Personal Operating Spaces

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Motives

- Nomadic Computing: People moving between new and familiar environments

- Smart spaces of the future: heavily ‘wired’ with lots of virtual services mapped to physical things

- Smart Phones: powerful personal devices (phone = me?)

- Why not allow nomads to interact with and personalise smart space services using smart phones?

Personal Operating Space (POS)

- Based on the concept of wireless, ad-hoc, personal area networks (PANs)

- Allow personal area networks to exploit services offered by a smart space. e.g. extend PAN to services located within the user's current space

Two parts to a POS:

- Discovery and Interaction: Allow a 'user' to effortlessly discover and invoke services in a space

- Personalisation: Personalise environmental services using phone as an identity

Scenario: Media spaces

- Walk into a hotel room and seamlessly form personal area network between phone and room based screen.
- Use phone to discover and invoke services, as tasks, in a space. e.g. ‘Email’, ‘NEWS’, ‘Music’ etc
- During service invocation, space may personalise request using a phone based profile.
  - E.g. A user’s media preferences such as RSS Feeds, Links to internet radio stations, application preferences and authentication credentials

Task based computing: user driven service manipulation

- Task based computing (Wang and Garlan 2002): Represent user 'intent' by abstracting low-level processes into user orientated tasks

- Free 'users' from low level discovery, interaction and configuration activities

- Tasks may be represented using a machine readable abstraction layer such as the OWL-S Process Model:

  - OWL-S provides a way to wrap existing low-level services, such as UPnP, Web or Application processes , and embed additional semantics, e.g. data format used for process personalisation.

  - OWL-S services may be atomic or composed into a workflow using other atomic processes.

Sample Task (NEWS)

Sample task: http://essex.ac.uk/idorm#NEWS

```
<process:AtomicProcess rdf:ID="NEWS">
        <service:describes rdf:resource="#NEWSService"/>

        <process:hasInput rdf:resource="#Personalise"/>
        <process:hasOutput rdf:resource="#Effect"/>
</process:AtomicProcess>

<process:Input rdf:ID=”Personalise">
    <process:parameterType
      rdf:datatype="&xsd;#anyURI">http://purl.org/rss/1.0#Channel</process:parameterType>
        <rdfs:label>Used to personalise a service </rdfs:label>
</process:Input>

<process:Output rdf:ID=”Effect">
    <process:parameterType
      rdf:datatype="&xsd;#anyURI">http:///www.w3.org/2001/XMLSchema#boolean</process:parameterType>
        <rdfs:label>Output results</rdfs:label>
</process:Output>
```

This task is grounded to a concrete application or service, e.g. the actual operations/protocols required to personalise an RSS NEWS Reader

Task based service discovery

- Tasks must be represented appropriately for effective service discovery and invocation by users and their mobile phones

