



# Finding Your Way with ArcGIS Network Analyst

*Frederic Schettini*

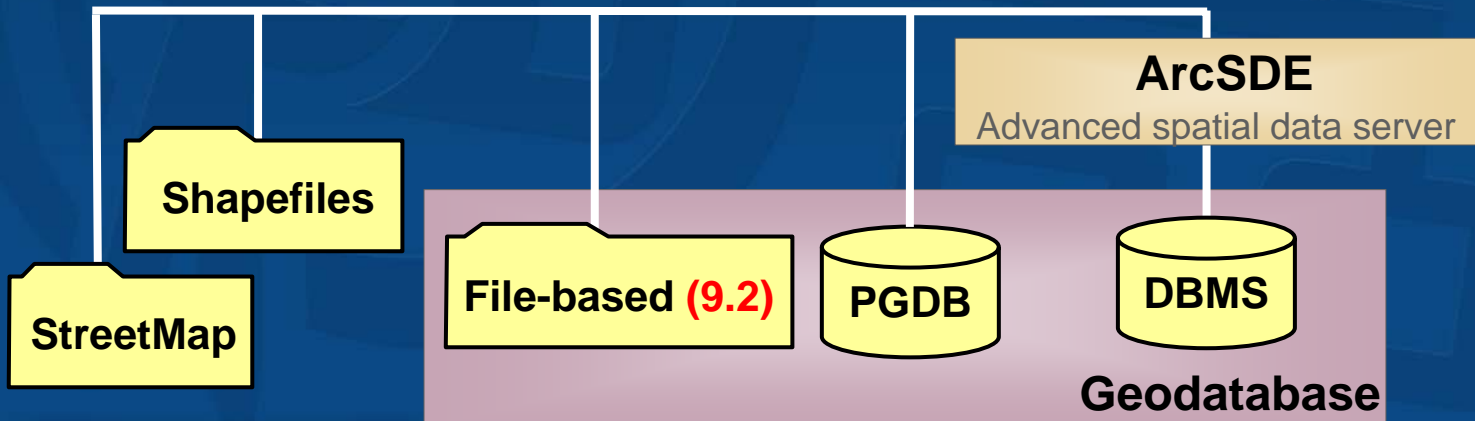
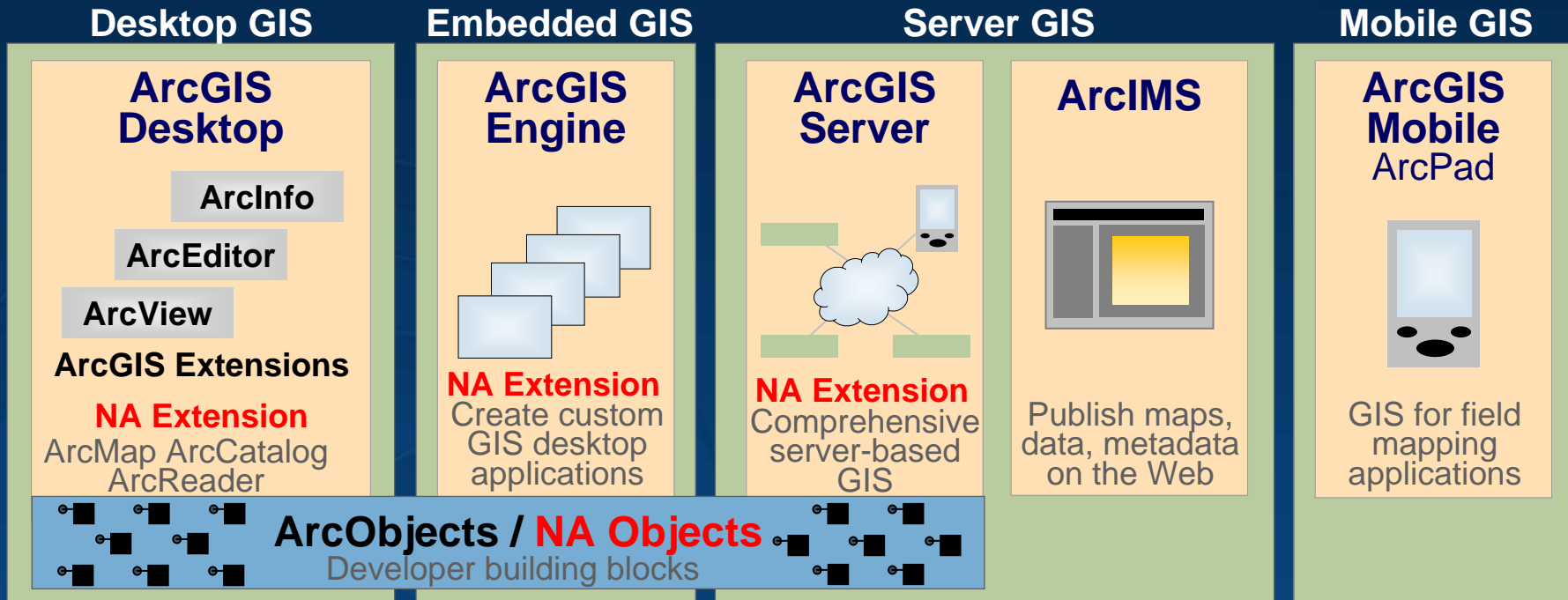
*Michael Rice*

