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Processing of sensor data streams based on SensorML

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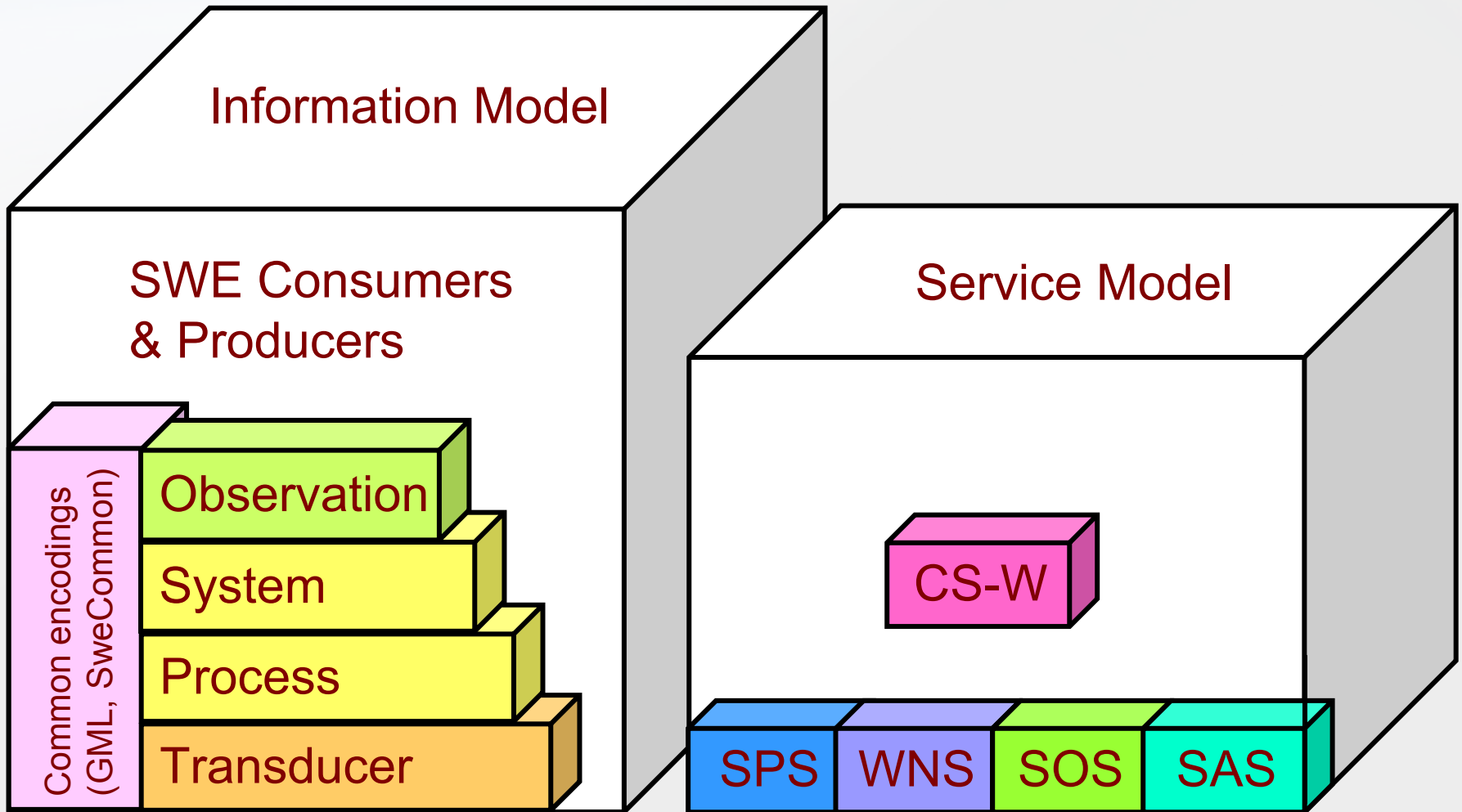
Agenda

- Overview
- Processes in SensorML
- Data streams
- EML
- Implementation
- Demonstration

