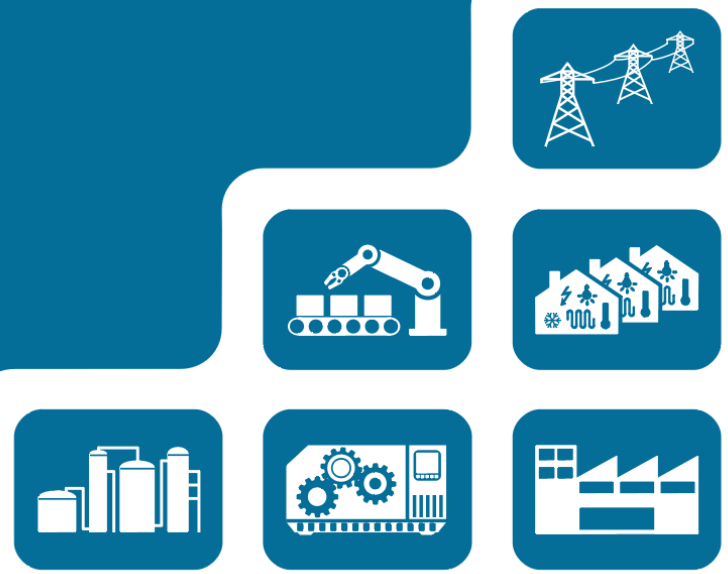
Theses Topics (and PR) at the LIT CPS Lab (and the CD Lab VaSiCS)

Univ. Prof. Dr. Rick Rabiser and Univ.-Prof. Dr. Alois Zoitl
Christian Doppler Lab VaSiCS
LIT | Cyber-Physical Systems Lab
Johannes Kepler University Linz