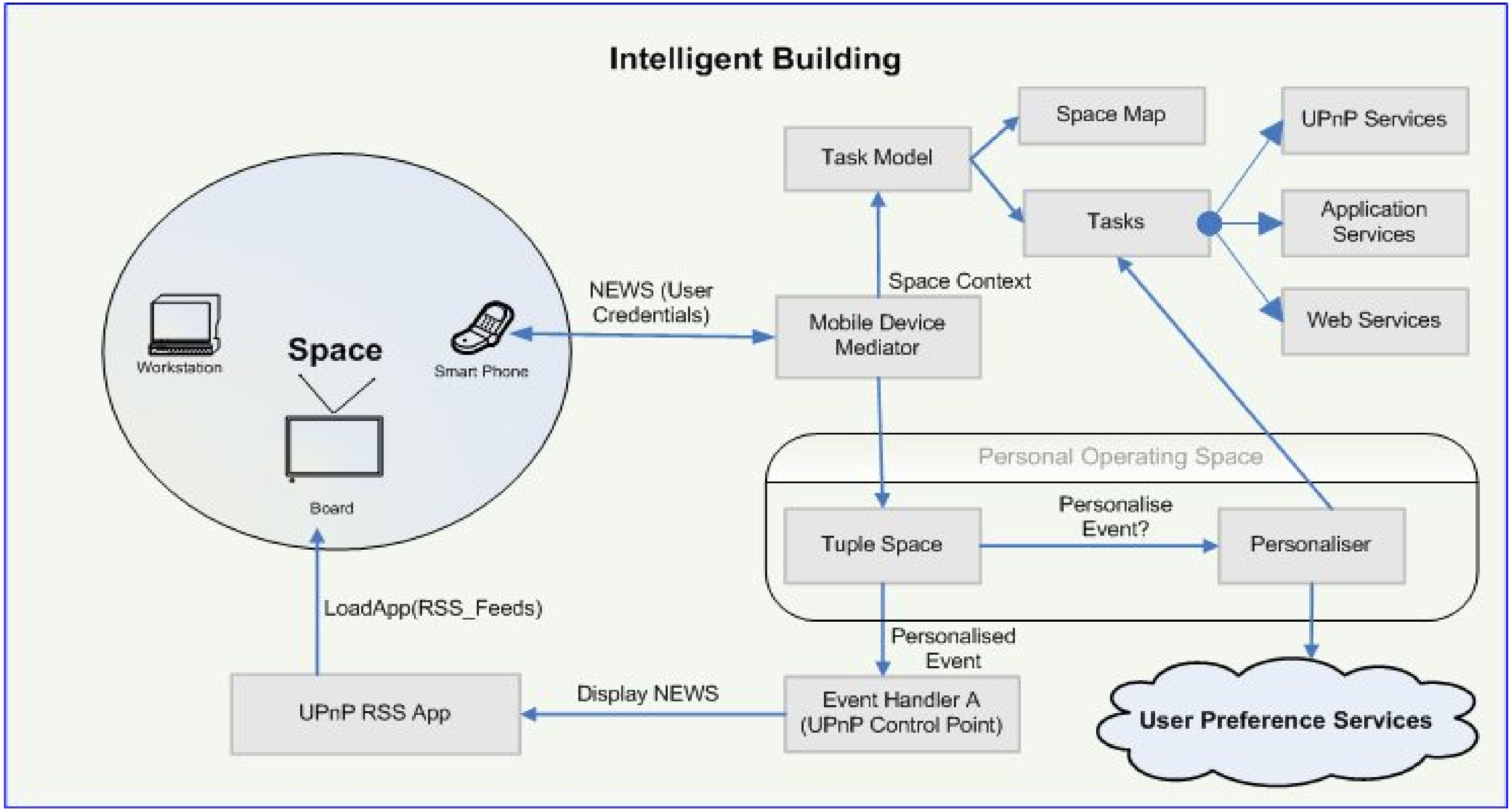
- Task definition schema: organise and present tasks hierarchically to fit phone interfaces:

```
<taskgroup label="IIE Room">
      <taskgroup label = "Control Space">
              <taskgroup label = "Lighting">
                <task label="Switch On" target="http://essex.ac.uk/idorm#LightOn"
                 oncomplete="Let there be light"/> </taskgroup>
      </taskgroup>

     <taskgroup label = "Personal Space">
              <task label="News" target="http://essex.ac.uk/idorm#NEWS"/> </taskgroup>

     <taskgroup label = "NoticeBoard">
          <task label="Add Note" target="http://essex.ac.uk/idorm#ADDNOTE"
              oncomplete="Enter NOTE on Board"/> </taskgroup>
</taskgroup>
```

Task based service discovery

Task definition is translated appropriately for display to a phone. Users can discover and invoke services by browsing relevant menus.

POS Architecture



Mobile device mediator:

- Detect mobile devices and unobtrusively make aware of any services provided by the current space
  - MDMs will typically cover room based regions in a building (as provided by Bluetooth)
- Authenticate mobile devices entering a space
- Discover and extract a user's profile for service personalisation
- Mediate events between mobile device and space services
  - Support both synchronous and asynchronous event passing

Task Model:

- Holds task definition files for presentation to a mobile device
- Space map: holds a list of Mobile device mediators (Bluetooth base stations) corresponding to rooms in a building
- Task model groups task definitions according to space map. E.g. Only allow a user to discover services situated within a space covered by Bluetooth (such as a room)
  - Elaborating upon this to limit the range of service discovery within our UPnP based intelligent building

