Collaborative Editing and Analysis of Alternatives using ArcGIS Server, Java Server Faces, and SOA

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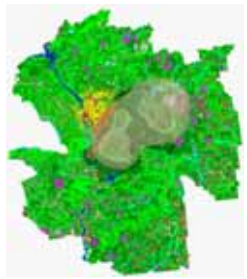
Problem Domain:

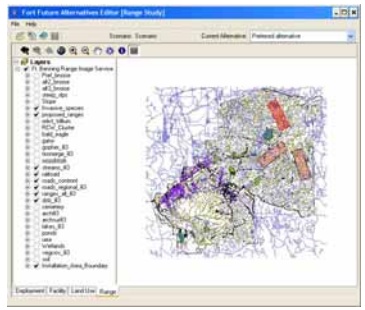
Integrated Planning, Simulation, and Analysis

Use multiple, cross-domain analyses and simulations to assess possible outcomes of plans

Collaborative Web-based Decision Support

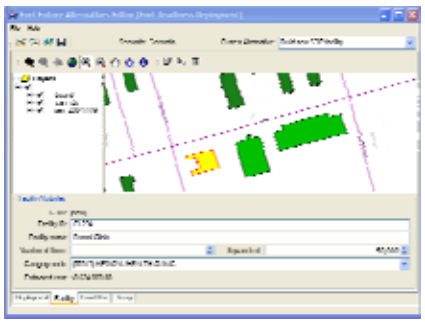


Encroachment and Land Use Simulation



NEPA Analysis for Range Siting

Deployment Process Studies



Facility Siting

Critical Electrical Infrastructure

Critical Water Infrastructure

Airborne Plume Modeling

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Technology Challenge

- Many simulation and analysis applications require geospatial data
- Need a way for stakeholders to create, modify, and assess alternative courses of action on the web → to collaborate
  - (Without the need for highly skilled GIS professionals to make each change)
- Need a protocol for decision support systems to initialize, track, and get results from analysis and simulation software
- Simulation software needs to be able to gain access to geospatial data for each alternative

Approach

- Use a Service-Oriented Architecture
- Set up services to:
  - Perform decision support: manage studies, alternatives, data, and results
  - Manage geospatial data for alternative Courses of Action (COA)
    - collaboratively edit geospatial and other data
  - Manage other types of data
  - Perform analysis and simulation

Approach

- Define system endpoints
- Determine data requirements for common DSS
- Create abstract control and data schema
- Create communication protocol
- Conduct proof-of-concept test of protocol and schema using a simple DSS with multiple simulation systems.

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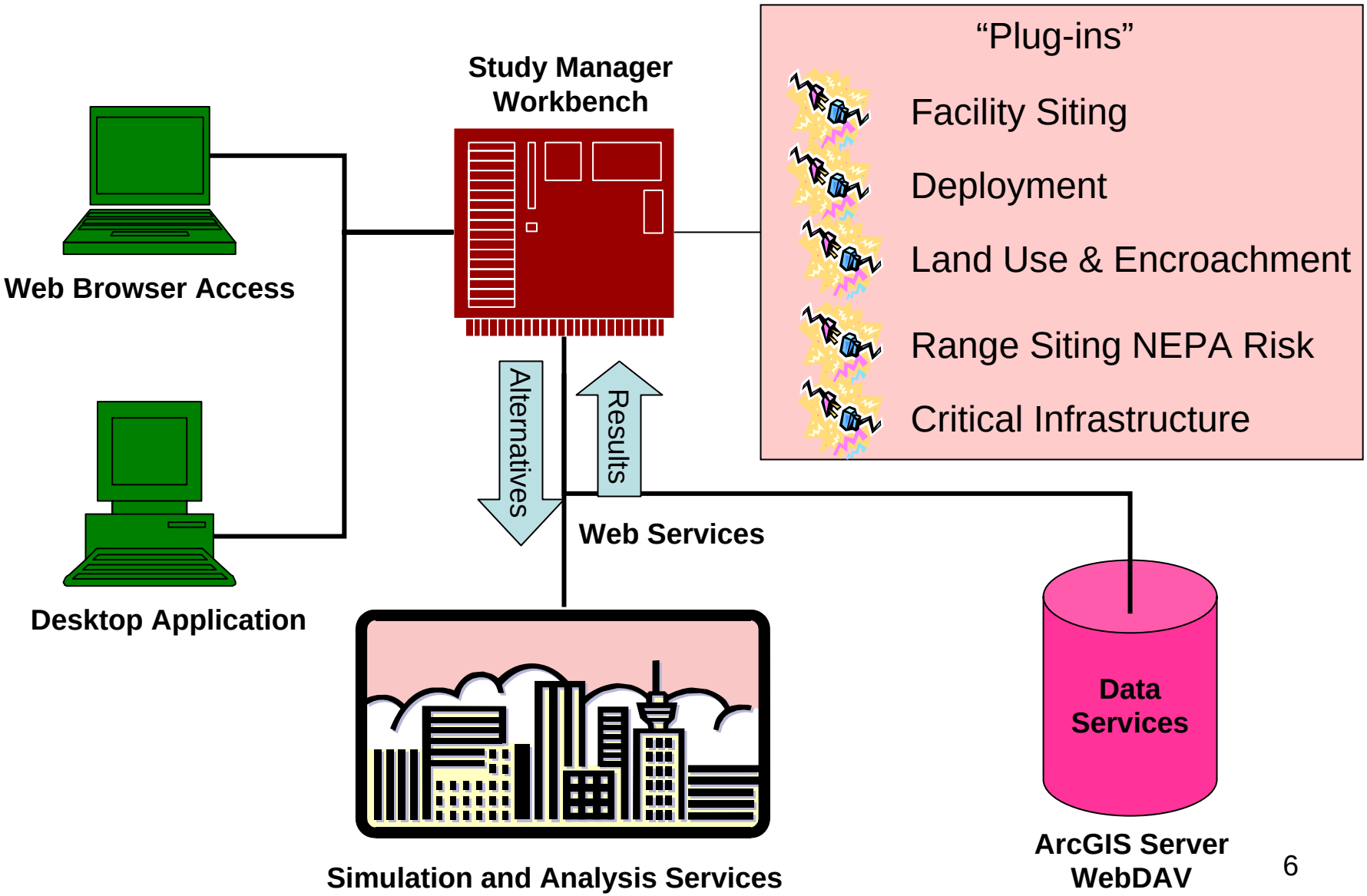
System Architecture (J2EE Framework)



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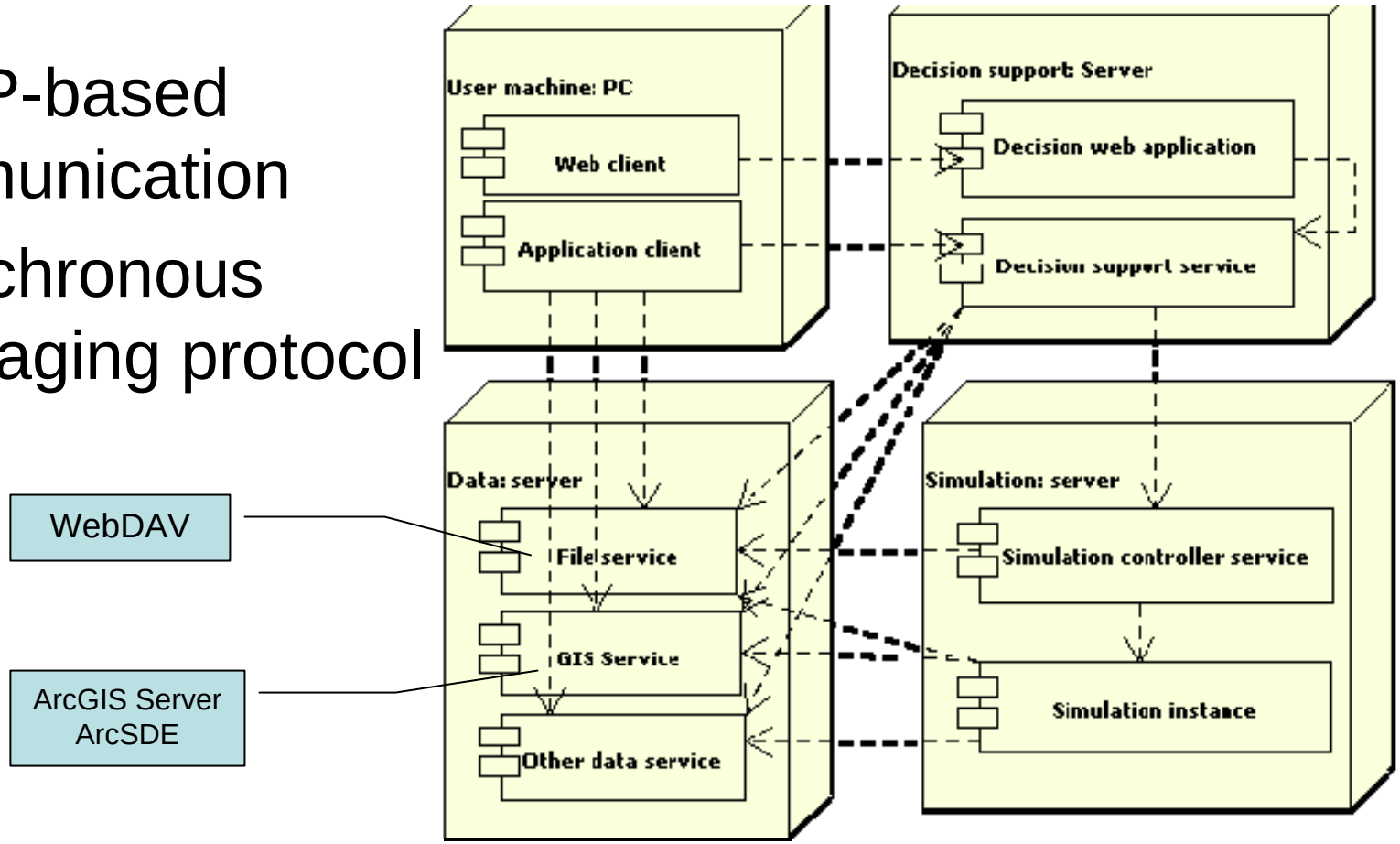
System Endpoints

