Generating architecture models using genetic algorithms

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Tampere University of Technology

Number of students: ~12000

Teaching & Research staff: ~2000

Annual Budget: ~65ME + ~65ME

Faculties:

- Automation, Mechanical and Materials Engineering
- Built Environment
- Business and Technology Management
- **Computing and Electrical Engineering**
- Science and Environmental Engineering

Faculty of Computing and Electrical Engineering

Departments

Electrical Engineering

Electronics and Communications Engineering

Signal Processing

Pervasive Computing

Department of Pervasive Computing

Personnel:

- 10 professors
- Total of about 140 professors/teachers/researchers/research assistants

Output/year (estimated)

- ~15000 credit points
- ~60 MSc's
- 5-6 PhD's

Laboratories

Software Engineering (prof. *Kai Koskimies*, prof. *Kari Systä*)

- Process, project management, product/configuration management, testing, specification and design methods, OO Methods, software architectures…

Embedded Systems and Computer Engineering (prof. *Hannu-Matti Järvinen,* prof. *Jarmo Takala,* prof. *Timo D. Hämäläinen*)

- Design and implementation of embedded systems, operating systems...

Distributed Software (prof.*Tommi Mikkonen, department head*)

- Implementation of distributed systems, Internet application technology, mobile applications...

Usability (prof.*Kaisa Väänänen-Vainio-Mattila,* prof. *Timo Saari*)

- Usability, user experience, UI design, ...

Information Security (prof. *Jarmo Harju*)

- Secure programming, secure networking, ...

Can systems design systems?

Darwin: project funded by Academy of Finland 2009-2011

Research problem: To what extent can systems design systems?

Approach: Application of genetic algorithms to synthesize a software architecture proposal from given requirements

Applications: automating software design, MDA transformations, software development work allocation planning, self-adaptive systems

