Self-Adaptation for Everyday Systems

Svein Hallsteinsen, Erlend Stav, Jacqueline Floch

SINTEF ICT
Norway
Mobile use means changing context

- When people are moving around using handheld networked devices, the operating environment for the provided services vary.
- The user activity and location change, influencing user needs.
- The capabilities of computers and networks change, influencing the service quality properties.
- Applications depend upon system resources to satisfy user needs.
- When resources and needs vary, static applications fail to satisfy user needs most of the time.
- Changing context requires adaptive applications!
Focus

Aspects of self-management we do address
- Main: software architecture, mobile computing, algorithms for system adaptation, adaptive components

Aspects we do not address
- Prog. language support, AI techniques, autonomic computing, assurance

Targeted application types and properties
- Mobile computing used in a changing environment
- Everyday systems, for which non-perfect adaptation is acceptable
- Cost effective development

Technical contributions
- Overall architecture for model based adaptation middleware, combining a system family approach with context awareness and runtime adaptation
- Uniform modelling of quality and context properties of components and composites
Overall approach to adaptive applications

- **architecture model**
  - components
  - nodes

- **adaptation middleware**
  - selects application variant
  - monitors
  - adapts
  - describes relation

- **adaptable application**
  - influence user's needs
  - mobile user
  - preferred quality
  - provided quality
  - affects operation
  - system context
  - battery
  - shared devices
  - network QoS

- **user context**
  - position
  - noise
  - light

- **user's needs**
Overall architecture

- **Application framework**
  - Architecture model
  - Component repository
  - 3. consult

- **FAMOUS middleware**
  - FAMOUS adaptation middleware
  - Resource manager
  - Context monitor

- **Adaptation manager**
  - Planner
  - 4. plans
  - 5. configure

- **Configurator**
  - 6. change

- **FAMOUS component platform**

- **Application instance**
  - Meta model
  - Component instances
  - 1. change event
  - 7. change

- **Distributed computing environment**

**Key Phases:**
1. change event
2. plan
3. consult
4. plans
5. configure
6. change
7. change
Property annotation of variants

**Medium client variant**

\[
\begin{align*}
\text{avy} &= \text{if } n.\text{nsb}>80 \text{ then } 100 \\
&\quad \text{else } 100 \times (1-(80-n.\text{nsb})/80) \\
\text{rsp} &= \text{if } n.\text{nbw}>80 \text{ then } 10 \\
&\quad \text{else } 10+100 \times (80-n.\text{nbw})/80) \\
\text{haf} &= \text{UI.o.haf}
\end{align*}
\]

**Name** | **Value range** | **Explanation**
---|---|---
ady | 1:100 | Availability of the service provided by the application
rspb | 1:100 | Response time
mem | 1:100 | Amount of memory
nbw | 1:100 | Bandwidth of network connection
nsb | 1:100 | Stability of network connection
haf | yes, no | Hand free operation
Utility function

- Selection of variant is based on a utility function
- User preferences are to decide weight each properties

utility =

if n.mem > exe.o.mem
    then 0
else
    ( (if usr.n.avvy <= app.o.avvy then 1 else 1- (usr.n.avvy-app.o.avvy)/usr.n.avvy)
     + (if usr.n.rsp >= app.o.rsp then 1 else 1- (app.o.rsp-usr.n.rsp)/app.o.rsp)
     + (if ((usr.n.haf and app.o.haf) or (!usr.n.haf and !app.o.haf) then 1 else 0) ) / 3
    )
Remaining questions

- How accurate do we need to model to achieve useful adaptations for everyday systems?
  - Non-exact models acceptable as long as benefit are provided to the user

- Is exhaustive search for best variant too expensive?
  - Resource constrained devices
  - Depends on number of variation points in application framework

- Current approach focused on structural adaptations of components and connections within an application
  - How to extend the approach to multiple applications?
  - How to support other kinds of adaptation (e.g. adjustment of parameters with continuous range in components)?
Organization and projects

- **SINTEF**
  - Largest independent research organisation in Scandinavia with about 1700 employees

- **FAMOUS project (2003-2006)**
  - Strategic research project at SINTEF, funded by the Research Council of Norway
  - Includes a PhD work on context awareness
  - For more info: www.famous-project.net

- **MADAM project (2004-2007)**
  - EU-funded research project with industrial and university partners
  - Additional topics
    - Modelling tool support
    - Network level middleware
    - Industrial pilot applications and experiments