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

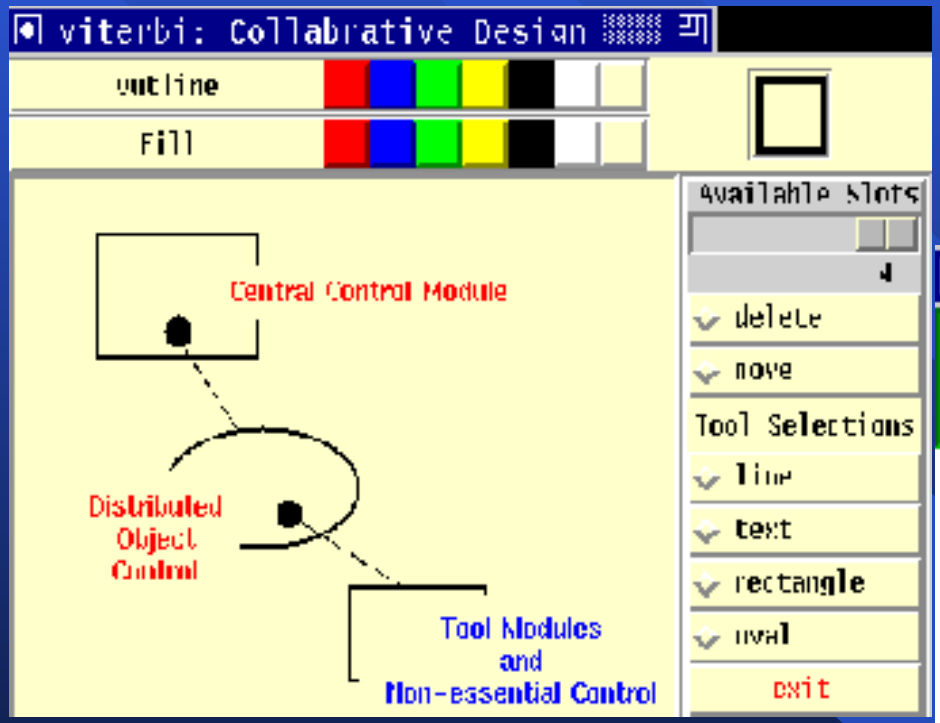
Types of applications

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

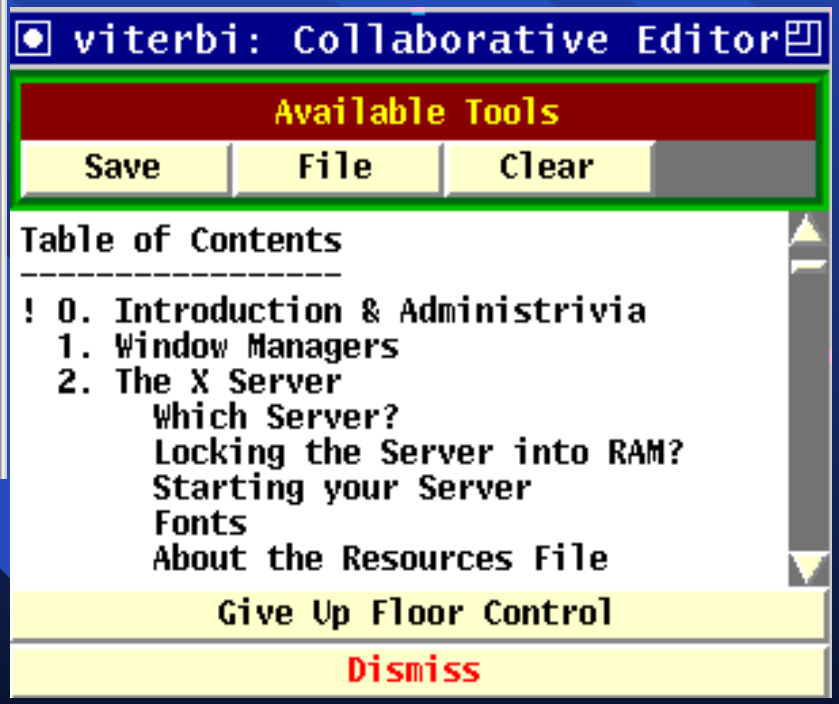
User-to-information server example

World-wide
web browser

User-to-user examples



Shared whiteboard

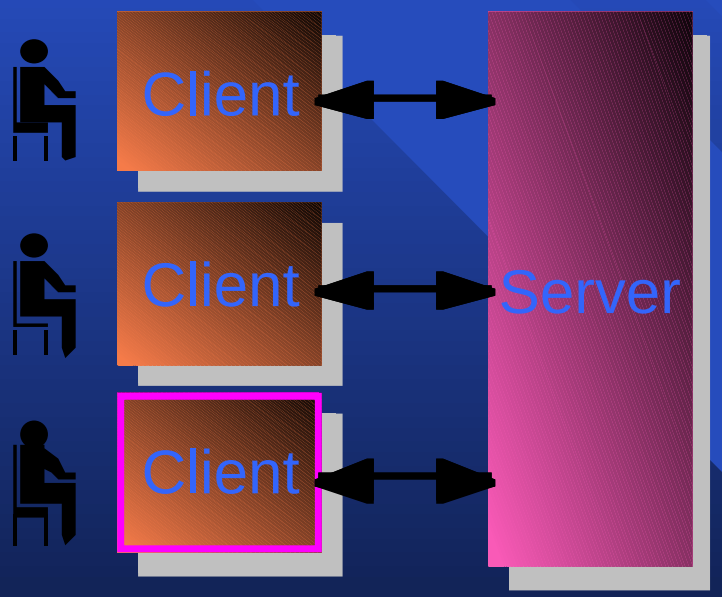


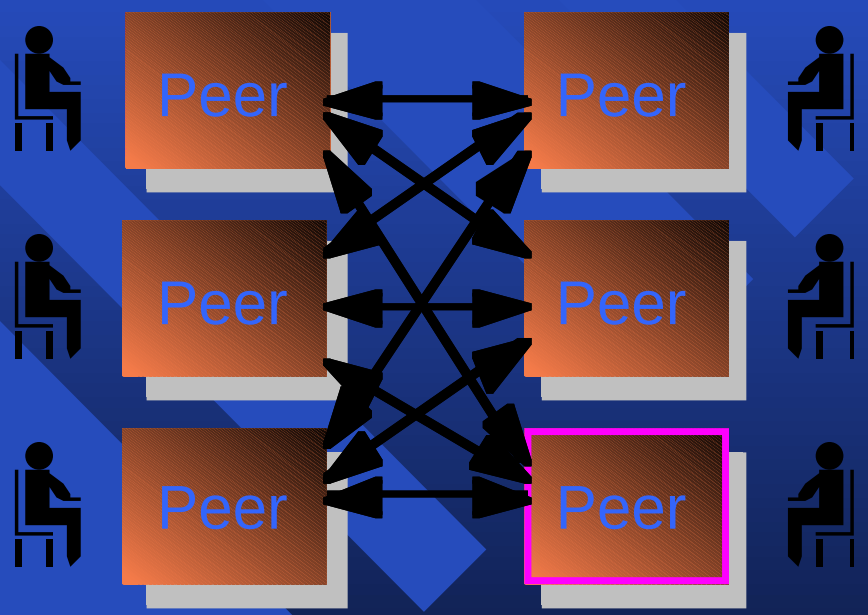
Shared editor

Taxonomy of networked applications

	Immediate	Deferred
User-to-information server	Video on demand WWW browsing	File transfer
User-to-user	Telephony Video conference	Electronic mail Voice mail

