Institut
für
Informatik

Ludwig——
Maximilians——
Universität——
München——

LMU

Policy Based Adaptive Services
for Mobile Commerce

Enrico Rukzio, Sven Siorpaes, Oliver Falke, Heinrich Hussmann
Media Informatics Group, University of Munich (Germany)

Enrico.Rukzio@ifi.lmu.de (www.rukzio.de)

Outline

- Problem Statement
- Scenario
- Related Work
- Adaptation Architecture
    - Core Elements
    - Requirements
    - Context and Policies
    - Physical View
- Prototype
    - Architecture
    - Implementation
    - Screenshots
- Summery & Conclusion

Problem Statement

- Simplicity and usability are important factors for the acceptance of mobile services by the user.
  - Task: "Select a supported encoding and an appropriate resolution before watching a video on a mobile phone!"
- → Research field "Context aware mobile services"
  - Adaptation based on the user (preferences), her device, her location, provided services, available networks, etc.
- EU-Project Simplicity (11 partner): Pragmatic solution for policy-based adaptations was needed, 2 year project
  - → Architecture and implementation for policy-based adaptations
  - → Reuse of existing and adaptation of matured APIs, middleware and standards
  - → Methodology for defining adaptations (context, policies)
  - → Used for several prototypes developed during the project
  - → Rapid development of context-aware mobile services

- Context-aware mobile cinema information service
- User stands in front of the cinema and does not know which movie is the best.
- Cinema offers <u>different trailers</u> in <u>different resolutions</u>, <u>encodings</u> (MPEG-4, Real Media) and <u>sizes</u> (MByte)
- Several networks (GPRS, UMTS, WLAN) and operators are available: <u>speed</u>, <u>price</u>
- Users might have different devices: <u>supported encodings</u>, <u>resolution</u>, <u>supported networks</u>
- User has different preferences: <u>price</u>, <u>time</u>, <u>quality</u>
→ What is the best combination?
  → Which combinations are possible from the technical point of view?
  → How can the different user preferences can be used?
→ Used for the prototype

- Gathering, describing and structuring context information
  - [Henricksen et al., Chen and Kotz, Abowd et al.]
  - Context: "information you need in your application"
  - Standardized ways to describe context: RDF, OWL
  - Specific application areas: UAProf or Core Information Model
- Reasoning about context: policies (policy based networking) / rules (artificial intelligence, intelligent agents)
  - ECA (Event Condition Action) rules or sophisticated IF – THEN statements to define the behavior of adaptive mobile services
  - Advantages: Flexibility (support unexpected situations), Changeability (policies), Declarative programming
  - Used / discussed by:
    - [Efstratiou et al.] policy driven adaptation on mobile systems
    - [Keeney and Cahill] framework for policy-driven adaptation based on contextual information
    - [Suryanarayana and Hjelm] situated web architecture