# Agenda



- **Introduction to Network Analyst**
- Working with ArcGIS Engine
- Working with ArcGIS Server
- Support & Resources
- Questions

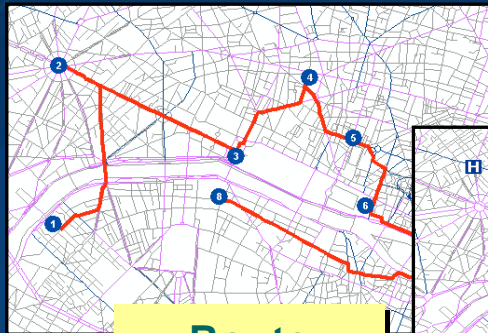
# ArcGIS Overview



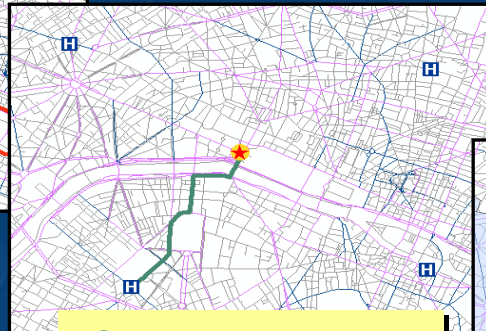
# What is Network Analyst?



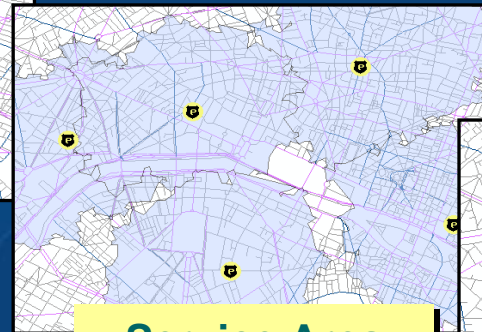
- Extension for analyzing transportation networks
  - Four network solvers



Route



Closest Facility



Service Area



Origin-Destination (OD) Cost Matrix



- Uses network datasets

# ArcGIS – Network Analyst Objects



- Collection of ArcObjects for building custom applications with...
  - ArcGIS Desktop and ArcGIS Engine
    - Network Analyst library
    - UI components for ArcGIS Engine (9.2)
  - ArcGIS Server
    - Network Analyst server objects (9.2)
- Extensible framework (e.g., solvers, agents, locators)
- Supports major programming languages and cross-platform development (e.g., Windows, Solaris, Linux)

# Agenda

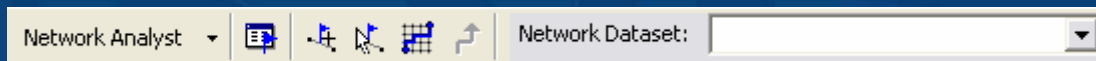


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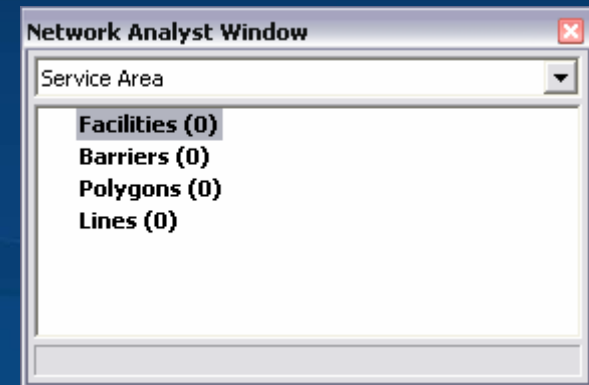
# Working with ArcGIS Engine



- Development platform for creating standalone GIS applications
- Engine API for Network Analyst is composed of...
  - ArcObjects components
  - UI components (9.2)



