

# TOWARDS HIGHLY ADAPTIVE SERVICES FOR MOBILE COMPUTING

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## Overview

- Our middleware architecture
- Profile and policy specification and processing
- Middleware implementation and testbed prototype
- Conclusion and future work

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# Our Middleware Architecture

Goal: adaptation and personalization  
of Internet-based services in a mobile  
environment

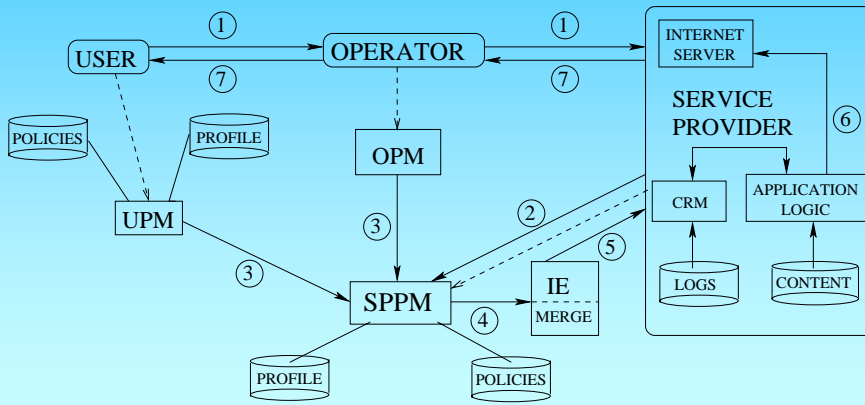
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## Adaptation Based on Profiles and Policies

- An extended notion of profile includes information about:
  - User personal data, device capabilities, network infrastructure, location, action context, content, *preferences and presentation parameters*
- Profile information is distributed:
  - Users
  - Network operators
  - Service providers
- Both user and service provider can declare policies to adapt and personalize the service

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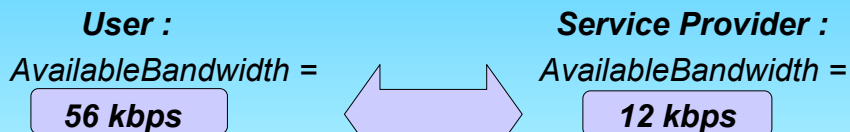
# Architecture Overview



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## Merging Profile Data

- Different entities can provide different values for the same profile attribute



### Profile Resolution Directive

*AvailableBandwidth* = <Service Provider, User>

**AvailableBandwidth = 12 kbps**

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# Policy Specification

<<When I am using a laptop, the bandwidth is higher than 128kbps, and the billing plan is not "per byte", I want to receive high-resolution multimedia content>>

User interface:

The screenshot shows a web browser window titled 'Policy Management - Microsoft Internet Explorer'. The address bar shows 'http://localhost/preferences.html'. The main content area is titled 'Media Quality Preference'. It features a table with columns for 'Attribute', 'Negation', and 'Value'. The table contains three rows of conditions:

	Attribute	Negation	Value	
I prefer MediaQuality	High			
When	DeviceType	is	Laptop	Remove
And	Bandwidth	is	Greater Than 128 kbps	Remove
And	BillingPlan	is not	PerByte	Remove

There is an 'Add Condition' button at the bottom right of the table.

Policy language:

*MediaQuality(High) ← DeviceType(Laptop), Bandwidth(X),  
X > 128 kbps, not BillingPlan(perByte)*

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## Policy Conflict Resolution: An Example

*R1: MediaQuality(High) ← DeviceType(Laptop), Bandwidth(X),  
X > 128 kbps, not BillingPlan(perByte)*  
*R2: MediaQuality(Low) ← BatteryLevel(Low)*  
*DeviceType(Laptop) ←*  
*BillingPlan(FlatRate) ←*  
*Bandwidth(256 kbps) ←*  
*BatteryLevel(Low) ←*



*MediaQuality('High')*

*MediaQuality('Low')*

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# Policy Conflict Resolution

- Conflicts between rules declared by different entities
  - solved considering *profile resolution directives* of the head attribute
- Conflicts between rules declared by the same entity
  - solved considering *priority directives* of the form **R2 > R1** declared by the entity

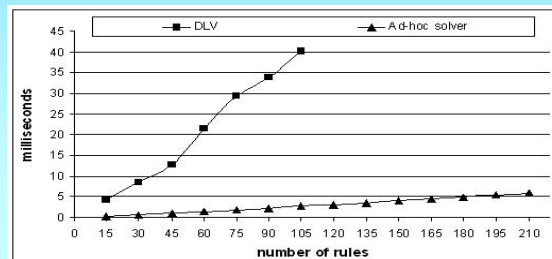
Priority directives are reflected in the logic program by appropriately transforming clauses:

```
MediaQuality(High, 0) ← DeviceType(Laptop, _), Bandwidth(X, _),  
    X > 128kbps, not BillingPlan(perByte, _), not MediaQuality(_, J), J > 0  
MediaQuality(Low, 1) ← BatteryLevel(Low, _), not MediaQuality(_, J), J > 1  
DeviceType(Laptop, 0) ← not DeviceType(_, J), J > 0  
BatteryLevel(Low, 0) ← not BatteryLevel(_, J), J > 0
```

