Coupling Transparency and Visibility: a Translucent Middleware Approach for Positioning System Integration and Management (PoSIM)

Paolo Bellavista
Antonio Corradi
Carlo Giannelli

DEIS, University of Bologna,
V.le Risorgimento n.2, 40136 Bologna Italy
{pbellavista, acorradi, cgiannelli}@deis.unibo.it
Location based services, positioning systems, their integration

The Translucent approach
  - positioning system integration coupling transparency and visibility

PoSIM middleware
  - high level control and delivery
  - low level integration and fully-aware access
Location Based Services (LBSs)
- virtual museum assistance
- service discovery

Positioning systems
- special purpose modules, e.g., GPS
- communication purpose wireless technologies, e.g., IEEE 802.11 (Ekahau), Bluetooth (BTProximity), GSM/GPRS/UMTS

Heterogeneity
- location information: symbolic vs. physical
- environment: indoor vs. outdoor
- accuracy: few centimeters vs. several kilometers
- power consumption: 1mW – 1W
- additional features, e.g., location information as probability distribution function
Devices may contemporarily access several positioning systems which differ in provided information and capabilities.

A middleware solution to provide
- an homogeneous access to positioning systems
- integration of available positioning systems
  - to perform location fusion
- dynamically control integrated positioning systems
  - to switch among available ones depending on their availability and application requirements
Current Contributions Limits

- Limited dynamicity
  - embedded data fusion algorithm
  - **embedded** positioning system switch policies

- Limited management
  - higher layers do not control positioning systems
  - only bottom-up data flows

- Limited extendibility
  - only high level, **predefined information**
  - positioning system peculiarities hidden
Differentiated visibility:

- **Transparent**
  - useful for simple LBSs
  - integrated positioning systems perceived as a unique multi-behavior component
  - extendible policy-based control

- **Visible**
  - underlying components low level details and management capabilities at application level
  - uniform access to underlying components for smart LBSs, while preserving their peculiarities
Positioning System Integration and Management
- based on translucent approach
  - Transparent: Policy and Data Managers
  - Visible: Positioning System Access Facility
■ Transparent control API
  - declarative policy de/activation at service provisioning time
  - pre-defined behaviors as policies, e.g., `POWER_USAGE_LOW`
  - no knowledge about actually exploited positioning systems
  - active monitoring and control

```plaintext
name:lowPowerConsumption
condition:
  Feature(name:Power, value: 8) op:greater
  Info(name:Accuracy, value:5) op:lower
action:
  Feature(name:State, value:off)
```
Policy Manager (2)

- **Policy Controller**
  - provides high-level API
  - gathers requested information
  - transforms Java classes in Policy Engine compliant policies

- **Policy Engine**
  - enforces active policies
  - requests for specific actions
    - implemented as a Jess rule engine
Transparent information delivery API
- aggregated data delivery as an XML document
- XML tags exploited to specify the semantic
- simple LBSs specify delivery rules

<Data>
  <sources>
    <source name="Ekahau">
      <info name="LocSymb" value="Italy, Bologna"/>
      <info name="Accuracy" value="7"/>
    </source>
    ...
  </sources>
</Data>
Data Builder
- collects information from positioning systems and context sources

Data Disclosure
- on demand: provides already available XML document
- periodical: provides it at a time interval
- event-driven: several triggering events
  - atLocation, atChanges and user defined ones
- filtering rules: filter XML document and provides only LBS-relevant data
  - highAccuracy and user defined ones
PoSIM extensibility

- Novel developers simply select among existing policies, events, and filters
  - already available capabilities suitable for most common LBSs

- Expert users can improve PoSIM capabilities
  - new policies, new triggering events, and new filtering rules added at service provisioning time
Positioning system integration in a plug-in fashion

Underlying layers information access and behavior control

Visible control and delivery API
- register/cancel positioning systems
- request for available information and manage capabilities

Info: information related to location
- location (physical or symbolic), location accuracy

Feature: information related to positioning system behavior
- power consumption, privacy level

Valencia, Spain — 07.09.2006
Positioning System Wrapper

- Uniform interface to interact homogeneously with positioning systems
  - specific API
    - `infoX()` to retrieve information
      - `infoLocation()`
    - `getX()/setX()` to control
      - `getPowerConsumption()`
  - PSAF dynamically retrieve information exploiting Java introspection
    - legacy positioning systems provide the required interface
Management of positioning systems integrated dynamically coupling both transparent and visible approaches, i.e., Translucent approach
- transparent access for simple LBSs with common requirements
- visible access for LBSs with peculiar requirements

Easily extendible, even at service provisioning time

Future work:
- Wrapper for BTProximity (GPS and Ekahau PSWs already available)
- Several pre-defined policies, filter rules, triggering events
Acknowledgements:
- Work supported by MIUR FIRB WEBMINDS and CNR Strategic IS-MANET Projects

Web references for software and additional documents:
- http://lia.deis.unibo.it/Research/PoSIM/
- http://lia.deis.unibo.it/Staff/CarloGiannelli/