Providing Real-Time Information to Transit Passengers Using Internet-Enabled GIS

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Acknowledgements

- Lenny Kneller
- RTD Staff

Presentation Outline

- Introduction—Where's My Bus
- GIS Approach
- Implementation
- Conclusion

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Introduction – Where's My Bus

- Demand
  - ATIS
  - GIS
- Project background
  - RTD Initiatives
    - CAD/AVL
    - GIS
  - ArcIMS
- Our goal
  - Evaluate COTS GIS Technology for ATIS

A GIS Approach To ATIS

- Why GIS
  - Location Services
  - Network Data
  - The Internet

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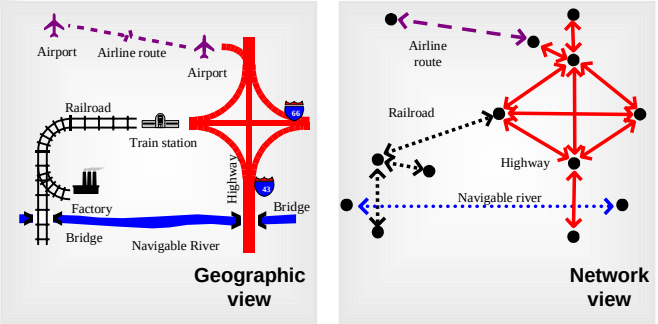
Location, Location, Location

- Vehicle Location On The Planet
- Location Relative To Landmarks
- Other Spatially Related Data
  - Traffic
  - Weather
- Commercially Available Data
  - Street Network, Weather, Traffic
- Operator-Specific Data
  - Routes, Stops

Networks

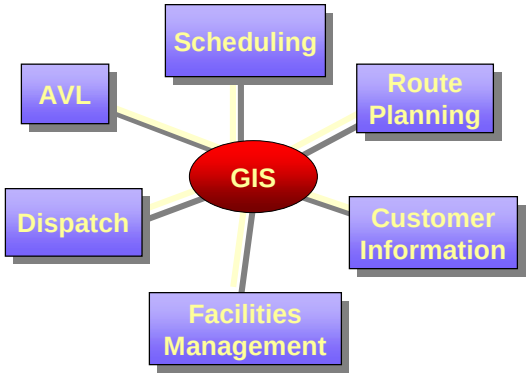


Geometry and Connectivity

The Internet

- Data Transfer Infrastructure
  - Kiosks
- Universal Web Browser
- Free Online Data and Applications
  - MapQuest
- COTS Internet Map Service Software

Broader Value of GIS



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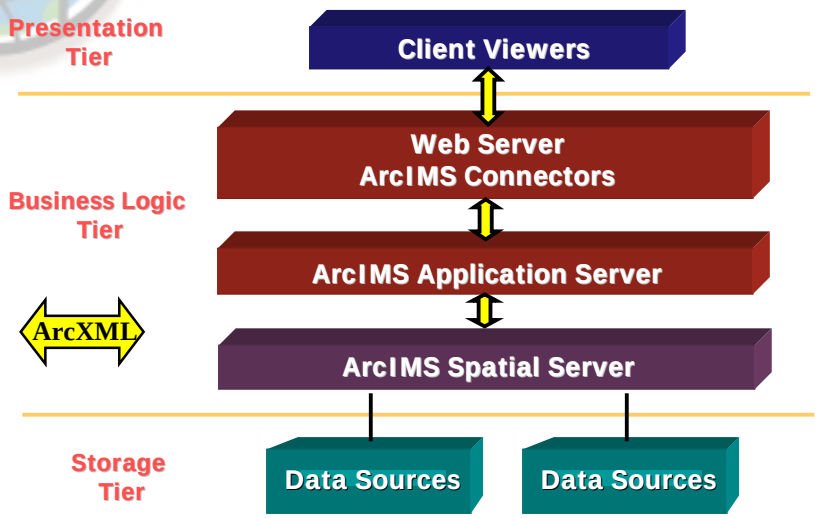
Implementation

- Internet Map Serving Technology
- Database design and data processing
- Application clients design
- Conclusion

