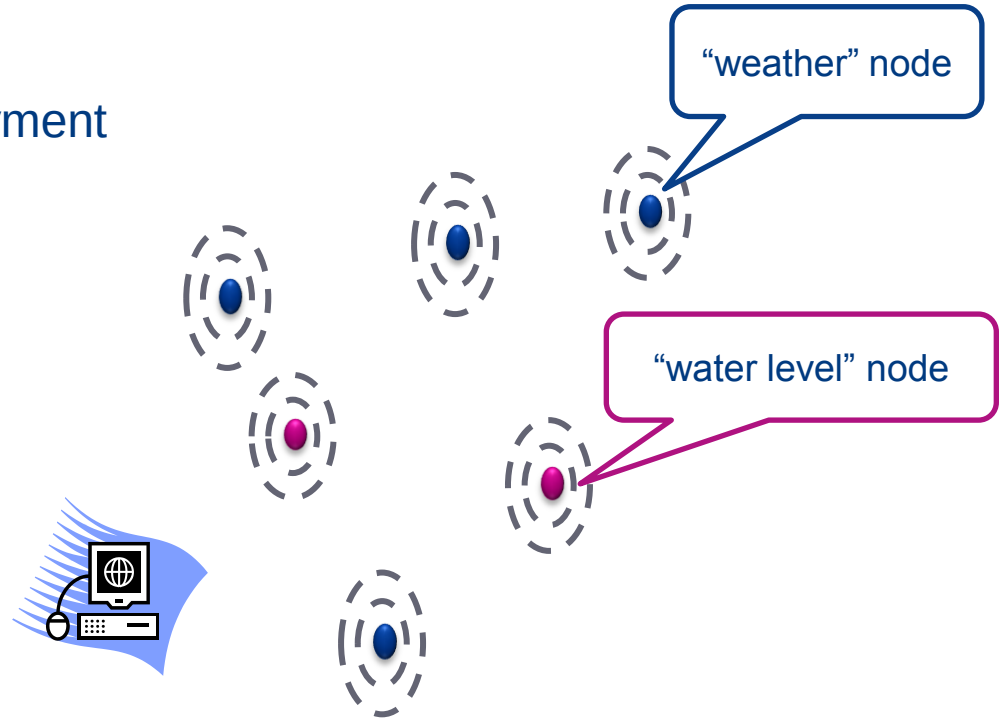
Extension of the Semantic Sensor Network Ontology for Wireless Sensor Network:

The Stimulus - WSNnode - Communication Pattern

Rimel BENDADOUCHE, Catherine ROUSSEY, Gil DE SOUSA, Jean Pierre CHANET and Kun Mean HOU

Wireless Sensor Network (WSN)

- Definition:
  - collection of WSN nodes connected to one or more gateways
- Characteristics:
  - large-scale deployment
  - limited resources
    - Energy
    - CPU
    - memory



Outlines

- Wireless Sensor Network (WSN), needs and objectives
- State of the art on sensor ontologies
- Semantic Sensor Network (SSN) ontology overview
- Wireless Semantic Sensor Network (WSSN) Ontology: extension of the SSN ontology
- Use of the WSSN ontology

Wireless Sensor Network (WSN)

NEEDS AND OBJECTIVES

- Adapt the WSN node behavior to the context:
  - Node state
  - Phenomena state

Context: *"The context is a set of entities states or information describing an environment where an event occurs"*

State: *"The state is a qualitative data, which changes over time summarizing a set of information"*

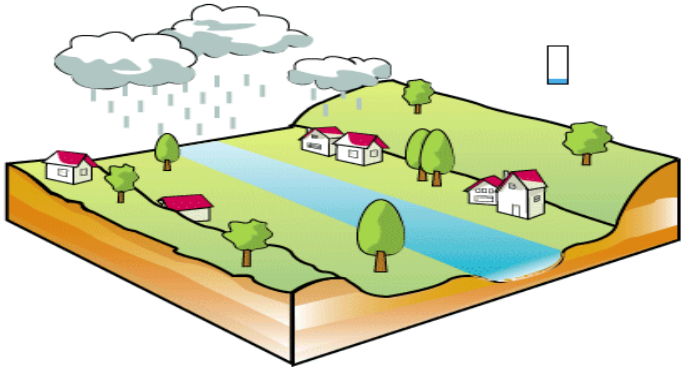
- Enhance the lifetime and the good functioning of the network

What is a context ?

FLOOD PHENOMENA

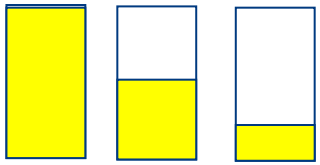
FLOOD PHENOMENA STATE:

1. “Normal”
2. “Waiting for rise in water levels”
3. “Rise in water levels”
4. “Flood warning”



