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Department of Computer Science

Software Architecture Principles of Self-Organizational Collective Intelligence Systems

Juergen Musil[1], Angelika Musil[1], Danny Weyns[2], Stefan Biffl[1]

[1] Institute of Software Technology and Interactive Systems
TU Wien, Austria

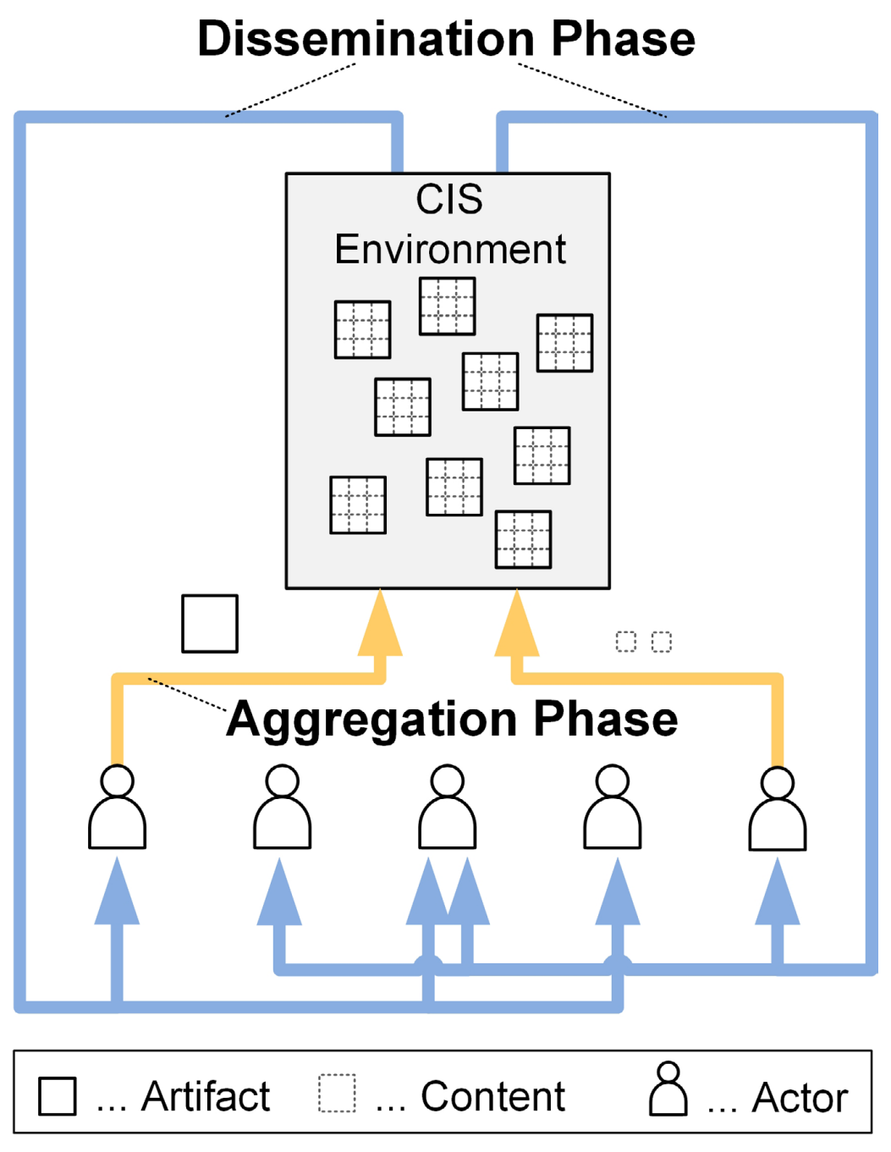
[2] Department of Computer Science
KU Leuven, Belgium

Context & Motivation

- Focus is on **self-organizational crowd-driven systems** (e.g. Wikipedia, LinkedIn, Stack Overflow) - we call them **Collective Intelligence Systems (CIS)**.

