Towards Multi-Models for Self-\* Cyber-Physical Systems

Hansen Salim and John Fitzgerald

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Agenda

Introduction

MetaSelf & INTO-CPS

Case study (UAV Swarm)

Conclusion
Introduction

Self-* Systems

• self-adapting, organising, healing, optimising, ...

• System improvement through a form of autonomy

Cyber-Physical Systems

• Interaction between cyber parts and physical entities.

E.g. Smart cars, UAVs

1 http://www.documentarytube.com/articles/self-driving-cars-when-we-will-have-them
Self-* Cyber-Physical Systems

Design challenges
- Cyber & Physical, Heterogenous, Level of Autonomy, Real time
- Transferability between different CPSs

Use existing self-* framework for CPSs?
- MetaSelf: Service Oriented Architecture (SOA) - Component/Agent based, Middleware framework

CPS Model-Based Design support Self-*?
- INTO-CPS: multi model approach
MetaSelf

• Architectural framework, basis for assurance in some self-* capabilities
• Follow SOA approach, not designed for CPSs
Overview of the structure of the INTO-CPS tool chain
Our approach

- Standalone MetaSelf FMU
- DE side – VDMRT files

Interaction between MetaSelf FMU with other FMUs in INTO-CPS multi-model
MetaSelf FMU (SysML block definition diagram)
VDMRT classes defined following the MetaSelf framework

Controller.vdmrt
Internal Policy for self-* mechanism

Component.vdmrt
Generic class for system components
Case study

INTO-CPS
(D3.5 - Examples Compendium 2)
“Swarm of UAV”

“Swarm of UAV” SysML Connection Diagram
Self-Organising UAV Swarm

System goal: Maximize UAV coverage over a designated area (1 directional plane)

Self-* goal: Perform UAV replacement or reconfigure formation

A) Optimum coverage
B) New formation with limited UAVs
Self-* UAV Swarm SysML Architecture Structure Diagram

*Might require multiple instances of the MetaSelf FMU for decentralised CPSs

Newcastle University
UAV swarm case study simulation graph – X coordinate of UAVs
Conclusion

MetaSelf for CPSs

• Cyber & Physical integration handled by INTO-CPS
• Real time - no support for timely policy execution
• Autonomy - Extension required for machine learning

INTO-CPS for Self-*

• SysML profile does not describe self-* properties:
  • Architecture diagram – Architectural reconfiguration
  • Connection diagram – Dynamic connection between FMU components

Further work: case study on decentralised CPS with heterogenous components & support for real time