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Managing Water in the West

The Evolution of CRSS: From Cyber-Mainframes to High Performance Computing

RiverWare User Group Meeting
February 4, 2015
Boulder, CO

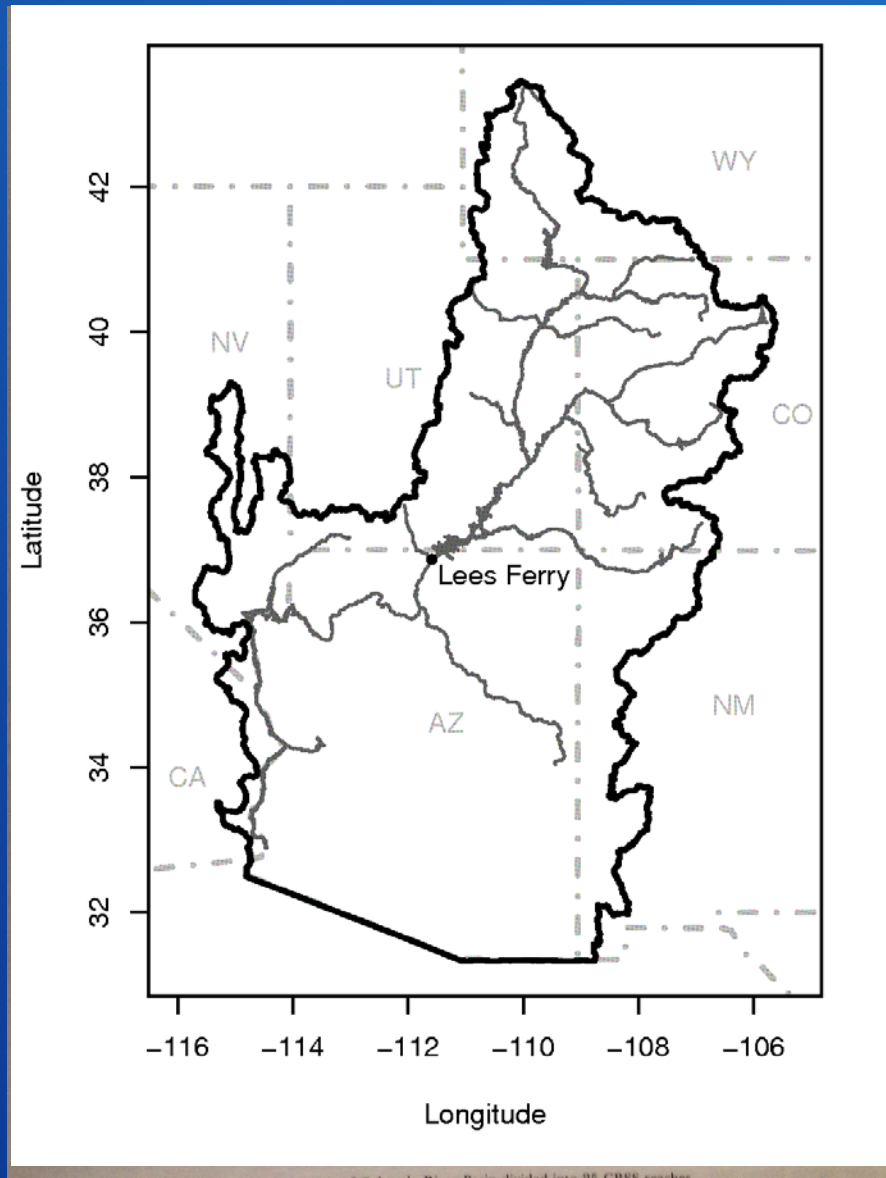
U.S. Department of the Interior
Bureau of Reclamation

Outline

- CRSS Background
- Colorado River Basin Study
- High Performance Computing

Background

- Colorado River Simulation System (CRSS)
  - Reclamation's long-term planning model
  - Developed as FORTRAN model late 1970's
  - Implemented in RiverWare mid-1990's
  - Simulates operations at 12 reservoirs
  - Models 500+ individual 'water users' at a monthly time-step



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Colorado River Basin Water Supply and Demand Study

- **Study Objective**
  - Assess future water supply and demand imbalances over next 50 years
  - **D**evelop and evaluate opportunities for resolving imbalances
- Study **c**onducted by Reclamation and the Basin States in collaboration with stakeholders throughout the Basin
- A 3 year study that began in January 2010 and completed December 2012
- A planning study – did *not* result in any decisions, but provides the technical foundation for future activities