Two architectures



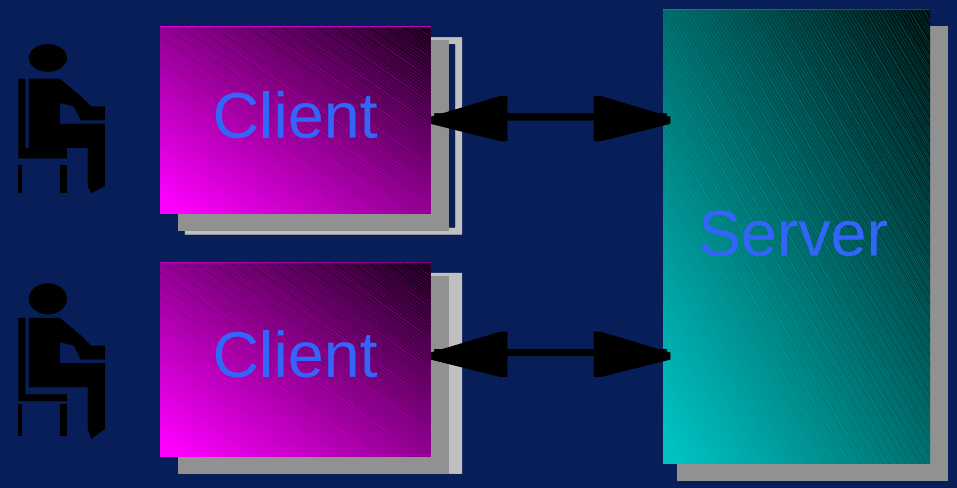


User-to-information server
User-to-user

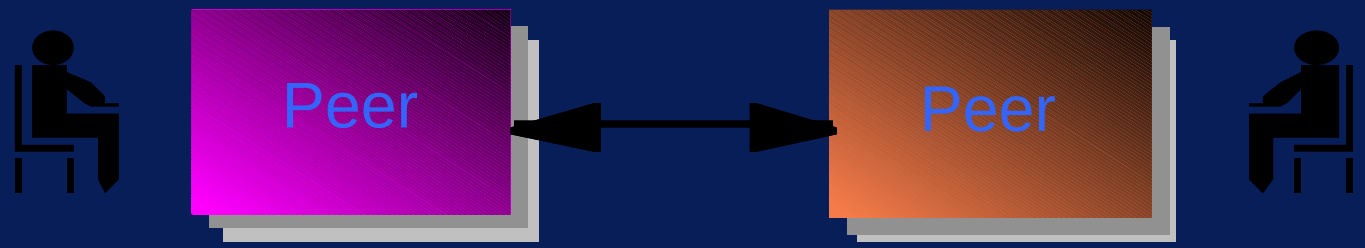
User-to-user

Two architectures for user-to-user applications

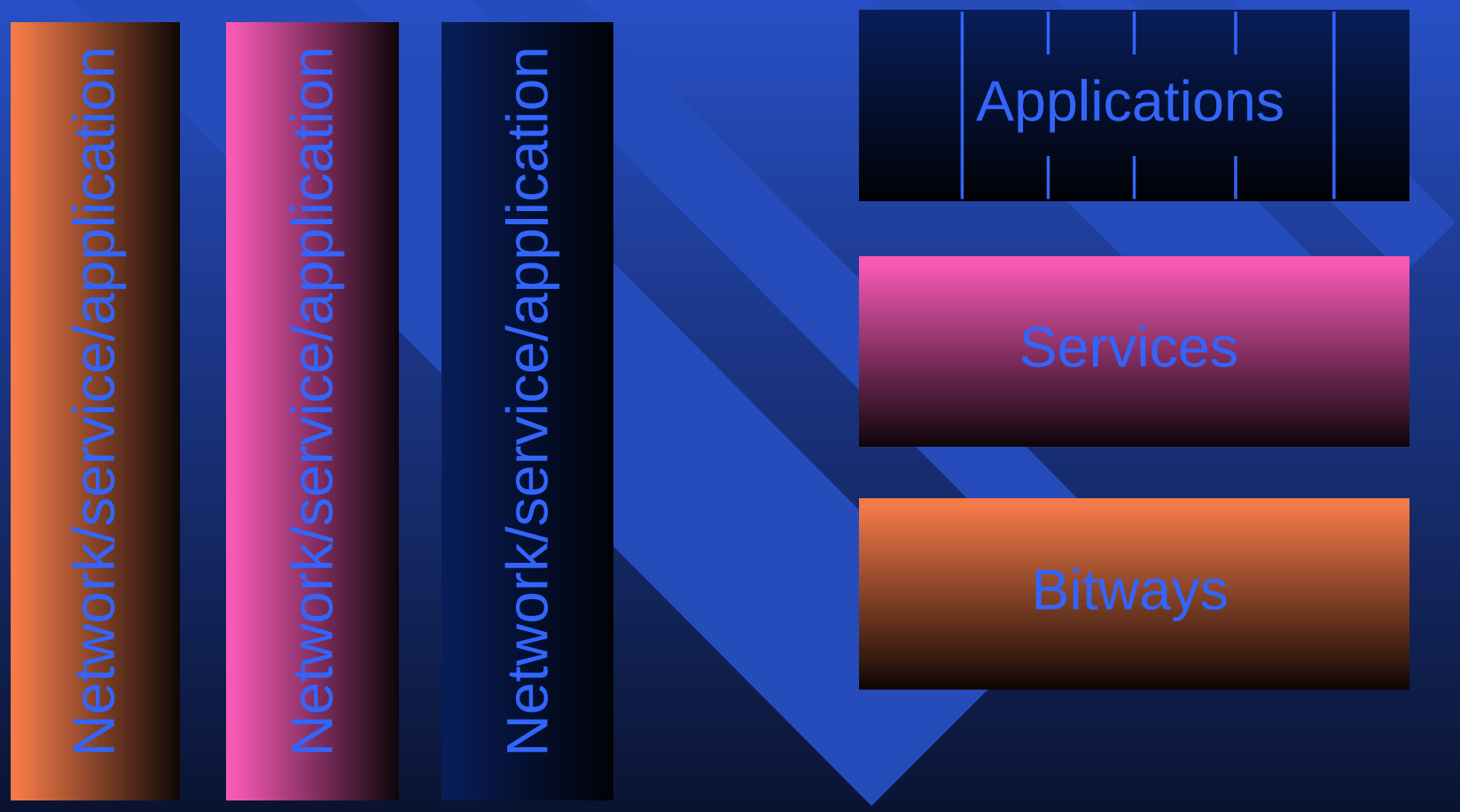
Computer worldview



Telecom worldview



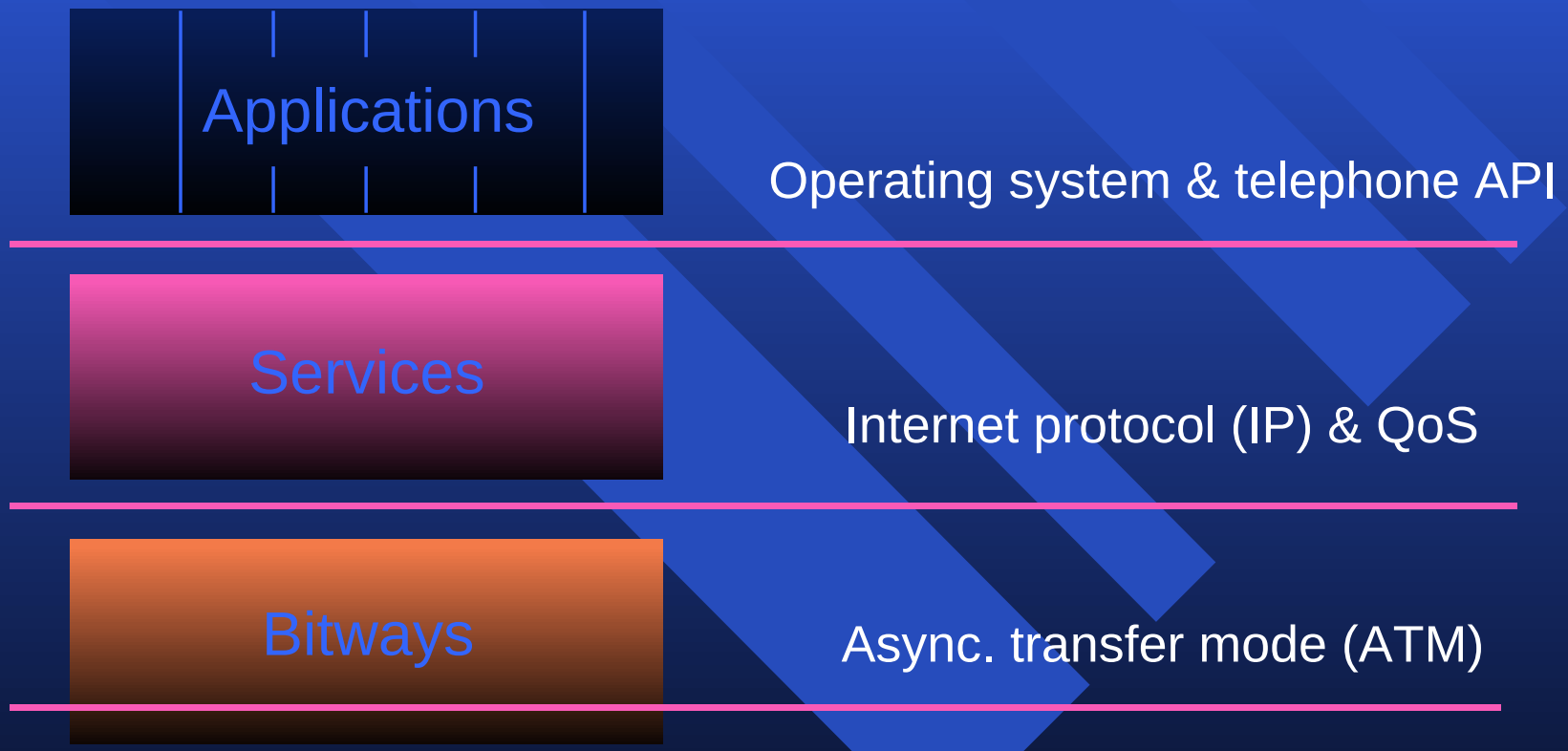