Institut für Informatik

**Adaptation Architecture:
Core Elements**

Ludwig——
Maximilians——
Universität——
München——
LMU

- Adaptation architecture for policy based adaptive mobile services
- Core elements *context*, *policies*, *policy decision point*, *policy enforcement point* are similar in most policy driven adaptive systems (e.g. [Efstratiou et al., Friedman-Hill])
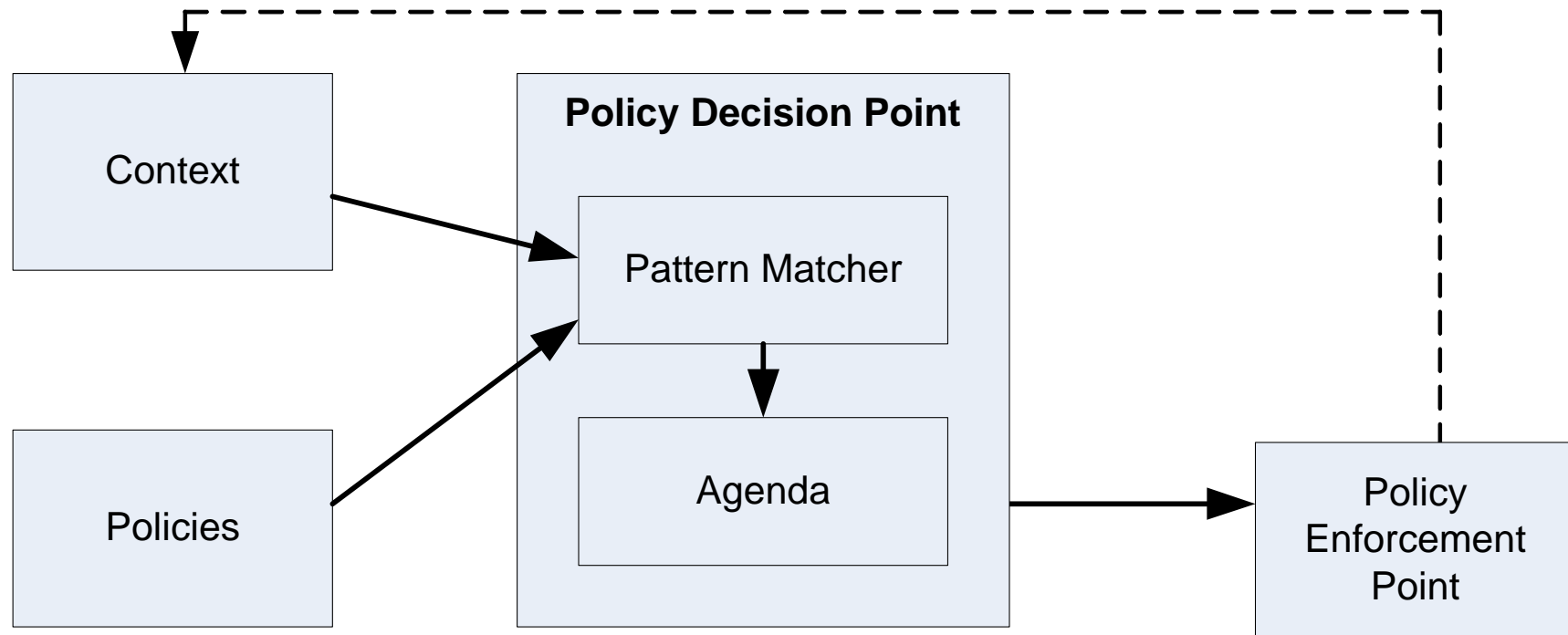
- Uniformity in the different adaptation areas
  - Distributed systems: distributed over different servers (e.g. for service provisioning, operator or billing) and mobile devices.
  - Flexibility, compatibility, extensibility and adaptability: representation of context information, definition of policies and reasoning take place in a uniform way
- Separation of context, policies, policy decision point and policy enforcement point
  - Sometimes these elements are woven into a single application
  - → Could lead to unintended adaptations (two applications run in a single system and do not share common context information or make independent decisions)
- Policy language should be generic regarding the range of adapted services
  - Not be specialized for a specific adaptation area
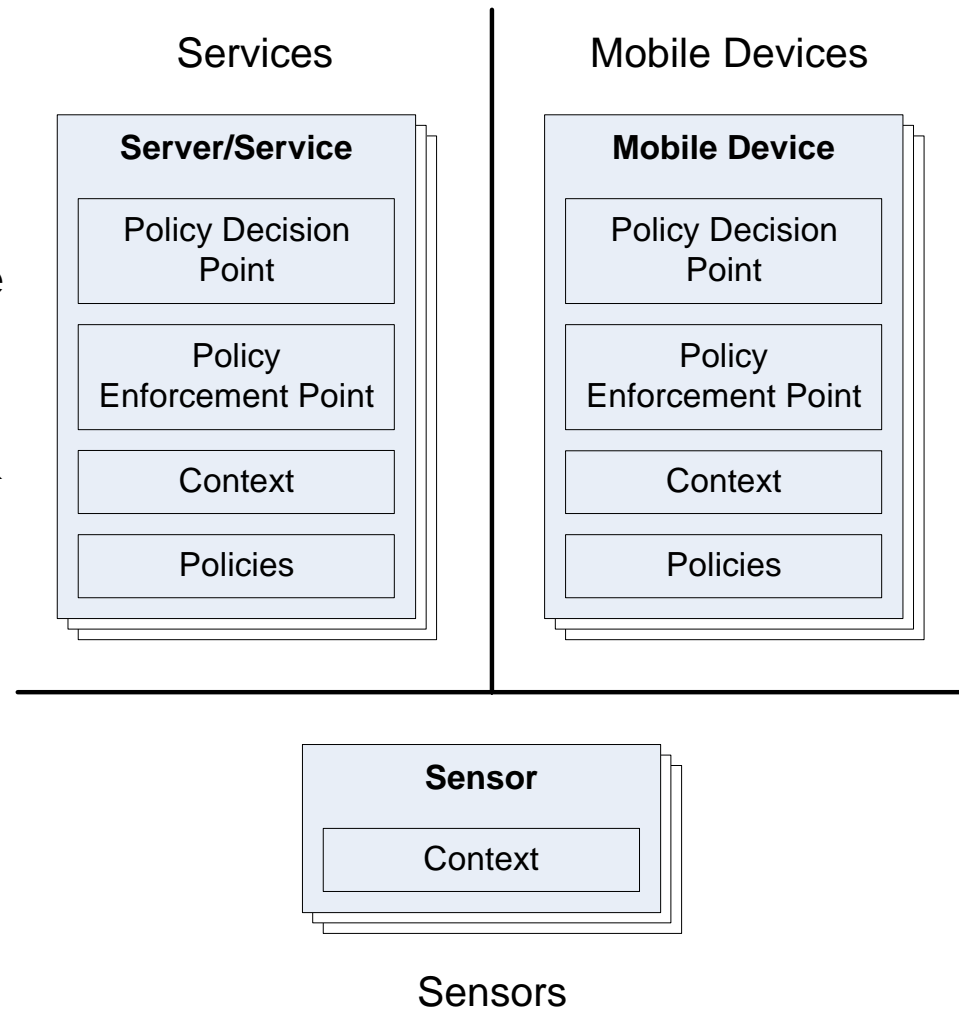 - → Integration of new adaptations