Overview

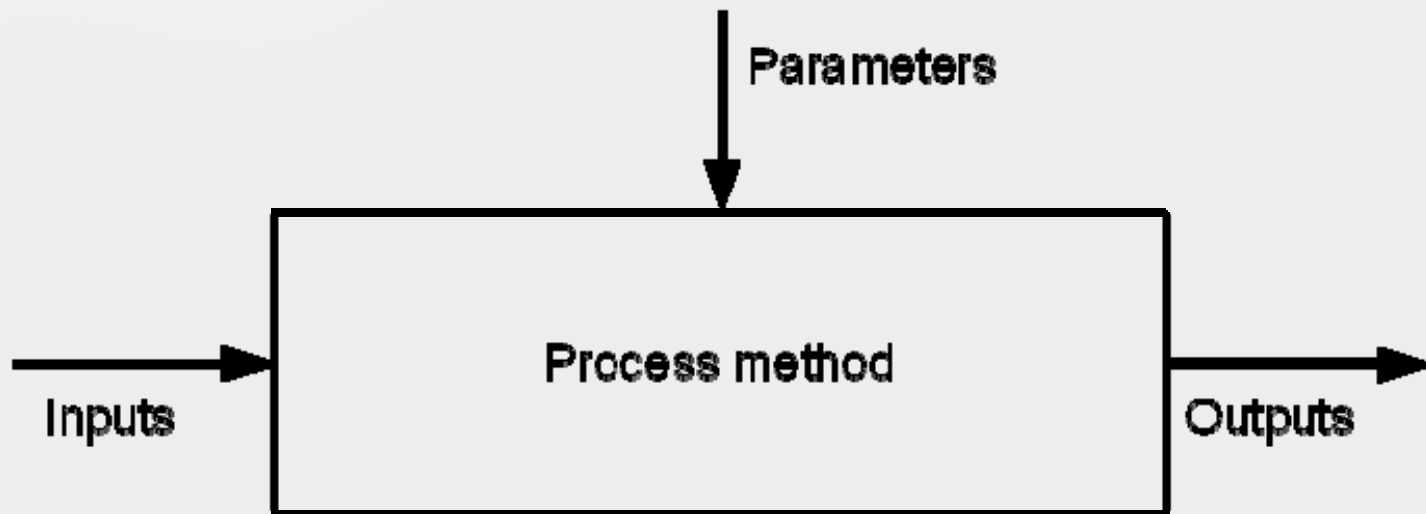
- Topic:
 - Processing of data streams containing sensor data
 - Early warning systems
 - Processes described in SensorML
 - Interpretation and execution
- SWE context:
 - SensorML as part of the SWE information model
 - sml:Process (non-physical)

Reminder: SWE Building Blocks



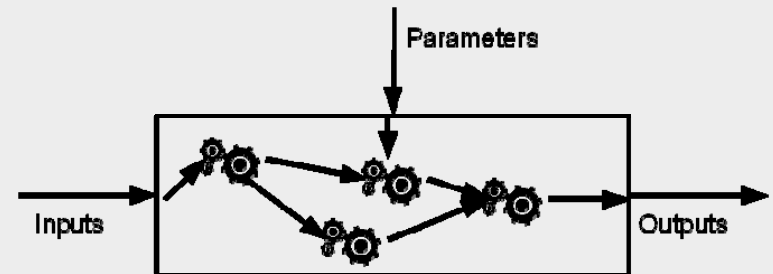
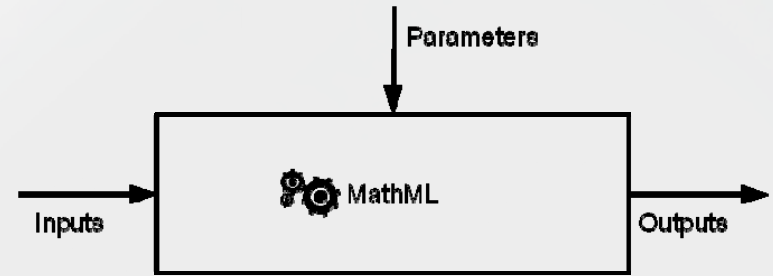
SensorML processes (I)