**Network Analyst Toolset**



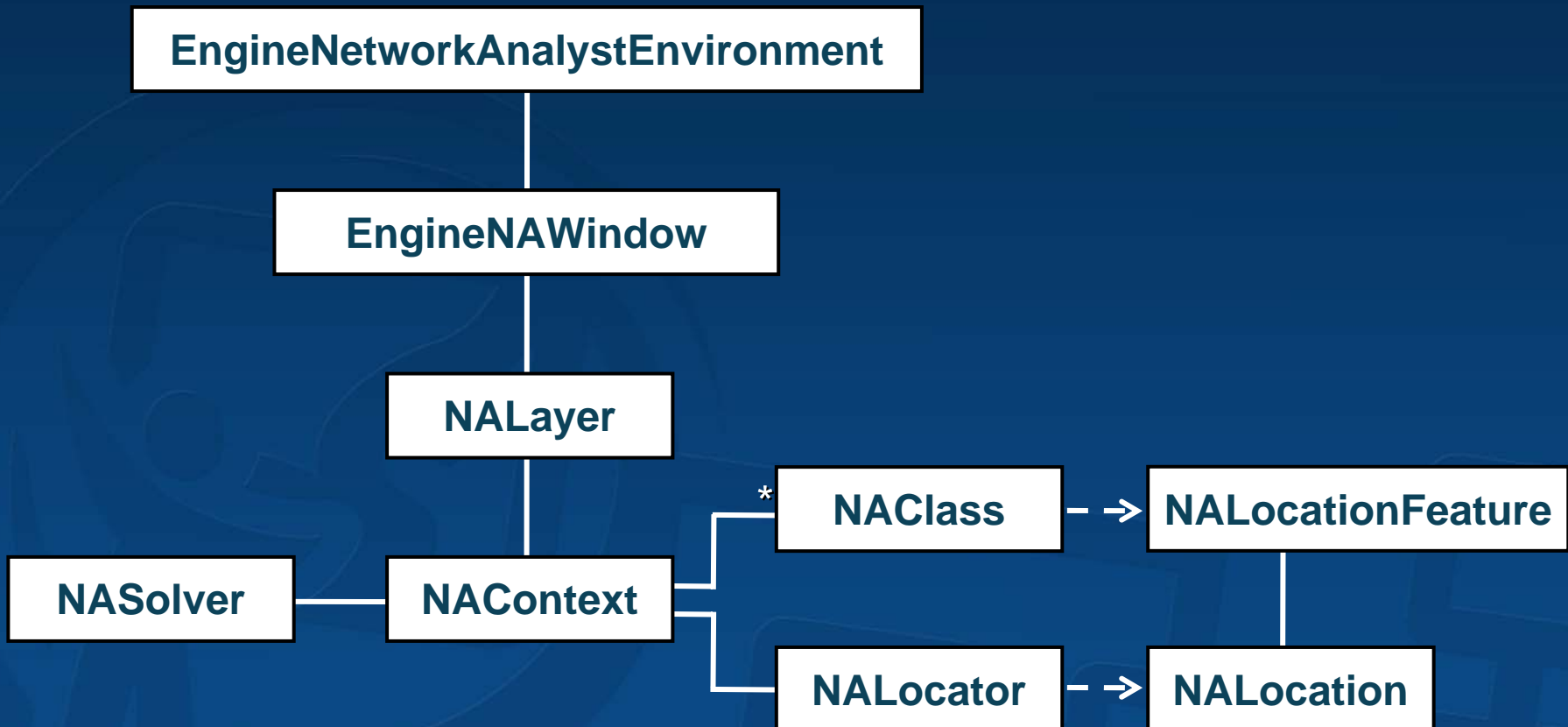
**Network Analyst Window**

- Requires NetworkEngine license



# ArcGIS Engine Demo #1

# Overview of Network Analyst Objects



# EngineNetworkAnalystEnvironment



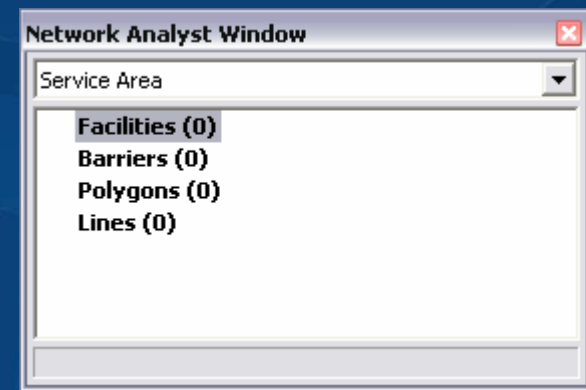
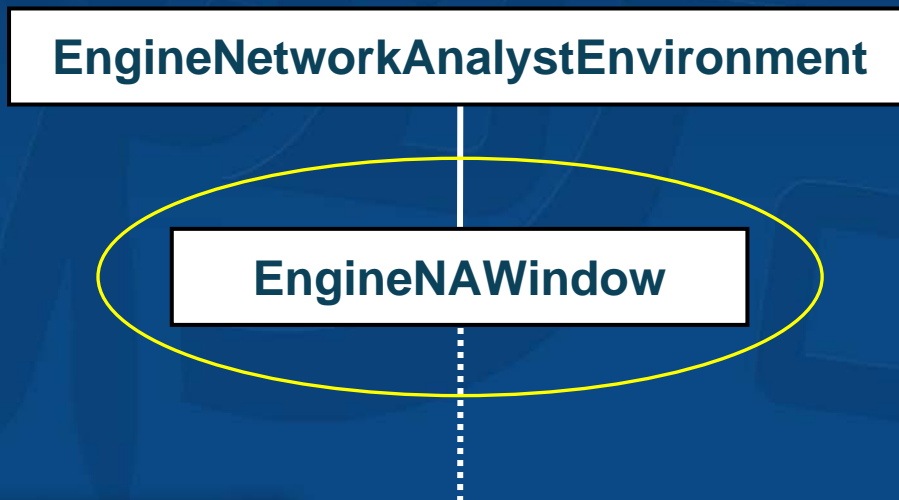
- Serves as the entry point to Network Analyst for Engine applications
- Allows high-level access to the...
  - NAWindow
  - Current network dataset
- Can be used to...
  - Set extension options
  - Add network locations
  - Get directions
  - Solve