- SOAP-based communication
- Asynchronous messaging protocol



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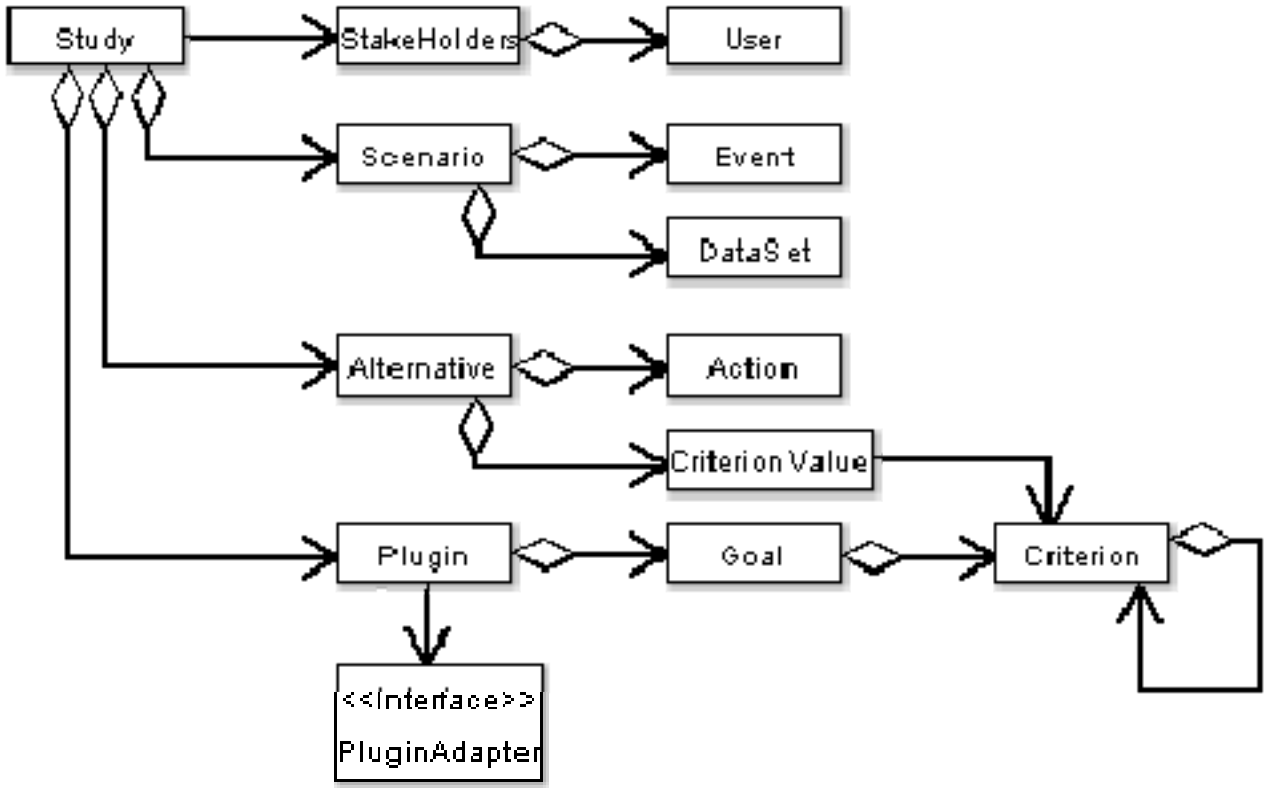
Abstract Concepts

- Study
- Stakeholder
- Scenario
- Event
- Dataset
- Alternative
- Action
- Plugin
- Goal
- Criterion
- Criterion Value



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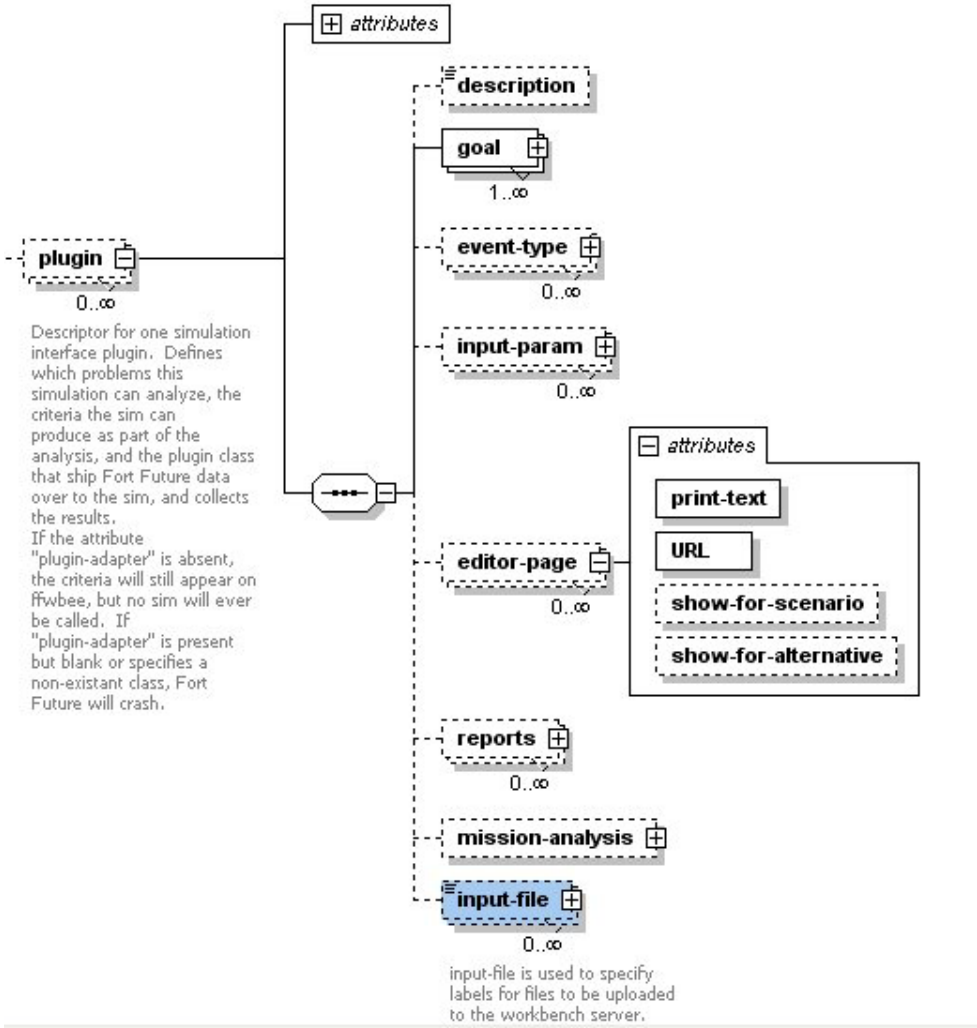
Simulation System Meta-data

- Simulations register with DSS using XML
- DSS can call PluginAdapter methods
- PluginAdapter has access to study data
- PluginAdapter formats input for sim, controls execution, and retrieves results using SOAP & XML
- DSS compares criteria and alternatives



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PluginAdapter Methods and Protocol

- For each remote plugin and study, DSS uses SOAP call to:
  - Initialize service to run a job for all alternatives
  - Create inputs
    - Including preparing geospatial data
  - Start jobs
  - Get status
  - Get results
  - Tell service to delete data
- Optional
  - Abort all or each job

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Process flow

- Configure Data Sets
- Create study
- Invite Stakeholders
- Set up scenario
  - Narrative
  - Select Data Sets for study
- Create alternatives
- Edit alternatives
  - ArcIMS and Map Objects – Java Webstart
  - ArcGIS Server and Java Server Faces
- Run Simulations
- Collect results
- Compare alternatives
- Iterate

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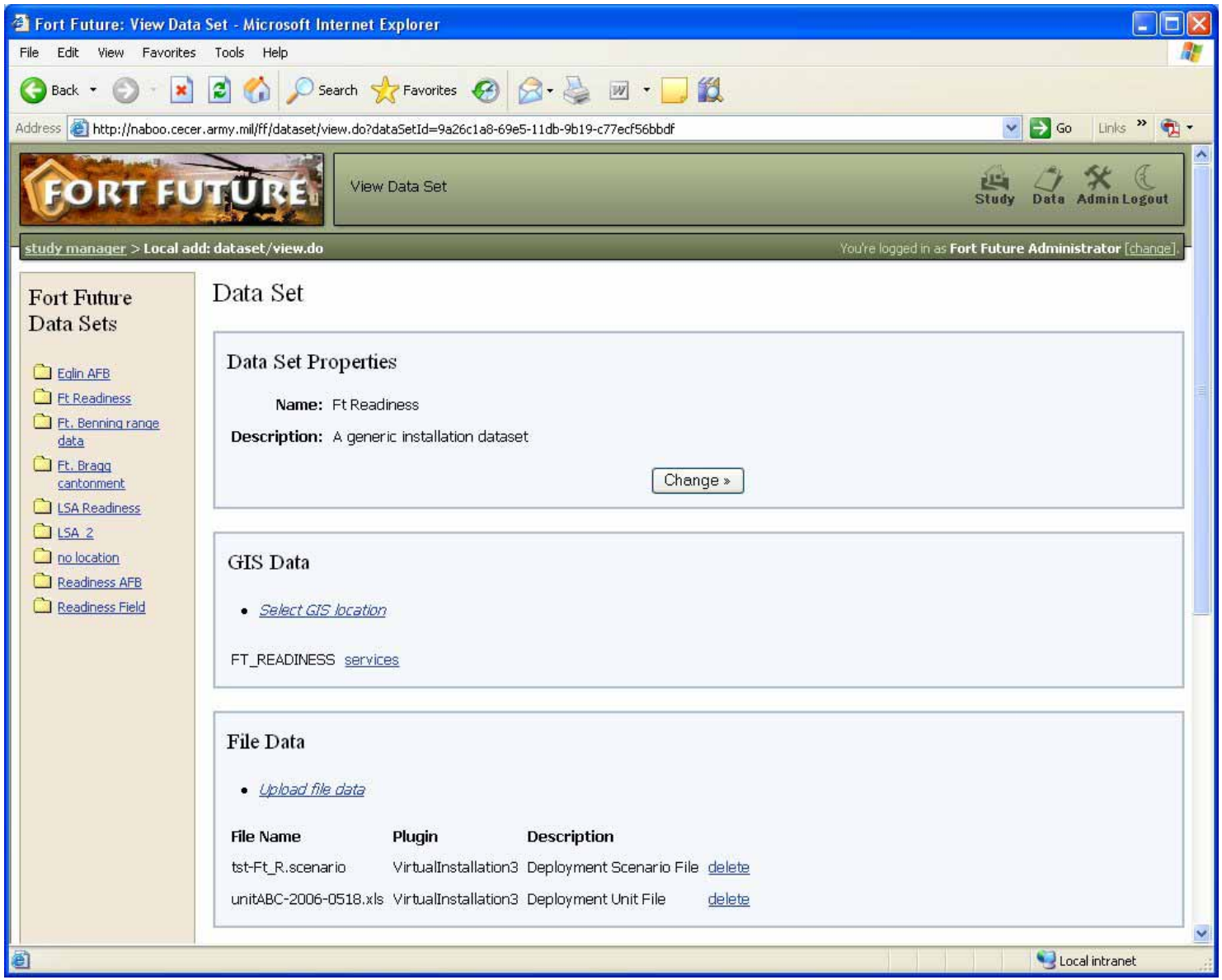
Setting Up Datasets