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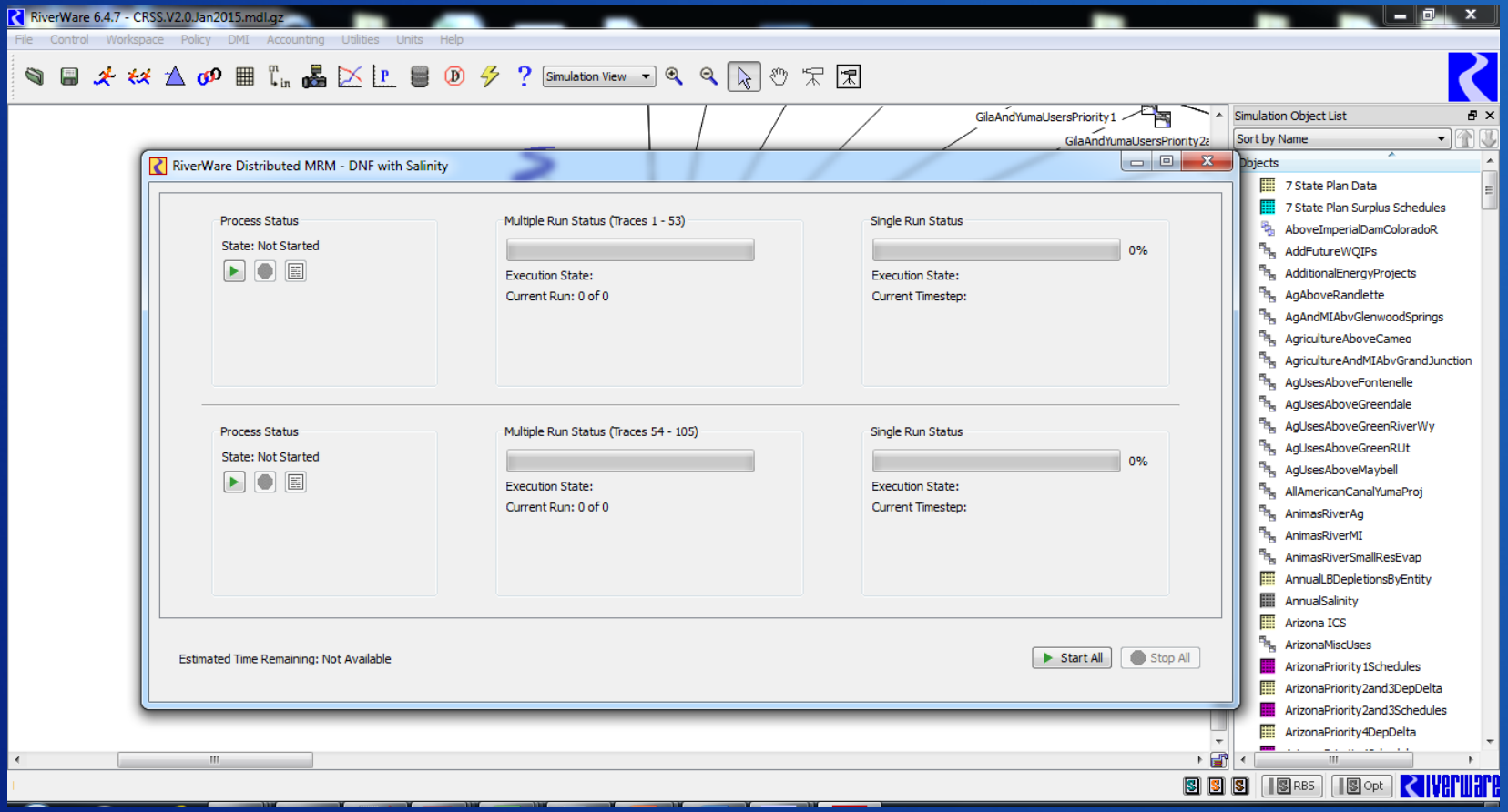
RiverWare Distributed MRM



