Ubiquitous Multimedia over Wireless Networks

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Outline of the talk

- Introduction to Ubiquitous Computing
- Ubiquitous Multimedia (UMM)
- Issues and Challenges in Handling UMM
- Different Approaches in Handling UMM
- Conclusions
Ubiquitous Computing (UC)

- **Ubiquitous - Omnipresent**

- First envisioned by Mark Weiser (Xerox PARC) 1990.

- UC is the method of enhancing computer use by making many computers available throughout the physical environment, but making them effectively invisible to the user - by Mark Weiser.
Salient Features of Ubiquitous Computing

- Invisible computing e.g. computers in light switches, doors, ovens, clothes, etc.
- Devices are mobile/wireless, may reside on a person.
- Sensors support, control and interact with the environment.
- Supports a world of fully connected devices.
- Ensures information is accessible everywhere.
- Provides an intuitive, non-intrusive interface without user intervention and with zero administration.
- Provides context aware services based on the user current situation.
Ubiquitous Network

Create a system that allows user to avail services *anywhere and anytime* by switching among networks and terminals.
Ubiquitous Multimedia (UMM) Salient Features

- UMM service must available without any discontinuity, even when user moves from one place to other, with any networking interface (if not, by adhoc networks).

- It must accommodate any kind of device change, based on user requirements.

- UMM service must meets the QoS requirements even with continuous change of surrounding environment conditions.

- Even it manage the irregular circumstances like hardware failure, connectivity loss, resource fluctuation, etc.
UMM Applications

- Each application allows people to access any multimedia services any time, any where, using different access networks and computing devices.

- Some of the examples:
  - Ubiquitous Learning
  - Ubiquitous Health Care
  - Ubiquitous Tourist/Museums
  - Audio/Video Streaming
  - Remote Video Surveillance
  - On-line Business
  - Smart Home/Office Environments
An Ubiquitous Tourists-Guide Scenario

Public UMTS
- Virtual tour of the spot, what all the exhibits to view (Video)
- User migrates from UMTS to Wi-Fi
- Parking and entry gate info (Image + Text)

Wireless LAN
- Preferred Exhibit Info on PDA (Video + Text)

User's car passing near to tourists spot
- Car Moving towards tourists spot

Tourists spot
- Nearby tourists spot and path to reach. (Image + Text)
Mobile Multimedia

-- Service continuity is not possible across heterogeneous network.

-- Service provision without context.

-- Most of the applications are reactive, based on user requests.

Ubiquitous Multimedia

-- Seamless service provision across heterogeneous networks -inbuilt context adaptation.

-- Services provision adaptive to user current situations

-- Applications are proactive, without user intervention.
Generic Idea of Ubiquitous Multimedia Service

Multimedia Service

Service Contents

User Preference

Context

Information

Adapted Service

User
Some of the issues and challenges in handling UMM

- Adaptation of multimedia contents according to user preference, device and network characteristics, etc.
  - Context Awareness
- Seamless connectivity across heterogeneous networks.
  - Host Mobility
- Application adaptation, with the switching of user devices.
  - Session Mobility
- Dynamic service composition based on user's requirements.
  - Personalization of service
- Efficient routing of multimedia traffic with network and device constraints in ubiquitous networking environment.
  - QoS and Resource management
Different Approaches in handling UMM

- **UMM Service Delivery Framework**

- **Personalized Service Composition for UMM Delivery**

- **Ubiquitous Multimedia Communication**
UMM Service Delivery Framework

Adaptation Engine

MPEG Video

Context Profile

Physical Environment
Network Conditions
Device Capabilities
User Preferences

Streaming Server

User Devices

Laptop
PDA
Smart Phone

Archive

Multimedia Contents
Customized Content
Varying capabilities of portable devices leads many restrictions in viewing multimedia contents.

It arises the need for adjusting quality of multimedia data while delivering based on the resources available.
Adaptation based on device capabilities & user preference

Original content

Video Information:
- Frame size: 1920 x 1080 pixels
- Frame rate: 30 fps

Audio Information:
- Sample rate: 96000 Hz
- Bit rate: 16 bits

Adapted content

Video size: QCIF(320x180)
- Sample rate: 5 kHz
- Frame rate: 15 fps

Video size: QCIF(176x144)
- Sample rate: 24 kHz
- Frame rate: 15 fps

Video size: QCIF(840x588)
Adaptation based on network conditions (mainly bandwidth)

- **WIFi- I**
  - Available BW: 512 kbps
  - Access: Video

- **WIFi- 2**
  - Available BW: 756 kbps
  - Access: Video+Text

- **UMTS**
  - Available BW: 160 kbps
  - Access: Audio+Text

User Migration from one network to other

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Shravanabelagola which is also known as 'the white pond of the Shrawana' or 'the Jain monk' is named with reference to the colossal Jain image of the place and its prefix 'Shrawana' that also serves to distinguish it from other Belgolas with the prefix Hal and Kola.