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ArcGIS Server/ArcIMS Configuration using XML

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```

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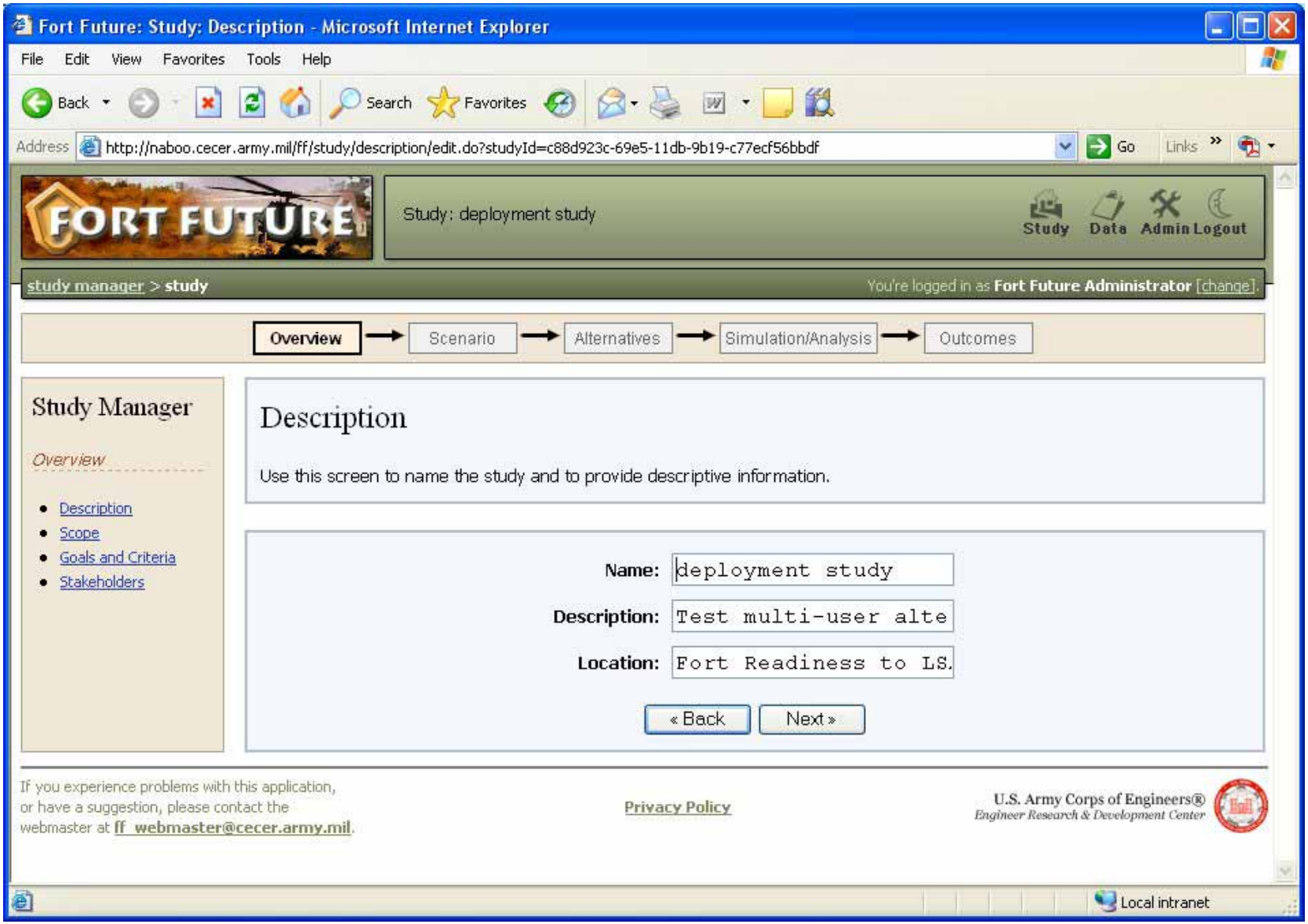
Creating A Study



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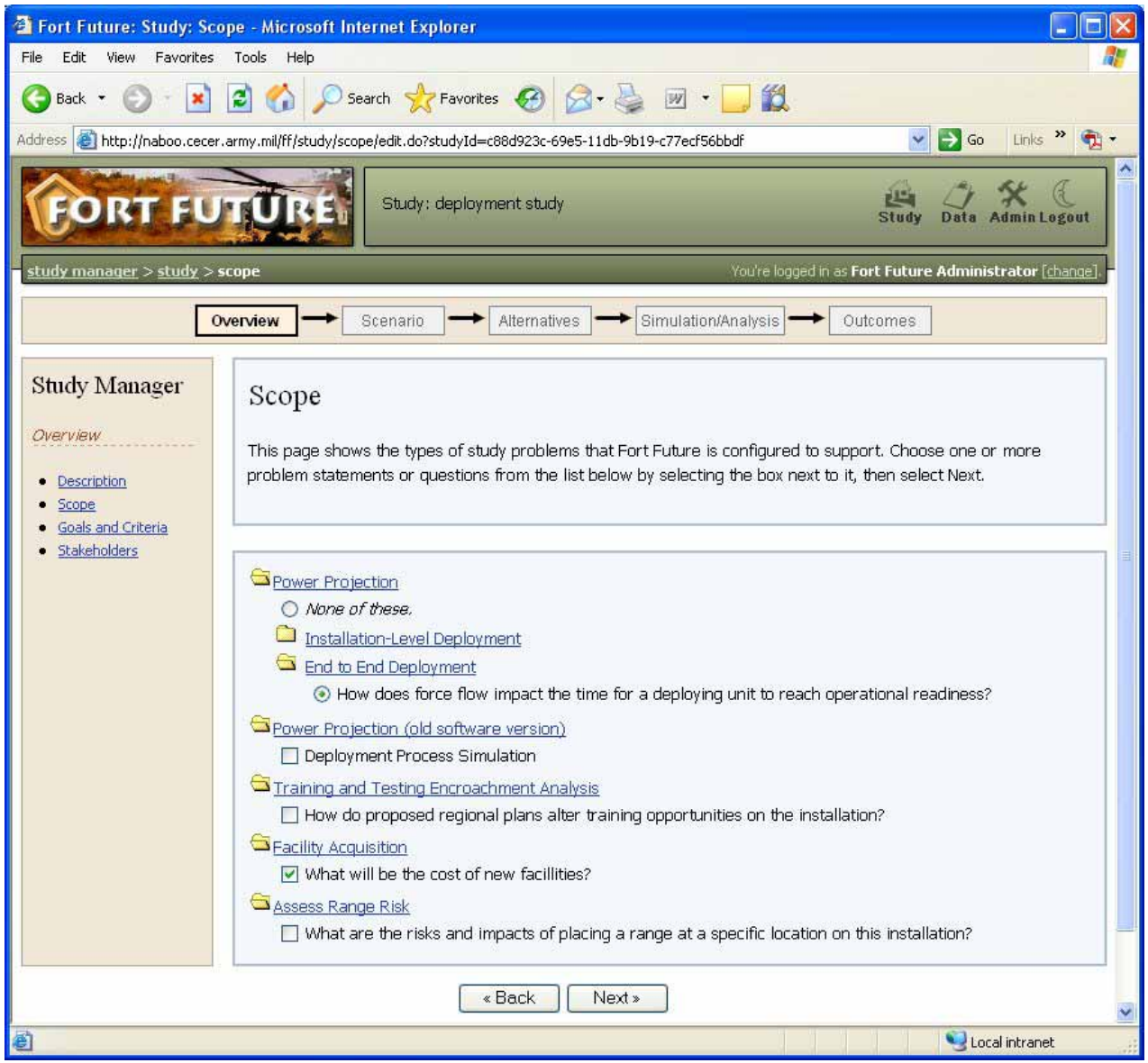
Setting The Study Scope



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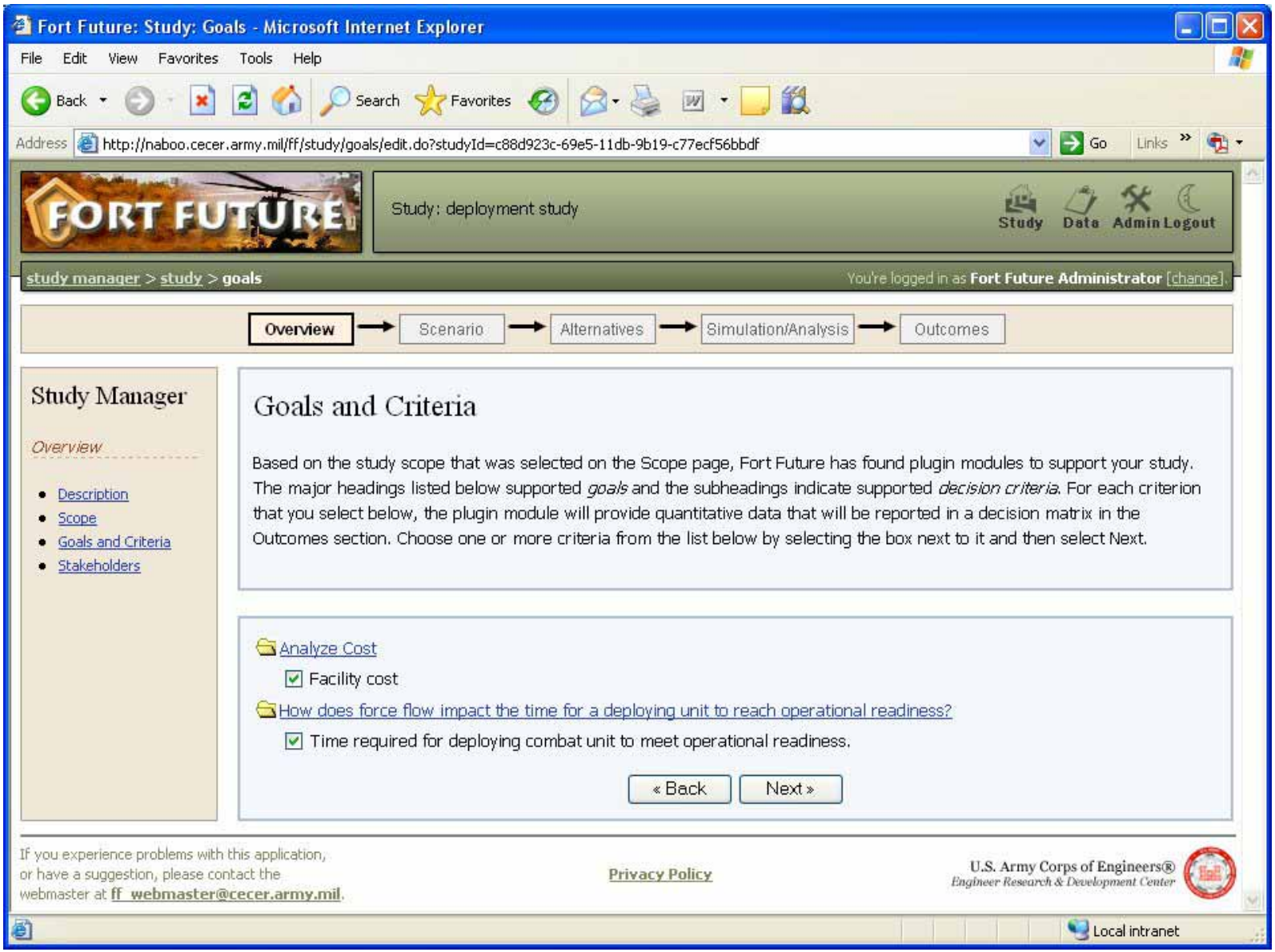
Setting Goals and Criteria