EngineNetworkAnalystEnvironment

# EngineNAWindow



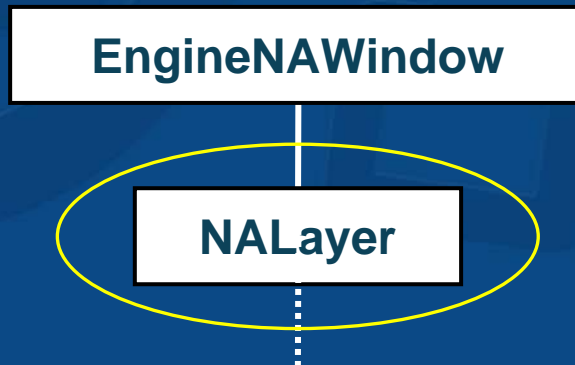
- Holds reference to the current analysis layer (i.e., NALayer) and its associated NAClasses
- Can be used to manage edit operations on NALayers
- Exposes event handling on the NAWindow



# NALayer



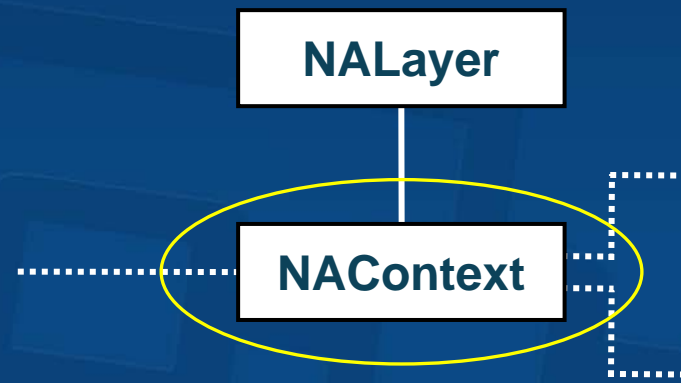
- Composite map layer
- Holds a reference to the NAContext
- Exposes the NAClasses within the NAContext as feature layers
- Maintains standard layer properties, including feature renderers, etc.
- Can be persisted within map documents (.mxd)



# NAContext



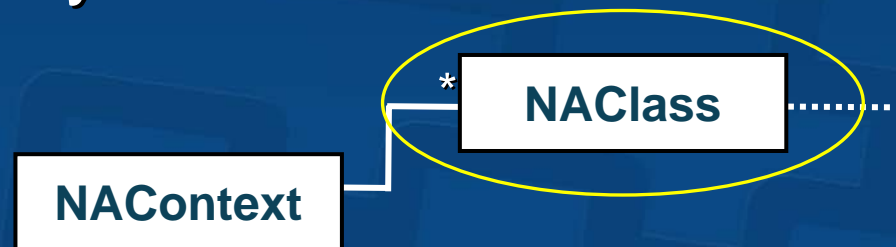
- Centrally manages the environment of a particular analysis
- The context holds references to the collection of objects associated with analysis
- This collection includes...
  - Network dataset
  - NAClasses
  - NASolver
  - NALocator
  - NATraversalResult
  - NAAgents



# NAClass



- The NAClass is an in-memory feature class
- Holds input/output associated with the solver
  - Network locations (e.g., stops, barriers, facilities)
  - Analysis results (e.g., routes, lines, polygons)
  - Descriptive info (e.g., vehicles, route name)
- Can be searched, updated, etc.
- Persisted within NALayer



# NASolver



- The NASolver is responsible for...
  - Managing the NAContext and NALayer
  - Performing the actual network analysis
- Used to set analysis properties
  - Impedance attribute
  - Restrictions
  - Hierarchy
  - Solver-specific properties
- Extensible framework
  - Can add custom solvers



# NALocator



- Used to locate and query network locations (i.e., NALocations) along network datasets
- Manages the set of associated NALocatorAgents to be used for finding NALocations
- Can perform geocoding and reverse geocoding along the network



# General Programming Pattern (C#)



```
// Step 1 – create new EngineNetworkAnalystEnvironment
IEngineNetworkAnalystEnvironment naEnvironment = new
    EngineNetworkAnalystEnvironmentClass();
```

```
// Step 2 – get the active analysis layer from the environment's NAWindow
INALayer naLayer = naEnvironment.NAWindow.ActiveAnalysis;
```

```
// Step 3 – get the context from the analysis layer
INAContext naContext = naLayer.Context;
```

```
// Step 4 – get the solver from the context
INASolver naSolver = naContext.Solver;
```

```
// Step 5 – change settings on the solver
((INARouteSolver)naSolver).UseTimeWindows = true;
((INASolverSettings)naSolver).ImpedanceAttributeName = "Minutes";
```

```
// Step 6 – update the context to reflect the changes
naSolver.UpdateContext(naContext, deNetworkDataset, new
    GPMessagesClass());
```



# ArcGIS Engine Demo # 2

# Agenda



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# Working with ArcGIS Server