The derivation of the word 'Belgola' appears to have been from the two Kannada words Bel (middle) and Kola (pond) in allusion to the beautiful pond in the middle of the town.
Personalized Service Composition for UMM Delivery

- Novel approach required to support adaptive services for multimedia delivery in heterogeneous wireless networks.

- The service adaptation and composition mechanism exploits the (PICO- Pervasive Information Community Organization) middleware tools.

- Ability to adapt the changes in a user’s environment.

- Ability to provide transparent access to multimedia data.

- Ability to support QoS guarantees.

- Aimed at providing a runtime platform for ubiquitous computing.
PICO Middleware

➢ Has mainly three abstract entities-

➢ The hardware resources involved in building a system are abstracted as *camileuns*.

➢ The software service elements, *delegents*, represent a specific functionality of the hardware, or are designed to provide a specific feature.

➢ Conglomeration of *delegents* working together is called a community.
Feature identification and abstraction

- Device abstractions represented as a camileun, $C = \langle H, F \rangle$
  
  H- set of hardware characteristics of the device

  F- set of features that are further made available as services.

- Software elements implement the individual services are abstracted as delegents $D = \langle M, R, S \rangle$

  M- set of modules

  R- set of rules to operate on the modules

  S- set of delegable services.

- The delegents are modelled as rule based state machines, with rules specified in ECA style.
A telemedicine scenario with PICO (colour combinations depict different program modules).
Ubiquitous Multimedia Communication Management

- Seamlessly utilizing of networks and terminals available everywhere

- Ubiquitous multimedia communication system consists of two main components.
  - **Ubiquitous Network Access Management** - deals with host mobility and bandwidth management in order to allow multimedia services to better handle network connectivity.
  - **Ubiquitous Session Management** - deals with session mobility, service discovery, and service configuration in order to allow the users to switch between different terminals.
Application layer mobility support - Resilient Mobile Socket (RMS)

- Designed to support UDP-based MM application.

- Able to hand over media streams to any available network.

- By encapsulating multiple sockets into a new socket abstraction (RMS) any encapsulated socket (internal socket) can fail or be replaced without disturbing the application.
Competition-based Soft-handover Management

- To decide when to perform a handover as well as how to select a new network, use network redundancy to achieve seamless handovers.
- Transmit redundant packet streams over several networks and measure the end-to-end delay for each connection.
- All connections except the best one are then dropped after a sample period has been completed.
Market-based Bandwidth Management

- Shares available bandwidth efficiently between different media components inside an application.

- The NA contributes to the market by obtaining the actual supply of bandwidth that will be sold by the BBA.

- BBA puts the current supply of available bandwidth “on the market” at a particular price.

- BCA use utility functions for each media to calculate the demand.
Ubiquitous Communication Management Framework

- Assist developers building ubiquitous multimedia communication systems
The framework consists of four components:

- **Information Repositories** - It forms a distributed database containing information about the system and the users, collected by several sensors.

- **Personal Communication Management Agent** - It makes configuration decisions, with the purpose of finding and selecting media resources for satisfying the user needs.

- Can be achieved by traversing information in the information repositories and observing when the state of the system changes, for example when a user moves to another location.

- **Remote Control User Interface** - It is a protocol that enables customizing user interfaces for specific devices and

- **Mobility Manager which switches between resources.**

- These components combined makes a dynamic wearable computer possible, which can be tailored to current communication tasks.
Conclusions

- UMM services are constructed on the convergence of various networks (wired or wireless networks, broadcasting or multicasting networks, etc.) and devices (Laptops, PDA, Cell Phone, TV, etc.).

- Ubiquitous Multimedia Service Management needs:
  
  ➢ To deal with heterogeneous client capabilities
  ➢ Dynamic end-to-end resources availability
  ➢ To ensure satisfactory service quality for each client
  ➢ Additionally, privacy, security and ethical issues
THANK YOU