- Context: Resource Description Framework (RDF)

  - Interoperable representation of context information

  - W3C Recommendation

  - Research field: semantic web and artificial intelligence

  - Structure: triple *resource*, *property* and *literal*

- Policies / Rules

  - Development of a new policy language or of a policy decision point needs several years.

  → Reuse of existing policy languages and policy decision points

  - DAML Rules or the reasoners of Jena → not in a mature state

  → Decision for Java Expert System Shell (Jess)

    - Basis for Java Rule Engine API (JSR 94)

    - Based on CLIPS

Adaptation Architecture:
Syntax of Jess / Policies

Ludwig———
Maximilians———
Universität———
München———

- Constructs

    - Templates (*deftemplate*): definition of the type of a fact

    - Facts (*deffact*): piece of information

    - Rules (*defrule*): definition of IF – THEN statements

```
1  (deftemplate mobilePhone
2  (slot encoding))
3
4  (deffacts example
5  (mobilePhone
6  (encoding mpeg)))
7
8  (defrule supports
9  (mobilePhone
10  (encoding mpeg))
11  =>
12  (printout t "Phone supports mpeg encoding." crlf))
```
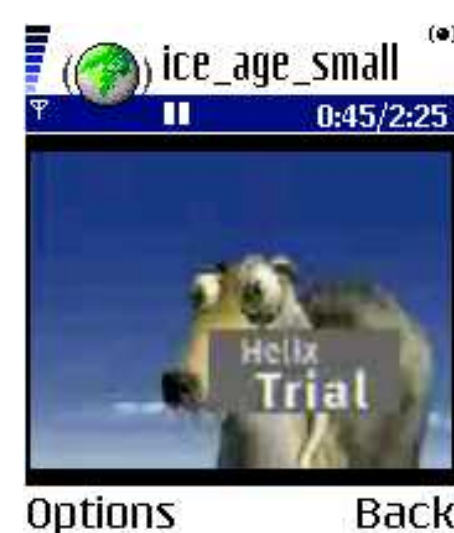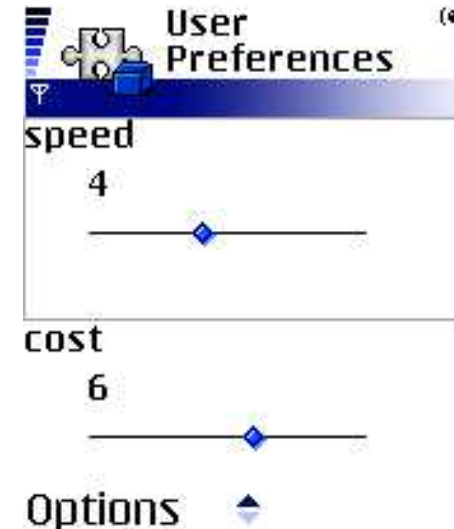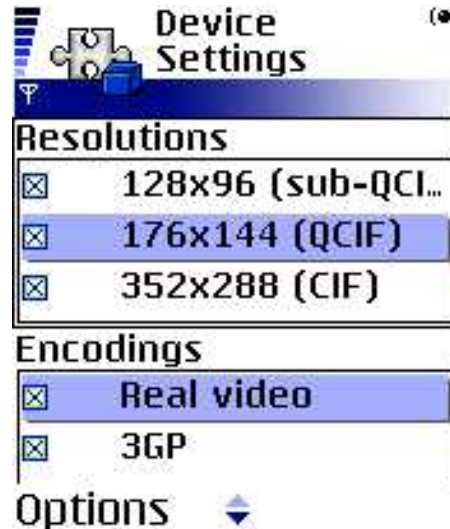
- Distribution of core elements to different entities in the network
- Entities
  - Sensors, services that are provided by servers, or mobile devices
  - Connected to the network
- Sensor: acquire context information
- Services: directly or indirectly used by the user
- Mobile device: mobile phone, PDA, Smart phone

