Introduction

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Audience

• Audience
  - System Architects
  - Project Managers
  - Developers

• Level:
  - Beginner / Intermediate
Agenda

- Architecture design framework
- ArcGIS Server architecture consideration
- Architecture design process
- System Designer tool overview
- Use Case and Demo
What is System Architecture?
What framework is used for System Architecture?

Based on The Open Group Architecture Framework (TOGAF)

Business Architecture

- Data Architecture
- Application Architecture
- Technology Architecture
System Architecture – why is it important?

Meeting business requirements: functional and quality

- Functional requirements
  - Business problems first
- Quality Attributes:
  - Performance and Scalability
  - Availability
  - Security
  - Maintainability
  - Compatibility
  - Extensibility
Business Architecture

- Business strategy
- Governance
- Organization
- Regulation
- Project Scope
- Key business processes
- Expected Service Level
- Participating sites and organizations
Data Architecture

- Conceptual
- Logical
- Physical
- Data management
Data Architecture - Geodatabase

Data architecture impacts geodatabase

- Geodatabase model
- Interoperability
  - ETL processes
- What is data quality?
- What is storage type and vendor
- Versioned vs. not versioned
- Participating in replication -> GUID field
- DB spatial and non-spatial views
- DB links
Application Architecture

Esri solution patterns

Asset Management
- Collect, organize & exchange data
- Geodatabase

Planning & Analysis
- Transform data into actionable information
- Geoprocessing

Field Mobility
- Get information Into and out of the field
- Mobile

Operational Awareness
- Disseminate knowledge where & when it’s needed
- Web APIs

A Complete Integrated System

desktop
server
online
Application Architecture

- Application needs
- Application components and interactions

http://resources.arcgis.com/content/enterprisegis/10.0/architecture

1. Map application architecture to Esri Solution patterns
2. Select required ESRI products and extensions
Technology Architecture

- Hardware
- Virtualization
- Network loads
- Storage mechanisms
- Security
- Availability
  - Disaster Recovery
- Scalability
- Aligns technology with business and application architecture
ArcGIS Server – Architecture Considerations
ArcGIS Server – Architectural Considerations

Map Cache

- Ideal for static data
- Takes time to build
- Allocate CPU, Network and I/O resources
- Limitation:
  - Can’t turn on/off layers
  - Download underlying features
  - Limited WMS support
Data Architecture

Data and Application Servers Location

- Data Servers (DBMS, FGDB, File Server) and Application Servers (ArcGIS Server, Citrix Servers/ArcGIS Desktop) should be:
  - Close to each other
  - Connected by fast speed (100 Mbps or 1 Gbps)
- If not possible, consider replicating
ArcGIS Server – Architectural Considerations

Replication and Geodata Service - requirements

- Geopgraphic area and selected layers
- Mixed DBMS
- Geodatabase aware
- Many to Many nodes
- Incremental Edits
- Large Truncate/Reload
- Performance
- Downtime
## Data Distribution Solutions

<table>
<thead>
<tr>
<th>Requirements</th>
<th>GDB Replication*</th>
<th>FGDB copy/paste</th>
<th>RDBMS clone</th>
<th>Disk Block-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Geographical area and selected layers</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Mixed DBMS</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>3 Geodatabase aware</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>4 Many to Many</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Incremental Edits</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Large Truncate/Reload</td>
<td>✓**</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>7 Near Time</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Downtime: 0</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Downtime: 5-60 min</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</tbody>
</table>

* 3rd party product integrated through Esri API

** Consider disconnected synchronization if network has high latency
ArcGIS Server – Architectural Considerations

**Network latency**

1. Distance

2. Payload

3. Infrastructure
ArcGIS Server – Architectural Considerations

Impact of service and return type on network transport time

- Compression
- Content
  - Vector vs. Raster
- Return type
  - JPG vs. PNG

<table>
<thead>
<tr>
<th>Application Type</th>
<th>Service/Op</th>
<th>Content</th>
<th>Return Type</th>
<th>Mb/Tr</th>
<th>56 kbps</th>
<th>1.54 Mbps</th>
<th>10 Mbps</th>
<th>45 Mbps</th>
<th>100 Mbps</th>
<th>1 Gbps</th>
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<tbody>
<tr>
<td>ArcGIS Desktop</td>
<td>Map</td>
<td>Vector</td>
<td></td>
<td>10</td>
<td>0.056</td>
<td>1.540</td>
<td>10.000</td>
<td>45.000</td>
<td>100.000</td>
<td>1000.000</td>
</tr>
<tr>
<td>Citrix/ArcGIS</td>
<td>Map</td>
<td>Vector+Image</td>
<td>ICA Comp</td>
<td>1</td>
<td>17.857</td>
<td>0.649</td>
<td>0.100</td>
<td>0.022</td>
<td>0.010</td>
<td>0.001</td>
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<tr>
<td>ArcGIS Server</td>
<td>Map</td>
<td>Vector</td>
<td>PNG</td>
<td>1.5</td>
<td>26.786</td>
<td>0.974</td>
<td>0.150</td>
<td>0.033</td>
<td>0.015</td>
<td>0.002</td>
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<tr>
<td>ArcGIS Server</td>
<td>Image</td>
<td>JPG</td>
<td></td>
<td>0.3</td>
<td>5.357</td>
<td>0.195</td>
<td>0.030</td>
<td>0.007</td>
<td>0.003</td>
<td>0.000</td>
</tr>
<tr>
<td>ArcGIS Server</td>
<td>Map Cache</td>
<td>Vector</td>
<td>PNG</td>
<td>0.1</td>
<td>1.786</td>
<td>0.065</td>
<td>0.010</td>
<td>0.002</td>
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<td>0.007</td>
<td>0.003</td>
<td>0.000</td>
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</table>
## ArcGIS Server – Architectural Considerations

