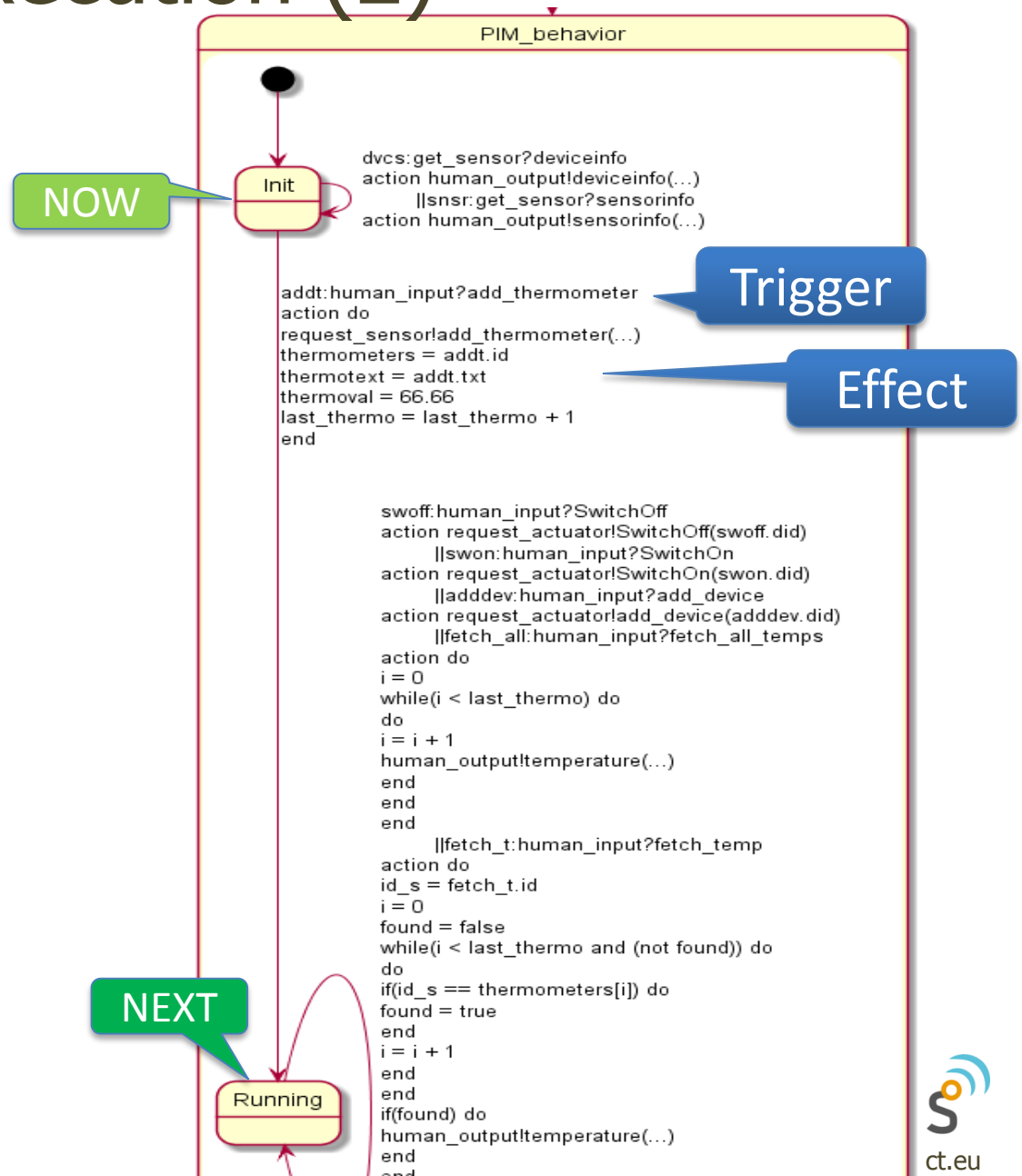
Consistency 4: Execution (1)





Consistency 4: Execution (2)





Consortium

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