Quality of service issues for world-wide mobile telephony

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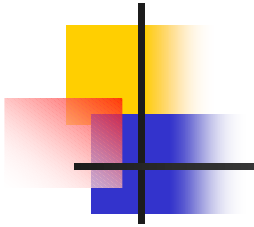
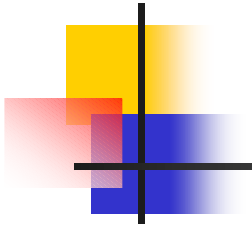


Abstract

The next-generation communication infrastructures will use digital multimedia technologies and evolve largely over IP-based networks. For instance, IP-telephony will involve not only voice communication, but also live video and possibly shared spaces for collaboration. However, the facilities and parameters used in a particular instance of communication will depend largely on the preferences of the users involved and the hardware/software limitations of their terminal devices. We envision an automatic negotiation process that selects the most appropriate communication parameters, which will depend on the device profiles and the users' preferences (user profiles). A so-called user home directory could be used to store the user's quality of service and call processing preferences in a known location. Such a home directory is key to user mobility, which means that the user, possibly at some remote location, may use any device which is locally available (including mobile terminals). We will explain how the functions of the home directory can be used for (a) the automatic selection of call quality parameters for multimedia conferencing between mobile users, (b) for the authentication and accounting of mobile users and (c) for providing presence information, as in certain chat facilities. We will also discuss how the quality negotiation can be adapted to situations where a very large number of users participate in a video broadcast, and how hand-held and/or wearable devices can be integrated into this distributed application architecture, possibly leading to the distribution of some of the user profile information.



Overview

- Motivating application scenarios: Mobility and QoS negotiation; the issues
- The user's *home directory (HD)*
- Role of the HD for session establishment, QoS management and security functions
- Mobile telephones and ubiquitous computing environments
- Conclusions

What is mobility ?

- Device mobility: mobile, wireless connection to the Network
  - Cellular phone system
  - Wireless Ethernet
  - Personal / desk-area network, e.g. Bluetooth
- User mobility: user may use any device anywhere
- Session mobility: an active session may be transferred to a different device

Futuristic application scenario

Alice calls her grandmother

- She uses her PDA-phone *(device mobility)* , sets video transmission on (which is off by default)
- Grandma: "Why don't you use a better video quality" ?
- Alice goes to her father's home office and uses his computer to continue the session *(session mobility)*
- When Alice tells an interesting experience, Grandma polls Grandpa's PDA (he is working in the garden); Grandpa joins the teleconference using his PDA
  - His PDA requires lower voice and video resolution *(QoS negotiation);* Alice and Grandma continue at high quality

- User mobility: the same scenario when ...
  - Alice is visiting a former classmate in another country
  - Grandma is on a tourist trip in Paris

"integrated" telephony

- Future of mobile telephony will be "integrated":
  - Communication applications: two-way telephony, teleconferencing, collaborative work (with shared spaces: documents, virtual environments, etc.)
  - Computer applications: Web, music – video on demand, e-commerce, and other applications
  - Using various networks: telephone, Internet, public and private

Issues:
user mobility & QoS negotiation

- User profile (stored in the user's *home directory*)
  - Public information (like on business card)
  - Policies for handling outgoing / incoming calls
  - QoS preferences
  - Subscribed services, cost limits, etc.
- Locating users, services, devices
  - A user may be reachable through various devices
  - Two aspects: Device address - Physical location
  - Authentication – permissions - accounting
- QoS: voice and video quality
  - Device limitations: CPU, memory, screen, microphone, etc.
  - Network limitations: network access, differentiated serv.
  - User preferences / cost trade-offs

Home directory: example (1)

User Identification Information and access rights

Basic Information:

User Name: Alice **Date of Birth:** January 10, 1970

User ID: Alice87349456@homedomain **Employer:** University of Ottawa

Address: 161 Louis Pasteur St., Ottawa, Ontario, K1N 6N5 Canada

Groups or organization: Distributed System, SITE, ACM, IEEE

Authentication:

Password: Ilovethisgame

Pubic Key: vafrughgkegnvnrugeogtghtnkgshgkgafghelgekgdvkvierufafvn

Private Key: mxawdjeffyregfhnybnvruifsarmvlswpifshsnvsytkckawodncsrg

Authorization:

