Lessons from IT Ecosystems

Michael Köster

Computational Intelligence Group,
Clausthal University of Technology

GaLOT Kickoff, February 11, 2013

Outline

IT Ecosystems

IT Ecosystems

- **Classical approaches** do not scale well for today's **large and complex software-intensive systems**.
- Software systems are **connected** among each other and **interact** massively.

⇝ IT Ecosystem:

- analogue to **biological ecosystems**
- based on the **balance between individuals** (autonomy) and **sets of rules** (control) defining equilibria within an IT Ecosystem
- **Maintaining** and continuously evolving IT Ecosystems requires deep understanding of this balance.

IT Ecosystems

- **Classical approaches** do not scale well for today's **large and complex software-intensive systems**.
- Software systems are **connected** among each other and **interact** massively.

$\rightsquigarrow$ IT Ecosystem:

- analogue to **biological ecosystems**
- based on the **balance between individuals** (autonomy) and **sets of rules** (control) defining equilibria within an IT Ecosystem
- **Maintaining** and continuously evolving IT Ecosystems requires deep understanding of this balance.

Application

In Smart Cities are the following IT Ecosystems:

- Smart-Living-Systems
- Smart-Working-Systems
- Smart-Transport-Systems
- Smart-Energy-Systems
- etc.

$\rightsquigarrow$ Smart Airport as a smaller instance of a Smart City

Smart Airport

Usual Day on an Airport:

- Journey to the Airport (Parking, Traffic Accident)
- Orientation
- Transportation in the Airport
- Shopping during Waiting time
- Goods Transport
- Check-in
- Baggage Drop-off
- Catastrophe
- etc.

IT Ecosystems Project

NTH focused Research School for IT Ecosystems:

- Technische Universität Braunschweig,
- Technische Universität Clausthal,
- Leibniz Universität Hannover.

Three main projects:

- AIM: Buttom-Up Approach
  Adaptive Information methods.
- RuleIT: Top-Down Approach
  Rules are inferred from the design phase and verified at runtime.
- Loccom: Combination of both: Bottom-Up and Top-Down approaches.

Loccom

Project Loccom

Professors:

- Prof. Dr. Lars Wolf (TUBS)
- Prof. Dr. Jürgen Dix (LUH)
- Prof. Dr. Michael Beigl (TUBS, jetzt KIT)
- Prof. Dr. Christian Siemers (TUC)
- Prof. Dr. Heribert Vollmer (LUH)
- Prof. Dr. Mark Vollrath (TUBS)

Research Assistants:

- Martin Berchtold
- Kerstin Bischoff
- Michael Köster
- Peter Lohmann
- Sascha Lützel
- Johannes Morgenroth
- Julian-Steffen Müller
- Klaus Reinprecht
- Sebastian Schildt
- Sergej Zerr

Loccom: Local Communities

Nowadays Social Networks:

- exchange of information,
- groups of interests, and
- explicit use of a computer or smartphone.

Local Communities: **social networks** + **real social networks**

- exchange of information works automatically,
- spontaneous and dynamic groups of interests, and
- implicit use of a smart phone.

Loccom: Local Communities

Nowadays Social Networks:

- exchange of information,
- groups of interests, and
- explicit use of a computer or smartphone.

Local Communities: **social networks** + **real social networks**

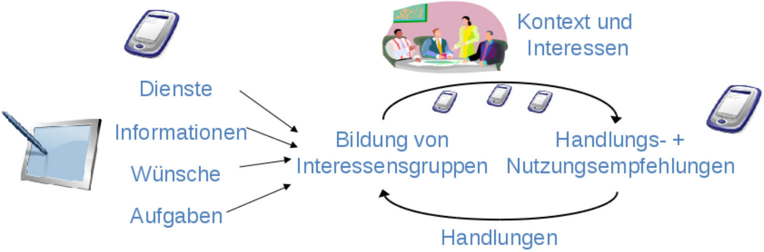
- exchange of information works automatically,
- spontaneous and dynamic groups of interests, and
- implicit use of a smart phone.

Overall Aim and Loccom Approach

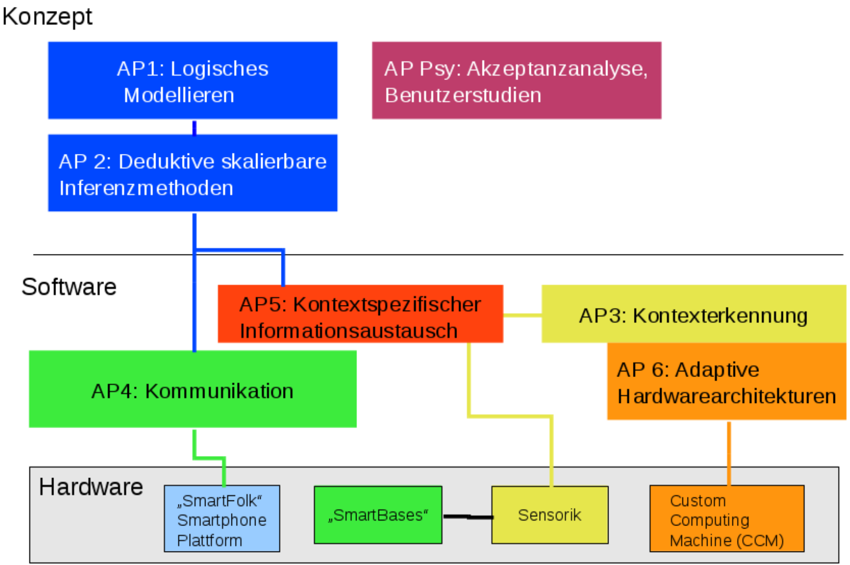
Goal: Combine social and real social networks by

- integrating the context
- ensuring minimal properties
- using resources jointly.