Services

Mobile Devices

Server/Service

Policy Decision Point

Policy Enforcement Point

Context

Policies

Mobile Device

Policy Decision Point

Policy Enforcement Point

Context

Policies

Sensor

Context

Sensors

Prototype: Architecture

- Prove of concept (architecture, process for defining context and policies) based on the presented architecture

Prototype: Implementation
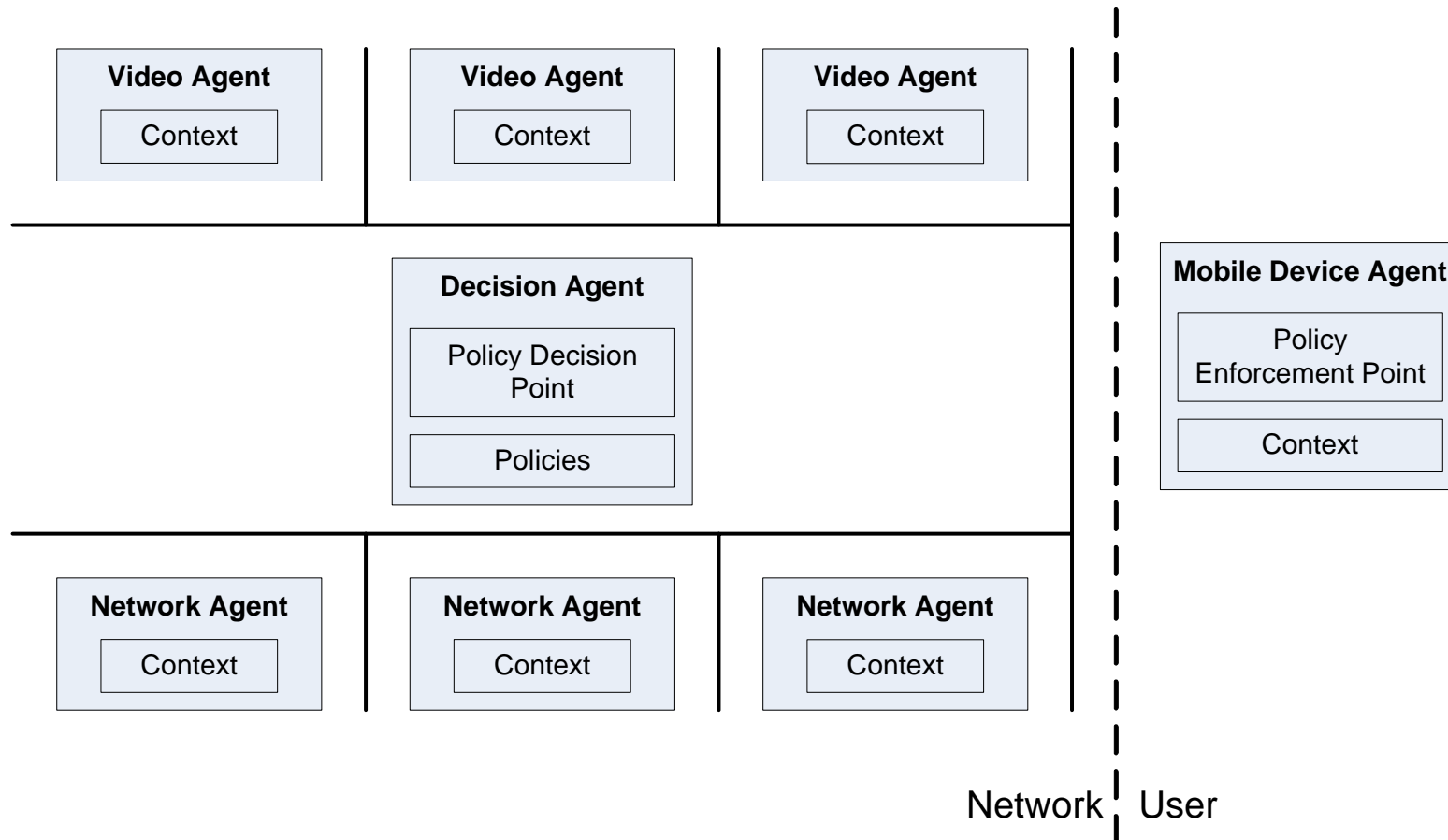
- Context information in RDF
  - →XSL transformations → Jess Syntax (*facts*)

