2008 ESRI Developer Summit

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Working with ArcGIS Server Web Services Using the SOAP API

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Introductions

Please silence devices

- **Who are we?**
  - **Sud Menon**
  - **Julio Andrade**
  - **Rex Hansen**
- **Who are you?**

- **Please complete the session survey – we take your feedback seriously!**

Agenda

- Brief overview of ArcGIS Server Web Services

- 9.3 SOAP API Walkthrough :
  - Functional capabilities of each GIS web service
  - The SOAP API for the service
  - Sample applications that consume the service

- SOAP API : Under the Hood
  - Implementation details of interest to you

ArcGIS Server Web Services - Overview

- ArcGIS Server has a rich set of GIS Web Services
- You can work with Web Services using the following api's / interfaces :
  - SOAP
  - REST
  - OGC

ArcGIS Server – Publishing GIS Web Services

- Author GIS resources (eg maps, locators) using desktop.
- Publish GIS resources to create GIS Services.
- A GIS Service may have multiple capabilities
  - Eg Mapping, Network Analysis
- Each capability is exposed to consumers as an independent GIS Web Service accessible over HTTP via SOAP or REST

ArcGIS Server : SOAP Web Service URLs

- A standard scheme for all SOAP web service URLS :
- http://<hostname>/<arcgis_instance>/services/<folder>/<servicename>/<servicetype>
- http://gis.mybiz.com/arcgis/services/usa/mapserver
- http://gis.mybiz.com/arcgis/services/northernca/SanFranciscoLocator/geocodeserver

- To get the wsdl :
- http://gis.mybiz.com/arcgis/services/usa/mapserver?wsdl

ArcGIS Server SOAP Web Services - Out of the Box Clients

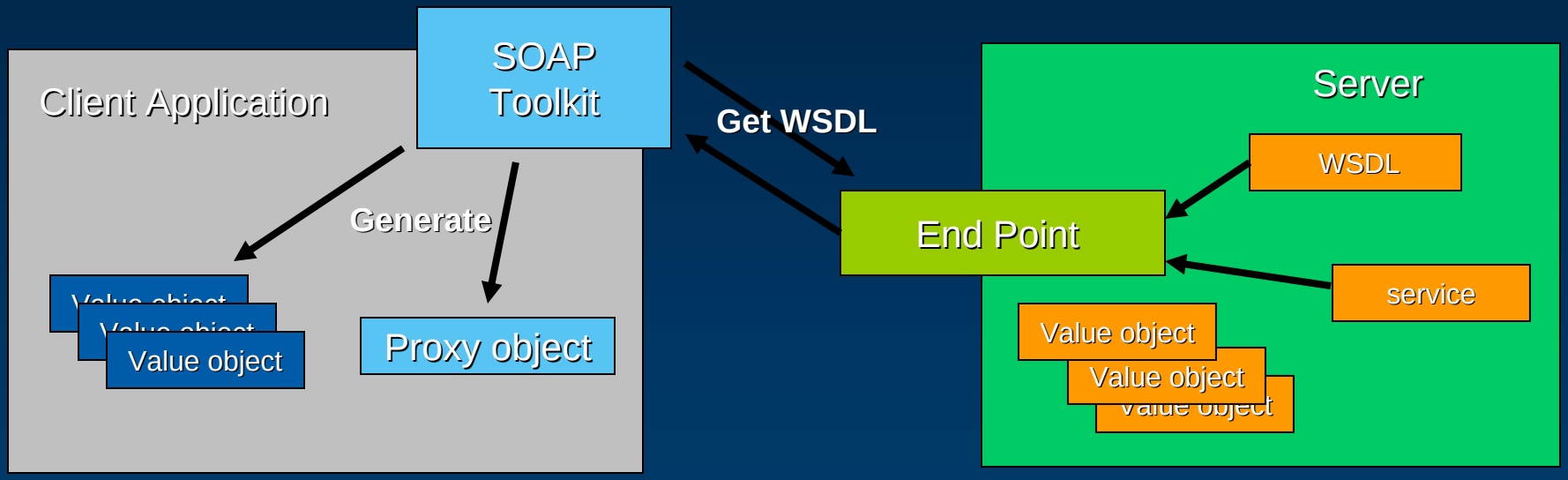
- ArcGIS Explorer and ArcGIS Desktop are out of the box Desktop Clients
- You can use Manager wizards to build Web Mapping Applications that consume GIS Web Services
  - **`no programming required`**

Options for Developing Custom Client Applications that use SOAP Web Services

- **Work with the Web ADF object model (for web apps)**
  - Use the ArcGIS Server Internet data source
- **Work with ArcGIS Engine (for desktop apps)**
  - Use the ArcEngine object model and controls
  - Use MapServiceLayers, WebLocators and built-in ArcObjects proxies for each web service
- **Work directly with the SOAP API**
  - The focus of this presentation
  - You can use pre-generated proxies that ship with the .Net and Java Web ADFs, eg ESRI.ArcGIS.ADF.ArcGISServer
  - You can generate the proxies yourself using your favourite wsdl tool

Working with a SOAP service

- You work with Proxies and Value objects
  - Generated from a WSDL using a SOAP toolkit



SOAP Web Services - Advantages

- easily accessible from .Net, Java, C++
- well defined interface contract
- lets you take advantage of compile time type checking
- lends itself to standard OO programming
- fully integrated into IDE's
  - Class documentation, Full intellisense

The ArcGIS Server SOAP API

- **Coarse Grained**
- **Stateless**
- **Described by a *wsdl* -** the calling contract for the service
- **Methods take serializable Value objects (simple structures) as parameters**
- **Value Objects are based on existing well known ArcObjects types**
  - **Eg Color, Symbol, Graphic Element, Geometries, DataElements**
- **Simple**
- **Powerful**

SOAP Web Services in 9.3

- **Service Catalog Service** – discover the services on this server
- **Map Service** – draw maps, query data
- **Geocoding Service** – address to location, location to address
- **Geometry Service** – projection, densification, buffering
- **Network Analysis Service** – routing and network problem solving
- **Image Service** - access to large image repositories
- **Geoprocessing Service** – synchronous and asynch spatial analysis
- **Geodata Service** – data discovery, query, extraction and replication

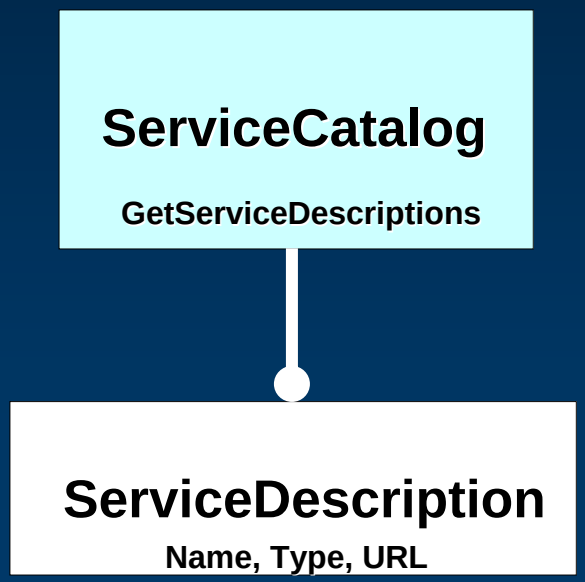
- Mobile Service (accessed using the Mobile ADF client)
- Globe Service (accessed using the ArcEngine client)

Discovering Services – The Service Catalog Web Service

Every ArcGIS Server has a Service Catalog Web Service :

```
http://<web server hostname>/<arcgis instance>/services?wsdl
```

- What Services do you have ?



WSDL

Method

```
<xs:element name="GetServiceDescriptions">
  <xs:complexType/>
</xs:element>
```

Response

```
<xs:element name="GetServiceDescriptionsResponse">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="ServiceDescriptions"
                  type="ArrayOfServiceDescription"/>
    </xs:sequence>
  </xs:complexType>
</xs:element>
```

Value Object

```
<xs:complexType name="ArrayOfServiceDescription">
  <xs:sequence>
    <xs:element name="ServiceDescription"
                type="ServiceDescription"
                maxOccurs="unbounded"/>
  </xs:sequence>
</xs:complexType>
```

Value Object

```
<xs:complexType name="ServiceDescription">
  <xs:sequence>
    <xs:element name="Name" type="xs:string"/>
    <xs:element name="Type"  type="xs:string"/>
    <xs:element name="Url"   type="xs:string"/>
  </xs:sequence>
</xs:complexType>
```

Map Service

- Based on a Map Document (.mxd) authored using ArcMap
- Can be used to dynamically generate map images in a variety of image formats
- Can be used to overlay additional information on top of the map
  - Graphics
  - Selection IDs and buffer distances

Map Service

- Can be used to identify features
- Can be used to query features
  - Results returned as Geodatabase record sets
  - Easily marshaled by value
  - Can be converted to ADO.NET datasets
  - Can return densified geometries (new at 9.3)
  - Can return geometries as KML (new at 9.3)

