Flatland Visualization of A Decision Support Tool Architecture

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The Team

- New Mexico State University- Jim Cowie, Chris Fields, Hung Nguyen , Bill Ogden, Ram Prasad
- Monterey Institute for International Studies- Gary Ackerman, Markus Binder, Sundara Vadlamudi
- University of New Mexico- Frank Gilfeather, Thomas Caudell, Panaiotis, Tim Ross, Mahmoud Taha

The Problem

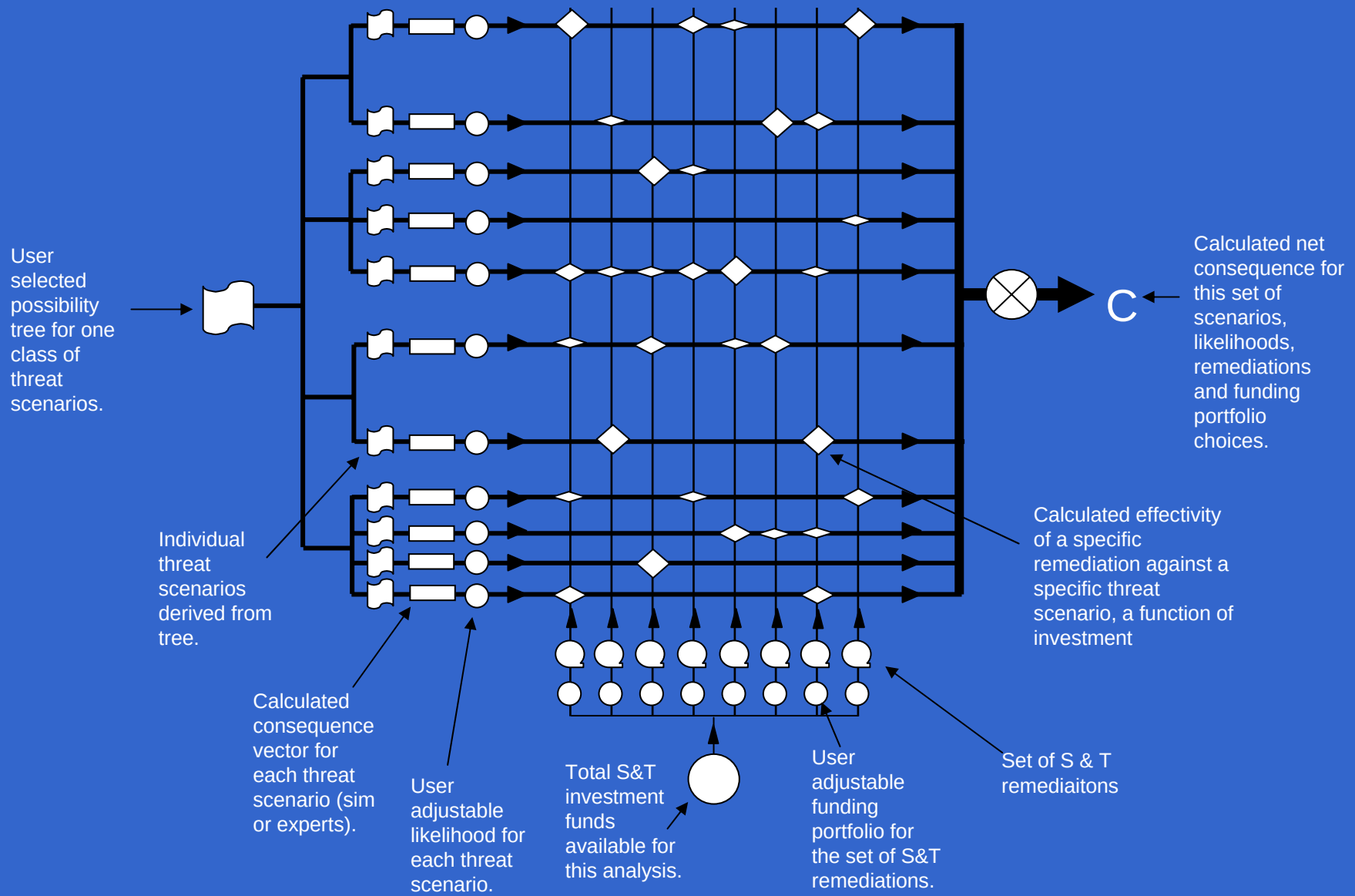
Allocation of Science & Technology (S&T) research funding to maximally reduce the threat and consequences of CB attacks on critical assets is complex and very hard to optimize globally.