Vertical to horizontal integration



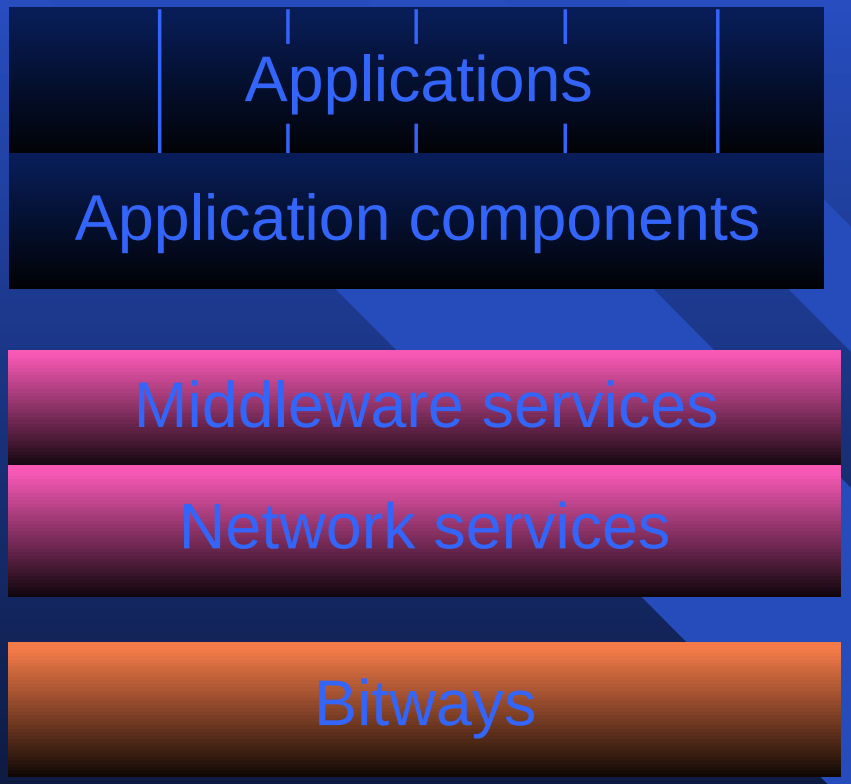
Advantages of horizontal integration

- 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



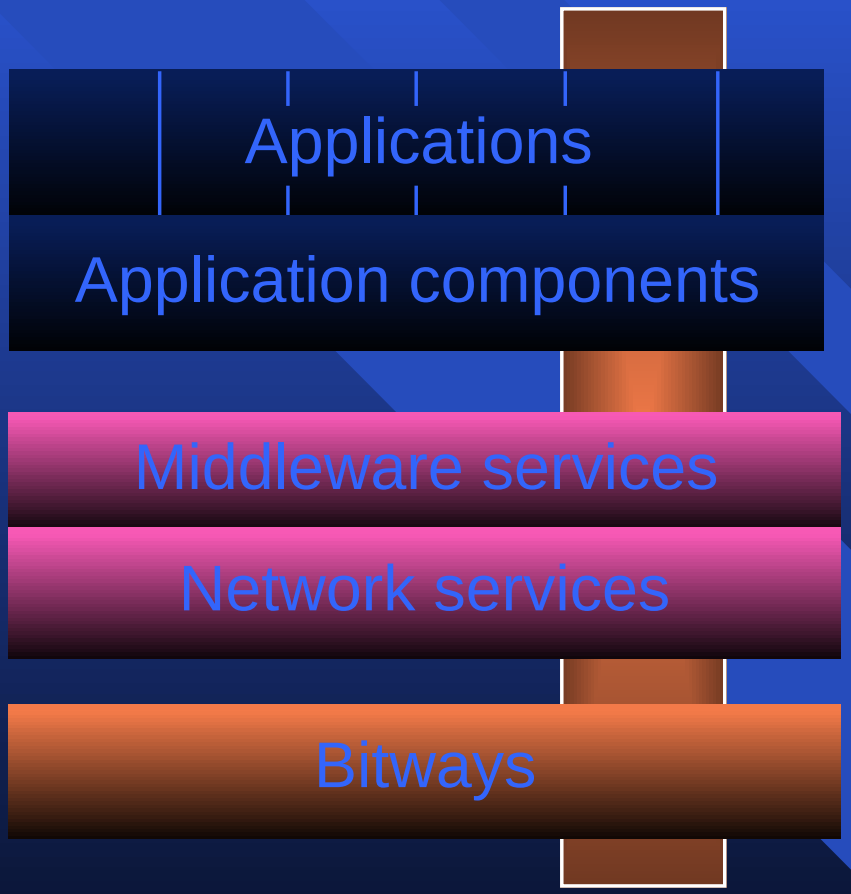
More layers emerging



E.g. OpenDoc, ActiveX

E.g. CORBA

Information appliances



Captures a turnkey stovepipe application snapshot in one “easy-to-use” product