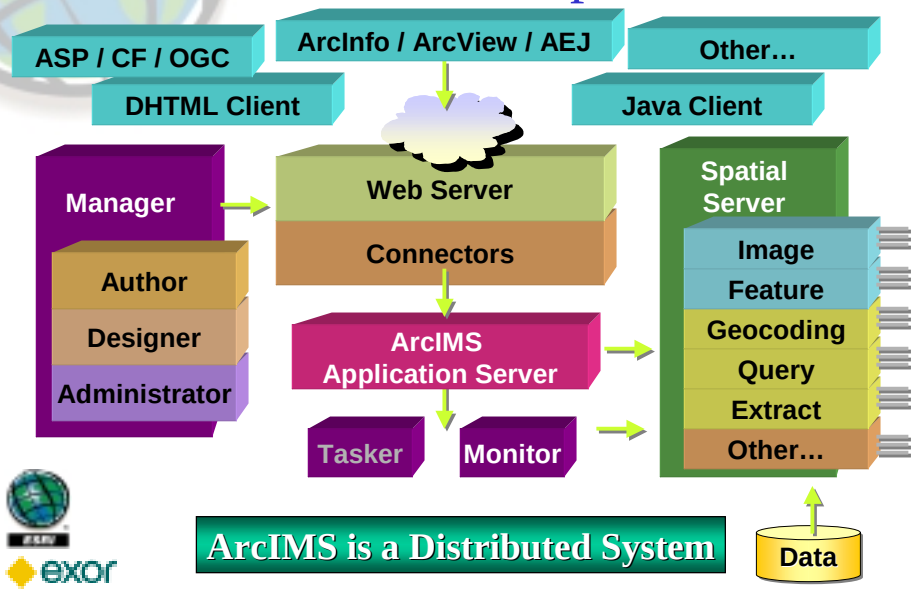
System Components

- Data collection
  - Denver RTD AVL/CAD system
  - Data is FTPed to ESRI Server
- Data loader
  - Gets the data from FTP
  - Inserts data into Oracle and ArcSDE
- Server
  - Windows NT Server 4.0
  - Web Server: Microsoft IIS, ServletExec 3.1
  - ArcIMS 3.0
- Client viewers
  - Customized HTML and Java viewer

ArcIMS is a Multi-Tier System



ArcIMS Components

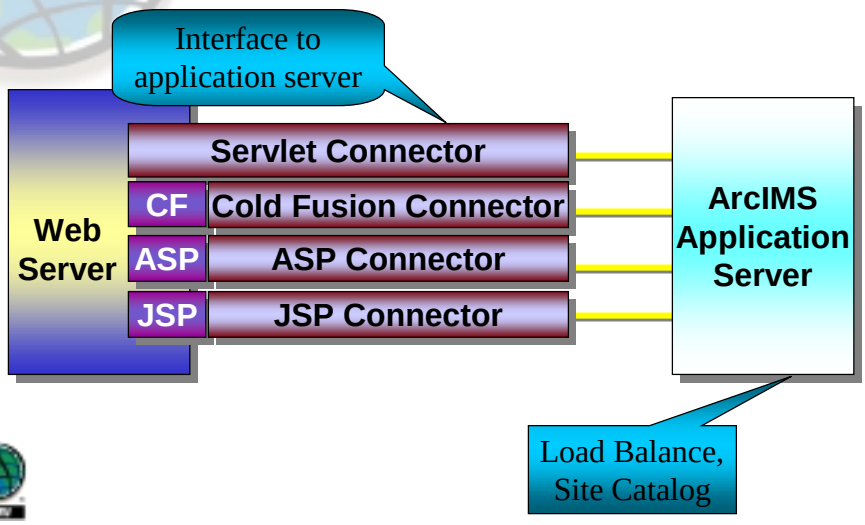


ArcIMS is a Distributed System

Web Servers

- Handle requests from a client using Hypertext Transfer Protocol (HTTP)
- Pass the request to the appropriate application
- Sends the response back to the requesting client

Connectors / Application Server



ArcIMS Spatial Server

- A container that holds the different server components
- Provides functional capabilities for accessing and bundling maps and data into the appropriate format

ArcIMS Spatial Server Support Components

- Weblink is communication link between the ArcIMS Application Server and Spatial Server
- XML parser parses ArcXML requests
- Data Access Manager provides links to the data