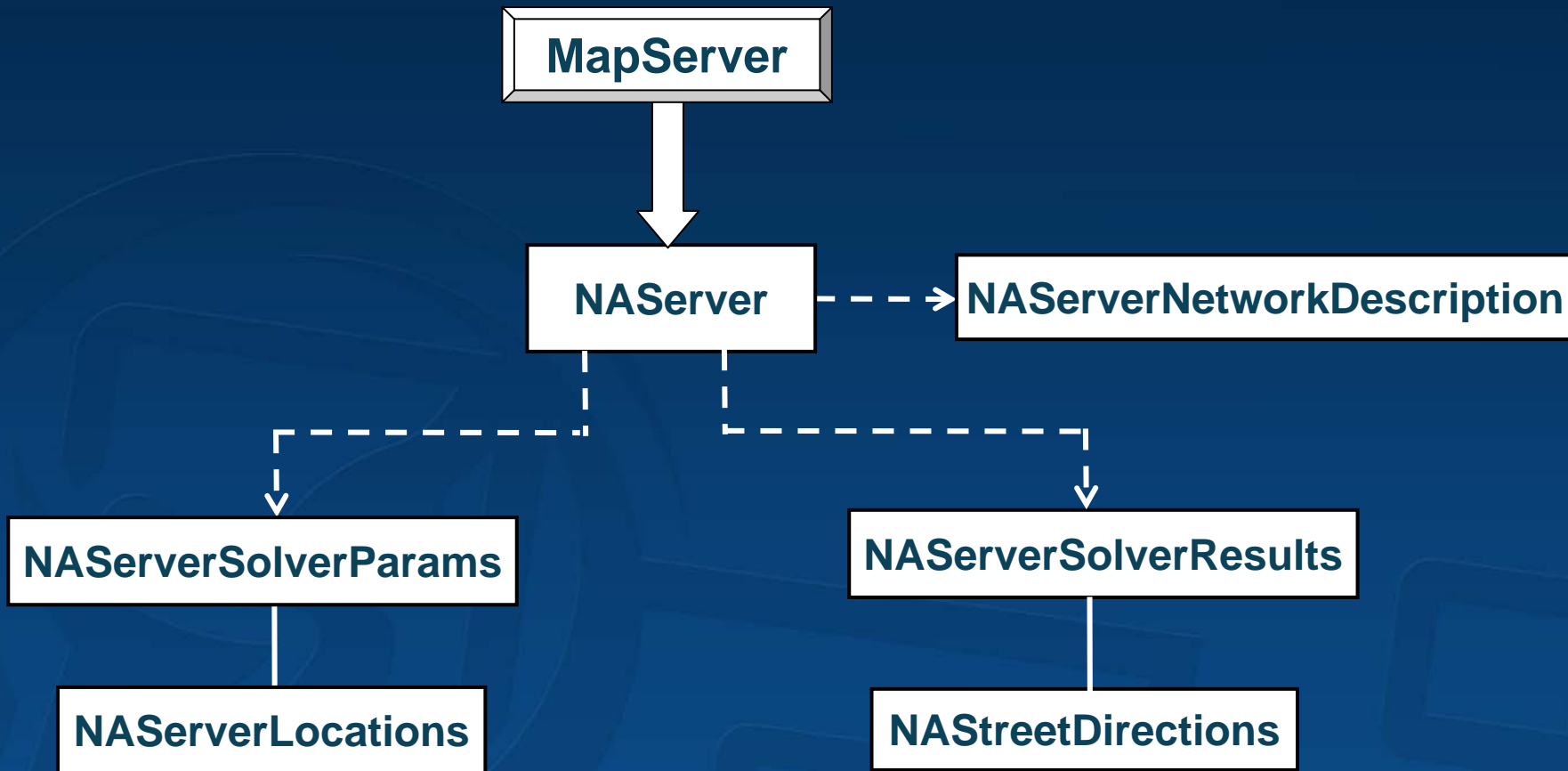
- Network analysis performed within ArcGIS server
- Network analyst server (NAServer)
  - Server object extension (new in 9.2)
  - Extends the MapServer server object
- Include network analysis functions
  - Route
  - Closest Facility
  - Service Area
- Requires NetworkServer license

# NAServer object extension



- Coarse-grained ArcObjects component
- Support for server applications using:
  - GIS Server (DCOM)
  - Web Services (SOAP)
  - GIS Client (DCOM or SOAP)
- Stateless objects
- Instances are created and managed by the server object manager

# Overview of the NAServer objects



*The complete diagram can be found in [NetworkAnalystObjectModel.pdf](#) (page 2)*



# NAServer

- Accessed by
  - a MapServer object and the *IServerObjectExtensionManager* interface (GIS Server)
  - Instantiate a new object provided by a web reference (WebService)
  - `IAGSServerObjectName.Name="MyServerObjectName"+ "_NASERVER"` and *IAGSServerObject* (GISClient)
- Methods
  - GetNALayerNames
  - GetNetworkDescription
  - GetSolverParams
  - Solve



# Getting the NAServer to a MapServer and find its NALayers (C# sample)

// Step 1 - Get the MapServer

```
IServerObjectExtensionManager soex;  
soex = serverContext.ServerObject;
```

// Step 2 - Get the NAServer

```
INAServer naServer;  
naServer = soex.FindExtensionByTypeName("NAServer");
```