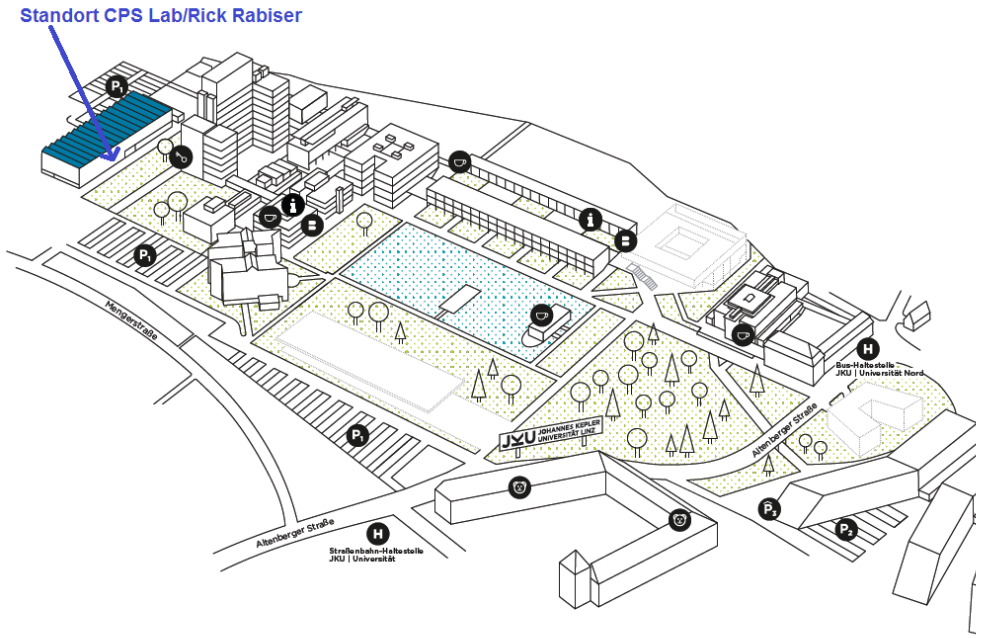


LIT Cyber-Physical Systems Lab

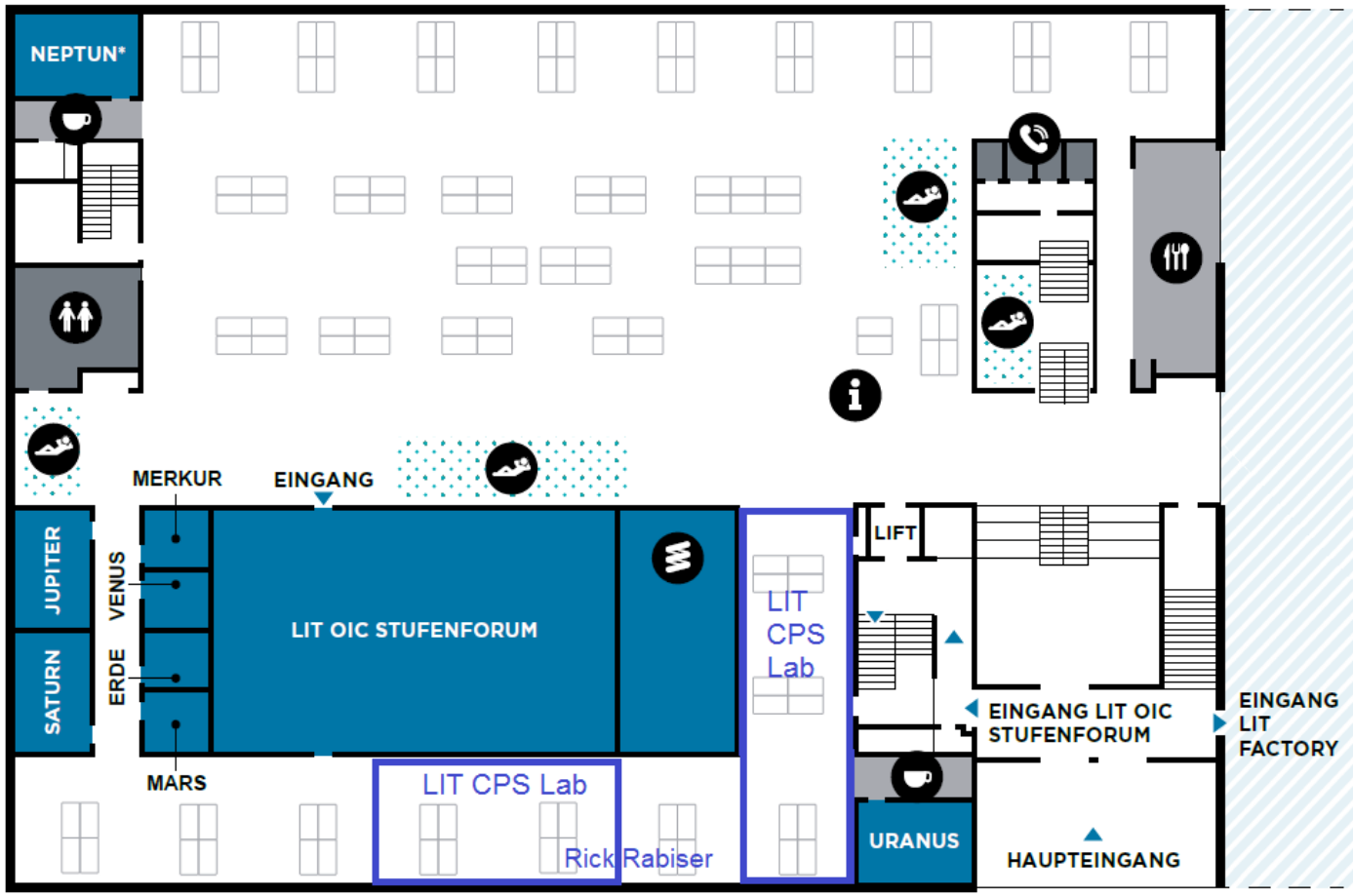
https://www.jku.at/lit/cps-lab

Where to find us

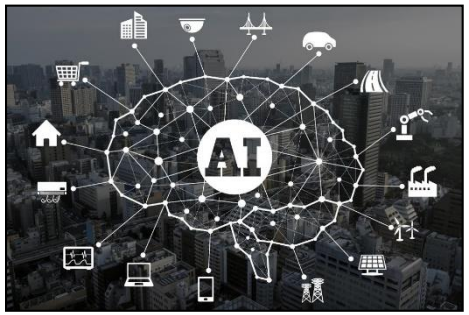
DER JKU CAMPUS.
OPEN INNOVATION CENTER

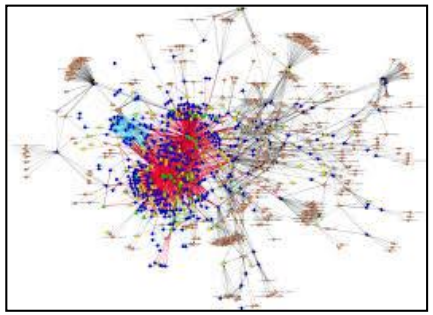


LIT OPEN INNOVATION CENTER.
ERDGESCHOSS



Hot Topics



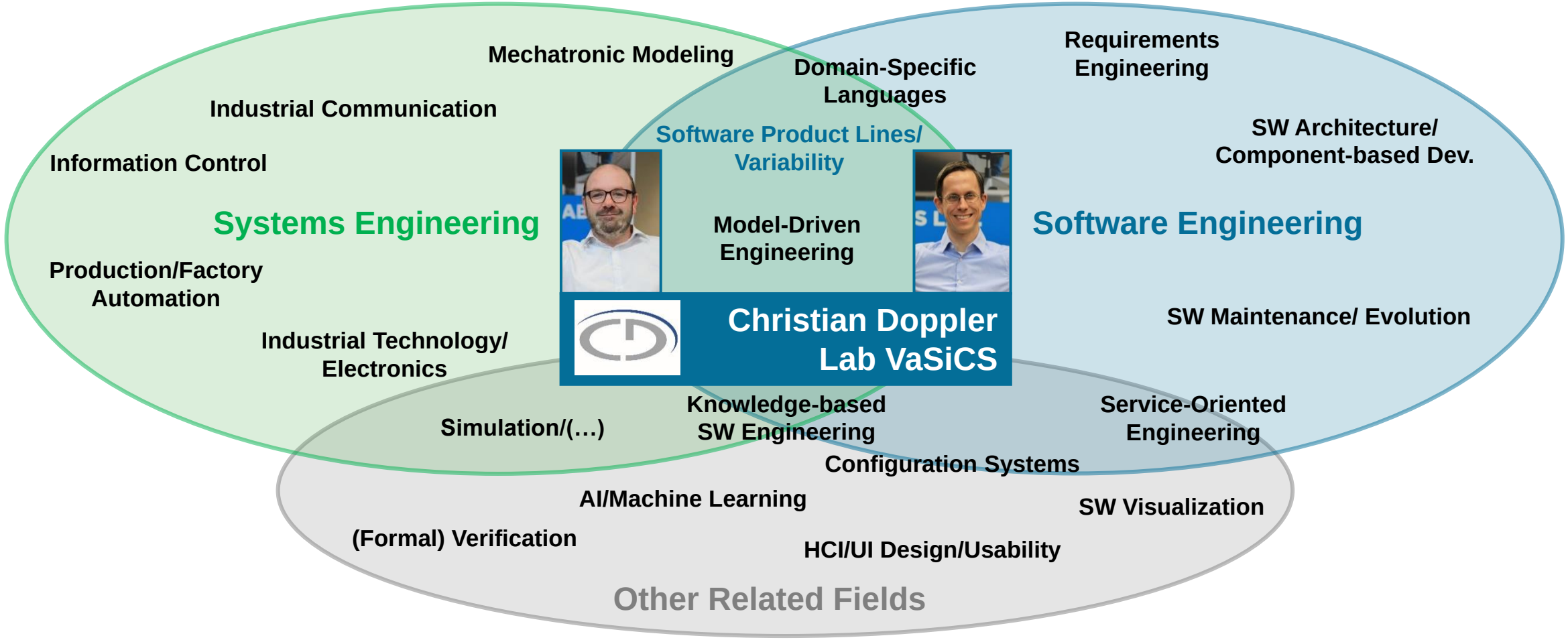


- **“Digitalization”**
- **Industry 4.0**
- Artificial Intelligence (Machine learning/Deep Learning)
- (Big) Data (analytics/science)
- Cloud-based computing
- Internet of Things (IoT)
- …

While […] machine learning, big data, or IoT are often seen as the key elements of digitalization, ***software and software engineering play the key role in research, teaching and practice***
(Broy et al. in Informatik_Spektrum_39_6_2016)

→ Cross-cutting issue: **Systematically dealing with variability and complexity!**

Scientific Landscape and LIT CPS Lab Profs.