Design Goals

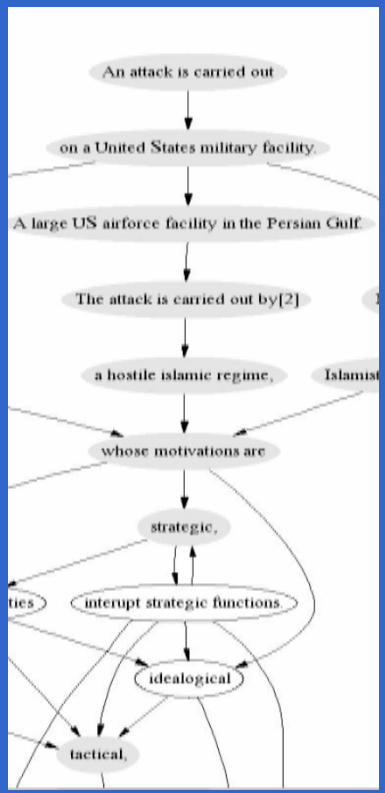
- Develop an analytic and algorithmic framework for threat consequence minimization.
- Create a feasible system architecture to evaluate modeling, analysis approaches, and user interactions within this framework.
- Enhance decision process transparency.

Initial Architecture

No Temporal Dynamics



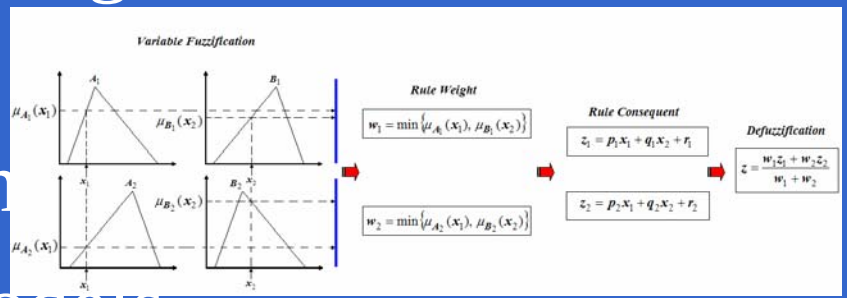
Specification of Scenarios



- Possibility Trees
- Spanning sets of scenarios
- Vectors of consequences per scenario
- Possible continuous scenario space
- Possible continuous consequence space