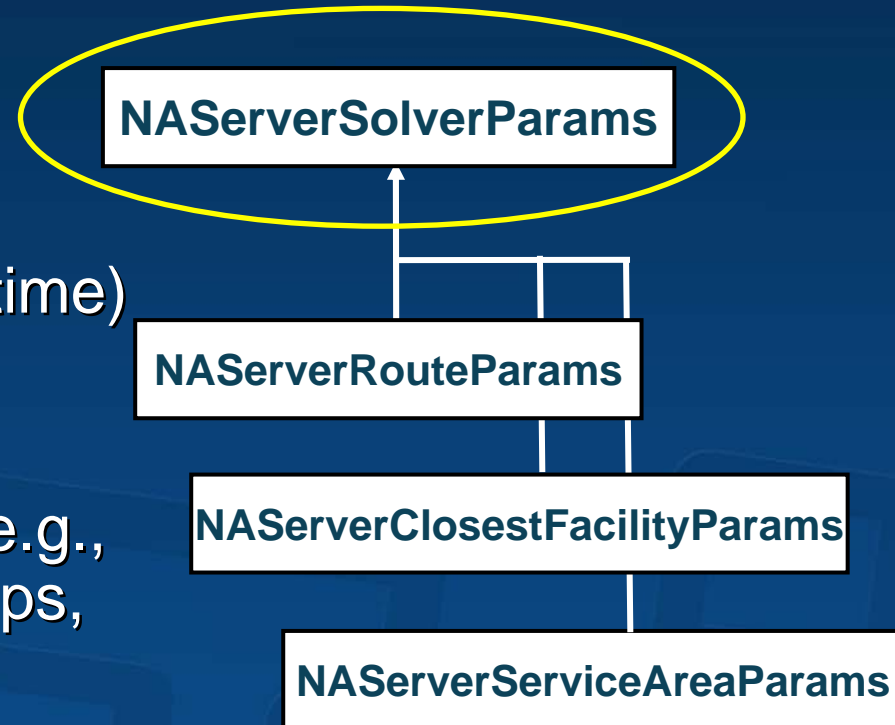
// Step 3 - Get the route network analyst layers of route type

```
string[] naLayers;  
naLayers=naServer.GetNALayerNames  
                (esriNAServerRouteLayer);  
string routeLayer = naLayers[0];
```

# NAServerSolverParams



- Properties to get and set
  - Server parameters (e.g., ReturnMap)
  - Solver parameters (e.g., impedance, restriction, starttime)
  - Network locations (stops, barriers, facilities)
  - Output analysis properties (e.g., ReturnDirections, ReturnStops, ReturnRoutes)



# Setting server parameters (C# sample)



**// Step 1 - Get the NAServerSolverParams**

```
INAServerSolverParams solverParams;  
solverParams = naServer.GetSolverParameters(routeLayer);
```

**// Step 2 - Get the NAServerRouteParams**

```
INAServerRouteParams routeParams  
routeParams = solverParams as INAServerRouteParams;
```

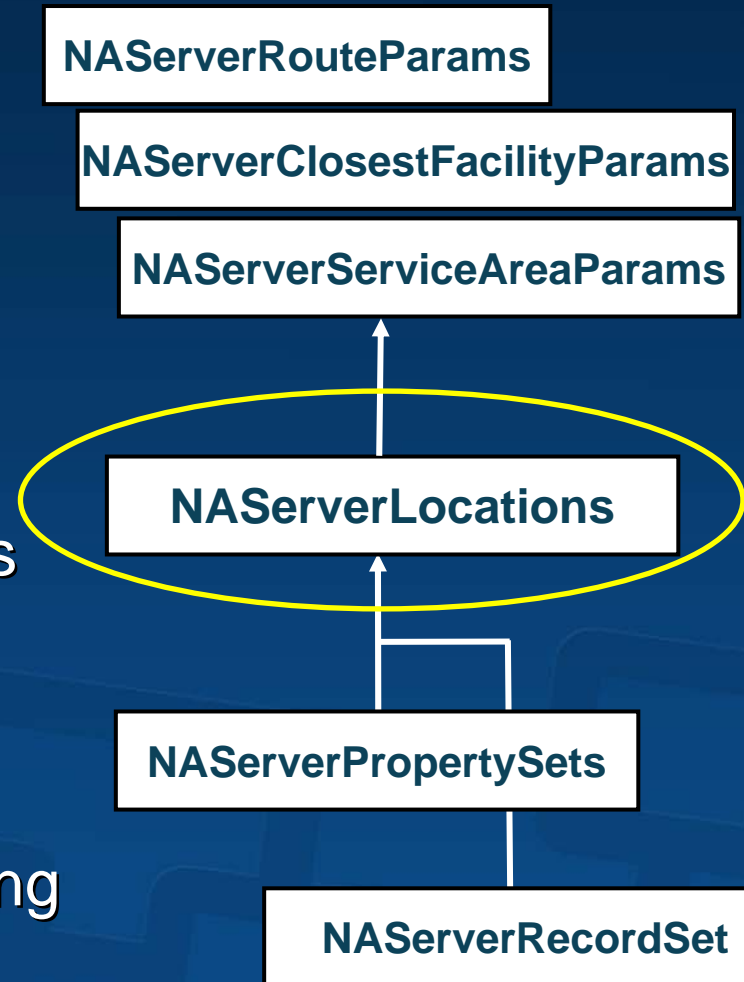
**// Step 3 - Set properties on NAServerRouteParams**

```
routeParams.ReturnMap = True;  
routeParams.ReturnRouteGeometries = True;  
routeParams.StartTime = "2PM 3/17/2006"
```