- Input
- Output
- Parameters
- Process method



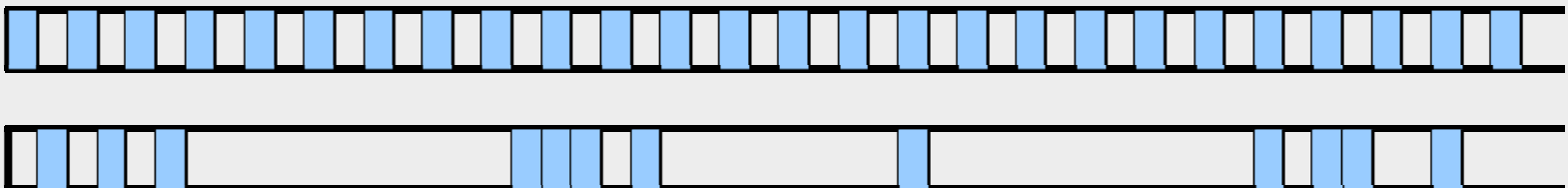
SensorML processes (II)

- Process method
 - MathML
 - Source or binary code
- Non-physical processes
 - No spatial reference
 - Process model
 - Single process
 - Process chain
 - Multiple connected processes
 - May also contain physical processes



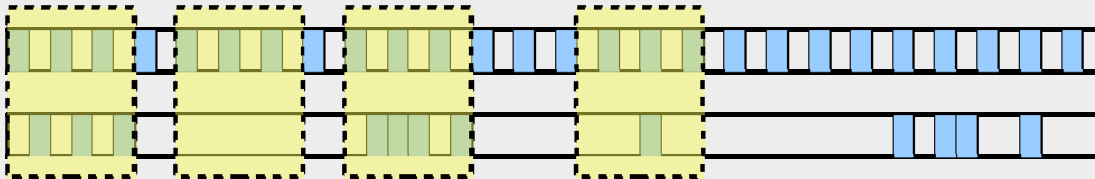
Data streams

- Continuous sequence of data elements
- Fixed order
- Potentially infinite size
- Processing of data streams:
 - Sequential
 - One pass paradigm
 - No storage
 - Event Stream Processing (ESP)



CEP / ESP

- ESP is a part of Complex Event Processing (CEP)
- CEP:
 - Find event patterns in an event cloud
- ESP:
 - Find event patterns in an event stream
 - Stream: cloud ordered by time
 - Use of data views
- Event Pattern Languages (EPLs) used to describe event patterns

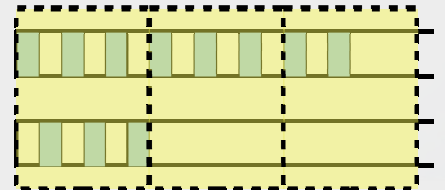
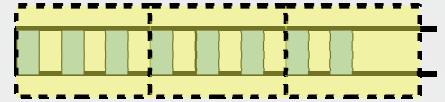


Event Pattern Markup Language (EML)

- XML event pattern language
- Used in SensorML process methods
- Supports:
 - Select functions `SELECT select_function`
 - Data views `FROM data_view`
 - Guards `WHERE guard`
 - Simple patterns
 - Complex patterns
 - Specialized patterns

EML Patterns

- Simple patterns:
 - Matching of only one type of events
- Complex patterns:
 - Combination of multiple defferent events
- Specialized patterns:
 - Timer pattern to generate clock events
 - Repetitive patterns to count events



Implementation

- Prototype:
 - Process chain design
 - Process administration
 - Communication handling
 - Different processes as plugins
- Communication:
 - No special streaming format
 - SensorML process descriptions can be used with and without streaming data
 - Blocking FIFO-Queues as data streams



Plugins (I)

- EML-Plugin:
 - Executes EML patterns
 - Uses Esper (<http://esper.codehaus.org/>)
- MathML-Plugin
 - Executes formulas written in MathML
 - Uses MathMLSolver (<http://sourceforge.net/projects/mathmlsolver/>)

Plugins (II)

- Java-Plugin
 - Executes Java binary code
- Unit conversion
 - Converts data between compatible units of measurement
 - Uses parts of a software of the VAST-Team of the University of Alabama in Huntsville (<http://vast.uah.edu/>)
- Other plugins for special purposes
 - Visualization, alert handler, SAS and SOS connection, connections to other frameworks, ...

Demonstration

- Calculation of the sensed temperature
 - Windchill temperature (WCT)
 - Heat index (HI)
- Selection of the valid temperature
 - WCT if temperature $< 4^{\circ}\text{C}$
 - HI if temperature $> 20^{\circ}\text{C}$
- Warnings
 - Cold warning if sensed temperature $< -29^{\circ}\text{C}$ (danger of frostbite)
 - Heat warning if sensed temperature $> 32^{\circ}\text{C}$ (danger of heat stroke)