e.g. WebTV, Nokia Comunicator

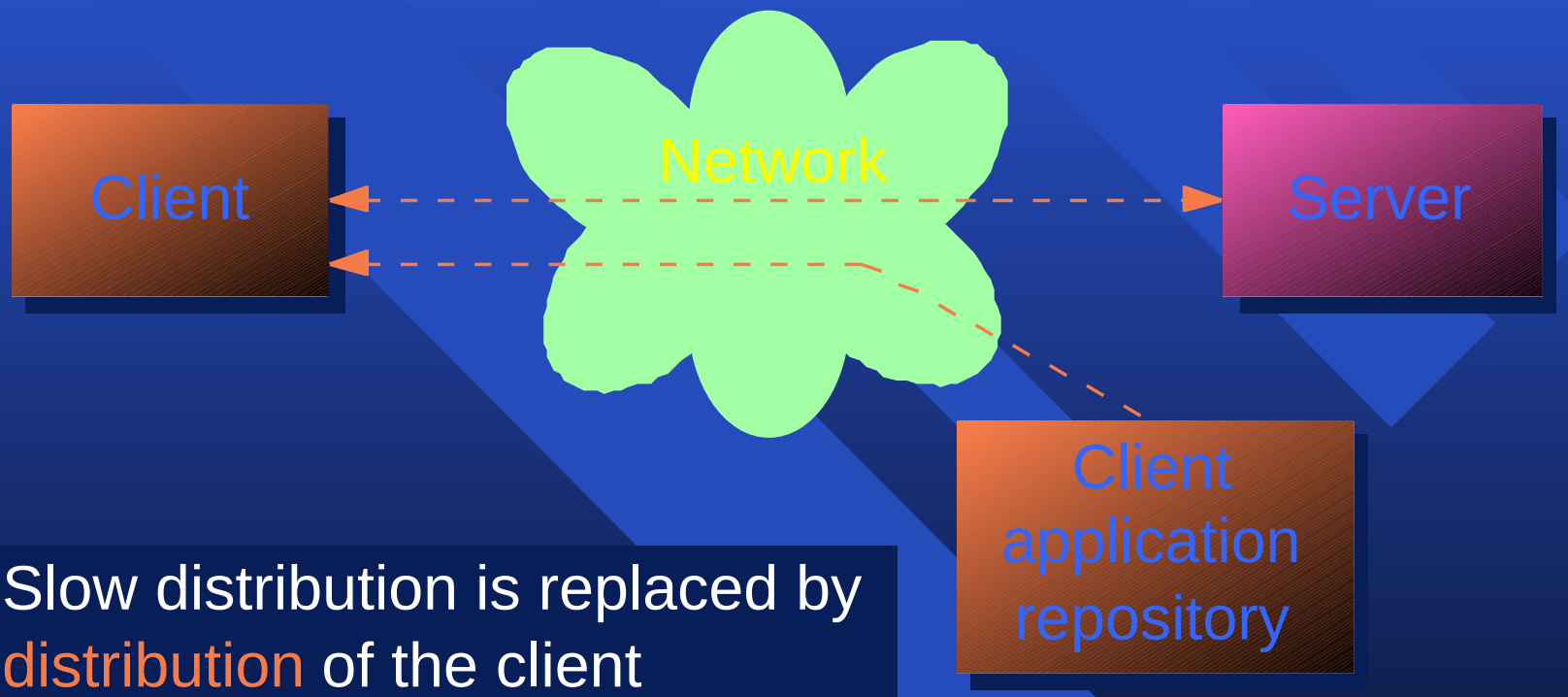
Obstacles to innovation

Client-server	All users possessing the client application immediately benefit fully	
Peer-to-peer	Users possessing the peer application benefit only to the extent that there are other peers with an interoperable application	Network externality