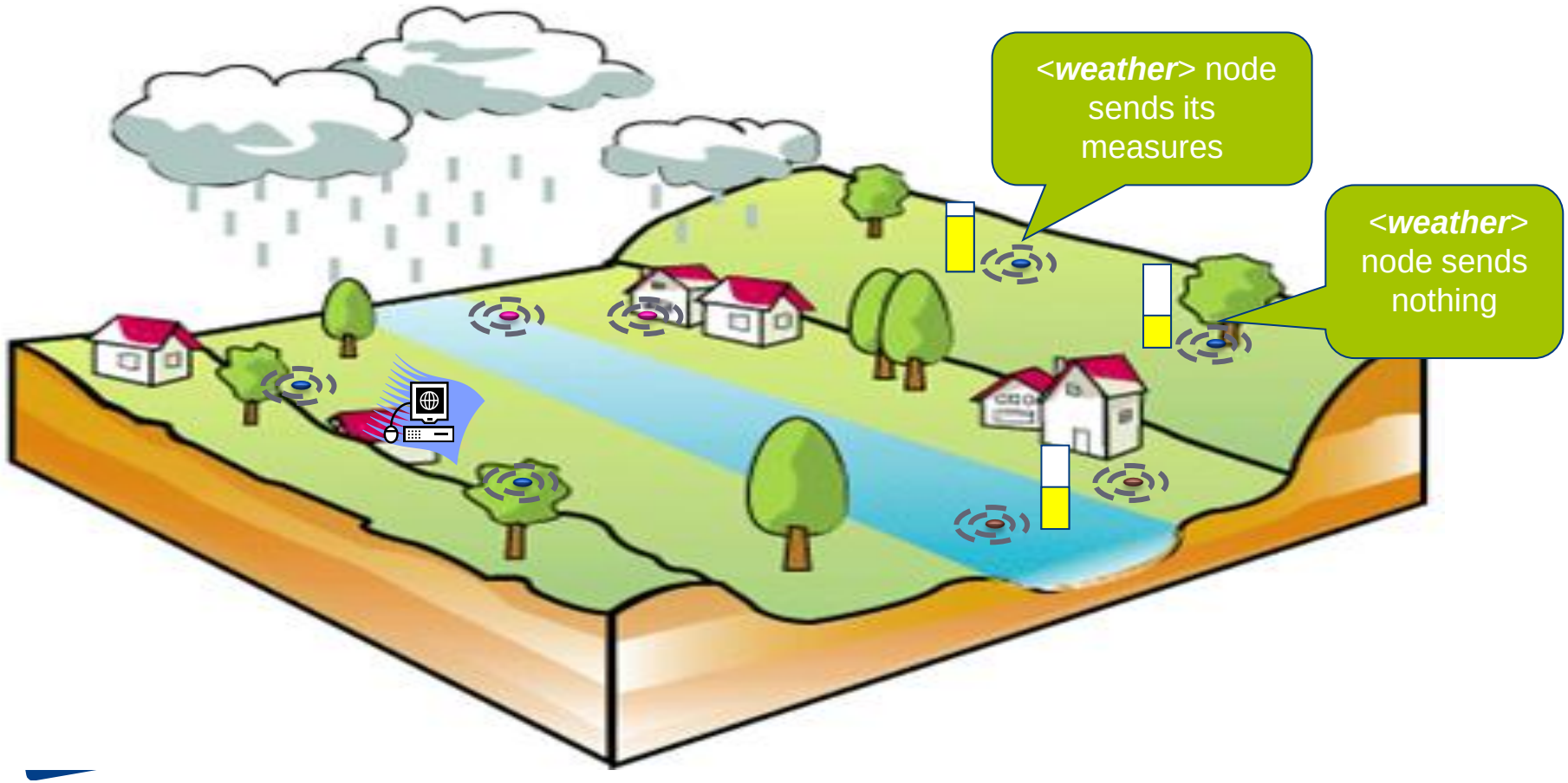
NODE (ENERGY) STATE:

1. Strong Energy state
2. Average Energy state
3. Low Energy state



Wireless Sensor Network (WSN)

Phenomena state Normal



Ontologies

- Definition:
  - "explicit specification of a conceptualization" (Gruber, 1993)
  - "explicit specification of a shared formal conceptualization" (Studer et al., 1998)

- Objectives:
  - normalize the vocabulary
  - defined the messages formats

Ontology goals

DESCRIPTION OF

- WSN and their devices
- Observation process
- Communication process
- Data stream
  - Acquisitional Data Stream
  - Communication Data Stream
- Context = Set of entity's state

Sensor Ontologies

1. Semantic Sensor Network ontology (SSN), 2010
2. Coastal Environmental Sensor Networks (CESN) ontology (Calder et al., 2010)
3. CSIRO Sensor Ontology, (Compton et al., 2009)
4. Stimuli-centered (Stasch et al., 2009)
5. OOSTethys (Bermudez et al., 2009)
6. MMI (Marine Metadata Interoperability)
7. Sensor Web for Autonomous Mission Operations (SWAMO) ontology, 2008
8. SEEK Extensible Observation Ontology (OBOE) (Madin et al., 2007)
9. Sensor Data Ontology (SDO) (Eid et al., 2007)
10. OntoSensor (Russomanno et al., 2005)