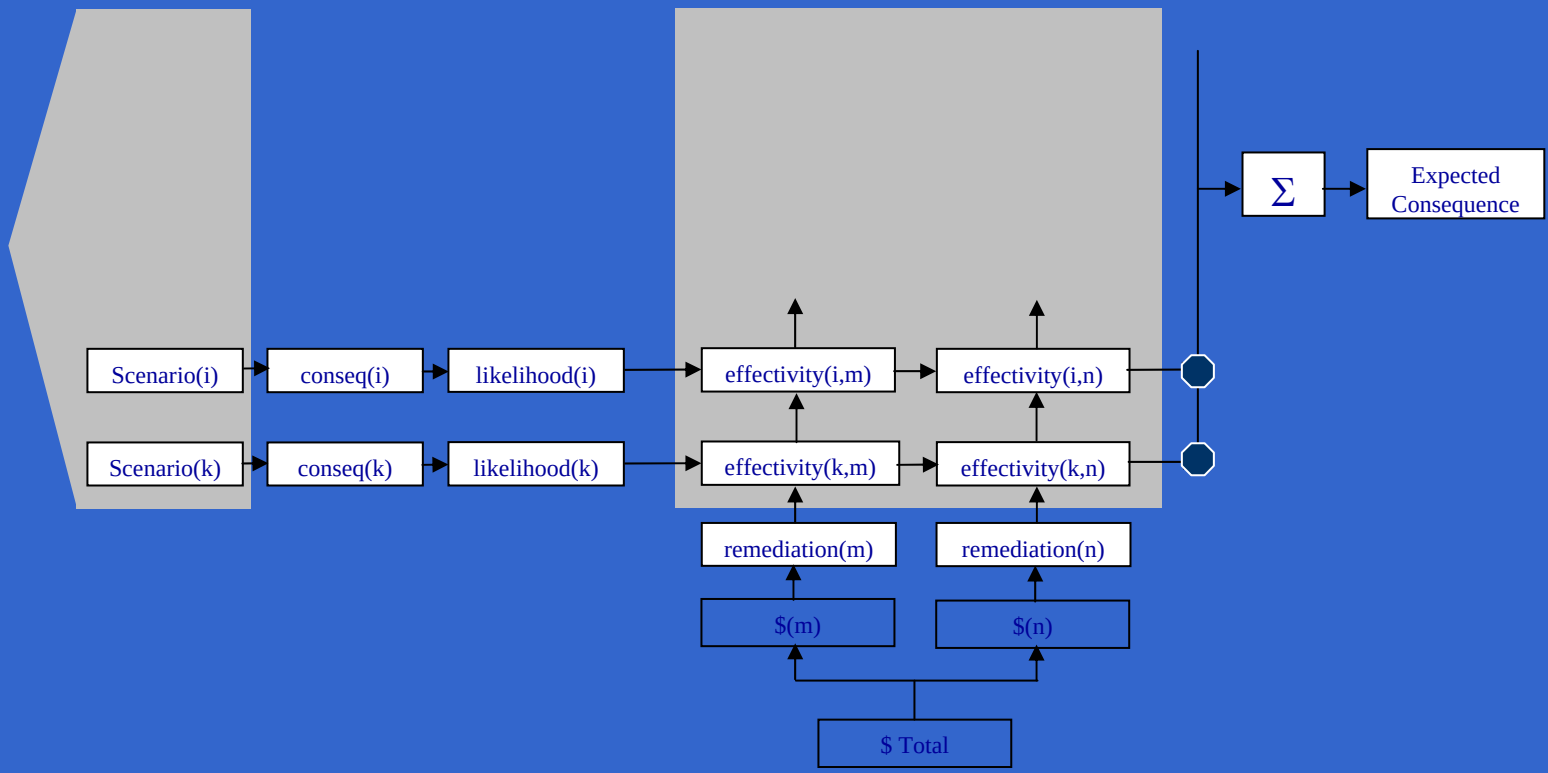
Creating Models of Consequences, Costs, and Effectiveness

- Relate remediation funding level to its effectiveness against a given scenario's consequences.
- Scientific Simulation
- Machine learning models
- Knowledge based systems



Details of Architecture

Consequence Flow Model



Mockup Mathematical Model

Assumes only one type of consequence per scenario.

$$\text{Expected Conseq} = \alpha \sum_{k=1}^{\text{NumScenarios}} \text{conseq}(k) * \text{likelihood}(k) * \prod_{m=1}^{\text{NumRemediations}} (1-\text{effectivity}(k,m))$$