Content: IEEE OPeRA(Online Periodicals and Research Area) -- http://www.opera.ieee.org/

Video on Demand – http://www.videoondemand.org

Application: FTP service ftp://ftp.site.uottawa.ca/, ICQ phone http://www.icq.com/icqphone/

Accounting Policy:

Pay method: Credit Card / month **Price Ceiling:** 0.2$/min

Home directory: example (2)

QoS Preference Policies

Audio Preference:

Min Acceptable: Telephone Quality **Ideal:** CD Quality

Video Preference:

Min Acceptable FrameRate: 10 **Ideal FrameRate:** 30

Minimum Acceptable Resolution: 320x240 **Ideal Resolution:** 800x600

Sensitivity Parameter 6

Weight factors by application:

Internet Telephony

AudioWeightFactor: 7 **VideoWeightFactor:** 3

Video on Demand

AudioWeightFactor: 3 **VideoWeightFactor:** 7

default:

AudioWeightFactor: 5 **VideoWeightFactor:** 5

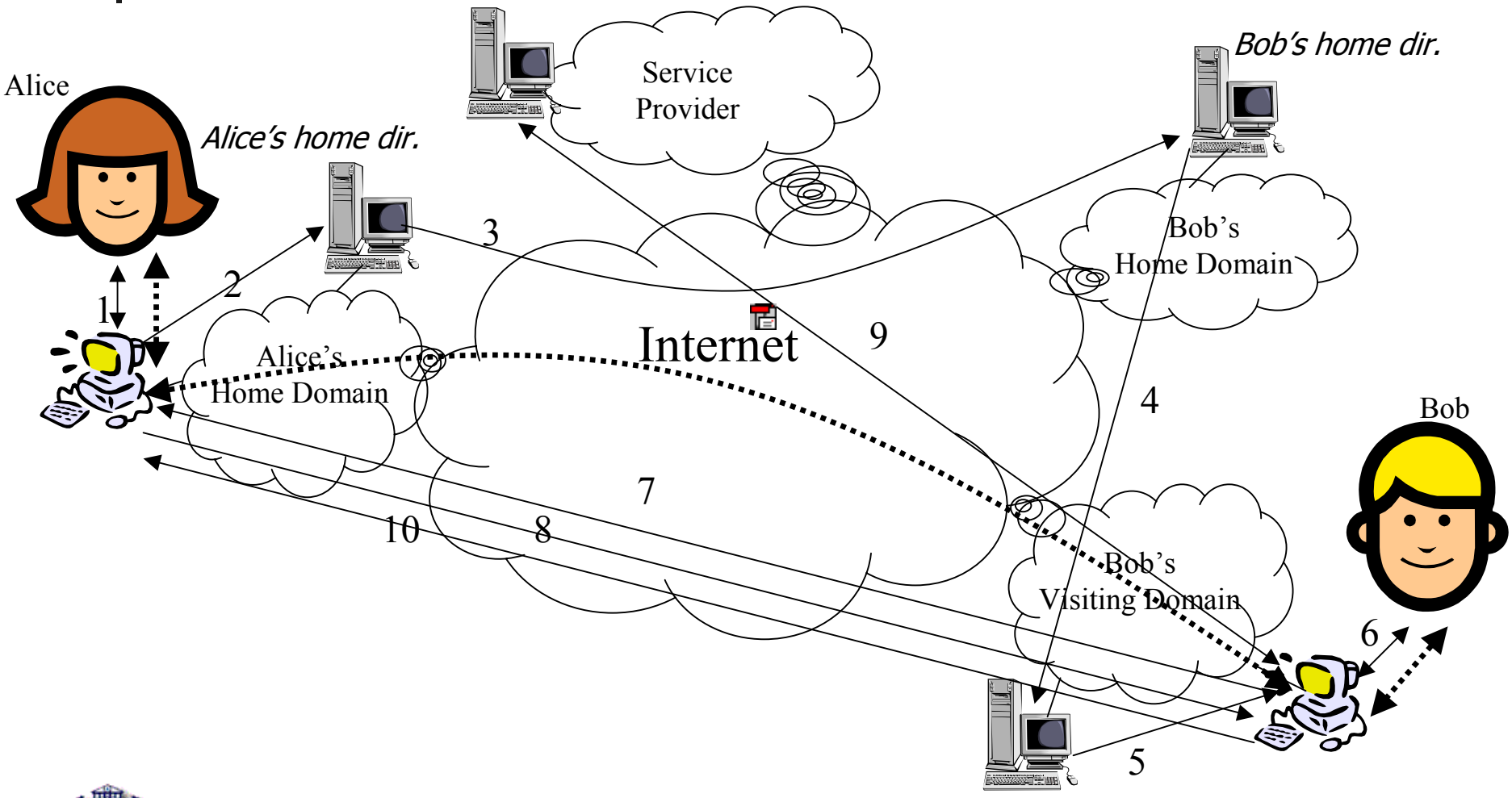
Price Ceiling: 0.2$/min

Home directory: example (3)

- Current User Access Possibilities
  (updated every time the user logs into the network)
- User Contact and Location Information (updated by the user)

Homepage: http://www.site.uottawa.ca/school/research/DSRLab/Alice
Email: Alice@site.uottawa.ca
Telephone in Office: 1-613-5625800 **Fax in Office:** 1-613-5625801
Available time: 9:00~13:00 / Mon.~ Fri.
Telephone in Lab: 1-613-5625800 **Fax in Office Lab:** 1-613-5625801
Available time: 13:00~18:00 / Mon.~ Fri.
Telephone at Home: 613-6868686 **Fax at Home:** 613-6868686
Available time: 18:00~9:00 / Mon.~ Fri., weekend and holiday
Pager: 9876543
Cellular Phone: 7654321
Voice Mail: Alice4587
Calendar: http://www.myevents.com/Alice