Analysis of the developed topics

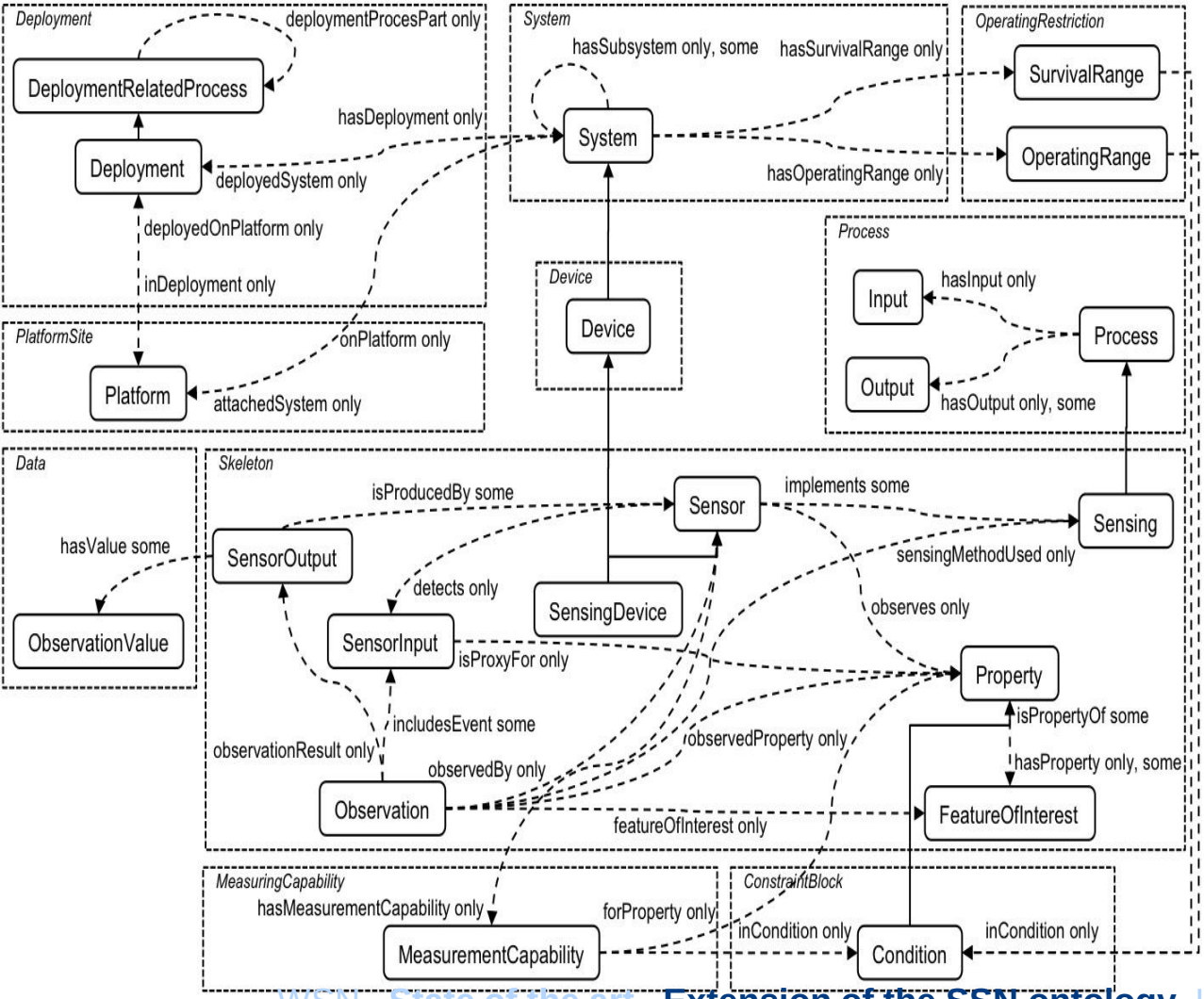
3 TOPICS

- *Sensor:* the sensor and its components (Compton et al., 2009)
- *Observation:* the measurement process (Compton et al., 2009)
- Data: processes using data like aggregation or communication processes

Analysis of the topics

	Sensor						Observation						Data				
Ontologies	**Sensor**	**Sensor type**	**Components**	**Deployment**	**Configuration**	**Action & process**	**Observation**	**Reponse model**	**Measurement**	**Accuracy**	**Frequency**	**Field of view/sensing**	**Data**	**Data stream**	**Data Stream acquisition politic**	**Data stream communication politic**	**Domain**
SSN	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*
CESN	*			*			*						*				*
CSIRO	*	*	*	*	*	*	*	*	*	*	*	*	*		*		*
Sensei O&M							*						*				
OOSTethys			*			*	*						*				*
MMI	*		*	*	*	*				*	*				*		*
SWAMO	*		*			*						*					*
SEEK							*		*				*				
SDO	*	*			*		*	*	*	*	*	*	*		*		*
SeReS O&M					*	*	*	*					*				
OntoSensor	*	*	*		*	*	*	*	*	*	*	*	*		*		*

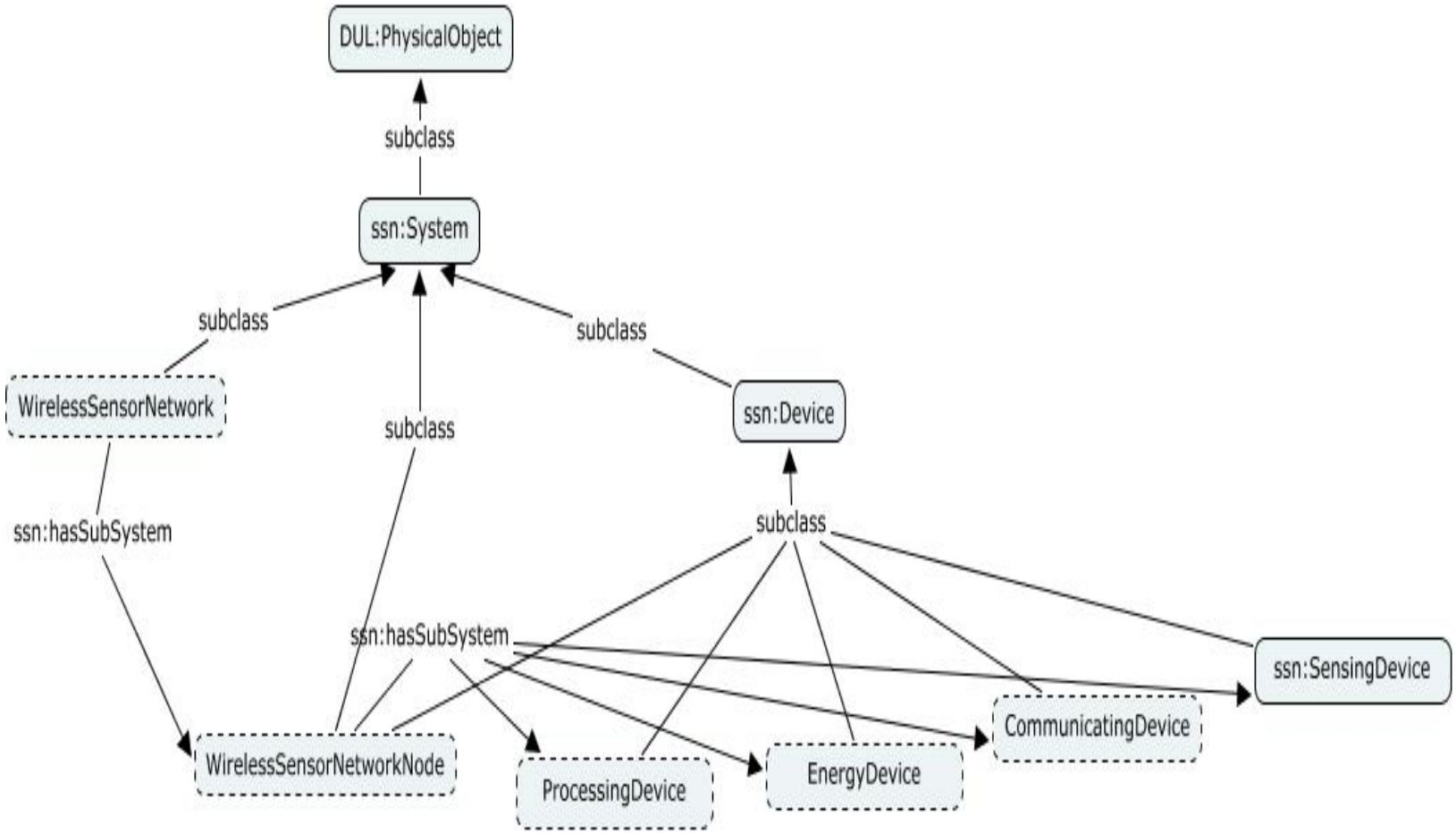
SSN ontology (Compton et al., 2012)



