NATO TG 12 Workshop on 'Middleware in Mobile Networks'

Context-Awareness in Middleware for Mobile Networks

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**Title:** Context-Awareness in Middleware for Mobile Networks

**Abstract:**

Approved for public release, distribution unlimited.
Introduction:
Middleware

What is middleware?

An *enabling layer of software* that resides between the *business application* and the *networked layer of heterogeneous (diverse) platforms* and *protocols*. It decouples the business applications from any dependencies on the plumbing layer, which consists of heterogeneous operating systems, hardware platforms and communication protocols. (Source: International Systems Group)
Introduction:

Mobile Middleware

- **Data-Access Middleware** (JDBC,...)
- **Message-Oriented Middleware** (MQ Series, JMS,...)
- **Transaction Processing Middleware** (X/Open, OTS, JTS...)
- **Desktop-Access Middleware** (Citrix,...)
- **Object Middleware** (DCOM, CORBA,...)

**Mobile Middleware**

- **Enabling Middleware**
  Service and device management (Jini, UPnP) etc.

- **Connectivity Middleware**
  Network gateways etc.

- **Front-End Middleware**
  Content processing for the front-end.

- **Back-End Middleware**
  Processing of back-end data (server data access).
Introduction:
Context and Context-Awareness

What is context?

Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves. (Source: A. K. Dey, Georgia Tech)
Introduction:
Context-Aware Computing

Features:

- **Presentation**
  of personalised and adapted data / information and services to the user
- **Automatic execution**
  of a service for the user
- **Logging**
  of context information to support later retrieval and evaluation
Introduction:

Related Work

- **MosquitoNet**: Mobile Computing Group at Stanford
- **Endeavour**: University of California in Berkeley
- **Oxygen**: MIT
- **Future Computing Environments (FCE)**: Georgia Tech -> *Context Toolkit*
- **Portolano**: University of Washington at Seattle -> *Context aware computing esp. w.r.t. user interfaces*
- **2K**: University of Illinois at Urbana-Champaign (a component-based, network-centric operating system)
- **PIMA**: IBM T.J. Watson Research Center
- **Monads**: Department of Computer Science at the University of Helsinki
**Application domain:**

**Home Networking**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Standard</th>
<th>Speed</th>
<th>Max. Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wired</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HomePNA</td>
<td>HomePNA v2.0</td>
<td>1~2/10 Mbps</td>
<td>150~1.5 km</td>
</tr>
<tr>
<td>USB</td>
<td>USB v1.1</td>
<td>12 Mbps</td>
<td>30 m</td>
</tr>
<tr>
<td>Ethernet</td>
<td>IEEE 802.3</td>
<td>10 M / 1 Gbps</td>
<td>100 m</td>
</tr>
<tr>
<td>IEEE 1394</td>
<td>IEEE 1394</td>
<td>~400 Mbps</td>
<td>72 m</td>
</tr>
<tr>
<td>Power Line</td>
<td>None</td>
<td>1~2 Mbps</td>
<td>100 m</td>
</tr>
<tr>
<td>Wireless</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bluetooth</td>
<td>Bluetooth v1.0</td>
<td>720 Kbps</td>
<td>10 m</td>
</tr>
<tr>
<td>HomeRF</td>
<td>SWAP v1.2</td>
<td>1~2 Mbps</td>
<td>50 m</td>
</tr>
<tr>
<td>IrDA</td>
<td>IrDA v1.3</td>
<td>max. 4 Mbps</td>
<td>1 m</td>
</tr>
<tr>
<td>Wireless LAN</td>
<td>IEEE 802.11</td>
<td>5.5~11 Mbps</td>
<td>50 m</td>
</tr>
</tbody>
</table>
Application example:

Mobile Inhome Entertainment

Extended Home Environment (xHE)

- Server (VDR / DTV)
- DECT
- WLAN / GSM
- PDA
- Web Pad

Application example: Mobile Inhome Entertainment

Extended Home Environment (xHE)
Requirements and Approach:
Middleware for Integration

Networks
- Powerline
- IP
- BT
- 802.11
- DECT
- PC, PDA
- Radio
- SMS

Services
- PKI
- Profiler
- WWW
- TV
- STB

Devices
- 3G, GSM
- Mobile
- WebPad
- TV
- PC, PDA
Architecture:
Components xHE

- **xHE HS**
  Home Server (controls access to xHE-CDs)

- **xHE CD**
  Controllable Device (e.g., TV sets, VCR or other domestic appliances)

- **xHE AD**
  Access Device (e.g., a PDA or a cell phone; addresses and controls specific xHE-CDs)

Network

PDA
Web Pad

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Architecture:
Adaptation & Personalisation

Central service to **adapt UI**
access device (AD) capabilities.

User agent handling user
**contexts and personalization**.
Prototype System:
OSGi-compatible HS

Open Services Gateway initiative:
- **Java** Technology for the web-based access to CDs
- xHE Components/Services -> Bundles
  - **Servlet** Packages in Java
  - Deployment to **central Server** (HS)
- Consideration of other Middleware Models:
  - HAVi, Jini, UPnP,…
- Different Products:
  - JES (Sun), ProSyst, IBM,…
  - OSCAR, JEFFREE, DC Server, Oxygen,…
Prototype System:
Deployment for Mobile Display

- xHE CD
- xHE HS
- Access Service
- VDR Device
- Registry
- Location Service
- Device Lookup
- Register
- UI ML
- http/IP
- xHE AD
- MPEG 2 via IP/UDP
- xHE CD
Prototype System: Deployment Follow-Me Display
Prototype System:
Java Board Tini

- Dallas Semiconductors
- Platform for small/tiny network-enabled applications
  - serial communications, 10Mb Ethernet, Controller Area Network and 1-Wire
  - JAVA programmable
  - TBM390 ca. 50$ + socket board
- -> Platform for HW Gateway
Prototype System:
Streaming & Timeshift Playout

Handling of streamed & recorded content:
- Handling of different client applications:
  Windows Media, JMF, MPlayer, Elecard,...
- Platforms: Linux, Windows 2k
Prototype System:

Additional Options

Additional Services:

- Personalisation of VDR Settings (Channel selections) via **SmartCard**
- **Portability**: HS-based profile (e.g. Playlist) to be used in car / office
- Distributed Media Archive utilising **Peer-2-Peer** technology (JXTA)
- ...
- **Transcoding** for different xHE-ADs using XML
UI Technologies:
Adaptation through Transcoding
UI Technologies: Adaptation through Transcoding

Text blocks

Tables

Images

Audio Clips

Sequential Table
**UI Technologies:**

Targeted UI-Middleware Technologies

- **UIML Service**
- **UIML Renderer**
- **Java UIML Browser**
- **OSGi Home-Server**
- **VoiceXML Service**
- **VoiceXML browser**
- **Speech Synthesis**
- **HelloIC**
- **Voice XML**
Data Management:
Peer-to-Peer Communications

- VDR-Service
- Peer
- Set Recording Date & Time Entry
- P2P Rendezvous Server
- Player-Service
- Play Movie
- Peer
- Peer
- Peer
- Peer