Extension of the Semantic Sensor Network Ontology for Wireless Sensor Network: The Stimulus - WSNnode -Communication Pattern

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Pour mieux affirmer ses missions, le Cemagref devient Irstea









Wireless Sensor Network (WSN)

Definition:

collection of WSN nodes connected to one or more gateways

Characteristics:

- large-scale deployment
- limited resources
 - Energy
 - CPU
 - memory



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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

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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"

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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

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Ontology goals DESCRIPTION OF

- WSN and their devices
- Observation process
- Communication process
- Data stream
 - Acquisitional Data Stream
 - Communication Data Stream

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• 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)

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5. OOSTethys (Bermudez et al., 2009)

- 6. MMI (Marine Metadata Interoperability)
- Sensor Web for Autonomous Mission Operations (SWAMO) ontology, 2008
- 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

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



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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



Communication: Stimulus-WSNnode-Communication pattern



Communication process





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Communication data stream









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)

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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

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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

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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

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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)





protégé

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File Edit Project Window Tools Hel

created ontology file: /home/chri created file: CD.java

status

added slots

String title skipping :CLASS created file: Track java

added slots

int duration

online here

int serialD created file: Sell.java added slots:

added slots:

String name

created file: Item java

String creditCardNumbe

skipping :CLASS

skipping :CLASS created file: Owns java

skipping :CLASS

skipping :CLASS

🔸 Classes 🛛 💻 Slots 🔰 🛢 Forms 🖌 🔶 Instances 🖌 📥 Queries 🛛 🐶 Ontology Bean Generator

A home/chris/projects/acklin/musicshop/src

example

public class CD implements Concept &

public void setPrice(int value) {

private int price;

this.price=value

lic int cetPrice(

ni.acklin.musicshop

Musicshop

Ontology Bean Generator for Jade 3.1

oackagename (e.g. mypackage onto)

location excl. package (e.g. /home/chris/projects/myproject/src/ This directory will be created if it doesn't already exist

ontologydomain (e.g. Newspaper

Generate Beans

generate jade ontology file

use JADE names when specifier

J2SE JavaBean compatible [JADE]

J2SE and Java 1.1 compatible [JADE, JADE-LEAP] J2ME compatible [JADE-LEAP]

IADE

generate beans

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)

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- Simulate on JADE a simple scenario which illustrate the interest of our contextual approach based on ontologies

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

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THANK YOU...