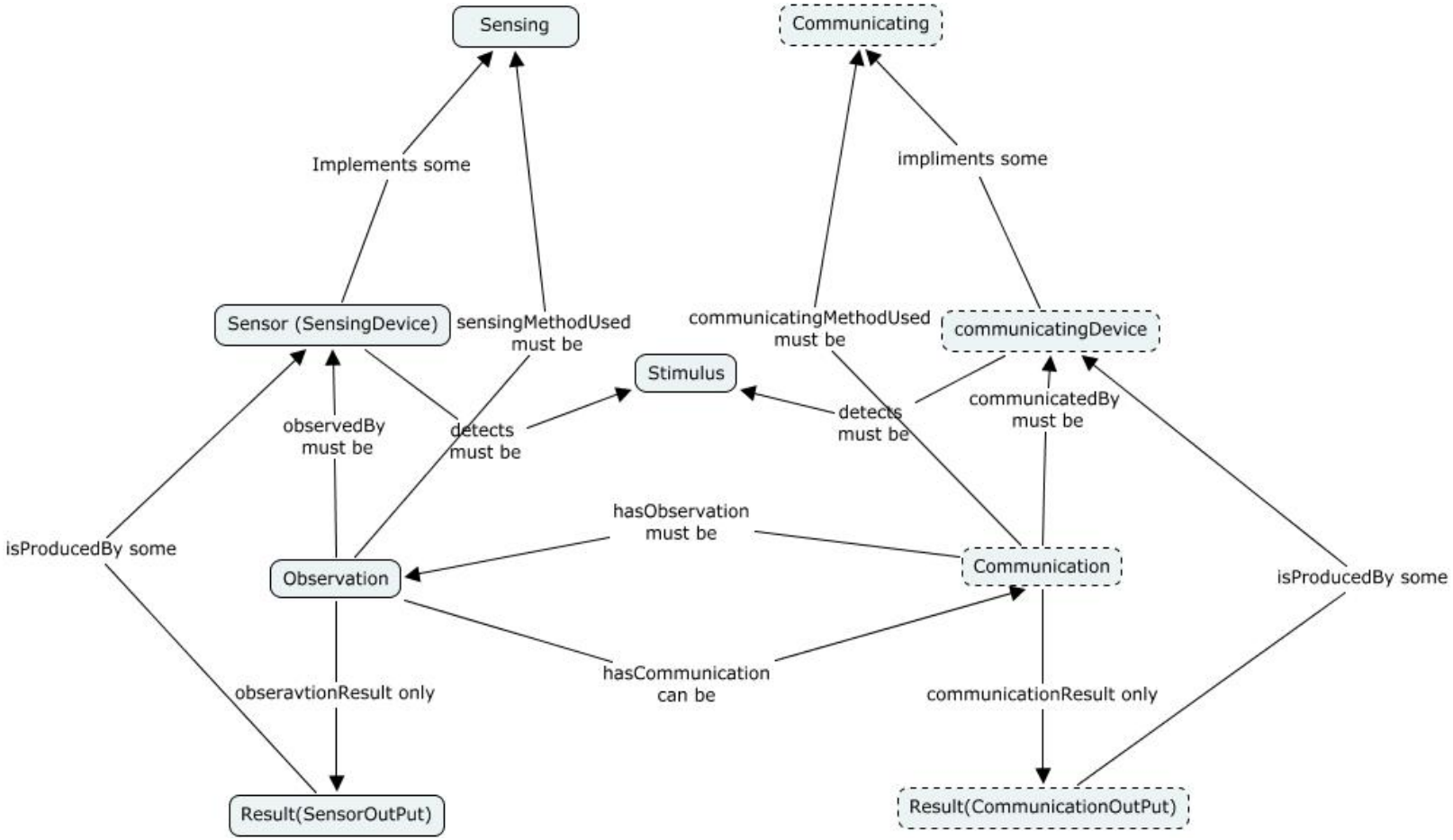
Our needs…

- WSN and their devices
- Observation process
- Communication process
- Data stream
  - Acquisitional Data Stream
  - Communication Data Stream
- Context = Set of entity's state

