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

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Agenda

- 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**

Positioning Systems

- 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

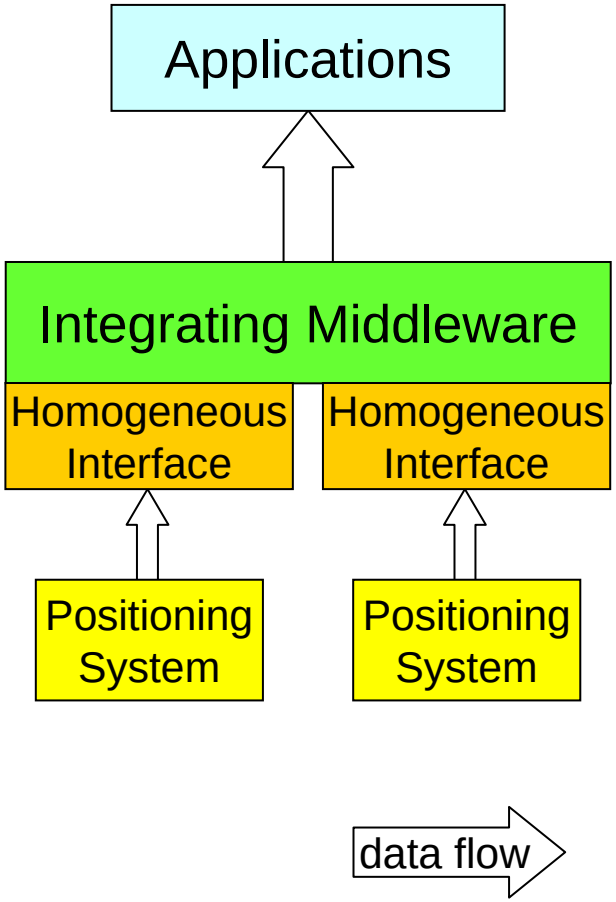
Positioning System Integration

- 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

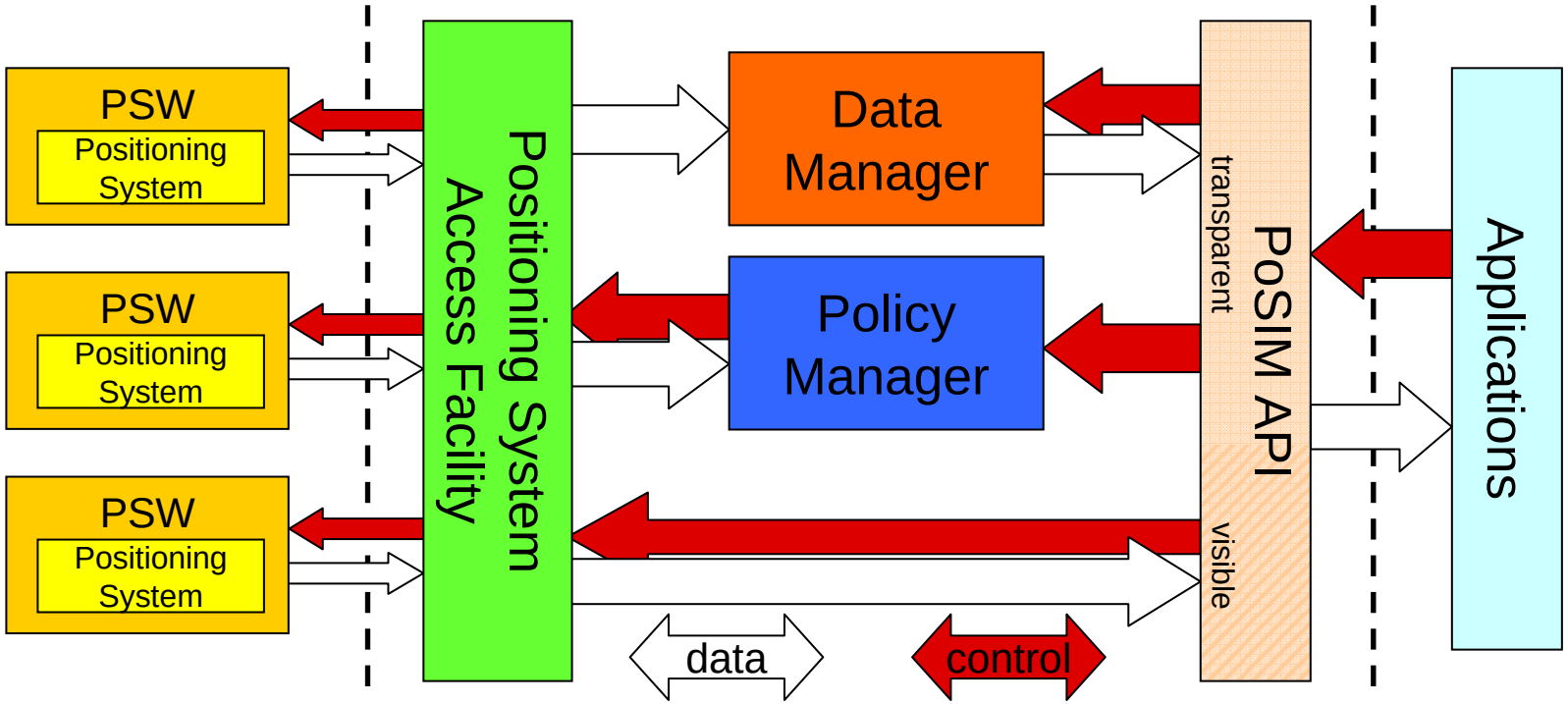


The Translucent Approach

- 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

PoSIM middleware

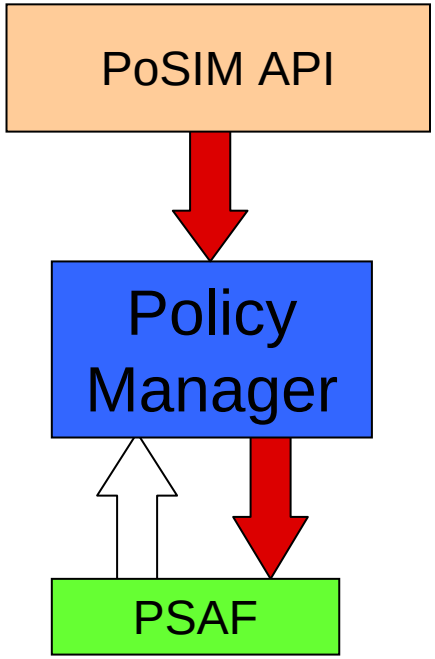
- Positioning System Integration and Management
  - based on translucent approach
    - Transparent: Policy and Data Managers
    - Visible: Positioning System Access Facility



Policy Manager (1)

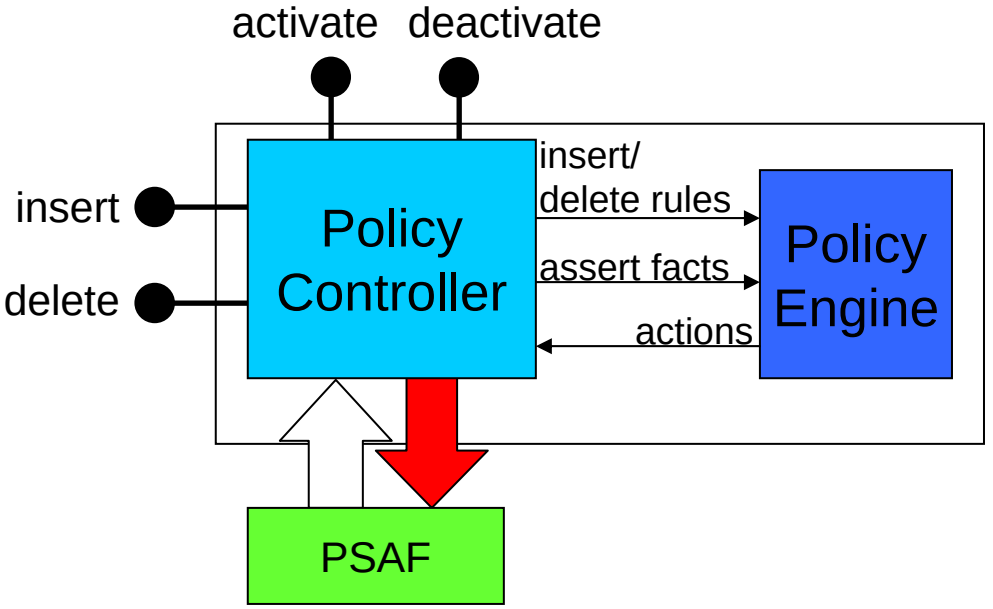
- Transparent control API
