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Overview of GIS Web Services

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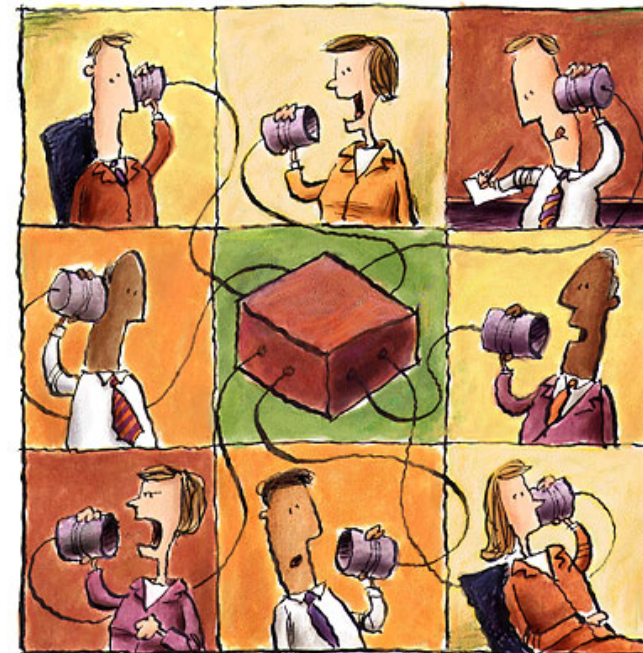
Global Science & Technology, Inc.
Geospatial Interoperability Group
Greenbelt, MD

Geospatial Interoperability Group

■ Interoperable geoprocessing

- the ability of digital systems to work together in manipulating information about phenomena on, above, and below the Earth's surface.

<http://www.gst.com/geo>



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The OpenGIS Consortium (OGC)

- International, not-for-profit consortium with 240+ industry, government, and university members
 - Operates a *Specification Program (SP)* similar to other Industry consortia (W3C, OMG, etc.).
 - Operates an *Interoperability Program (IP)*, a global, innovative, collaborative, hands-on engineering and testing program designed to deliver proven specifications into the Specification Program.
 - Operates an *Outreach and Community Adoption Program (OCAP)* to facilitate the adoption of OGC technology.

OGC Mission

**Deliver
spatial interface
specifications
that are openly
available for global
use.**

<http://www.opengis.org>

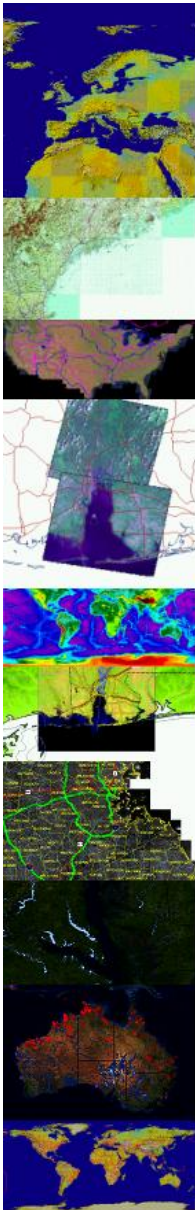


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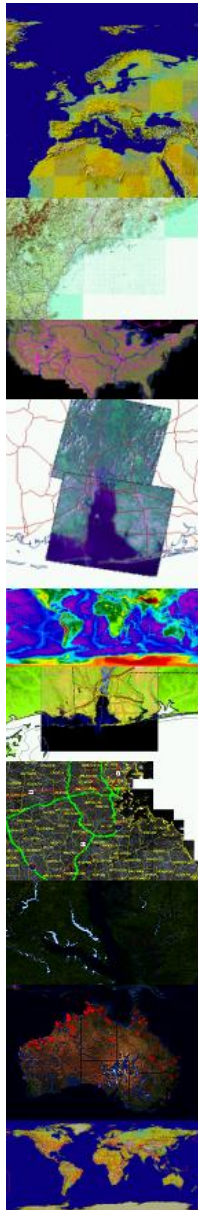
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Presentation Outline

- **Introduction**
 - Evolution of GIS
- **Overview of GIS Web Services**
 - GIS Web Services Architecture
- **Enabling GIS Web Services**
 - Role of the OGC
 - Leveraging General Web Services Technologies
- **Application Development using GIS Web Services**
 - Overview of Service Chaining
- **Conclusion**
 - Shaping the New GIS Marketplace
 - Parting Thoughts

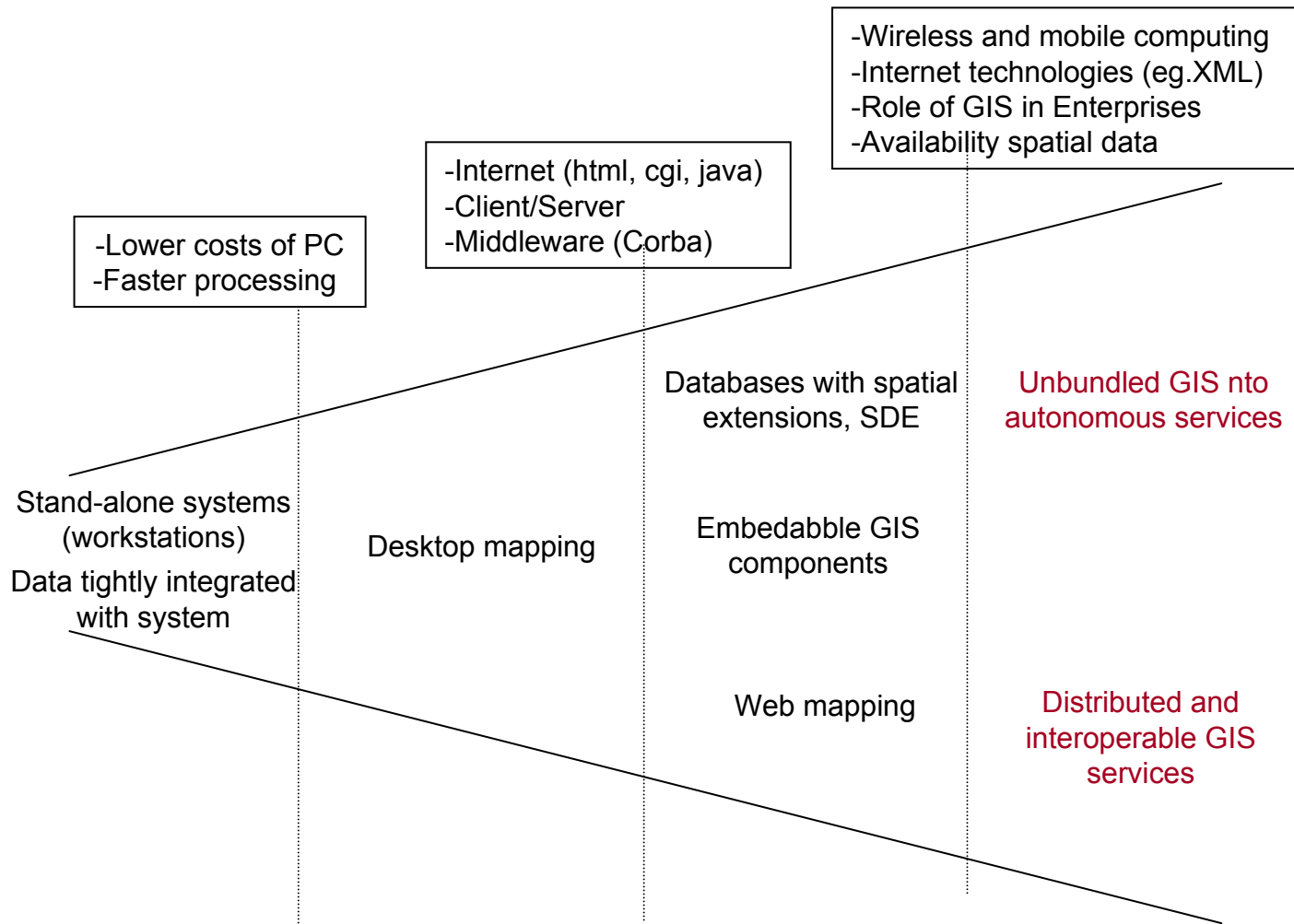


Evolution of GIS: From Stand-alone to Web Services

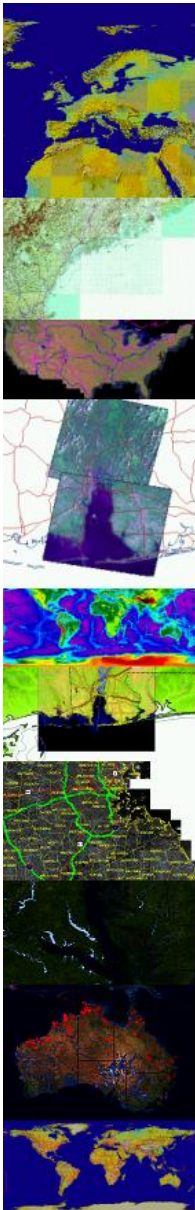
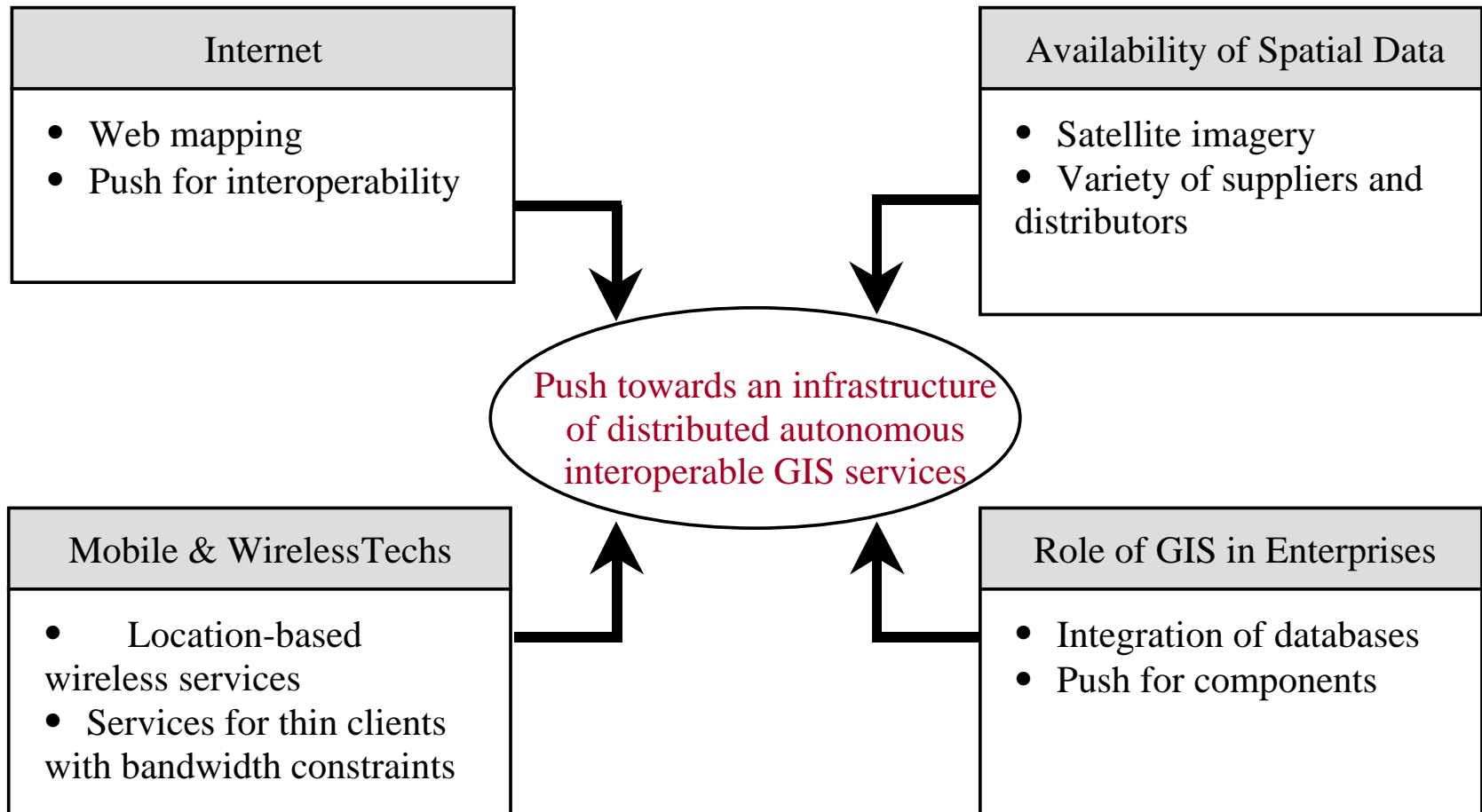