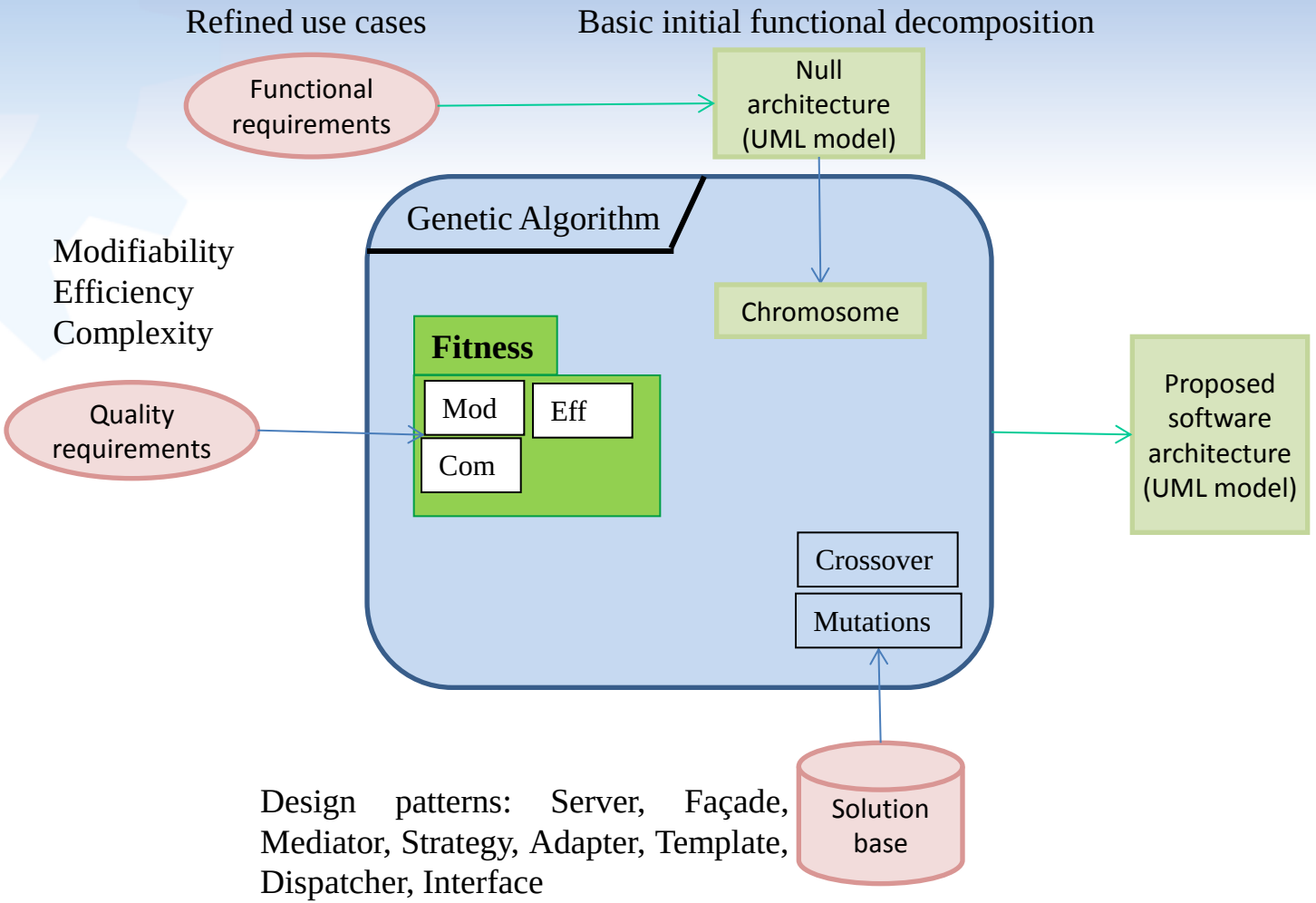
Software Architecture

Here software architecture means:

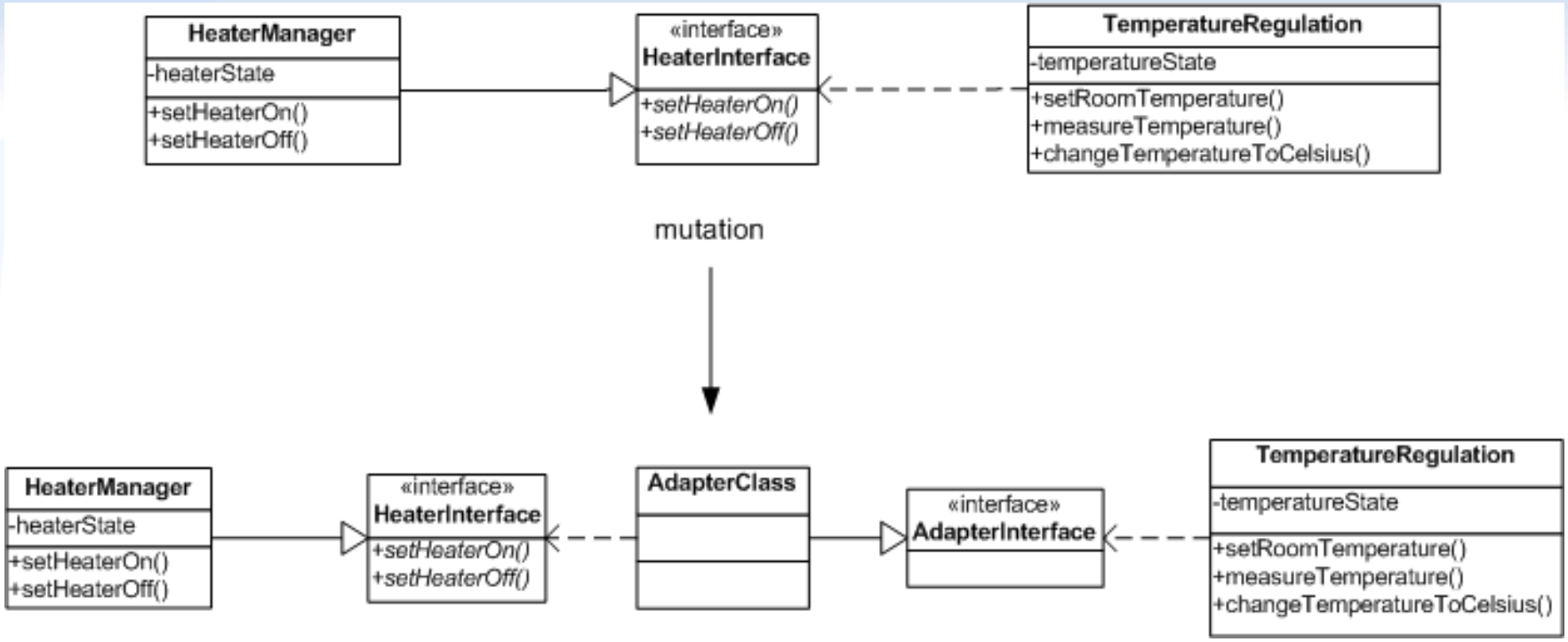
UML class diagram with

- classes (& interfaces)
- operations
- attributes
- stereotypes
- use relationships
- inheritance relationships
- implementation relationships

