SysML Miscellaneous Grab Bag

Systems Engineering BSc Course





Budapest University of Technology and Economics Department of Measurement and Information Systems

Modeling of logical and physical data

Using block definition diagrams





Value type (Data type)

- Primitives: Boolean, String, Complex, etc.
- Can have Unit and/or QuantityKind (formerly dimension)
 - QuantityKind: Length, Energy, Time, etc.
 - Unit: meter, inch, Watt, secundum, etc.
 - Has a QuantityKind





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Data of a block

- Blocks can have attributes and/or values
- Value given by / restricted by
 - Definition (bdd)
 - e.g. in a specialized block (motorized =,,true")
 - o Use (ibd)
 - o Runtime
 - The value may change over time



Signal, Block

- A signal defines a message that can be sent and received by a block.
 - Has a set of attributes
 - Used by interfaces





Well-formedness constraints





Well-formedness constraints

- Describes additional constraints that should be satisfied on every instance
- Structural constraint
 - A turnout sensor should be connected to exactly one zone controller
- Value constraint
 - The operator should be at least 175 cm tall
 - Components should have a unique name
- Behavioral constraint
 - CPU should receive 12V +- 1V electricity



Motivation: Early validation of design rules

SystemSignalGroup design rule (from AUTOSAR)

- A SystemSignal and its group must be in the same IPdu
- Challenge: find violations quickly in large models
- New difficulties
 - reverse P: SignallPdu navigation R3:signalToPduMapping R4:signalToPduMapping complex M_CHILD **M PARENT** manual : ISignalToIPduMapping : ISignalToIPduMapping solution R1:signal R5:signal NEG S CHILD : ISignal S PARENT : ISignal R2:systemSignal R6:systemSignal **R7:systemSignal** SS PARENT: SystemSignalGroup SS CHILD : SystemSignal



Motivation: Early validation of design rules

SystemSignalGroup design rule (from AUTOSAR)

Mapping I	Signals	to	IPDUs
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Position of ISignals in the selected IPDU

Ach status ccSpeedU

🏣 Model tree 📾 System editor: demoSystem 🔀

🛆 ISignals	Signal
B_sigPedalPosition	-∕l, sigPedalPosition
B_sigSpeedValue	-∕l, sigSpeedValue
ch_sigEngineTemperature	-∕l,sigEngineTempera
🗠 ch_sigIgnition	-/ı- sigIgnition
🗠 ch_sigRpm	-∕l, sigRpm
🖃 🚧 ch_status	🚈 status
	-∕l/status_ccActive
•	

AUTOSAR:

- standardized SW architecture of the automotive industry
- now supported by modern modeling tools **Design Rule/Well-formedness constraint:**
- each valid car architecture needs to respect
- designers are immediately notified if violated **Challenge:**
- >500 design rules in AUTOSAR tools
- >1 million elements in AUTOSAR models models constantly evolve by designers

Resource

/alma

/alma

/alma

/alma

- 🧅 Element description 🚼 Problems 🔀 errors, 2 warnings, 0 others
- Description 🔺

n

ISignals

🖃 🔞 Errors (4 items)

😣 ISignal of a grouped System Signal should be mapped to an IPdu along with the IS as or the System Signal Group demo_swc.arxml 😣 ISignal of a grouped System Signal should be mapped to an IPdu along with the ISignal of the System Signal Group demo_swc.arxml 😣 ISignal of a grouped System Signal should be mapped to an IPdu along with the ISignal of the System Signal Group demo_swc.arxml 😢 Reference iPduTimingSpecification has invalid multiplicity! (Must be in: [1, 1]) demo_swc.arxml

p___ch_status_ccSp



AUTOSAR P...

AUTOSAR P...

AUTOSAR P...

AUTOSAR P...

/rootP...

/rootP...

/rootP...

/rootP...

SysML Constraints

- Different semantics can be used

 plain English vs formal languages (OCL, Javascript, etc.)
 formal language can be used for automatic validation
- Can also be defined as a separate block with <<constraint>> stereotype





SysML Constraints

Different compantics can be used

Don't confuse with SysML Parametrics Diagram!

- Constraints are given by the designers
- Parametrics diagram considers the behaviour of nature (will cover later)

nguages (OCL, Javascript, etc.) used for automatic validation

arate block with

Box constraints {The height of the box should be less than 50 cm.} {self.size.height < 0.5}

pe

block»

values weight : kg{unit = Kilogram} size : Size

material : Material



Constraint in plain

english and OCL

OCL: an OMG Standard

- Object Constraint Language
- Declarative language for defining constraints

- Unique name constraint defined by OCL:
 - o context Component inv: Component.allInstances()-> forAll(c1, c2 | c1 <> c2 implies c1.name <> c2.name)



VIATRA

- VIATRA is an open source Eclipse project
 O Affiliated with the research group
- VIATRA Query Language
 - Graph pattern matching
 - Can evaluate queries incrementally upon changes
- Unique name constraint defined by VQL
 - o pattern nameCollision(c1, c2) {
 Component.name(c1,name1);
 Component.name(c2,name2);
 c1 != c2;
 name1 == name2; }









UML Profiles

- Profiles can be used to extend the UML/SysML language.
- Examples
 - SysML is defined as a profile on a subset of UML.
 - SYSMOD (a methodology for SysML) also defines a profile for SysML
 - MARTE (which is an OMG standard) profile is used for modeling real-time and embedded applications.
 - Tools usually support the creation of custom profiles.



Defining a Profile



MÚEGYETEM 17

Using a Profile

A profile should be applied to the project to use





Summary

Top-down and bottom-up design

Top-down: using decomposition
 When designing a subsystem, its goal is already known

There are no working parts during development
 Problems, needs of subsystems revealed late

Bottom-up: using composition
 Subsystems can be tested one-by-one
 There are always some working parts during development

S Exact roles of the subsystems are revealed late

- (Not only in structural modeling...)
- Meet-in-the-middle approach
- Iterative approaches









Ports

- What is a port?
 - Interaction points with external entities limiting and differentiating the possible connection types



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