Teaching (Winter Semester)

- **Networked Embedded Systems** (VO/UE, Englisch) (Alois Zoitl, diverse)
  - Pflichtfach für ELIT, Mechatronik
- **Production Automation Systems** (VO, Englisch) (Alois Zoitl)
  - Wahlpflichtfach für Artificial Intelligence, Wahlfach für diverse Studienrichtungen
- **Practical Work in AI (Master)** (PR) (Alois Zoitl)
  - Pflichtfach für Master AI
- **Seminar in AI (Master)** (SE) (Alois Zoitl)
  - Pflichtfach für Master AI
- **Cloud Computing** (Rick Rabiser, Andreas Grimmer, Johannes Bräuer)
  - Wahlfach
- Project in **Computational Engineering** (PR) (Alois Zoitl, Rick Rabiser)
  - Wahlpflichtfach für Computer Science
- Project in **Software Engineering** (PR) (Alois Zoitl, Rick Rabiser)
  - Wahlpflichtfach für Computer Science
- **Projektpraktikum** (PR) (Bakk-Arbeit) (Rick Rabiser, Alois Zoitl)
  - Pflichtfach für Informatik
- **Master's Thesis Seminar** SS (SE) (Alois Zoitl, Rick Rabiser)
  - Begleitend zur Masterarbeit
- **Dissertantenseminar** Informatik (SE) (Alois Zoitl, Rick Rabiser)
  - Pflichtfach für Doktoratsstudium, Fach Informatik

Teaching (Summer Semester)

- **Algorithmen und Datenstrukturen** (VO/UE) (Rick Rabiser, div.)
  - Pflichtfach für ELIT, Mechatronik, Maschinenbau
- **Präsentations- und Arbeitstechnik** (KV) (Grünbacher, Kotsis, Rabiser, div.)
  - Pflichtfach für Informatik Rick Rabiser
- **Software Engineering für Jurist*innen** (KS) (Rick Rabiser)
  - Wahlpflichtfach für Bachelor REWI
- **Product Line Engineering** (KV) (Rick Rabiser, div.)

- **Production Automation Systems** (UE) (Alois Zoitl)
  - Wahlpflichtfach für Artificial Intelligence, Wahlfach für diverse Studienrichtungen
- **Networked Embedded Systems** (PR) (Alois Zoitl)
  - Pflichtfach für ELIT, Mechatronik

- **Parallel Computing** (KV) (Wolfgang Schreiner, Alois Zoitl)
  - Wahlpflichtfach für Computer Science
- Project in **Computational Engineering** (PR) (Alois Zoitl, Rick Rabiser)
  - Wahlpflichtfach für Computer Science
- Project in **Software Engineering** (PR) (Alois Zoitl, Rick Rabiser)
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Selected Current Projects & Topics

Please note: for all these projects, practica and theses are possible (Bachelor, Masters, PhD)

Christian Doppler Lab VaSiCS
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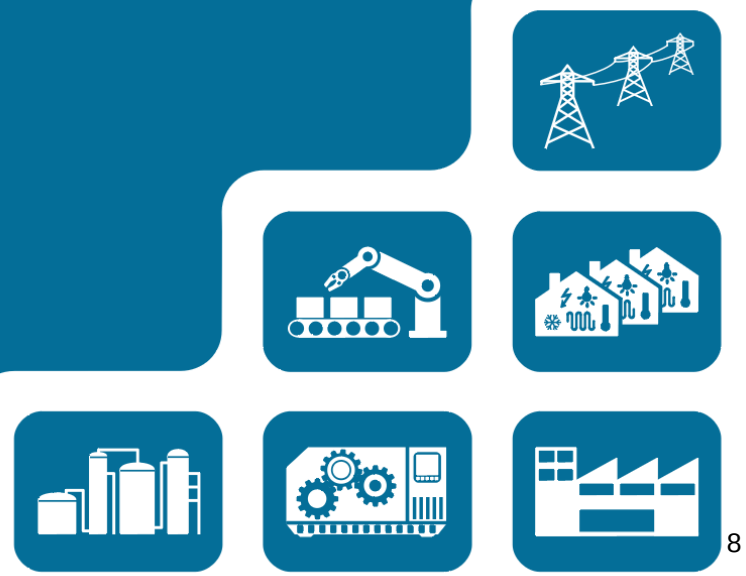
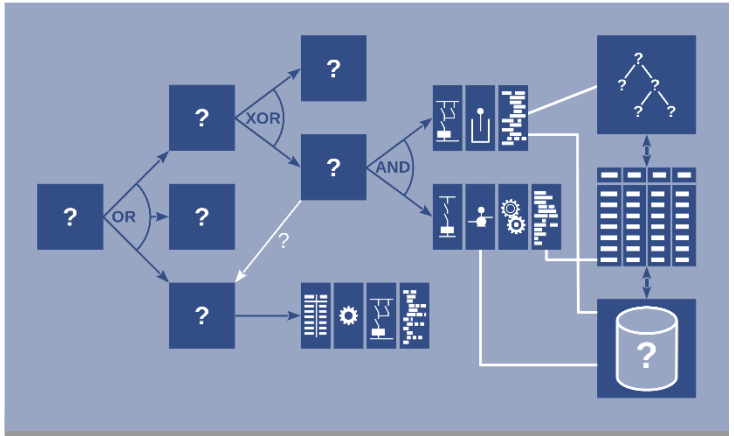


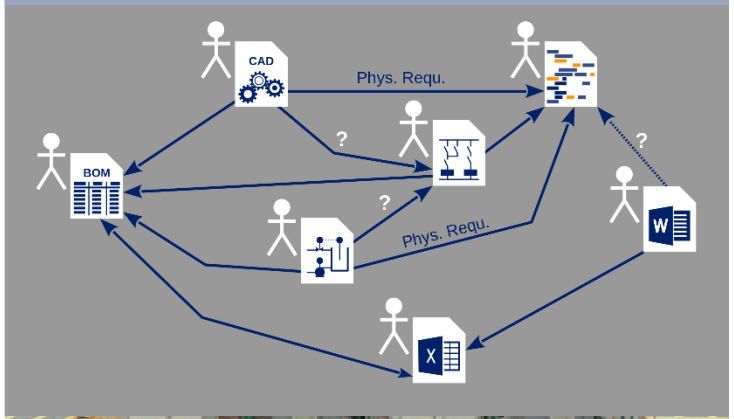
Christian Doppler Lab VaSiCS (2/2021-1/2028)