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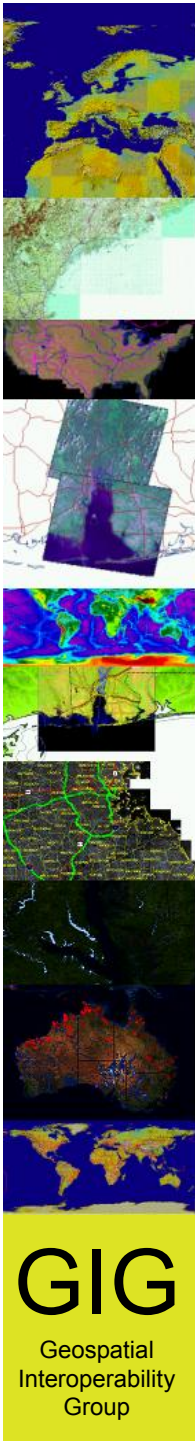
Evolution of GIS: From Stand-alone to Web Services



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We Already Use Services



Home | Help

MAPQUEST eHealthInsurance **GO**
 MAJOR PLANS INSTANT QUOTES BEST PRICES SUPERIOR SERVICE

MAPS DRIVING DIRECTIONS ROAD TRIP PLANNER YELLOW PAGES HELP ?

maps

- Address: 7855 Walker Dr, Greenbelt, MD 20770-3212, US
- Airport
- ZIP Code
- City
- Area Code
- Lat / Long
- Road Atlas Key
- Saved Maps

What's Nearby

Search for the nearest:

- BORDERS
- MapQuest

Search Clear

Orbitz Travel Deals

- Flights: Find low fares to the Baltimore area!
- Rental Cars: Find special offers on rental prices in the Baltimore area!
- Lodging: Save up to 75% on Orbitz Savers nationwide. Search Greenbelt, MD!

City Guide

- Baltimore, MD
- Baltimore, MD
- Baltimore, MD
- Baltimore, MD

ORBITZ

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Geocoding

- Products & Services
- Batch Geocoding
- ZIP11 ACG
- Postal Points
- The Eagle Geocoder
- Test Drive Eagle

EZ-Locate

- EZ-Locate Interactive
- About EZ-Locate
- Using EZ-Locate
- Getting Started
- Trial Account
- Download Area
- Account Subscription

Test Drive Eagle

Test drive Tele Atlas North America's Eagle geocoding technology

These results are presented as a demonstration of Tele Atlas North America's geocoding technology. Use of these results is limited to evaluation of Tele Atlas North America's geocoding technology for the purpose of purchasing Tele Atlas North America's Geocoding Services. **Any other use is strictly prohibited.** License to use these results for other uses may be obtained via the purchase of Geocoding Services or an EZ-Locate subscription.

You may geocode up to 25 addresses for pre-purchase evaluation purposes via this Test Drive page. If you need to evaluate a larger quantity of addresses, please sign up for a free EZ-Locate trial account (which includes 100 free geocodes). Alternatively if you have decided to use our technology you can purchase an EZ-Locate subscription.

EZ-Locate rates begin at just \$50 and can be pre-paid with a credit card on our secure E-Commerce site. [Click here](#) to learn more about EZ-Locate pricing.

Use of this information is subject to [license](#).

7855 Walker Drive, Greenbelt, MD 20814
 EZ-Locate returned a **Near Match** from the **Tele Atlas map database**.

Matched Address	Location (WGS-84)	2000 Census
7855 WALKER DR GREENBELT, MD 20770	Lat: 36.998550 38.59; 54.780N Lon: -076.894970 76.53; 41.892W	FIPS County: MD033 DAC: 0840 Pop. Density: U MCD: MD033105 Place: MD0435
Standard Address	Postal	
7855 WALKER DR, GREENBELT, MD 20770- 3212	CARRIER: C023 DPBC: 99	TRACT: MD03306706 BLOCKGROUP: MD033067061 FIPS PLACE: MD34775 FIPS MCD: MD31900 MSA: 8840

Inset map showing the location of the matched address (red X) on a street grid.

www.gatewayguide.com

Select a Region

Gateway Guide Region

Missouri

Illinois

Real-Time Traffic Info

about gateway guide follow our progress ITS nationwide keep me in the loop MoDOT news meet the staff what's next take our survey faq links contact us

TAKE A TOUR OF OUR FACILITIES

You must download Quicktime to view our VR Tour

Get QuickTime

PRESENTED BY East-West Gateway Coordinating Council

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TerraServer

Advanced Find | Info | Download | Print | E-Mail | Help | House and Home

Search TerraServer GO

Home > Navigate Map > -74.83,40.56

72 km W of New York, New York, United States 16 Apr 1995 USGS

View: Aerial Photo

16 meter resolution

Map Size: Medium

Advanced Find

Famous Places

Web Services

About

Related Links:

Other Imagery:

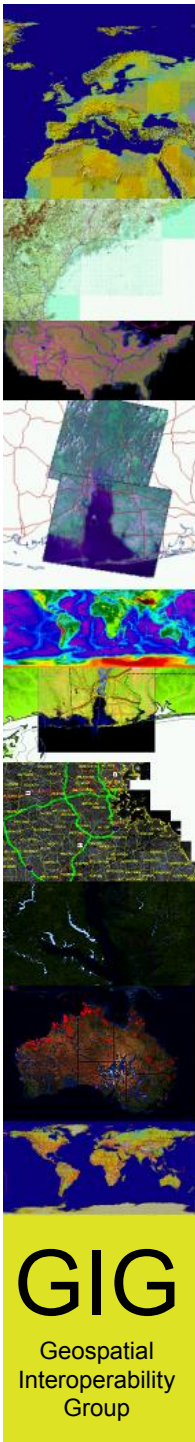
- USGS Topo Map 01 Jul 1986

House and Home:

- Homes for sale in 08822
- Homes for sale in 08833

Image courtesy of the U.S. Geological Survey

Meeting Today's Challenges



- One of the keys to meeting the complex challenges of today is the ability to discover, access, integrate and share information from multiple sources.

Homeland Security, Geospatial Intelligence, Global Change, Command and Control, Environmental Mgmt...

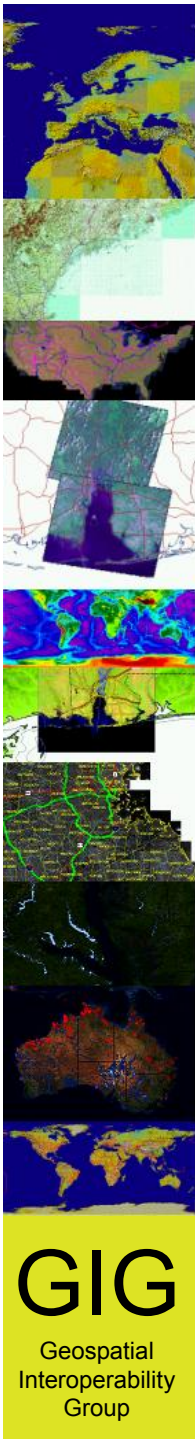


Interoperable Web Services

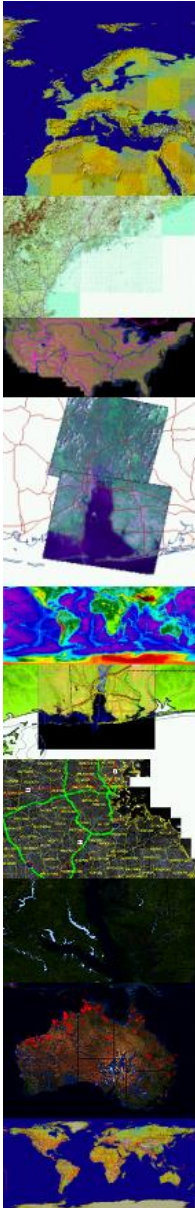


GIS Web Services: Definition

- Web Services are self-contained, self-describing, modular applications that can be published, located and dynamically invoked across the web.
 - Existing applications can be exposed as Web Services.
- Three basic categories of GIS Web Services Defined by OGC
 - **Data Services**
 - Offer access to customized portions of data
 - **Processing Services**
 - Provide operations for processing data in a manner determined by user-specified parameters
 - Coverage Portrayal Service (CPS)
 - **Registry/Catalog Services**
 - Classify, register, describe, search, maintain and access information about data and services

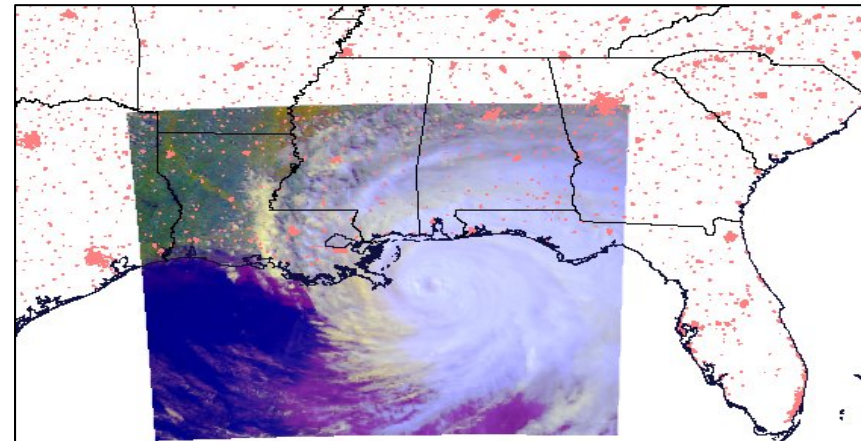


OGC Data Services: Web Mapping Service (WMS)



REQUEST1:

```
http://a-map-co.com/mapserver.cgi?VERSION=1.1.0&REQUEST=GetMap&
SRS=EPSG:4326&
BBOX=-97.105,24.913,78.794,36.358&
WIDTH=560&HEIGHT=350&
LAYERS=AVHRR-09-27&STYLES=&
FORMAT=image/png&
EXCEPTIONS=application/vnd.ogc.se_inimage
```