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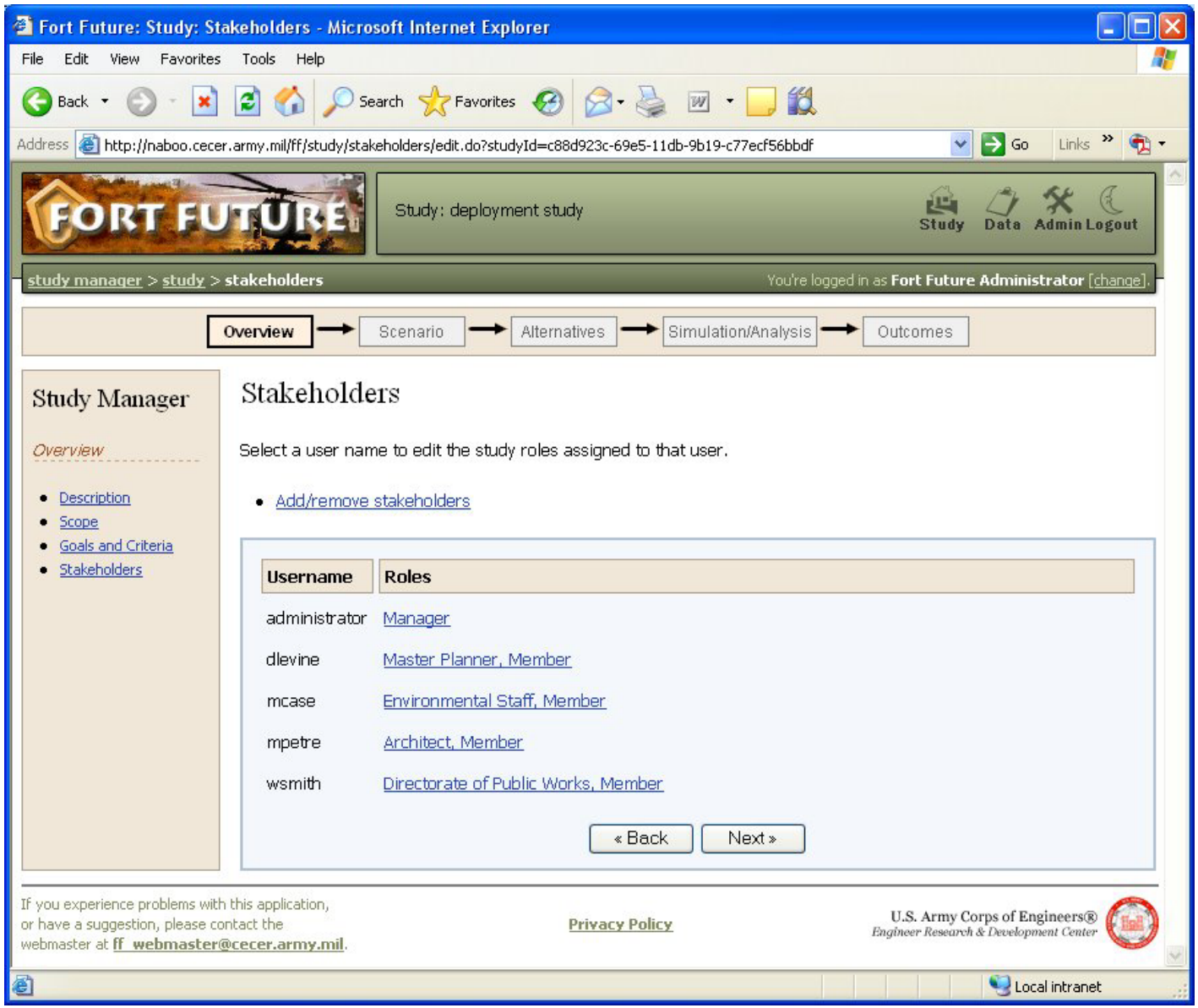
Add Stakeholders



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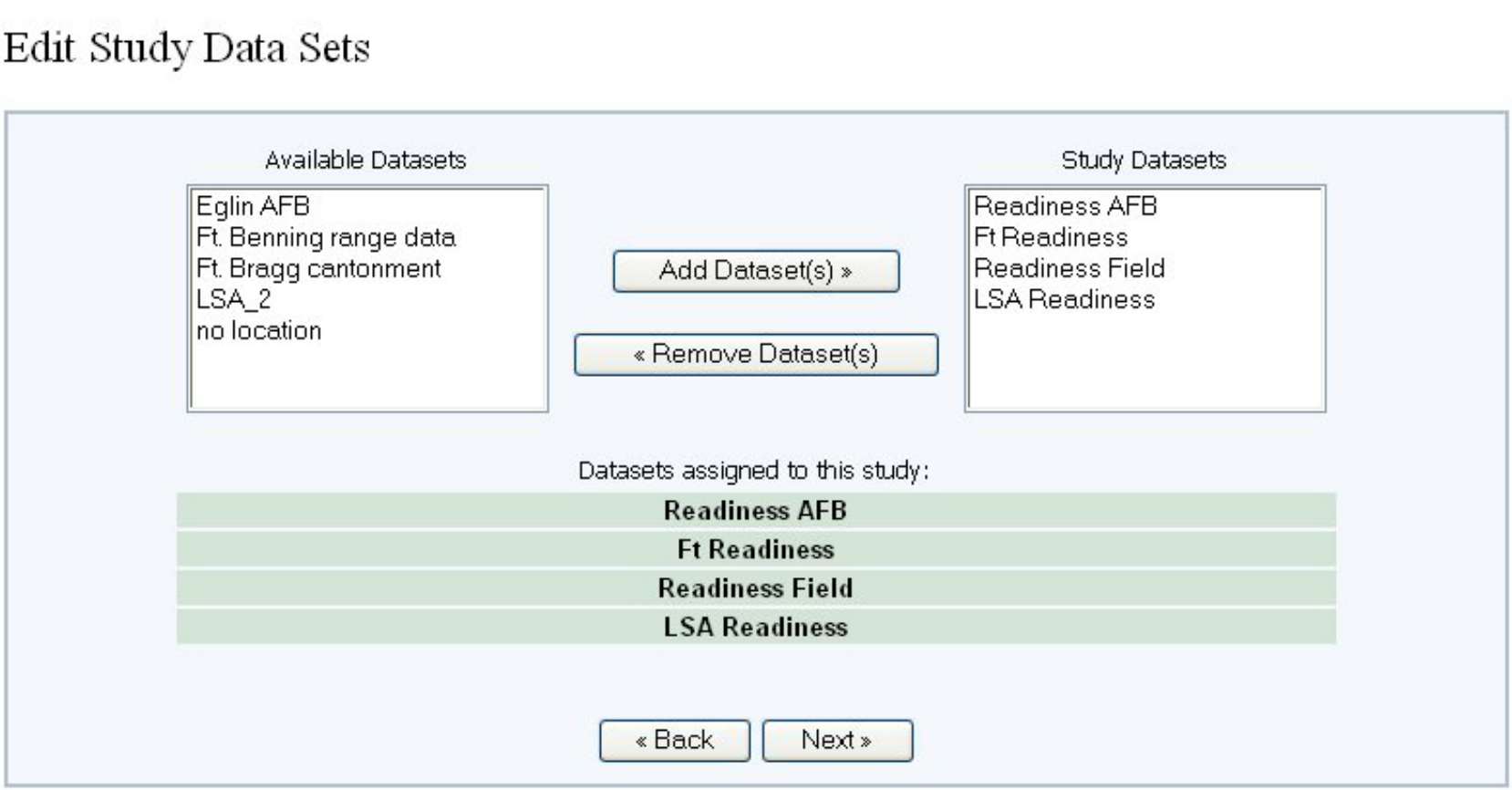
Associate Datasets with Study