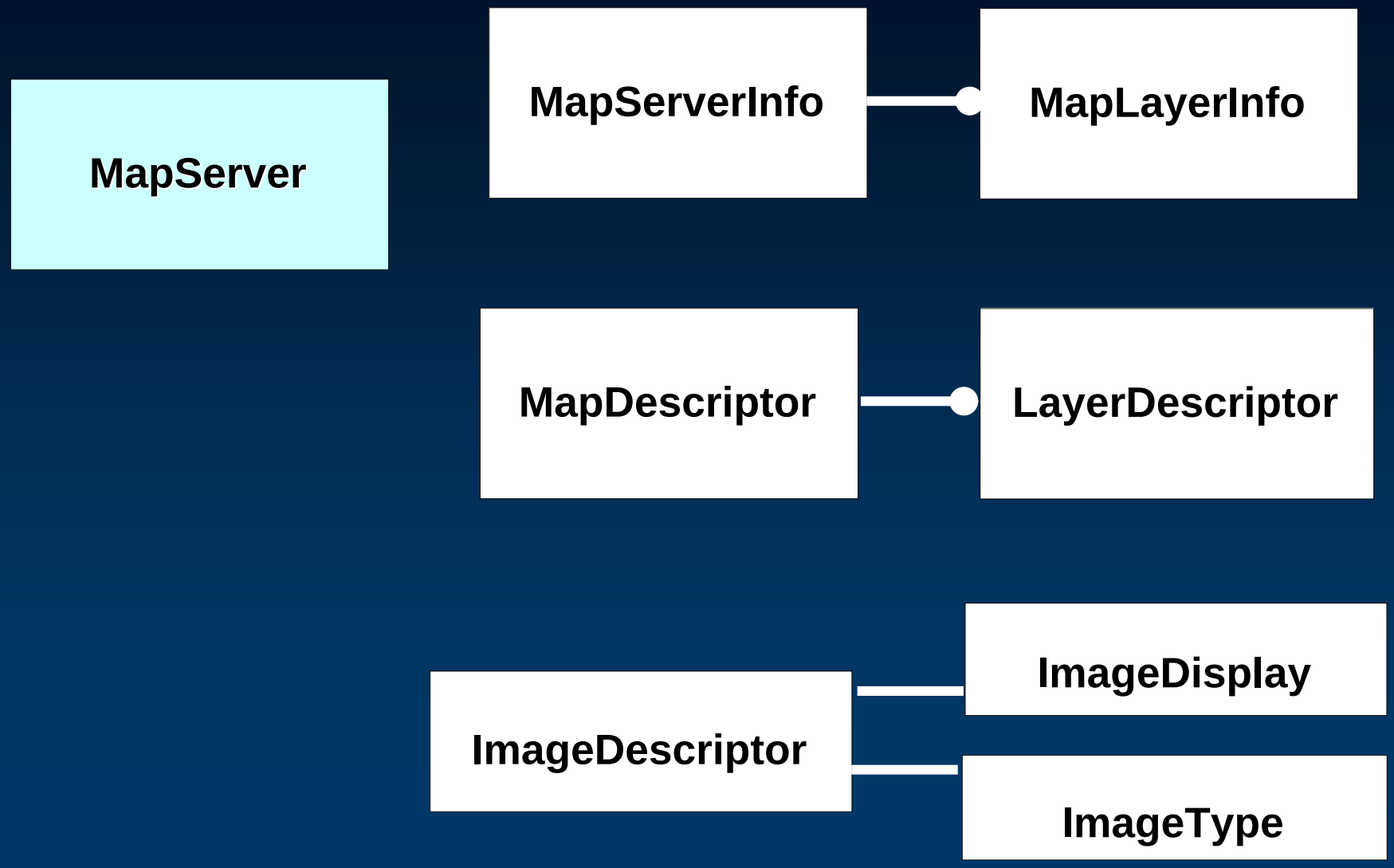
Map Service

- Maps can be pre-rendered and cached for performance resulting in a tiled map service that has a fixed set of scales
- Methods to discover if
  - A map is a tiled fixed scale map
  - If the map tiles correspond to single fused images or if there are separate tiles for each layer
- Methods to get the tiling scheme
- Methods to fetch tiles
- Tiles can also be obtained directly via HTTP Get.

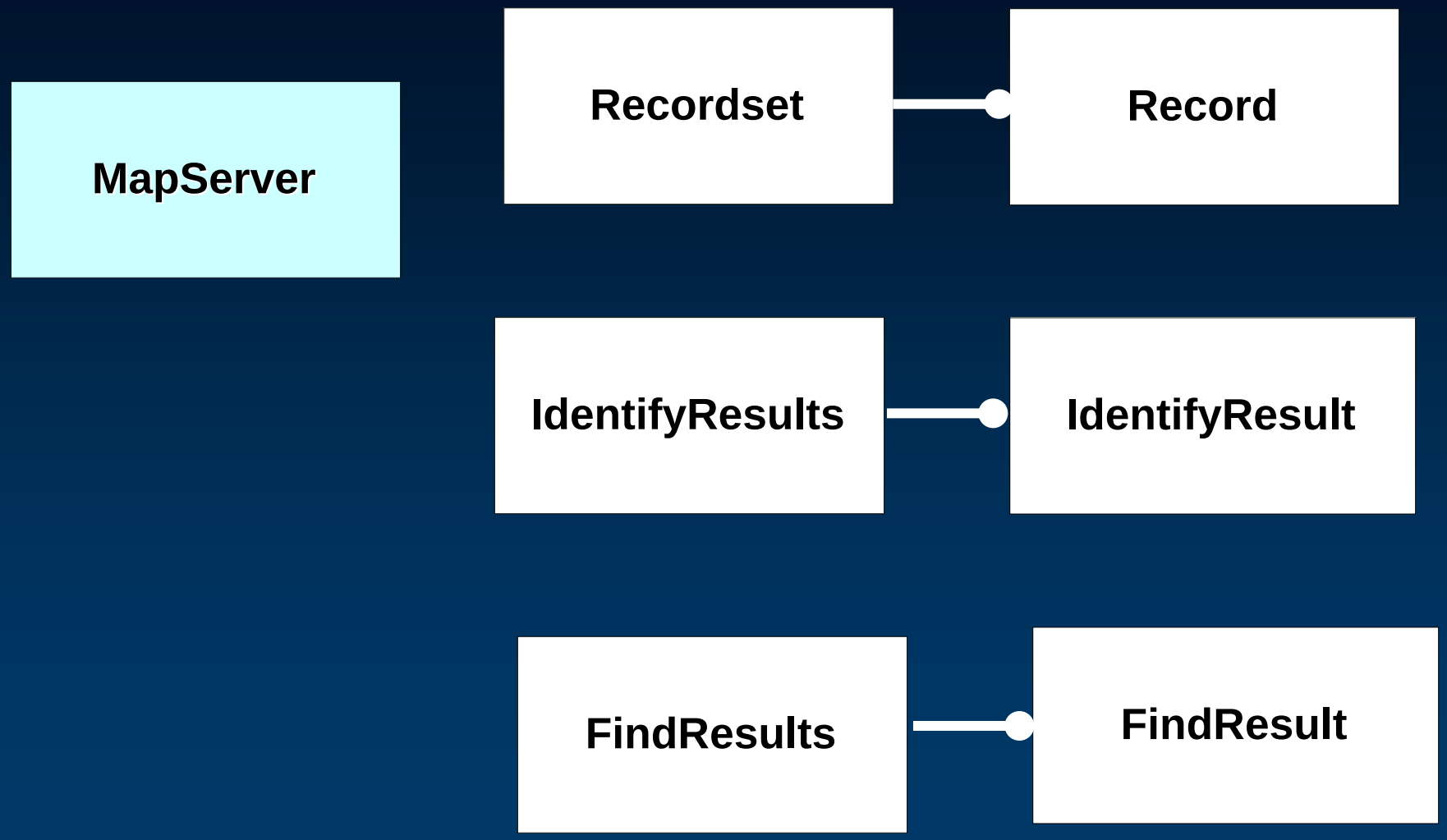
Working with the Map Service

```
// Drawing the map - generating map images

MapImage mi = ms.ExportMapImage (mapDescription, imageDescription);


// Querying the map

Recordset rs = ms.QueryFeatureData(mapName, layerID, queryFilter);


FidSet fs = ms.QueryFeatureIDs(mapName, layerID, queryFilter);


MapServerFindResult[] results
  = ms.Find(mapDescription, mapImageDisplay, searchString,
            expression, searchFields, findOption, layerIDs);
```

