



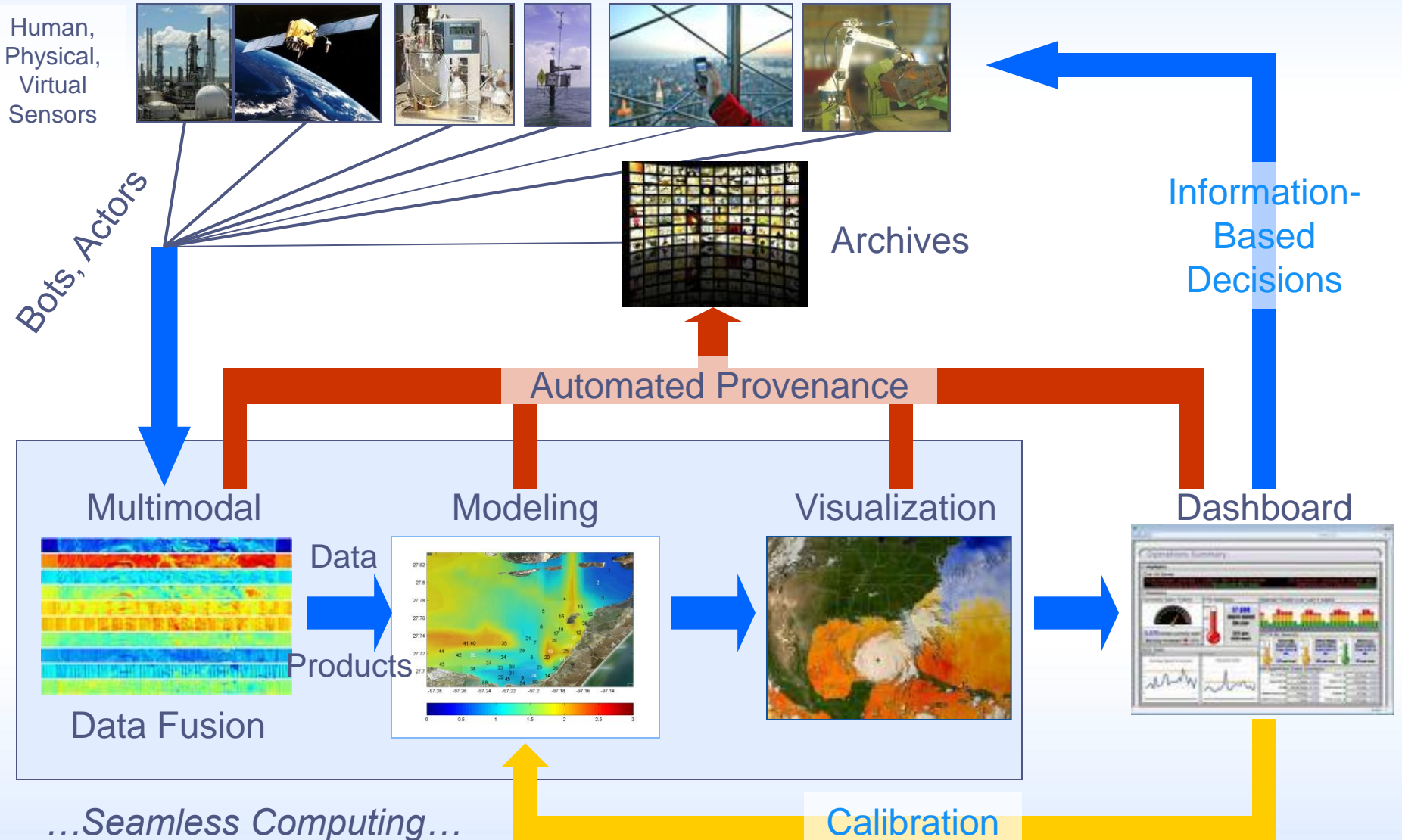
Real-Time Water Decision Support System

Barbara Minsker, Jong Lee and
Tingting Zhao

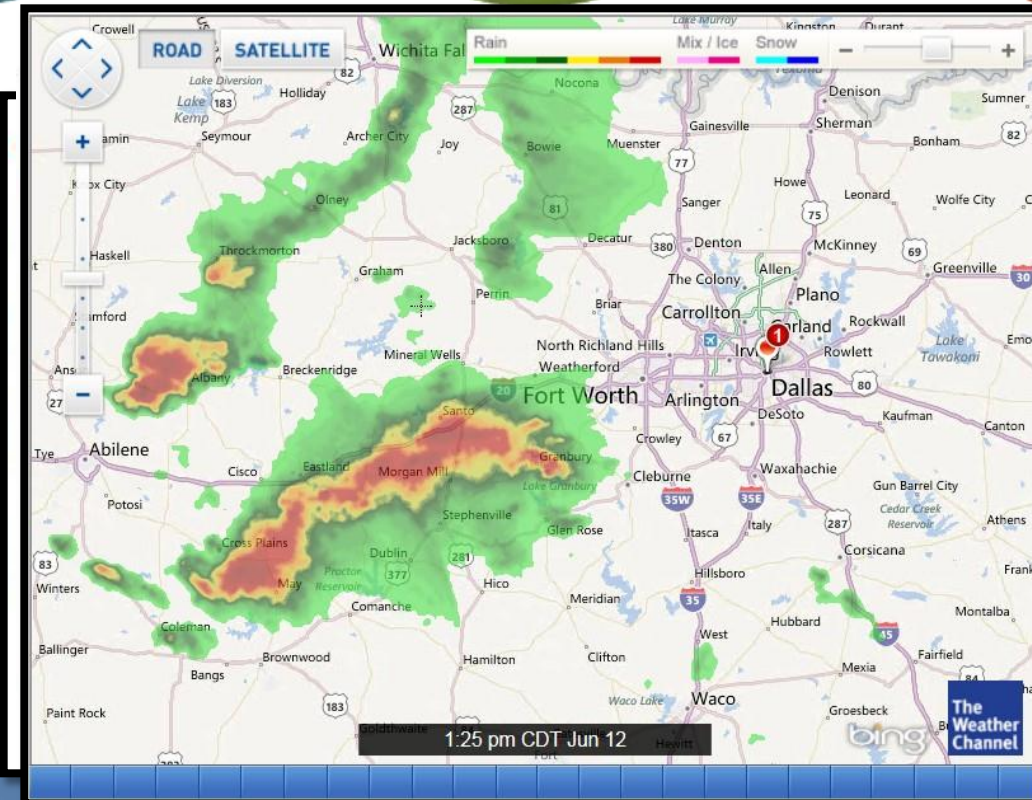