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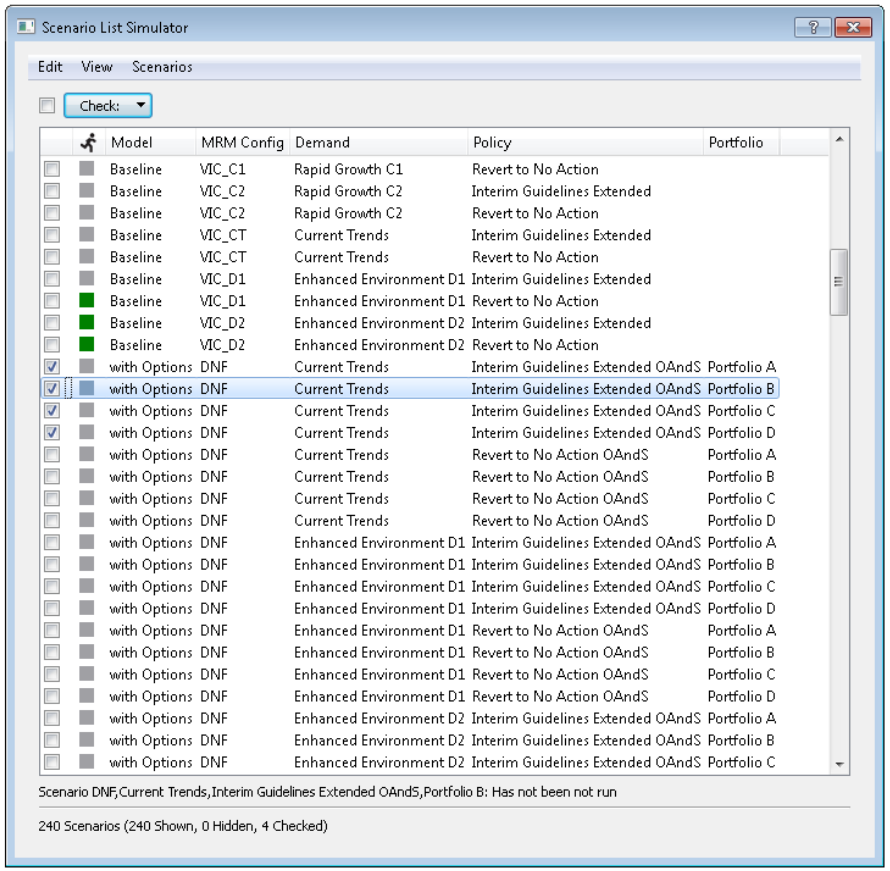
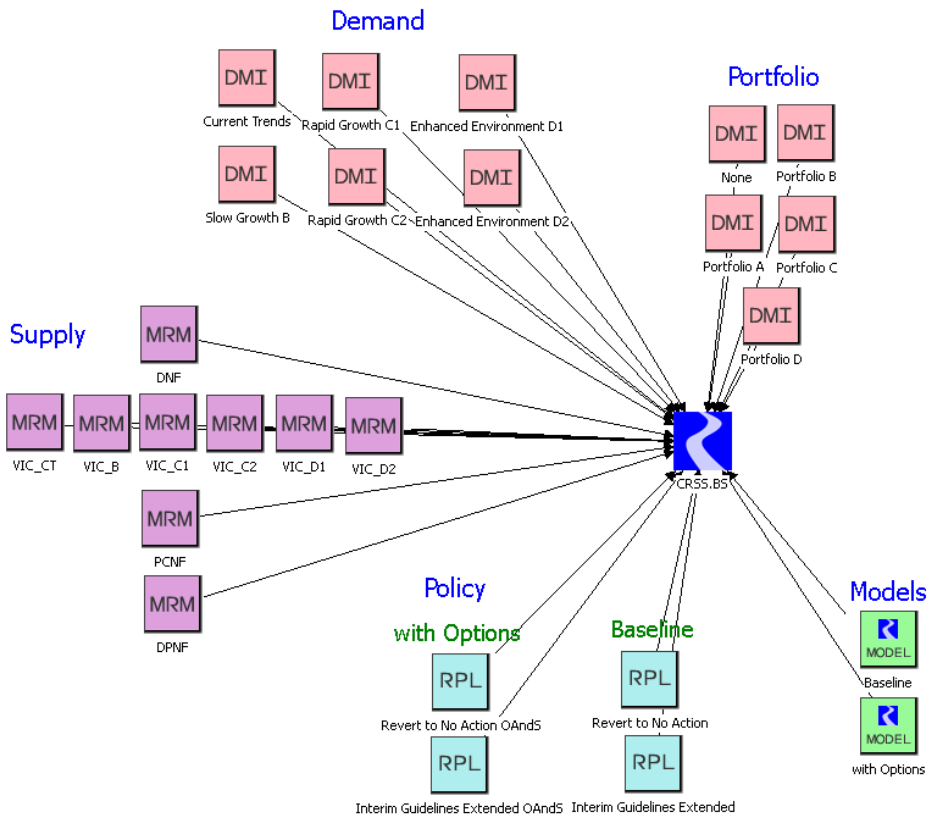
RiverWare™ Study Manager