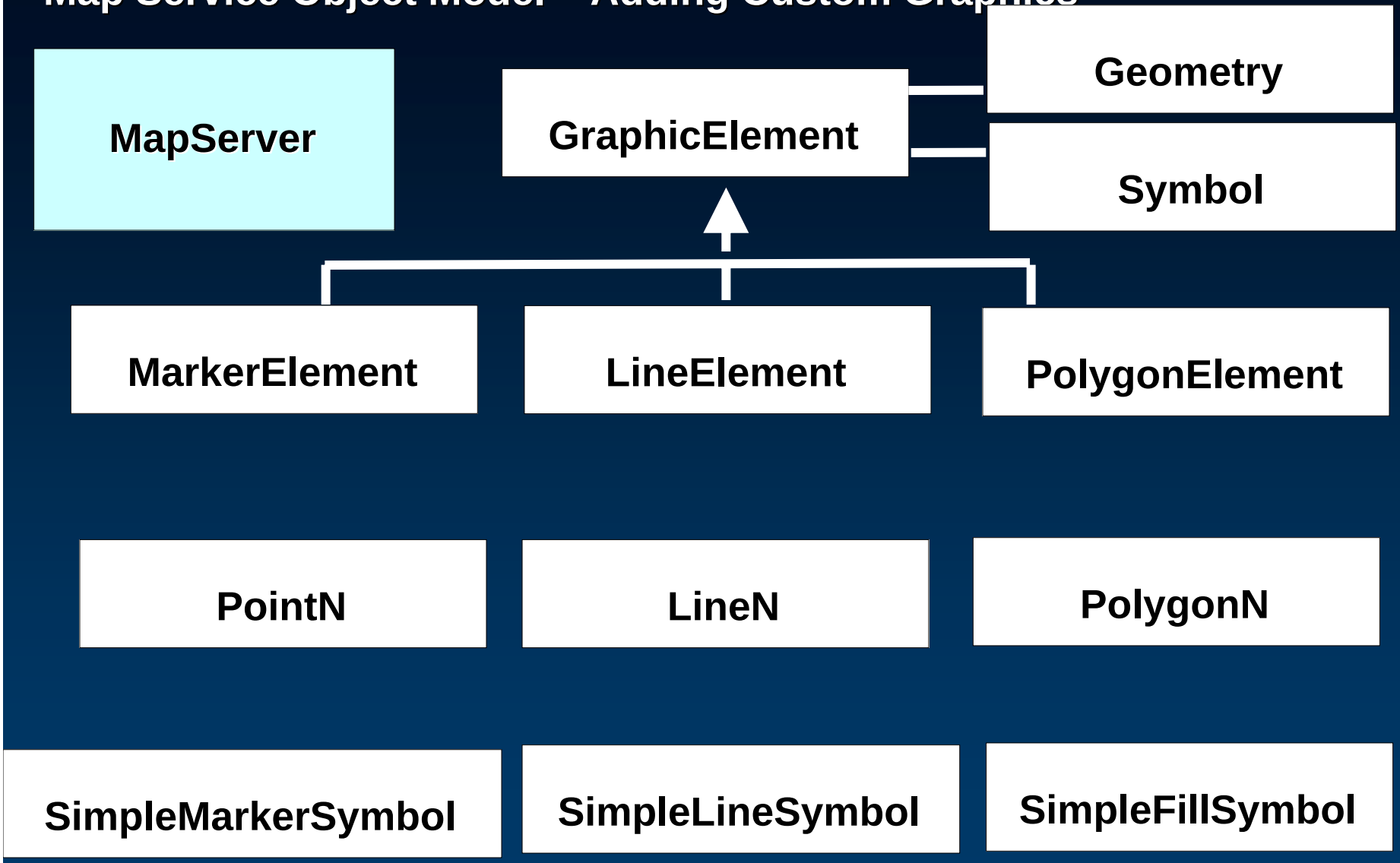
Map Service Object Model - Drawing



Map Service Object Model – Querying Features



Map Service Object Model – Adding Custom Graphics



Map Server – Key Methods

MapCount	No of maps in the service
MapName	Name of a map, by index
GetServerInfo	Retrieves Information about a specified map
ExportMapImage	Generates an image based on a specified map description
GetLegendInfo	Returns legend information for specified layers
Identify	Returns a collection of Identify Results
Find	Returns a collection of Find Results
QueryFeatureData	Returns a recordset of features based on a query filter
FromMapPoints	Converts from map to screen/image coordinates
ToMapPoints	Converts from screen/image to map coordinates

MapDescription value object :

Properties used to control the drawing of the map

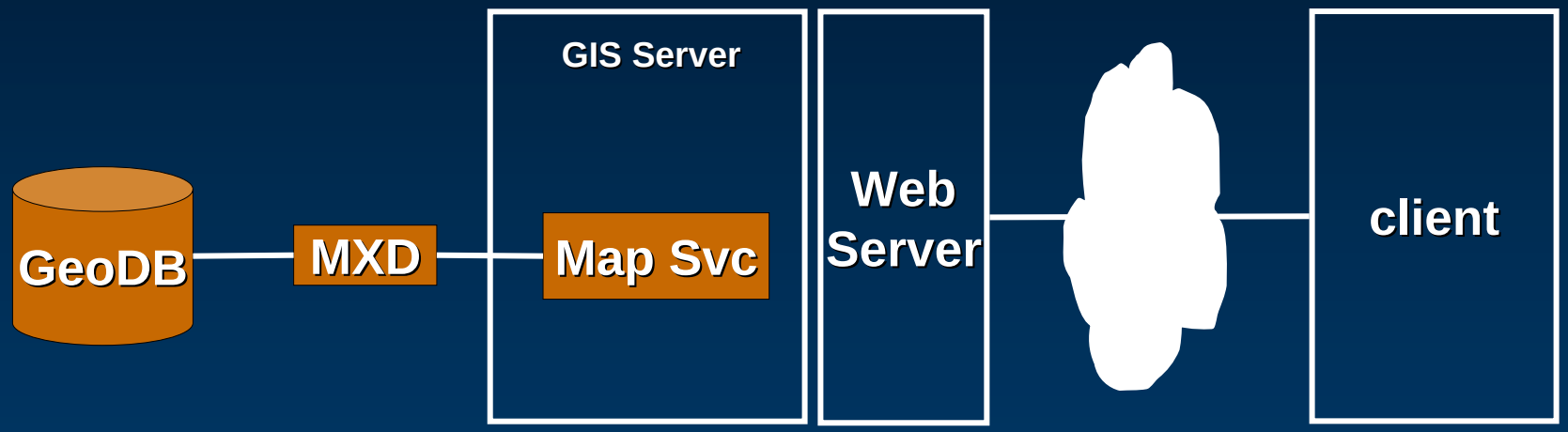
Name	The name of the map
LayerDescriptions	A collection of layer descriptions
CustomGraphics	CustomGraphics to be drawn on the map
SpatialReference	The spatial reference in which to draw the map
TransparentColor	The color that is transparent

LayerDescription value object :

Properties used to control the drawing of a layer

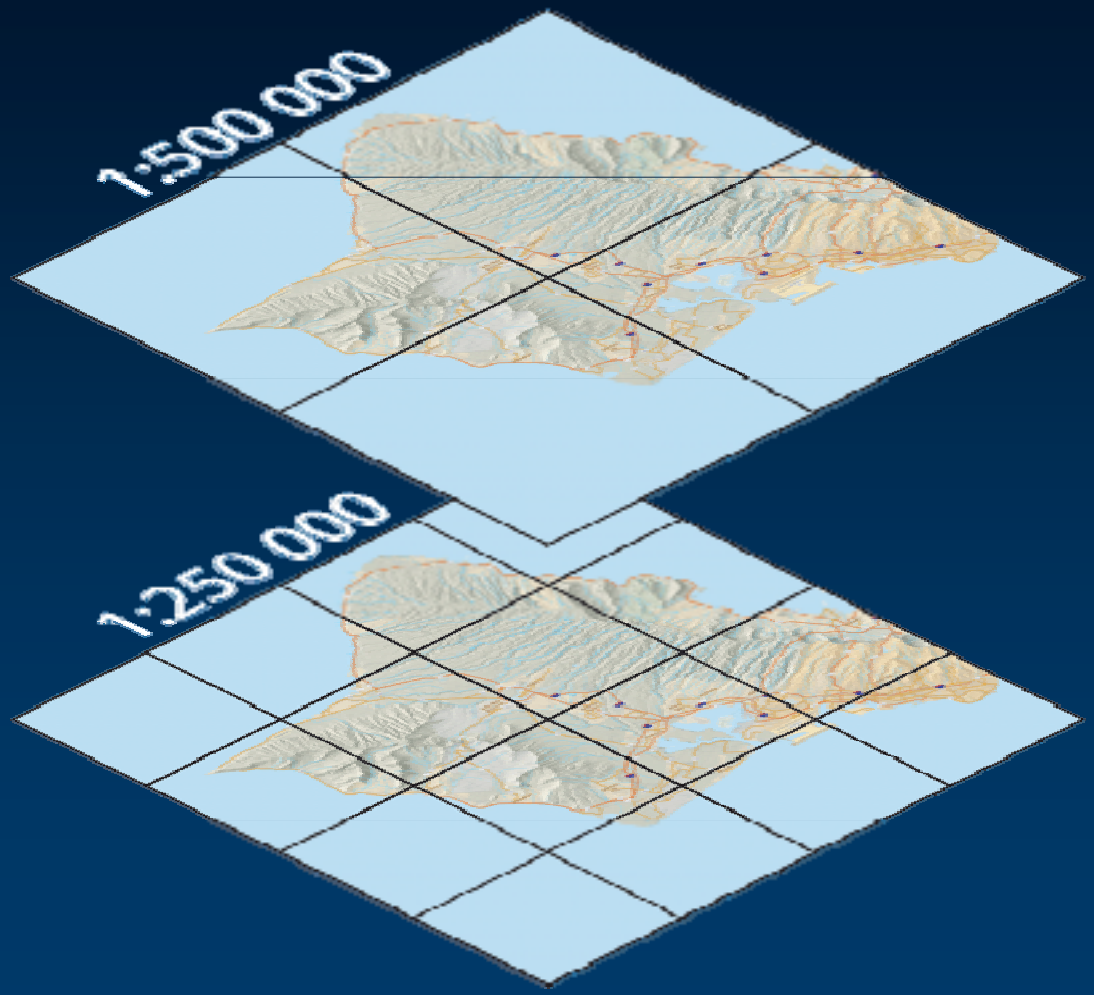
LayerID	The ID for the layer
DefinitionExpression	The definition expression for the layer
Visible	Is the Layer Visible
ShowLabels	Should labels be drawn
SelectionFeatures	Selected feature ids
SelectionColor	Color to be used for selected features

Map Service demo



Cached Map Services

- Tiles pre-rendered at fixed scales
- Rapid display of static base maps
- Richer symbols and more information



Map Service Object Model – Tiled Map Services

Map Service – Methods for working with tiled map services

IsFixedScaleMap	Indicates that the map has a fixed set of LODs
HasSingleFusedMapCache	Indicates that the map has a single cache that prefuses all layers
GetTileCacheInfo	Gets the tiling scheme for the map
GetMapTile	Gets the specified tile for the map given tile *level*, *row* and *column* coordinates
GetVirtualCacheDirectory	Gets the virtual cache directory for the map, if present

Tile Cache Info Object :