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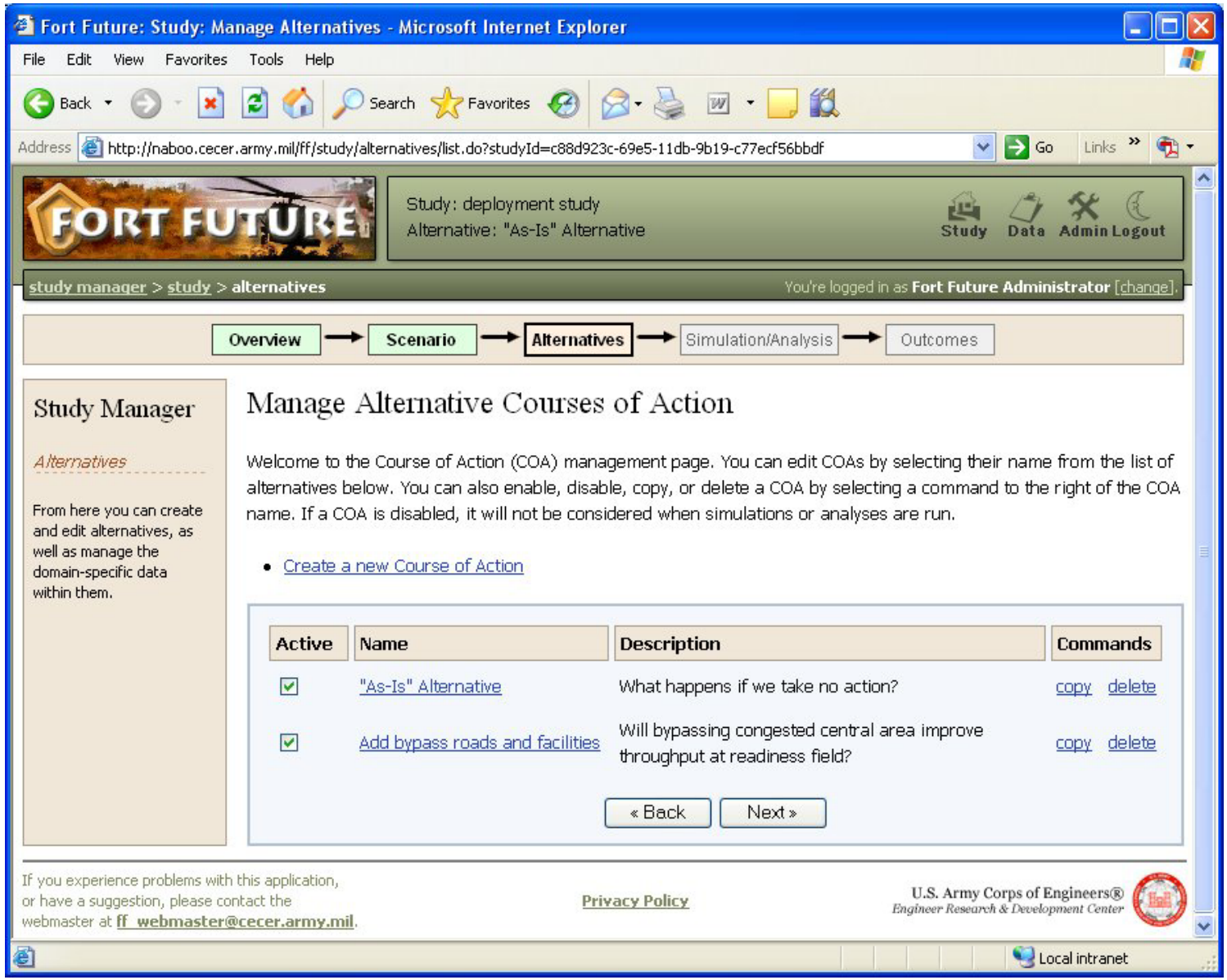
Setting Up Alternatives



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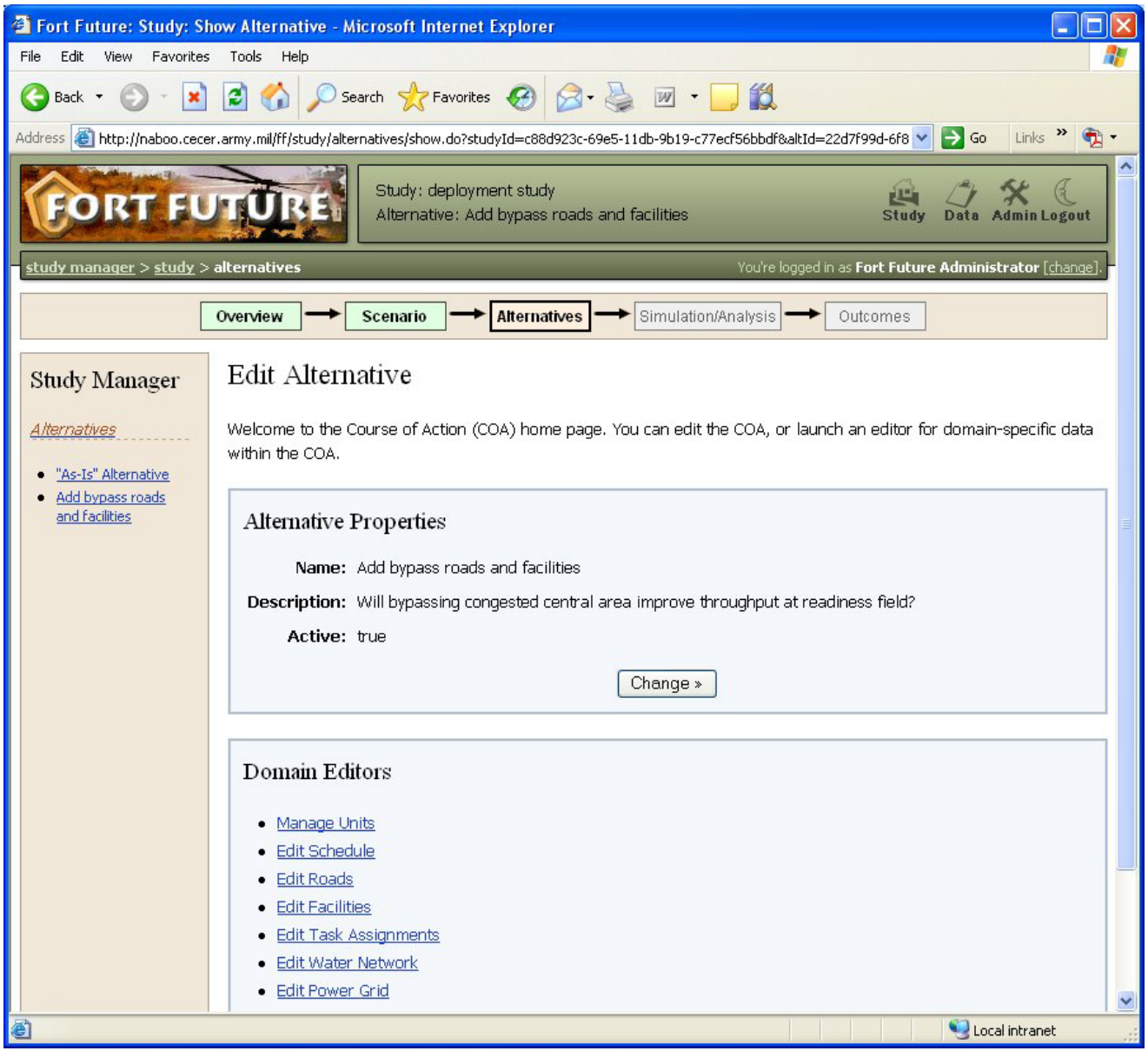
Shared and Custom Editors



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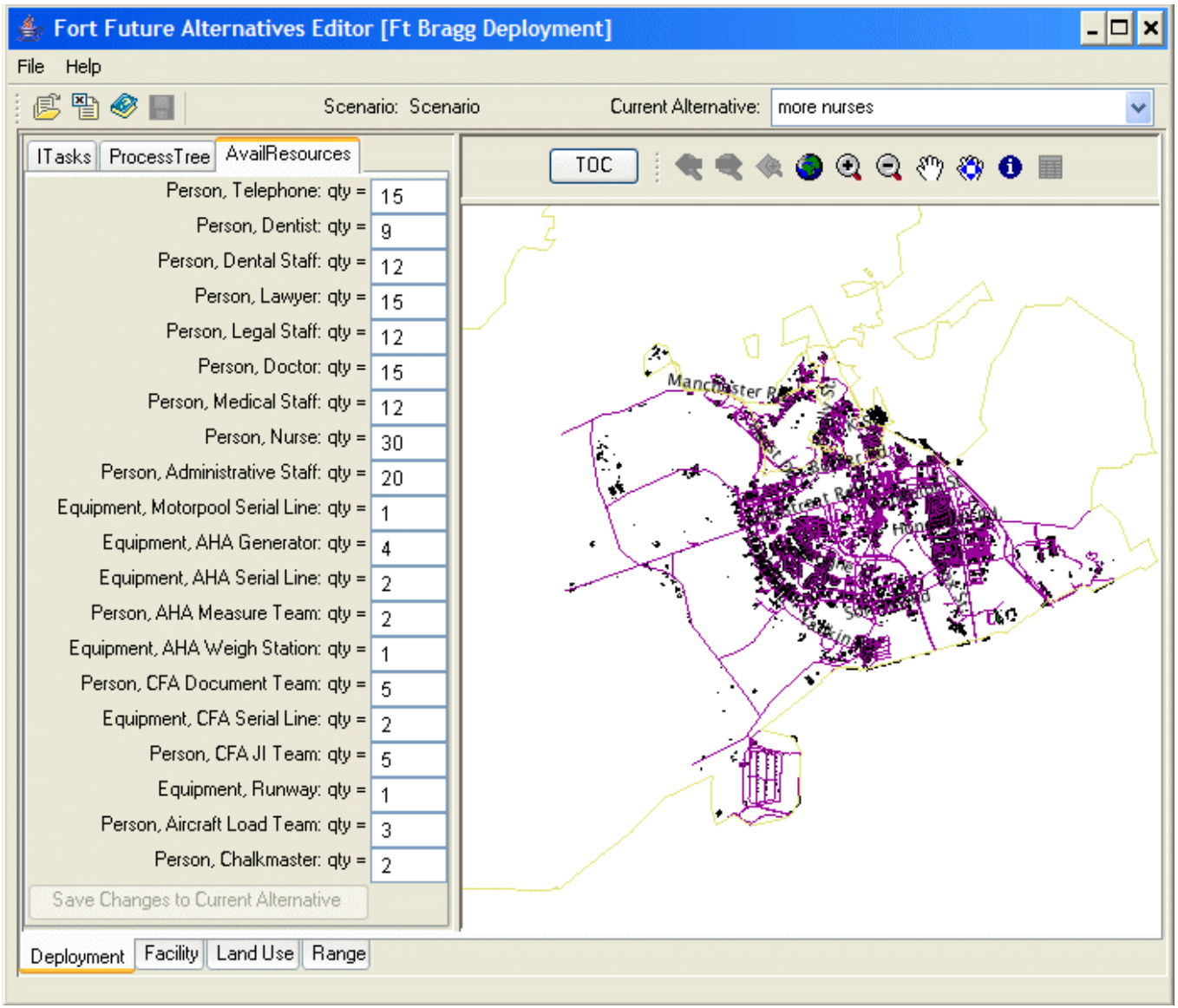
Deployment Alternatives Editor – MapObjects Version



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Using ArcGIS Server and Java Server Faces

- Spiral 1: MapObjects thick client approach
  - used ArcIMS to provide data
  - too slow – too much data to download
  - Java Webstart worked, but introduced authentication/authorization difficulties.
- Spiral 2: Web server-based editing
  - Adopted ESRI ADF with ArcGIS 9.1
  - ArcGIS Server uses ArcSDE
  - DSS web application only communicates with ArcGIS Server (not directly with ArcSDE)
  - Alternative edits stored on dedicated edit layers, identified by unique alternative GUID
  - Baseline geospatial data not changed.