# NAServerLocations



- Used to populate the location properties (stops, barriers, etc.)
- Network locations created when `INAServer.Solve` is executed
- Allows to create network locations using:
  - `PropertySets (X,Y)`
  - `RecordSet`
- Search tolerance and field mapping are set via the `NAServerSolverParams` object



# Creating stop network locations (C# sample)



// Step 1 - Create stops as property set

```
IPropertySet propStartSet = serverContext.CreateObject("esriSystem.PropertySet")
    as IPropertySet;
propStartSet.SetProperty("Name", "Palm Springs Convention Center");
propStartSet.SetProperty("X", -122.49);
propStartSet.SetProperty("Y", 37.748);
```

// Step 2 - Add the property sets in an array of PropertySets

```
IPropertySetArray propSets;
pPropSets.Add(propStartSet);
pPropSets.Add(propEndSet);
```

// Step 3 - Create NAServerPropertySets

```
INAServerPropertySets stopsPropSets;
stopsPropSets.PropertySets = propSets;
```

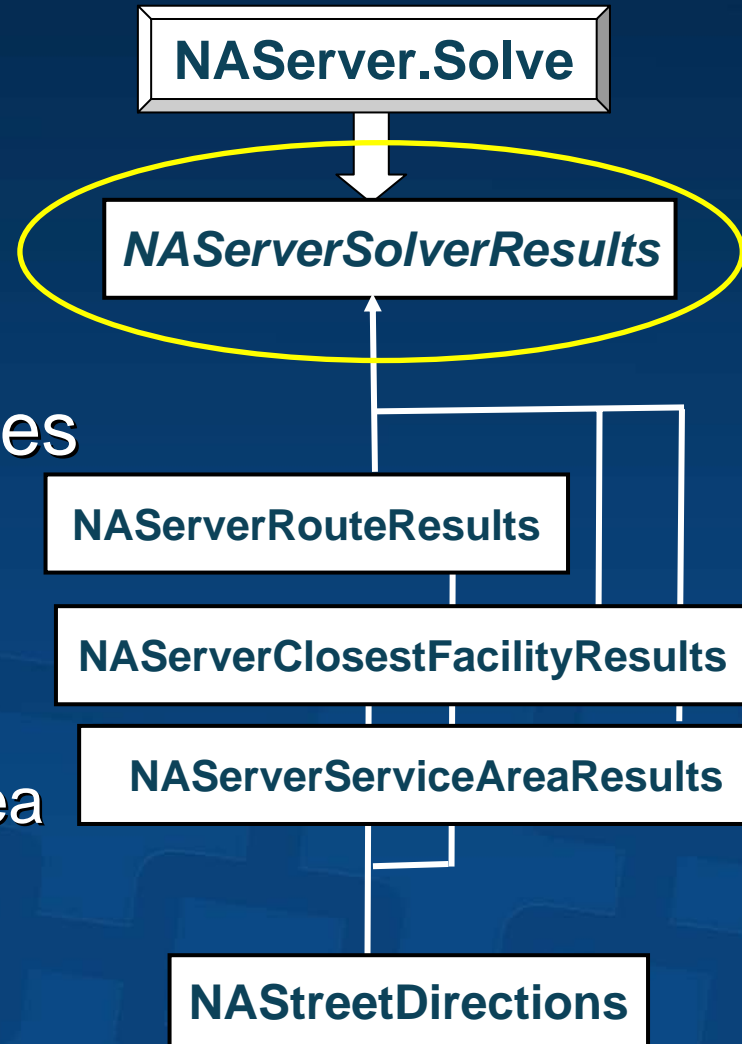
// Step 4 - Populate the stops property sets

```
routeParams.Stops = stopsPropSets
```

# NAServerResults



- Returned by the `NAServer.Solve` method
- Provides access to the `MapImage` and `SolveMessages`
- Provides solver outputs
  - `NAClasses` as `RecordSets`
  - Route polylines and service area polygon geometries
  - Street directions





# Accessing the NAServer results (C# sample)

```
// Step 1 - Solve and get the NAServerSolverResults  
INAServerRouteResults routeResults;  
routeResults = naServer.Solve(solverParams);
```

```
// Step 2 - Get the Map Image
```

```
IMapImage mapImage;  
mapImage = routeResults .MapImage;  
pictureBox.Image = System.Drawing.Image.FromStream(new  
    System.IO.MemoryStream(mapImage.MimeData));
```

```
// Step 3 - get the total impedance of the route
```

```
Double totalImpedance;  
totalImpedance = routeResults.TotalImpedances[0];
```

# Demonstration – Creating a geocoding and routing web application



- Explore a map document with a NALayer (ArcMap)
- Create a map server object on the GIS Server (ArcCatalog) enabling a network analysis server object extension
- Explore a geocode server object (ArcCatalog)
- Publish a Web Service Catalog
- Run and explore a web application



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# Network Analyst samples in 9.2 (Beta 2)



