Converting an ArcGIS Desktop Application to ArcGIS Server Web Application

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Overview

- Background of desktop application
  - Paul’s REALLY brief description of CITYgreen
- Desktop Application User Interface
- Why Web-enable?
- Challenges
- Building the Web Application
  - Architecture
  - Components
  - Converting the ArcToolbox tools
- Using the Web Application
Abstract

American Forests developed CITYgreen, an ArcGIS desktop application, to evaluate ecosystem services in urban areas. Harris Corporation, in cooperation with American Forests and the U.S. Geological Survey's Comprehensive Urban Ecosystems Studies (CUES) project, has web enabled portions of the CITYgreen software using ArcGIS Server. ArcToolbox tools were rewritten to run on the ArcGIS Server in order to accommodate the complex data processing model on the server. The application utilizes data from USGS' National Land Cover Dataset to estimate the economic benefit of urban tree cover from reduced storm water runoff as well as reduced levels of air and water pollution, the type and amount of air pollution removed by the trees, amount of water runoff and associated cost savings. The web-based application allows users to generate reports with summary ecosystem service analyses for over 3,000 urban areas in the U.S.
Background

- American Forests’ CITYgreen desktop application:
  - Uses satellite-derived land cover data to estimate economic benefits of trees in urban settings.
  - Calculates dollar benefits of “urban ecosystem services”, based on estimated changes in storm water runoff, air & water quality, carbon storage, and summer cooling costs.

- This project’s goal was to web enable part of the desktop application to:
  - Allow regional scale (30 meter resolution) assessments of urban ecosystem services.
  - Generate automated maps and reports summarizing key findings.
CITYgreen Desktop Application

User interface of the desktop application
CITYgreen Desktop Application

CITYgreen Desktop Reports

- Land cover map
- Storm runoff, water quality
- Land Cover, air quality, carbon storage

USGS

science for a changing world

HARRIS
Why Web-enable?

- Accessible via internet – Nothing to install
- Centralized GIS processing allows wider use
- Generated reports can be cached and reused for future identical requests
- We thought it would be cool
Challenges

- Complex processing model utilizes many ArcToolbox tools not available on server
- Large dataset (over 5G) creates speed issue
- Asynchronous processing
- Interactive features through web page
- Complex crystal report templates
Building the Web Application

Web Application Architecture

- Web Interface
- ArcView
  - Citygreen Data
  - Geographic Data
  - Map Symbology
  - Map Layout
- ArcGIS Server
  - Server Container
  - Server Manager
  - Server Object
  - ArcObjects
- Crystal Report
  - Templates
- VS .NET
Building the Web Application

Web Application Components

- **ArcView**
  - Create the map
- **ArcGIS Server**
  - Host, manage, and serve GIS resources
- **Crystal Report**
  - Create PDF crystal report with templates
- **Visual Studio .NET**
  - Implement GIS functions and GUI
Building the Web Application

Creating the Project

- Choosing a development platform
  - Visual Studio .NET (VB.NET/C#)
  - ArcGIS .NET API

- Creating the Server Object
  - Pooled server object
    - Client cannot change the properties of the web map

- Creating a VS.NET web application
  - Shallowly stateful application
    - Makes stateless use of server object in the GIS server by maintaining aspects of application state such as layer visibility, client-added graphics
    - Using the server’s session state management capabilities
Building the Web Application

Converting the Model

ArcGIS Desktop

ArcGIS Server

ArcToolBox

ArcToolBox Model

Server Functions

Converting

Feature Raster
Extract by Mask
Tabulate Area
Get Centroids
Clip
......
Building the Web Application

Data Processes on the Server –
ArcToolbox tools rewritten to run on server…

- Feature to Raster Conversion
- Raster Int Operation
- Raster Extract by Mask
- Raster Tabulate Area
- Feature to Point (Get Centroids)
- Feature Clip
- Raster Reclassify
- Raster Pick Operation
- Raster Zonal Statistics
- Raster to Polygon
- Add Fields
- Calculate Field
- Feature Intersect Operation
Building the Web Application

Running the Model on the Server

- Fine-grained ArcObjects Programming
- 13 main process functions
- 34 process steps
- Includes data conversion, raster analysis, feature analysis, and table operations
Fine-grained ArcObjects Programming Sample: Calculate a field of a table

'Get the featureclass from the shape file
pInFeatureClass = ReadShapeFileToFeatureClass(myServerContext, inShapePathName)

'Find the fields
pTable = pInFeatureClass
intFldIndex = pTable.FindField(FieldName)
If intFldIndex = -1 Then
    MsgBox("There must be a field named in the featureclass")
    Exit Sub
End If

'Perform the calculation
pCursor = pInFeatureClass.Update(Nothing, True)

pInRow = pCursor.NextRow
Do Until pInRow Is Nothing
    pInRow.Value(intFldIndex) = ExpressionStr
    pInRow.Store()
    pInRow = pCursor.NextRow
Loop
pCursor = Nothing
Building the Web Application

Creating Report on the Server

Data Tables

ArcGIS Server Container

Data Processing

Crystal Report Templates

PDF Reports

Crystal Report Engine
Building the Web Application

Crystal Report Template
Using the Web Application

The user interface of the web application
Using the Web Application

**Processing Steps**

- **Select Data Layer**
  - Cities & Towns
  - County
  - Watersheds
  - Urban Areas

- **Select Report Template**
  - For 1992
  - For 2001
  - For Comparison
  - Default

- **Input Area Name**

- **Self-digitized area on web map**

- **Zoom In/Zoom Out**

- **Select area on the map**

- **Save Feature**

- **Process Data & Create PDF report**
Using the Web Application

Select area of interest: Cities & towns...
Using the Web Application

or... **Select area of interest**: County
Using the Web Application

or... **Select area of interest**: Watersheds
Using the Web Application

or… Select area of interest: Urban area
Using the Web Application

or… **Select area of interest**: Area defined by user
Summary

- We essentially rewrote an ArcGIS Desktop application to run as a web application on ArcGIS Server.
  - Rewrote individual ArcToolbox tools to run on ArcGIS Server.
  - Used ArcGIS .NET API to glue together converted ArcToolbox tools and provide web functionality.

- The application utilizes data from USGS’ National Land Cover Dataset to estimate the economic benefit of tree cover and calculate an associated cost savings for a defined area.
Future Work

- Allow use of different types of land cover data
- Allow users to select area of interest, then submit request for analysis. Requests will be put in a queue and results e-mailed to users automatically.
- Cache reports generated by users in a library to speed future requests
- Integrate with other web GIS applications
- Other optimizations
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