Architecting Challenges

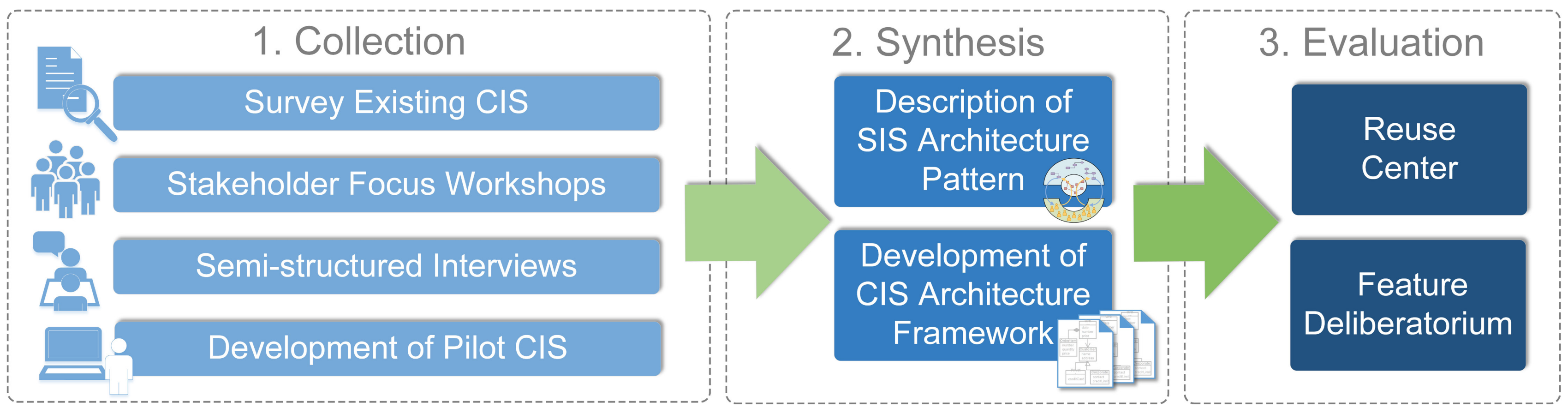
- Lack of **guidance** beyond implementations: trial & error, clone & own.
- Complex to design w.r.t. **coordination, content discoverability, actor engagement**.
- Lack of **consolidated knowledge** of architectural principles and practices.