Transportable computation

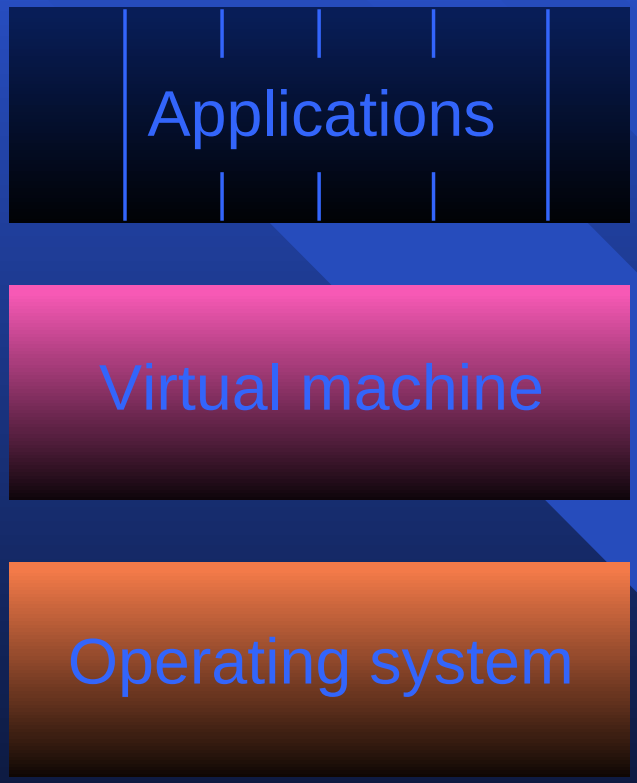
- Transport not only data, but also computation across the network
- Primary impacts:
  - Scalability
  - Interoperability

Network distribution



Slow distribution is replaced by distribution of the client application over the network itself