### The challenge of modeling memory

<table>
<thead>
<tr>
<th>Item</th>
<th>Low</th>
<th>High</th>
<th>Delta</th>
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</thead>
<tbody>
<tr>
<td>XenApp Session</td>
<td>500MB</td>
<td>1.2GB</td>
<td>140%</td>
</tr>
<tr>
<td>Database Session</td>
<td>10MB</td>
<td>75MB</td>
<td>650%</td>
</tr>
<tr>
<td>Database Cache</td>
<td>200MB</td>
<td>200GB</td>
<td>99,900%</td>
</tr>
<tr>
<td>SOC Process (Dynamic Map Service)</td>
<td>50MB</td>
<td>500MB</td>
<td>900%</td>
</tr>
<tr>
<td>SOC Process (Image Service)</td>
<td>20MB</td>
<td>1,024MB</td>
<td></td>
</tr>
<tr>
<td>SOC Process (Geoprocessing Service)</td>
<td>100MB</td>
<td>2,000MB</td>
<td></td>
</tr>
<tr>
<td>SOM</td>
<td>30MB</td>
<td>70MB</td>
<td>133%</td>
</tr>
</tbody>
</table>
ArcGIS Server – Architectural Considerations

Include Staging and Development

- Development
- Staging
- Production

EDN System

Staging Virtual Machines (Reflect Production)

Production Systems
ArcGIS Server on Amazon
Cloud - Benefits

New architecture and deployment paradigms

- Global reach
- Information sharing and collaboration
- Reduced IT costs
- High security
- High scalability
- High availability
- High load elasticity
What is ArcGIS Server on Amazon EC2?

- ArcGIS Server that runs on Amazon's hardware
- Administer through Web services
- Includes:
  - Windows 2008 64 bit
  - ArcGIS Server 10 .Net
  - ArcGIS Desktop
  - 100G EBS
  - Automation scripts
  - PostgreSQL 8.3 (Enterprise)
ArcGIS Server on Amazon EC2

Advantages

- No installation required—preconfigured Amazon Machine Image (AMI) with ArcGIS Server
- Scalable on demand—Creating new instances can even be done programmatically in response to usage statistics
- No hardware infrastructure to maintain
ArcGIS Server on Amazon EC2

Transferring data to the cloud

- Remote Desktop copy/paste
- S3 client utilities
- Your own web server
- FTP (use SSL for security)
- Ship the data
ArcGIS Server on Amazon EC2

Replicating data – connected (<4 Mb) or disconnected

On-Premise

Parent Replica

1-way replication

Geodata Service

ArcGIS Server 1..n

Child Replica

Map Service

Amazon EC2
ArcGIS Server on Amazon EC2

Scalable Architecture

• Each Instance has
  - SOM, SOC, and Web server deployed together
  - Identical data
  - service configurations

• Elastic Load Balancer
ArcGIS Server on Amazon EC2

Limitations related to the use of the Elastic Load Balancer

- No guarantee request will be handled by a particular EC2 instance
- limits the use of stateful Web applications and services
ArcGIS Server on Amazon EC2

Not supported functions

- ArcGIS Server Web ADF applications
  - Store session in SQL Server, sticky sessions
- Nonpooled services
- Asynchronous geoprocessing services
- Map caching in a distributed deployment
  - assign each machine a different geographic area to cache
Architecture Design Process
Step 1: Collect Requirements

- Business
- Data
- Application
- Technology
Step 2: Define Sites, Users, Data Centers
Step 3: Define User workflows

Active Users and Pacing vs. Workflows/Hour
Modeling Workflow

Uncertainty of Information

Active Users
Operational Details
Pacing
Think Time
Benchmark Selection
Infrastructure
Modeling workflows

- Units of work from the system’s perspective
- For capacity planning, should correspond to something that has a benchmark model
Modeling workflows

Identify peak hour for design target
Modeling workflows

- Low and high bounds which are 90% likely to contain the true number.
Modeling workflows

- Calibrate With Data

![Diagram showing workflow and data points]