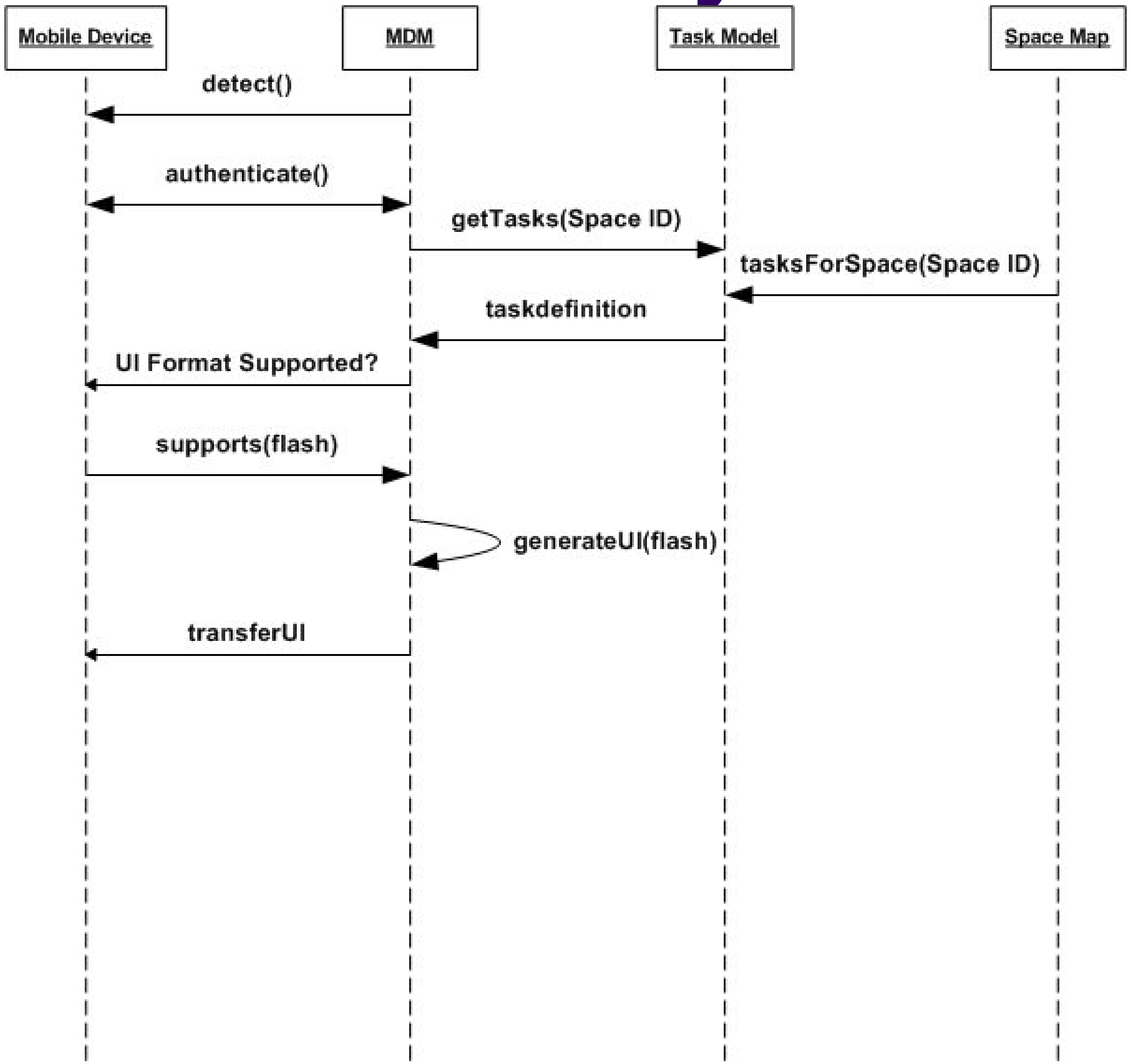
Personalised Tuple Space:

- Mobile device mediator stores events and user preferences (extracted from phone) here
- Based on the tuple space model for loosely coupled, flexible interaction amongst services.
- Determines whether a task request may be personalised by interacting with the task model and examining a task's OWL-S based semantic description
- Passes any relevant service monitoring events back to the mobile device via the mobile device mediator (event notification)

