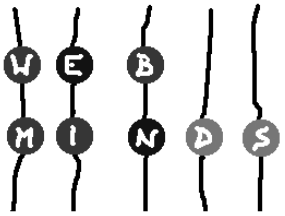
Riunione FIRB WEB-MINDS GL-4/5

Unità di Bologna (Ingegneria)



Middleware per il Supporto di Servizi Context-aware in Sistemi Wired-Wireless:

- **Gestione della Mobilità**
- **Livelli Differenziati di QoS**

Altre informazioni sull'attività di ricerca in corso presso l'Unità all'URL:
http://lia.deis.unibo.it/Research/

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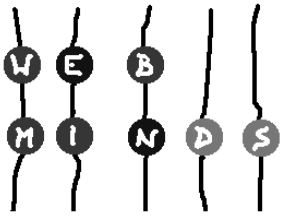

Middleware per il Supporto di Servizi Context-aware in Sistemi Wired-Wireless:

Prima Parte: Gestione della Mobilità

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Service Provisioning to Wireless Devices

Mobility (device miniaturization and wireless connectivity) suggests ***novel service scenarios***

- ***Mobility handling*** (wireless connectivity, access points, tracking, roaming, resource/service discovery, …)
- ***Dynamic service tailoring*** (high heterogeneity in hw/sw capabilities of access terminals, configuration management, …)
- ***Dynamic handling*** of temporary ***disconnection***

context-aware services and develop. ***complexity*** in open syst.

➡ need for ***innovative*** and ***re-engineered*** middleware solutions

Context-aware Middleware for Wireless Internet

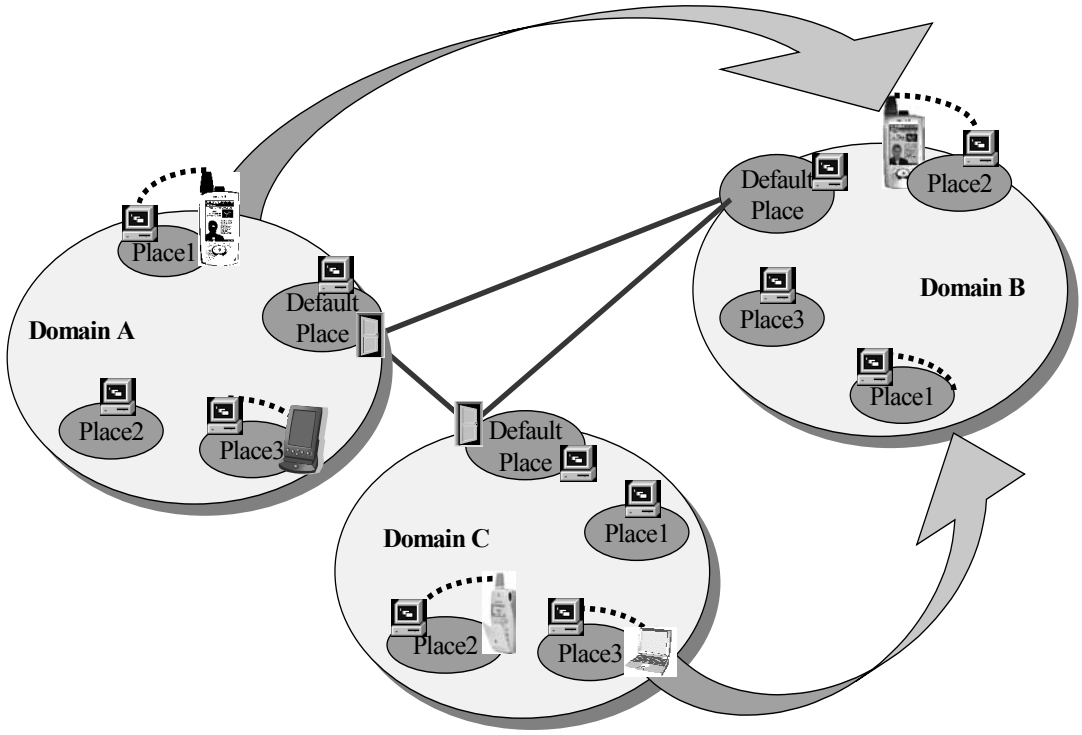
- ***Wireless Internet***: extending the accessibility of the ***fixed Internet*** via ***IEEE 802.11 and Bluetooth service access points*** (SAPs) working as bridges between fixed hosts and ***wireless devices***