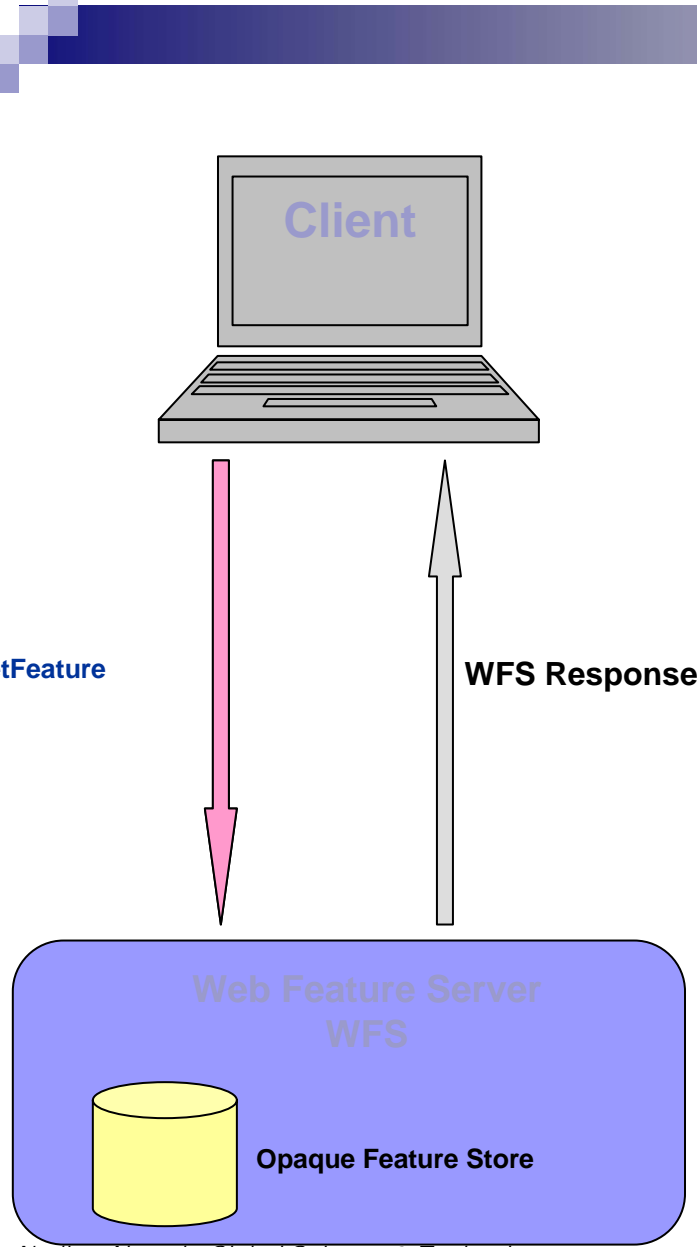
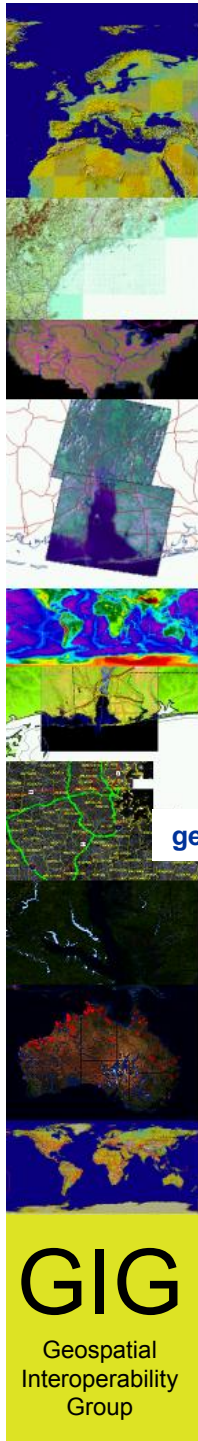
REQUEST2:

```
http://b-maps.com/map.cgi?VERSION=1.1.0&REQUEST=GetMap&
SRS=EPSG:4326&
BBOX=-97.105,24.913,78.794,36.358&
WIDTH=560&HEIGHT=350&
LAYERS=BUILTUPA_1M,COASTL_1M,POLBNDL_1M&
FORMAT=image/png&STYLES=style1,style2,style3&
TRANSPARENT=TRUE&
EXCEPTIONS=application/vnd.ogc.se_inimage
```

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OGC Data Services: Web Feature Service (WFS)



```

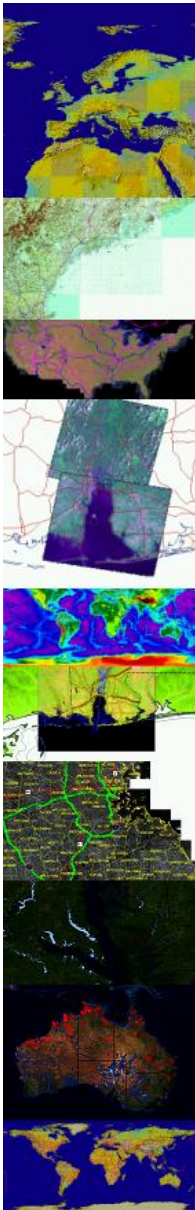
getFeature
<?xml version="1.0" ?>
<GetFeature version="1.0.0" service="WFS"
  xmlns:myns=http://www.someserver.com/myns

  <Query typeName="myns:ROADS">
    <ogc:PropertyName>myns:PATH</ogc:PropertyName>
    <ogc:PropertyName>myns:LANES</ogc:PropertyName>
    <ogc:Filter>
      <ogc:Within><ogc:PropertyName>myns:PATH</ogc:PropertyName>
      <gml:Box>
        <gml:coordinates>50,40 100,60</gml:coordinates>
      </gml:Box>
    </ogc:Within>
    </ogc:Filter>
  </Query>
</GetFeature>
  
```

```

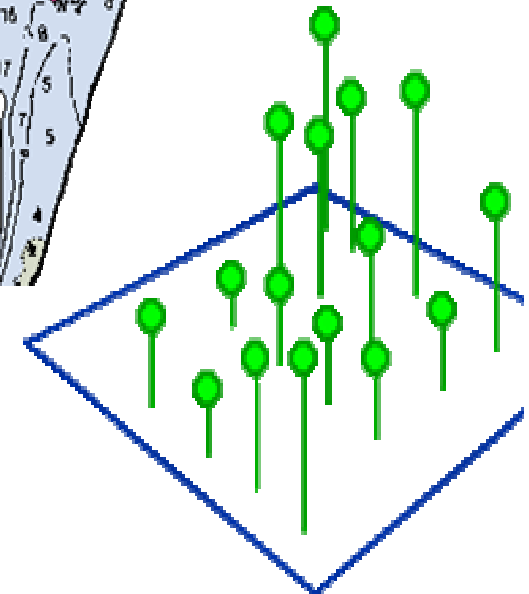
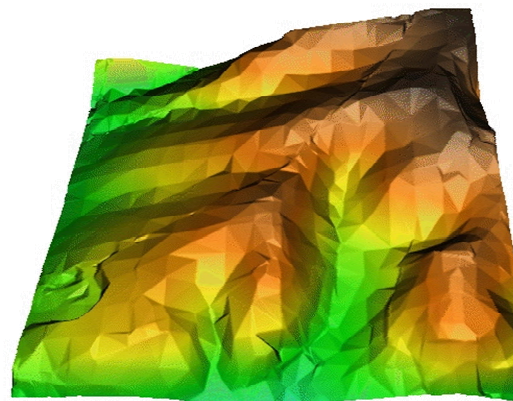
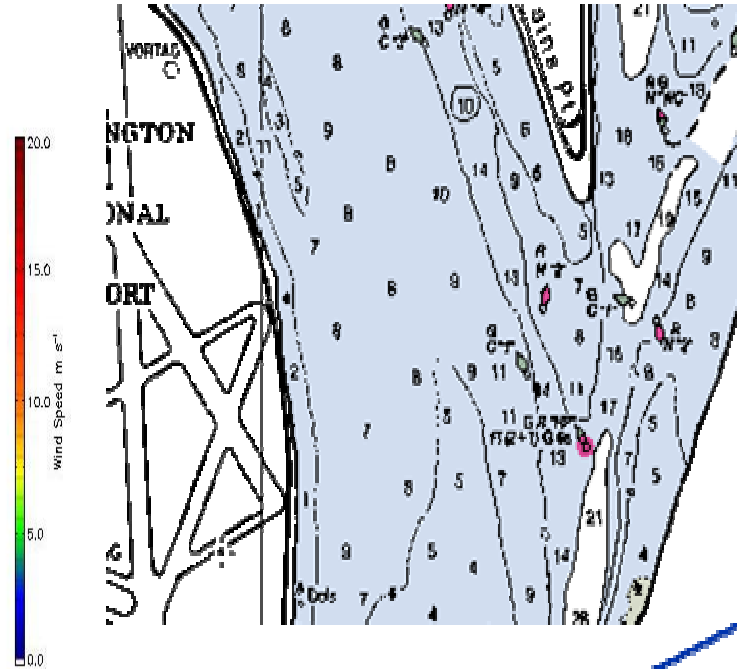
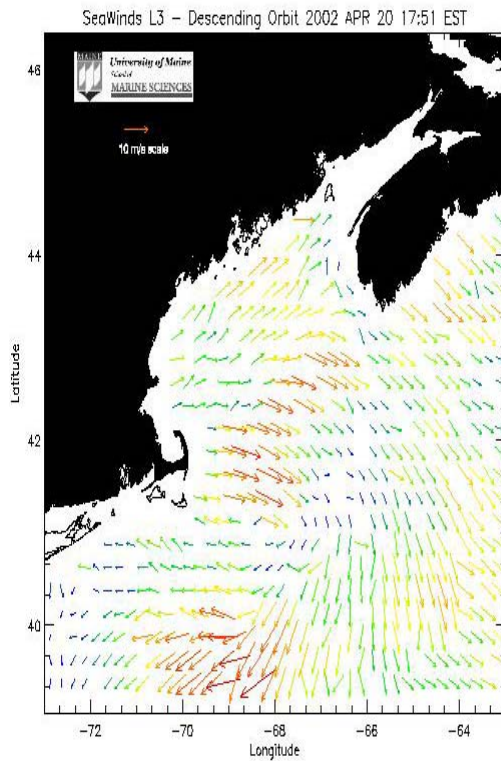
<?xml version="1.0" ?>
<wfs:FeatureCollection
  <gml:featureMember>
    <ROADS fid="ROADS.100">
      <PATH>
        <gml:LineString gid="1" srsName="epsg.xml#4326">
          <gml:coordinates>10,10 10,11 10,12 10,13</gml:coordinates> </gml:LineString>
        </PATH>
        <NLANES>4</NLANES>
      </ROADS>
    </gml:featureMember>
    <gml:featureMember>
      <ROADS fid="ROADS.105">
        <PATH>
          <gml:LineString gid="2" srsName="epsg.xml#4326">
            <gml:coordinates>10,10 10,11 10,12</gml:coordinates> </gml:LineString>
          </PATH>
          <NLANES>2</NLANES>
        </ROADS>
      </gml:featureMember>
    </FeatureCollection>
  
```

OGC Data Services: Web Coverage Service (WCS)