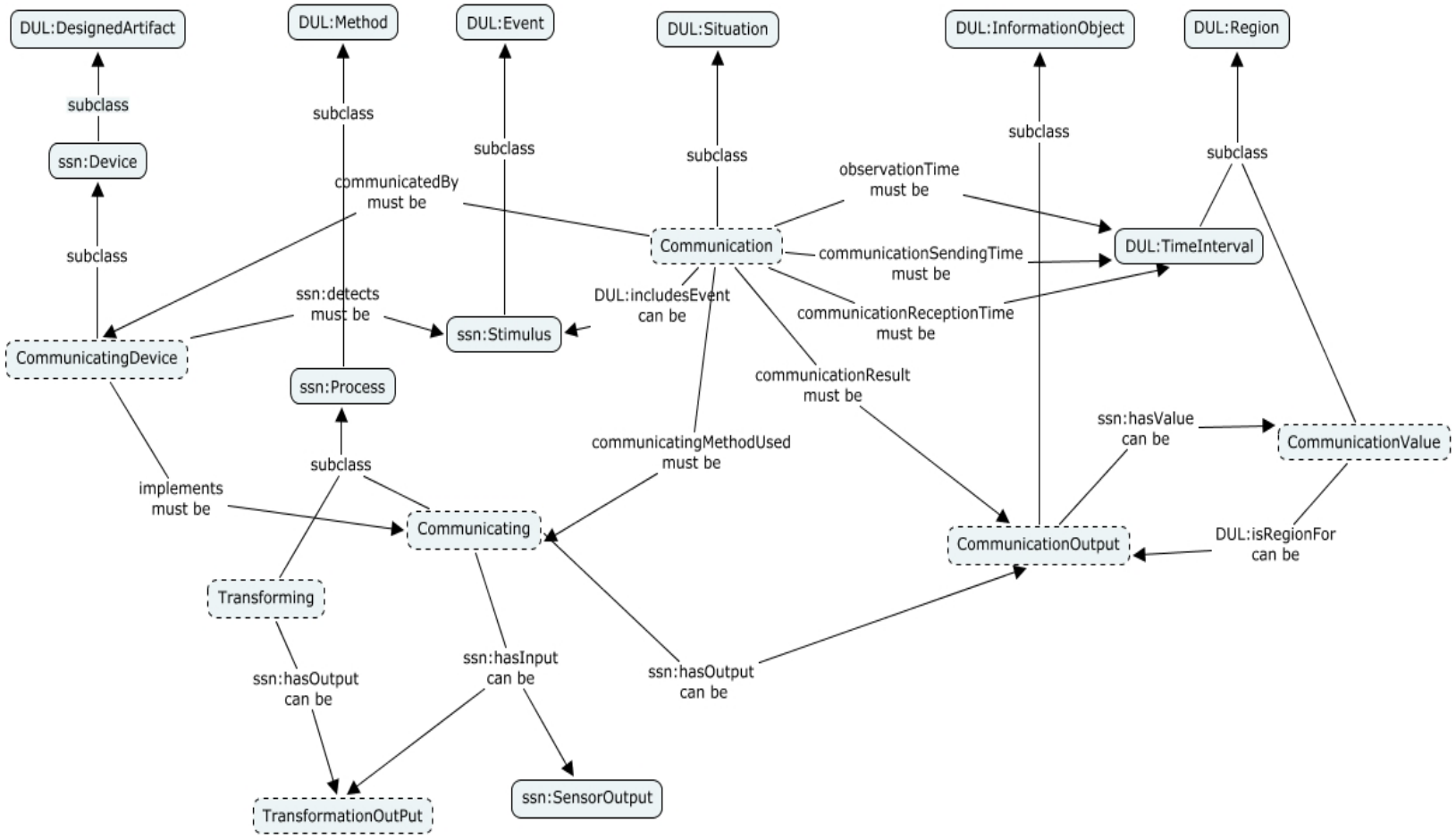
WSN and its devices



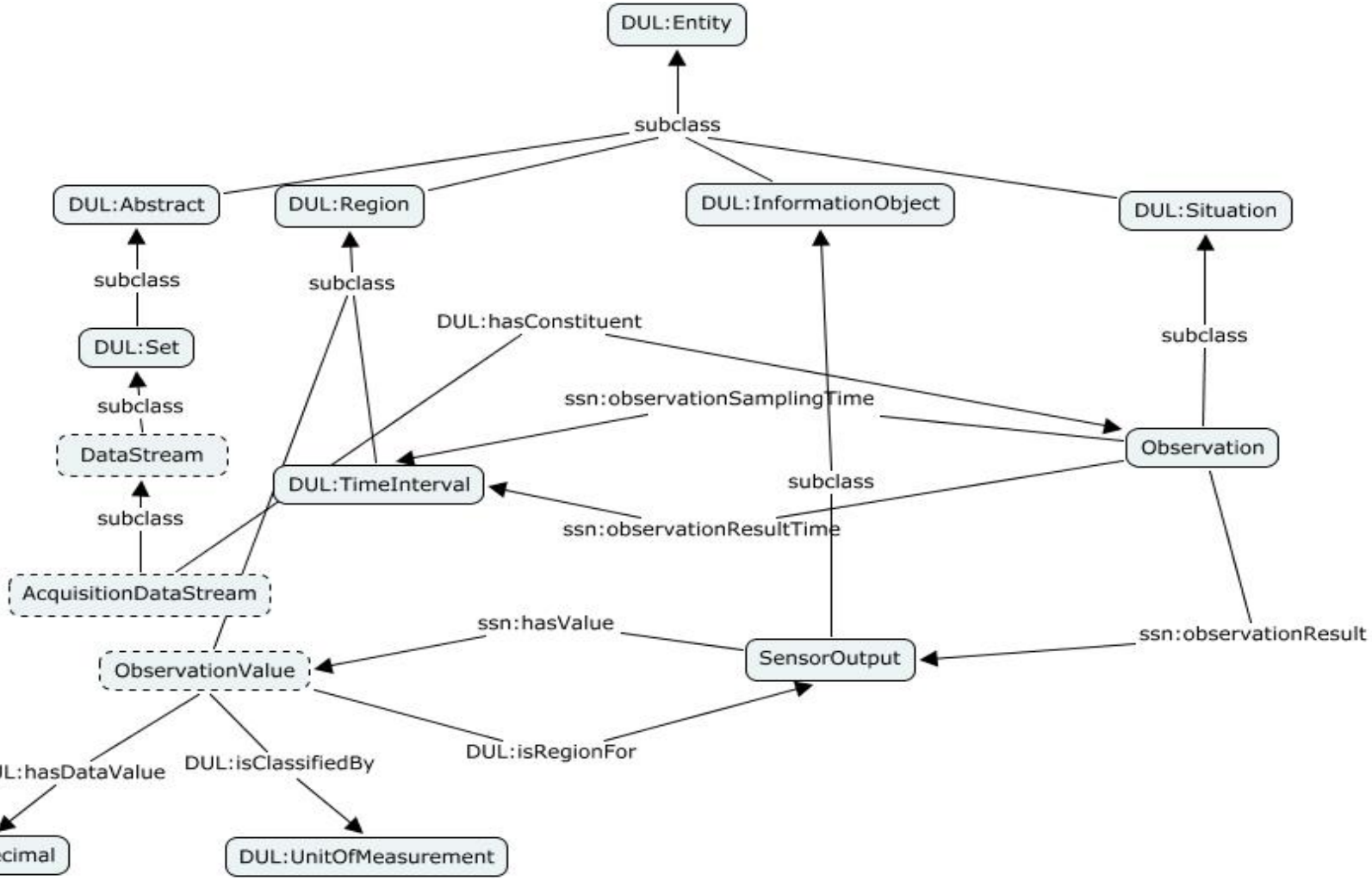
Communication: Stimulus-WSNnode-Communication pattern