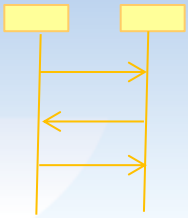
Genetic algorithms in architecture synthesis



Mutations: Example (Adapter)

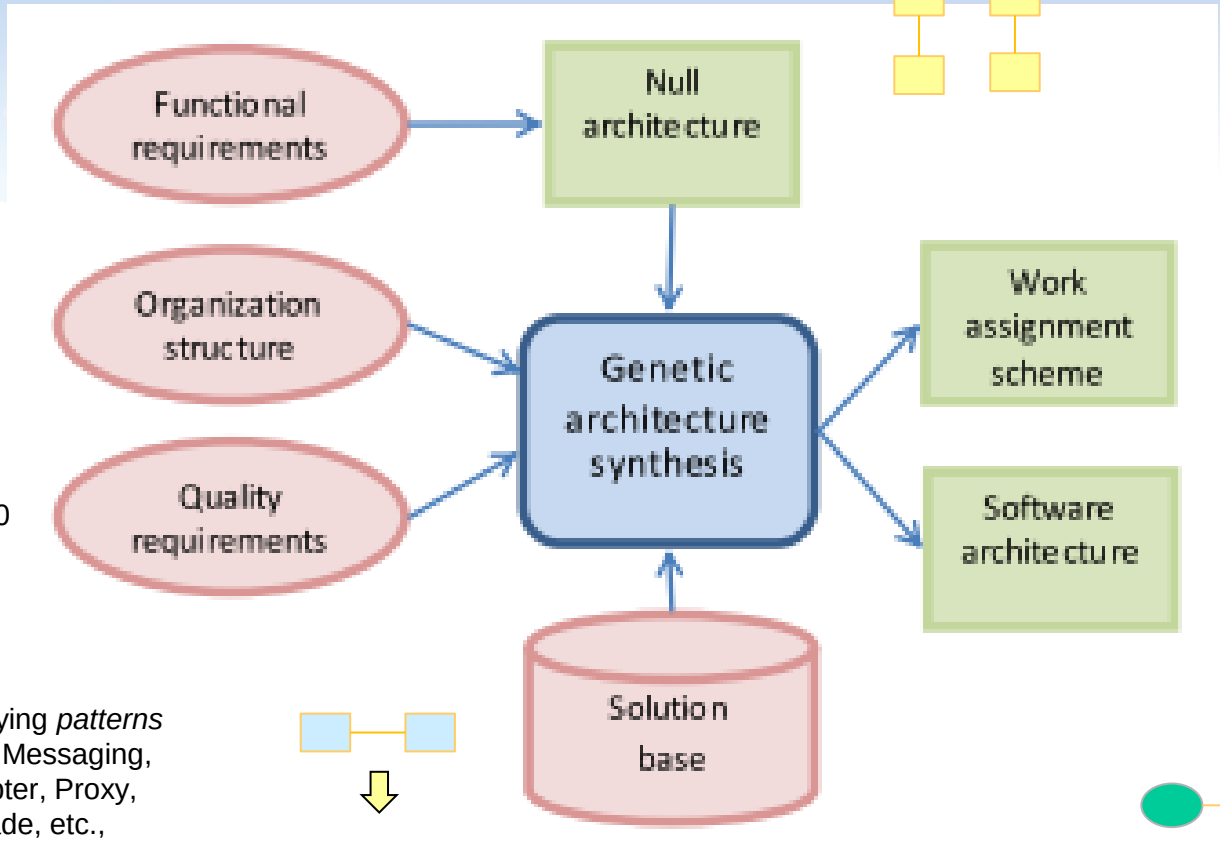


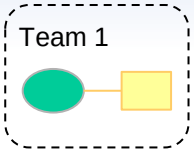
Genetic software architecture synthesis

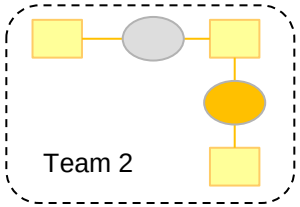


Team 1:
- size 20
…
Team 2:
…

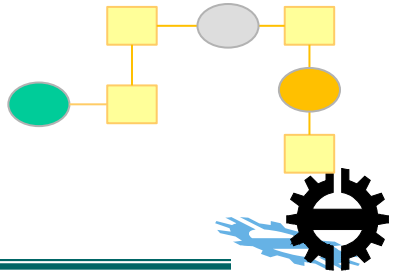
Efficiency: 25
Modifiability: 50
Simplicity: 10