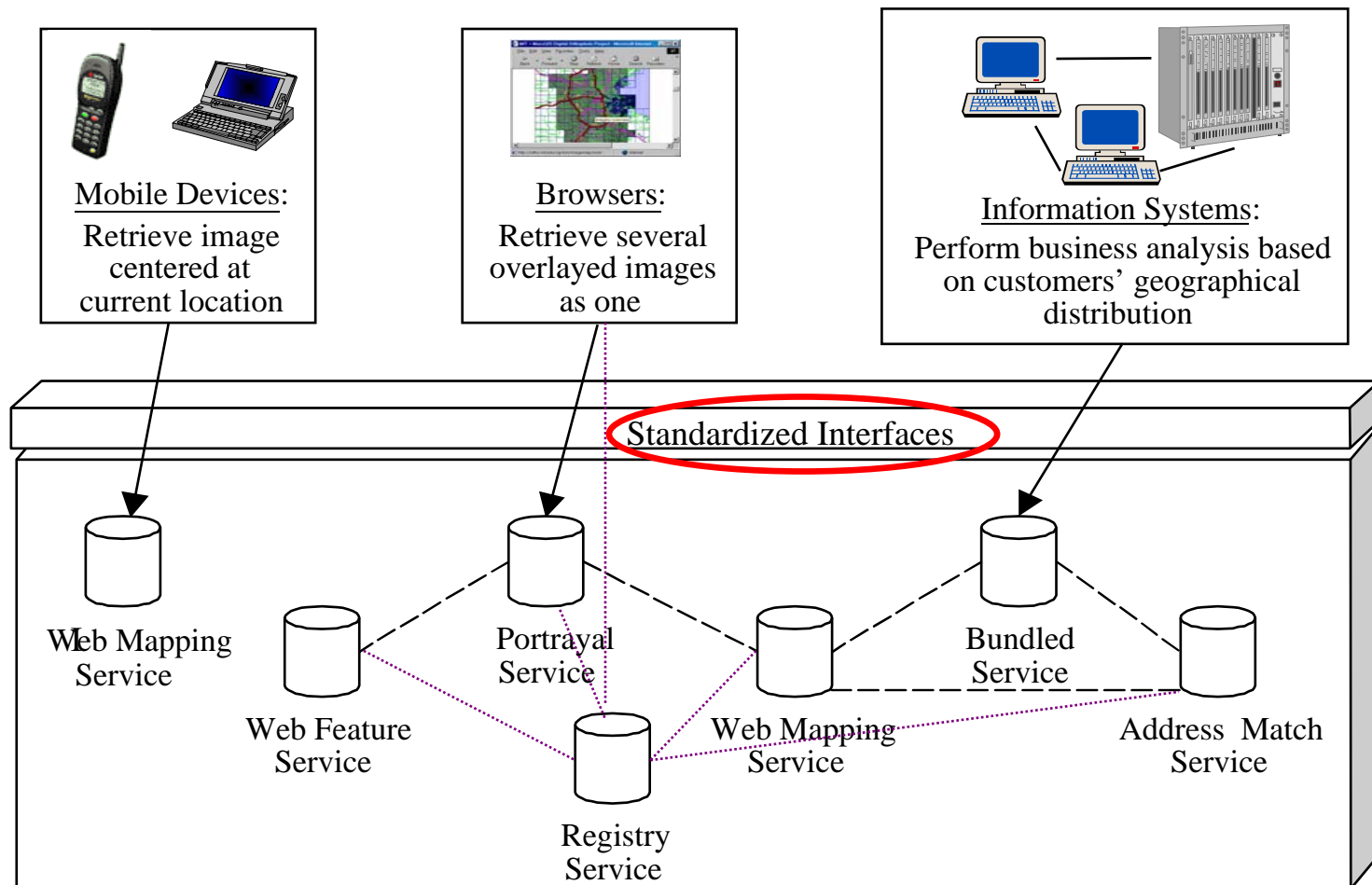
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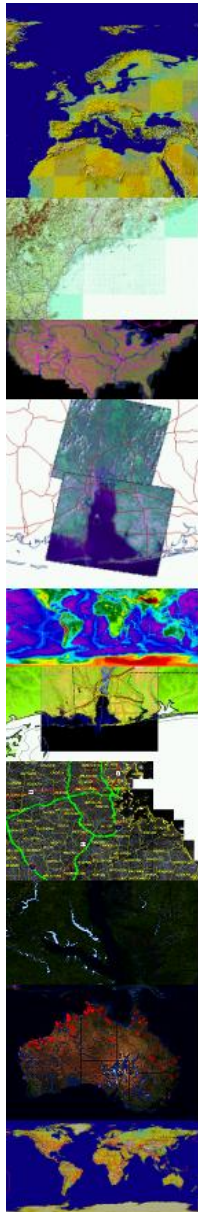


GIS Web Services: Architecture

- Applications can be dynamically assembled from multiple network-enabled web services for use by a variety of client applications.
- Lower the learning curve
- Share data and services more effectively
- Cut system integration and deployment cost
- Learn, use/get and pay only for what you need

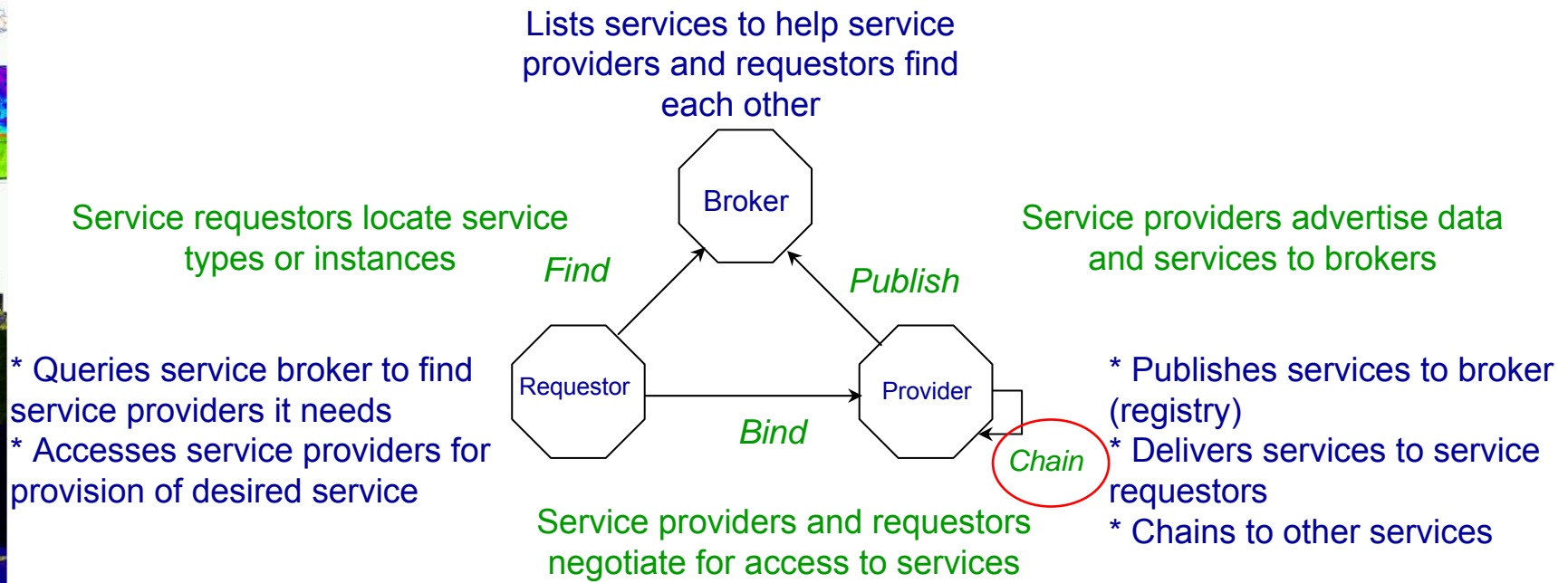


GIS Web Services: Publish/Find/Bind Pattern



Roles

Operations

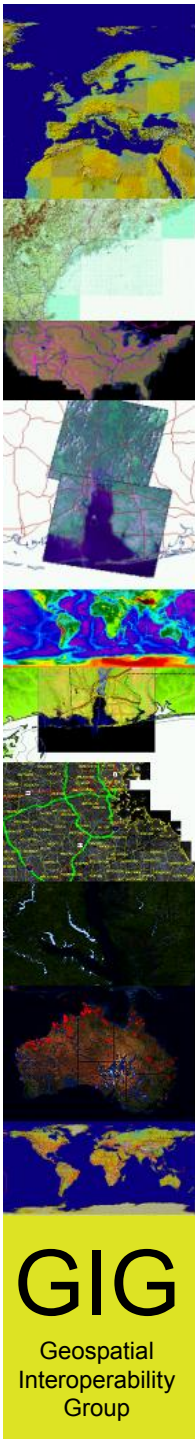


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Interoperability & Role of Open GIS Consortium

- Defining/refining the GIS Web Services framework
- Defining the core service types and their behaviors
- standardizing request/response parameters
 - And various bindings (http get, post, SOAP, etc)
- Defining the Service Information Model and operations common to all services
 - Example: getCapabilities
- Standardizing encodings
 - Styled Layer Descriptors (SLD)
 - Geography Markup Language (GML)
- Identifying registry requirements (defining the Registry Information Model)
- Adopting, extending and customizing (when possible) general web services technologies

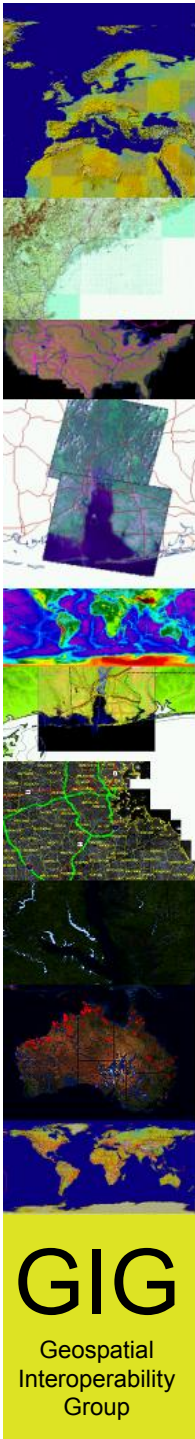


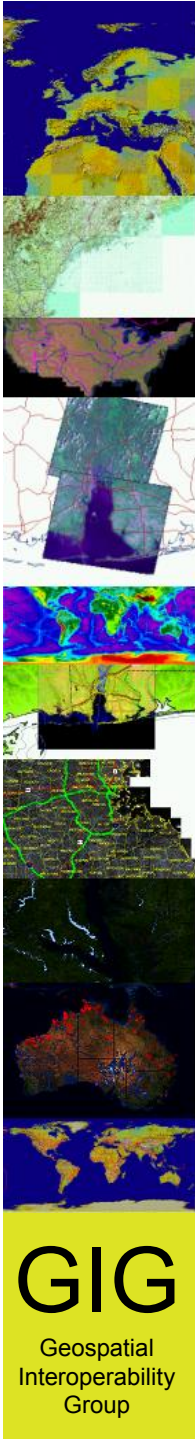
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Leveraging General Web Services Technologies

- XML
- **Web Service Description Language (WSDL)**
 - Provides a standard way to describe service operations and associate these interfaces with different bindings
 - Does not provide a way to describe service data contents and content types
 - Limitations of proxy generators
- **Uniform Description, Discovery and Integration (UDDI)**
 - Provides a standard way to register and discover registered businesses and services
 - Does not provide a way to perform a bounding-box search
- **SOAP**
 - XML-based protocol designed to exchange structured and typed information on the web
 - Could be helpful to enable service chaining



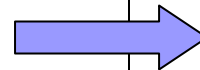


Leveraging General XML Technologies

Web Service Description Language (WSDL)

- Provides a standard way to describe service operations and associate these interfaces with different bindings
- Proxy generators are still evolving
- Does not provide a way to describe service data contents and content types

```
<definitions>....  
<message name="AddInput">  
  <part name="op1" element="xsd:int"/>  
  <part name="op2" element="xsd:int"/>  
</message>  
<message name="AddOutput">  
  <part name="result" element="xsd:int"/>  
</message>  
<portType name="AddPortType">  
  <operation name="Add">  
    <input message="AddInput">  
    <output message="AddOutput">  
  </operation>  
</portType>  
</definitions>  
  
<binding name="b" type="AddPortType">  
<http:binding verb="GET"/>  
  <http:operation location="http://example.com/o1">  
    <input> <http:urlEncoded/></input>  
    <output> <mime:contentType="text/html"/></output>  
  </operation>  
</binding>
```