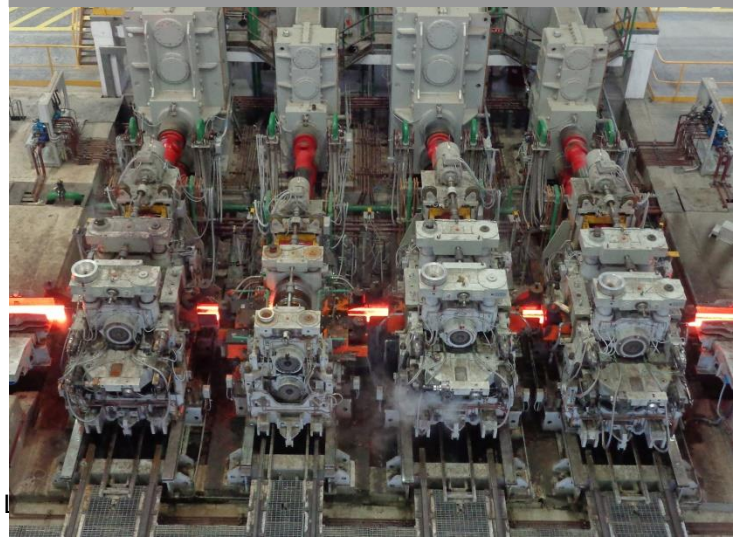
- **VaSiCS: Mastering Variability in Software-intensive Cyber-Physical Production Systems**
  - CPPS variability **modeling** approach
  - **analyze** existing CPPS to automatically mine and model variability
  - support **configuring** and generating CPPS target artifacts
  - support CPPS roundtrip/**evolution**

PRIMETALS TECHNOLOGIES

https://www.jku.at/cdl-vasics/

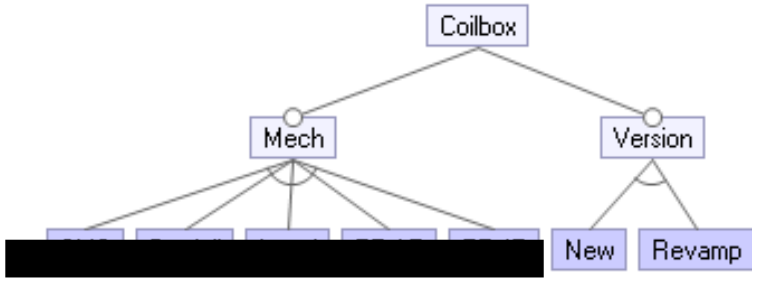


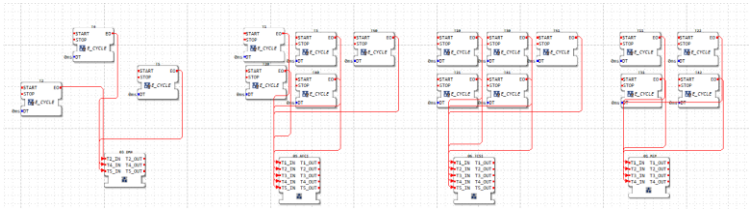


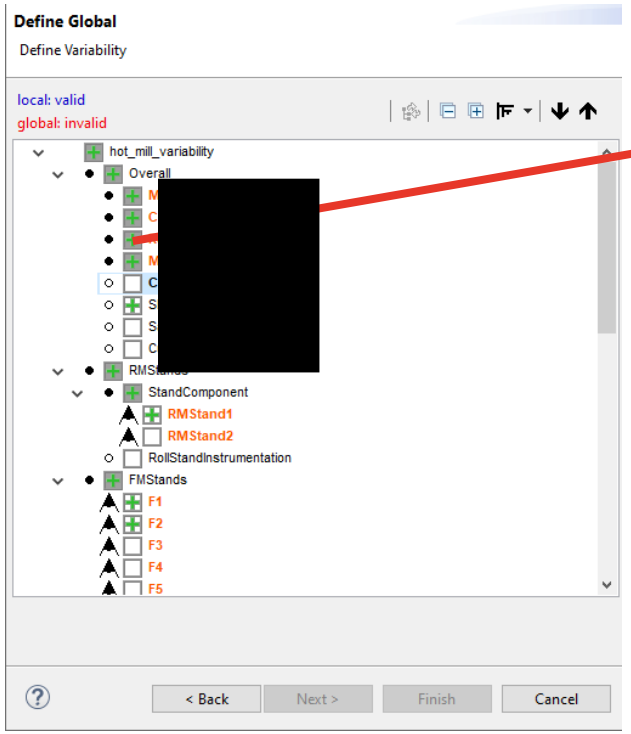


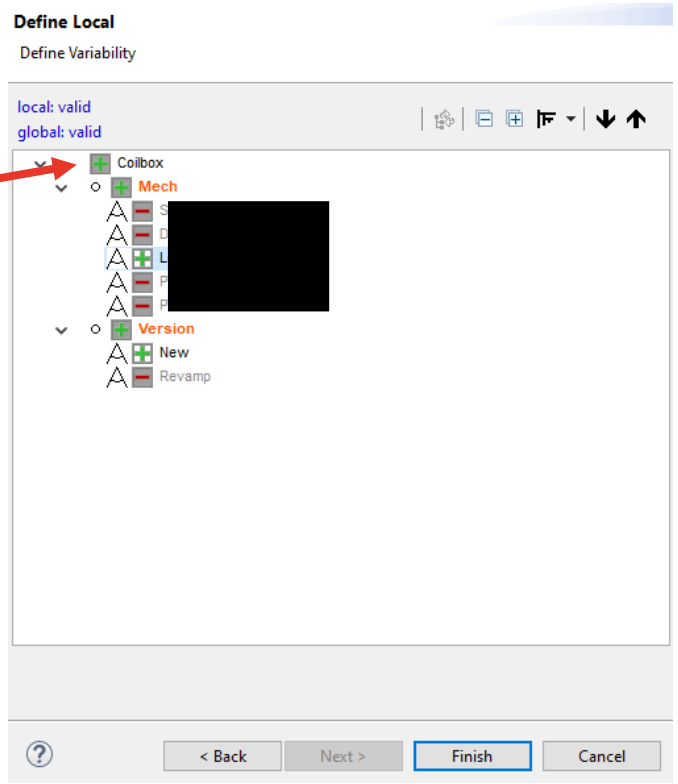
Multidisciplinary Delta-Oriented Variability Management in Cyber-Physical Production Systems