- Manage input and output for all 240 scenarios
- Automate simulation process





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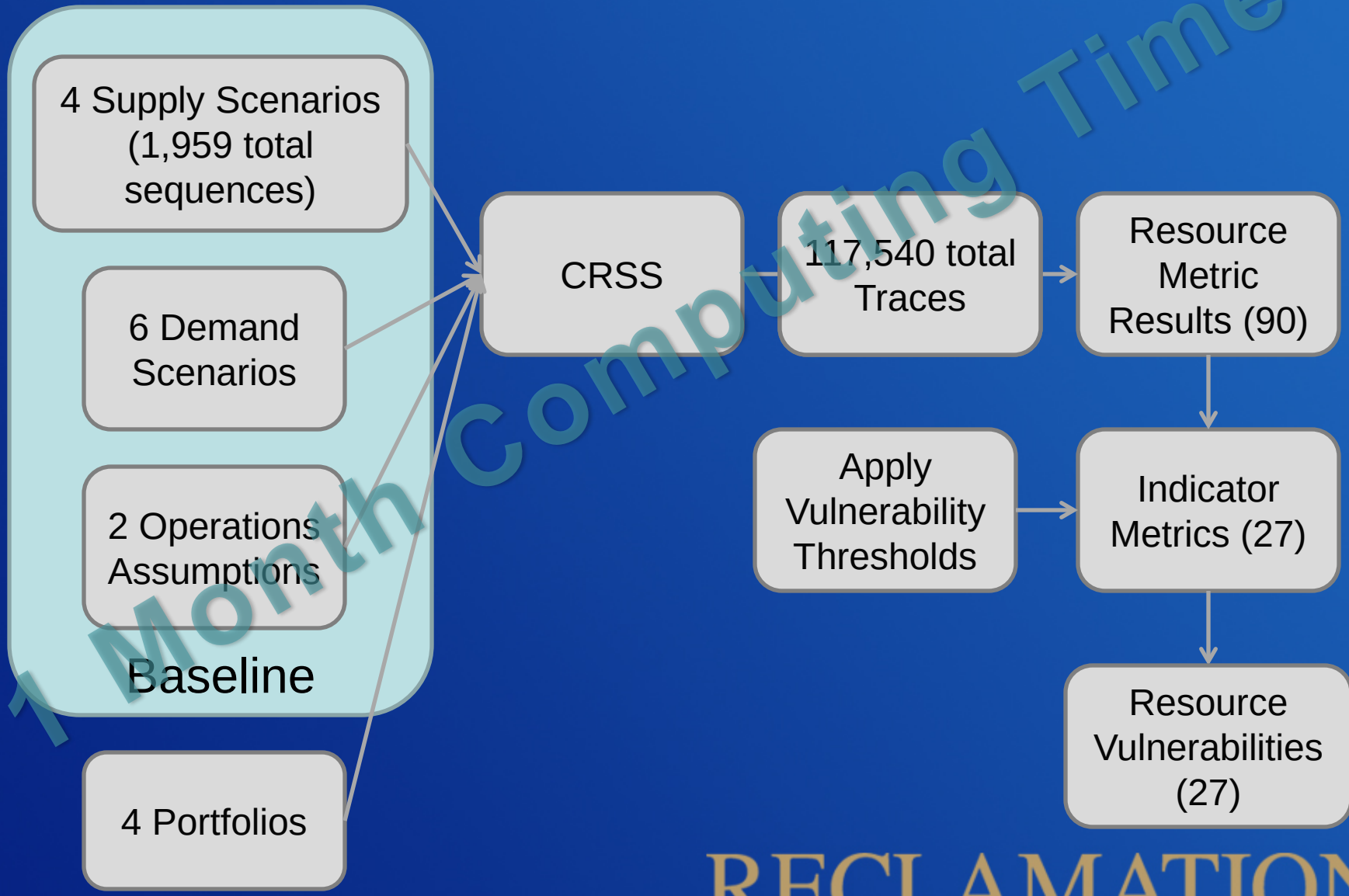
Basin Study Modeling



