Utilising the Event Calculus for Policy Driven Adaptation in Mobile Systems

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Overview

- Adaptation in Mobile Systems
- Requirement for a Policy Based approach
- The Coordinated Adaptation Platform
- Event Calculus as a Policy Language
- Examples
- Open Issues
- Conclusions

Adaptation

- Current systems dealing with a single type of adaptation (i.e. network QoS, power).
- Need for applications capable of adapting to multiple types of adaptation triggers
  - Network QoS
  - Power availability
  - Service availability
  - User context
- Multiple applications

Problems and Restrictions of Current Systems

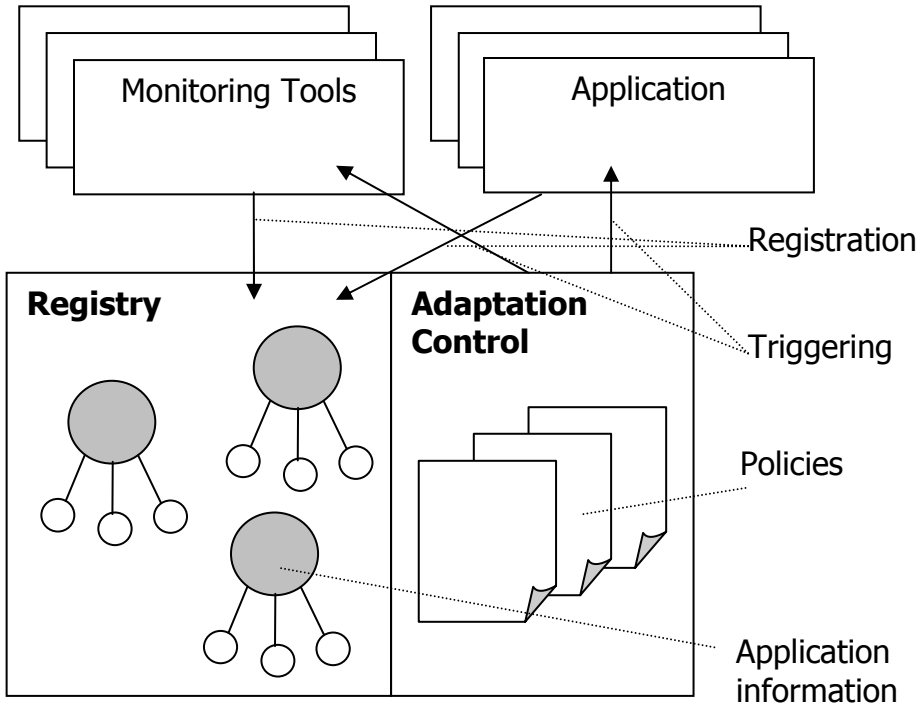
- Conflicting adaptation
- Un-coordinated adaptation
- No user awareness
  - Understanding of system behaviour
  - Support for customisable adaptation

The cause: Tight coupling of adaptation policies and mechanisms

- Current systems: hard coded adaptation policies within the adaptive applications.
- Requirement for:
  - Decoupling policies and mechanisms
  - Allow modification of policies
  - Allow dynamic user involvement in the adaptation cycle

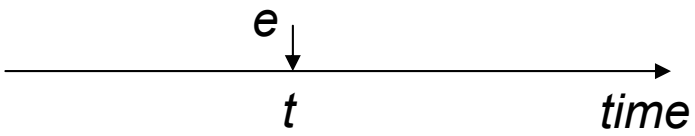
The Coordinated Adaptation Platform

- Application Registration
  - Mechanisms
  - State variables
- Policy evaluation
  - State variables as events
  - Adaptation mechanisms as actions

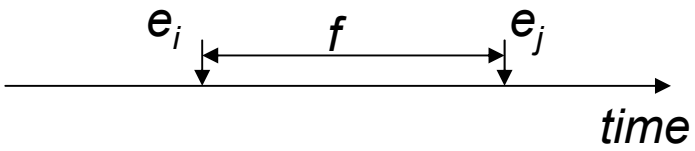


The Event Calculus

- Event



- Fluent



- Happens(e, t)
- HoldsAt(f, t)
- Initiates(e, f, t)
- Terminates(e, f, t)
- Clipped(f, t_1, t_2)
- Declipped(f, t_1, t_2)
- $t_1 < t_2$

The Event Calculus Policy Language

event definition$_1$
…
event definition$_n$

fluent definition$_1$
…
fluent definition$_m$

condition { *condition* **}**
action {
    action$_1$
    …
    action$_k$
}

Policy Rules: Example 1

event lowBand :- NetworkInterface.availableBandwidth < 19200
event normBand:- NetworkInterface.availableBandwidth >= 19200

fluent inLowBand **{**
    initiates(lowBand)
    terminates(normBand)
}

condition {
    initiates(lowBand, inLowBand, t1) **and**
    not clipped(inLowBand, t1, t2) **and**
    t2 = t1 + 30
}

action {
    WebBrowser.LowBand()
}

Policy Rules: Example 2

```
event lowPower :- Battery.Percent < 10
event normPower :- Battery.Percent >= 10

fluent inLowPower {
        initiates(lowPower)
        terminates(normPower)
}
condition {
        initiates(lowPower, inLowPower, t1)
}
action {
        WebBrowser.LowBand()
}
```

Policy Rules: Example 3

```
event lowPower :- Battery.Percent < 10
event normPower :- Battery.Percent >= 10
event webHighPriority :- Priorities.getPriority("WebBrowser") = 1
event webNormPriority :- Priorities getPriority("WebBrowser") != 1

fluent inLowPower {
        initiates(lowPower)
        terminates(normPower)
}
fluent atWebPriority {
        initiates(webHighPriority)
        terminates(webNormPriority)
}
condition {
        ( initiates(lowPower, inLowPower, t1) and
                not holdsat(atWebPriority, t1)  ) or
        ( terminates(atWebPriority, t2) and
                holdsat(inLowPower, t2) )
}
action {
        WebBrowser.LowBand()
}
```

Open Issues

- Efficient Policy Evaluation
  - Model event calculus predicates as FSMs.
- Policy Specification Conflicts
- Adaptation Conflicts
  - Sequence of adaptation actions aiming at conflicting goals
  - Not always possible to determine what is the primary goal
  - User involvement may be necessary to resolve unclear situations

Conclusions

- Supporting multiple adaptive applications triggered by a variety of adaptation attributes.
- Decouple adaptation mechanisms and adaptation policies.
- Utilise an event based policy language that allows the explicit specification of time dependencies.