Example: Alice calls Bob

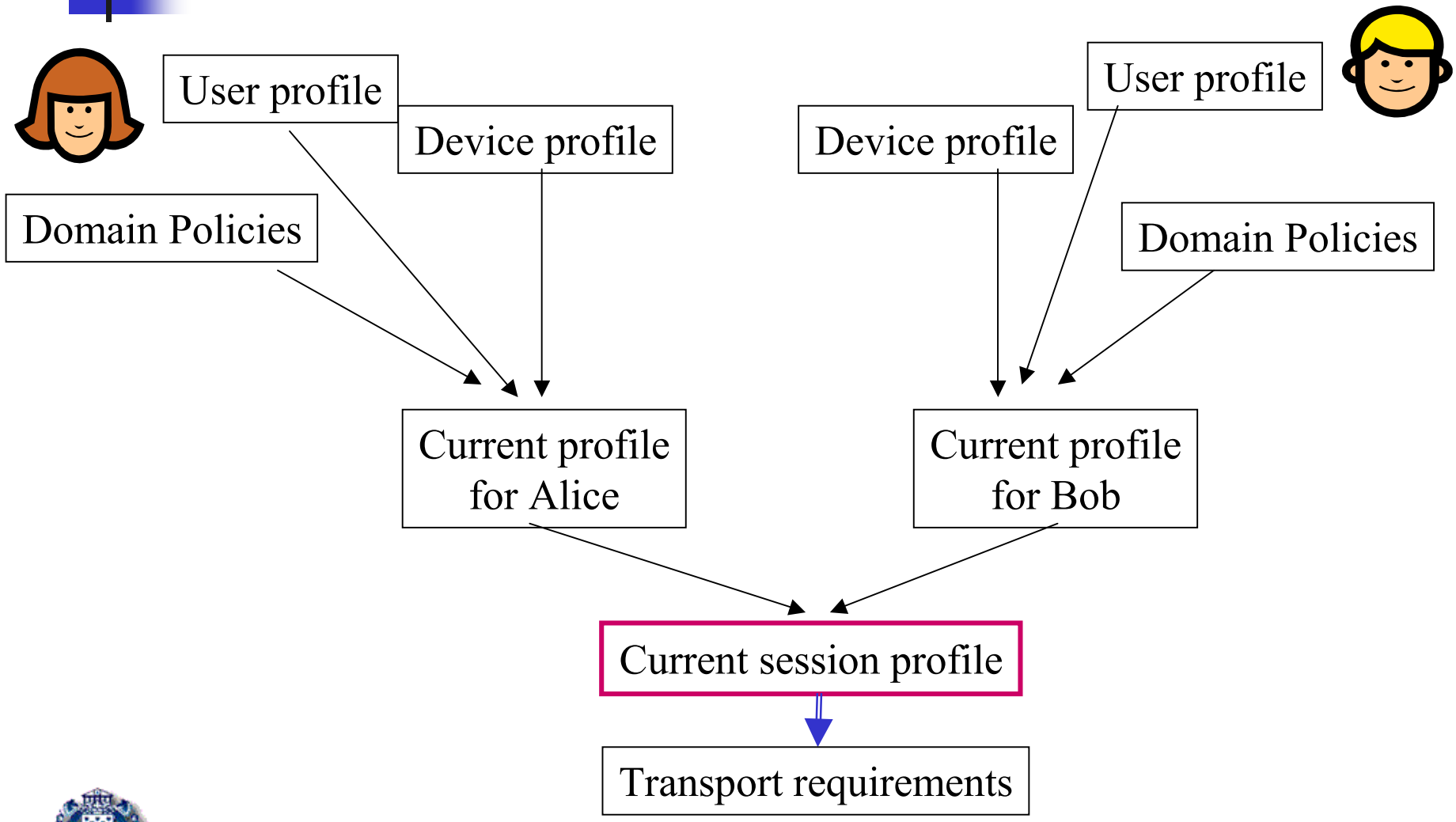


QoS management

We are mainly concerned with performance properties that influence the quality of multimedia presentations:

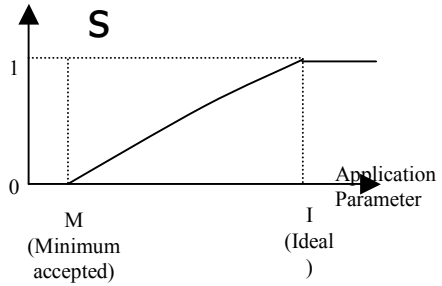
- **End-user preferences and requirements:** sound quality, video quality, colour rendering, and also ***cost***
- **Terminal constraints:** limitations due to screen size and precision, audio equipment, operating system's real-time response, available decoding software, etc.
- **Server constraints :** number of users, overall throughput limitations, access delay and jitter
- **Viewed document constraints:** encoded information structure, possibly scalable encodings (or several versions)
- **Network constraints:** available throughput, delay, jitter (mainly access liminations)

Merging user and device profiles



Automatic QoS selection

- Optimize user satisfaction "s"
- For each parameter (e.g. resolution, frame rate)
  - Minimum acceptable and ideal values
  - Interpolation function
  - Weight



- Combined satisfaction

$$S_{tot}^{user} = f_{comb}(s_1, s_2, s_3 \ldots, s_n, w_1, w_2, w_3 \ldots, w_n) = \frac{n\overline{w}}{\sum_{i=1}^{n} \frac{w_i}{s_i}}$$

  - e.g. resolution, frame rate, voice quality
  - Consider also cost *(requires trade-off)*
- Group satisfaction (weighted combination)
  - different weights for different users ?

QoS selection for broadcasting appl. (e.g. teleteaching)

- Assumptions
  - Sender cannot know all receivers
  - Different receivers have different QoS preferences / device constraints
- Sender provides several QoS variants
  - e.g. scalable video encoding; CD & telephone voice
  - Receiver selects best variant based on local profile
  - Problem: How does the sender select a set of QoS variants which maximize the overall user satisfaction ?
- Ongoing work: experiments + simulations

Security

- Requirements
  - User authentication
  - Privacy (including possibly anonymity)
  - Accountability
    - Identification of users
    - No repudiation of provided service
- Levels of security
  - No special precautions
    - e.g. authentication based on human voice recognition
  - With security protocols
    - Available for different security levels

Security mechanisms

- User authentication
  - Secret password, or public key technology
- Privacy
  - Authenticated users select private key and encryption algorithm for communication
- Accountability
  - Identification of users: *see user authentication*
  - No repudiation of provided service
    - Signed service request messages *(public key technology)*