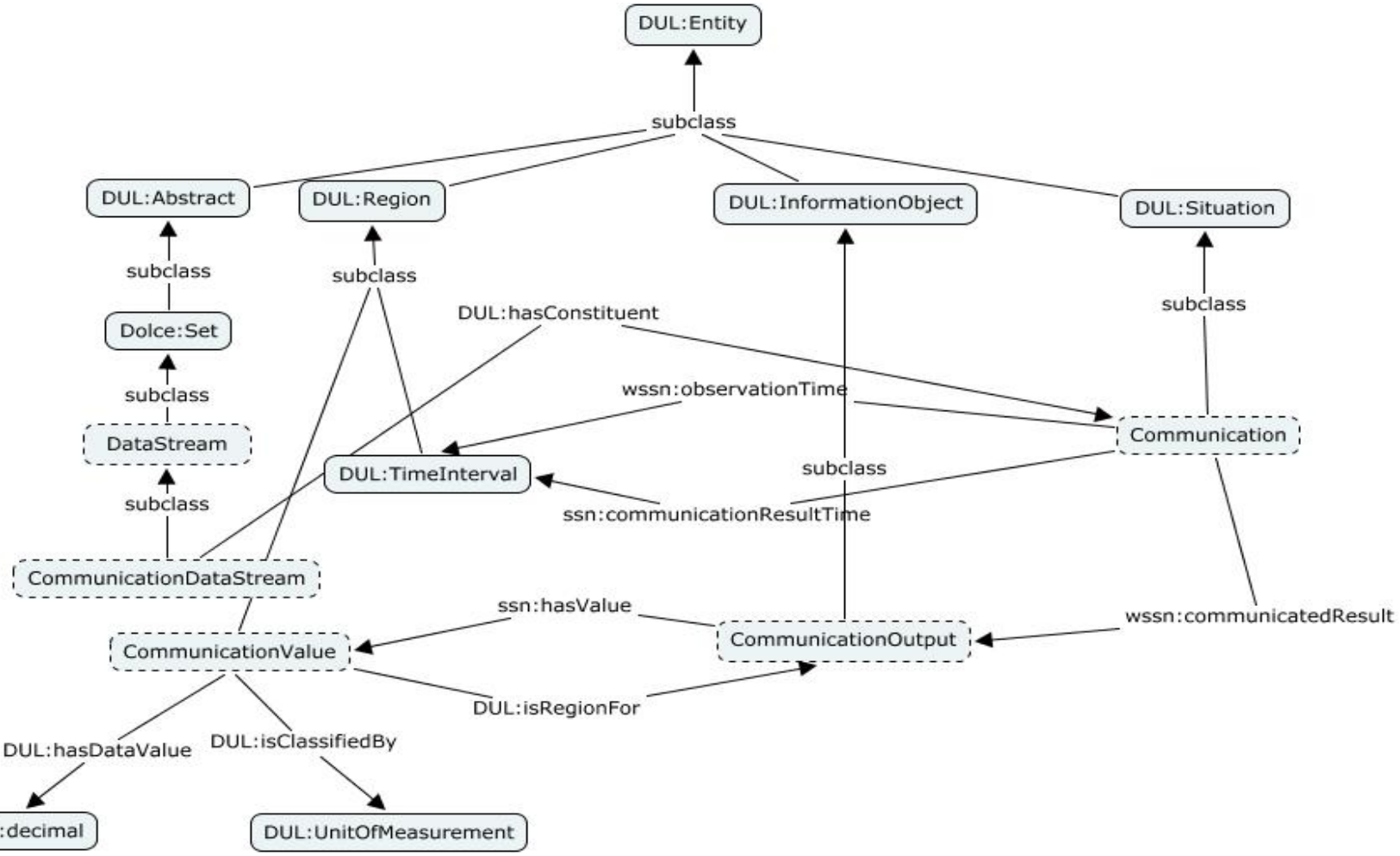
Communication process



Acquisition data stream

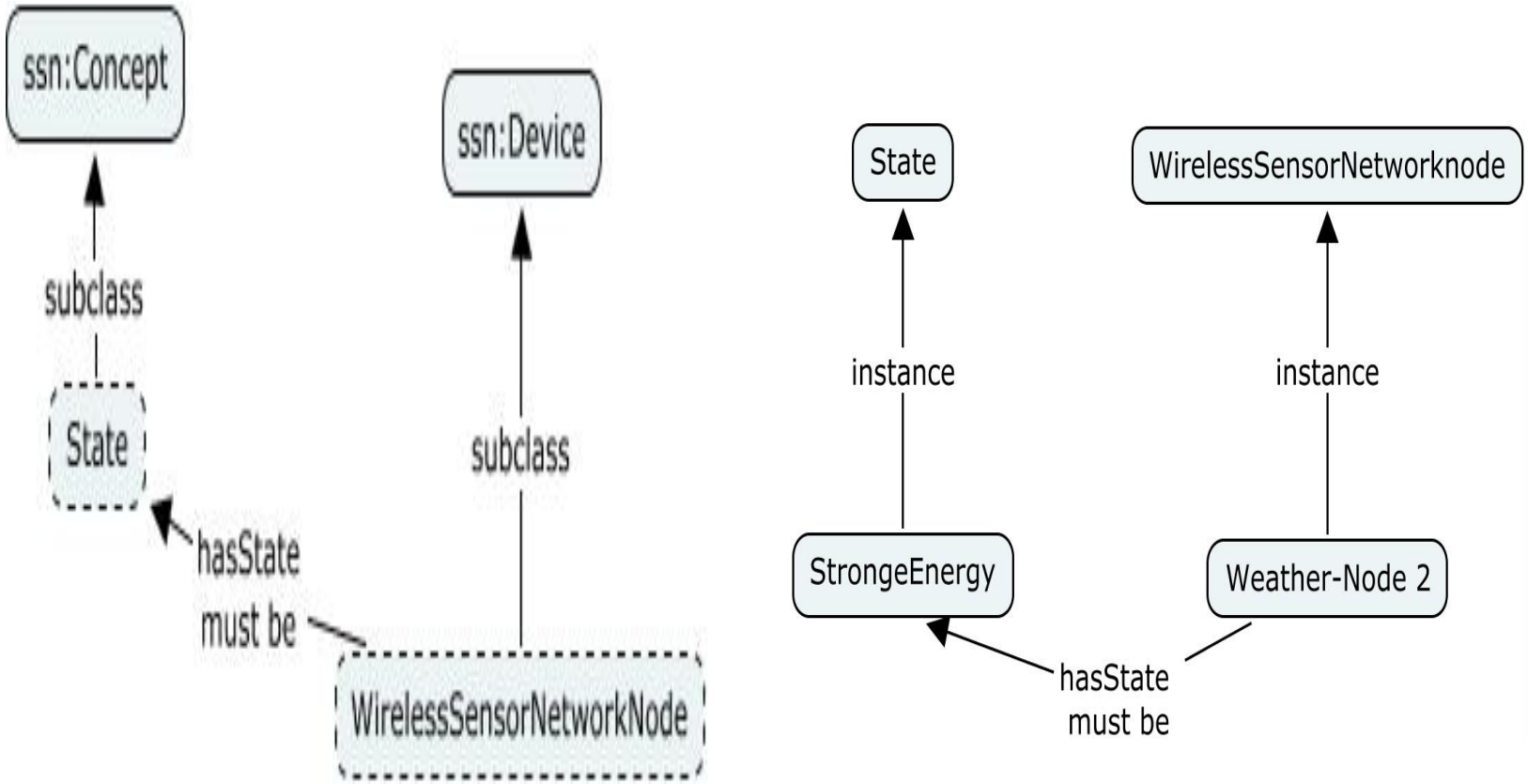


Communication data stream



State

OUR EXAMPLE



The use of the WSSN ontology

SIMULATED SCENARIO

- In an agri-environnemental scenario…
  - Flood monitoring in watersheds
  - Description of WSN:

    two «weather» nodes:

    sensor of the precipitations quantity (pluviometer)

    Decision Support System (DSS)

The use of the WSSN ontology

IMPLEMENTATION OF THE SCENARIO

The default settings of the two nodes

- Each node has an energy device: 240 transmitting packets
- Acquisition and the communication frequencies are equal: one communication per 1 hour
- Node 2 adapts its behavior to its context