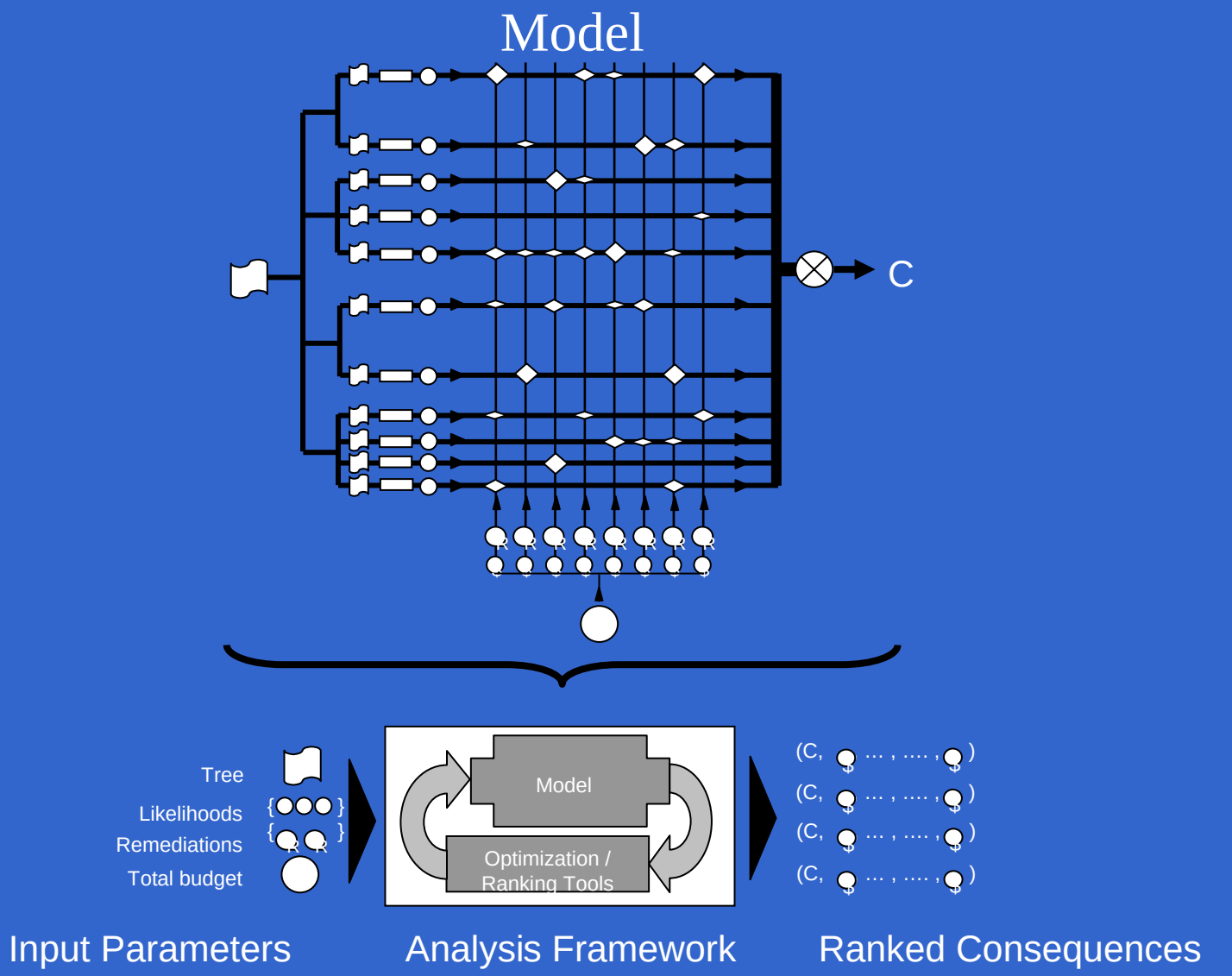
Where:

* α is a normalization constant,
* conseq(k) is a real scalar,
* likelihood(k) is a probability (sums to 1),
* $(m) is a real (sums to $ Total = 1),
* effectivity(k,m) = β(k,m) * F($(m)),
* β(k,m) = rand(0,1).

User Adjustables:

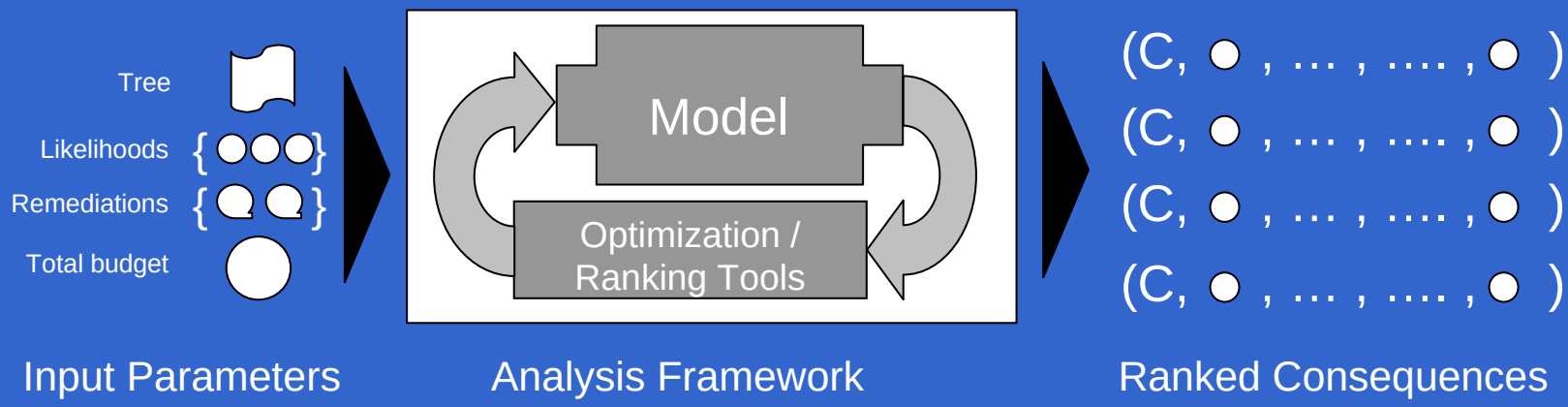
a) {likelihood(k), k=1, NumScenarios}
b) {$(m), m=1, NumRemediations}