Virtual machine interface

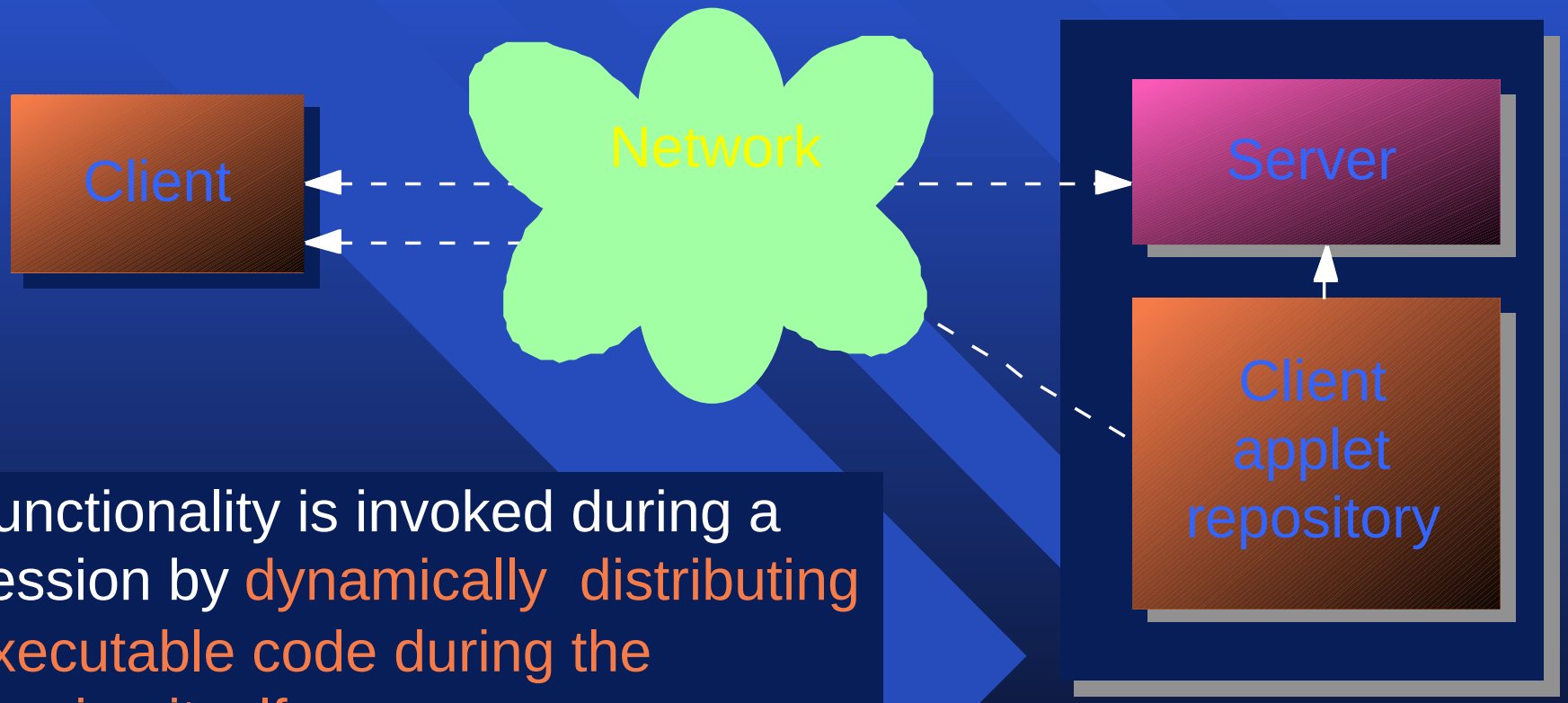


WWW browser

Java bytecode interpreter
Telescript

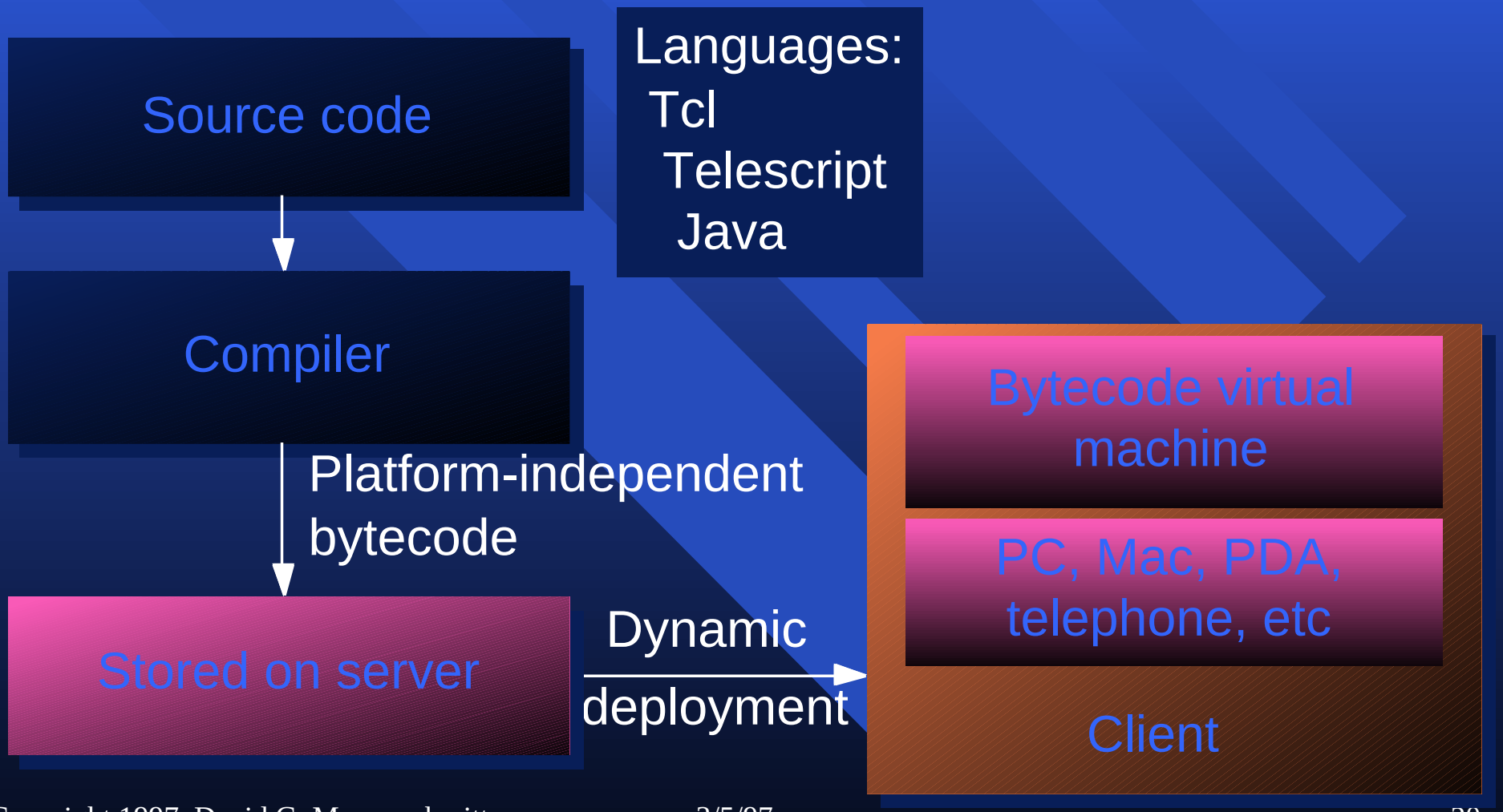
UNIX, MacOS, Win95