- All agents realized as Jade – Leap agents
  - Lightweight Extensible Agent Platform (Leap) extension of Java Agent Development Framework (Jade)

- Mobile device: Nokia 6600 / Siemens S65
  - J2ME (Java 2 Micro Edition): CLDC 1.0/1.1, MIDP 2.0
  - Mobile Media API (MMAPI)

- Server: Laptop, PC
  - J2SE (Java 2 Micro Edition)

Prototype: Screenshots

Prototype: Context & Policies

Ludwig
Maximilians
Universität
München

LMU

- At the beginning: *offered services*, *available networks*, *mobile device*, *user* and *general properties*

- 1. Step
  - Which videos with which encodings / resolutions could be played by the device?
  - Which networks could be used by the device?
  - Transmission times / costs of the videos are calculated

- 2. Step
  - Combinations of videos, networks, network providers and their cost and transmission time are calculated.
  - Minimal transmission time and cost of a video

- 3. Step
  - Possible combinations are assessed regarding their correlation to the user preferences time, quality and cost

- 4. Step
  - Best combination is selected

Summery

- Presented / Developed
  - Adaptation architecture (core elements, requirements, useful / matured technologies)
  - Definition of context and policies (methodology, diagram for the visualization of context and policies, module pipeline)
  - Prototype

- Usage in demonstrators in the Simplicity project
  - Multimedia chat on different mobile devices (Siemens)
  - Home Environment Server (Siemens Business Services)
  - MyPC (Telecom Italia Learning Services)

Conclusion

- Description of context with semantic web technologies
  - Structuring information in an efficient way
- Usage of policies for adaptive mobile services
  - What are the advantages when compared to an imperative language (flexibility, changeability, declarative programming)?
  - Advantages / Disadvantages not recognizable when implementing demonstrators: no study; No proof what is better

→ Open question: Acceptance by the user
  - Do users understand what they do when defining their preferences regarding speed, cost and quality?
  - Provision of an appropriate user interface for the definition of preferences
  - Which adaptations should be done by the system and which decisions should be done by the user?

Questions ?

Enrico Rukzio
Enrico.Rukzio@ifi.lmu.de (www.rukzio.de)

Simplicity Project
www.ist-simplicity.org

[Henricksen et al.] Henricksen, K.; Indulska, J.; Rakotonirainy, A. *Modeling Context Information in Pervasive Computing Systems.* First International Conference on Pervasive Computing. Zurich, 2002.

[Chen and Kotz] Chen, G.; Kotz, D. *A Survey of Context-Aware Mobile Computing Research.* Technical Report: TR2000-381 Dartmouth College, 2000.

[Abowd et al.] Abowd, G.; Dey, A.; Brown, P.; Davies, N.; Smith, M.; Steggles, P. *Towards a Better Understanding of Context and Context-Awareness.* In Proceedings of the 1st International Symposium on Handheld and Ubiquitous Computing, pp. 304-307, 1999.

[Efstratiou et al.] Efstratiou, C.; Friday, A.; Davis, N.; Cheverst, K. *Utilising the Event Calculus for Policy Driven Adaptation on Mobile Systems.* In 3rd International Workshop on Policies for Distributed Systems and Networks (POLICY'02). Monterey, California, USA. 2002.

[Keeney and Cahill] Keeney, J.; Cahill, V. *Chisel: A Policy-Driven, Context-Aware, Dynamic Adaptation Framework.* In Proceedings of the Fourth IEEE International Workshop on Policies for Distributed Systems and Networks (POLICY 2003), pp. 3-14, 2003.