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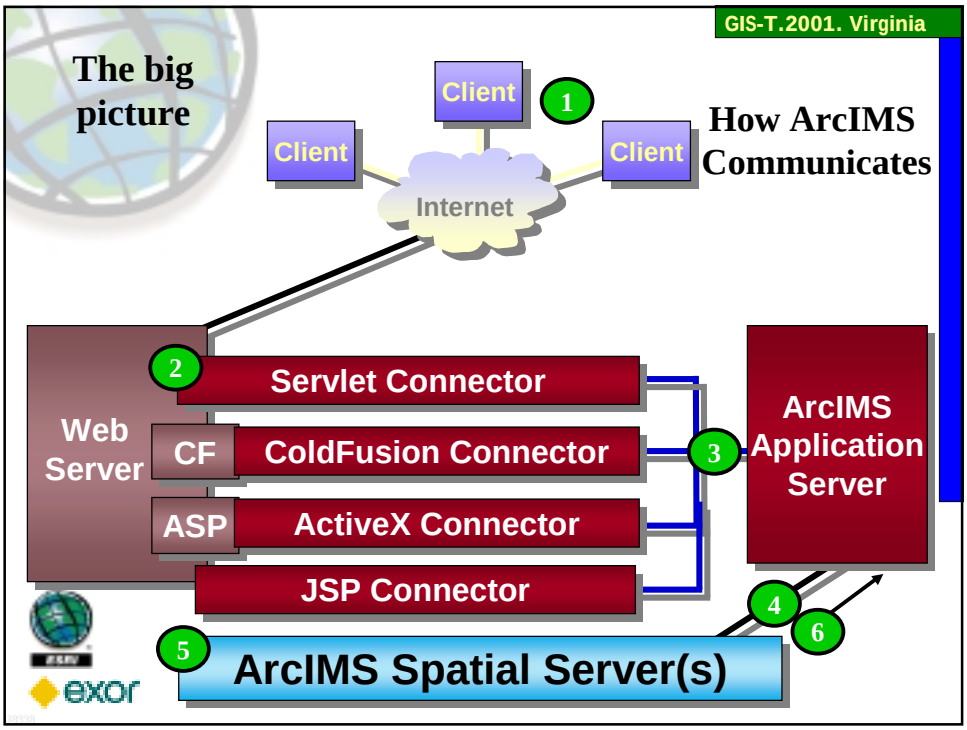
ArcIMS MapServices

- Processes that run on an ArcIMS Spatial Server
- Define how to display maps on the web
- Two types of MapServices
  - Image
  - Feature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The big picture
How ArcIMS Communicates
Client
Client
Client
1
Internet
Web Server
2
Servlet Connector
CF
ColdFusion Connector
ASP
ActiveX Connector
JSP Connector
3
ArcIMS Application Server
4
6
5
ArcIMS Spatial Server(s)
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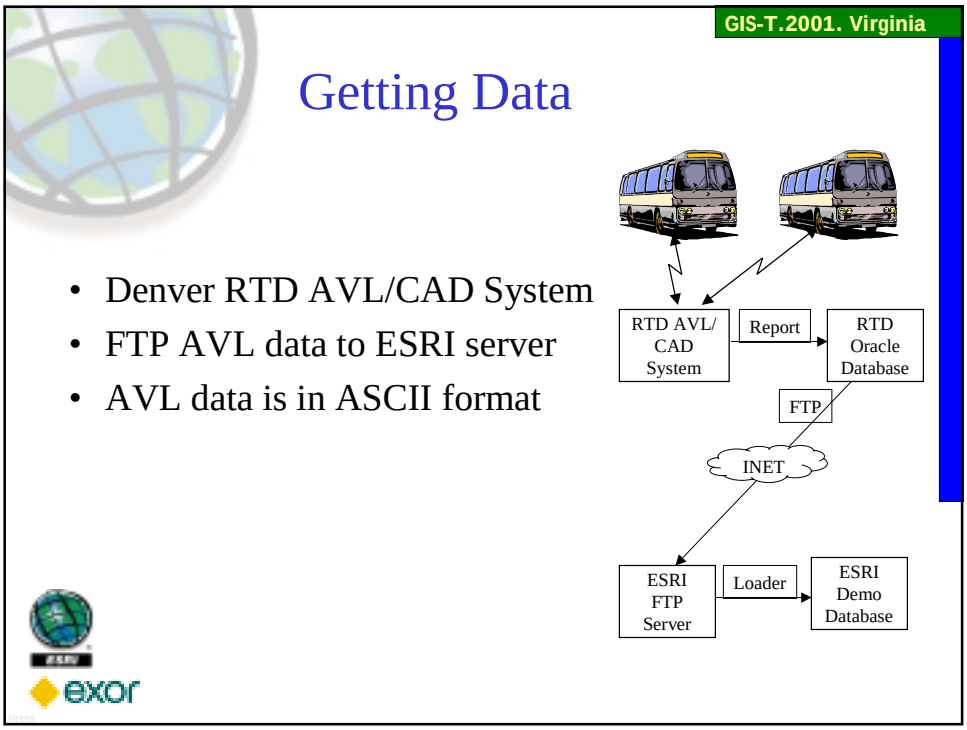
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Getting Data
• Denver RTD AVL/CAD System
• FTP AVL data to ESRI server
• AVL data is in ASCII format
RTD AVL/ CAD System
Report
RTD Oracle Database
FTP
INET
ESRI FTP Server
Loader
ESRI Demo Database
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AVL data in ASCII format

```
38  41    29-MAR-01 11:28:12   2172289 708743  W
12  9     29-MAR-01 11:26:26   2148358  694210  NNW
44  15    29-MAR-01 11:28:04   2101498 702595  WSW
18  3     29-MAR-01 11:25:04   2191681  682024  SSE
18 1      29-MAR-01 11:26:35   2178476  695122  WSW
```