## ArcGIS Engine

- NAEEngine (C#)
- Network Analyst Solvers
  - Route Solver (VB6)
  - Closest Facility Solver (VB.NET, C#, VB6)
  - OD Cost Matrix Solver (VB6)
  - Service Area Solver (VB6)
- Custom Solver (C++)

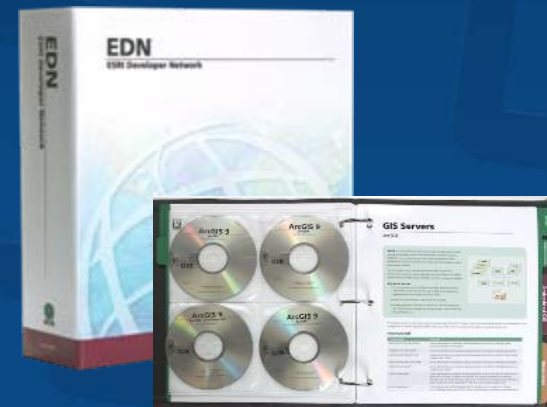
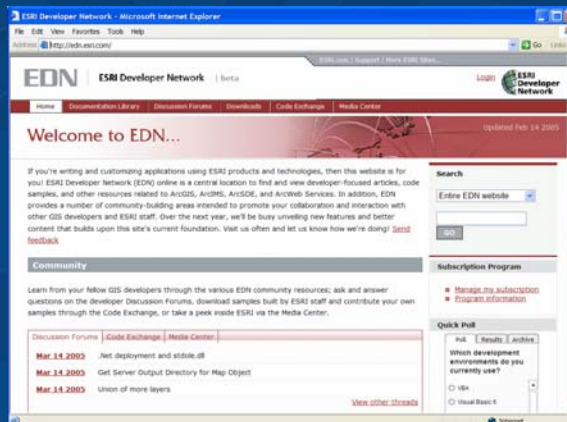
## ArcGIS Server

- GIS Server (VB.Net, C#)
  - Point-to-Point Routing
  - Finding Closest Facilities
  - Generating Service Area
- GISClient (C#)
  - Point-to-Point Routing
- Web Services (C#)
  - Point-to-Point Routing
  - Geocoding and Routing

# ESRI Developer Network (EDN)



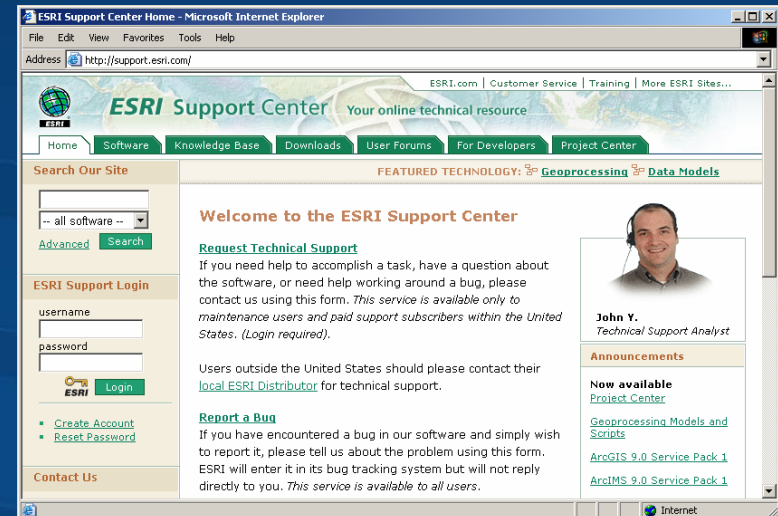
- ArcGIS Engine
  - Network Extension fully supported for developers
- ArcGIS Server
  - Network Extension fully supported for developers
- Developer Samples
- Technical Document
  - Programming ArcGIS Server Network Analyst Applications



# ESRI Support Center



- Online portal to technical information
  - Knowledge Base
    - Technical articles
    - White papers
    - System requirements
  - Downloads
    - Patches and service packs
    - Data models
    - ArcScripts and samples
  - User forums
    - Discussion groups
    - E-mail lists



<http://support.esri.com>

# For more information



- Network Analyst Product Page
  - <http://www.esri.com/software/arcgis/extensions/networkanalyst/index.html>
- Free webcast - Introduction to Network Analyst
  - [http://campus.esri.com/acb2000/showdetl.cfm?DID=6&Product\\_ID=837](http://campus.esri.com/acb2000/showdetl.cfm?DID=6&Product_ID=837)
- Free Podcasts
  - [http://www.esri.com/news/podcasts/instructional\\_series.html](http://www.esri.com/news/podcasts/instructional_series.html)
- Training - Working with ArcGIS Network Analyst
  - <http://training.esri.com/ilt/schedule/index.cfm?fa=courseLink&courseID=D+50099071>

# Other sessions at the Developer Summit or the Business Partner Conference



- Tech Talk from 2:30-3 Today- Oasis 3 Room 4
  - Meet with ESRI Network Analyst
  - Informal Q&A
- Business Partner Conference
  - ArcGIS Network Analyst and the Network Dataset – An Introduction
  - Monday, March, 20<sup>th</sup>, 3:45-5PM
  - Room Mesquite DE

# Session Evaluations Reminder



Questions ?

*... Thank you*