Wireless Internet stresses the need for ***Context Awareness***

- ***Context***: the ***logical set of resources*** accessible to a client during a service session depending on *client location*, *access device capabilities*, *management policies* of SAP locality, *subscribed services, user prefs, level of trust* (***context info***)

Developing context-aware services for the wireless Internet is very ***complex***: ➡ ***novel middleware*** solutions (*design methodologies, technologies, …*)

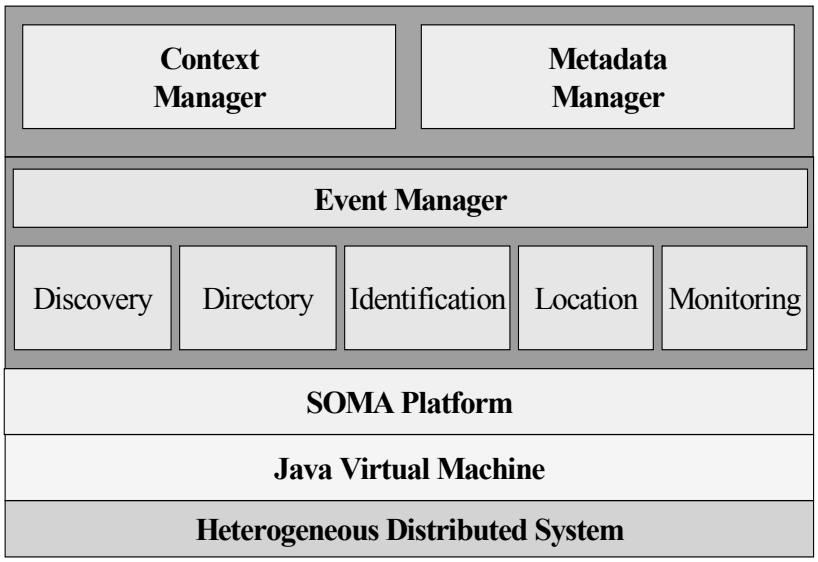
COLOMBA:
a context-aware middleware for the wireless Internet



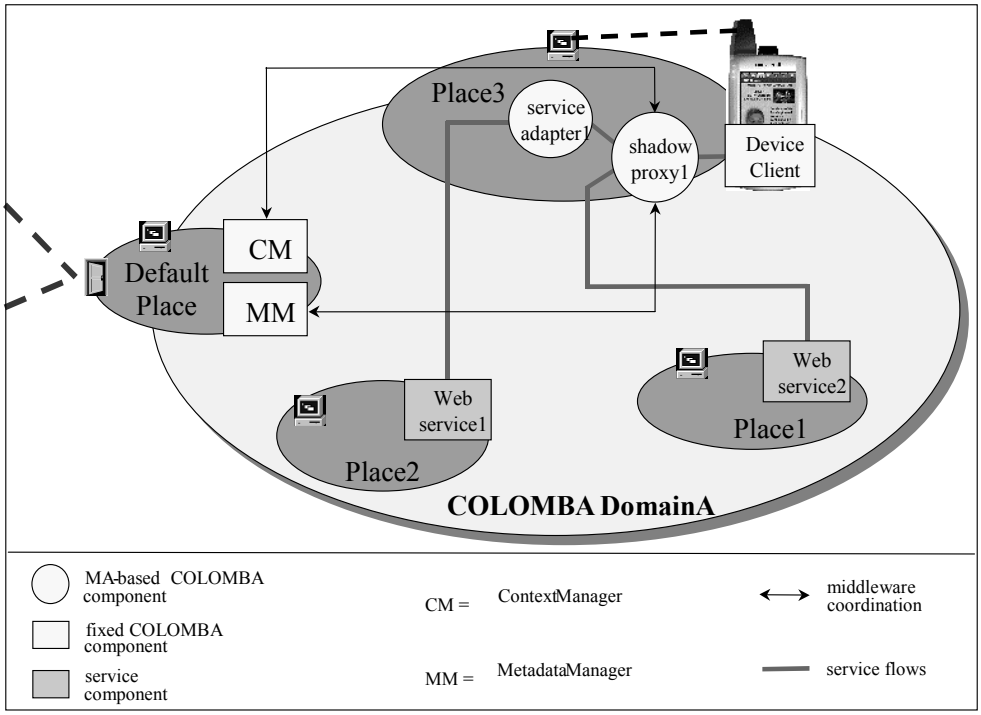
COLOMBA:
a context-aware middleware for the wireless Internet

Main concepts:

- ***Mobile support proxies*** over the fixed Internet
- Dependence on ***context metadata*** (user/terminal/resource profiles, management policies)



COLOMBA:
a context-aware middleware for the wireless Internet



Mobile Support Proxies over the Fixed Internet

Shadow proxies can act ***on behalf of limited portable devices*** by working over the ***fixed*** network, ***locally*** to device points of attachment

- Proxies can ***follow device roaming*** (***mobility*** of middleware components)
- Proxies can ***asynchronously*** work in case of temporary ***device disconnection*** (***autonomy*** of middleware components)
- Proxies can ***support and automate the rebinding*** of mobile clients to needed resources ***after client migration*** (delegated ***binding management***)

COLOMBA implements ***mobile support proxies*** as ***Mobile Agents***

Code Mobility

Several ***recent*** programming ***paradigms*** exploit ***code mobility***:

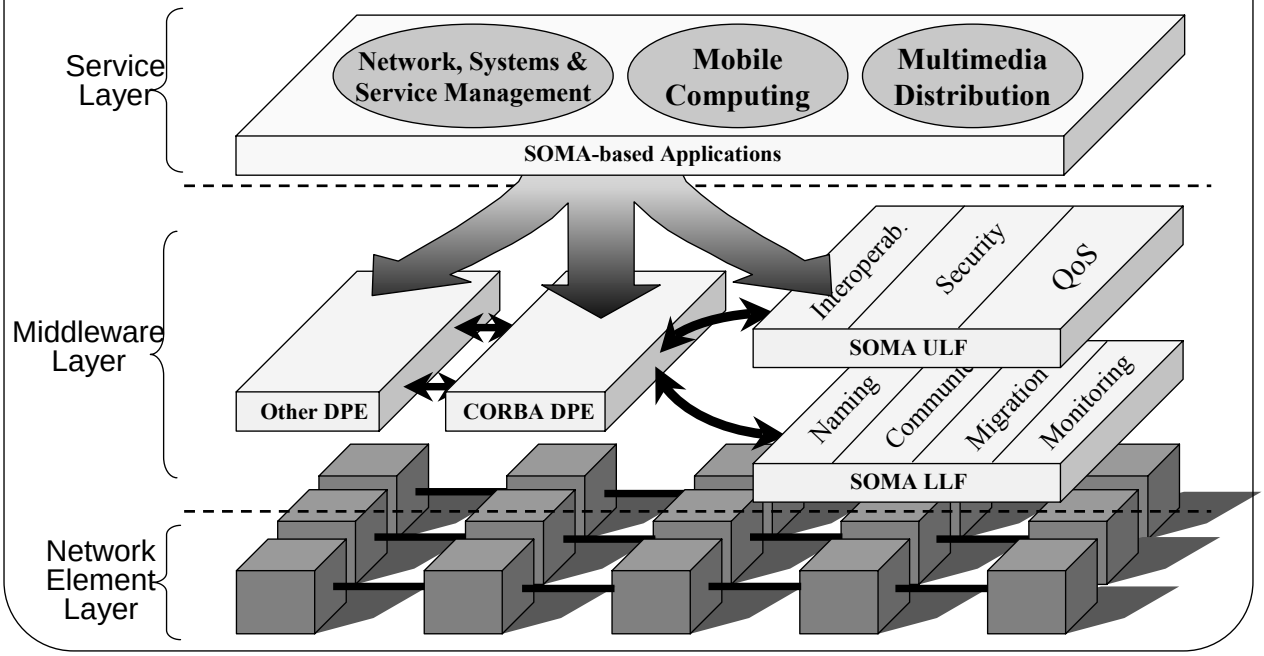
- Remote Evaluation
- Code on Demand
- ***Mobile agents***: entities that execute on behalf of a ***principal***, have ***visibility*** of their ***location*** and can ***autonomously migrate while in execution*** (***code*** together with ***reached execution state***)

Taxonomy of mobile code programming paradigms (Fuggetta et al., IEEE TSE, May 1998)

	Before		*After*	
Paradigm	S_A	S_B	S_A	S_B
Client-server	A	Know-how, resource, B	A	Know-how, resource, B
Remote Evaluation	Know-how, A	Resource, B	A	Know-how, resource, B
Code on Demand	Resource, A	Know-how, B	Resource, know-how, A	B
Mobile Agent	Know-how, A	Resource	-	Know-how, resource, A

COLOMBA is built on top of the SOMA platform

Documents about the SOMA platform and its downloadable code are available at:
`http://lia.deis.unibo.it/Research/SOMA/`



Binding Management in COLOMBA

By focusing on one specific aspect:

Change of client location during provisioning of an information service requires properly handling the ***linking to data resources*** (DRs) at runtime

Usage scenario 1 – ***on-board resources***: MT is a fully equipped laptop, free space on MT disk, disconnected ops, frequent MT/DR requests/replies

Usage scenario 2 – ***moving resources locally to the client***: MT is a PDA with no disk, local ops on DR, possibility of network partitioning

Usage scenario 3 – ***location-dependent information services***: MT has to rebind to new local DRs, sensing dis/connection, DR discovery

Need for ***deciding*** the most suitable ***binding strategy*** only at service ***provision time*** depending on ***current context***

Four Strategies for Resource Binding

Different binding strategies are recognized in the mobile code research area:

- ***Resource movement***
  when MT moves, ***bounded DRs are moved*** along with it
- ***Copy movement***
  when MT moves, ***copies*** of bounded DRs are ***instantiated*** and ***transferred*** along with it
- ***Remote reference***
  when MT moves, resource ***bindings*** are ***updated*** to ***refer*** DRs ***remotely***
- ***Rebinding***
  when MT moves, resource ***bindings*** are ***updated*** to ***equivalent DRs*** in the new MT ***locality*** (multiple choices?)

Context-aware Service Provisioning

Context: the ***set of resources*** accessible to a client during a service session depending on *client location*, *access device capabilities*, *management policies*, *subscribed services, user preferences, level of trust* (***context info***)

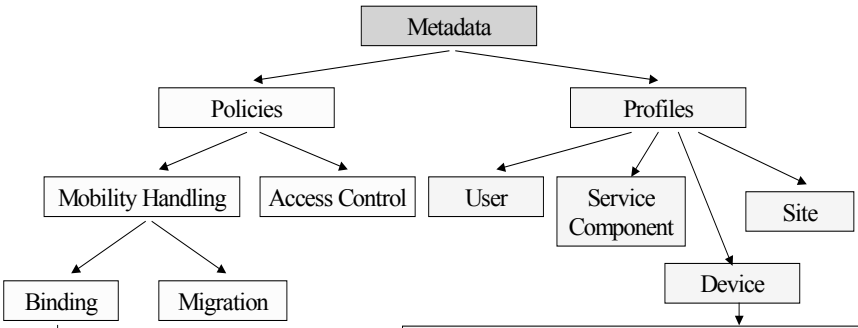
Developing ***context-aware services*** for the wireless Internet is difficult

Metadata to describe resources and management policies

Novel middleware solutions

design methodologies, technologies, …

COLOMBA Metadata Taxonomy




```
inst oblig ResourceMovement {
on DomainArrival(DeviceID,LocalityID);
subject s = DeviceID.getServingProxy();
target t = s.myContext;
do t.setAgentBindingType("resource movement");
when CARMEN.Monitoring.getFreeDiskSpace(DeviceID)
       > threshold;
}
```

```
<?xml version="1.0"?>
<RDF     xmlns=http://www.w3.org/1999/02/22-rdf-syntax-ns#xmlns:rdf=
  http://www.w3.org/1999/02/22-rdf-syntax-ns#xmlns:ccpp=http://www.w3.org/
  2000/07/04-ccpp#xmlns:ccpp-client=2000/07/04-ccpp-client#
 <Description about="ldap://lia.deis.unibo.it/MU/MyProfile">
     <ccpp:component>
     <Description about="ldap://lia.deis.unibo.it/MU/TerminalSoftware">
     <type resource="ldap://lia.deis.unibo.it/Schema#Software-Platform">
     <ccpp-client: name>Palm OS</prf: OS>
     <ccpp-client: version>4.1</prf: OS>
     <ccpp-client: virtual machine>KVM</prf: Java>
     <ccpp-client: configuration>CLDC</prf: Java>
     <ccpp-client: profile>MIDP</prf: Java>
     </ccpp:component>
     </Description>
…
```

Middleware per il Supporto di Servizi Context-aware in Sistemi Wired-Wireless:

Seconda Parte: Livelli Differenziati di QoS

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QoS-enabled Services over the Internet

- ***competition*** among service providers, strong user need for ***service personalization***
- growing ***heterogeneity*** in client devices and operating envs, also changing at service provision-time (*wireless portable devices*, *ubiquitous computing*)

⇒ mechanisms, technologies, tools and methodologies for ***dynamically differentiated QoS levels***

Current research efforts:

- ***specification*** and ***negotiation*** of QoS levels
- ***network-level protocol*** solutions (*acceptance*, *standardization*,…)

What about networks based on the ***best-effort*** model?

Towards Active Infrastructures

Scenario: standard ***best-effort*** IP networks

Approach: ***activation*** of some ***intermediate nodes*** along the path between clients and servers. Active nodes perform ***management operations*** on data flows working at the ***application level***

- ***QoS negotiation***
- flow ***caching***
- resource ***monitoring/control/management***
- service ***tailoring*** and ***adaptation***

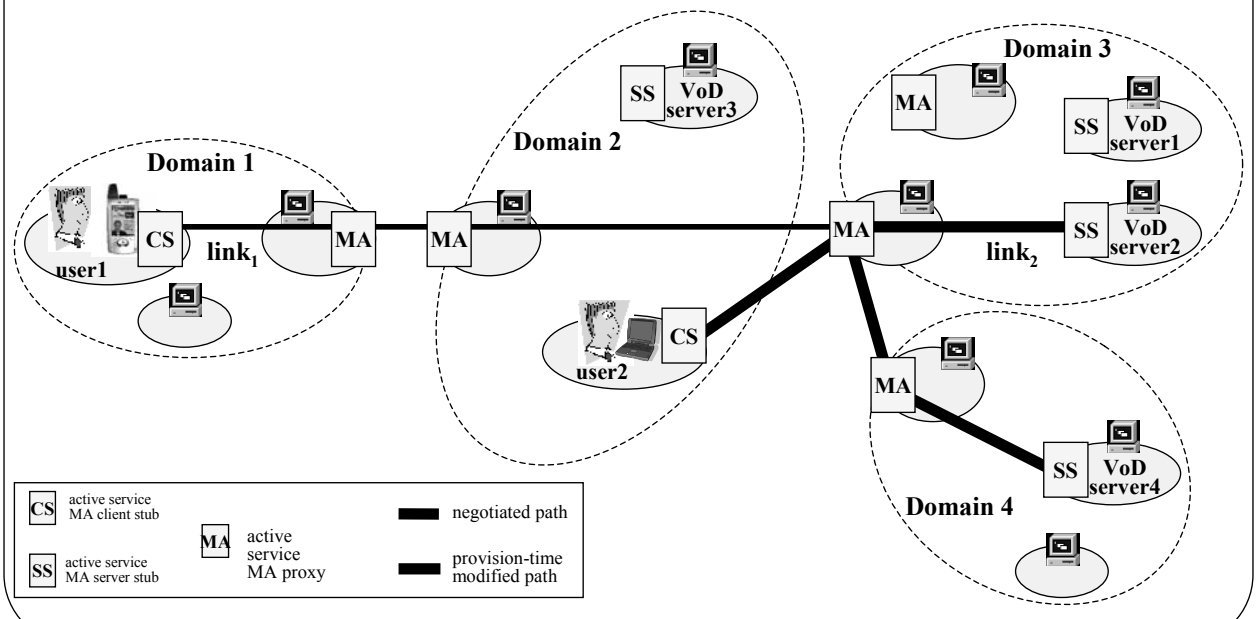
Need for completely decentralized, scalable, extensible solutions

✓ ***Mobile Agents*** as a suitable implementation technology

MA Active Infrastructures for VoD: a Usage Scenario

1) ***QoS tailoring*** at negotiation time

2) ***QoS adaptation*** at provision time



ubiquitous **QoS** Middleware: ubiQoS

- ***Ubiquitous Accessibility***: pervasive reception of VoD flows from ***anywhere***
  tailoring content to *user preferences* and *terminal profiles*
  adapting QoS levels depending on *monitored res. state*
- ***Ubiquitous Middleware***. ubiQoS components are ***pervasively spread*** in the system to support negotiation and provision

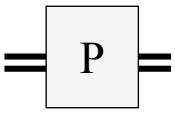
ubiQoS is built on top of ***SOMA***

and extensively exploit ***standard*** mechanisms and ***portable*** technologies:

RTP, SUN JMF, W3C CC/PP, SNMP, JVMPI, ...