- Main Focus of CDL VaSiCS (https://www.jku.at/en/cdl-vasics/)
- Configure/Generate Target Artifacts such as Control Software Code, XML files









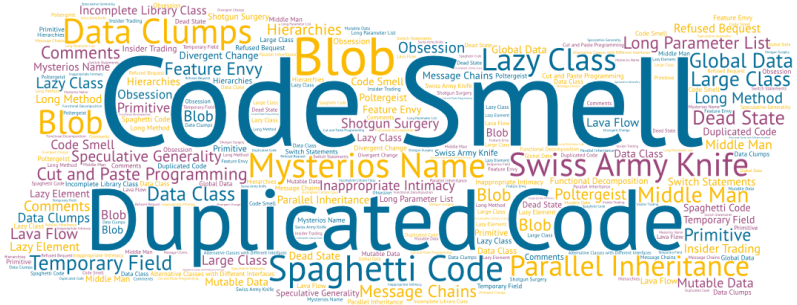
Contact: Sayyid Fadhlillah

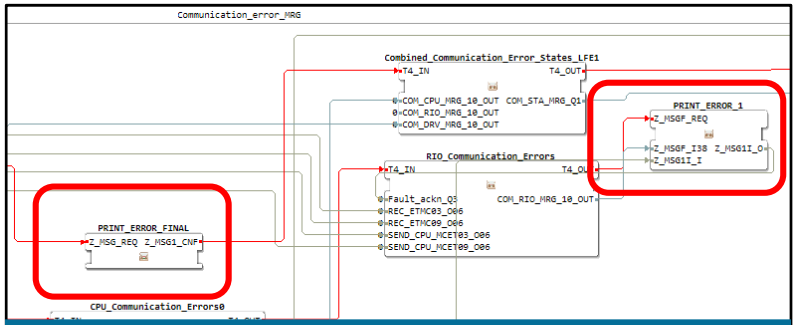
Better Control Software Design

- Work of CDL VaSiCS (https://www.jku.at/en/cdl-vasics/) and EU Project 1-SWARM (https://www.jku.at/en/lit-cyber-physical-systems-lab/research/research-projects/1-swarm)
- Cooperation (among others) with Primetals Technologies (CDL) and multiple partners in the EU-Project (see https://cordis.europa.eu/project/id/871743)
- Bad Smells, Metrics, Design Patterns, etc. for CPPS

IEC 61499 Bad Smells Catalog

Name	Level	Description	Impl.
Duplicated Code	ALL	The same or similar code appearing more than once.	N
Long Algorithm	FB	An algorithm that is too long and complex.	N
Large Type	FB	An FB type that is too large and complex.	N
Large Interface	FB	Too many interface elements.	N
Divergent Change	FB	One change leading to many changes within the same FB type.	N
Shotgun Surgery	FB	One change leading to changes in many different FB types.	N
Feature Envy	ALL	An IEC 61499 component having high cohesion to another that should not be coupled tightly.	N
Data Clumps	FBN	A group of interface elements that always appear together.	N
Lazy Element	ALL	An IEC 61499 component without purpose (e.g., CFB only containing one FB).	N
Dead State	ECC	State (except start state) which does not have any input transitions or to which a path cannot be found from the EC initial state by following the directed links.	Y
Dead Transition	ECC	Transition with lower priority than the 1 transition condition	Y
Dead FB	FB	FB (except start FB) which does not have any input event connections.	Y
Terminal State	ECC	State that is reachable, but which does not have any outgoing EC transitions.	Y
Unused Event	FB	Event input/output of the FB type containing the ECC that is not used in any EC transitions.	Y
Unused Data	FB	When the particular input event is connected, the associated data input is unconnected or not configured.	Y
Mutable Data	ALG	The algorithm writes on a data input.	N
Dead Event	FB	An event that is not used in the transition condition of any stable ECC state and is thus always ignored.	N





Improve SW Quality

Improve Understandability

Reduce Maintenance Effort

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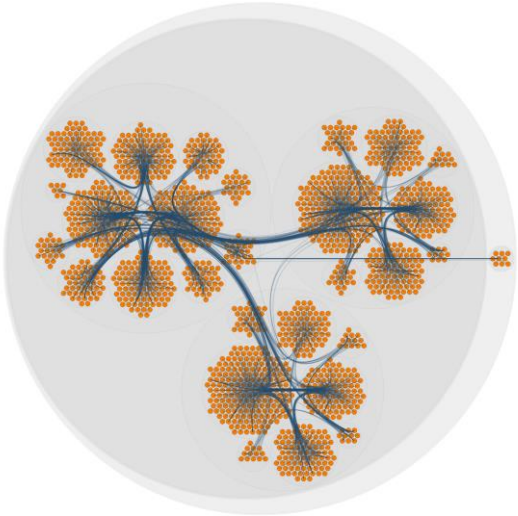
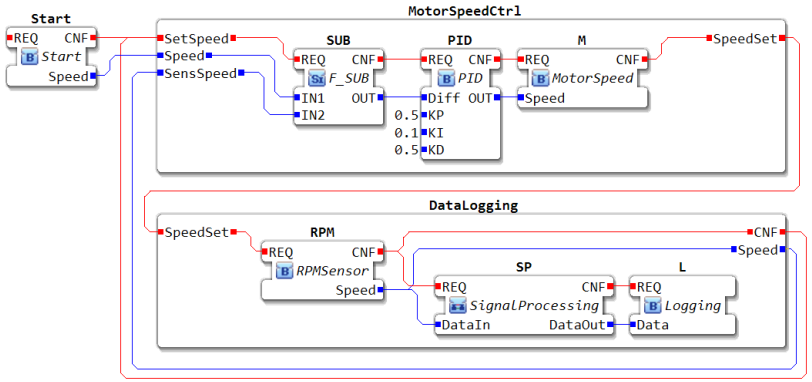
Christian Doppler Lab VaSiCS