Optimization Loop



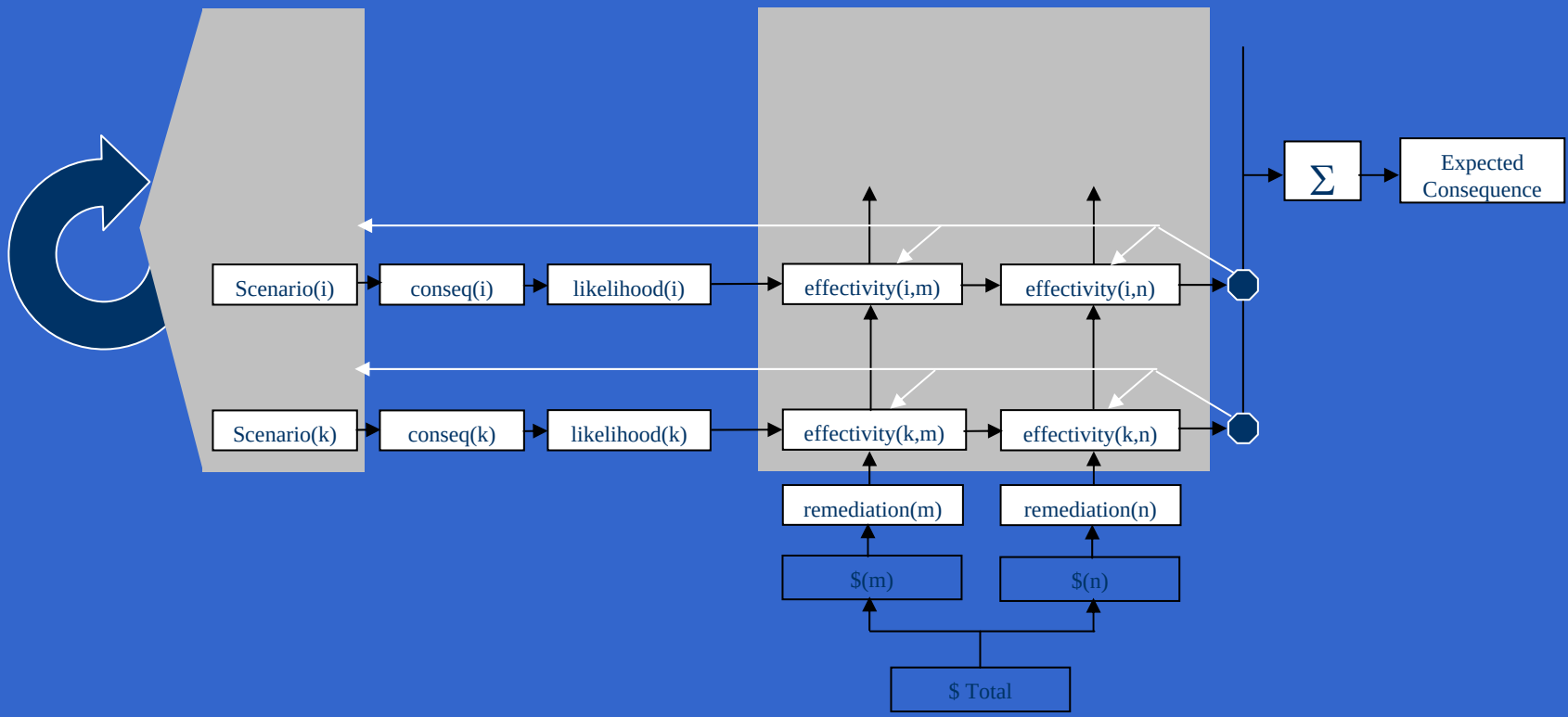
Optimization

Allocation of funds to minimize expected consequences



Mockup: $\$_n(k+1) = \$_n(k) - eta * gradient(Expected Consequences)$