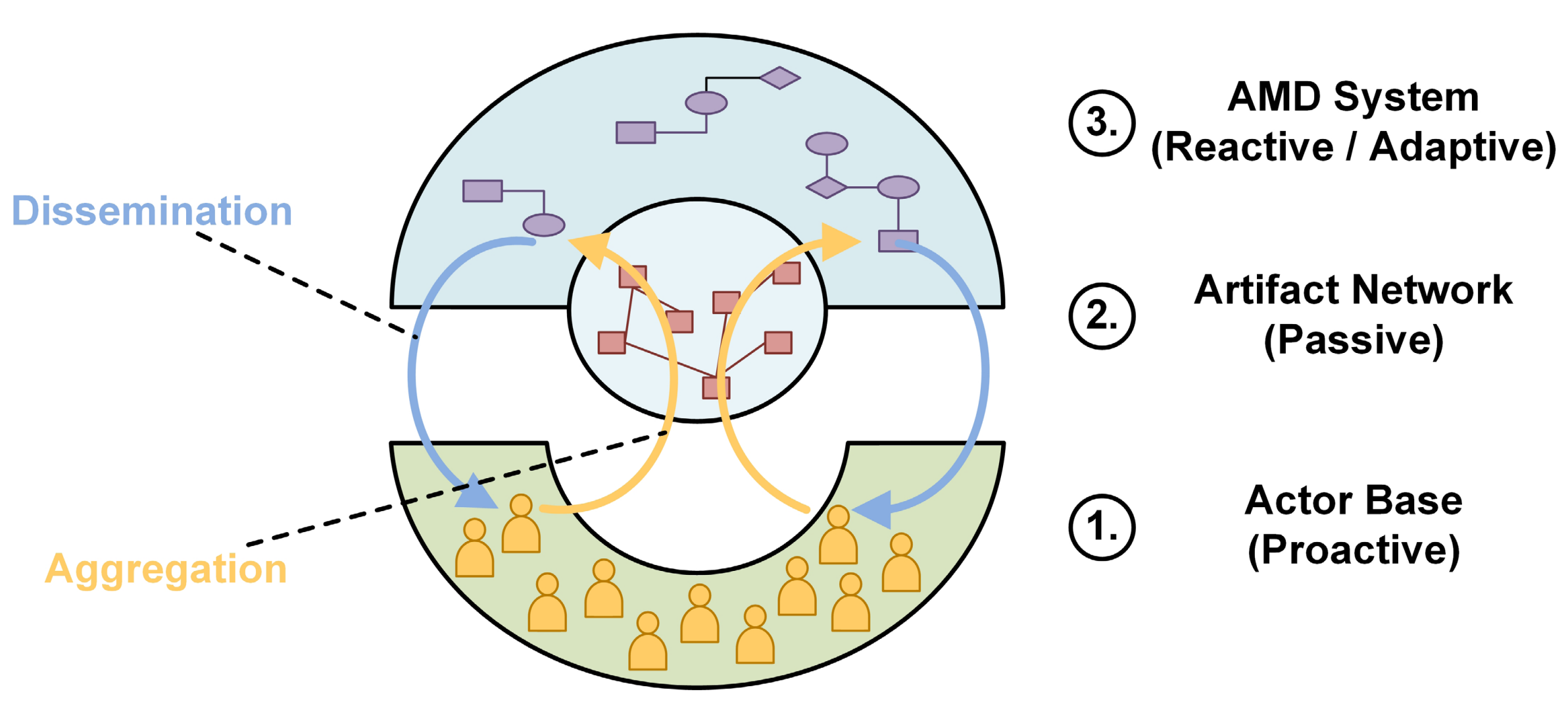
Research Questions & Approach

RQ 1. What are the most important CIS-specific architectural principles?

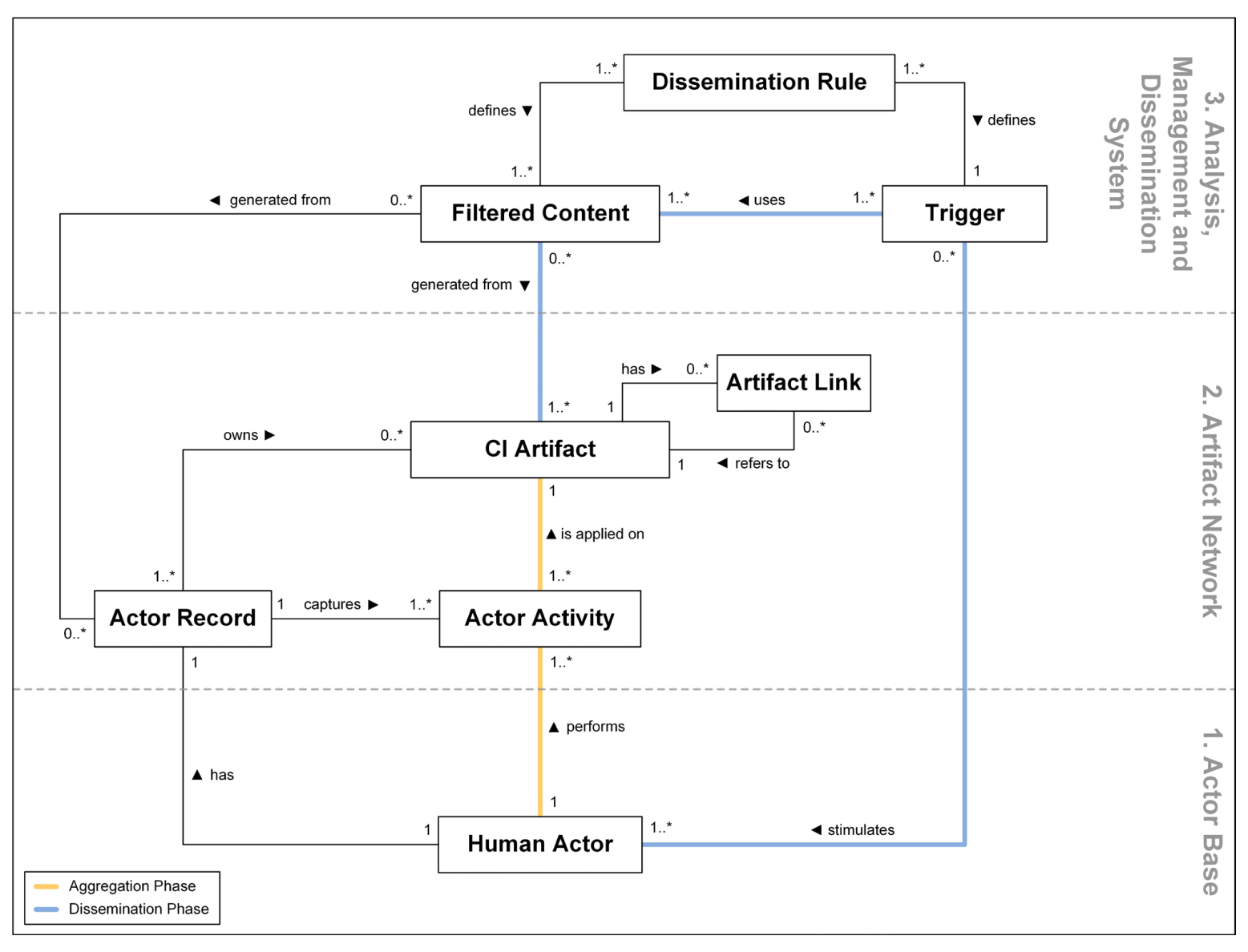
RQ 2. How to codify these architectural principles to make them useful for engineering CIS?


