The convergence of network computing and telecommunications

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Terminology

Applications

Video conferencing, voice and electronic mail, WWW browsing, etc.

Services

Audio, video, payment, directory, privacy keys, etc.

Bitways

ATM, IP, wireless, etc..

Realizing the Information Future: The Internet and Beyond, Nat. Res. Council
Telecommunications-computing confusion

- Infrastructure blurring
  - Data, audio, video in ATM network
  - Data, audio, video in desktop computer

- Applications blurring
  - Home banking by DTMF and voice response
  - Home banking by desktop computer and modem or Internet
Types of applications

- User-to-user
- User-to-information server
- User-to-user with information server
User-to-information server example

World-wide web browser
User-to-user examples

Shared whiteboard

Shared editor
Taxonomy of networked applications

Immediate
- Video on demand
- WWW browsing

Deferred
- File transfer

User-to-information server

User-to-user
- Telephony
- Video conference
- Electronic mail
- Voice mail
Two architectures

User-to-information server

User-to-user

User-to-user
Two architectures for user-to-user applications

Computer worldview

Client

Client

Server

Telecom worldview

Peer

Peer
Vertical to horizontal integration
Advantages of horizontal integration

- **Services and bitway providers:**
  - Administration and economies of scale

- **Independent application developer**
  - Economically significant market built on existing infrastructure

- **User**
  - Multimedia applications
  - Diversity of applications
  - Single services and bitway access provider
The open horizontal interface

- Applications
- Services
- Bitways

- Operating system & telephone API
- Internet protocol (IP) & QoS
- Async. transfer mode (ATM)
More layers emerging

- Applications
  - Application components
    - E.g. OpenDoc, ActiveX
  - Middleware services
    - E.g. CORBA
  - Network services
  - Bitways
Information appliances

Captures a turnkey stovepipe application snapshot in one “easy-to-use” product e.g. WebTV, Nokia Comunicator
### Obstacles to innovation

<table>
<thead>
<tr>
<th>Client-server</th>
<th>All users possessing the client application immediately benefit fully</th>
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<tr>
<td>Peer-to-peer</td>
<td>Users possessing the peer application benefit only to the extent that there are other peers with an interoperable application</td>
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Network externality
Transportable computation

- Transport not only data, but also computation across the network

- Primary impacts:
  - Scalability
  - Interoperability
Network distribution

Slow distribution is replaced by distribution of the client application over the network itself.
Virtual machine interface

- Applications
- Virtual machine
- Operating system

WWW browser
Java bytecode interpreter
Telescript
UNIX, MacOS, Win95
Dynamic deployment: client-server

Functionality is invoked during a session by dynamically distributing executable code during the session itself.
Applet execution

Source code

Compiler

Platform-independent bytecode

Languages:
- Tcl
- Telescript
- Java

Bytecode virtual machine

PC, Mac, PDA, telephone, etc

Client

Stored on server

Dynamic deployment
Example Java applet

Nuclear reactor simulation
Advantages

- **Client-server:**
  - No functional advantage over, say X
  - Reduced latency
  - Scalability

- **Peer-to-peer**
  - Bypasses network externality
Network externality problem is avoided by deploying the peer application during establishment, or dynamically during the session.
Java-to-Share

- Helper application for standard Java-enabled WWW browser
- Turns client-server WWW browser into platform for user-to-user applications in peer-to-peer architecture
- Peers need not have application software in advance
Java-to-Share

Netscape browser

Java virtual machine

Java applet

Java applets

Http server

Netscape browser

Java virtual machine
Endpoint: complete convergence