Unifying our Research

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Outline

1. Aim
2. Efre: Supervising Collaboration in Virtual Organizations
3. DFG: Human-Centered IT Ecosystems
4. DFG: Multi-Agent Planning with Temporal Logic
5. Sim-Centre: DeSim

Aim

Aim

- Trying to bring together what we are doing.
- Potential to apply for funding, in particular **Simulation Centre**.
- Re-use old proposals and check what persists.
- Common theme temporal logic of one kind or another.

Challenge:

Tous pour un, un pour tous.

Efre: Supervising Collaboration in Virtual Organizations

General Info

- Support and control **Collaborative behaviour of self-interested actors in heterogenous networks**
- More flexible formation of virtual organizations
- Which supervision and enforcement concepts are needed?
- **Holistic logical framework**
- New virtual organization programming language, simulation infrastructure and verification environment

More concretely

- Theoretical background of VO's
- How to describe it with certain computational logics?
- Verification, Simulation
- Software Engineering

More concretely (cont.)

- Collection of **use-cases**. Hamburg group.
- Categorization of the use cases for different simulation scenarios.
- Validation initial logic framework. Lisbon group
- Executable simulation model. Utrecht group
- Verification of supervision and behavious enforcement. Clausthal

DFG: Human-Centered IT Ecosystems

General Info

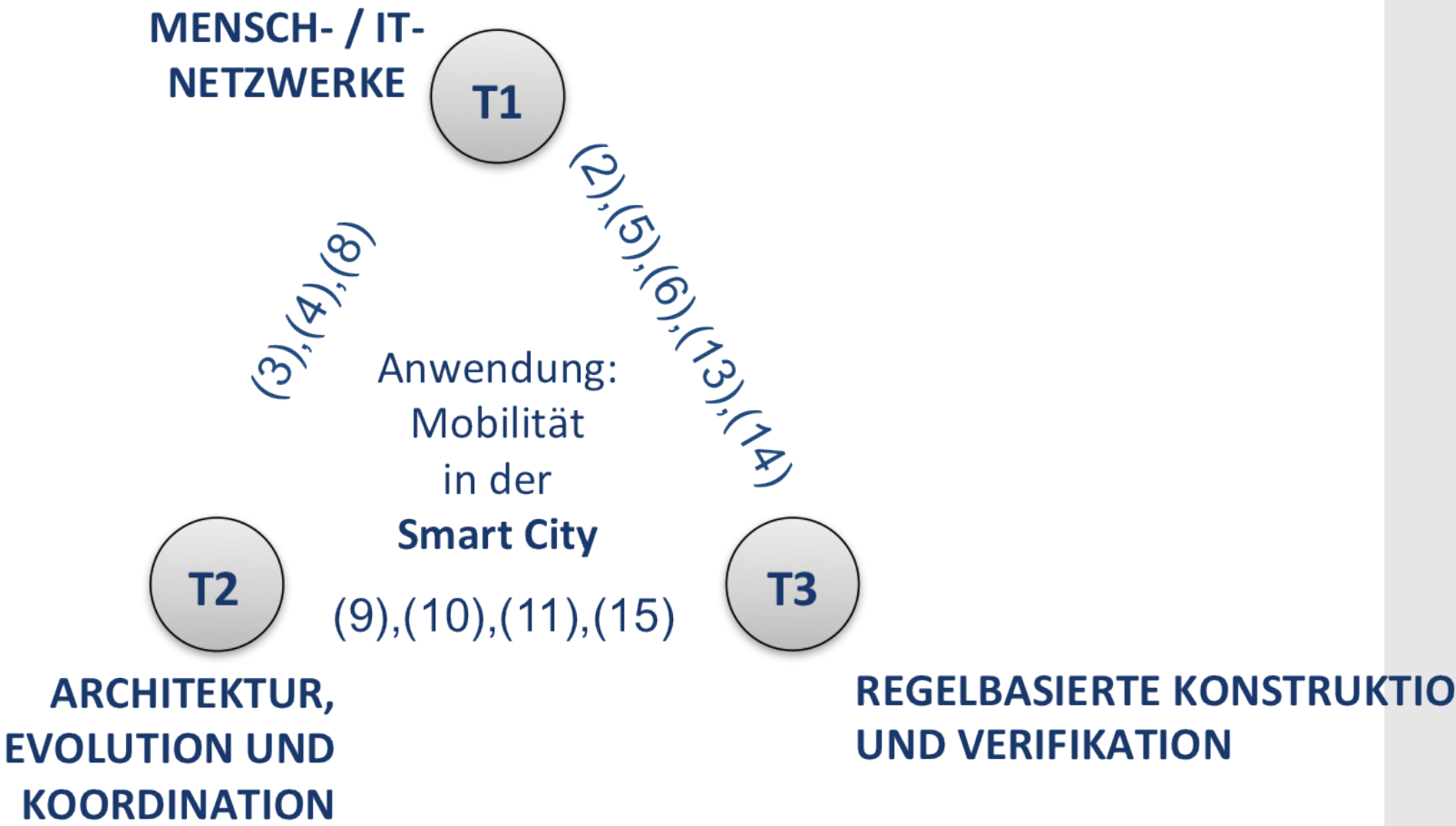
- Proposal for a **Graduiertenkolleg**
- Outcome of IT-Eco-Systems
- 15 PhD new positions (6 for Clausthal), additional 15 from the colleagues involved.
- **still pending**
- Planning a City vs **Planning a single building**
- CMU: Ultra Large-Scale-Systems

The very idea

More concretely

- **Coalitions** (of actors, systems) evolve over time dynamically.
- **Organisations** evolve dynamically.
- IT Ecosystem should force general rules (norms).
- **Autonomy** vs **Managebility**
- Equilibria

The very idea



Some PhD projects

- Dix, Müller, Le
  (8) Towards adjustable autonomy: Mechanisms for learning norm-compliant behavior and norms emergence in IT Ecosystems **T2/T1**
- Müller, Vollrath, Dix
  (9) Modeling and Model Checking in IT Ecosystems **T2/T3**
- Dix, Vollmer, Goltz, Herold
  (10) Skalierbare Erkennung und Lösung von Ressourcen-, Plan- und Zielkonflikten in großen IT Ecosystems **T2/T3**

Some PhD projects (cont.)