Secure authentication of mobile users

- *A completed project at UofOttawa*
- Assumptions
  - No smart card with fixed public/private key
    - A card seems to be the only way to carry a private key securely
    - User authentication based on password only known by home directory
    - Need for a mechanism for peer to peer authentication
  - Trust in home directory for authentication
  - No trust in home directory and foreign domain concerning privacy

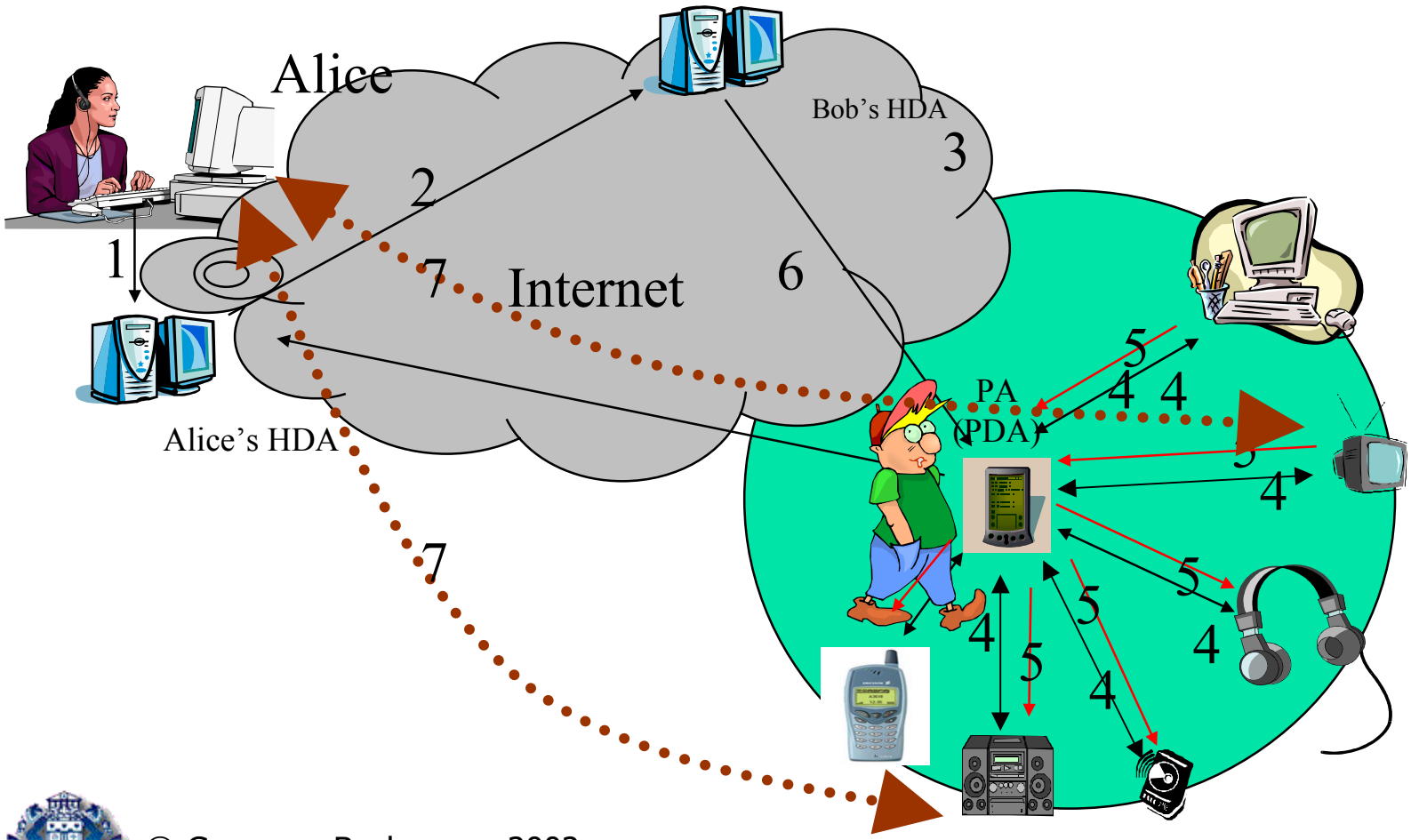
Mobile telephones and QoS

- QoS problems with wireless networks
  - Low bandwidth (depending on technology)
  - Relatively high error rate
  - Varying transmission quality (fading, hand-off)
- Solution approaches:
  - New protocols, e.g. WAP
    - Difficulty for "integration"
    - OK for specific wireless applications
  - Adapting the QoS features of the global protocols at a gateway to the wireless network
    - This is difficult, especially the aspects related to small screen sizes