National Center for Supercomputing Applications
University of Illinois at Urbana-Champaign

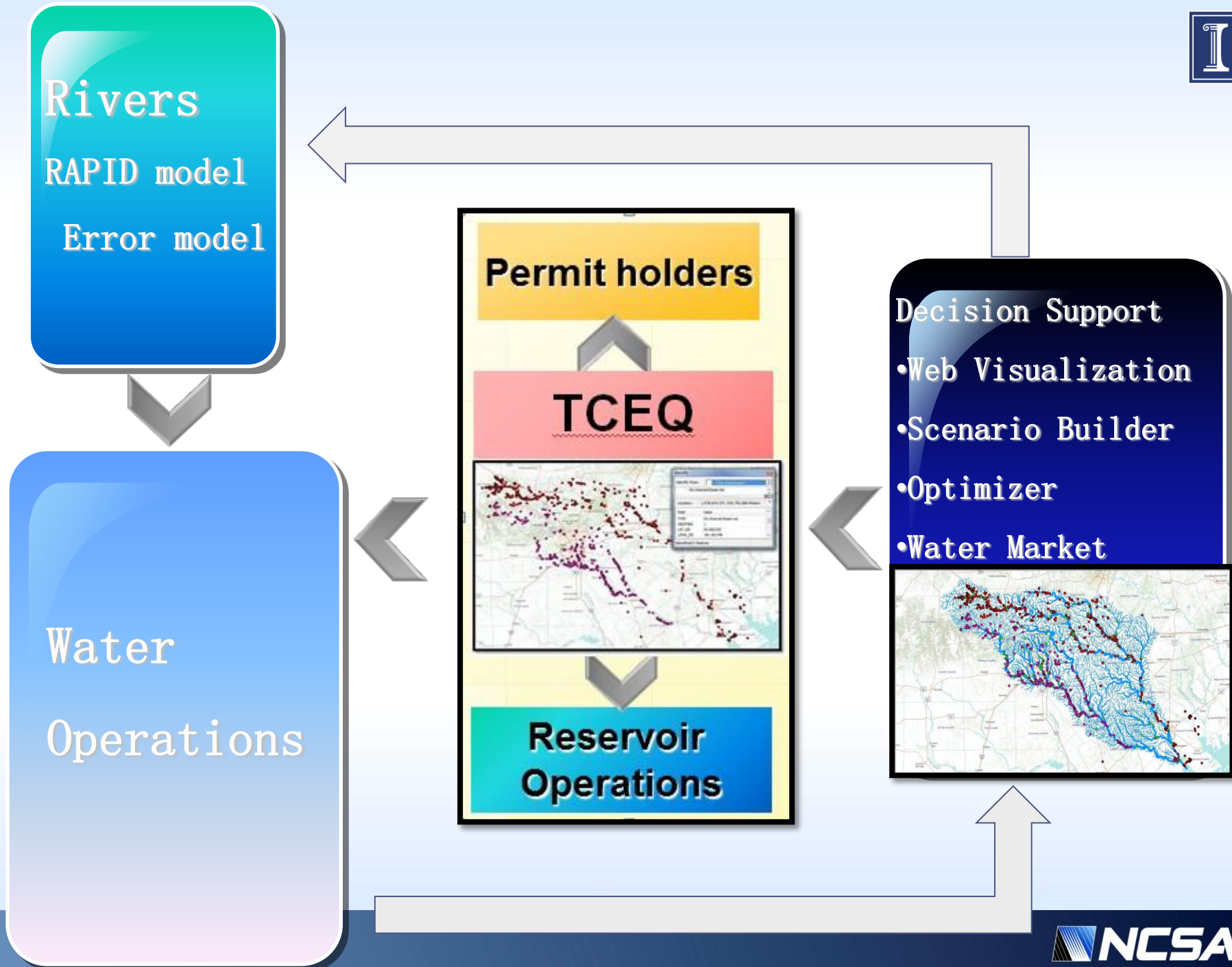
Integrated, Information-Based Decision Making