- Total annual output of dept
- 90% Confidence
- Web hits for the busiest site on the busiest day of last year
- Current Desktop Licenses
- Other Dept Could not Accept More Output Than This
- Total Employees with Job Function

Page 40
Step 4: Define Applications and Software

- Logical stacks of software
- Manage availability strategies
- Document security attributes
- Document memory/storage requirements
Step 5: Define Infrastructure

- Switches and Gateways
- Capacity Hardware: Servers
  - Cores and SPECintRate2006
  - Memory and Storage
- Virtualization
- Maximum Utilization
- Firewall
- Load Balancer
- Router
- Storage
Define Infrastructure

Hardware type
Step 6: Associate Operation and Hardware

- Creates a relationship between:
  - The workflow Operation
  - Pieces of the logical software stack (Applications)
  - Infrastructure (Hardware and Network)
Associate Operation and Hardware
Step 7: Assign models to operations

![Diagram showing model assignment to operations](image-url)
Assign models to operations

- Creates a relationship between:
  1. The workflow Operation
  2. Service Time and Network Per Transaction
Step 8: Calculate Capacity

- How many CPU cores?
- How many servers?
- What is required network bandwidth?
Step 9: Validate Design
System Designer – Overview
System Designer - what is it?

A tool for Solution Architecture design

- Gathering requirements
- Designing
- Capacity: CPU, Network, Memory
- Reporting
System Designer Framework

Aligns with TOGAF framework

- **Business Architecture**
  - User and infrastructure location
  - Business processes
    - User workflows
- **Data Architecture**
- **Application Architecture**
  - Software quantities
- **Technology Architecture**
  - Capacity planning
    - Hardware and Network
  - Deployment details
System Designer

System Designer is not just a tool...
System Designer

Project phase

• Pre-Sales
  - Proposals
  - ROM

• Projects
  - Strategy and Planning
  - Requirements Analysis
  - Design
  - Deployment

• Operations and Maintenance
System Designer

Value

- Ability to quickly decompose a complex architectural problem into an easily understood visual view
- Provides quality and interactive presentation
- Reduces design costs:
  - Standards, Automation, Samples
- Clearly defines requirements and assumptions
Key features

Task automation

• Automated Visio

• Automated Word
Key features

Data Repository

• Solutions mining

• DBMS and Local backups

• Security
  - Solution lock
Challenges / Risks

Lessons Learned

• Wrong Results
  - Over- or Under-sized hardware and license counts
  - Over- or Under-sized WAN/Inet gateways

• Inappropriate Designs
  - Solutions do not reflect best practices
  - Solutions would not be effective

• Reduced Productivity
  - Inefficient use of tool
  - Modeling dead-ends
Use Case
Use Case - Requirements

Core business processes

• Global company
  - Headquarters in Amsterdam
  - Mobile users
  - Offices: Houston, Caracas, Singapore, Kazakhstan,

• Core business processes
  Asset Management (primarily ArcGIS Desktop)
  Analysis (primarily ArcGIS Desktop and GP service)
  Operational Awareness (Web dashboard)
  Field Mobility (mobile data collection)

• Real/Near time information sharing and collaboration
Use Case - Requirements

Quality Attributes

• Quality Attributes:
  - Security
  - Availability
  - Performance and Scalability
  - Compatibility (3rd party application)
  - Interoperability (OGC)
Use Case

How did we address requirements?

- **Application**
  - ArcGIS Server, ArcGIS Desktop, ArcGIS Mobile
- **Availability**
  - Disaster recovery site, N+1 redundancy
- **Performance**
  - Map Cache
- **Network Latency**
  - Citrix, Map Cache, Replication
- **Sharing and Collaboration**
  - Replication
Use case

Sample design
System Designer – Demo

Creating a new project
Trying System Designer

- Trial version and training, please contact:
  - Chad Helm, chelm@esri.com
Resources - System Designer

• Traditional spreadsheet and Visio approach still valid
• For complex solution, consider high productivity tools that allow:
  - Reuse solutions
  - Sharing design
  - Extensive QC functionality
  - Configuration details
  - Fast report generation
Summary

- System Architecture is about identifying and managing risk appropriately
- It is an iterative process
  - Use tools that provide high productive and Q/C
- Patterns, Templates and Best Practice can guide
- Ensure Architecture provides “blue print” details sufficient for implementation
References

• TOGAF – An Enterprise Architecture Framework
  - http://www.opengroup.org/togaf/

• ESRI Enterprise GIS Resource Center Website
  - http://resources.arcgis.com/content/enterprisegis/10.0/about

• MS Open Source Application Architecture Pattern Guidance
  - http://www.codeplex.com/AppArch

• Building a GIS
  - http://esripress.esri.com/display/index.cfm?fuseaction=display&websiteID=141&moduleID=0
Contact us

- Andrew Sakowicz, asakowicz@esri.com

- System Designer trial version and training:
  - Chad Helm, chelm@esri.com