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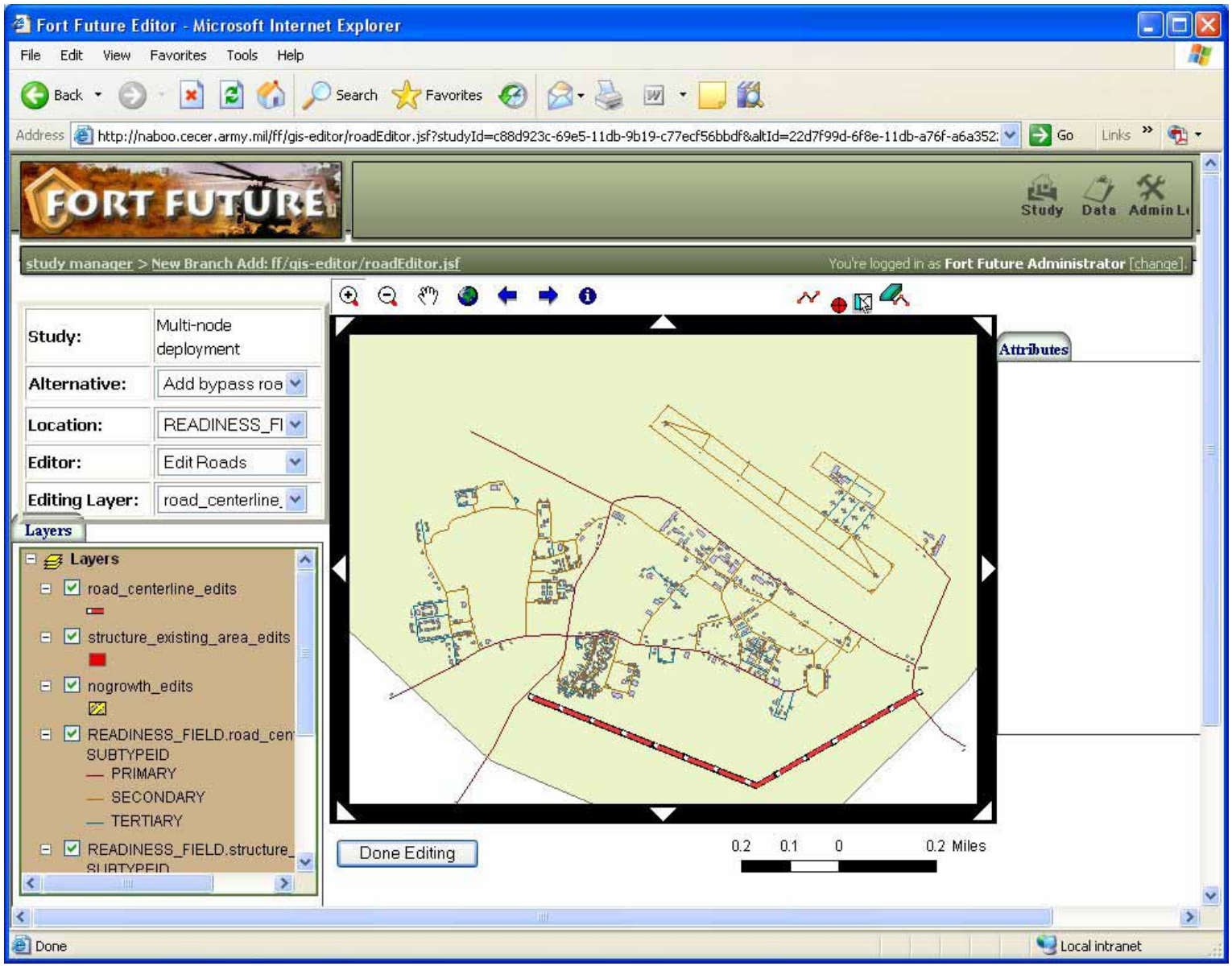
Road Editor



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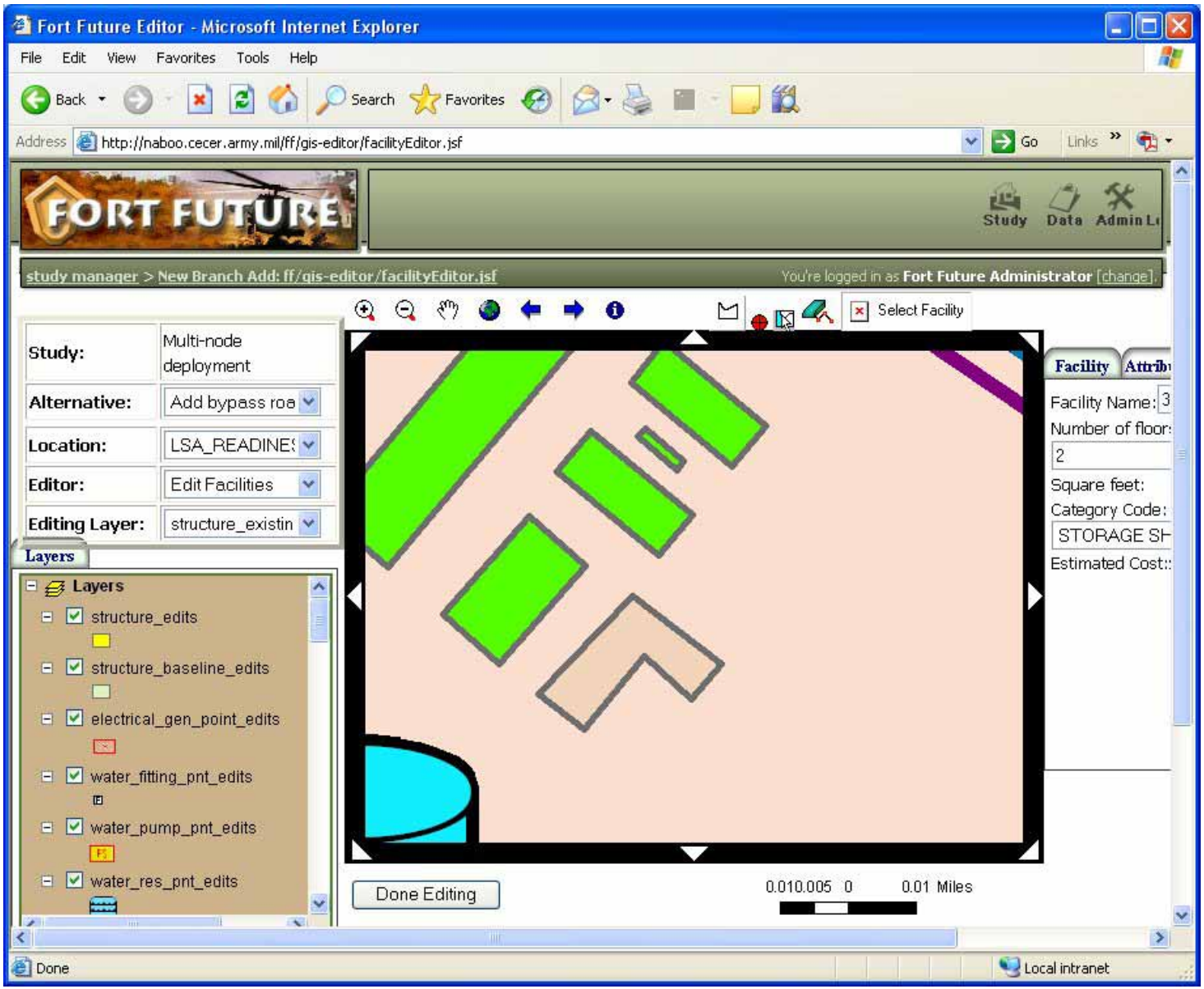
Facilities Editor



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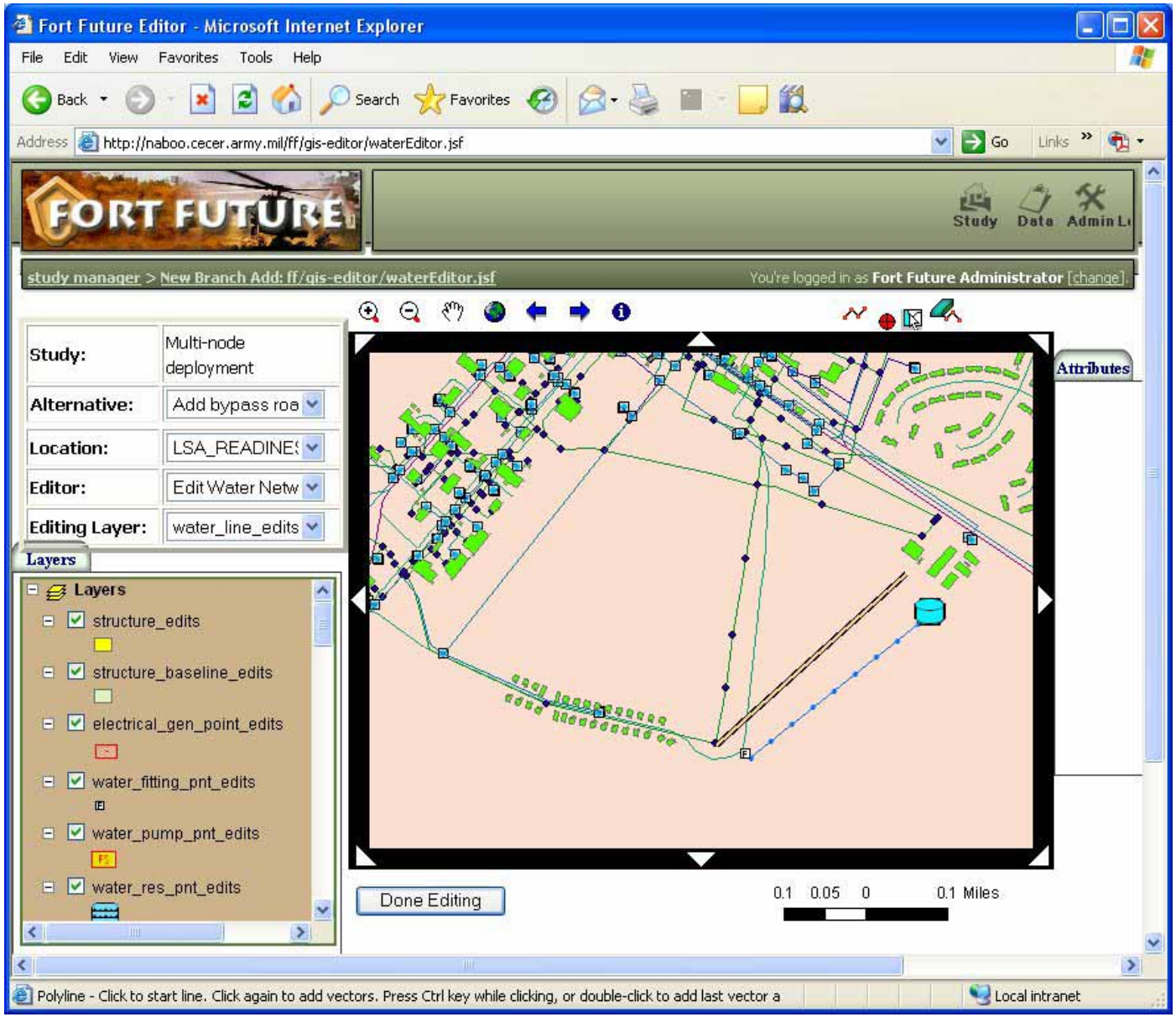
Water System Editor