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Post Basin Study

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High Performance Computing and Water Resources Management

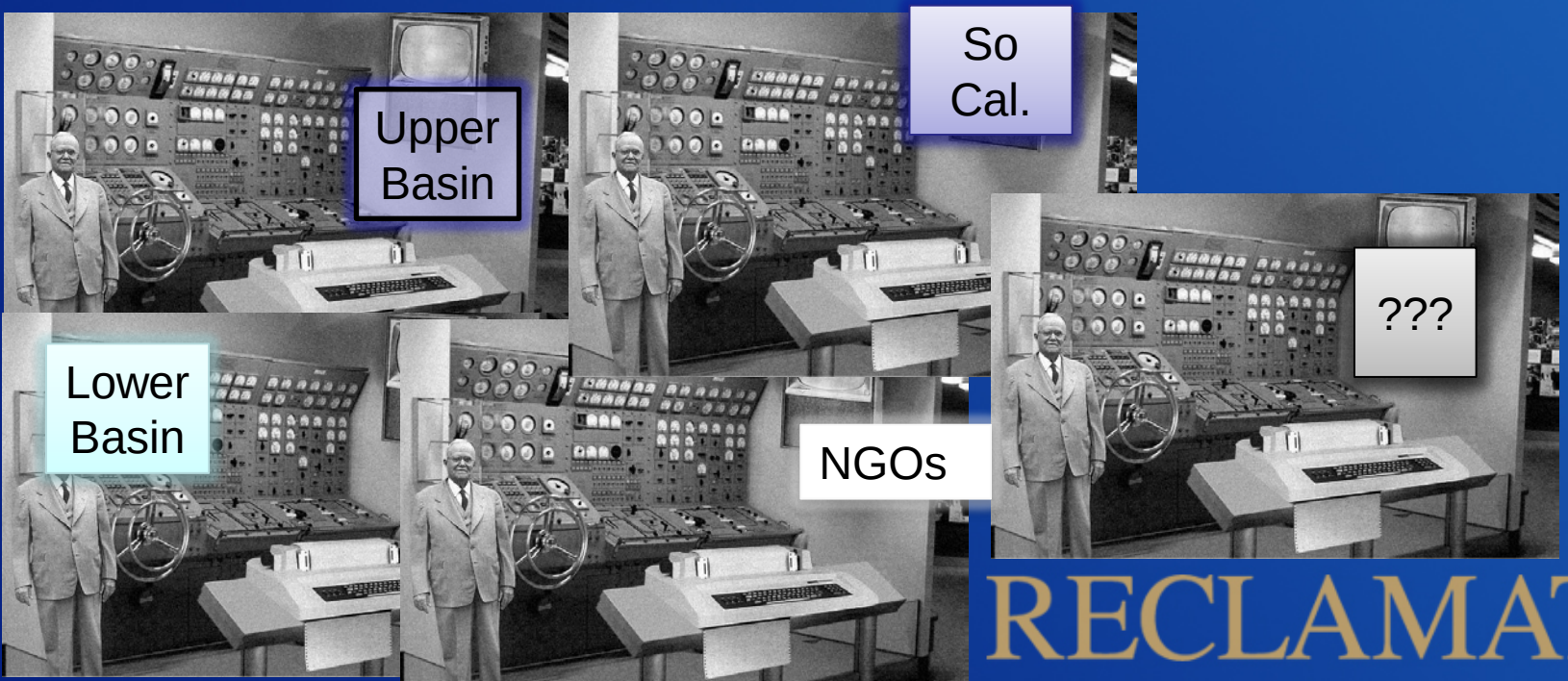
- A project with the RAND Corporation, Lawrence Livermore National Laboratories (LLNL), CADSWES, and Reclamation to explore the use of supercomputing in water resource management
- The Colorado River Basin Water Supply and Demand Study was used as the test-case
- The biggest challenge of the project was getting RiverWare to run on the supercomputer