  - declarative policy de/activation at service provisioning time
  - pre-defined behaviors as policies, e.g., `POWER_USAGE_LOW`
  - no knowledge about actually exploited positioning systems
  - active monitoring and control

```
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)

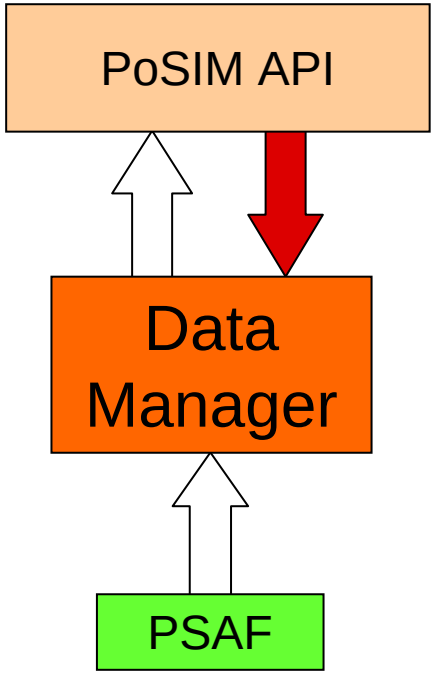
- Policy Controller
  - provides high-level API
  - gathers requested information
  - transforms Java classes in Policy Engine compliant policies
- Policy Engine
  - enforces active policies
  - requests for specific actions
    - implemented as a Jess rule engine



Data Manager (1)

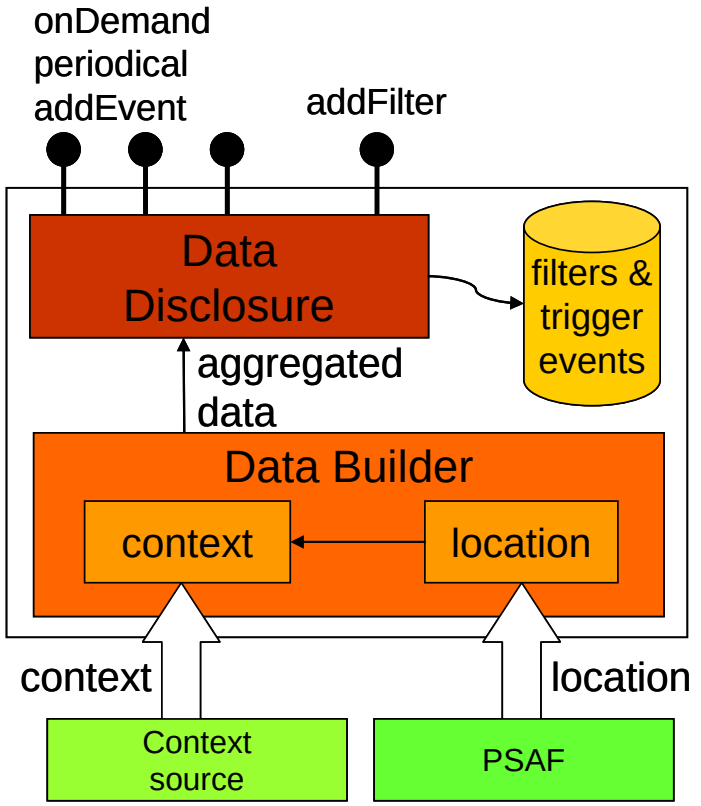
- Transparent information delivery API
  - aggregated data delivery as an XML document
  - XML tags exploited to specify the semantic
  - simple LBSs specify delivery rules