- Vollmer, Goltz, Dix
  (12) Expressibility and Complexity of Temporal Dependence Logic **T3/T2**
- Goltz, Dix, Vollmer
  (15) Ausdrucksfähigkeit von Logiken über kausalitätsbasierten Modellen und deren Einsatz für die Modellierung in IT-Ökosystemen **T2/T3**

DFG: Multi-Agent Planning with Temporal Logic

Main Idea

Teamwork: team-level planning in cooperative settings

- Foundational Issues of planning.
- Reduce big part of the problem (eg. coordination) to model checking and propositional satisfiability **of theories in temporal modal logics**.
- Combine **planning as model checking** with **planning with temporal logics**.
- Not extending traditional decentralized goal-tree decomposition techniques (Lesser et al.)

More concretely

provided a set of partial temporal specifications of implemented capabilities and constraints of individual agents together with a joint goal, a great deal of the problem of finding a (partial) joint concurrent plan can be dealt by model checking and/or computing propositional satisfiability of a corresponding formal theory in a temporal modal logic.

More concretely

- State-of-the-art focusses either on planning for single agents or on reasoning about joint capabilities of teams of agents, not taking the coordination into account.
- Temporal logics are useful for partial specifications of agents capabilities.
- We look for a planning framework in which the joint goal, as well as the individual agents' activities can be formulated as partial temporally extended specifications.

More concretely

MASPLAN is a tuple

$$\Pi = (\mathcal{L}, K_{dom}, K_{sync}, \{(C_i, \phi_i)\}_{i=1}^{n}, S_o, \gamma).$$

$\mathcal{L} = \mathcal{L}_{dom} \cup \mathcal{L}_{sync}$ is a language of a temporal modal logic with $\mathcal{L}_{dom}$ and $\mathcal{L}_{sync}$ providing vocabularies for $K_{dom} \subseteq \mathcal{L}_{dom}$ and $K_{sync} \subseteq \mathcal{L}_{sync}$, which are finite theories describing domain knowledge and control knowledge about synchronized actions of the agent team.
C_i the set of capabilities of agent $\mathcal{A}_i$ characterized by a set of corresponding temporal specifications ϕ_i formulated in $\mathcal{L}$.
S_0 is a propositional characterization of the initial situation and γ is a temporal specification of the joint team mission formulated in $\mathcal{L}_{sync}$, a *temporally extended joint goal*.

MASPlan

A solution to the MASPLAN problem is a concurrent plan, a tuple $\pi_1, \ldots, \pi_n$, where each π_i is a program for the agent $\mathcal{A}_i$ specified in terms of a composition of its capabilities (C_i) which is *feasible* w.r.t., the initial situation S_0, the domain knowledge K_{dom}, the control knowledge about the synchronized actions between agents K_{sync} and the specification of the joint goal γ.
I.e., informally, the **resulting plans must be performable** by the individual agents and at the same time **invocations of synchronized (public) actions should be consistent** with the individual plans of the involved agents.

Sim-Centre: DeSim

Centres of Excellence

Political decision (suitable for Clausthal as well): **Research should be done in Centers of Excellence**.

- **PFP: Produktionstechnisches Zentrum (NTH-H)**.
- **EFZN: Energieforschungszentrum (NTH-C)**.
- **NFF: Forschungszentrum Fahrzeugtechnik (NTH-BS)**.
- **CZM: Materialwissenschaftliches Zentrum (C)**, new building to be finished soon.
- **SWZ: Simulationszentrum (C)**.

Funding goes to such Centers

The Simulation Centre

Evaluated by the Scientific Commission Niedersachsen: **4 Mio Euros for 4 years**.

- Jointly with University of Göttingen.
- **To improve technical or natural processes.**
- eg. airport managment, logistics
- technical processes: numerical simulation eg. ventilators, turbulences
- Area 1: Materials
- Area 2: Processes, Anlagen, Logistics
- Area 3: Energy and Environment
- Area 4: Hochleistungsrechnen
- Area 5: **Visualization, Data Analysis and Software Engineering**

Our idea: Research around the *Agent Contest*

DeSim

Joint project with Jörg Müller,
1 position: 3+1 or 2+2 (not yet decided).
Each of us gets 0.5 positions. **Could be filled with a good Master Student**, e.g. Tobias Ahlbrecht.

- Systems of Systems (SoS): decentralised modelling and Simulation
- MABS: Multi-Agent based Modelling and Simulation
- Platforms: JADE, JACK, MASSIM
- Applications: Desaster Management, Logistics, cooperative robotics
- MABS vs. loosely coupled SoS: Relation?

Most Important Step

Choice of a suitable application scenario, eg

- Cooperative Task-planning of mobile autonomous vehicles
- Energy-efficient driving in convois of electro vehicles