Challenges

- Supercomputers operate on Linux
- Cannot rely on Excel DMIs
- File management
  - Transferring many small files across the file system was problematic

High Performance Computing Workshop

- Held at LLNL in November 2014
- Invitees represented a mix of academics, CRB water managers, CA water managers, Feds, others
- Breakout groups tasked with developing new portfolios from assigned perspectives



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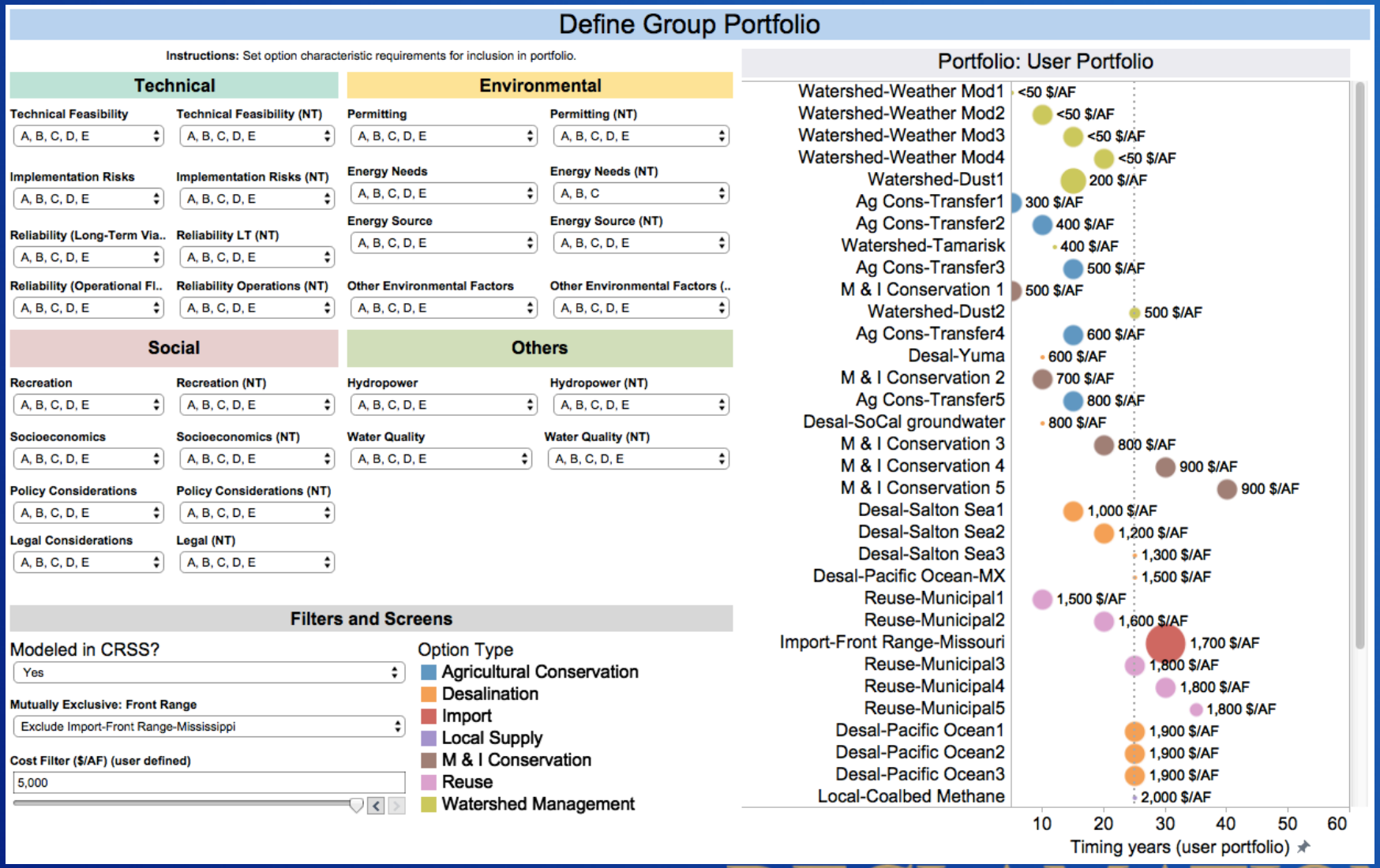
Portfolio Development Tool