Dynamic deployment: client-server



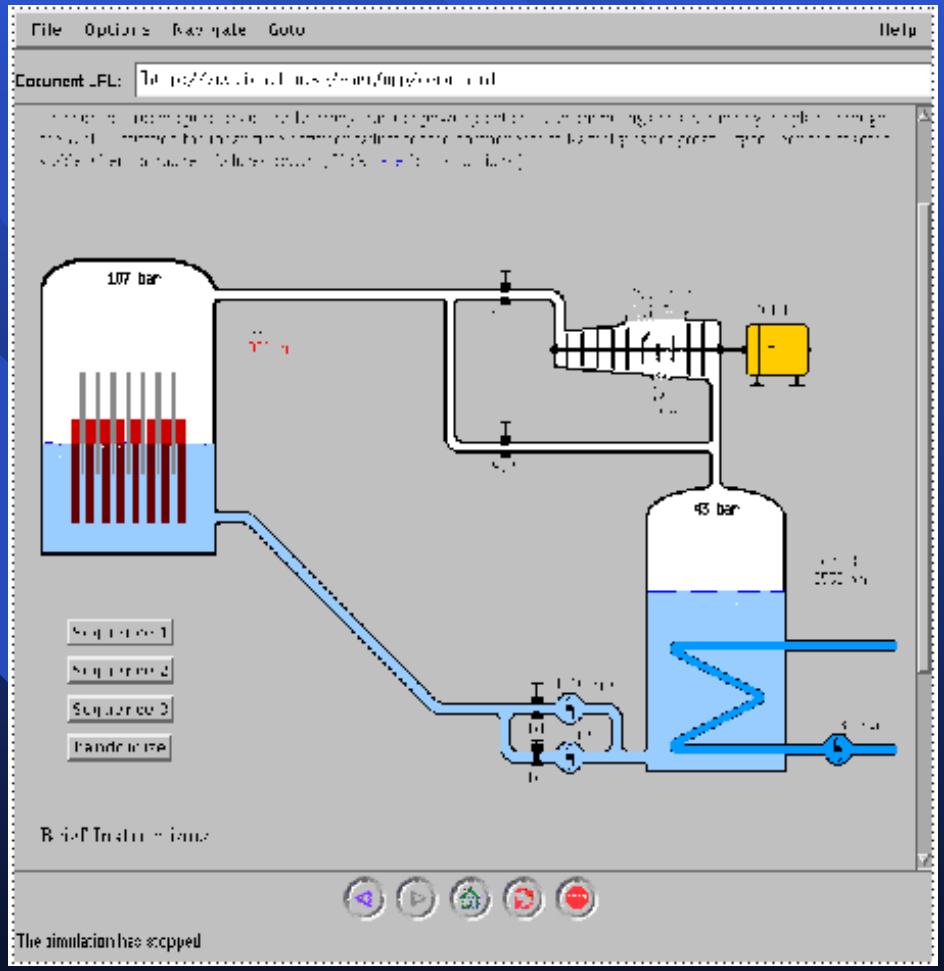
Functionality is invoked during a session by dynamically distributing executable code during the session itself