Properties that describe a tiling scheme

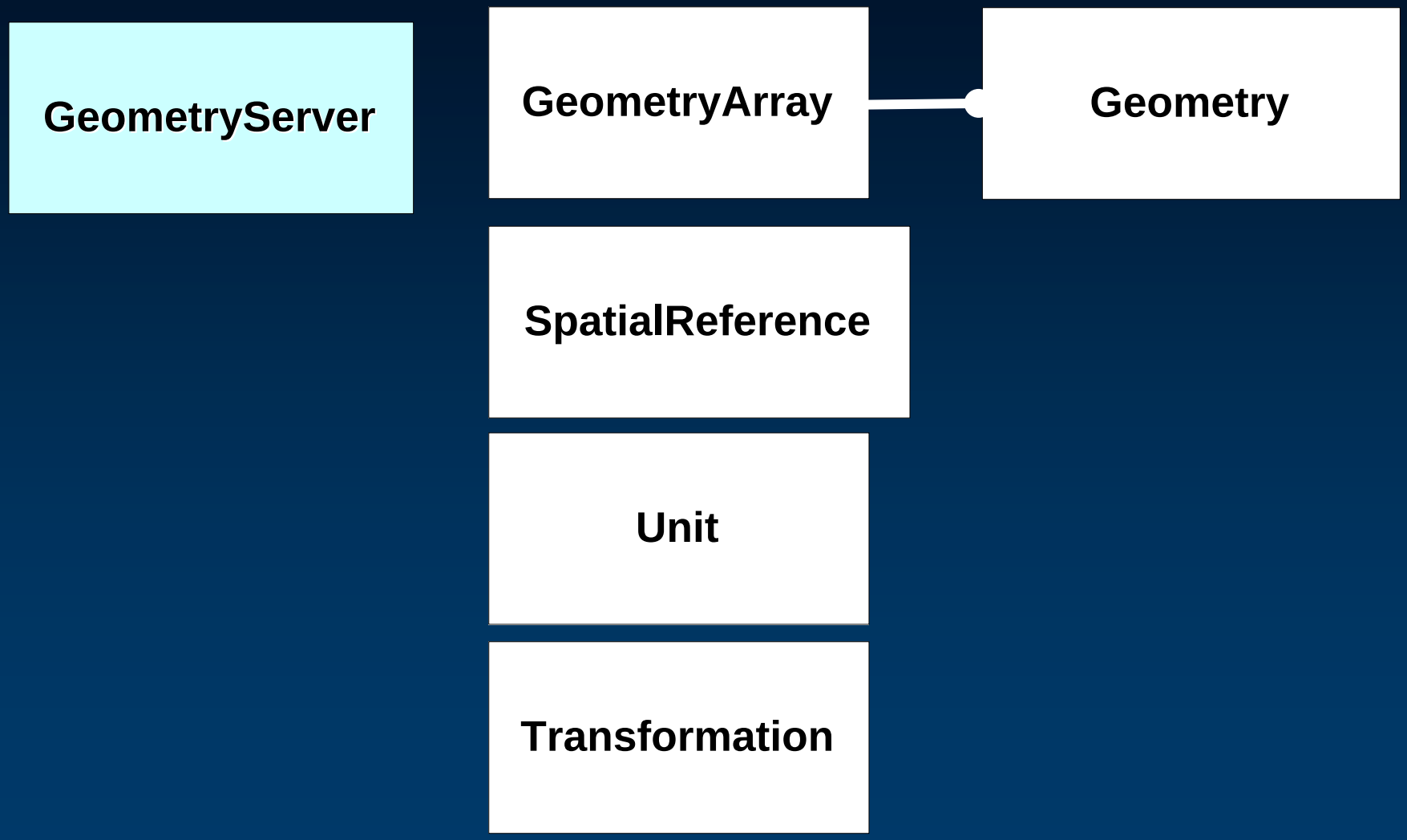
LODInfos	The levels of detail in the cache {id, scale, resolution}
Origin	The origin for the tiling grid
TileCols	The number of columns in a tile
TileRows	The number of rows in a tile
DPI	Resolution in dots per inch
SpatialReference	The spatial reference of the cache

```
tileWidth = tileCols * LODResolution

tileColumn  = floor ((x – xorig) / tileWidth)

tileHeight = tileRows * LODResolution

tileRow = floor ((y – yorig) / tileHeigh)
```

Geometry Service

- A computational service, not bound to any data on the server. New at 9.3
- An ArcGIS Server can host a Geometry Service
  - Number of instances (service threads) can be increased as needed
- Provides basic geometric operations for use by web service clients
- You can also support geometric clients by publishing GP tools like buffer, project and intersect

Geometry Service – Object Model



Geometry Service - Key Methods

Buffer	Buffers each geometry in an array of geometries by distances specified in an array of distances
Project	Projects an array of geometries from their current spatial reference to the specified spatial reference
Simplify	Generates topologically correct geometry
Densify	Converts non linear geometry to linear geometry
Relation	Determines the pairs of geometries in the input that participate in the specified topologic relationship

Geocode Service

- Integrated application using Map, Geocode and Geometry Services

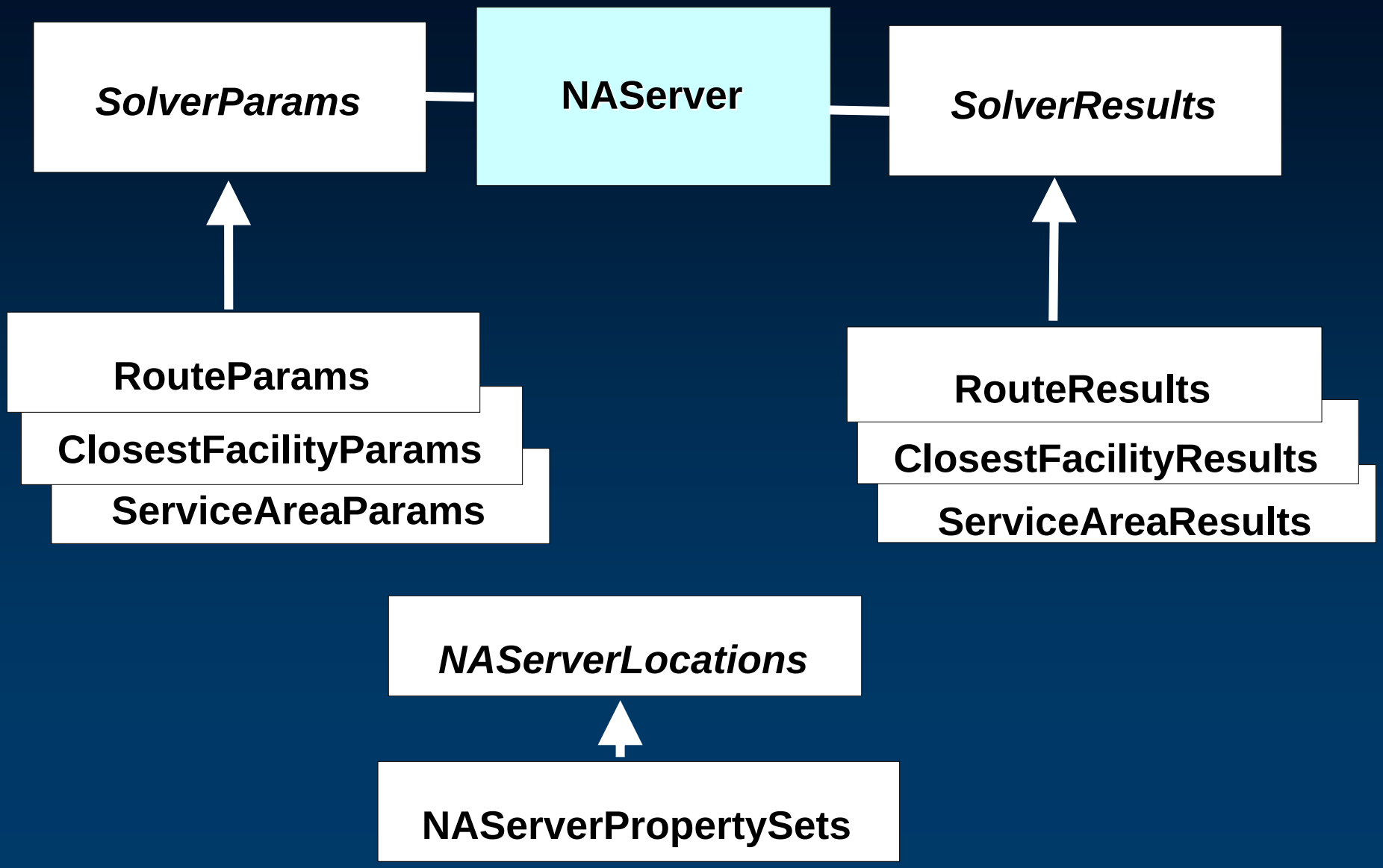
Demo

- Based on a Locator stored in the file system or in a Geodatabase
- Methods to perform single address and batch geocoding
- Methods to perform reverse geocoding
- Support for different address styles

Network Analysis Service

- Based on publishing a map containing network analysis layers
- A network analysis layer represents a specific analysis (Routing, Service Area, Closest Facility) to be performed against a specific network dataset (for eg. LA Streets)
- Methods to :
  - Discover the parameters of the analysis solver
  - Solve
  - Get Results (paths, directions etc)
- Callers supply input parameters (for eg stops, barriers) using basic web service types such as PropertySets and RecordSets.