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Database Design - Challenges

- The database needs to be constantly retrieved, mapped and updated
- Storing location data can represent a major cost in real-world tracking systems
  - Too many records to store
  - Performance considerations
- AVL data is in a different projection than the base street data from GDT

The Solution is Spatial Database

- ArcSDE stores and manages spatial data in relational database management system (RDBMS)
- ArcSDE supports multiuser GIS
- ArcIMS supports ArcSDE layers directly

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Database Design - Implementations

- Three programs running in parallel:
  - Loading Data into Oracle (written in Java)
    - Gets the AVL bus file from ESRI FTP server, parses the bus file and inserts the records in Oracle
    - Keeps only the most current position for each bus
    - Un-projects bus points to geographic coordinates
  - Creating ArcSDE layer (written in C)
  - Purging old data (written in Java)

Client Viewers - Requirements

- Defines the graphical look and functionality of the website
- Includes a map component and navigation tools
- Tracks the real-time bus locations
- Query by specific bus route and bus stop
- Combines traffic and weather data from other Internet sources

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Client Viewers – ArcIMS templates

- ArcIMS includes two types of client viewers:
  - ArcIMS HTML Viewer
    - A thin client written in HTML and JavaScript
    - Supports Image MapService
  - ArcIMS Java Viewer
    - A thicker client that requires a plug-in
    - Supports feature streaming
    - Supports data integration from other Internet sources

Client Viewers - Challenges

- Automatically repainting map when the database is updated
- Combining data from other Internet sources such as traffic and weather conditions
- Performance requirements

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Client Viewers – the First Prototype

- We used ArcIMS HTML client because it:
  - is a thinner client
  - supports both IE and Netscape browsers
  - is easy to customize
  - supports the concept of an “acetate layer”, which is ideal for tracking objects
- Drawback:
  - Can not integrate traffic, weather data from other Internet sources

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Client Viewer - Implementations

- Create a custom acetate layer to display bus locations
  - Sits on top of the map
  - Ideal for tracking objects that move in time
  - When objects move, only the acetate layer needs to be repainted

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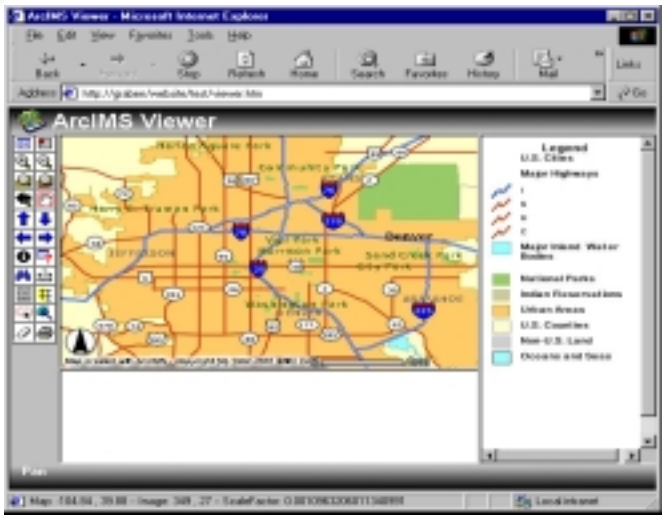
Client Viewer - Implementations