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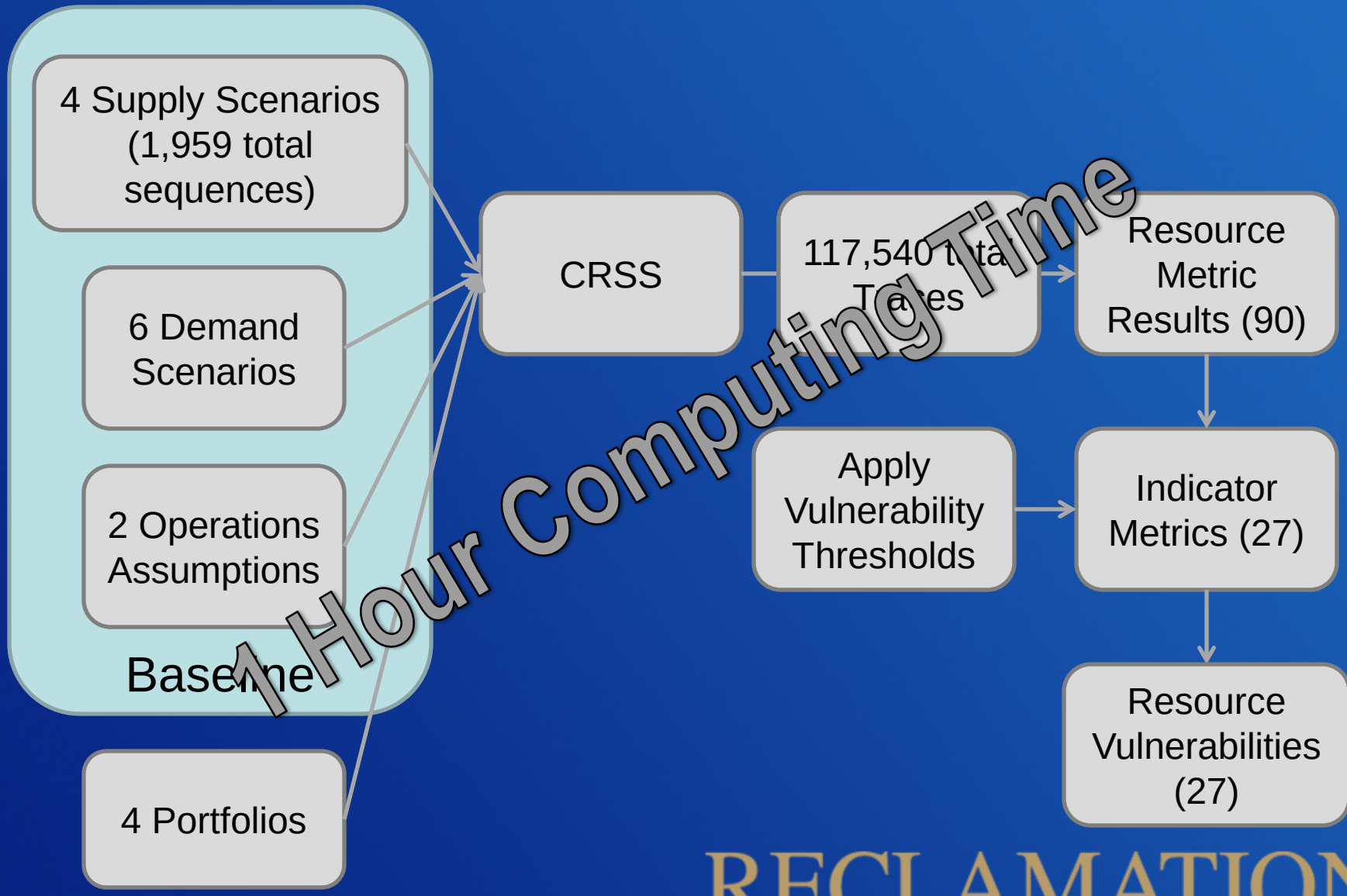
Bring in the Super Computer….