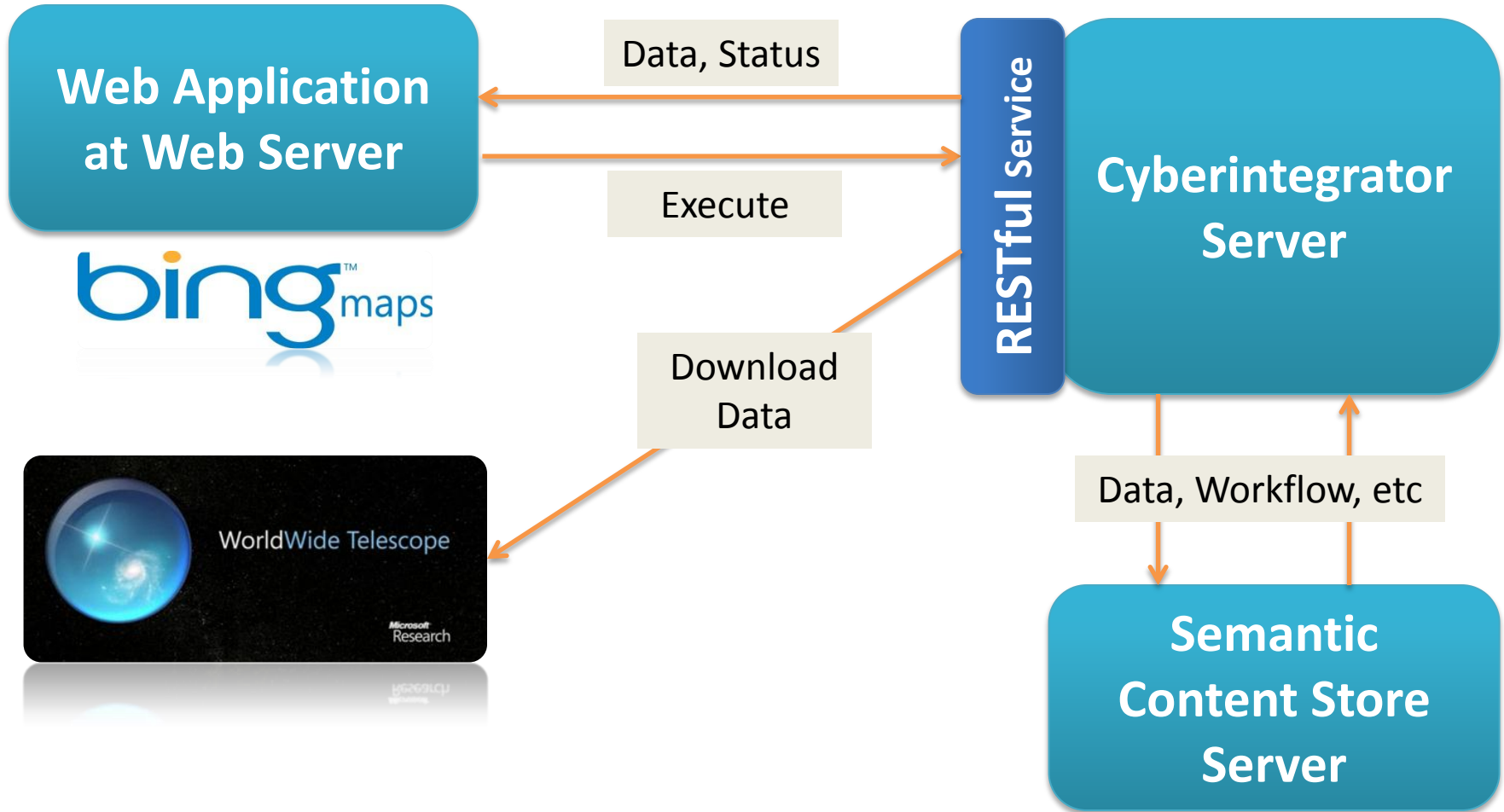
Real-Time Water Decision Support System



Water
operations



Real-Time Modeling Service Architecture



Web Application: Set Parameters

REST Client Real-Time Water Decision

rapid.ncsa.illinois.edu:8080/rapid/

RTWDSS v0.1 [About](#)

Real-Time Water Decision Support System v0.1

This prototype real-time modeling system downloads Noah-MP Land Surface model data, which forecast runoff, soil moisture, evapotranspiration, and water table levels given land surface features. These results are then used by a river model called RAPID to forecast stream flows. Model forecasts are visualized as a Web application for students and decision makers to understand the impacts of drought and flood conditions on streamflows. Users can adjust model parameters to predict the impacts of alternative curtailment scenarios or weather forecasts.

Setting up Workflow

Input the following parameters to run the workflow

NLDAS start date:

NLDAS end date:

Viz start date:

Viz end date:

[Run »](#) [Reset](#)

Job Status