"Personal" networking

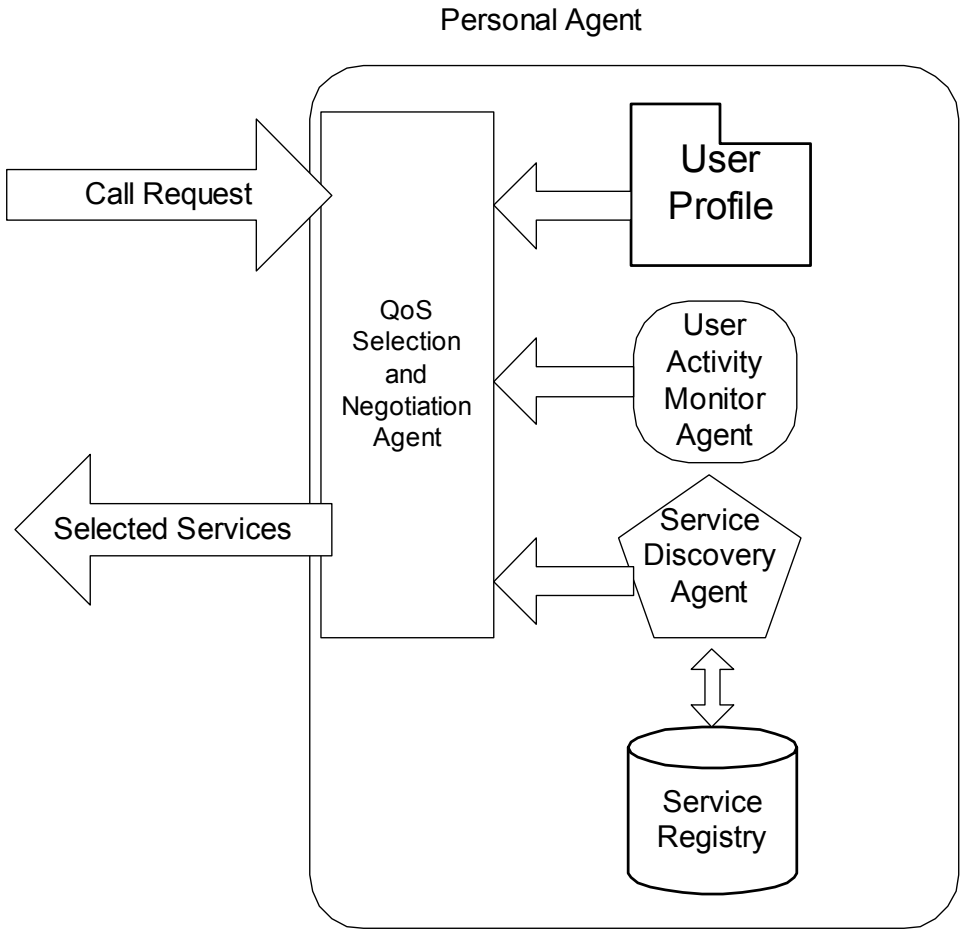
- Many buzzwords
  - *PDA, wearable computers, PAN (personal area networks, e.g. Bluetooth), personal agents*
- We propose a personal agent ...
  - . . . is a kind of extension of the home directory, possibly located in a PDA
  - knows the devices that are close to the user
    - This information is more up-to-date than what is in the home directory
  - may be responsible for
    - device selection, QoS negotiation, security aspects
  - may include a private key for authentication