Network Analysis Service – Object Model



NetworkAnalysis Server – Key Methods

GetNALayerNames	Array of Network Analysis Layers of a particular type
GetNetworkDescription	Returns the Network Dataset Data Element for the specified layer
GetSolverParameters	Default Solver Parameters for the specified Network Analysis Layer
Solve	Perform Network Analysis based on the specified solver parameters

- **Finding a Route :**
  - Get Route Network Analysis Layer
  - Get Default Route Solver Parameters
  - Specify Desired Route Solver Parameters
    - Barriers, Stops, FindBestSequence, UseTimeWindows, …
  - Solve
  - Consume Results

Geocoding and Network Analysis Service demo - routing

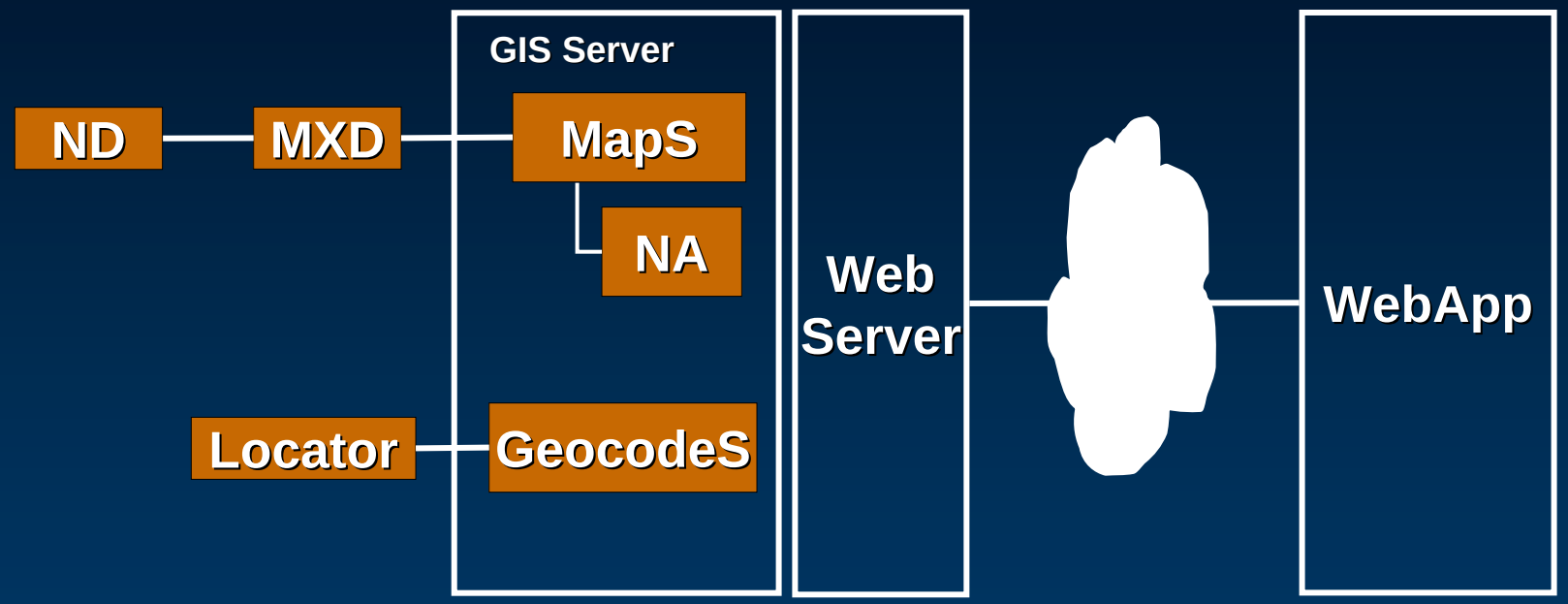


Image Service

- New at 9.3
- Allows you to serve imagery and raster data :
  - Raster Datasets
    - eg large mosaics in SDE
  - Raster Layers
    - With rendering set up on the server
  - Image Service Definitions
    - Catalogs of file based imagery that can be mosaiced and processed on the fly
    - Uses a back end ArcGIS Image Server
- Clients can control
  - Returned image format, mime or url
  - band selection, compression, projection, interpolation

Image Service – Object Model

ImageServiceInfo

ImageServer

GeoImage Description

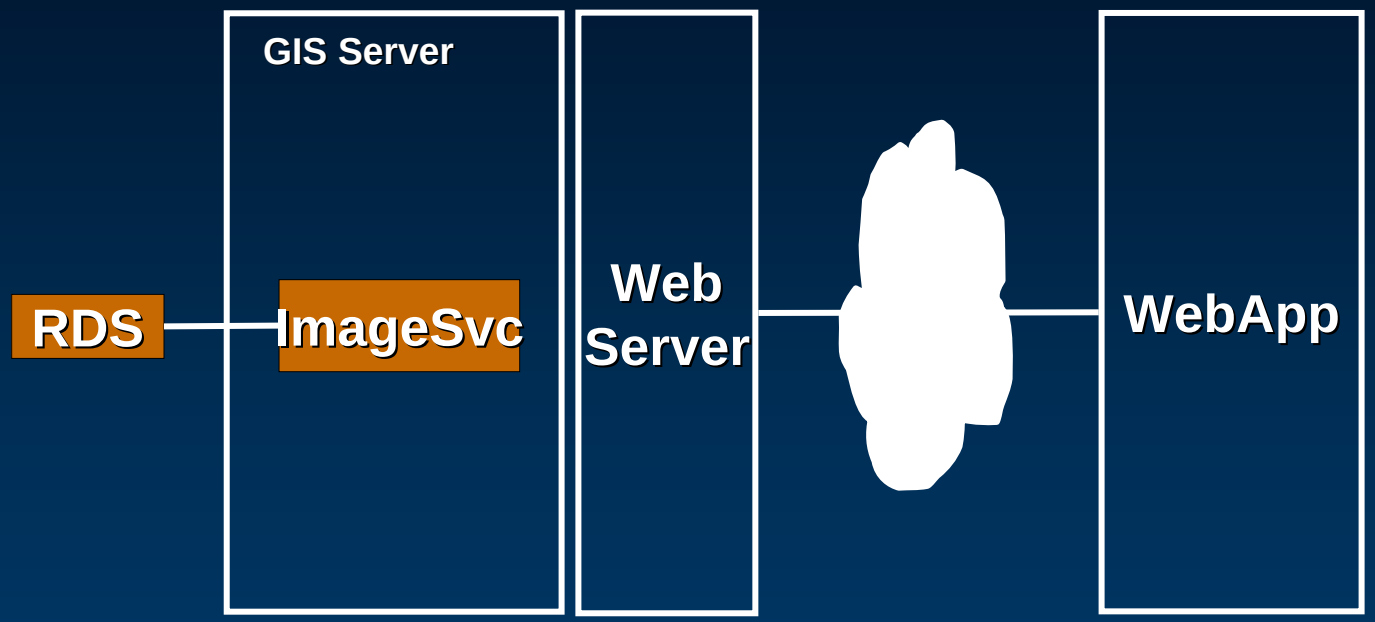
ImageType

ImageResult

Image Server - Key Methods

ExportImage	Returns the requested image using a well known image format
GetImage	Returns the requested image as a byte stream
GetServiceInfo	Returns the properties of the image service - numBands, pixelType, statistics etc

Image Service demo - routing



ArcGIS Server 9.3 - Geoprocessing Service

- Allows organizations to centralize both data and processing on the server
- Allows organizations with spatial data to expose spatial analysis functionality against that data as easy to use tasks that can be invoked by less experienced users
- Allows GIS Analysts to easily author and publish geoprocessing models

ArcGIS Server 9.3 - Geoprocessing Service

- You publish either a geoprocessing Toolbox or a Map containing Tool Layers
- The service makes the tools available to the consumer
- A GP Service may be associated with a map service that can be used to render results created on the server.
- Clients can also fetch vector and raster results by value.

Geoprocessing Service – 9.3 Enhancements

Improved Performance

- Reduced framework overhead for fast synchronous services
- Optimized transfer of large recordsets to and from server
- Tools have improved performance against SDE
- Faster execution of Python Script Tools

Improved Logging

More output formats (KML)