Job Id:

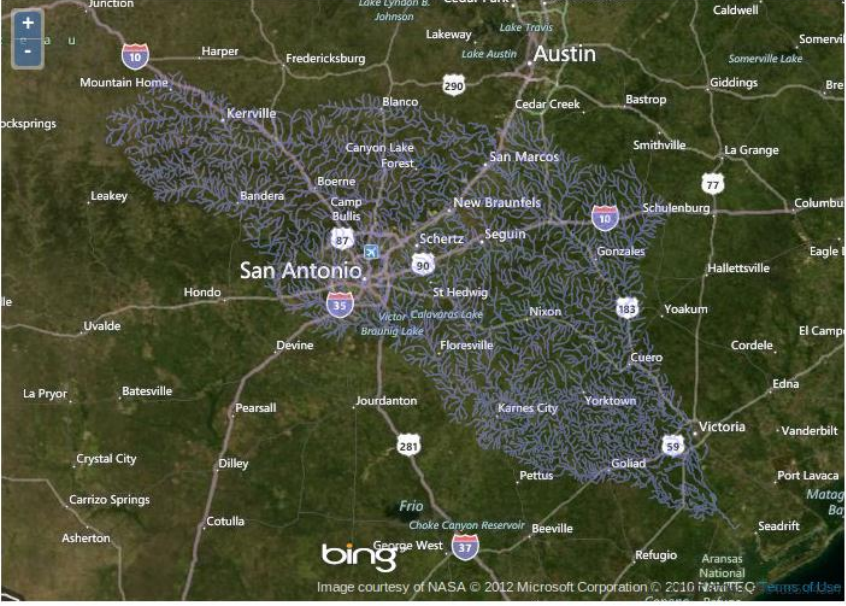
Download NLDAS data:

Execute RAPID:

Generate Viz:

[Visualize the result »](#)

Model Results



< 0/0 > [Play](#) [Stop](#)

Collaboration with [Center for Research in Water Resources](#), Texas Commission on Environmental Quality (TCEQ)

Web Application: Monitor Job Status

REST Client Real-Time Water Decision

rapid.ncsa.illinois.edu:8080/rapid/

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Real-Time Water Decision Support System v0.1

This prototype real-time modeling system downloads Noah-MP Land Surface model data, which forecast runoff, soil moisture, evapotranspiration, and water table levels given land surface features. These results are then used by a river model called RAPID to forecast stream flows. Model forecasts are visualized as a Web application for students and decision makers to understand the impacts of drought and flood conditions on streamflows. Users can adjust model parameters to predict the impacts of alternative curtailment scenarios or weather forecasts.