- Supercomputer “Cabernet”
- Capacity
  - 1,296 nodes x 16 Intel cores
- Speed
  - 431 Teraflops
- Memory
  - 41.5 Petabytes

High Performance Computing Modeling



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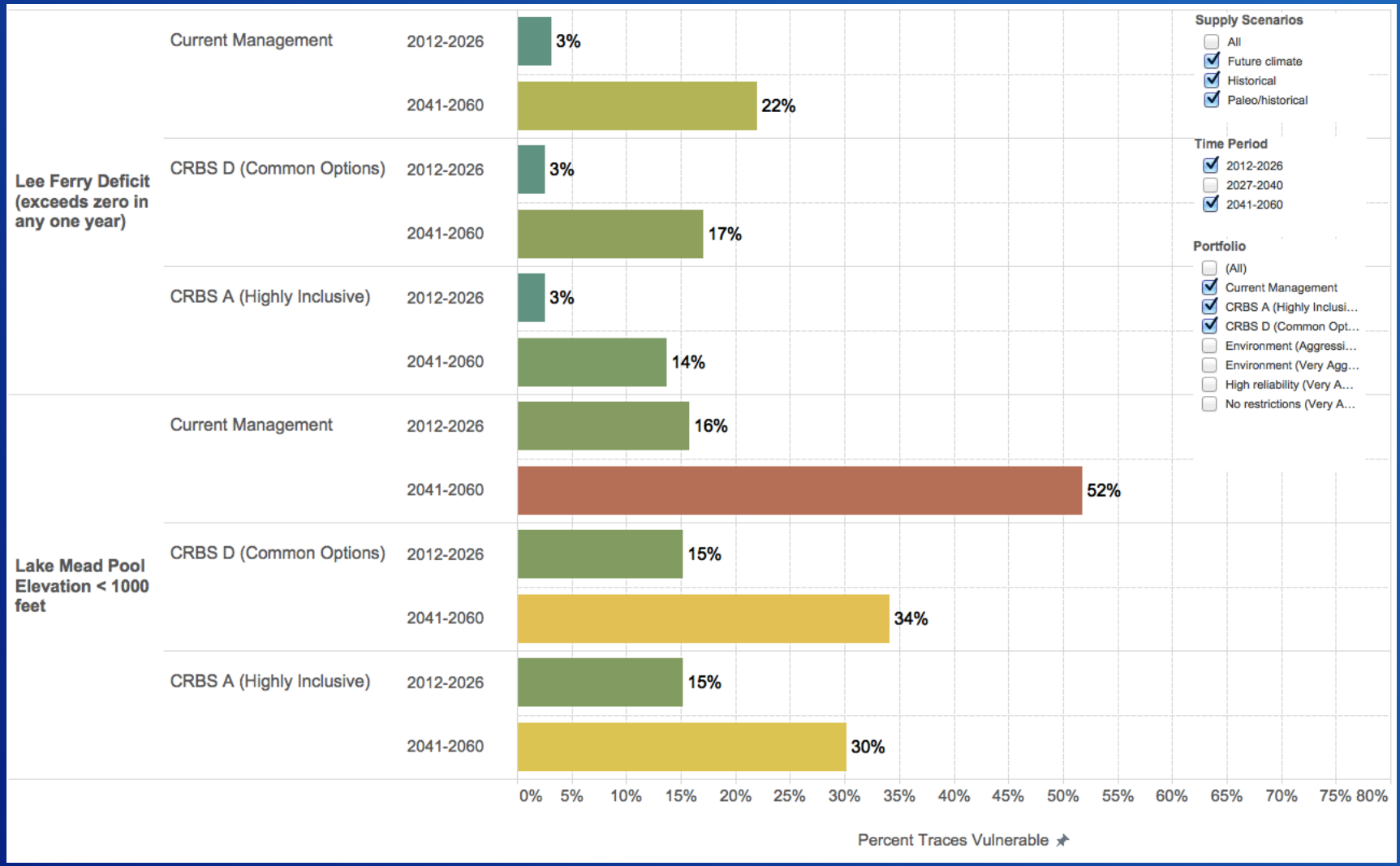
How much vulnerability is reduced?



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Lessons Learned and Future Work

- RiverWare modeling can be implemented in a high performance computing environment
  - Reduces run-time constraints
    - Number of simulations
    - Model complexity

- However, for “regular” use in high performance computing, RiverWare development for Linux likely needed

- Output data management, processing, and visualization pose challenges

Lessons Learned and Future Work

- High Performance Computing is commercially available
  - Amazon cloud, EC2, etc.
- Are development and computing costs justified?
  - Decisional framework
  - Results analysis and processing
  - Future model complexity and needs

Thank You

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