


ALaRI – Faculty of Informatics, University of Lugano, Switzerland

Introduction to SysML




Workshop on UML for SoC and Embedded Systems Design

DATE '07 - Nice
Friday, April 20th, 2007

Mauro Prevostini
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ALaRI – Master in Embedded Systems Design

Some questions before starting




- How many of you:
 - know something about UML?
 - have used UML in the past?
 - still use UML?
 - use UML within Academia?
 - use UML within Industry?
 - know SysML?
 - use SysML?

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Outline




- Motivation
- Background
- Pillars of SysML
- SysML Diagrams Overview
 - by means of a small Case Study

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System Modeling




Addressing multiple aspect of a System

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Background




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Background: UML 1.x → UML 2.0



- Software Developers → System Engineers
- UML 2.0 improvements:
 - More precise syntax and semantics, e.g.:
 - Component diagrams
 - Interfaces, Ports and Connectors
 - Timing diagrams
 - Expressive and powerful (applicable to wider range of projects)
 - Abstract (designers and architects work at higher level)
 - Interchangeable between tools (XMI)

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SysML

- May 2006
OMG + INCOSE → SysML
Systems Modeling Language
- SysML: it's a profile to extend UML 2.0 to systems which are not purely software based.
- www.omgsysml.org

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SysML

- Graphical modeling language for specifying, analyzing, designing, and verifying complex systems that may include hardware, software, information, personnel, procedures, and facilities.
- Address the requirements of Systems Engineering as specified in the UML for Systems Engineering RFP developed by OMG, INCOSE, and ISO AP233 workgroup
- Provides model and data interchange via XMI

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Contributions

- **Industry**
 - American Systems Corporation
 - BAE SYSTEMS
 - Boeing
 - Deere & Company
 - EADS Astrium
 - Eurostep
 - Israel Aircraft Industries
 - Lockheed Martin Corporation
 - Motorola
 - Northrop Grumman
 - oose Innovative Informatik GmbH
 - PivotPoint Technology
 - Raytheon
 - THALES
- **US Government**
 - NASA/Jet Propulsion Laboratory
 - National Institute of Standards and Technology (NIST)
 - DoD/Office of the Secretary of Defense (OSD)

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Contributions

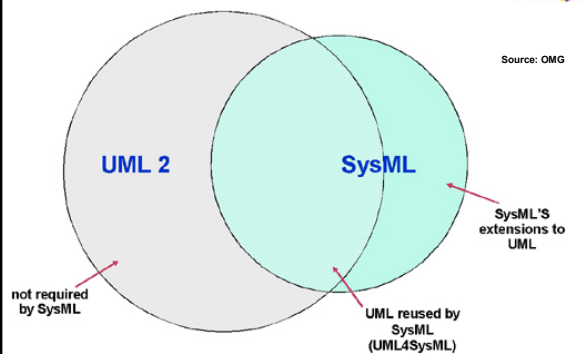
- **Vendors**
 - ARTISAN Software Tools
 - Ceira Technologies
 - EmbeddedPlus Engineering
 - Gentileware
 - IBM
 - I-Logix
 - Mentor Graphics
 - Telelogic
 - Structured Software Systems Limited
 - Sparx Systems
 - Vitech
- **Academia**
 - Georgia Institute of Technology
- **Liaisons**
 - Consultative Committee for Space Data Systems (CCSDS)
 - Embedded Architecture and Software Technologies (EAST)
 - International Council on Systems Engineering (INCOSE)
 - ISO STEP AP233
 - Systems Level Design Language (SLDL) and Rosetta

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SysML / UML Inter-relationship