Approach: Use mobile devices to combine social network services with the real world.



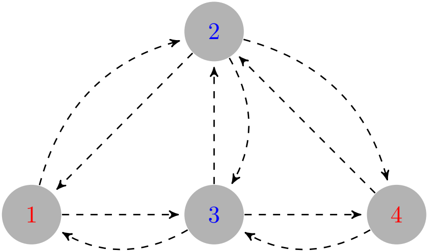
Project Structure



Specification and Verification of MAS

Local Communities: **social networks** + **real social networks**

- exchange of information works automatically,
- spontaneous and dynamic groups of interests, and
- implicit use of a smart phone.



- Specification: Modular Interpreted System
- State Space: Abstraction for MIS
- Minimal Properties: ATL, MDL, MTL
- Model Checking AMIS

Model Checking AMIS

Idea:

- Input:
  - MIS S
  - $init$ of global states of S
  - ATL formula φ
  - for each quantifier subformulae an abstraction relation
- Output:
  - true: if $S, q \models \varphi$ for all $q \in init$
  - unknown: we do not know whether S satisfies φ or not

Modal Dependence Logic

Dependence between propositions.

Complexity results:

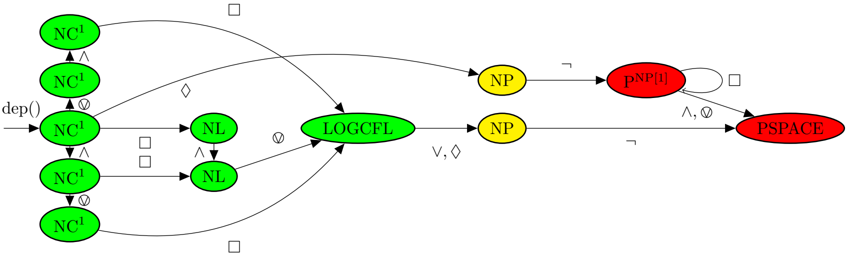
- Model Checking: NP-complete
- Satisfiability: NEXPTIME-complete
- $\rightsquigarrow$ Fragments for MDL satisfiability.

Modal Team Logic

No dependence between propositions.

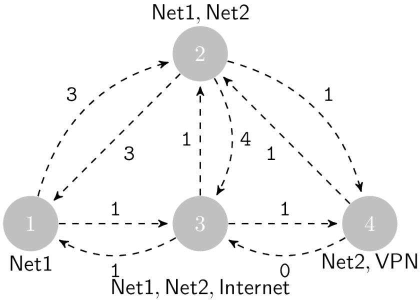
Complexity results:

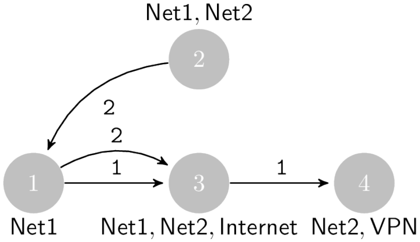
- Model Checking: PSPACE-complete
- Fragments for MTL Model Checking:



Opportunistic Networks

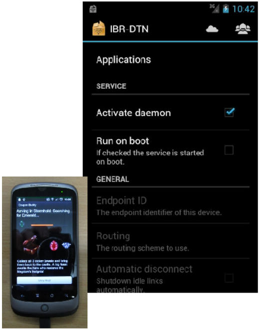
- DTN Networks
- Agents' Goals in CTL
- Game-theoretic Approach for Optimal Topology



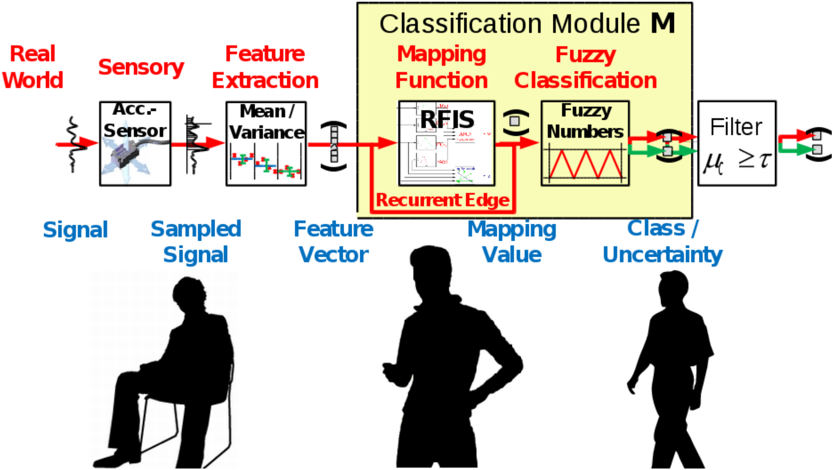


DTN Communication

- Opportunistic Networks
- Underlying communication infrastructure in a SmartCity
- Integration in Android



Context Recognition



Privacy and Data Sharing: Classification

Classification of images:

Private

Public

Work Sea Winter Water

Conclusion

Ongoing Work

Parallel (approximate) Model Checking for MIS:

- Model Checking happens in the modules
  - Constrain ATL formulae: Length of path and/or nesting
  - Look only at the states in the direct neighbourhood
- Implement the algorithm in JAVA.
- Translate the algorithm to cellular automata to use FPGAs.

Lessons learned

Problems:

- A formal description of an IT Ecosystem was missing.
- The Scenario was quite vague.
- Heterogeneous group of researchers even in the smaller projects.

Interesting Aspects:

- Working with researchers from different fields.
- Underlying idea of an IT Ecosystem.