The use of the WSSN ontology

IMPLEMENTATION OF THE SCENARIO

- "Strong Energy state", when the current amount of transmitted packets performed by the node is under 120 packets
- "Average Energy state", when the current amount of transmitted packets is between 120 and 180 packets
- "Low Energy state", when the current amount of transmitted packets performed by the node is above 180 packets

The use of the WSSN ontology

IMPLEMENTATION OF THE SCENARIO

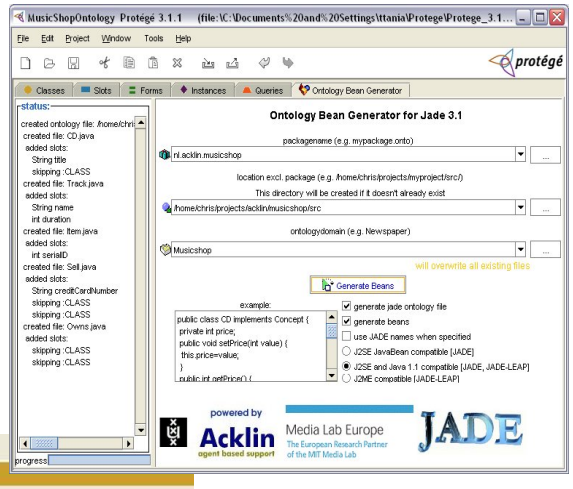
Depending of its state, the node 2 changes its communication frequency:

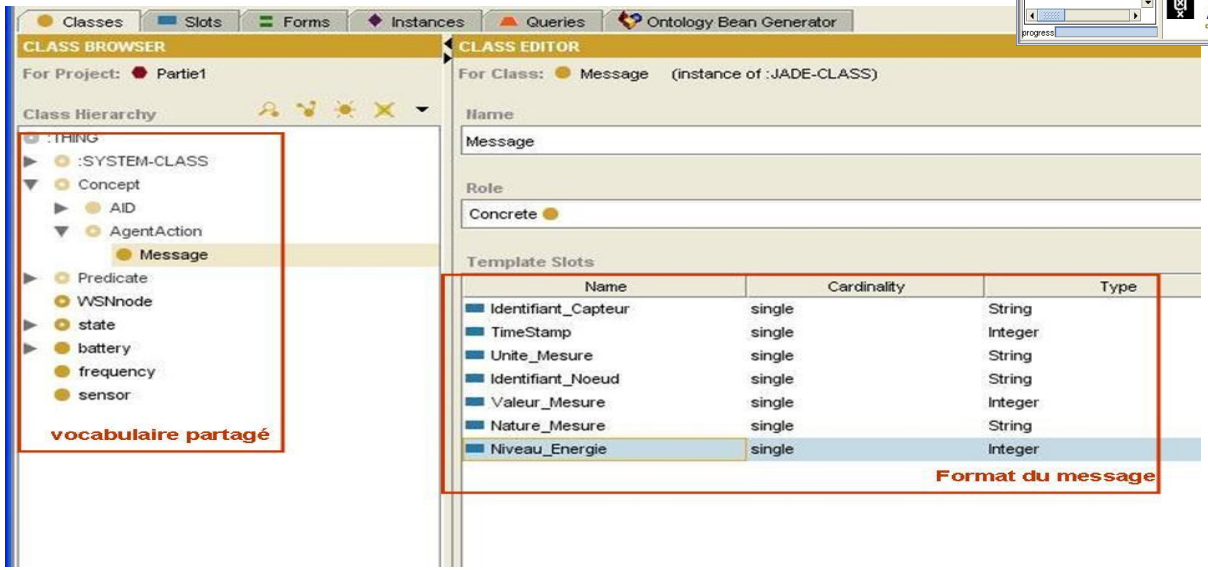
- “Strong Energy state”: one communication per 1 hour
- “Average Energy state”: one communication per 2 hours
- “Low Energy state”: one communication per 4 hours