<http://example.com/o1?op1=5&op2=6>

Leveraging General XML Technologies Uniform Description, Discovery and Integration (UDDI)

- Provides a standard way to register and discover registered businesses and services
- Does not yet provide a way to perform a bounding-box search

Systinet WASP UDDI, 4.0 SP1 - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address <http://sindbad.gsfc.nasa.gov:8080/uddi/web>

Systinet WASP UDDI, 4.0 SP1 User nc

Main > Find business > Find business results > View business

View business

Business default name: CubeWerx Inc.
Business owner: pvretano
Business key: 4cd200a0-941a-11d6-876f-b8a03c50a862

Details Services Contacts Categories Identifiers Discovery URLs Permissions

Names

business name	language code
CubeWerx Inc.	English

Descriptions

description	language code
Software vendor selling web enabled geospatial data warehouse products.	English

Edit Delete Back

Main
Home
Find business
Find service
Find binding
Find tModel
Direct get
Publish

User
Login
Register

Taxonomies
Browse
Validate

Information
Help
Tutorial
Demo
FAQs
Documentation
Contact

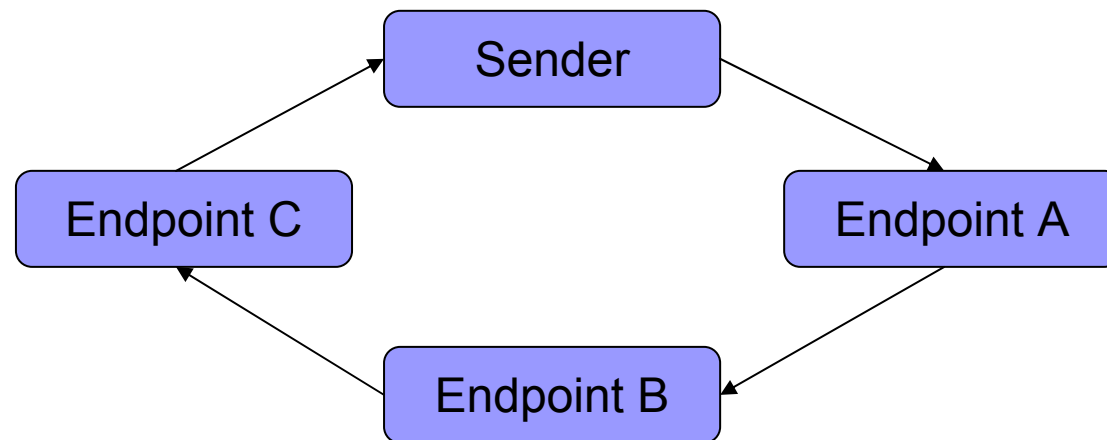
Resources
uddi.org
systinet.com
zvon.org

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Leveraging General XML Technologies

Simple Object Access Protocol (SOAP)

- XML-based protocol designed to exchange structured and typed information on the web
- Defines a model for exchanging messages
 - Intermediaries: endpoints that function as both sender and receiver, passing messages that they receive on to other endpoints
 - Actor attribute: a URI that identifies the endpoint the Header element entry is targeted for.



Workflow

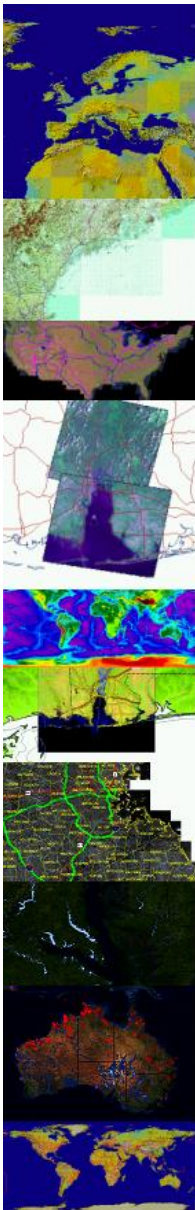
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Leveraging General XML Technologies

- **DAML-Based Web Service Ontology (DAML-S)**
 - Core set of markup language constructs for describing the properties and capabilities of Web services in an unambiguous, computer-interoperable form.
 - Supports automatic selection, composition and interoperation of Web services
 - Declarative specifications of the prerequisites and consequences of individual service use

- **Web Services Flow Language (WSFL)**
 - XML language for the description of Web services compositions
 - Describes how to choreograph the functionality provided by a collection of Web services, and describes how these services interact with each other
 - Expresses
 - Transition conditions, exit conditions, synchronization, forking and parallelism, input and output of flows, etc

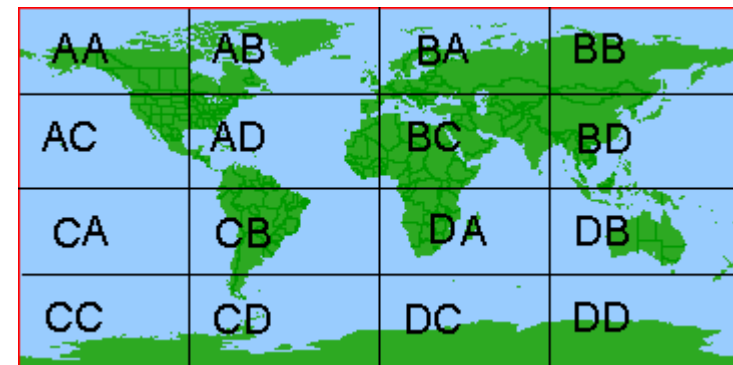
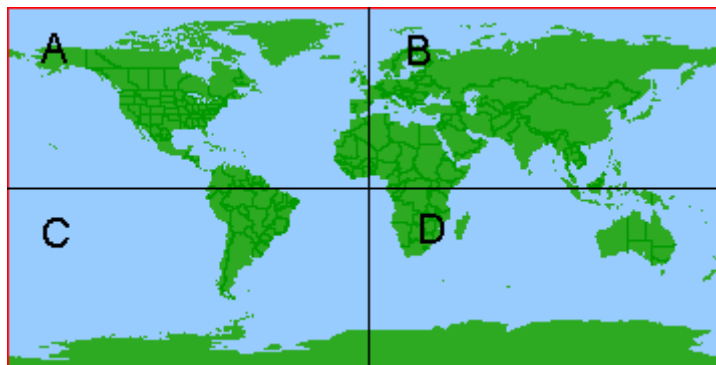


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Relevant OGC Work

- OWS1.2 SOAP Experiment
 - RPC vs. Document/Literal
 - Issues with proxy generators (Apache axis, Visual Studio .net, SOAP lite)
- UDDI 1.2 UDDI Experiment
 - Quad-tree taxonomy to simulate spatial-search
 - Each quadrant labeled with a letter that is the quadcode for that quadrant



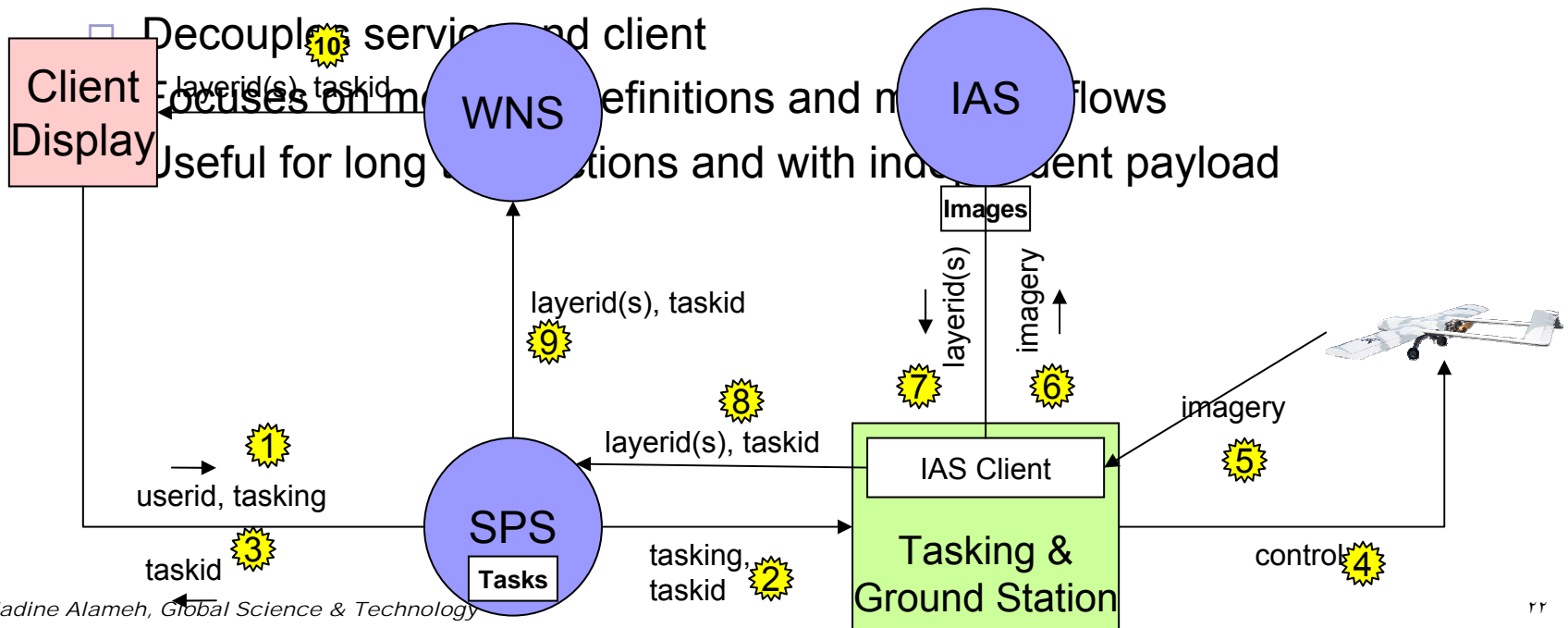
Other Relevant OGC Work

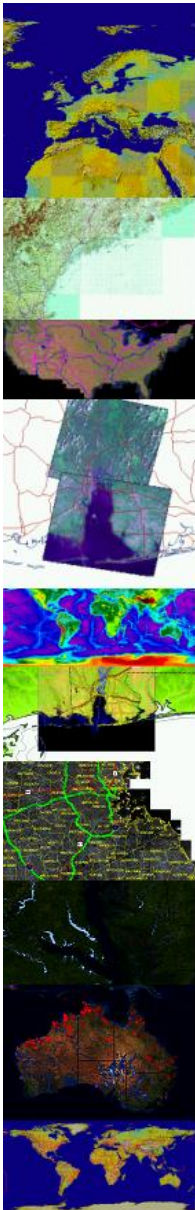
Web Notification Service

- First asynchronous messaging service specified by OGC
- Sends notifications of well-structured content to a client.
- Useful when many collaborating services are required to satisfy a client request and/or when significant delays are involved in satisfying the request.