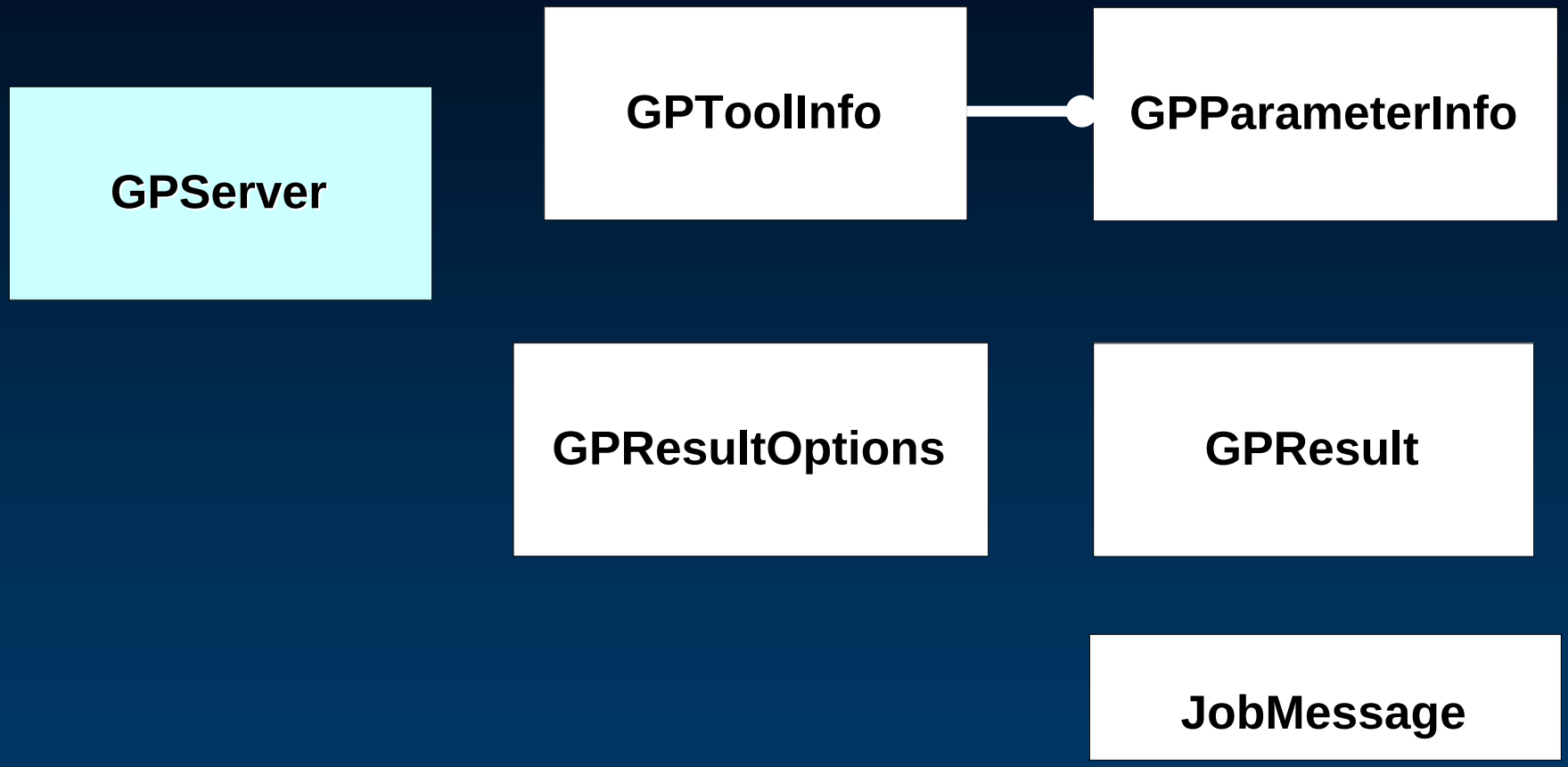
Improved Publishing

- Better error reporting
- Better detection of models that do not confirm to server publishing rules (incompatible types)

Improved documentation

- Included with both Server and Desktop

Geoprocessing Service – Object Model



Geoprocessing Service - Parameters

- Supported parameter types
  - String
  - Long
  - Double
  - Boolean
  - Date
  - Linear unit
  - Feature Set
  - Record Set
  - Raster

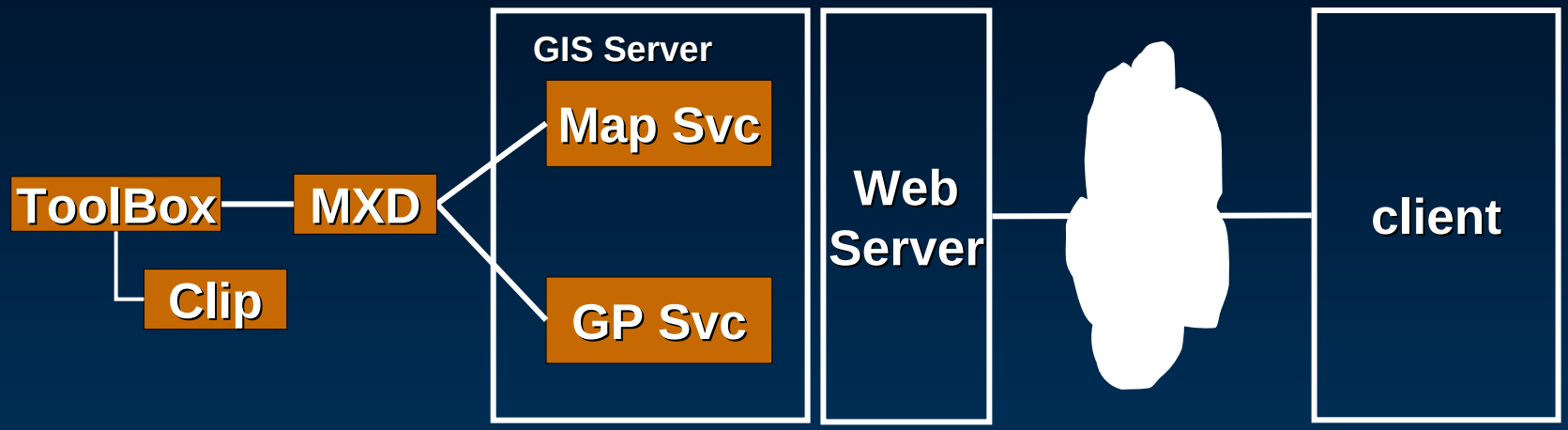
Geoprocessing Service Properties

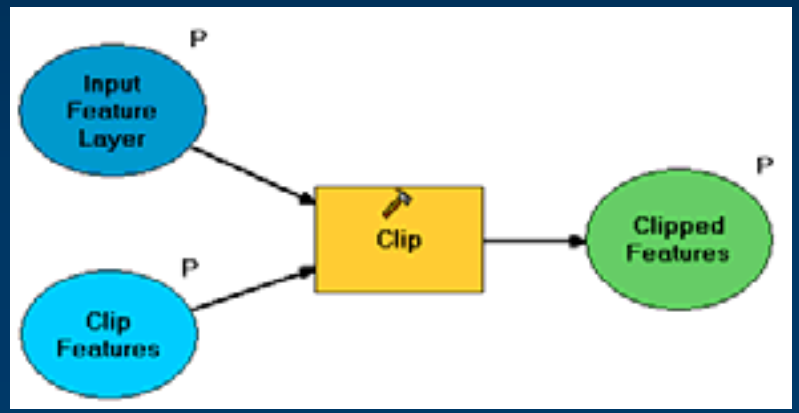
- **Execution Mode :**
  - **Synchronous**
    - **Results calculated and returned immediately by value**
    - **Appropriate for fast tools with small results**
  - **Asynchronous**
    - **Allows client to submit a job and come back later to fetch or draw results**
    - **Results are saved on the server**
    - **large results are best left on the server**

Geoprocessing Service – Key Methods

GetToolNames	Return the names of the tools in the service.
GetToolInfo	Returns the signature and default parameter values for a tool
GetExecutionType	Return the type of execution: synchronous or asynchronous.
Execute	Execute a synchronous geoprocessing tool.
SubmitJob	Execute an asynchronous geoprocessing tool.
GetJobStatus	Return the current status of a geoprocessing job.
GetJobMessages	Return verbose messages representing the current state of a submitted geoprocessing job.
GetJobResults	Return the results of a geoprocessing job that has completed successfully.

Geoprocessing Demo – interrogate a service, use a clip tool in the service





Geodata Services and Replication

- Geodata Services allow you to publish a geodatabase so that it can be accessed remotely over the Web
- ArcGIS Desktop can be used as a client with both local and remote geodatabases in order to
  - Extract data
  - Create replicas
  - Synchronize replicas

Working with Geodata Services in ArcGIS Desktop

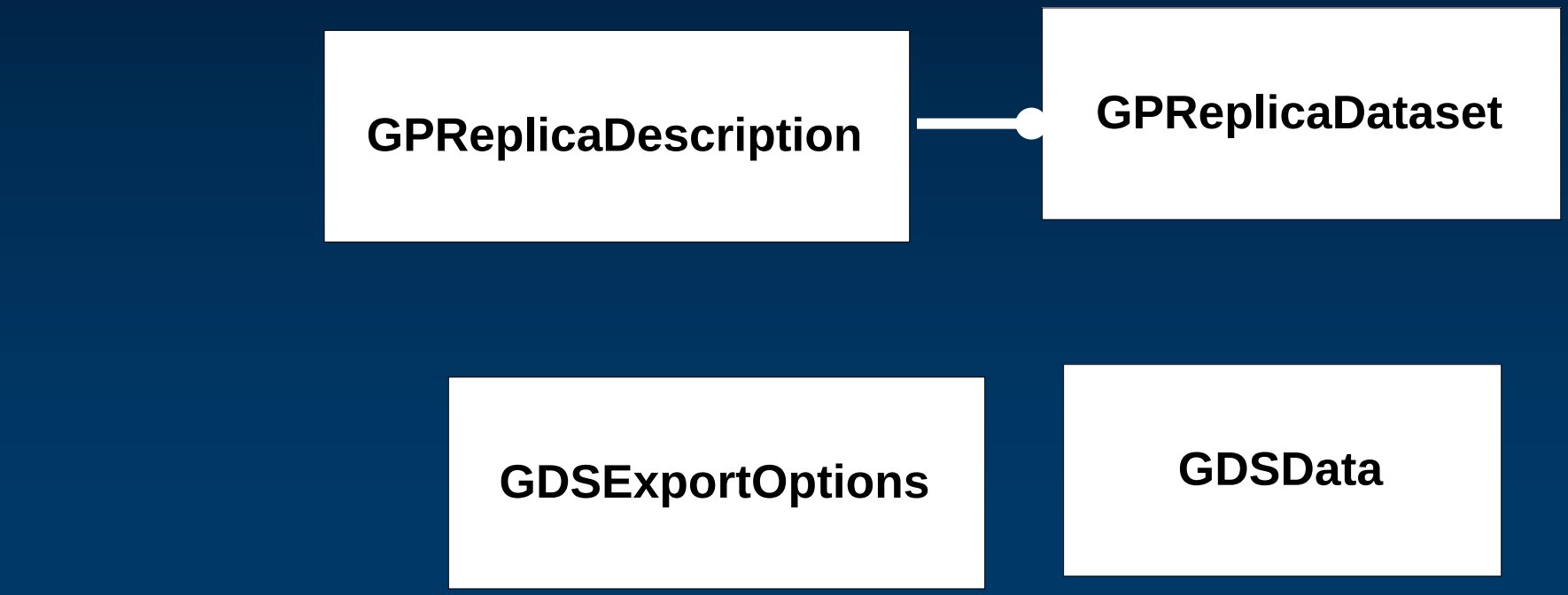
- All the distributed database tools work with local geodatabase connections as well as with geodata services (“ remote geodatabase connections “)