1. Collection
Survey Existing CIS
Stakeholder Focus Workshops
Semi-structured Interviews
Development of Pilot CIS
2. Synthesis
Description of SIS Architecture Pattern
Development of CIS Architecture Framework
3. Evaluation
Reuse Center
Feature Deliberatorium

I. Stigmergic Information System Architecture Pattern


Dissemination
Aggregation
3. AMD System (Reactive / Adaptive)
2. Artifact Network (Passive)
1. Actor Base (Proactive)

- **Bottom-up information sharing** and **knowledge aggregation**.
- **Stigmergic process:** Perpetual feedback loop between actors and coordination infrastructure.
- Coordination infrastructure:
(1) **Artifacts** store shared content in **network structure**,
(2) **Rules** of **interaction** and **coordination**.
- Success factor: **Continuous flow of user contributions**.



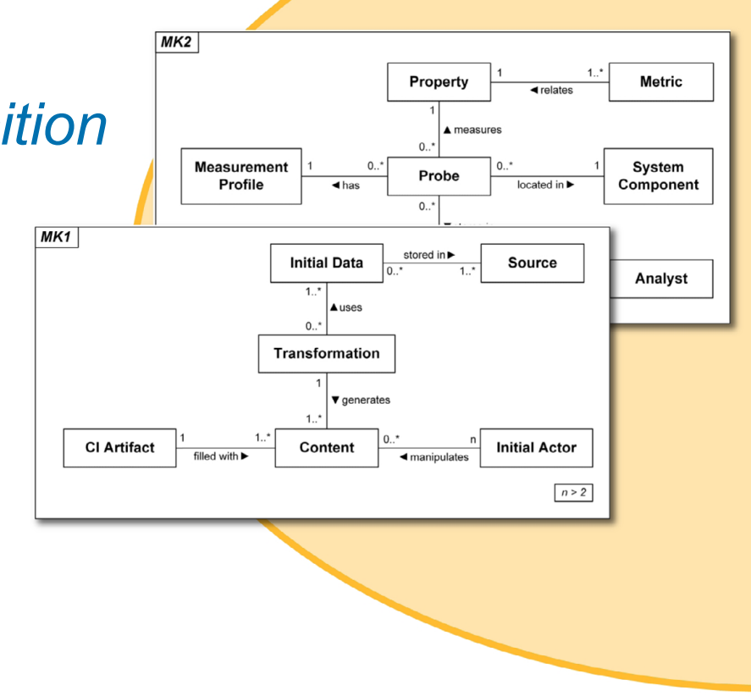
II. Architecture Framework for Collective Intelligence Systems

III. CI Operation Viewpoint

Model Kinds:

1. Initial Content Acquisition

2. CI Analytics



Overview

CIS operation startup and defines models to identify initial content, actor groups, and measures for CIS aggregation and dissemination performance.