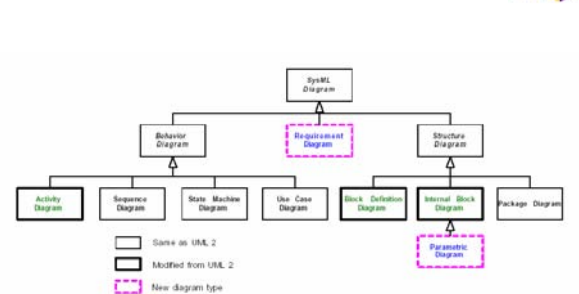


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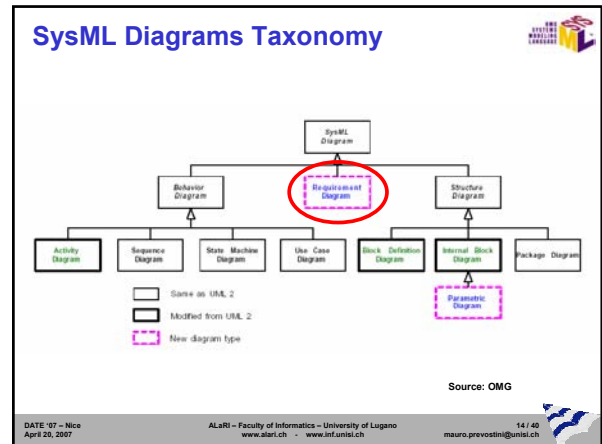
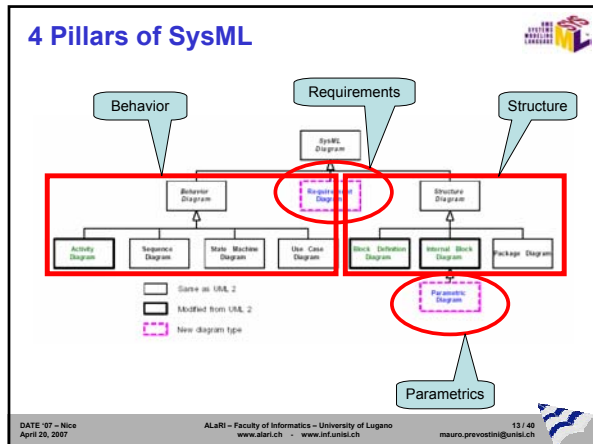
SysML Diagrams Taxonomy



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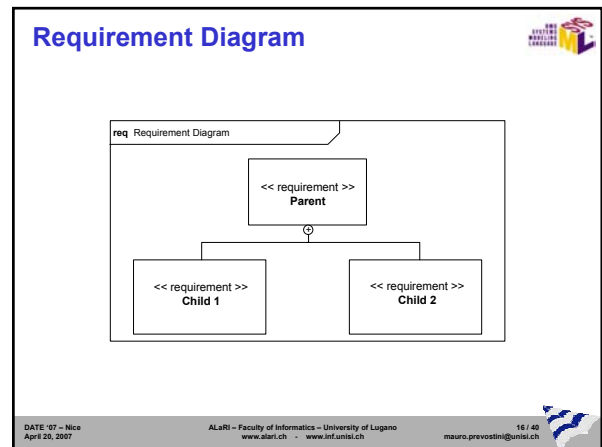
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Requirement Diagram

- The «requirement» stereotype represents a text based requirement
 - Includes id and text properties
 - Can add user defined properties such as verification method
 - Can add user defined requirements categories (e.g., functional, interface, performance)
- Requirements hierarchy describes requirements contained in a specification
- Requirements relationships include DeriveReq, Satisfy, Verify, Refine, Trace, Copy

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Case Study: Wireless Sensor Network

Requirement 1:
The System should be based on a WSN able to measure microclimate data and store it in a repository

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Case Study: Wireless Sensor Network

Requirement 1:
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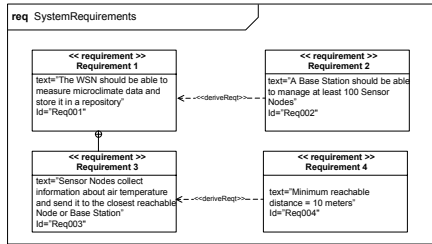
Requirement 2:
A Base Station should be able to manage at least 100 Sensor Nodes

Requirement 3:
Sensor Nodes collect information about air temperature and send it to the closest reachable Node or Base Station

Requirement 4:
Minimum reachable Distance = 10 meters

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Requirement Diagram

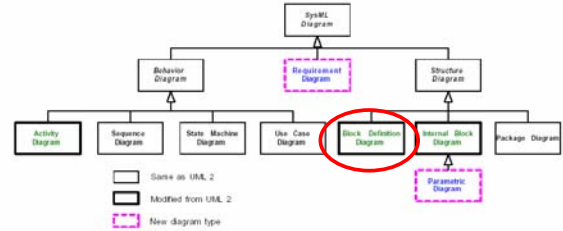


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SysML Diagrams Taxonomy



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Block Definition Diagram

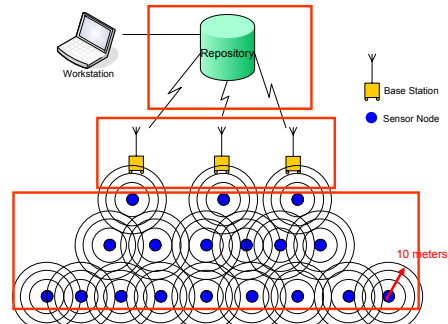
- Blocks are basic structural elements
- Blocks specify hierarchies and interconnection
- BDD describes the relationships among blocks
- Based on UML Class from UML Composite Structure