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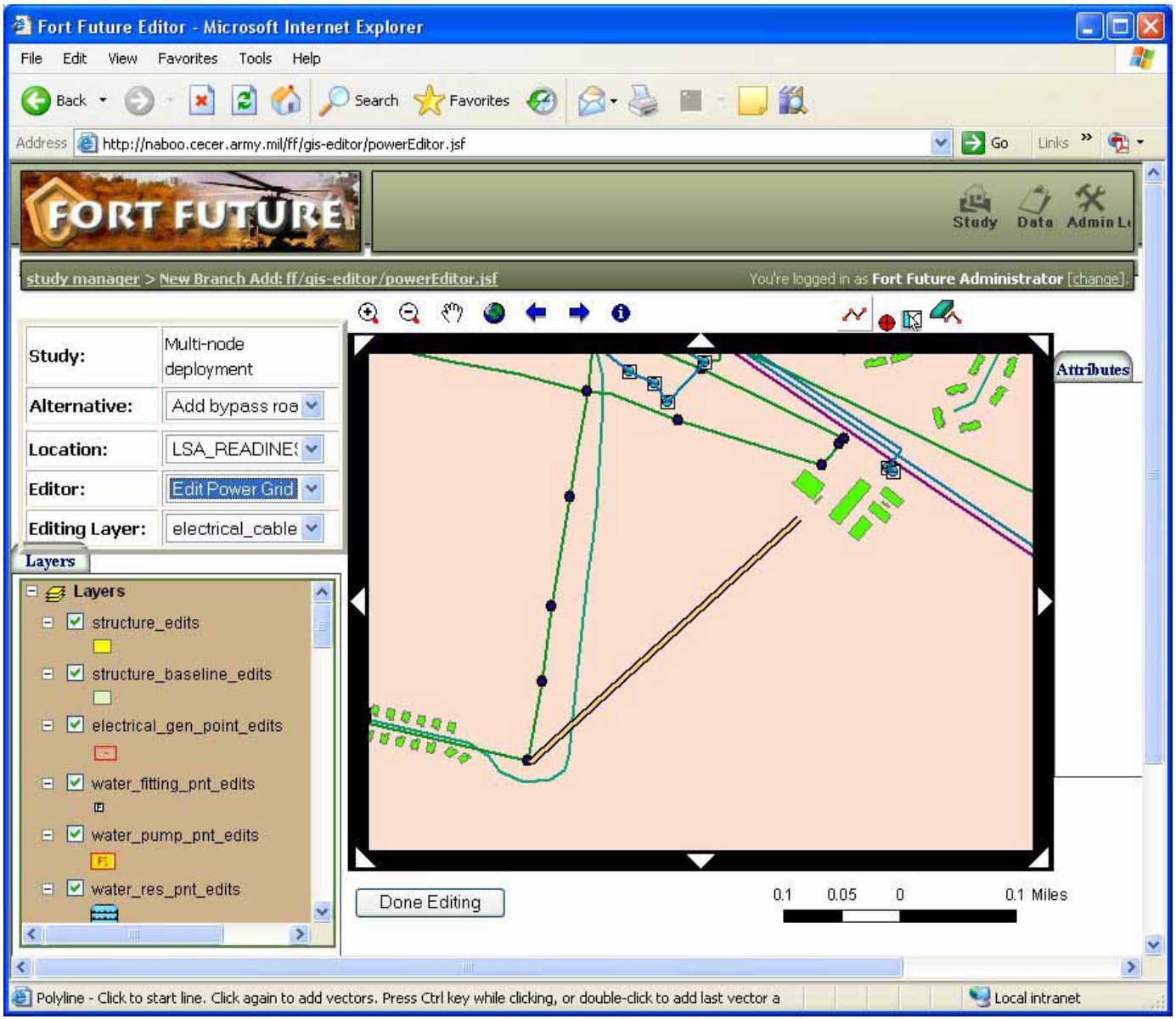
Power System Editor



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Managing Simulations

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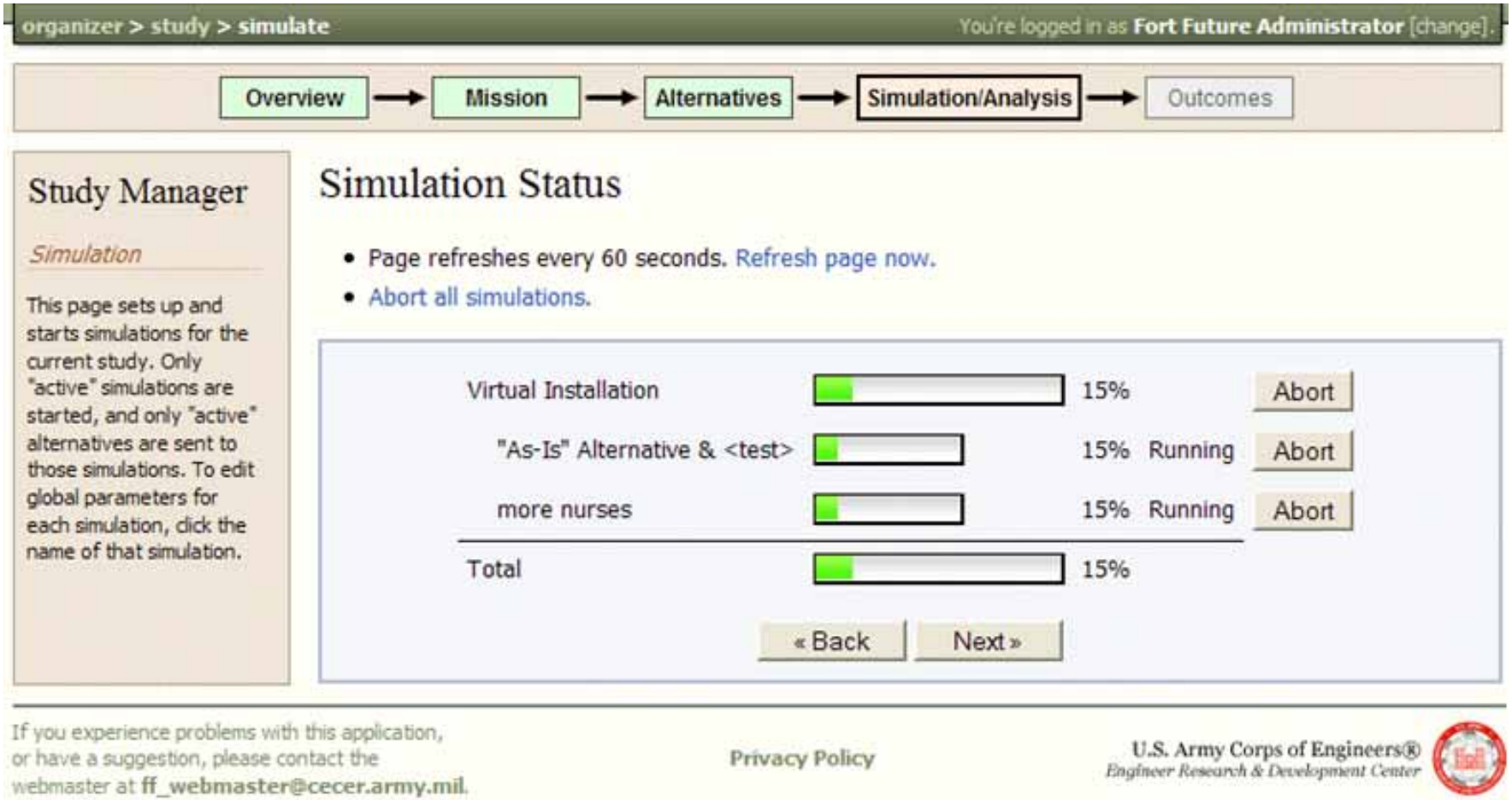
Running Simulations



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Viewing Simulation Results

Sample from Spiral 1. Spiral 2 simulation service in progress

FORT FUTURE

Study: Ft Bragg Deployment

MyFF | Admin | Account | Logout | Help

organizer > study > outcomes

You're logged in as **Fort Future Administrator** [change].

Overview → Mission → Alternatives → Simulation/Analysis → Outcomes

Study Manager

Outcome

- Decision Matrix

View Outcomes (Compare How Well COAs Meet Goals)

Scenario: Scenario	COA 1 "As-Is" Alternative &	COA 2 more nurses
Determine power projection time (hours)	Details...	Details...
Total Time to Complete	27.1	24
Total Personnel Idle Time	3,290	2,870
Average Personnel Idle Time	17.2	15
Total Personnel Group Wait Time	2,960	2,590
Total Personnel Travel Time	84.5	84.5
Average Personnel Travel Time	0.442	0.442
Total Personnel Resource Wait Time	329	277
Average Personnel Resource Wait Time	1.72	1.45
Total Vehicle Resource Wait Time	34.8	33.4
Average Vehicle Resource Wait Time	0.891	0.856

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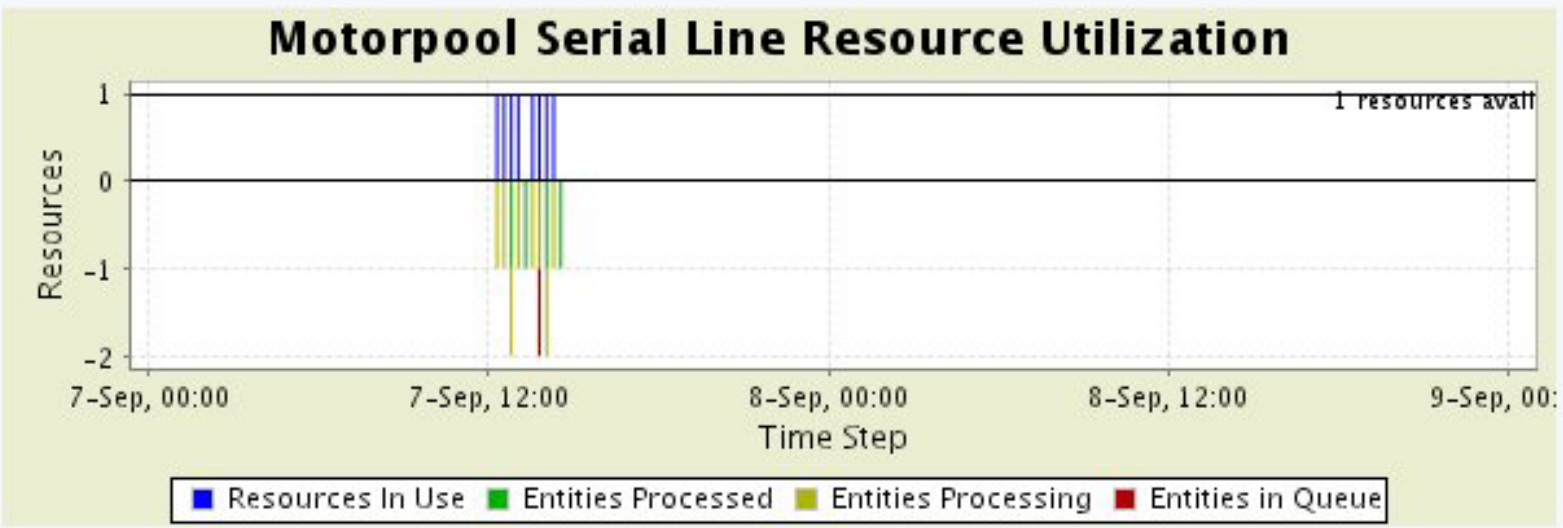
Protocol Supports Simulation-Specific Results