Messaging Framework

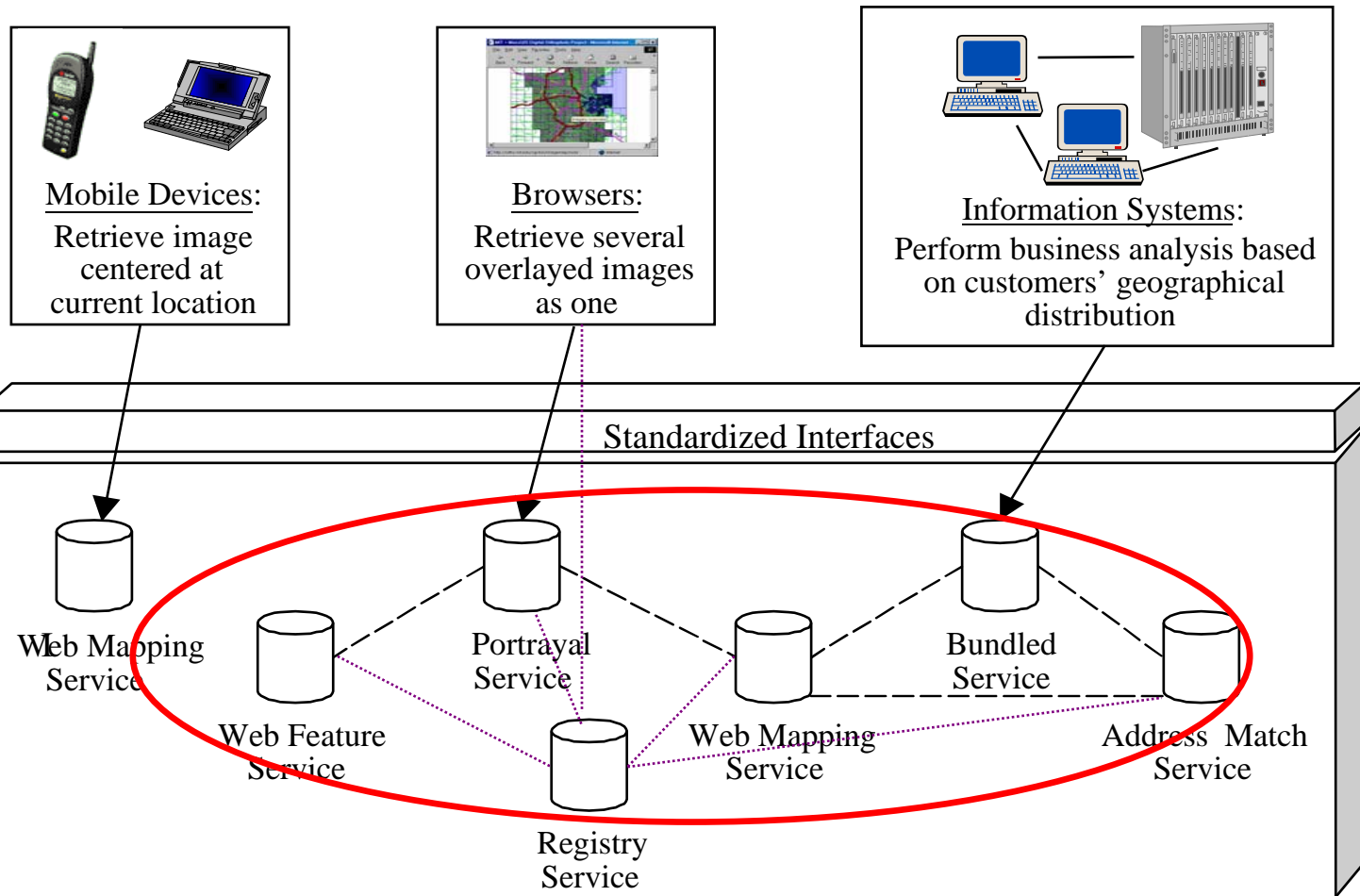
- Decouples service and client
- Focuses on metadata definitions and metadata flows
- Useful for long duration operations and with independent payload





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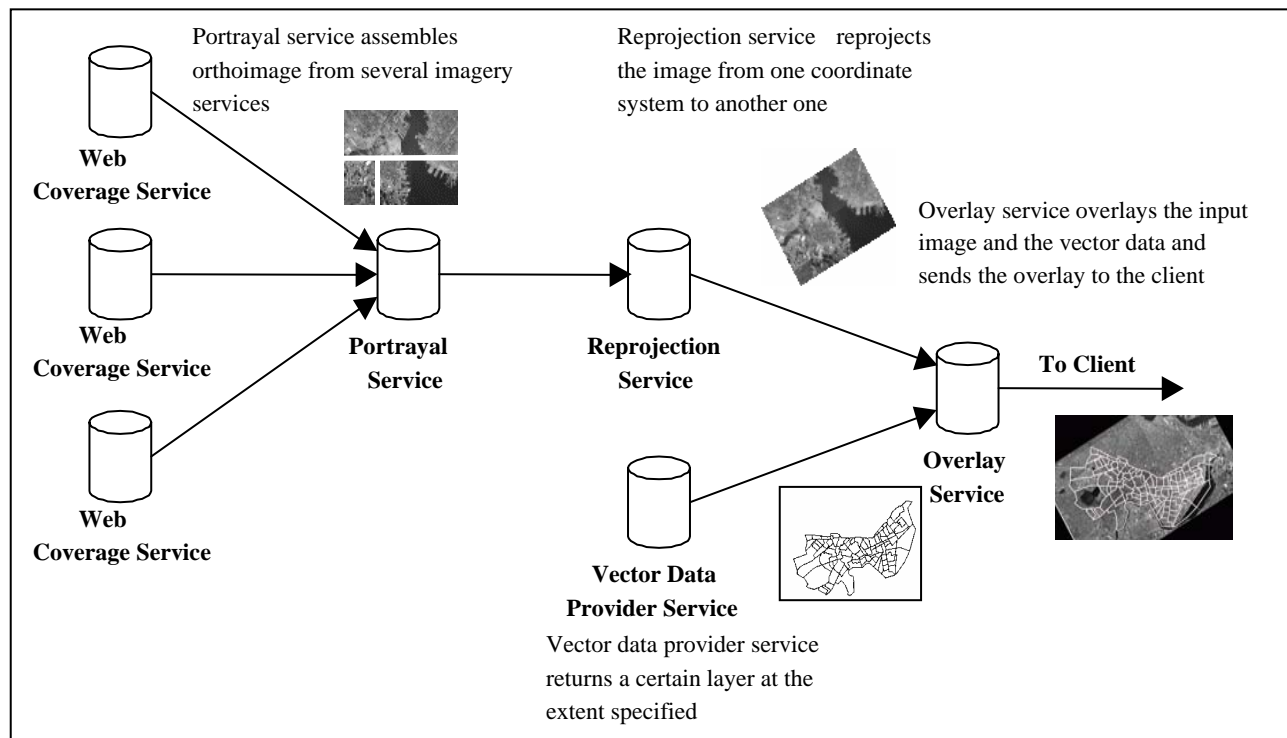
Application Development using GIS Web Services

■ Service Chaining

- When a task needed by a client cannot be provided by a single service, but rather by combining or pipelining results from several complementary services.

■ Key Issues

- Chaining transparency, metadata tracking, error reporting, synchronicity



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Service Chaining

- **Client-defined transparent chaining**
 - Client controls order and execution of services
- **Opaque chaining**
 - Aggregate service bundles static (pre-defined chains)
- **Workflow-managed chaining**
 - Mediating service acts as gateway to other services by coordinating between multiple services
 - Chains are constructed dynamically to meet pre-defined client requirements
 - Likely to be tuned to specific domains



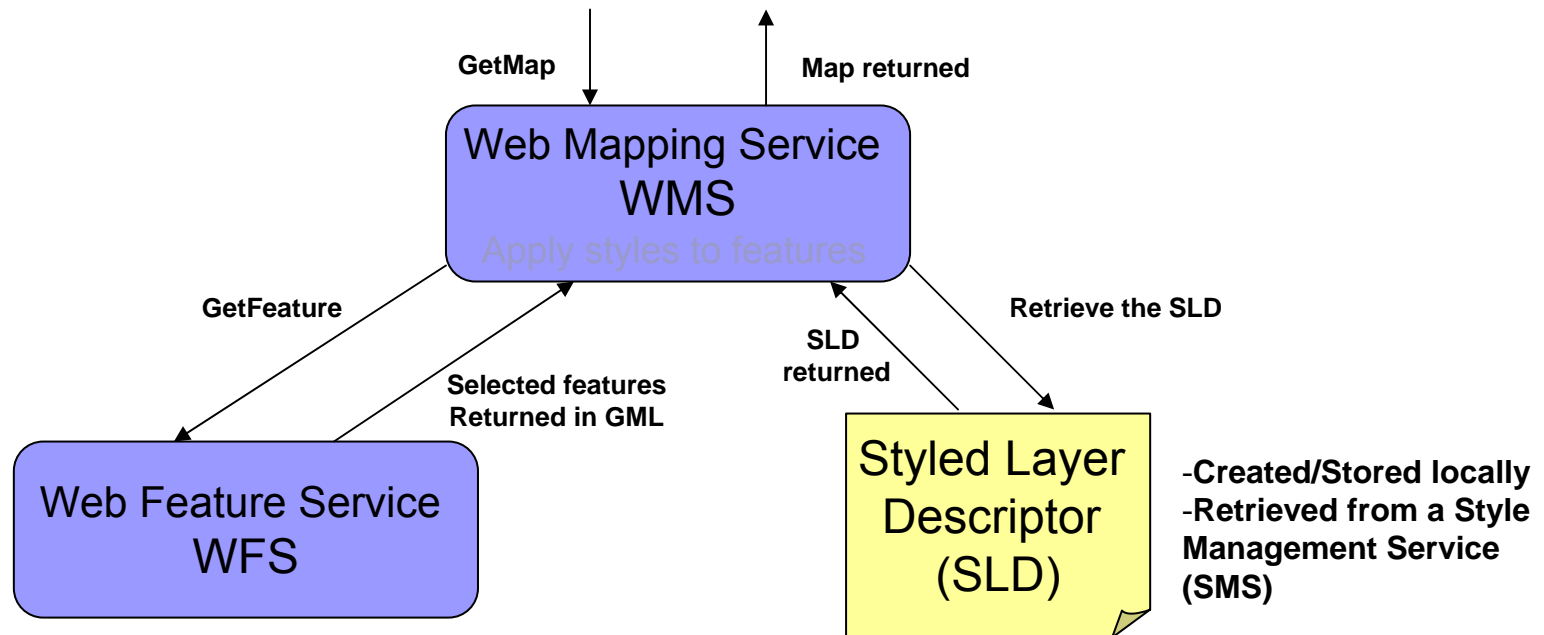
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Client-Coordinated Service Chaining

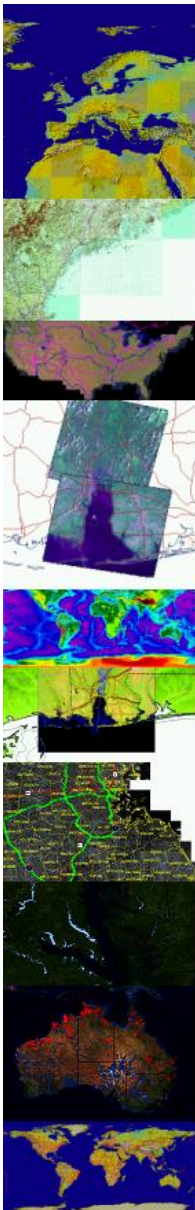
- Client controls order and execution of services
- Clients often directly embed, in the input of one service, a request to the following service

REQUEST: http://yourfavoritesite.com/WMS?VERSION=1.0.5&REQUEST=GetMap&SRS=EPSG%3A4326&BBOX=0.0,0.0,1.0,1.0&SLD=http%3A%2F%2Fmyclientsite.com%2FmySLD.xml&WIDTH=400&HEIGHT=400&FORMAT=PNG&REMOTE_OWS_TYPE=WFS&REMOTE_OWS_URL=http%3A%2F%2Fanothersite.com%2FWFS%3F