[Suryanarayana and Hjelm] Suryanarayana, L.; Hjelm, J. *Profiles for the situated web.* In Proceedings of the Eleventh International Conference on World Wide Web, ISBN 1-58113-449-5, pp. 200-209, Honolulu, Hawaii, USA, 2002.

[Friedman-Hill] Friedman-Hill, E., *Jess in Action: Java Rule-based Systems.* Manning Publications. ISBN 1930110898, 2003.

Institut für Informatik

Defining Context and Policies

- Iterative process for the definition of context and policies
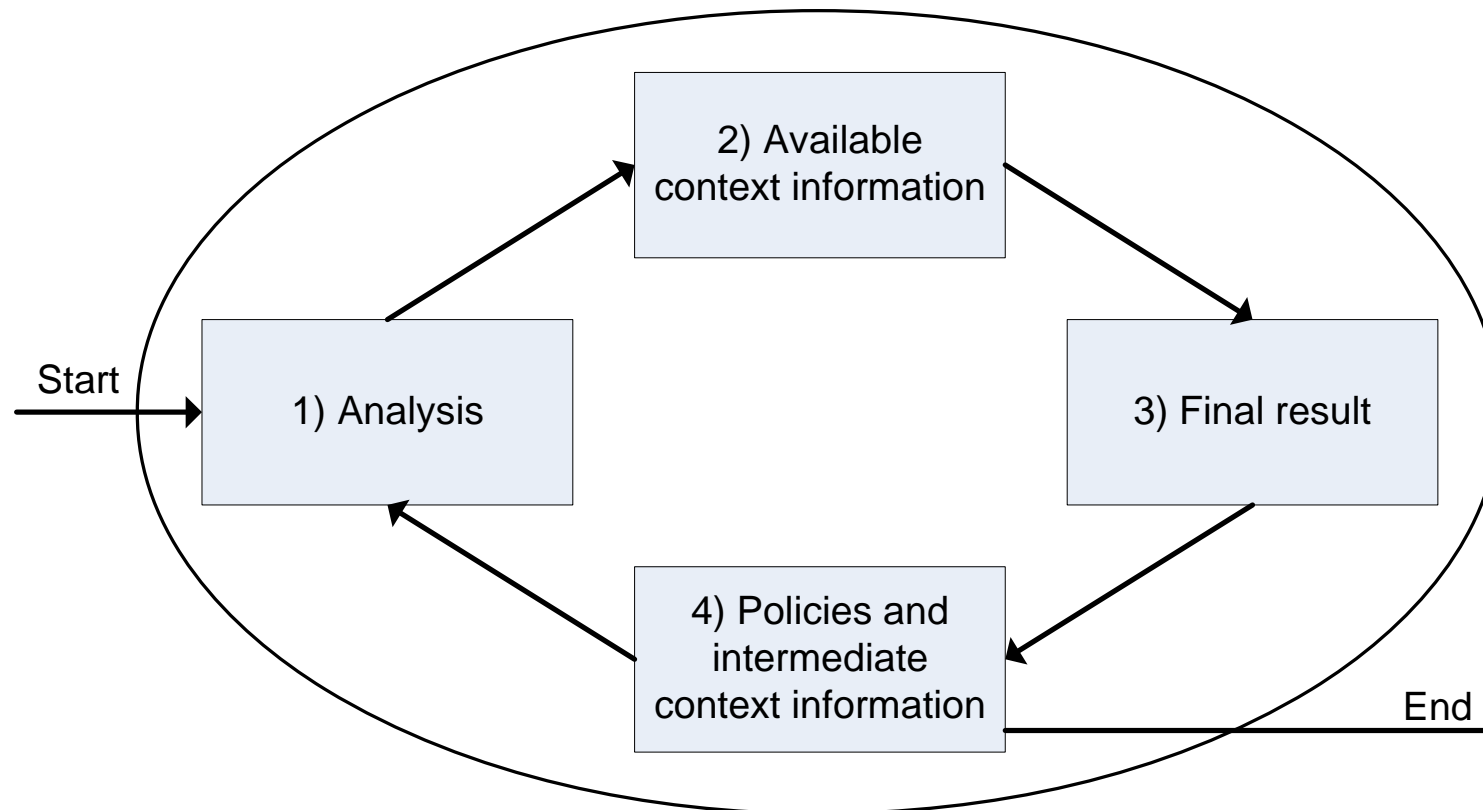
- Diagram for the Visualization of Context and Policies
- Concept: Module pipeline