Setting up Workflow

Input the following parameters to run the workflow

NLDAS start date:

NLDAS end date:

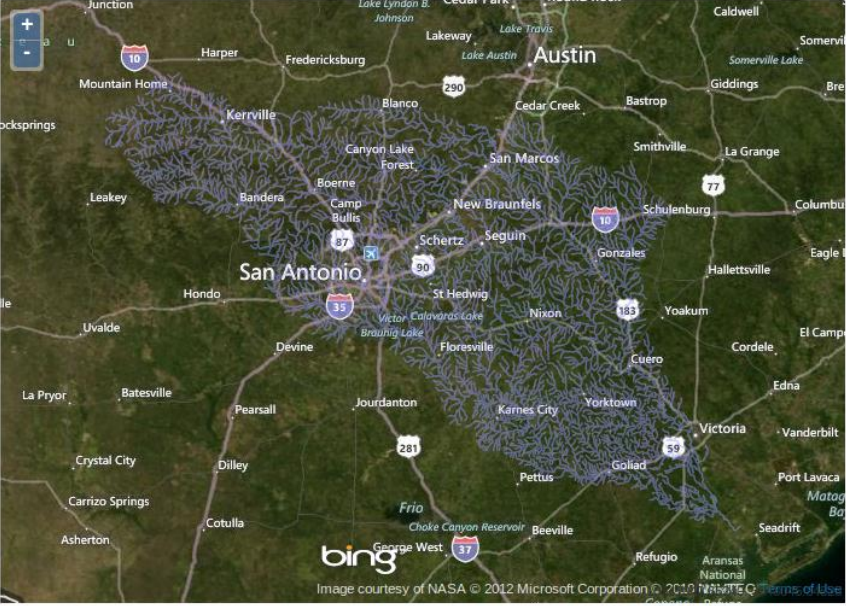
Viz start date:

Viz end date:

Job Status

Job Id: f54e1260-490f-4d7f-b250-ed5316137865
Download NLDAS data: **RUNNING**
Execute RAPID: **WAITING**
Generate Viz: **WAITING**

Model Results



The map displays a network of streams in blue over a satellite-style background of the region between San Antonio and Austin, Texas. Major cities and highways are labeled. The stream network is dense, particularly around San Antonio and the Colorado Plateau area.

0/0

Collaboration with Center for Research in Water Resources, Texas Commission on Environmental Quality (TCEQ)

Web Application: Visualize & Download Results

REST Client Real-Time Water Decision

rapid.ncsa.illinois.edu:8080/rapid/

RTWDSS v0.1 [About](#)

Real-Time Water Decision Support System v0.1

This prototype real-time modeling system downloads Noah-MP Land Surface model data, which forecast runoff, soil moisture, evapotranspiration, and water table levels given land surface features. These results are then used by a river model called RAPID to forecast stream flows. Model forecasts are visualized as a Web application for students and decision makers to understand the impacts of drought and flood conditions on streamflows. Users can adjust model parameters to predict the impacts of alternative curtailment scenarios or weather forecasts.

Setting up Workflow

Input the following parameters to run the workflow

NLDAS start date:

NLDAS end date:

Viz start date:

Viz end date:

[Run >>](#) [Reset](#)

Job Status

Job Id: f54e1260-490f-4d7f-b250-ed5316137865


Download NLDAS data: **FINISHED**

Execute RAPID: **FINISHED**

Generate Viz: **FINISHED**

[Visualize the result >>](#)