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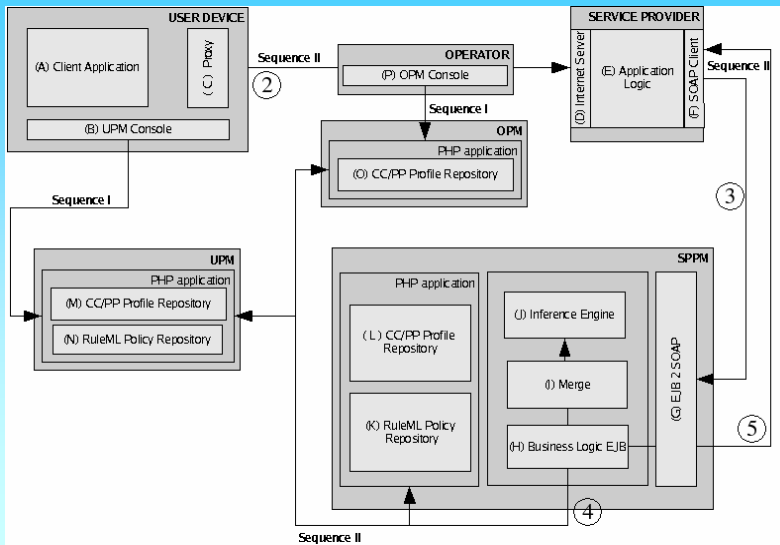
# Performance Evaluation

- Our policies can be evaluated by standard solvers (e.g. Mandarax, DLV)
- We have developed an ad-hoc evaluator in order to improve the performance, exploiting the characteristic features of our language



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# Architecture Implementation



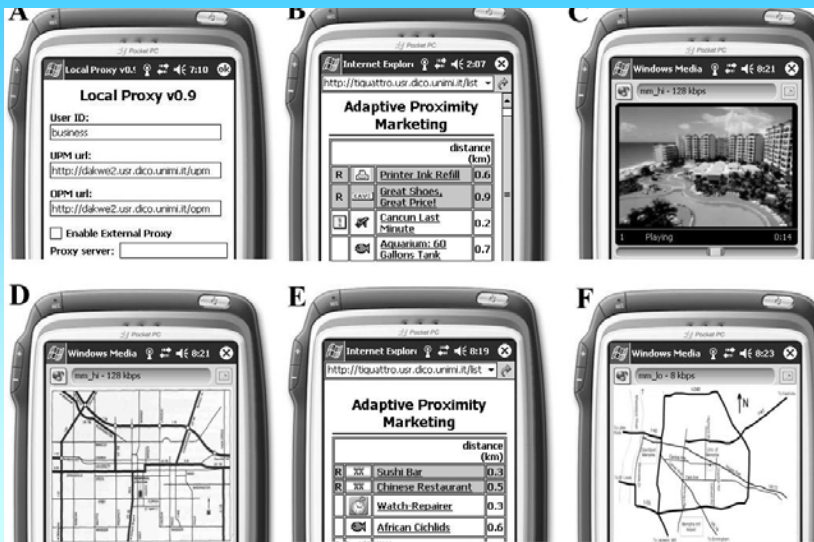
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## Adaptive Proximity Marketing

- A web-based service providing targeted, location-aware *advertisements*
- Ads are selected based on the user shopping list
- Ads are ordered taking into account various profile attributes (solving conflicts)
- Multimedia content, possibly associated with ads, is adaptively delivered to the user's device (solving conflicts between policies given by users and providers)

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# Some Screenshots



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## Multiple Policies in Proximity Marketing

### Policies

- (1 - user) **If DeviceType = 'Pda' Then Set MediaQuality = 'High'**
- (2 - SP) **If AvailableBandwidth < 56kbps Then Set MediaQuality = 'Low'**
- (3 - SP) **If UserSpeed = 'Slow' Then Set RefreshTime = '15min'**
- (4 - SP) **If UserSpeed = 'Fast' Then Set RefreshTime = '3min'**

### Profile Resolution Directives

- (5) *setPriority AllowRecommadations = (SPPM, UPM)*
- (6) *setPriority Coordinates = (UPM, OPM)*
- (7) *setPriority MediaQuality = (SPPM, UPM)*
- (8) *setPriority UserSpeed = (UPM, OPM, SPPM)*

# Future Work

- Definition of ontologies for more powerful reasoning on user context
- Implementation of a trigger mechanism for intra-session adaptation
- Prototypes:
  - Extended Points of Interest
  - Integration with an adaptive streaming server