Device selection in the PAN

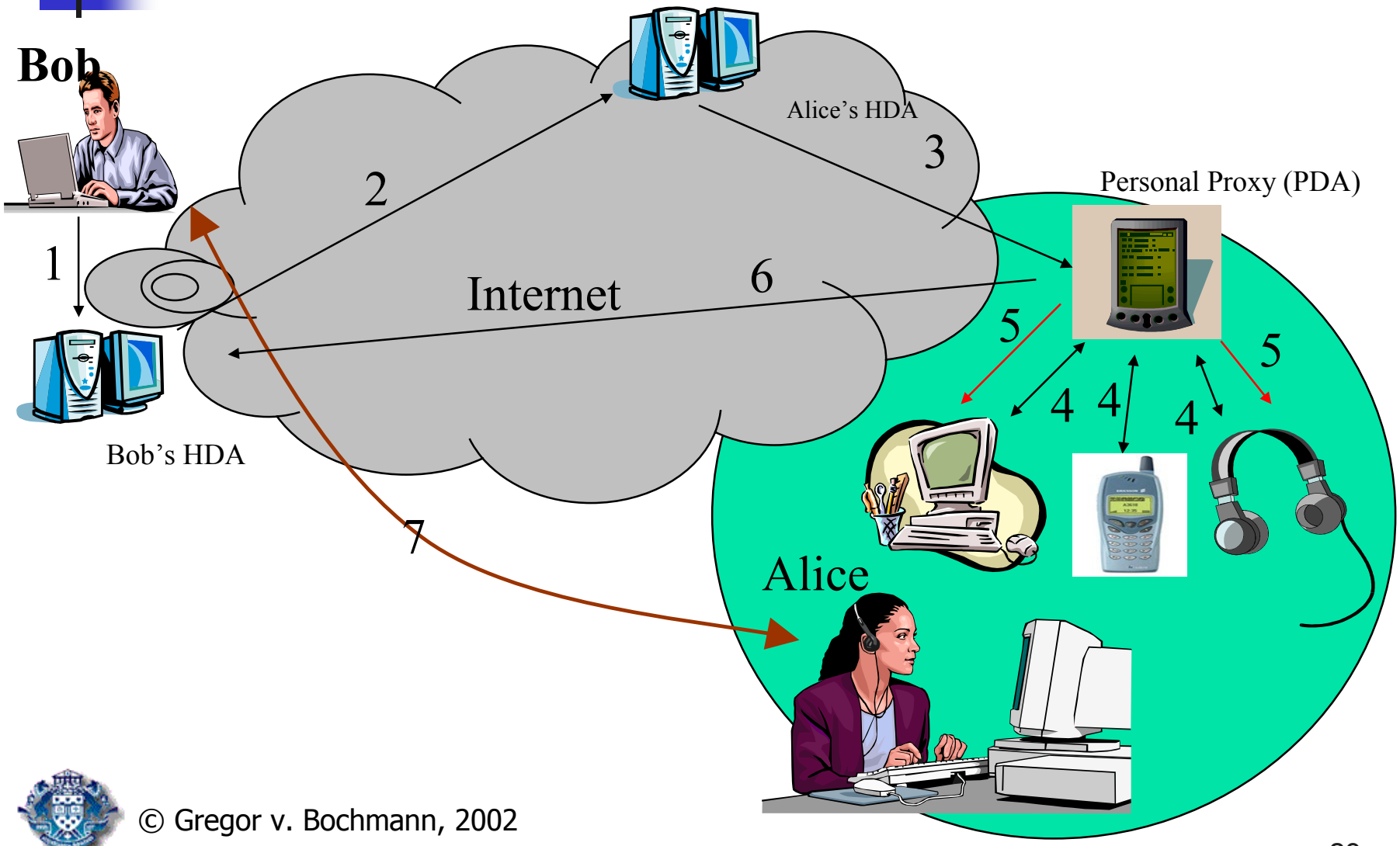


QoS management in a ubiquitous computing environment

Selecting
- appropriate services / devices and QoS
- for an interactive application



Connecting Alice and Bob through a Personal Proxy



Conclusions

- General context: "Intelligent Networks (IN)" and "telephony integration"
  - IN stands for new intelligent services in the traditional telephone networks
  - The Internet protocols provide a very flexible environment for deploying new services
- In addition to the basic networking infrastructure (including end-to-end data transport with QoS and device mobility), various other services are required for establishing the future intelligent telecommunication infrastructure:
  - User location service, Device location service, Home directories of users, Authentication service (PKI: Public Key Infrastructure), Device profiles
- User preferences must be taken into account; they should be given in terms of abstract, user-friendly concepts
- The automatic selection of technical QoS parameters used in a communication session should be based on the applicable device limitations and the user preferences, including the cost
- There is lots of work for standardization