Model Results

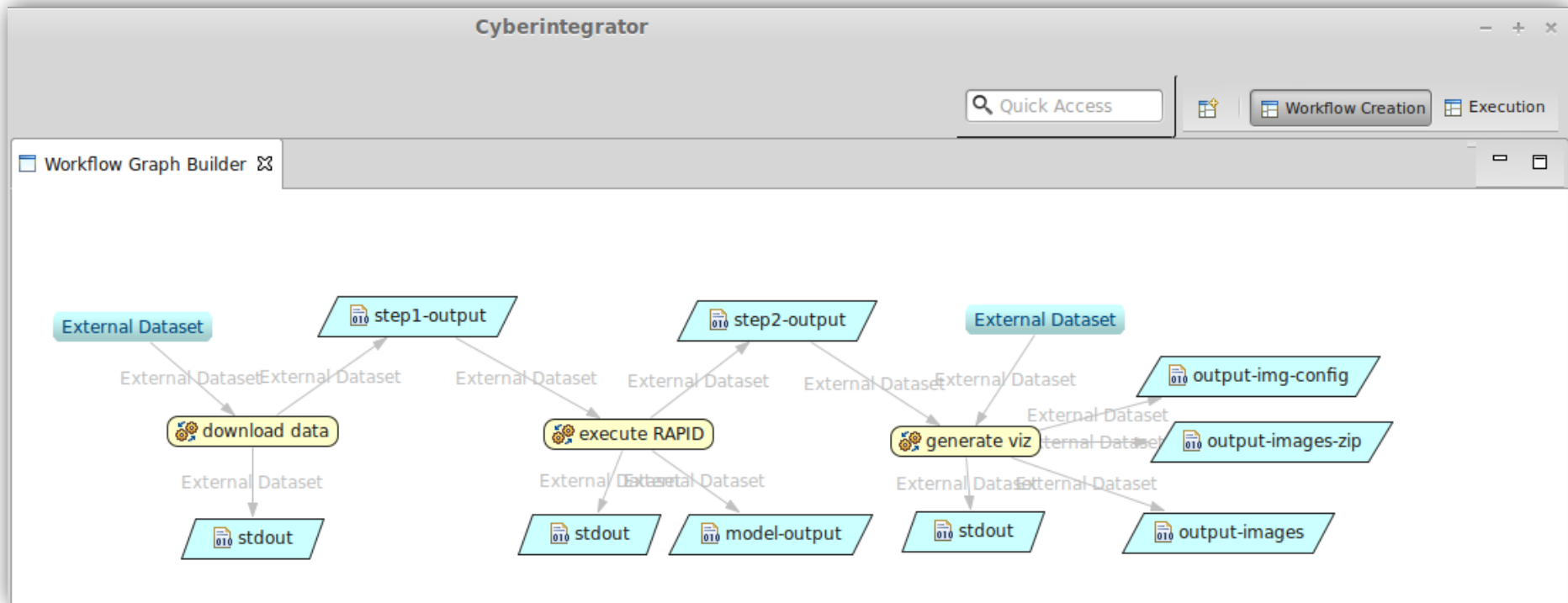


The map displays the San Antonio and Austin regions in Texas. A network of blue lines represents streamflow, originating from the west and flowing towards the east. Major cities like San Antonio, Austin, and New Braunfels are labeled. The map includes a Bing logo and copyright information for NASA and Microsoft.

< 2012-01-26 00:00:00 > [Play](#) [Stop](#) [Result Images](#) [Result NETCDF](#)

Collaboration with [Center for Research in Water Resources](#), [Texas Commission on Environmental Quality \(TCEQ\)](#)

Cyberintegrator Workflow



- Download NLDAS data
- Execute RAPID model
- Generate visualization (images) of the model results

1. Define Workflow Steps

Command Line Wizard

Setup command line tool
External tool command line with options.

Executable: ...

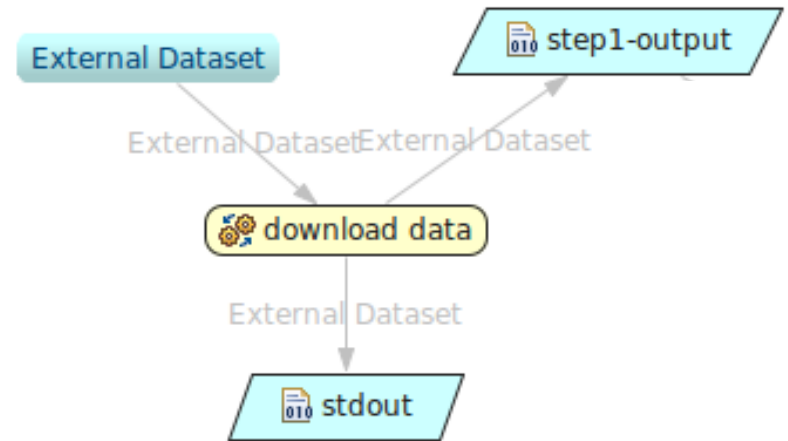
Capture stdout? also stderr?

Capture stderr?

Options:

file(in:step1_input.zip[not passed])	Add Value
start-year[NUMBER] = 2012	Add Parameter
start-day[NUMBER] = 1	Add Data
end-year[NUMBER] = 2012	Edit
end-day[NUMBER] = 1	Delete
file(out:input_RAPID_workflow.zip)	Up
	Down