Concerns

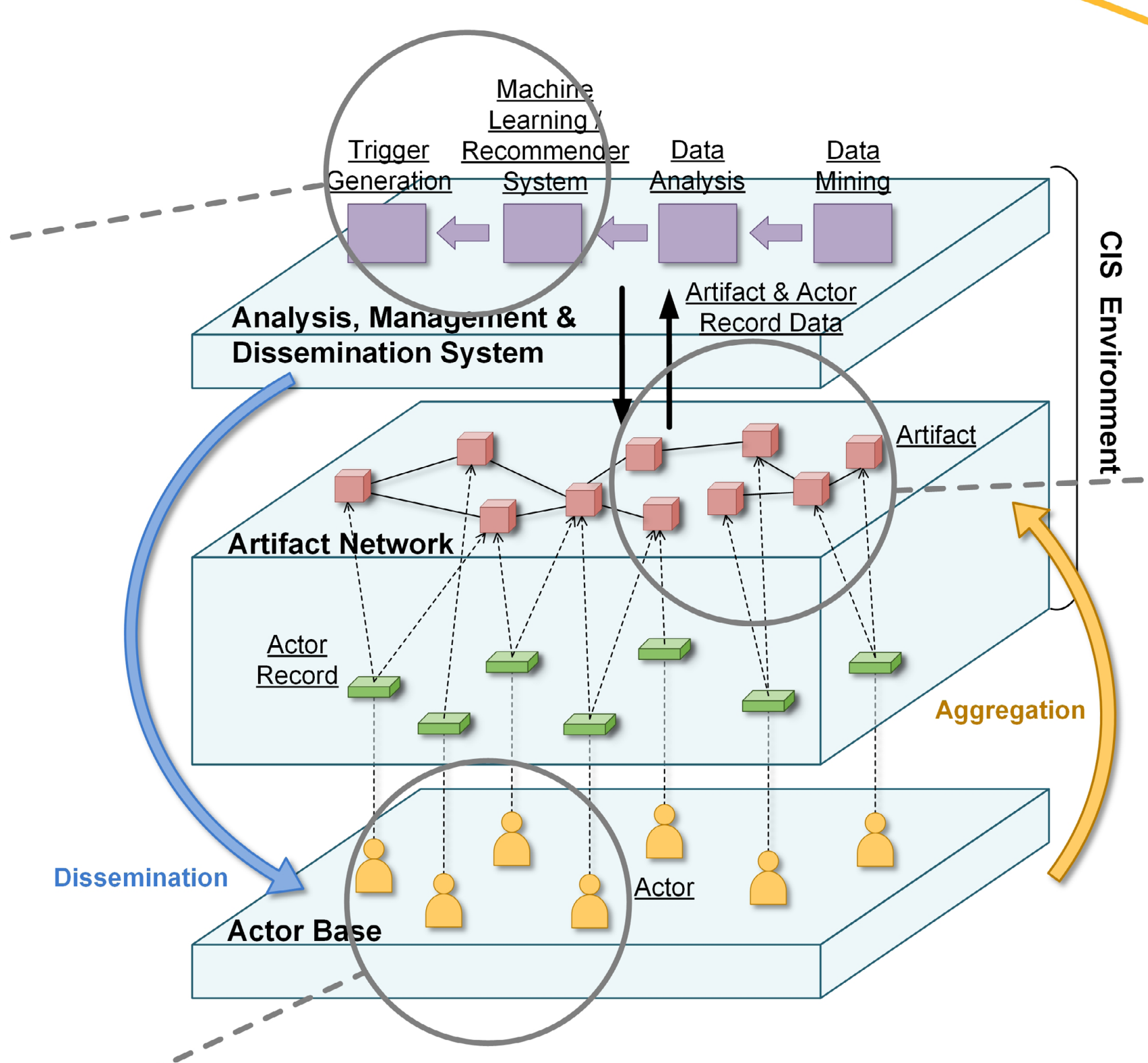
Kickstart - How to derive initial content from existing data?