Applet execution



Example Java applet

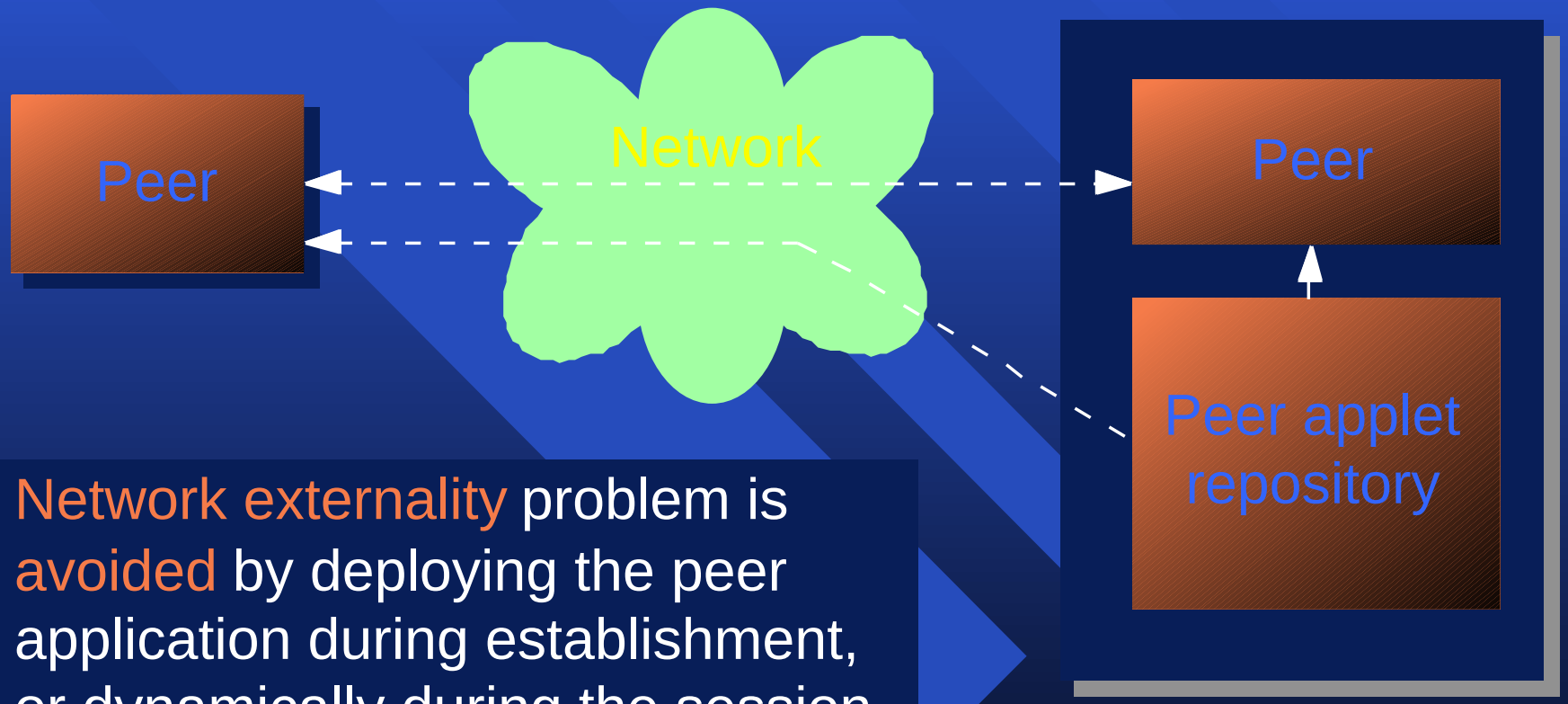
Nuclear
reactor simulation



Advantages

- Client-server:
  - No functional advantage over, say X
  - Reduced latency
  - Scalability
- Peer-to-peer
  - Bypasses network externality

Dynamic deployment: peer-to-peer

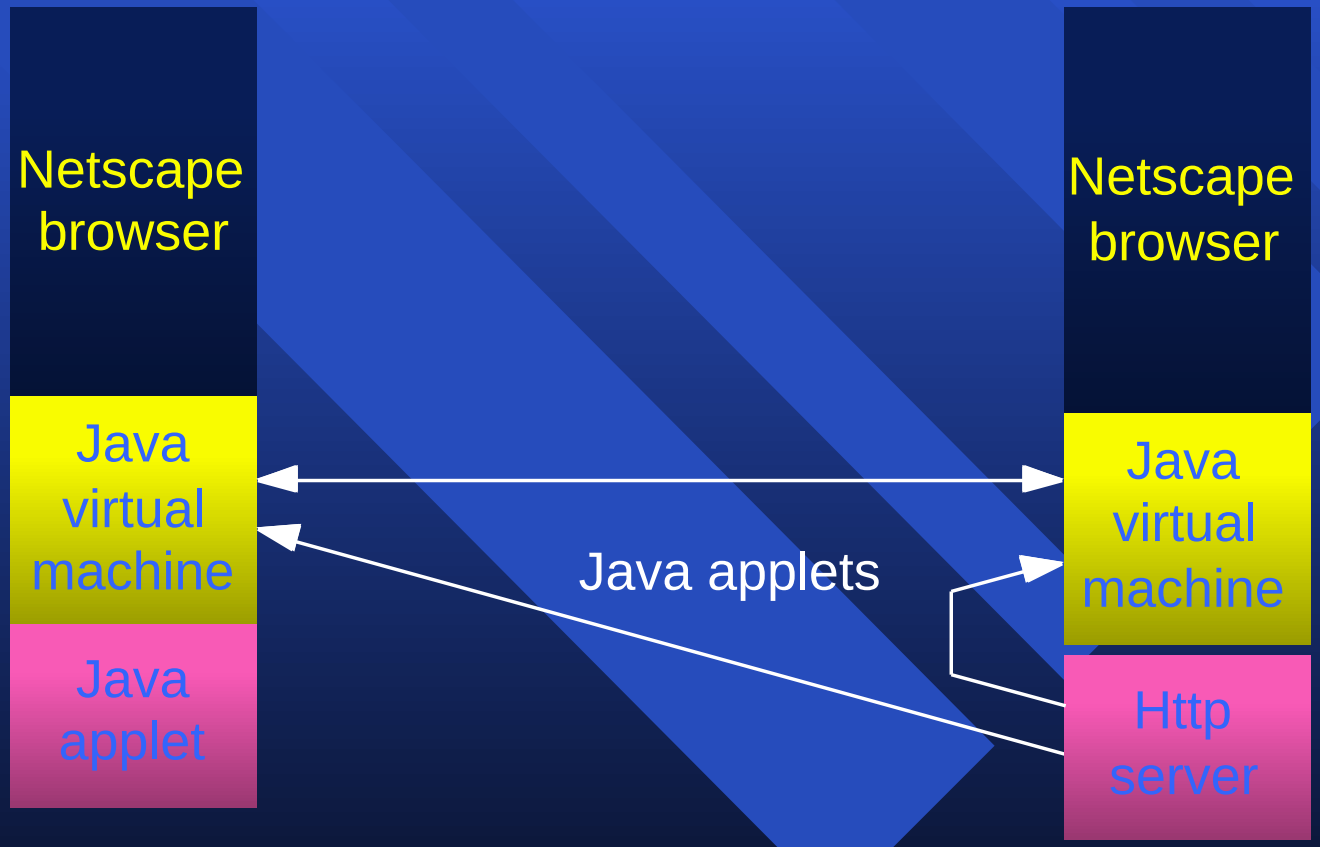


Network externality problem is avoided by deploying the peer application during establishment, or dynamically during the session

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



Endpoint: complete convergence