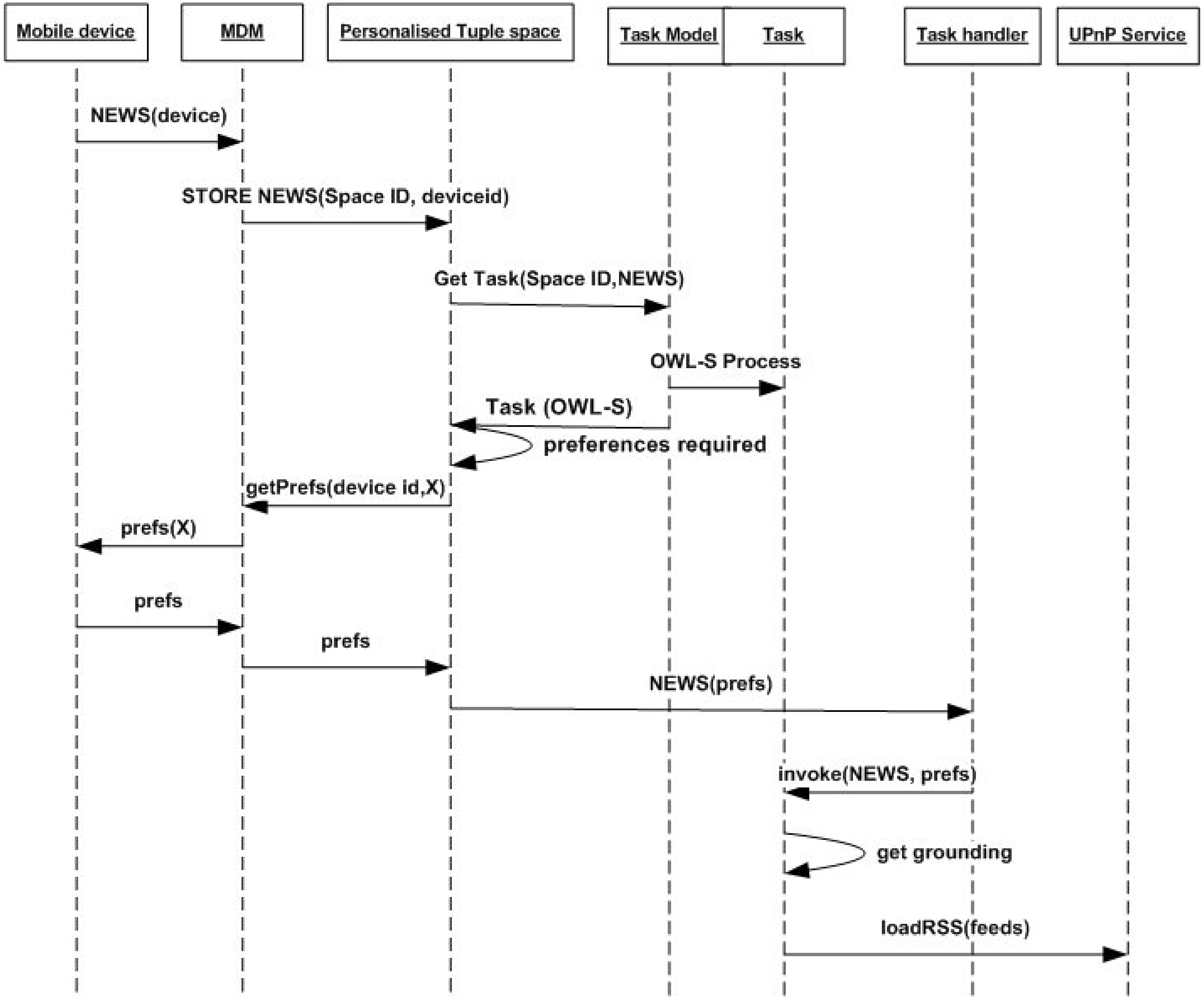
Smart Space Personalisation:

- User preferences held on a mobile device
- Set of preferences required to personalise a task
- Use appropriate algorithm to perform matching between preference and task data types
  - Preferences stored in FOAF Schema (RDF format) on phone: http://purl.org/rss/1.0/ (namespaces define the type of preferences)
  - Tasks are described in terms of the data preferences they support
    - E.g. NEWS Process ‘can be personalised’ by a type of preference adhering to the http://purl.org/rss/1.0/ schema format
- If namespaces point to ontology descriptions then could use the semantic relationships between these descriptions to perform matching