Monitoring - Detail metrics and probes for monitoring?

constraints

forces

refines



II. CI Technical Realization Viewpoint

Overview

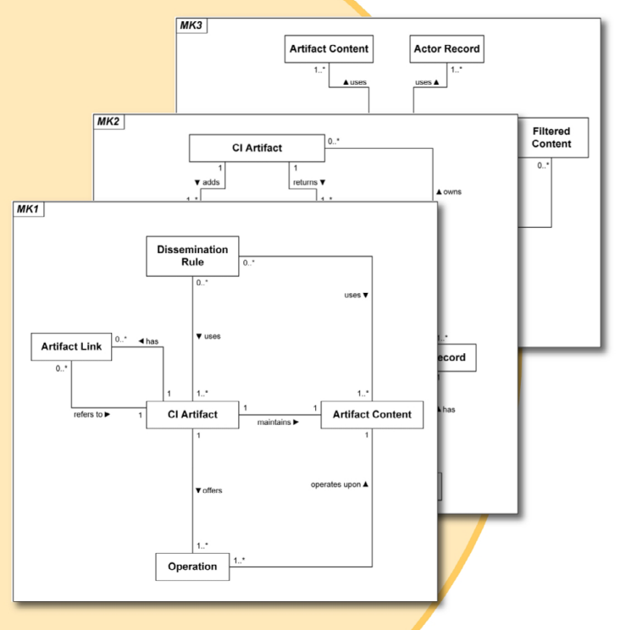
CIS realization and defines models to model collective knowledge, the aggregation of data and stigmergy-based dissemination of knowledge.

Concerns

Data Aggregation - Kind of data needed from actors? How is the data collected & stored?

Knowledge Dissemination - Data processing mechanisms for effective knowledge distribution and user awareness?

Interactivity - What interactions (activities) can actors do?



Model Kinds:

1. Artifact Definition

2. Aggregation

3. Dissemination

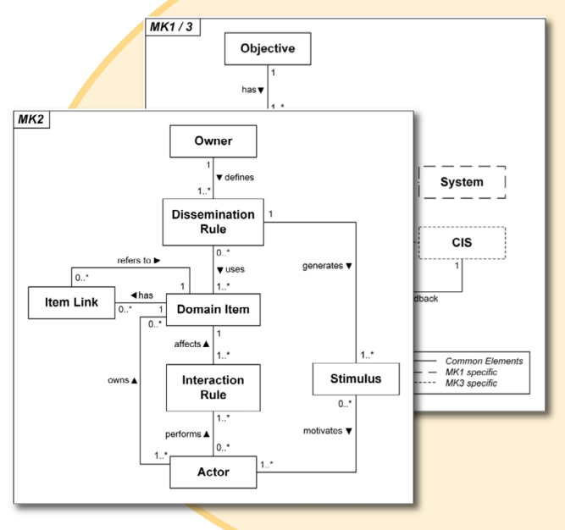
I. CI Context Viewpoint

Model Kinds:

1. As-Is Workflow

2. Stigmergic Coordination

3. To-Be Workflow



Overview

Designs CI-specific system capabilities and defines models for new CIS construction and capture of design decisions.

Concerns

Usefulness - Process limitations addressable with CIS?

Perpetuality - Identify stigmergic process for the application scenario?

- Facilitates systematic design & architectural analysis.
- Based on **ISO:42010:2011** software architecture standard.
- Focus on **aggregation, dissemination & perpetuality**.
- Technology **agnostic** models.

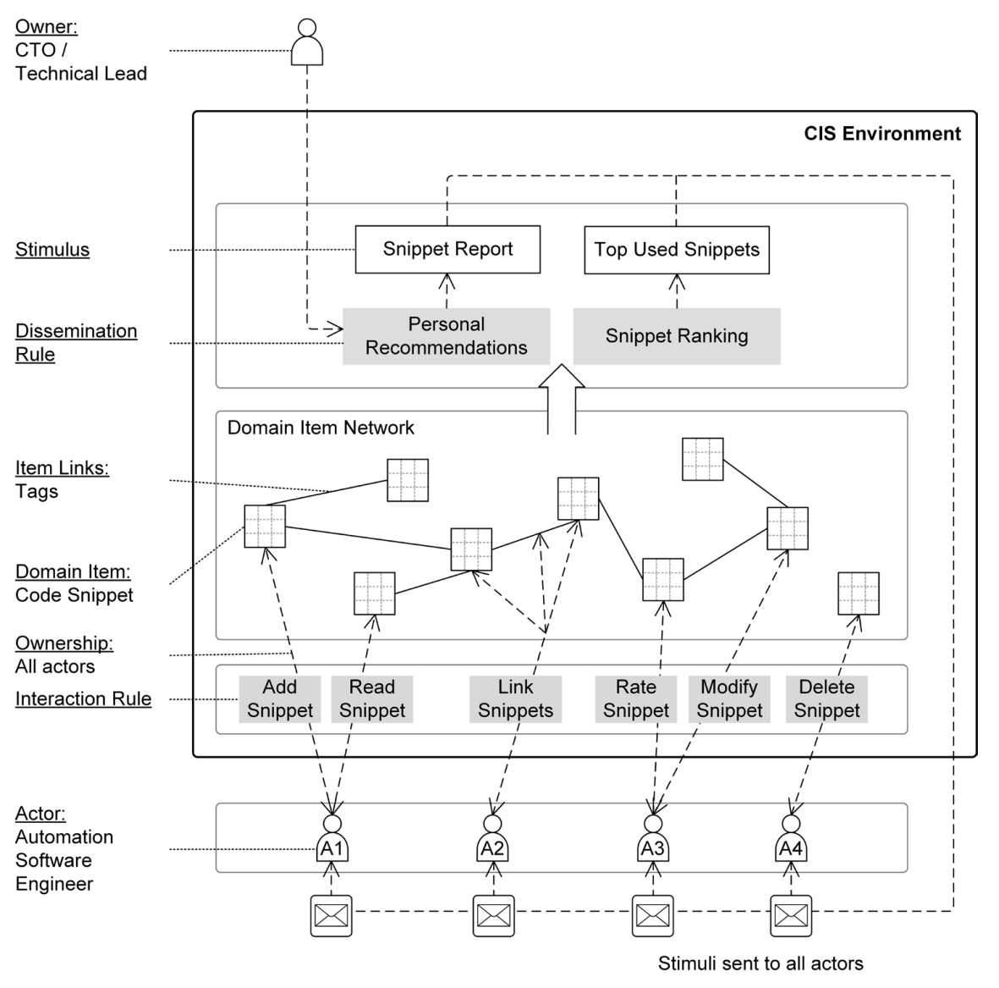
Evaluation & Results

Qualitative evaluation in **2 industrial cases**:
(1) Reuse Center
(2) Feature Deliberatorium

+ **Increased understanding and competency** in CI principles of stakeholders.

+ **Shared vocabulary** and **stakeholder guidance**.

+ **Kickstarting support**. Strategies for startup of CIS in organizations.



Conclusion & Future Work

- Potential of AF to **focus on CIS core elements and processes.**
- Introduce architects about principles of CIS domain.

Future Work

- Exploring **tool-support** for CIS-AF.
- **Extend CIS-AF**: actor engagement, trust, content growth, evolution.
- Derive CIS-AF for **other families** (crowdsourcing, human computation).
- **Survey CIS** for variations and architecture-relevant features.

Contact: Juergen Musil
juergen.musil@tuwien.ac.at

More Infos

http://qse.ifs.tuwien.ac.at/ci