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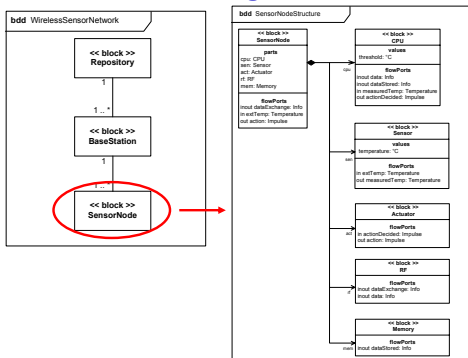


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Block Definition Diagram

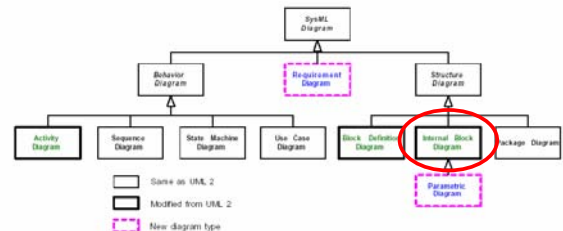


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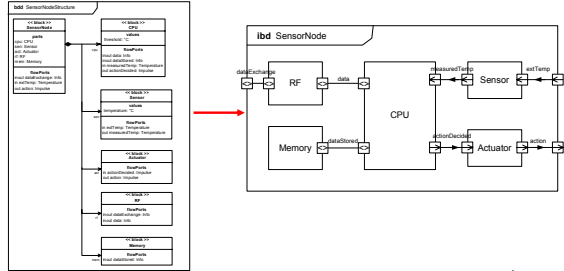
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Internal Block Diagram

- Describes the internal structure of a block
- Specifies interconnection of parts

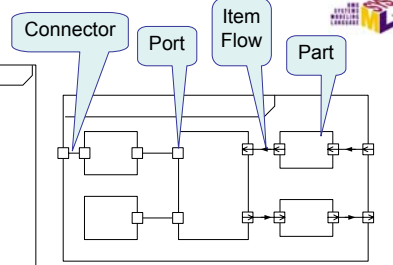


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Features



- Usage**
- Part is the usage in a particular context
 - Typed by a block
 - Also known as a role

- Definition**
- Block is a definition/type
 - Captures properties
 - Reused in multiple context

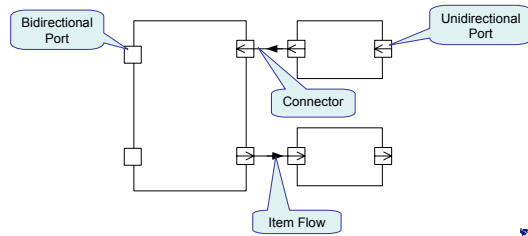
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SysML Port

- Specifies interaction points on blocks and parts
- Supports integration of behavior and structure
- Specifies what can flow in or out of block/part

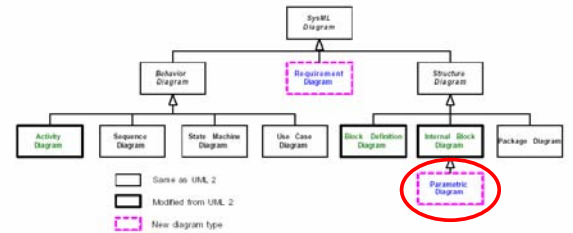


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Parametric Diagram

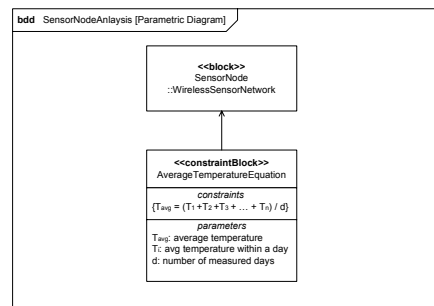
- Used to express constraints (equations) between value properties
 - Provides support for engineering analysis (e.g., performance, reliability)
- Constraint block captures equations
 - Expression language can be formal (e.g., MathML, OCL) or informal
 - Computational engine is defined by applicable analysis tool and not by SysML
- Parametric diagram represents the usage of the constraints in an analysis context
 - Binding of constraint usage to value properties of blocks