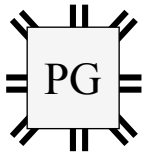
ubiQoS Middleware Components (1)

- ***Proxies***



Infrastructure components
Admission control and ***reservation*** of local res.
Monitoring of system- and application-level state
Triggering of local ***adaptation*** operations
Coordination with previous&next ubiQoS comp. on path

- ***Gateways***



Proxy extensions with inter-domain coord. & naming
Any gateway has visibility of ***neighbor domains*** and ***awareness of stubs/proxies*** within the domain

- ***Processors***

Per-flow components
User/terminal profile retrieval
Tailoring and ***adaptation*** ops on traversing VoD flows

ubiQoS Middleware Components (2)

Client Stubs

CS =

Client request ***forwarding*** to ubiQoS components
Redirect ***RTP*** flows to local visual. tools transparently
(for *JMF* and *Mbone vic* players)

Server Stubs

= SS

Encapsulate VoD flows from legacy servers into RTP ones transparently (for *JMF* data sources)

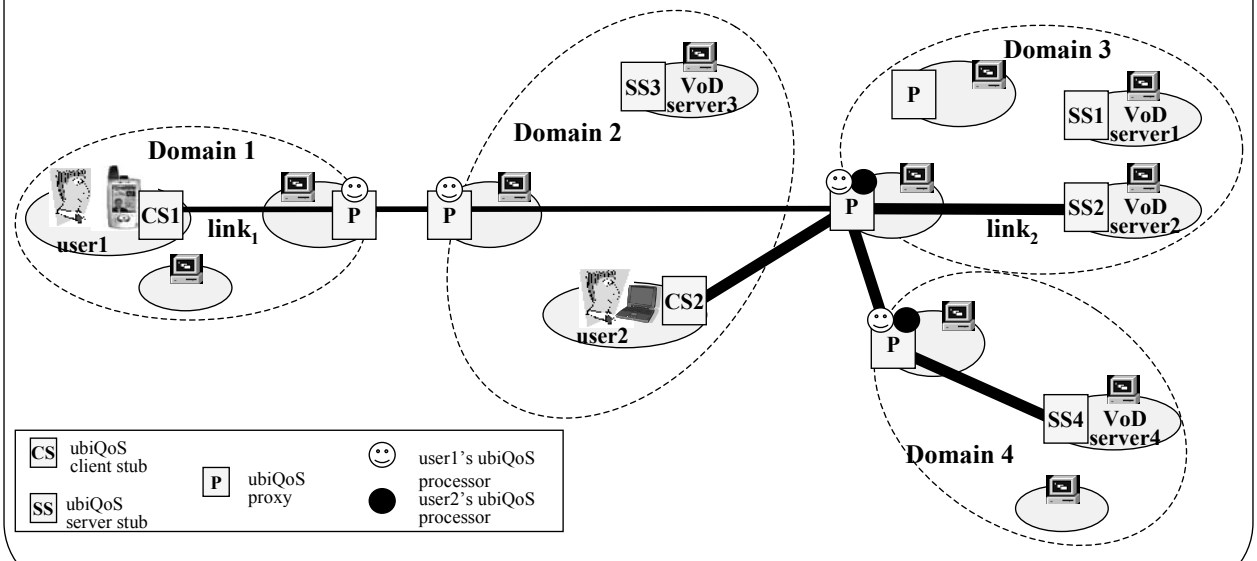
Negotiation time:

processors retrieve ***profiles*** and interrogate proxies/gateways to establish the ***active path***. ***Cloning***&***forwarding***. Initial ***tailoring***