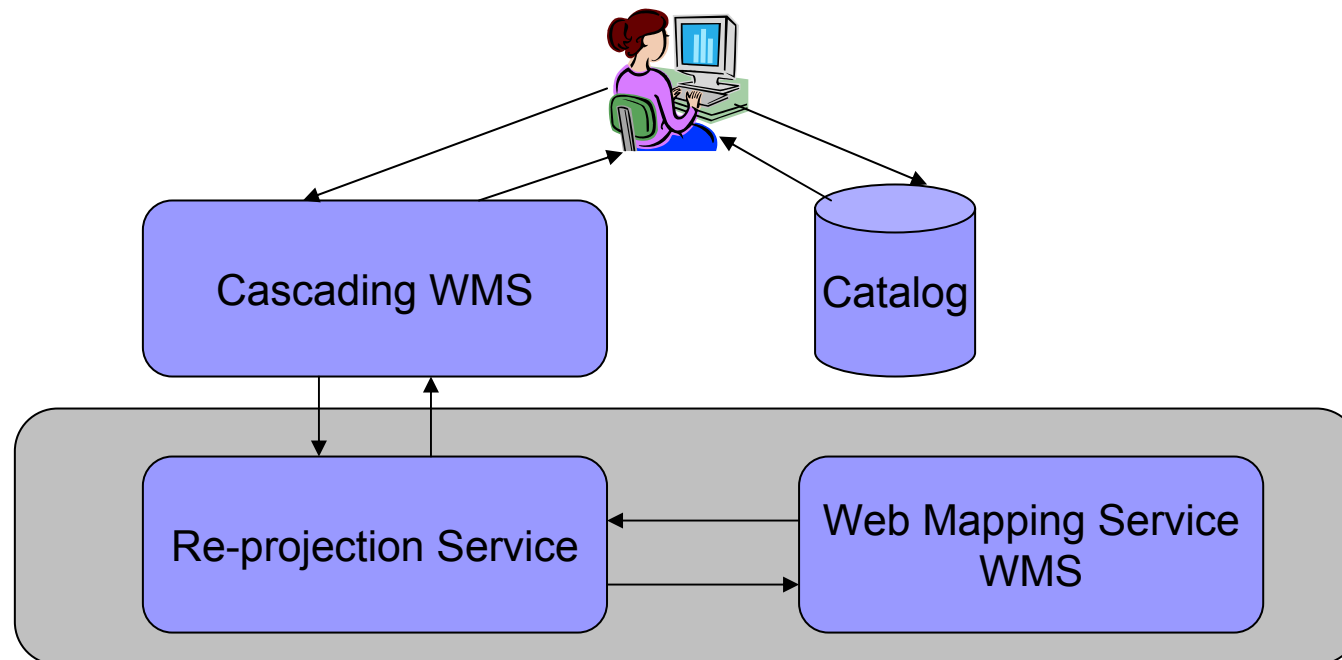
Client-Coordinated Service Chaining

- Client controls order and execution of services
- Clients often directly embed, in the input of one service, a request to the following service
- Issues
 - Requires the client to know about the types of services needed for a particular operation
 - Introduces complexities in the areas of error handling
 - Forces the client to deal with delays and failures
 - Especially in the synchronous case



Static Chaining using Aggregate Services

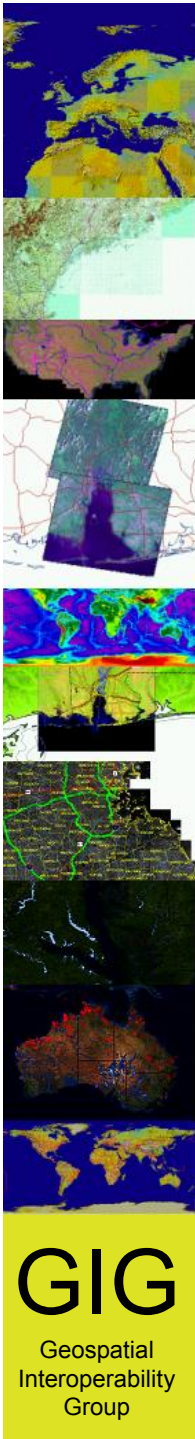
- Aggregate service bundles static (pre-defined chains)
- Issues
 - Loss of flexibility and control by client
 - Need to differentiate between basic and aggregate services



Workflow-Managed Service Chaining

- Mediating service acts as gateway to other services by coordinating between multiple services
 - Chains are constructed dynamically to meet pre-defined client requirements
 - Mediating service matches the output of one service to the input of the next one
 - Likely to be tuned to specific domains

- Issues
 - Capturing application or chaining requirements of client
 - May create inconsistencies in the responses received by the client
 - Require a degree of intelligence and a framework
 - Service types
 - Relationship between services
 - Automatic generation of requests
 - Orchestration language
 - Authentication, billing and ordering
 - Other over-arching issues
 - Synchronous vs. asynchronous services
 - Notification mechanisms

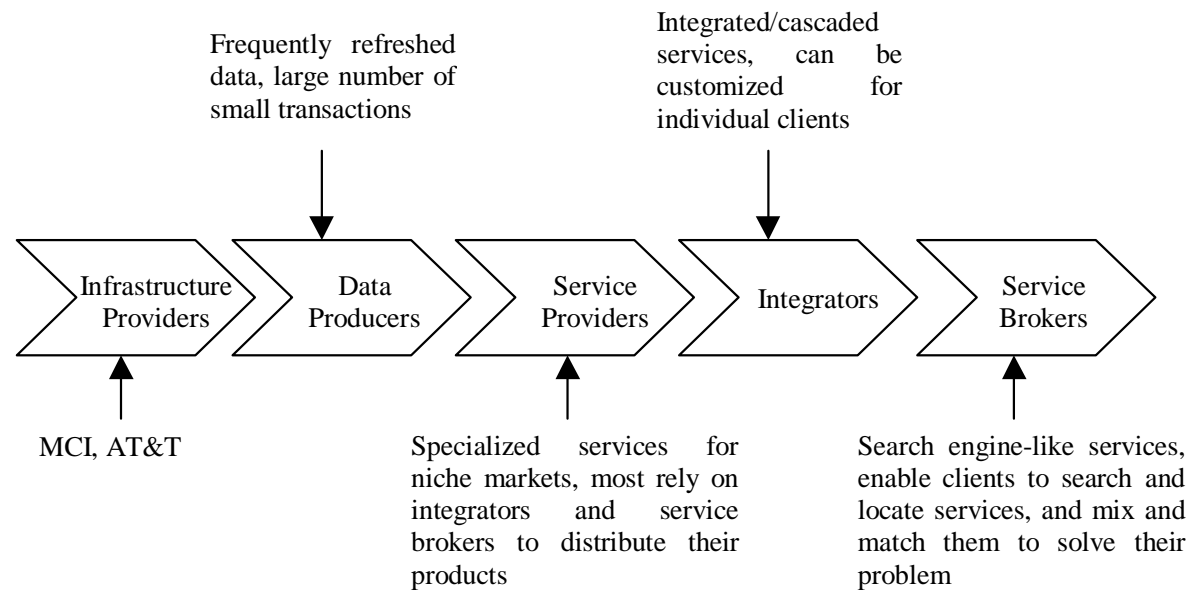


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Shaping the Future GIS Marketplace

- Changes in GIS marketplace
 - Unbundling of GIS into independently-provided interoperable components
 - Delivery of subsets of data to users on demand

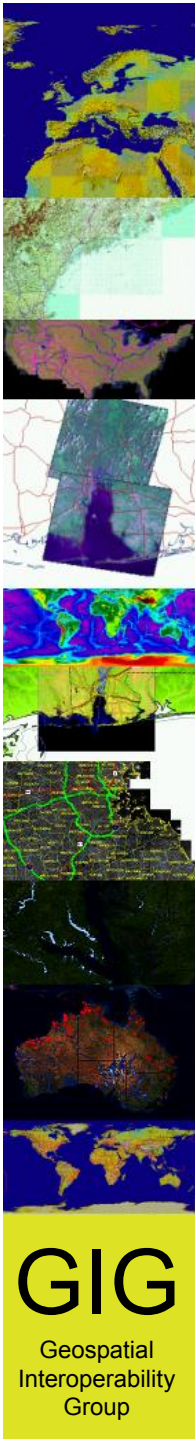


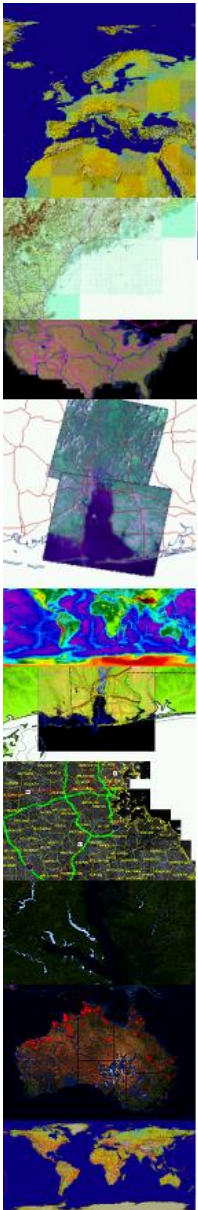
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Conclusion (s)

- Applications of Web Services in the GIS field are promising.
- Existing functionality can be exposed as Web Services.
- GIS Web Services are more than browser-based web mapping.
- GIS Web Services do not replace traditional stand-alone systems. They complement them.
- General IT technologies need to be leveraged as much as possible.
- Current technologies do not yet satisfy all the requirements of a geo-spatial application community.
- Both synchronous and asynchronous services are needed.
- Interoperability is critical in the described Web Services environment.
- Other challenges
 - Security
 - Scalability
 - Managing change