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Parametric Diagram



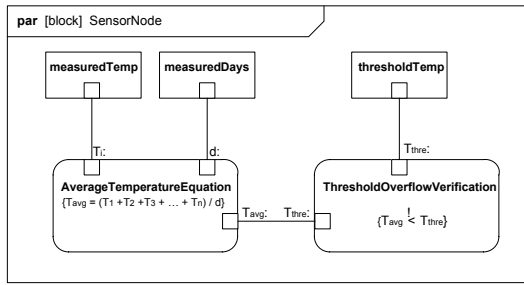
Parameterics enable integration of Engineering Analysis with Design Models

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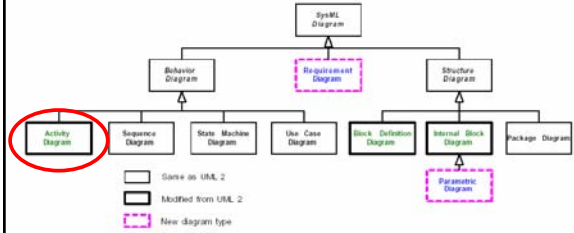
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Parametric Diagram



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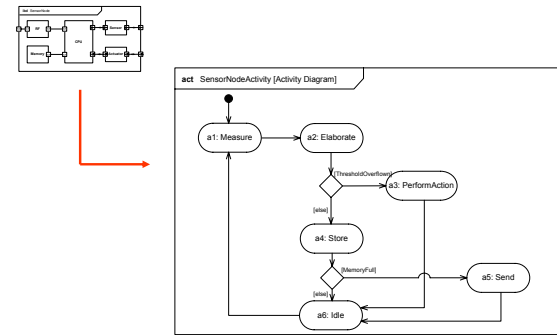


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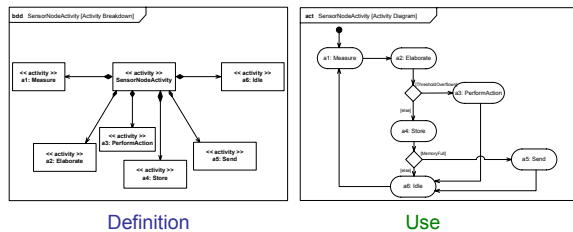
Activity Diagram

- Activity used to specify the flow of inputs/outputs and control, including sequence and conditions for coordinating activities
- Secondary constructs show responsibilities for the activities using swim lanes
- SysML extensions to Activities
 - Support for continuous flow modeling
 - Alignment of activities with Enhanced Functional Flow Block Diagram (EFFBD)

Activity Diagram

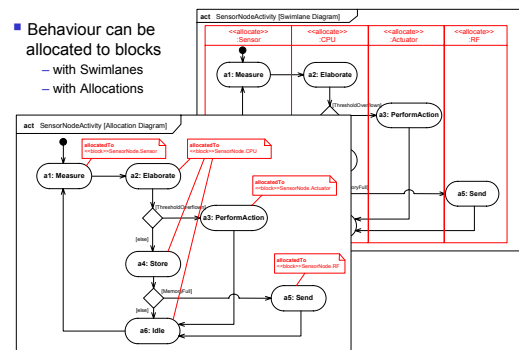


Activity Decomposition



SysML Allocation

- Behaviour can be allocated to blocks
 - with Swimlanes
 - with Allocations



Summary



- SysML sponsored by INCOSE/OMG with broad industry and vendor participation
- SysML provides a general purpose modeling language to support specification, analysis, design and verification of complex systems
 - Subset of UML 2 with extensions
 - 4 Pillars of SysML include modeling of requirements, behavior, structure, and parametrics
- OMG SysML Adopted in May 2006
- Standards based modeling approach for SE expected to improve communications, tool interoperability, and design quality

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References



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 - <http://www.omgsysml.org>
- UML for Systems Engineering RFP
 - OMG doc# ad/03-03-41
- UML 2 Superstructure
 - OMG doc# formal/05-07-04
- UML 2 Infrastructure
 - OMG doc# ptc/04-10-14
- OMG SysML Final Adopted Specification
 - OMG doc# ptc/06-05-04
- OMG-INCOSE SysML Tutorial
 - by S. Friedenthal, A. Moore, R. Steiner, July 2006

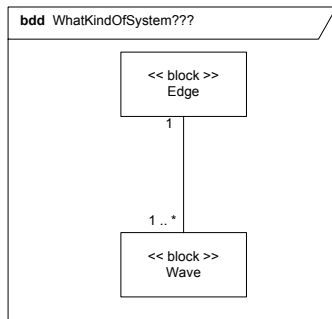
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Small Quiz



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