- A customized ASP program
  - Called by a hidden form on the client interface
  - Use ODBC to read Oracle directly
  - Read AVL data into arrays
- Customized JavaScript functions
  - Read elements in the arrays to construct a series of ArcXML requests to plot points in a acetate layer
  - Sent requests to server – use GET_IMAGE request
  - ArcIMS Spatial Server generates a new image with the bus points
- Use JavaScript function setInterval() to schedule the above functions at a two minutes interval

Default ArcIMS HTML Viewer



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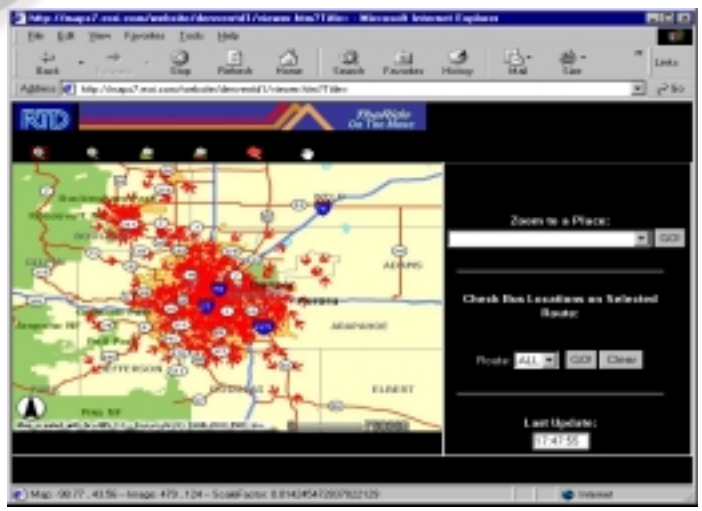
Customized Client Interface



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User Experience

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Client Viewers – Further Development

- A true ATIS should provide passengers with more information like traffic and weather conditions
- ArcIMS Java Viewer supports multiple MapServices to be combined
- Live traffic and weather conditions can be added from Geography Network – a collection of ArcIMS services provided by organizations around the world

Geography Network (www.geographynetwork.com)

- Multi-participant, open network for publishing, sharing, and using geographic information on the Internet
- Portal site for data, maps, and geoservices
- Data from various providers through one Web site
- Most of the services using ArcIMS as the delivery mechanism
- Querying Geography Network Explorer to find map services
- MapService can be added to ArcIMS Java Viewer directly

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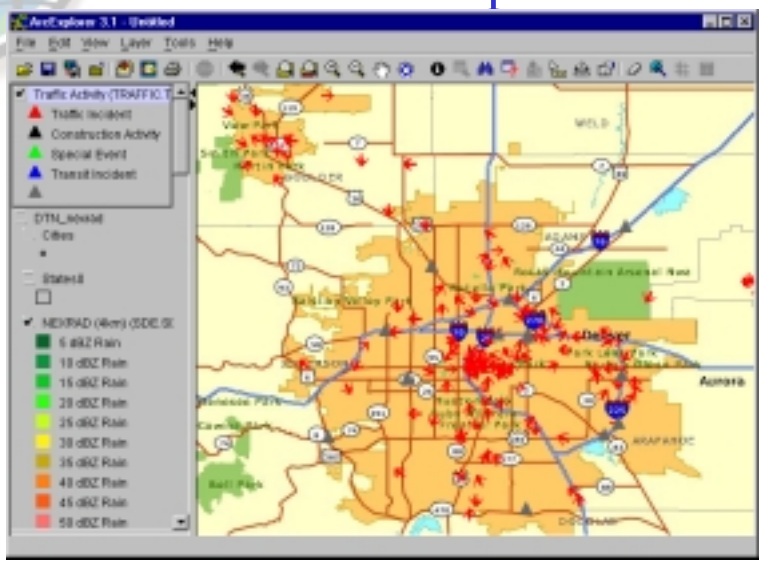
Java Viewer Still Under Development



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Afterthoughts
A better way?

- Direct access to RTD AVL system instead of using FTP
  - AVL data FTP to ESRI Server: 3-4 minutes old
  - Data Loader to Oracle: another 1-1.5 minutes
  - Data displayed in client viewer: 5-6 minutes old
- Create a custom Java Client that allows data integration and query functions
- Is automatically repainting the map screen really necessary?

Questions?

To Get Hold of The Presenters Later:

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