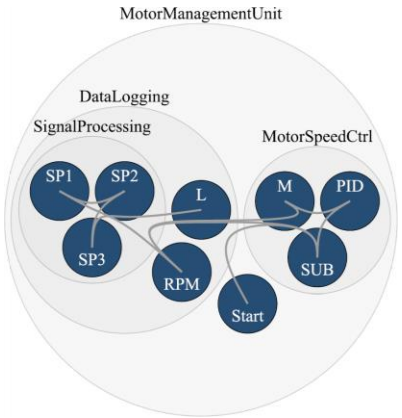
Contact: Lisa Sonnleithner

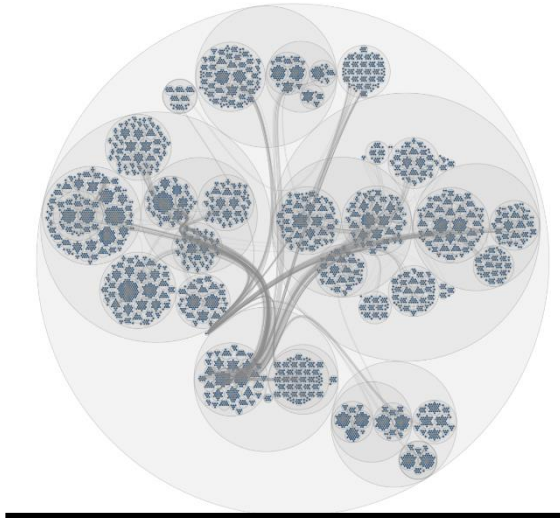
Complexity/Modularization in/of 4diac/IEC 61499

- **Visualize modularization/complexity of control software**
- **Use Cases**
  - Understand structure of existing systems and component relations
  - Analyze modularization of existing systems (as input to improve/refactor)
  - Input for variability management
  - Support round-trip engineering (diffs of versions…)





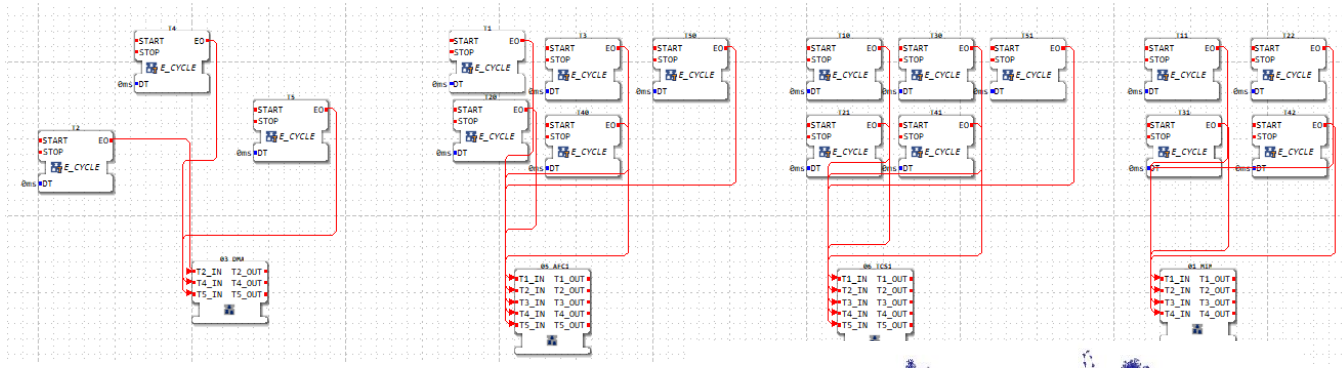


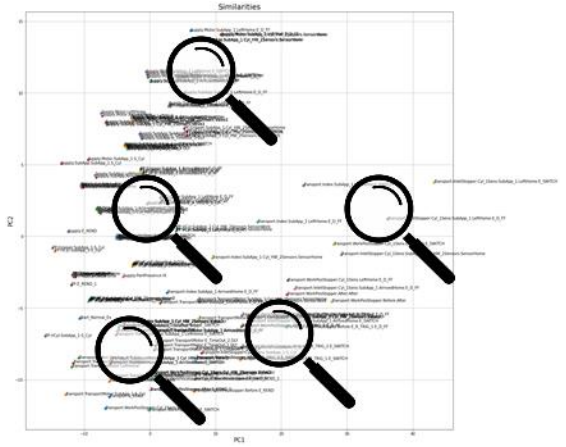


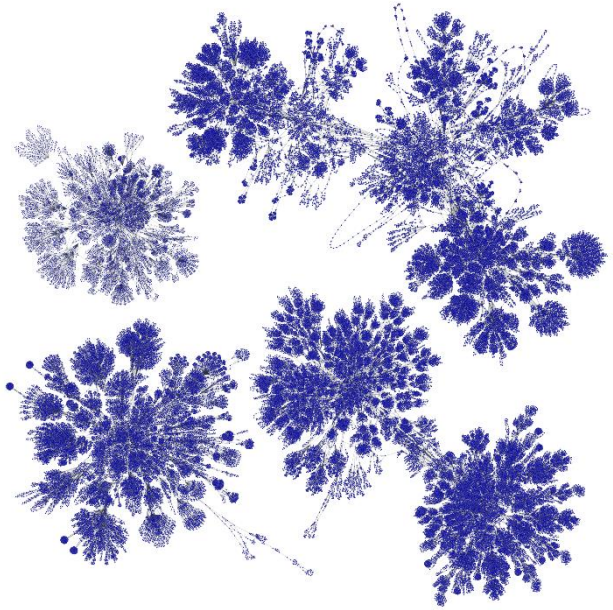
Contact: Lisa Sonnleithner

Mining from Function Block Networks

- Work of CDL VaSiCS (https://www.jku.at/en/cdl-vasics/)
- Clone detection/Similarity analysis
- Modularity analysis
- Variability mining