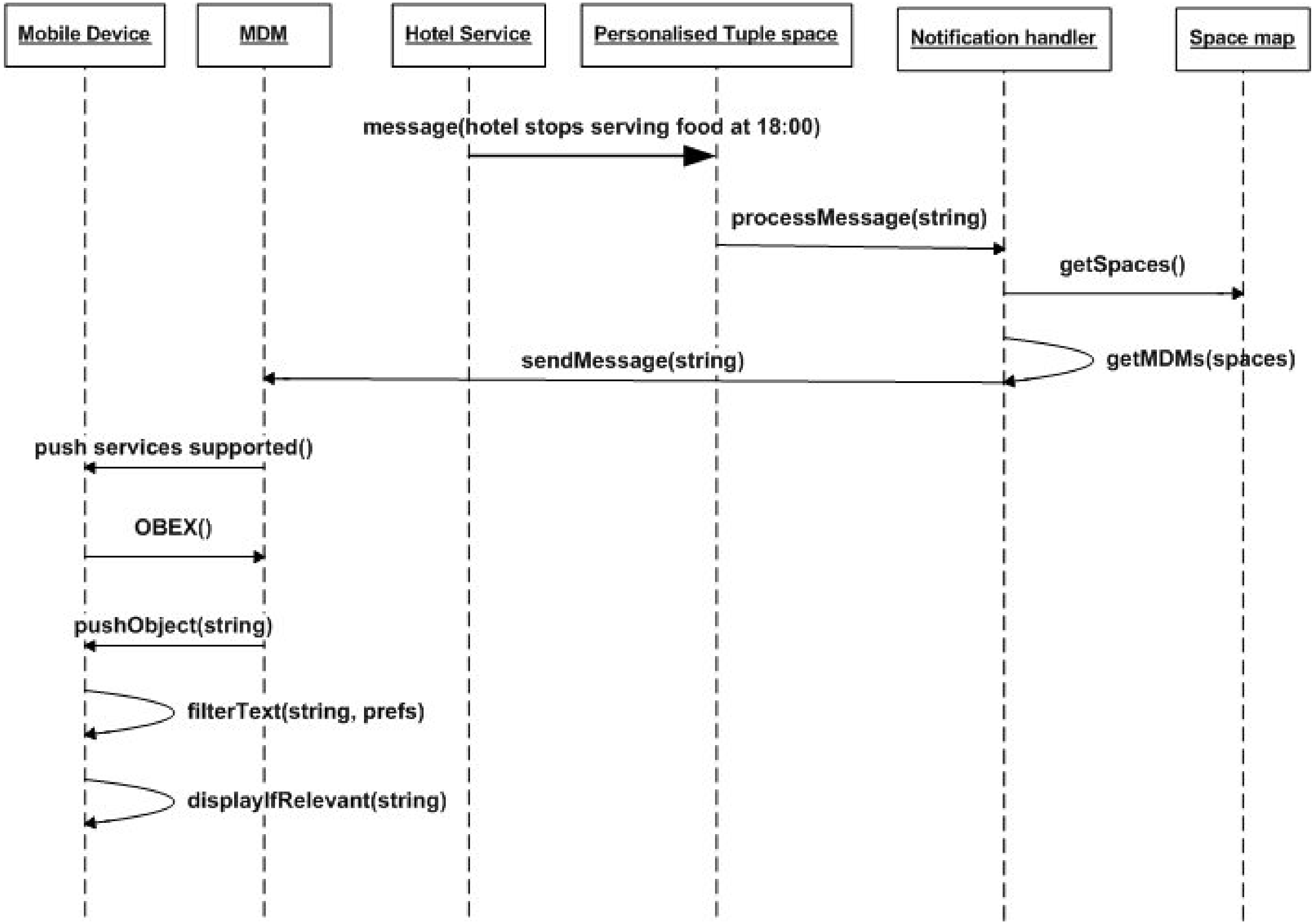
POS Task Discovery



POS Task Interaction



POS Asynchronous Interaction



How is this different from other work?:

- Focus is on phone interaction with space based processes rather than information such as web pages in cool town.

- Supporting phone interaction with building based middleware technologies such as Jini and UPnP. These technologies offer sophisticated service discovery (multi-casting and SDP descriptions) and service monitoring when compared to HTTP (as in cool-town).

- Looking at ways in which nomads can seamlessly discover and invoke these services using a mobile device. This is different from browsing a local UDDI directory. You cannot expect users to do this!

- Concerned with personalising services in different environments by abstracting service descriptions into semantically enriched 'Tasks' and determining whether a set of preferences may be integrated with these Tasks.

  - Semantic web techniques are being utlised to provide a common representation format to describe things (tasks and preferences)

Future work:

- Conduct user experiments:
  - Do users find task driven interaction effective?
    - Is it more seamless and stress free than existing interaction methods?
    - Which user group would benefit from using mobile devices to control a building?
    - How must existing phone interfaces be changed to aid phone to process interaction?
  - What's the user reaction to using mobile devices as a means to personalise computing spaces? Is this better than manual configuration?

Future work:

- Learning user behavior in intelligent environments
  - How can an intelligent environment learn from control decisions made using a phone?
    - Mobile device mediator may log phone events: This gives us very useful data!
    - Labeled actions in terms of tasks http://essex.ac.uk/idorm#LightOn
    - Location information in terms of Bluetooth bound rooms
    - User information in terms of which user performed an action
  - Can we use this data to anticipate user behavior?
  - How does this compare with and extend existing approaches?
    - Current machine learning and fuzzy agent work for achieving ambient intelligence

Discussion: