P2P and mobile agents for web-based geovisualization

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Evolution of internet computing

Server/client architecture

Peer-to-peer architecture and mobile agents
Presentation outline

• Geographic information services
• Server/client architecture
• P2P architecture for geovisualization
• Mobile agents for geovisualization
• Research needs and discussions
GIService over the Internet

• A gradual shift from centralised GIS to decentralised GIService
• GIService = data + computing services
• We believe that geovisualization plays a rather important role in GIService, linking to both data and computing.
Server/client Architecture

- **Server-side applications**: rely on server-side for all processing, thus higher powered server requirements.
  - Common Gateway Interface (CGI), and
  - Server API (java servlets)

- **Client-side applications**: rely on client-side for all processing, thus higher end client requirements, and advanced application interfaces
  - Java applets,
  - Plugins and helper programs, and
  - ActiveX Controls
CGI approach

Web browser \(\xrightarrow{HTTP}\) Web server

CGI program \(\xrightarrow{CGI}\) GIS DB

Web browser \(\xleftarrow{HTTP}\) Web server

CGI program \(\xleftarrow{HTTP}\) CGI program
Server API approach

- Web browser
- Web server
  - Server Extension
- GIS DB

Connection: HTTP
Client-side applications

- Web browser
  - Client Extension
- Web server
- GIS DB

HTTP
A hybrid approach

• The approach (Huang, Jiang and Lin 2001) aims to allocate different tasks to the appropriate side for *workload balancing*, in general
  – Complex spatial data processing on the server side, while
  – Basic map operations such as zooming, and feature selection on the client side
A three-tier client/server architecture
Welcome to the Webpage of

GIS supported 3D Visualization, Analysis and Interaction

3D Visualization

3D Surface Analysis

2D visualization and VRML interaction functions are included in the two modules.
Unbalanced traffic flow with client/server architecture

Server-side application

Client-side application

Light server

Heavy server

Light client

Heavy client

Heavy traffic

Light traffic
Peer-to-Peer (P2P)

- A decentralised network system, which allows the sharing of computing resources by direct exchange between computers.
- P2P allows every computer to be an equal player, a kind of symmetric interaction from a communication point of view.
Two basic kinds of peer-to-peer architectures (Napster and Gnutella)

Server mediated P2P

Pure P2P

😊 Light server 😊 Peer

→ Search from peer to peer ← Communication between sever and peer

← File transfer →
Potential applications of P2P

• file sharing and exchanges,
• information discovery,
• distributed computing, and
• collaboration
Implications for web-based geovisualization

• well-balanced traffic flow between hosts
  – First of all, no heavy load server is needed for such tasks; or alternatively, a central server may be used for repository, but there is no need for every client to fetch data or computing service from it.
  – Secondly not only final visualization results, but also intermediate visualization results can be shared among the interested parties; this is particular true for model-based geovisualization, which involves heavy interaction between users and machine.
Mobile Agents

• What is an agent?
  – An agent is a program that acts on its own agenda; sometimes it is called an intelligent agent.

• What is a mobile agent?
  – A mobile agent is a special kind of agents with the mobile ability; it is not bound to the system or place where it begins execution (like applets and servlets).
Elements of mobile agents

• **Agents** and their execution **environment** are two fundamental concepts for mobile agents.

• Mobile agents have certain **behaviours** linking to its mobility such as creation, clone, disposal, and transfer in web environment (lifecycle).

• Agents can **communicate** with other agents residing in the same or different places.
Mobile agent architecture

Host A

Application

Host B

Service

Application

Remote communication

Local communication

Migration
Implications for web-based geovisualization

• Firstly mobile agents can reduce the network load.
  – Through mobile agents, we move the computing to the data rather than the data to the computing.

• Secondly mobile agents overcome network latency, i.e. delay between a request and a response.
  – Mobile agents can be dispatched from a central controller to act locally and directly execute the controller’s direction, thus no delay caused.
Implementation platforms

• **JXTA project** – Sun Microsystems
  – A common P2P infrastructure, aims to bring to P2P world what HTTP and the browser brought to the Internet.
  – **JXTA is independent of preferred programming languages, development environments, or deployment platforms.**
  – **JXTA is designed to be implementable on every device with a digital heartbeat.**
Implementation platforms

- **Aglets** – IBM Tokyo Research Laboratory
  - Java-based, so it is platform independent
  - Open source code, well developed community, and rich documentation
Research needs

• Killer applications of P2P and mobile agents for web-based geovisualization, or GIService in a more general sense.
  – Web-based planning support systems
  – Local-based services
Discussions

• Geovisualization within a web community
  – e.g. public participation systems and location based services

• Geovisualization based on a heterogeneous web environment
  – Different bandwidth connection, different devices such as PC, PDAs, cell phones