- GIS Analysts can also use GP scripting to setup automated synchronization jobs that automatically synchronize geodatabases at periodic intervals

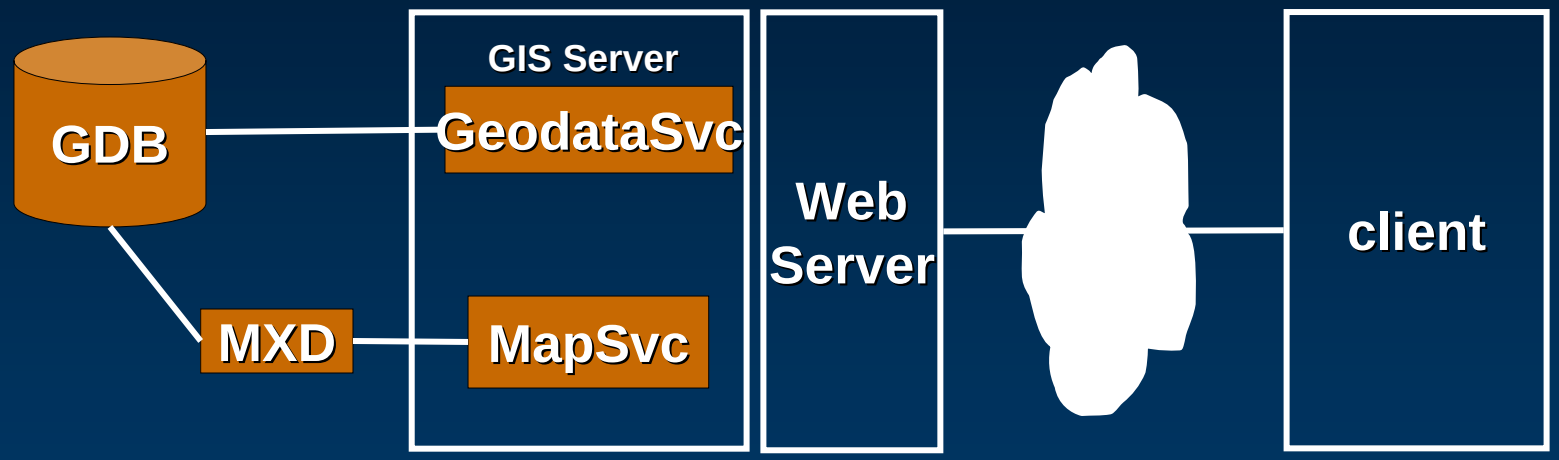
Geodata Service

- Methods for
  - browsing datasets
  - exporting datasets to XML
  - creating check-out, 1 way and 2 way replicas that can be down loaded and edited
  - exporting and importing replica changes.

Geodata Service – Object Model



Geodata Service demo – data extraction



Geodata Service - Creating a replica

```
//create array of datasets
GPReplicaDataset[] repDSs = new GPReplicaDataset[2];

//fill it up w/datasets to replicate
GPReplicaDataset repDS = new GPReplicaDataset();
repDS.DatasetName = "Parcels";
repDS.DatasetType = esriDatasetType.esriDTFeatureClass;
//selection IDs, UseGeometry, DefQuery...
repDSs[0] = repDS;

repDS = new GPReplicaDataset();
repDS.DatasetName = "Buildings";
repDS.DatasetType = esriDatasetType.esriDTFeatureClass;
repDSs[1] = repDS;

//setup a replicaDescription
GPReplicaDescription repDesc = new GPReplicaDescription();
repDesc.GPReplicaDatasets = repDSs;
repDesc.QueryGeometry = myEnvelope;
repDesc.SingleGeneration = true; //ie checkOut …
```

Geodata Service - Creating a replica

```
//extra options
GPReplicaOptions repOpts = new GPReplicaOptions();
repOpts.AccessType = esriReplicaAccessType.esriReplicaBothReadWrite;

//how to format the data
GDSExportOptions expOpts = new GDSExportOptions();
expOpts.ExportFormat = esriGDSExportFormat.esriGDSExportFormatFileGDB;

//how to transfer the data
esriGDSTransportType transpType =
  esriGDSTransportType.esriGDSTransportTypeUrl;

//create the replica
GDSData data =
  m_gds.CreateReplica(sdeVersion, repName, repDesc, repOpts, expOpts,
  transpType);

DownloadFile(data.URL, outFGdb);

//m_gds.ExtractData with similar signature will extract the data (no replica
  created)
```

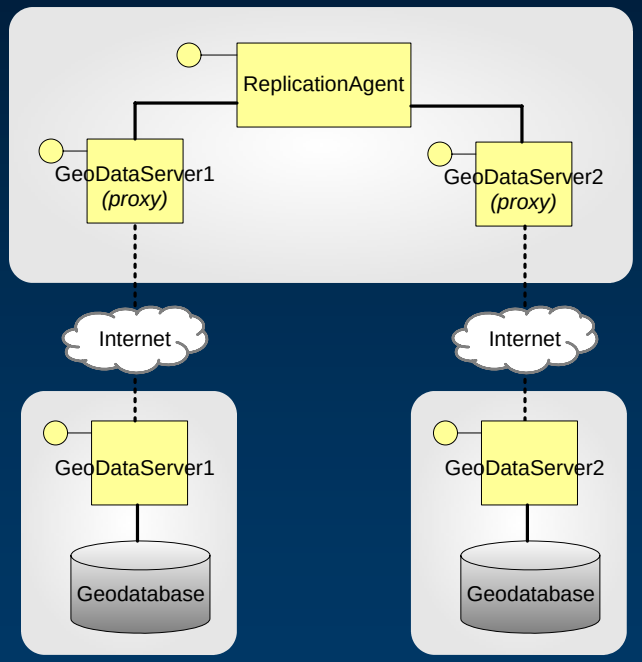
Geodata Service – Synchronizing Replicas

```
//export from source gds
GDSData changhes
  = src_gds.ExportReplicaDataChanges(repName, expOpts, transpType,
  esriExportGenerationsOption.esriExportGenerationsAll, switchRoleYes);

//import into destination gds
dest_gds.ImportReplicaDataChanges(
  esriGDSReplicaImportSource.esriGDSReplicaImportSourceDeltaFileGDB,
  esriReplicaRecPolicyType.esriResolveConflictsInFavorOfDatabaseChanges,
  colLevelYes, changes);

//repeat in the opposite direction
```

Developing Desktop and ArcEngine Clients to the GeodataService

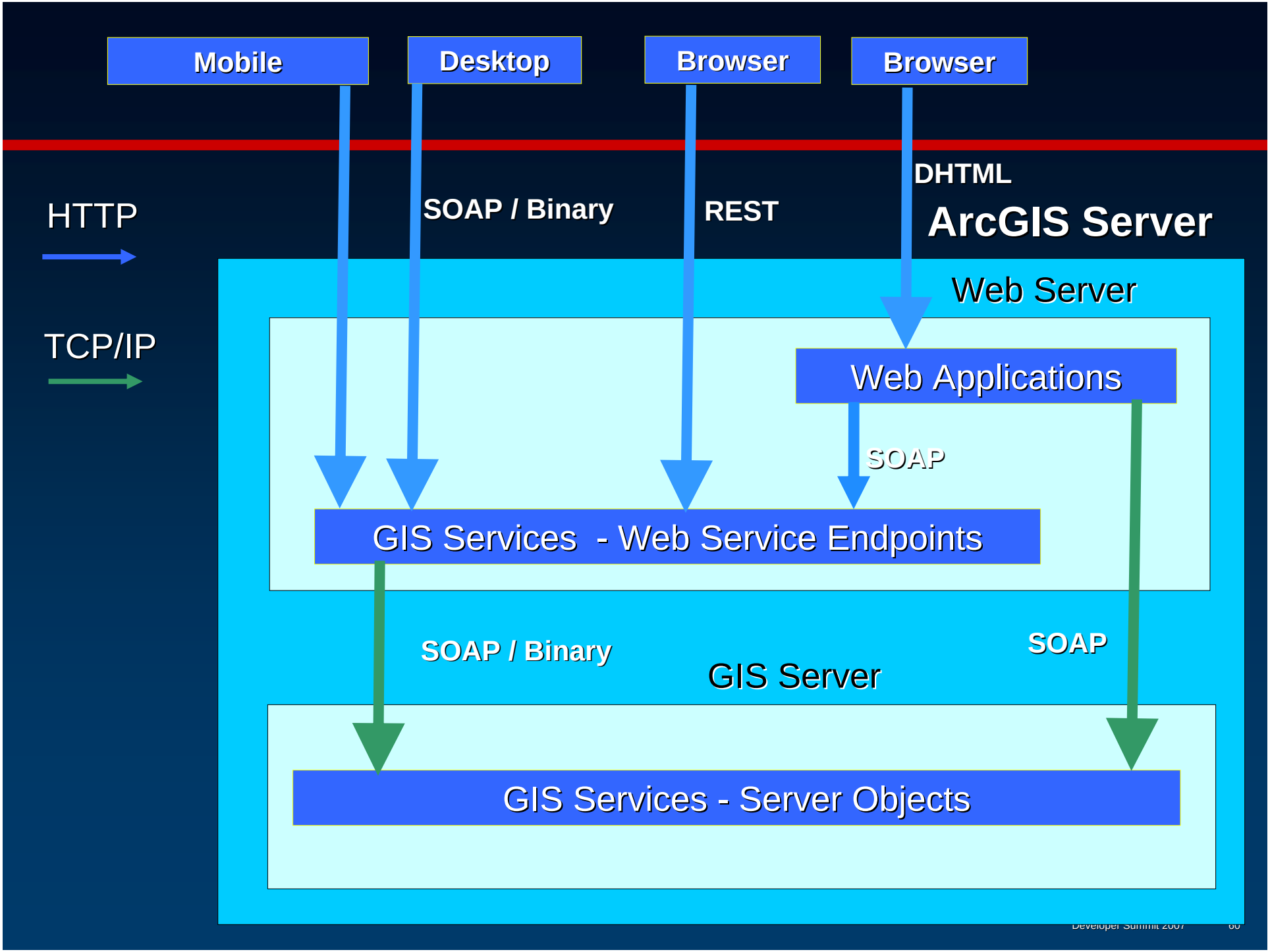
- Use the GeoDataServer and ReplicationAgent proxy classes that are part of the GeodatabaseDistributed ArcObjects assembly