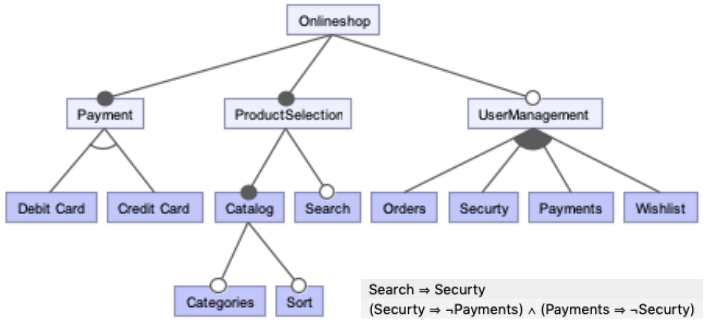




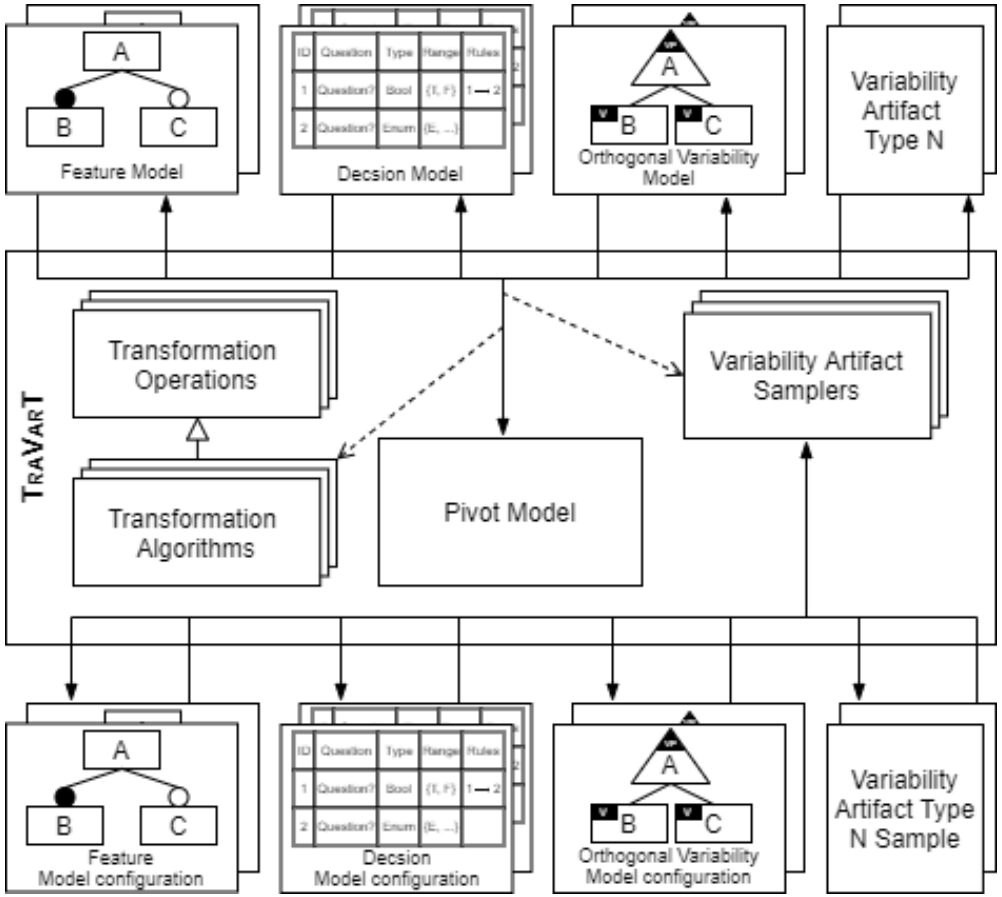
Contact: Antonio Gutierrez

TRAVART:
An Approach for Transforming Variability Models

- https://github.com/SECPS/TraVarT
- Coop. with TU Vienna



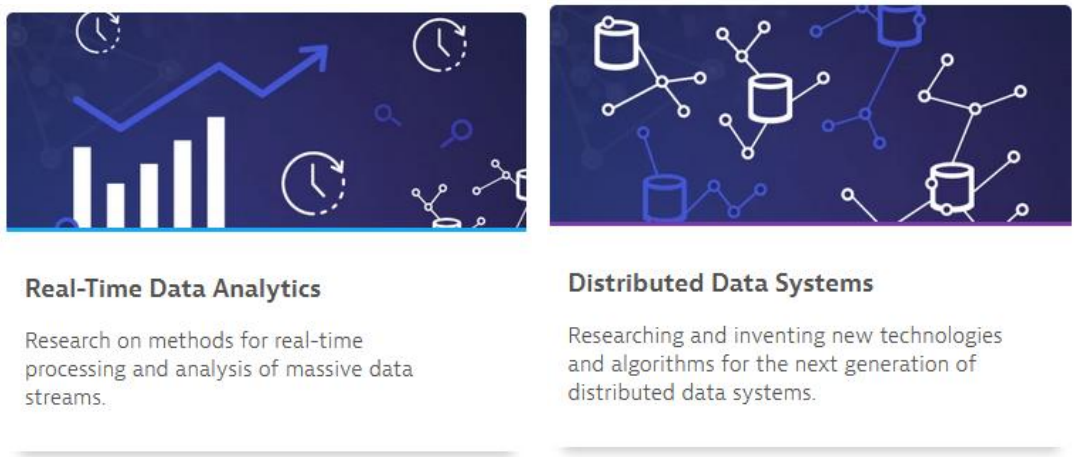

```
menu "Power management and ACPI options"
  depends on !X86_VOYAGER

  config PM
    bool "Power Management support"
    depends on !IA64_HP_SIM
    ---help---
        "Power Management" means that ...

  config PM_DEBUG
    bool "Power Management Debug Support"
    depends on PM

  config CPU_IDLE
    bool "CPU idle PM support"
    default ACPI

  config PM_SLEEP
    bool
    depends on SUSPEND || HIBERNATION ||
               XEN_SAVE_RESTORE
    default y
...
endmenu
```



Contact: Kevin Feichtinger

JKU/Dynatrace Co-Innovation Lab

- “The aim of this lab is to perform trans-disciplinary, original scientific research between industry and academia on recent computer science topics, particularly from the areas of software engineering, artificial intelligence, and data science.”