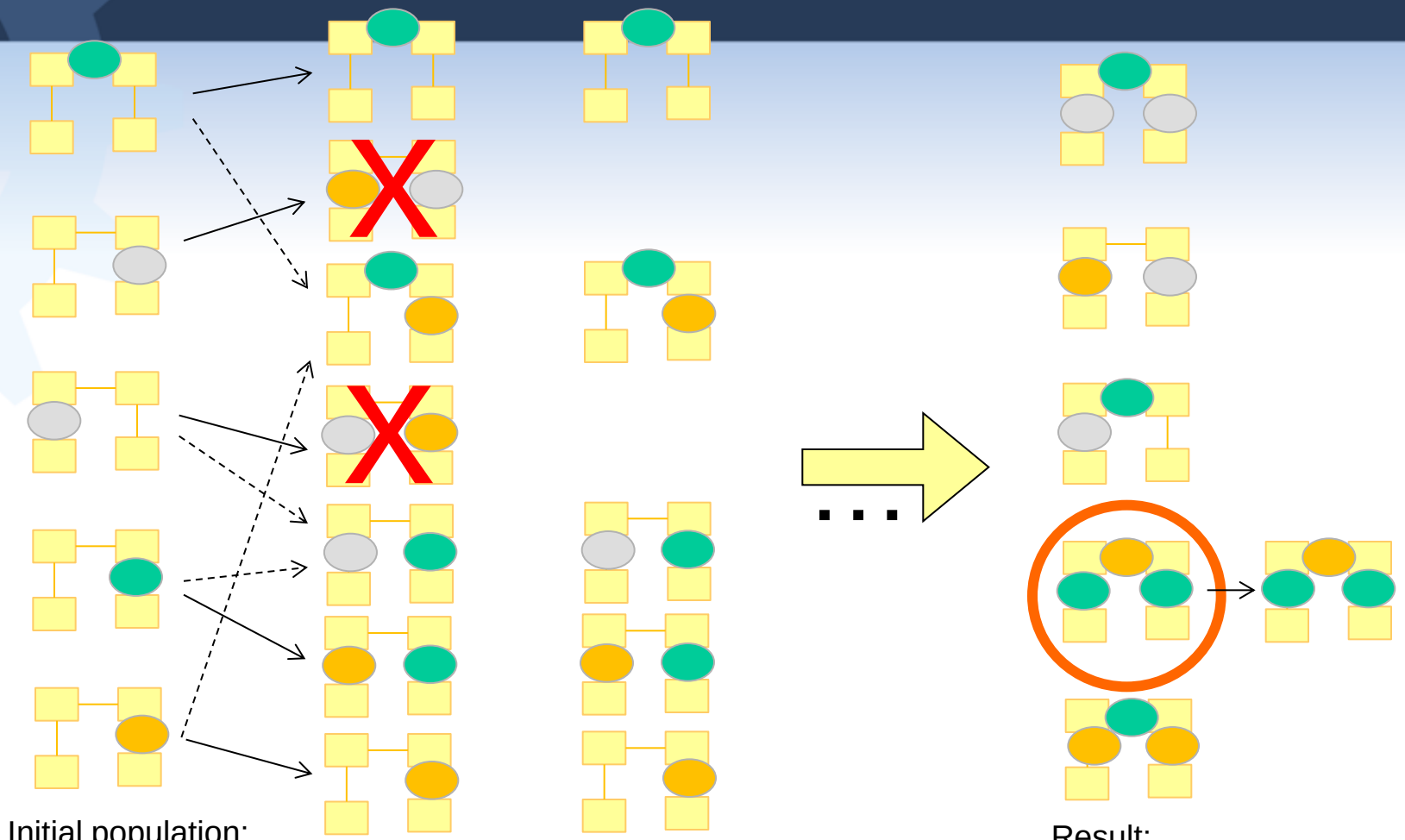




Applying *patterns*
(e.g. Messaging,
Adapter, Proxy,
Facade, etc.,
also allocating
component to a team)