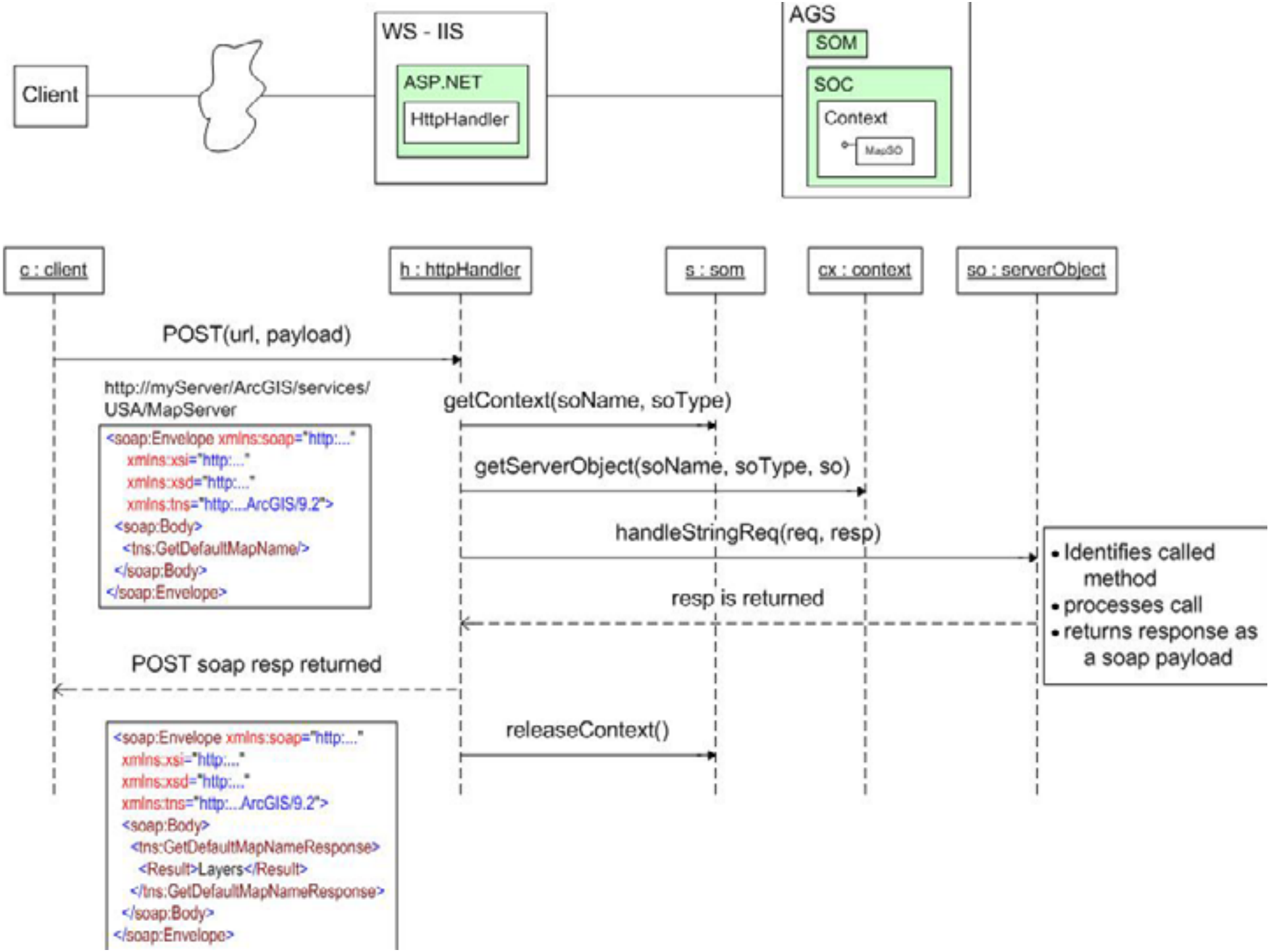
- ReplicationAgent gives you single call synchronization



ArcGIS Server Web Services – Under the Hood

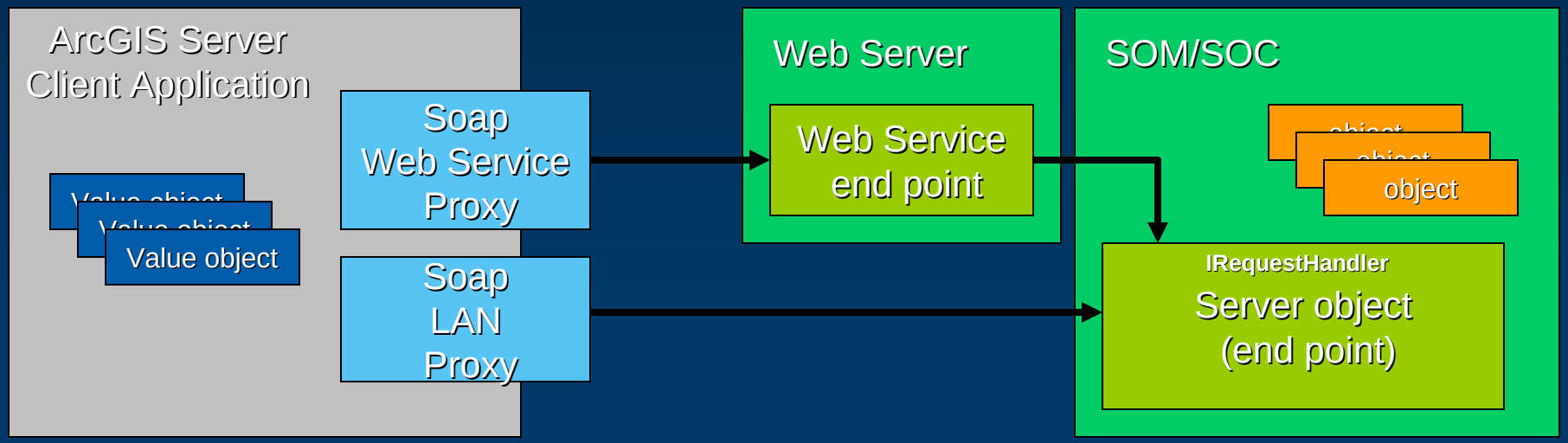
- SOAP requests received by the web server are handled by a custom HTTP handler [.Net] / Servlet [Java] and forwarded to the corresponding server object in the GIS Server for processing.
- ArcGIS includes its own SOAP stack and XML serialization framework for ArcObjects
- All parameter objects implement IXMLSerialize
- SOAP requests [the SOAP body] is deserialized and processed by the server object
- Results are serialized into the corresponding SOAP response


Mobile
Desktop
Browser
Browser
HTTP
TCP/IP
SOAP / Binary
REST
DHTML
ArcGIS Server
Web Server
Web Applications
SOAP
GIS Services - Web Service Endpoints
SOAP / Binary
SOAP
GIS Server
GIS Services - Server Objects


Client
WS - IIS
ASP.NET
HttpHandler
AGS
SOM
SOC
Context
MapSO
c : client
h : httpHandler
s : som
cx : context
so : serverObject
POST(url, payload)
http://myServer/ArcGIS/services/USA/MapServer
<soap:Envelope xmlns:soap="http:..."
xmlns:xsi="http:..."
xmlns:xsd="http:..."
xmlns:tns="http:...ArcGIS/9.2">
<soap:Body>
<tns:GetDefaultMapName/>
</soap:Body>
</soap:Envelope>
getContext(soName, soType)
getServerObject(soName, soType, so)
handleStringReq(req, resp)
• Identifies called method
• processes call
• returns response as a soap payload
resp is returned
POST soap resp returned
<soap:Envelope xmlns:soap="http:..."
xmlns:xsi="http:..."
xmlns:xsd="http:..."
xmlns:tns="http:...ArcGIS/9.2">
<soap:Body>
<tns:GetDefaultMapNameResponse>
<Result>Layers</Result>
</tns:GetDefaultMapNameResponse>
</soap:Body>
</soap:Envelope>
releaseContext()

Working with SOAP requests over the LAN

- Web ADF includes both a Web proxy as well as a LAN proxy
- Web service proxy generated from WSDL - MapServerProxy
  - Used for SOAP / HTTP
- LAN proxy is also included - MapServerDCOMProxy
  - Used for SOAP / LAN
  - Uses the IRequestHandler interface to submit SOAP requests directly to the server object



Summary

- ArcGIS Server has a rich set of GIS Web Services
- You can work with services using the SOAP API
- The SOAP API is
  - easily accessible from .Net and Java
  - has a well described contract
  - is fully integrated into IDE's
  - lets you take advantage of compile time type checking

In Conclusion…

- Other recommended sessions and meetings
  - Using the ArcGIS Server REST API
- All sessions are recorded and will be available on EDN
  - Slides and code will also be available
- Please fill out session surveys!
- Still have questions?
  1. Tech talk, Demo Theatres, Meet the Team
  2. "Ask a Developer" link on web page
     - www.esri.com/devsummit/techquestions