- 2 Post-Docs payed 50/50 by JKU and Dynatrace perform software engineering research on
  - Data storage, with a particular focus on scalability
  - Distributed software architectures
  - Query processing and optimization
  - Cloud infrastructures
  - Overall goal: infrastructures, algorithms, and tools supporting processing (ingest, storage, data analysis, and anomaly detection) huge amounts of data, in real-time

- See https://engineering.dynatrace.com/research/

dynatrace

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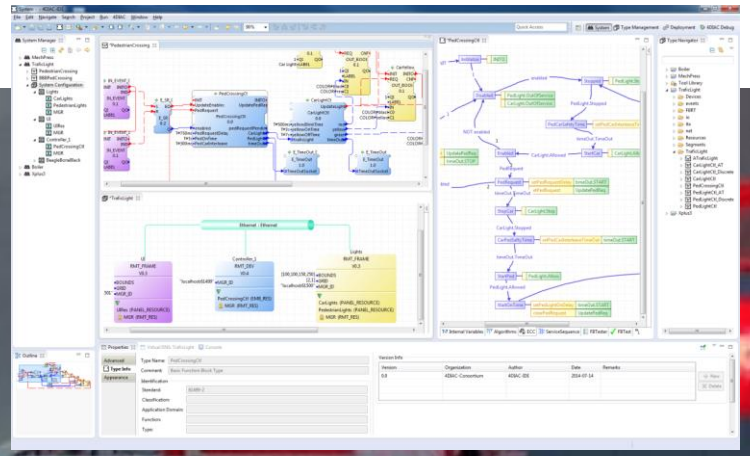


Tool Development:

- Sequence Diagrams
- Model-Checking
- Version Management
- Doc Generation
- Tools in the Cloud
- Other Inputs
- UX
- ...

Web-based HMI:

- Connect Machines and Web Servers
- Web-Server <-> Browser

Control Applications:

- Automating Example Machines
- Library Development
- Design Patterns

IEC 61499

Improved Device Support:

- Porting
- I/O Support

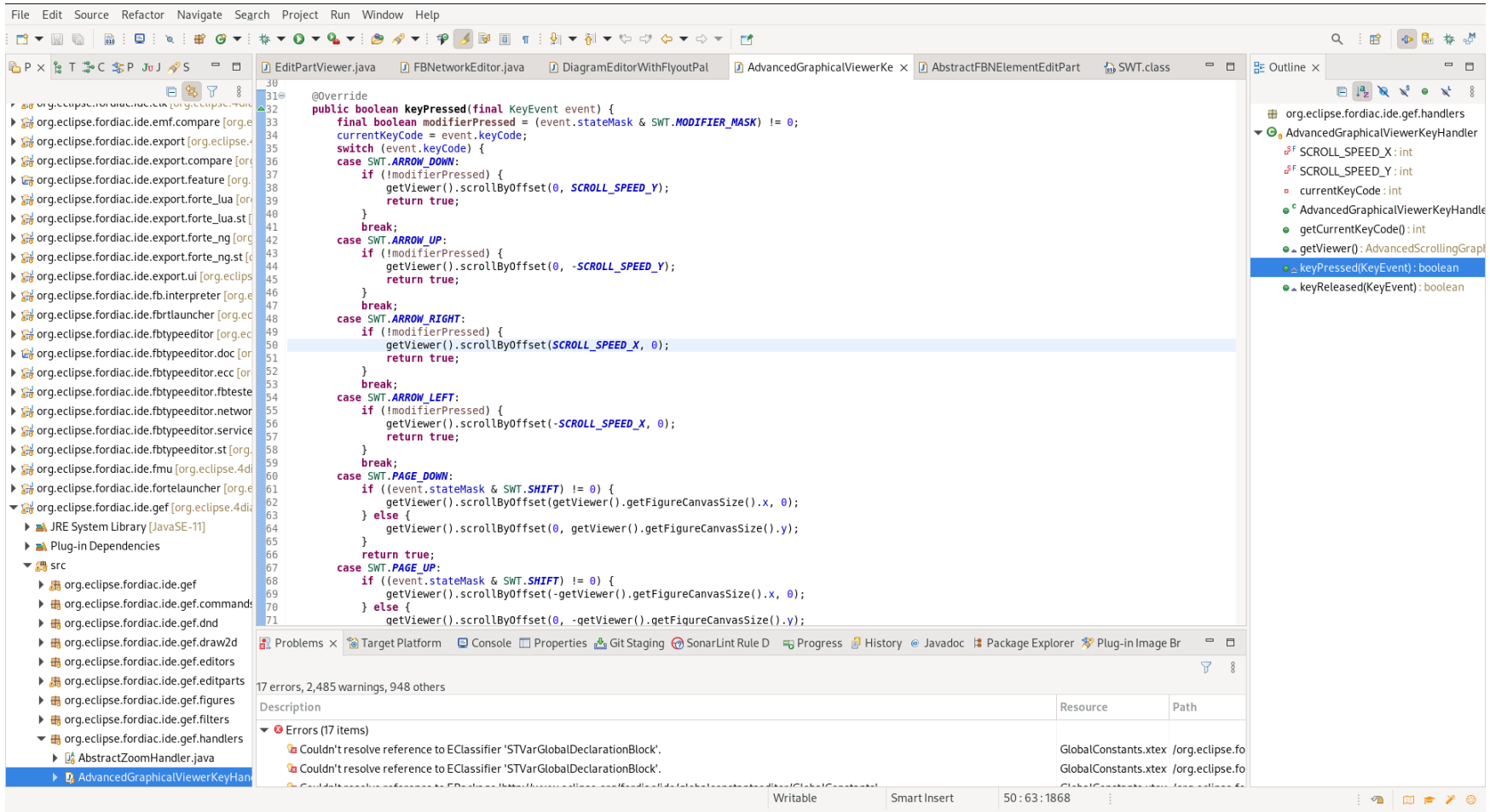
Communication:

- Reverse Engineer Lego Mindstorms USB Protocol for new Controller
- Evaluating TSN (deterministic Ethernet)

et Hacks

Contact: Alois Zoitl

Improving the Eclipse Platform



Contact: Alois Zoitl

Thank you!

https://www.jku.at/lit/cps-lab

Prof. Rabiser / Prof. Zoitl
Christian Doppler Lab VaSiCS
LIT | Cyber-Physical Systems Lab
Johannes Kepler University Linz

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Federal Ministry
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Digital and
Economic Affairs