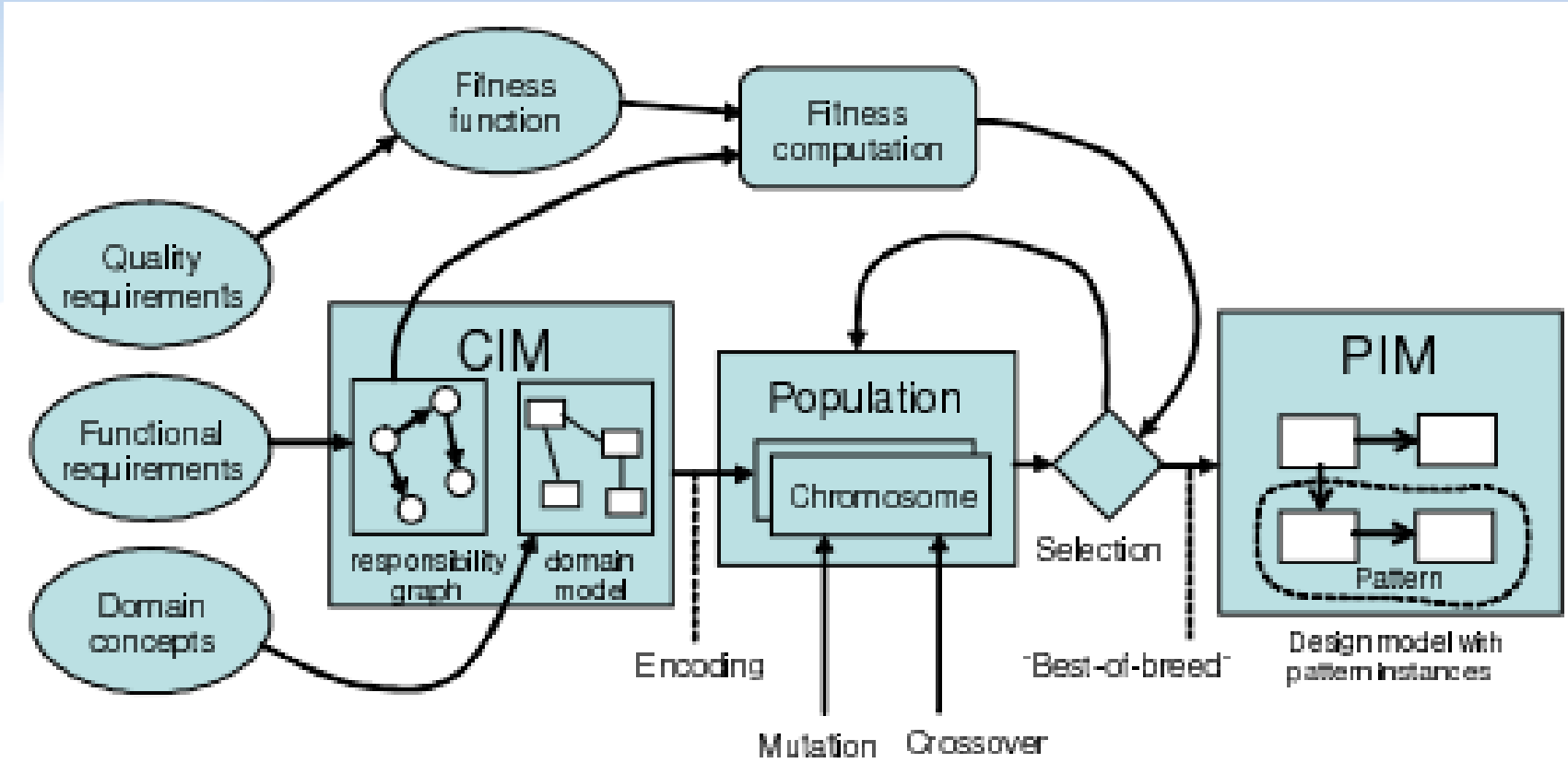
Simulated evolution of software architectures