```
<Data>
   <sources>
         <source name=“Ekahau">
            <info name="LocSymb“ value=“Italy, Bologna"/>
            <info name="Accuracy" value=“7"/>
         </source>
         ...
   </sources>
</Data>
```



Data Manager (2)

- 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

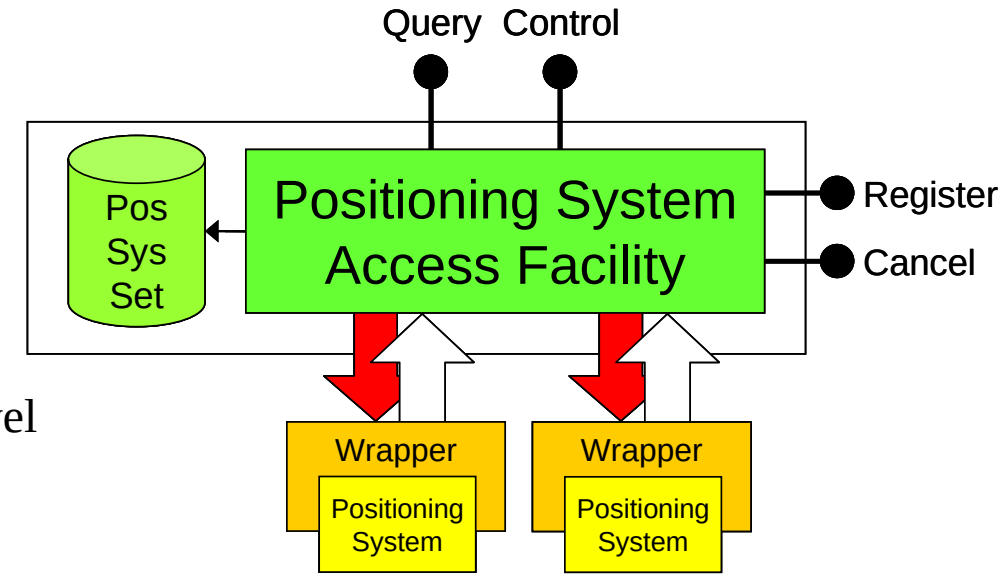


PoSIM extensibility

- 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

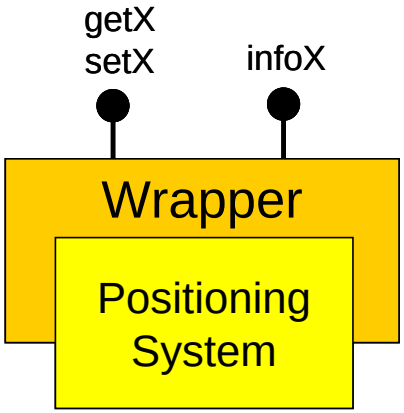
Positioning System Access Facility

- 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



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



Conclusions & Ongoing work

- **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

Any question?

- 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/