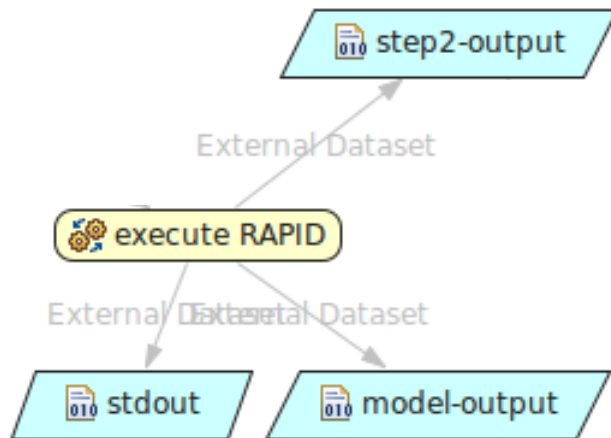
< Back Next > Cancel Finish



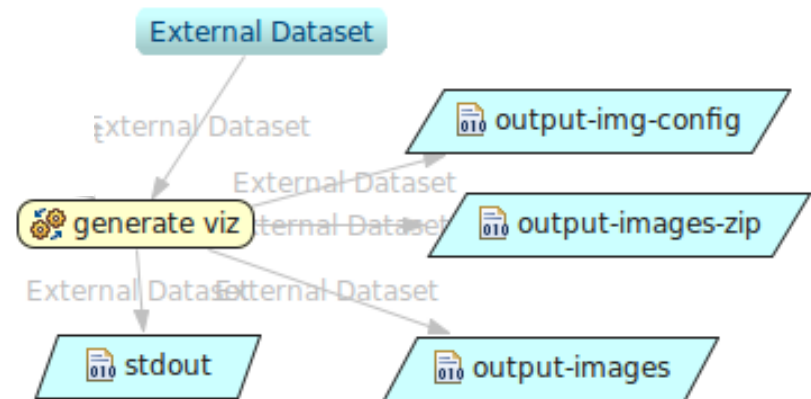
Download NLDAS data

1. Define Workflow Steps

- Define other steps the same way



Execute RAPID model



Generate visualization

2. Connect Steps

Connect Tool Input
Connect the selected tool's input to another tool's output.

Tool Input to Connect: 0 - step2-input - (application/zip)

Select Tool to Connect to: download data

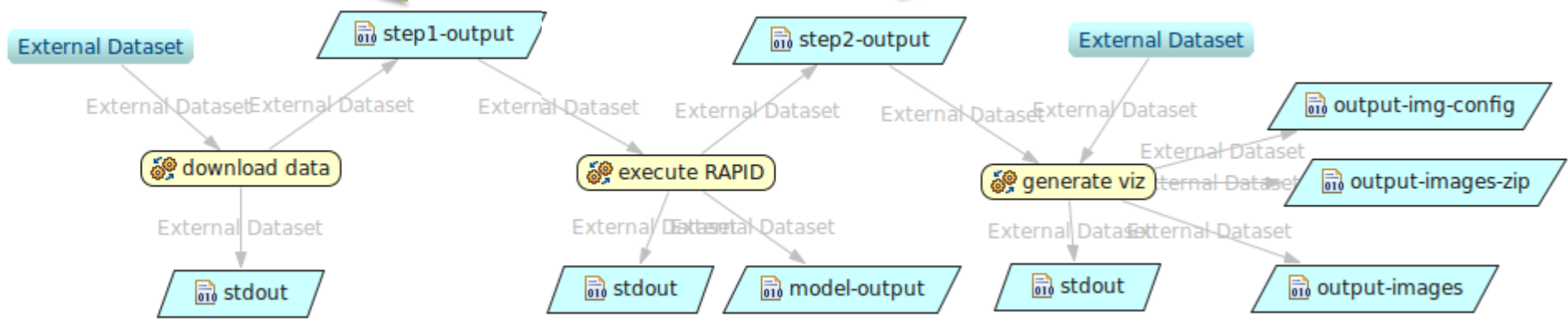
Available Outputs: 1 - step1-output - (application/zip)

Connect Tool Input
Connect the selected tool's input to another tool's output.

Tool Input to Connect: 1 - step3-input2 - (application/zip)

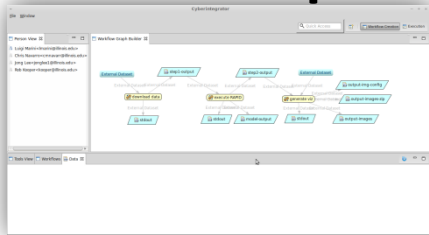
Select Tool to Connect to: execute RAPID

Available Outputs: 0 - step2-output - (application/zip)

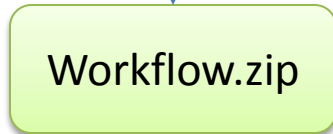


3. Sharing the Workflow as a Service

Cyberintegrator Desktop

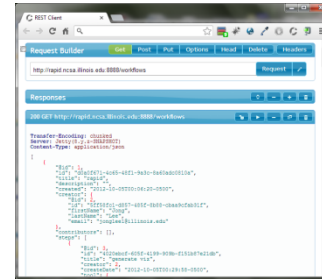


1. Export Workflow

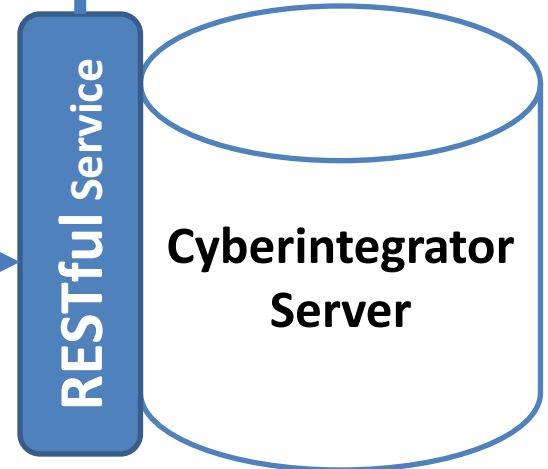


2. Upload the zip file
POST <http://<hostname>/workflows>

Clients
(i.e. Web browser)