Tool

For a tool demo, see video at www.cs.tut.fi/~kk/DarwinDemo.wmv

Genetic model synthesis in MDA



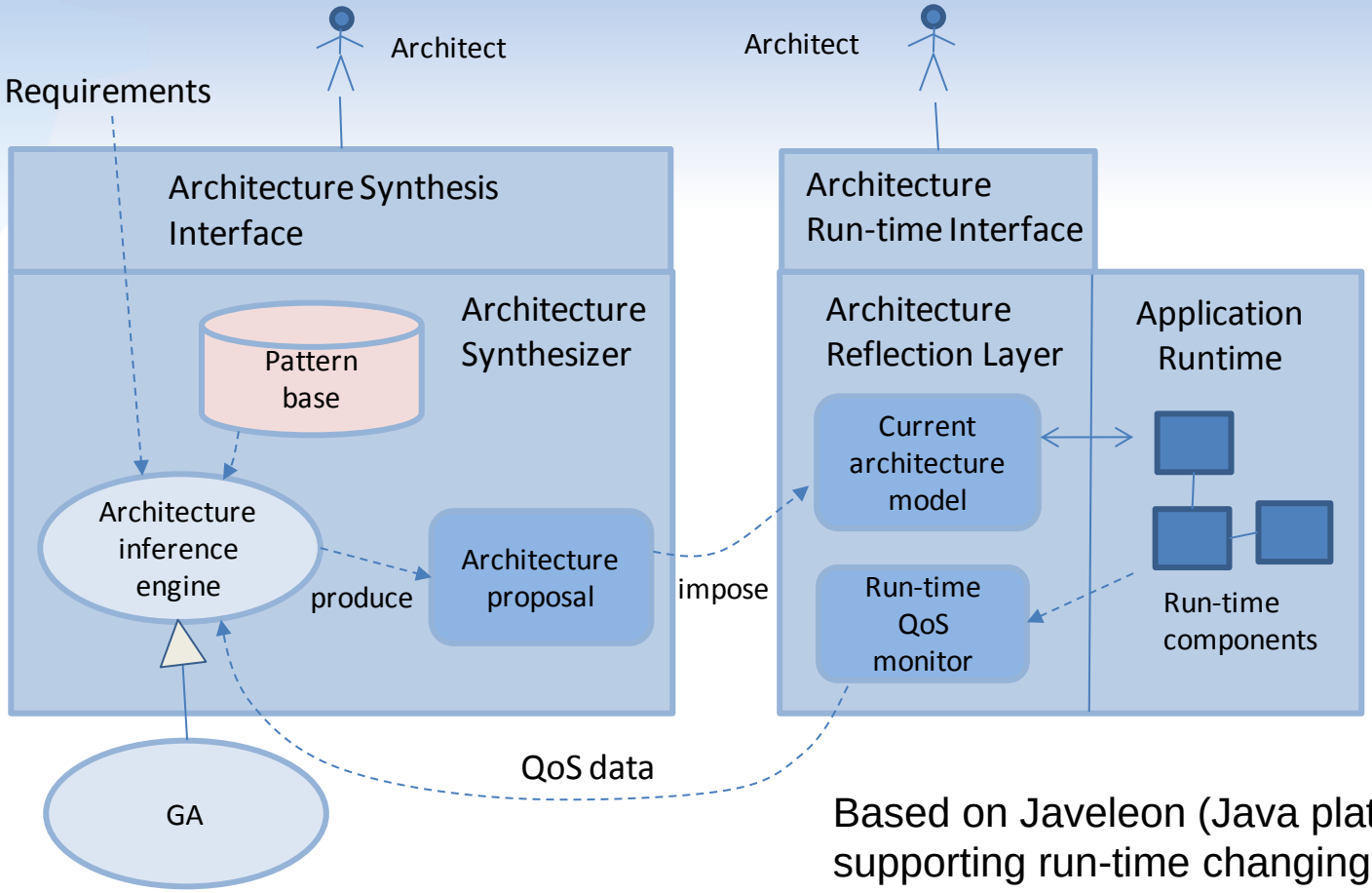
Using architecture synthesis in self-adaptive systems

Motivation

- The usage environment may change during the lifetime of a software product
- Adaptive maintenance should be done by the system itself as much as possible
- In general, systems should be more architecture-aware, capable of reflecting and improving their own architecture

Genetic software architecture synthesis provides an approach for pattern-based self-adaptive systems, capable of architecture level self-improvement

Self-adapting architecture infrastructure



Based on Javeleon (Java platform supporting run-time changing of classes)

Reflections

Problem domain syntax

Solution domain

Domain model + Patterns = Architecture (structure)

Architecture + Logic = Application (behavior)

Problem domain semantics

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