The use of the WSSN ontology

USING TOOLS

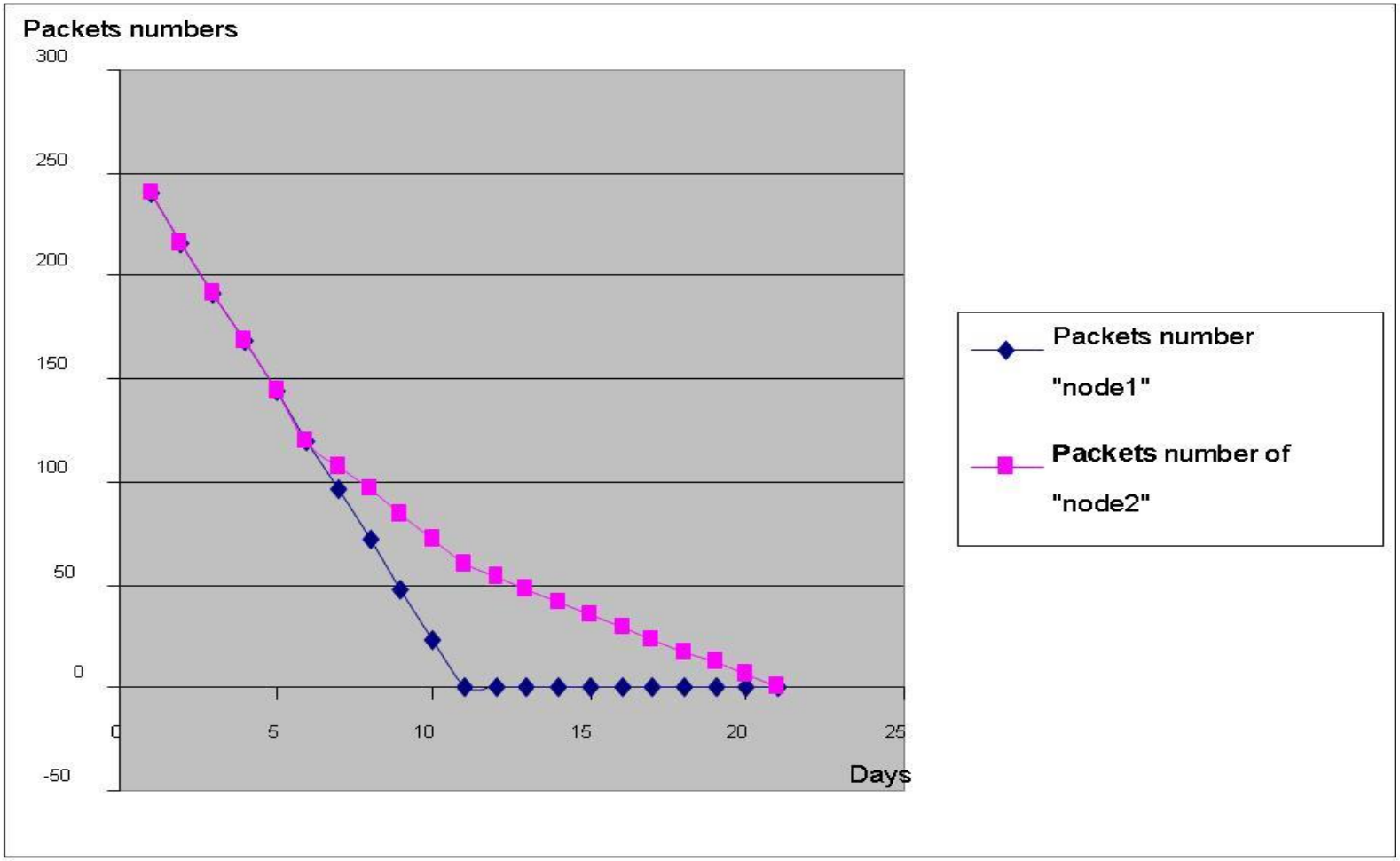
- Model the WSN and its nodes
  - JADE Simulator (Bendadouche et al. 2012)
- Develop the WSSN ontology
  - Protégé (BeanGenerator plugin)





Simulation Result

COMPARING THE LIFETIME OF THE TWO ”WEATHER” NODES



Conclusion

- SNN is the ontology that describes most of topics that a sensor ontology must describe
- No ontology is able to characterize the communication data policy
- Propose a new ontology design pattern called Stimulus-WSNnode-Communication (SWC)
- Enrich the SSN ontology using SWC pattern with WSN concepts, Wireless Semantic Sensor Network ontology (WSSN)
- Simulate on JADE a simple scenario which illustrate the interest of our contextual approach based on ontologies

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Perspectives

- Enrich our ontology in order to point out the difference between the communicated data and the acquired one
- Model the knowledge used in rules engines
- Simulate on JADE a complete scenario for the flood monitoring in a watershed
- Implement on physical WSN nodes our approach and make more complex experiments


THANK
YOU...