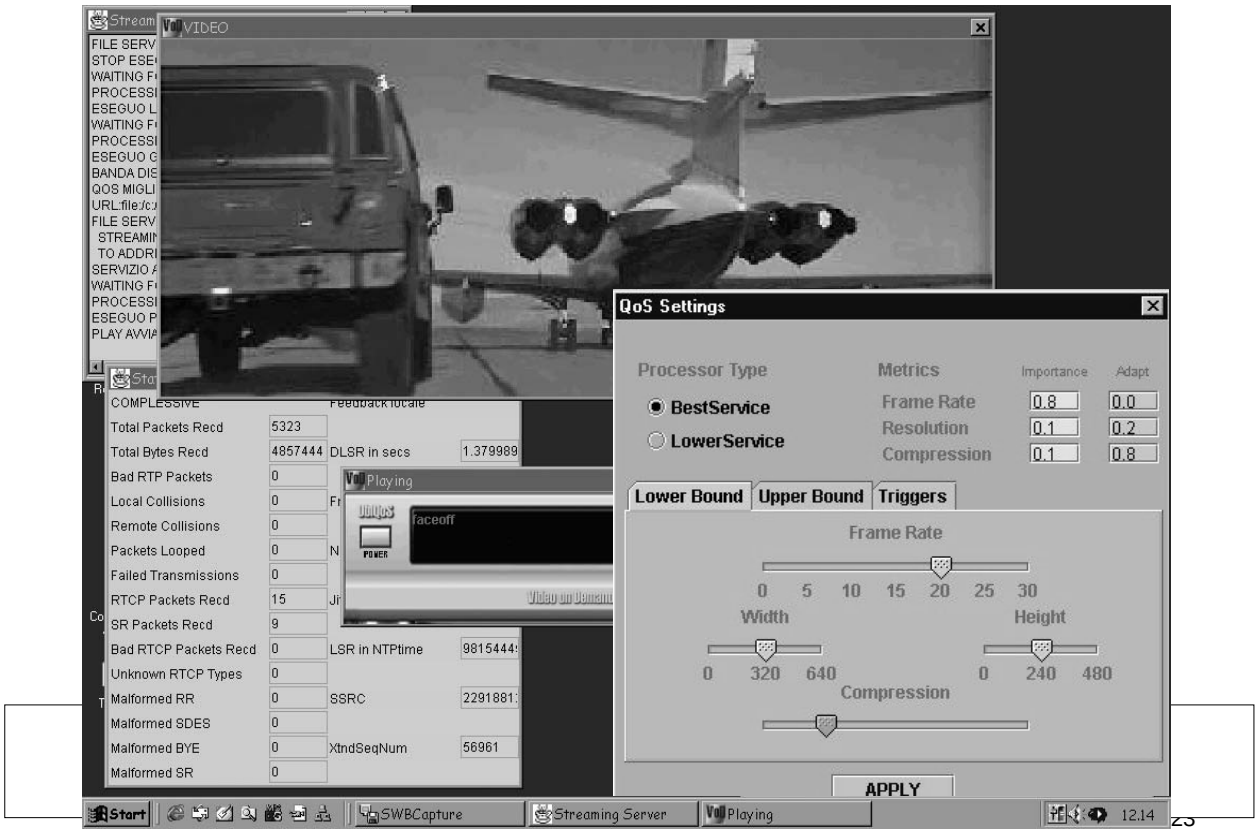
Provision time:

proxies for ***monitoring*** local resources and path segments
processors, triggered by local proxies, perform ***transcoding***