3. Access the shared workflow
GET <http://<hostname>/workflows>



Behind the Web App: Cyberintegrator RESTful Service

- Browse detailed information about the workflow
 - `http://<hostname>/workflows/{id}`
 - JSON result:

```
{
  "@id":1,
  "id":"d0a0f671-4c65-48f1-9a3c-8a60adc0810a",
  "title":"rapid",
  "description":"",
  "created":"2012-10-05T00:06:20-0500",
  "creator":{" ...  },
  "contributors":[ ... ],
  "steps":[
    {
      "@id":3,
      "id":"4020ebcf-605f-4199-909b-f151b87e21db",
      "title":"generate viz",
      .
      .
    }
  ]
}
```


Behind the Web App: Cyberintegrator RESTful Service

- Check the status of the execution
 - `http://<hostname>/executions/{id}`
 - JSON result:

```
{
  "@id":1,
  "id":"221aa03b-58d3-4110-b609-696fec0b40e5",
  "workflowId":"d0a0f671-4c65-48f1-9a3c-8a60adc0810a",
  "date":"2012-10-07T02:13:58-0500",
  "creator":{" ... },
  "parameters":{"... },
  "datasets":{"... },
  "stepsQueued":{"... },
  "stepsStart":{"... },
  "stepsEnd":{"... },
  "properties":{"... },
  "stepStates":{
    "4c8879ff-d089-45a4-8c44-4bc5704cc732":"FINISHED",
    "4020ebcf-605f-4199-909b-f151b87e21db":"FINISHED",
    "83b6fcdd-48ef-444c-82ab-efe6b33a30be":"FINISHED"
  }
}
```

Behind the Web App: Cyberintegrator RESTful Service

- Browse the datasets
 - `http://<hostname>/datasets/{id}`
 - JSON result:

```
{
  "@id":47,
  "id":"232327f8-4ccf-44e0-bc28-898c7f3569ab",
  "title":"model-output",
  "description":"",
  "date":"2012-10-05T14:22:04-0500",
  "creator":2,
  "contributors":[],
  "fileDescriptors":[
    {
      "@id":48,
      "id":"33857c1b-01ea-4cf2-bb42-41488e4c0e1a",
      "filename":"result.nc",
      "size":4492040,
      "dataURL":".../result.nc",
      "md5sum":"49a514b73ddd8726c7e63100f7309cda",
      "mimeType":"application/octet-stream"
    }
  ]
}
```

World Wide Telescope Visualization

Explore Guided Tours Search Community Telescope View Settings Introduction Sign Out

Tour Properties Save Music: Browse... Show Safe Area Dome Voiceover: Browse... Text Shapes Picture

0:06.0 0:01.0 0:06.0 0:03.0 0:10.0 0:05.0 0:31.0 0:32.0

img-7483
img-7487
img-7491
img-7495
img-7499
img-7503
img-7507
img-7511
img-7515
img-7519
img-7523
img-7527
img-7531
USGS_3D
TCEQ_3D
img-7295
img-7299

Value

2010/07/31 23:59:00

Series Auto Loop Add Paste Reset

Look At Imagery Earth Virtual Earth Aerial * Context Search Filter All 1 of 1 N 40,865 km

Next Steps & Future Work

- Improve modeling
 - Replace NLDAS data with real-time land-surface modeling service
 - Enable RAPID to:
 - Model water withdrawals
 - Assimilate real-time data
 - Visualize model errors
 - Implement real-time error model
 - Model social & economic dimensions
 - Adaptive meshing for large-scale implementation

Next Steps & Future Work

- Improve decision support & visualization
 - Create scenario builder interface for comparing multiple model scenarios
 - Allow real-time & long-term scenarios
 - Develop optimization model for real-time water withdrawal decision making during droughts
 - Explore impacts of alternative real-time water market scenarios
 - Better automate connection to World Wide Telescope

Acknowledgments

- This work was funded under Microsoft Research grant 2010-02620.
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- Kathy Alexander, Cindy Hooper, Jordan Gouger, and others at the Texas Commission on Environmental Quality (TCEQ) collaborated in defining requirements and provided data