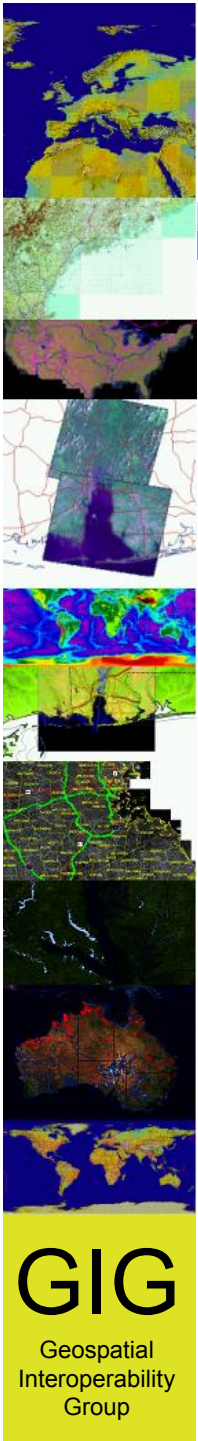


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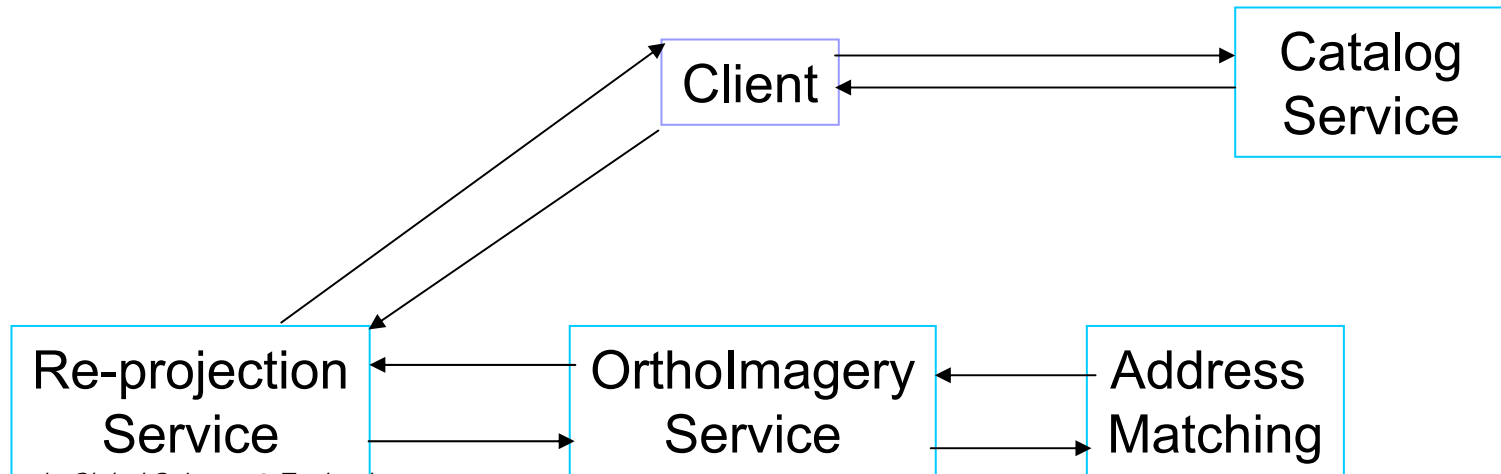
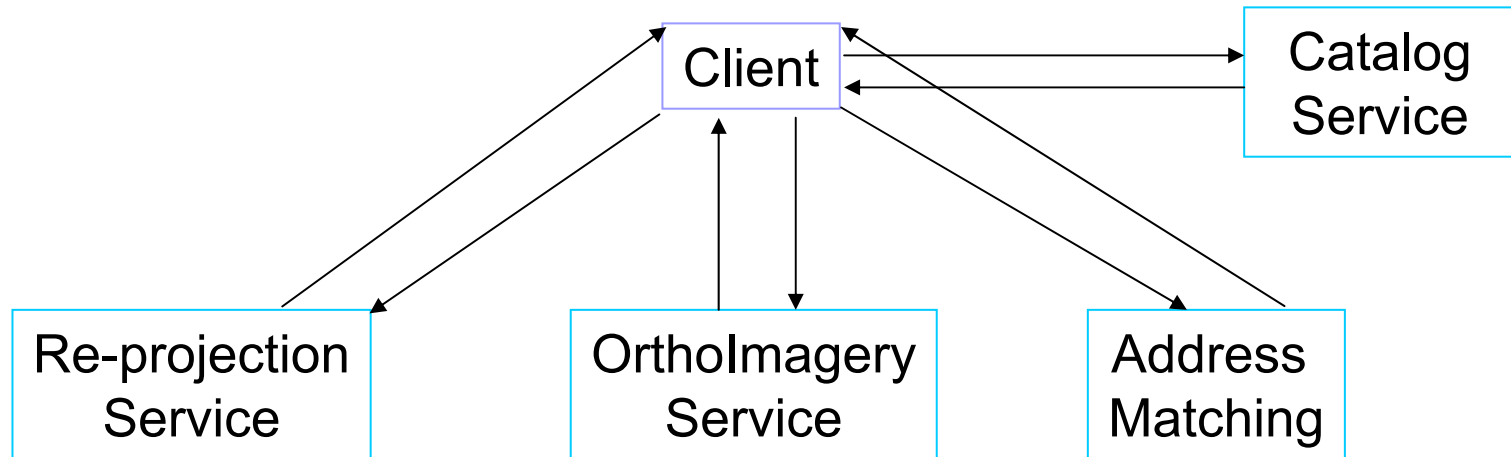
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Thank You!
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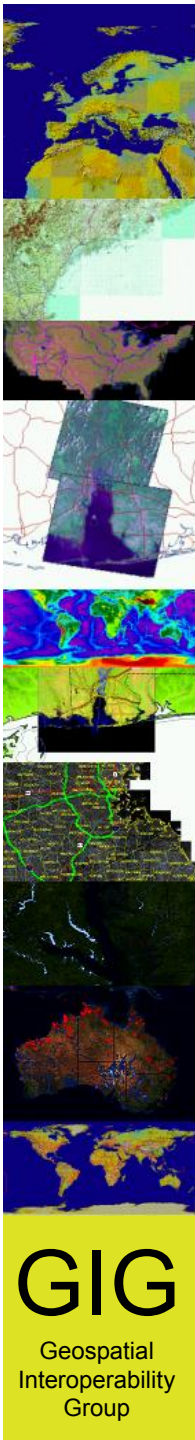
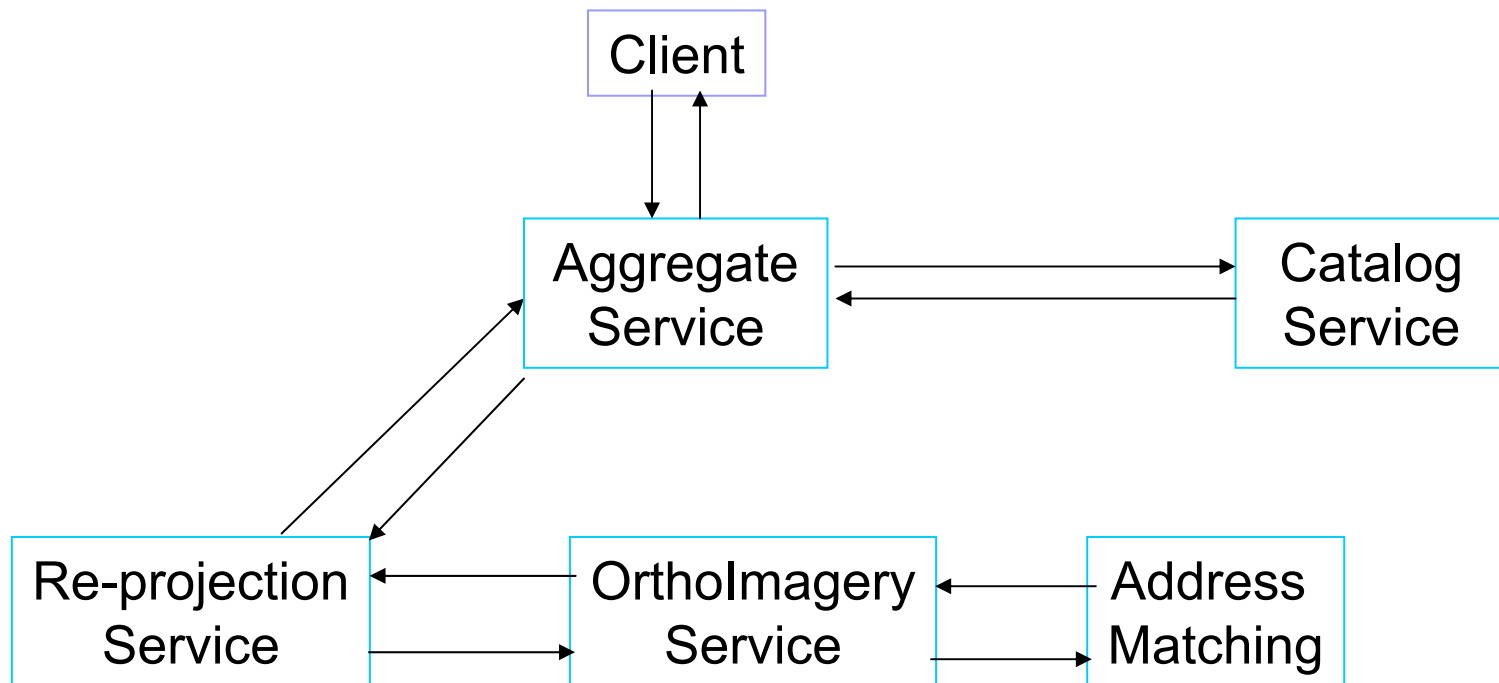
User-Defined Chaining

- Chaining is transparent: User defines and controls the order of execution of the individual services.



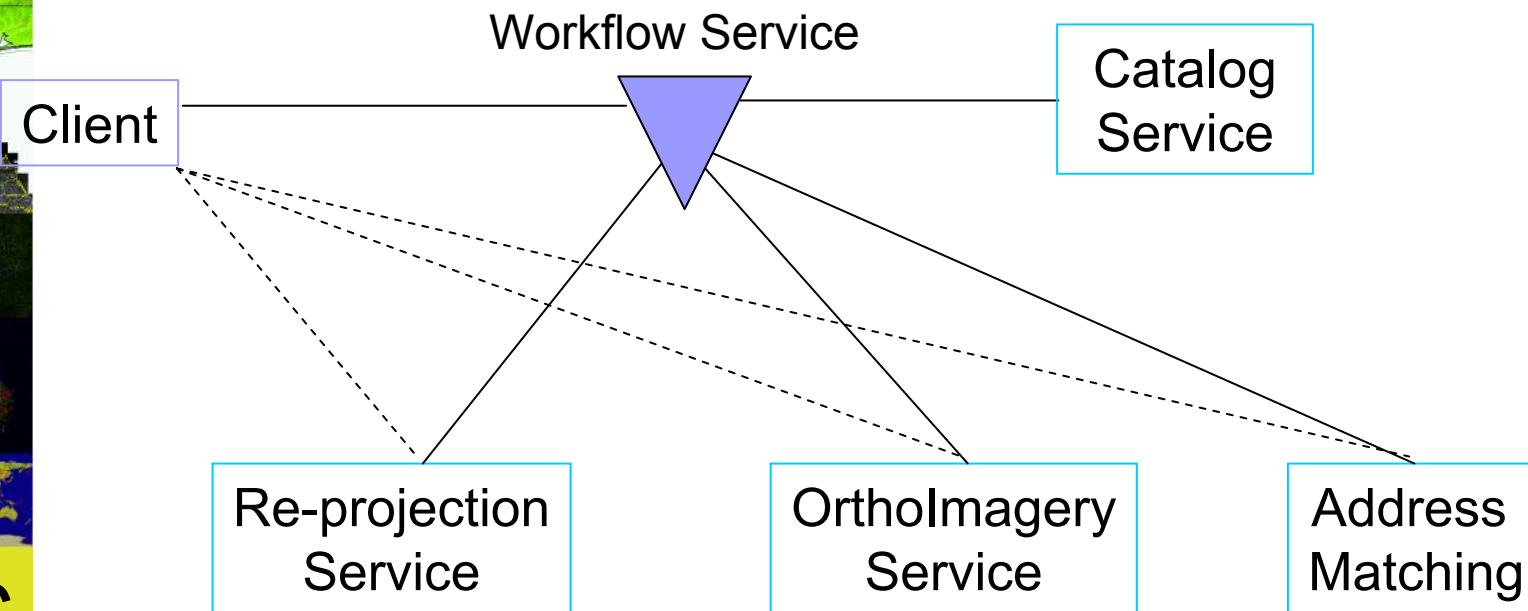
Aggregate Service

- Chaining is opaque: the services appear as a single service which handles all coordination of the individual services behind the aggregate service. The user has no awareness that there is a set of services behind the aggregate service.



Workflow-Managed Chaining

- Chaining is translucent (in between transparent and opaque): execution of the chain is managed by a workflow service. User may select a chain of interest that is executed by the workflow service.



Opportunities

- Portals for Community Statistics Field
 - Focus on providing specialized aggregate and workflow services
 - Customize chains and combine services to meet community statistics needs
- Sophisticated tools:
 - Tools for users to construct and customized their own chains
 - Tools for finding the right services based on characteristics such as service scope, performance, service/data quality, price
 - Tools for constructing “optimal chains”: least expensive, minimum number of constituent services, most accurate results, etc.
- Challenge
 - Sustainability of such a service-based architecture requires standards and well-defined interfaces for the underlying services