Select "details…" for each alternative Course of Action

Motorpool Serial Line Details



Total resources available	1
Max resources used in a time step	1
Max entities processed in a time step	1
Max entities processing in a time step	1
Max entities queued in a time step	1
Total time resource was needed	2h 15m

Sample Spiral 1 Decision Matrix for Range Risk

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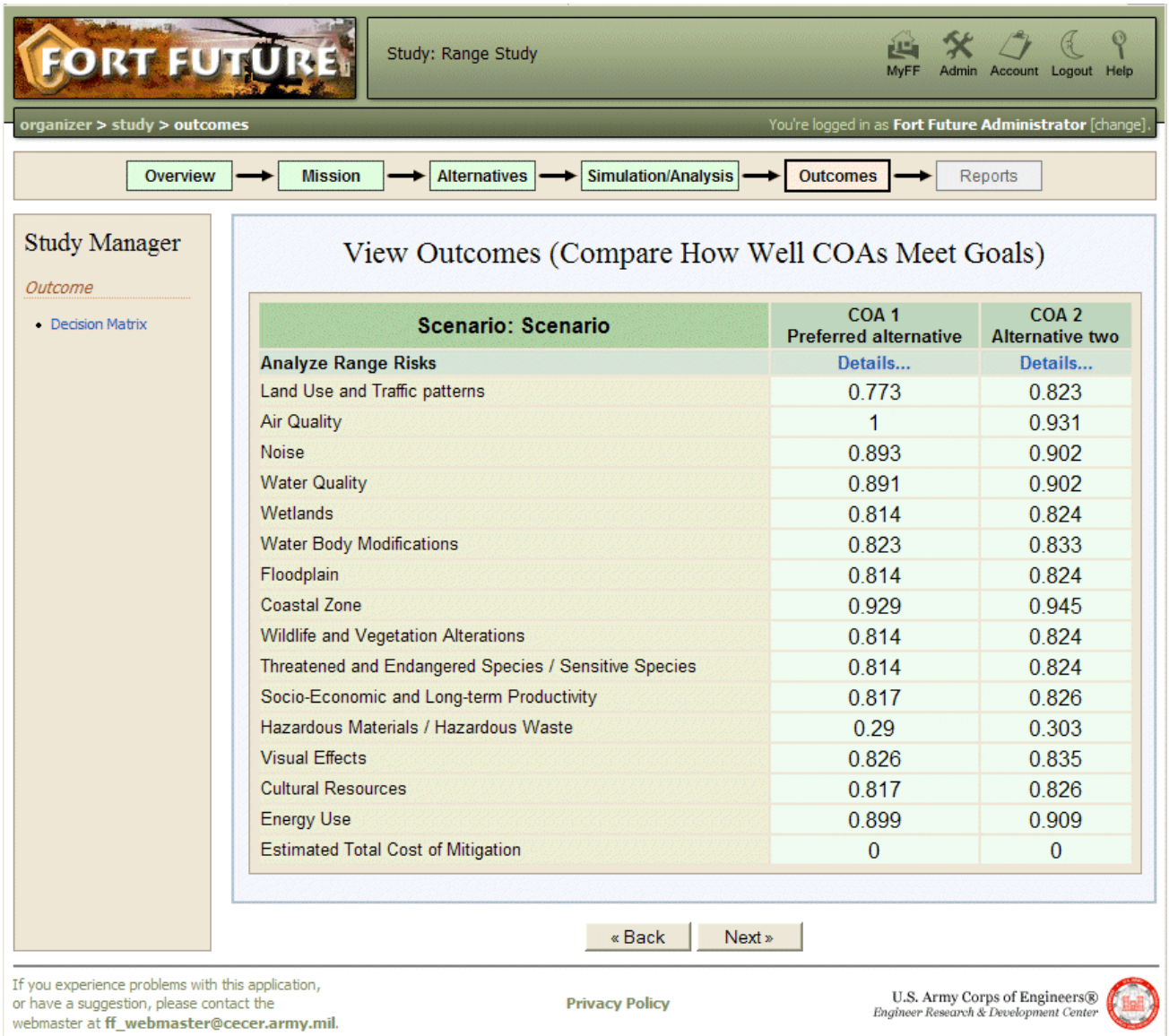

Scenario: Scenario	COA 1 Preferred alternative	COA 2 Alternative two
Analyze Range Risks	Details...	Details...
Land Use and Traffic patterns	0.773	0.823
Air Quality	1	0.931
Noise	0.893	0.902
Water Quality	0.891	0.902
Wetlands	0.814	0.824
Water Body Modifications	0.823	0.833
Floodplain	0.814	0.824
Coastal Zone	0.929	0.945
Wildlife and Vegetation Alterations	0.814	0.824
Threatened and Endangered Species / Sensitive Species	0.814	0.824
Socio-Economic and Long-term Productivity	0.817	0.826
Hazardous Materials / Hazardous Waste	0.29	0.303
Visual Effects	0.826	0.835
Cultural Resources	0.817	0.826
Energy Use	0.899	0.909
Estimated Total Cost of Mitigation	0	0

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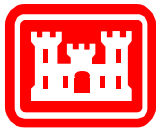
Range Risk Details…

Range Risk Matrix

	Land Use and Traffic Patterns	Air Quality	Noise	Water Quality	Wetlands	Water Body Modifications	Floodplain	Coastal Zone	Wildlife and Vegetation Alterations	Threatened and Endangered Species / Sensitive Species	Socio-economic and Long-term Productivity	Hazardous Materials / Hazardous Waste	Visual Effects	Cultural Resources	Energy Use	Physical Impact:	Management and Externalities	Cumulative
1 Construction	0.914	1.000	0.965	0.970	0.940	0.940	0.940	0.983	0.940	0.940	0.940	0.675	0.940	0.940	0.970	0.337		
a. Clearing	0.924	1.000	0.985	0.990	0.961	0.961	0.961	1.000	0.961	0.961	0.961	0.695	0.961	0.961	0.990	0.449	0.770	0.540
b. Horiz Construction	0.892	1.000	0.945	0.950	0.921	0.921	0.921	0.965	0.921	0.921	0.921	0.655	0.921	0.921	0.950	0.248	0.770	0.342
c. Vertical Construction	0.928	1.000	0.965	0.970	0.941	0.941	0.941	0.985	0.941	0.941	0.941	0.675	0.941	0.941	0.970	0.343	0.770	0.439
2 Operations & Maintenance	0.943	1.000	0.982	0.984	0.956	0.956	0.956	0.994	0.956	0.956	0.959	0.683	0.959	0.959	0.988	0.429		
a. Ammunition	0.919	1.000	0.955	0.955	0.931	0.931	0.931	0.975	0.931	0.931	0.931	0.660	0.931	0.931	0.960	0.291	0.770	0.387
b. Unit Activity	0.942	1.000	0.980	0.980	0.951	0.951	0.951	0.995	0.951	0.951	0.966	0.700	0.966	0.966	0.995	0.438	0.770	0.530
c. Equipment (unit)	0.937	1.000	0.975	0.980	0.951	0.951	0.951	0.995	0.951	0.951	0.951	0.685	0.951	0.951	0.980	0.399	0.770	0.493
d. Wastes	0.955	1.000	0.995	0.995	0.966	0.966	0.966	1.000	0.966	0.966	0.971	0.650	0.971	0.971	1.000	0.472	0.770	0.561
e. Maintenance	0.951	1.000	0.990	0.995	0.966	0.966	0.966	1.000	0.966	0.966	0.966	0.700	0.966	0.966	0.995	0.493	0.770	0.580
f. Targets	0.955	1.000	0.995	1.000	0.971	0.971	0.971	1.000	0.971	0.971	0.971	0.705	0.971	0.971	1.000	0.528	0.770	0.611
3 Closure	0.896	1.000	0.942	0.934	0.906	0.916	0.906	0.950	0.906	0.906	0.906	0.629	0.916	0.906	0.937	0.204		
a. Dormancy	0.901	1.000	0.945	0.935	0.911	0.921	0.911	0.955	0.911	0.911	0.911	0.630	0.921	0.911	0.940	0.218	0.770	0.309
b. Clearing	0.892	1.000	0.940	0.930	0.901	0.911	0.901	0.945	0.901	0.901	0.901	0.625	0.911	0.901	0.935	0.191	0.770	0.279
c. Cleanup	0.892	1.000	0.940	0.930	0.901	0.911	0.901	0.945	0.901	0.901	0.901	0.625	0.911	0.901	0.935	0.191	0.770	0.279
d. Re-use	0.901	1.000	0.945	0.940	0.911	0.921	0.911	0.955	0.911	0.911	0.911	0.635	0.921	0.911	0.940	0.220	0.770	0.312
Cumulative	0.773	1.000	0.893	0.891	0.814	0.823	0.814	0.929	0.814	0.814	0.817	0.290	0.826	0.817	0.899	0.309		
Score with significance	0.773	1.000	0.893	0.891	0.814	0.823	0.814	0.929	0.814	0.814	0.817	0.290	0.826	0.817	0.899	0.791		0.835



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Summary and Future Work

- Proof of concept for a DSS-Simulation protocol was successful
- Collaborators were able to edit alternatives over the network
- Results of editing provided as data to simulation services
- XML-based registration could be made more dynamic using WSDL
- Protocol could be incorporated into the Military Scenario Definition Language (MSDL) as meta-control language
- With pluggable architecture, new simulations can be added at any time, and different simulations can be run within the same study

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Questions?

- Fort Future Home Page
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