The Deployment of ubiQoS Components



A Flavor for ubiQoS GUIs for Visualization and Control



Wireless Portable Devices:
the ubiQoS-based Movie-Info Service

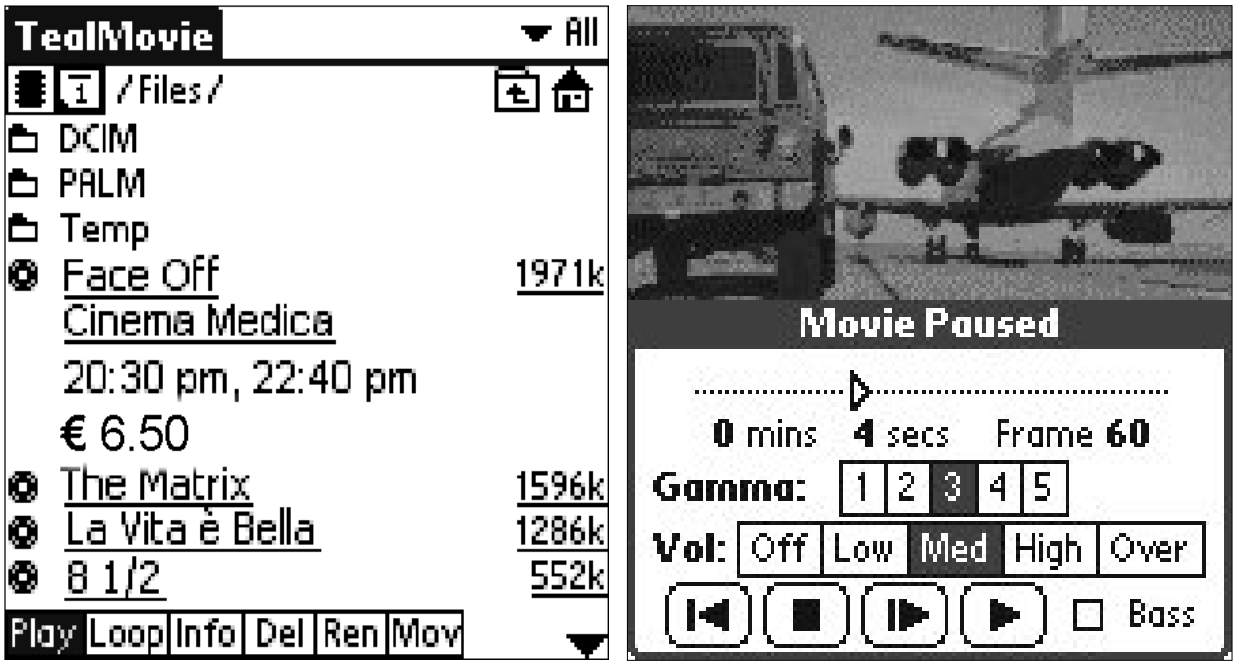
Location-dependent service for retrieving local movie-info

Any ***ubiQoS domain*** models a ***locality (LAN + wireless SAP)***

Support to ***disconnected operations***

- QoS adapters for:
  1. ***Palm PDAs*** with ***KVM/CLDC/MIDP*** and ***TealMovie*** client (convert AVI and WAV files on-the-fly to the proprietary TealPoint format)
  2. discarding ***trailers*** from movie-info results
  3. discarding ***trailers*** and ***fixed images*** from movie-info results
- Completely ***standard HTTP servers*** with movie information

Movie-Info Service: GUI Screenshots



Related Publications

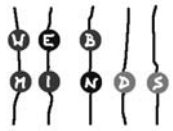
About SOMA middleware for mobile computing and portable devices:

- P. Bellavista, A. Corradi, C. Stefanelli, Mobile Agent Middleware to Support Mobile Computing, ***IEEE Computer***, Vol. 38, No. 5, May'01.
- P. Bellavista, A. Corradi, C. Stefanelli, The Ubiquitous Provisioning of Internet Services to Portable Devices, ***IEEE Pervasive Computing***, Vol. 1, No. 3, Sep.'02.
- P. Bellavista, A. Corradi, R. Montanari, C. Stefanelli, Dynamic Binding in Mobile Applications, ***IEEE Internet Computing***, Vol. 7, No. 2, Mar.'03.

About ubiQoS:

- P. Bellavista, A. Corradi, A Mobile Agent-activated Middleware for Internet Video on Demand, ***IPSJ Journal***, Vol. 43, No. 11, Nov.'02.
- P. Bellavista, A. Corradi, Active Middleware for Internet Video on Demand: the QoS-aware Routing Solution in ubiQoS, ***Elsevier Microprocessors and Microsystems***, Special Issue on "Middleware Solutions for QoS in Distributed Multimedia Services", Vol. 27, No. 2, Mar.'03.

On-going Work



Infrastructure-based Wireless Networks

- ***Mobility Prediction*** in a portable way over IEEE 802.11
- Complete Integration with ***Bluetooth*** BLIP via Java Bluetooth API ***(JSR82)***

Ad-hoc Wireless Networks

- Extension of the infrastructure to include ***spontaneous PAN***, either 802.11-based or Bluetooth-based

Verso SIP?

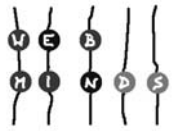
Differentiated Levels of QoS for Multimedia Applications (in the II/III years)

- ***Content-based and QoS-based P2P routing***
- Service ***dynamic composability*** (on-the-fly ***transcoding***)

Metadata-based systems management

- ***Context-aware security***

Collaborations



Possible collaborations to establish within the GL-4/5?

- Profiles
- Policies and Reflection: Comparisons…
- (to exploit and integrate) Comps. for VoD transcoding
- …