Temporal Dynamics



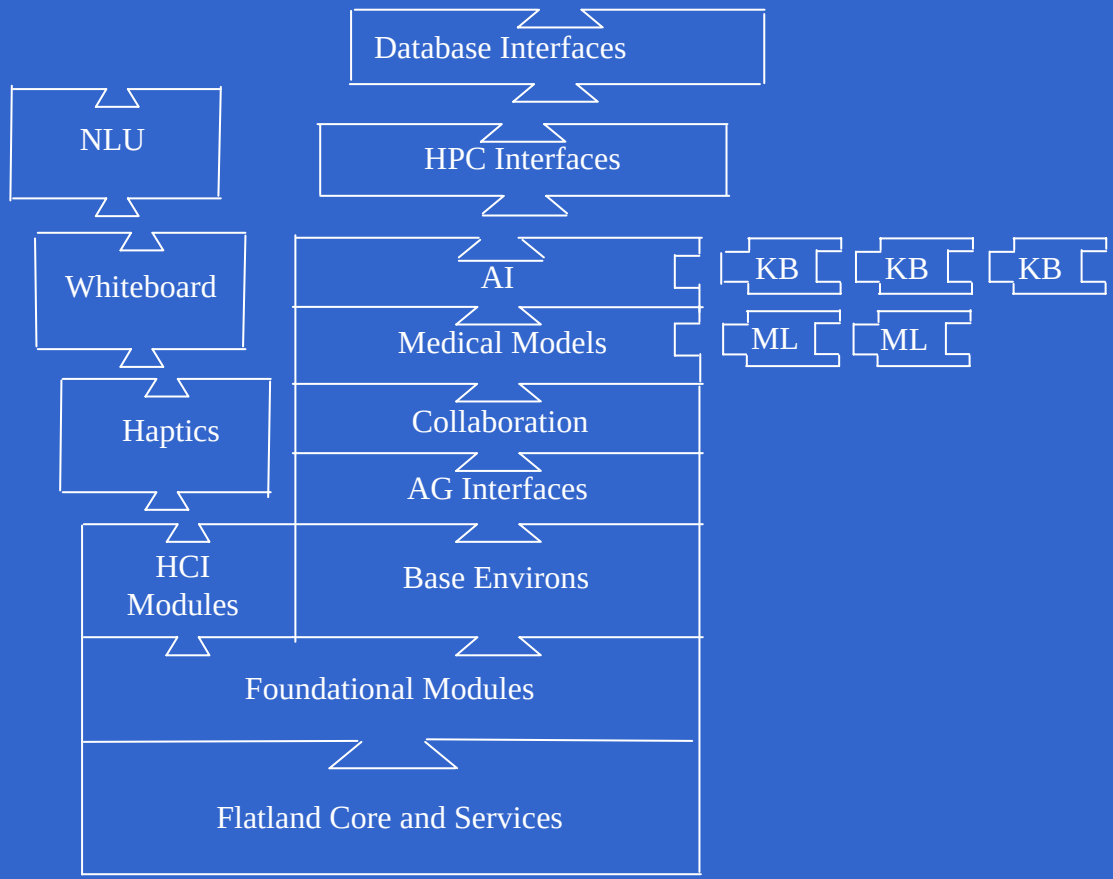
The visualization team

- Shan Xia - UNM, ECE
- Victor Vegara- UNM, ECE
- Panaiotis- UNM, ECE & Music
- Steve Smith- LANL
- Thomas Caudell- UNM, ECE & CS

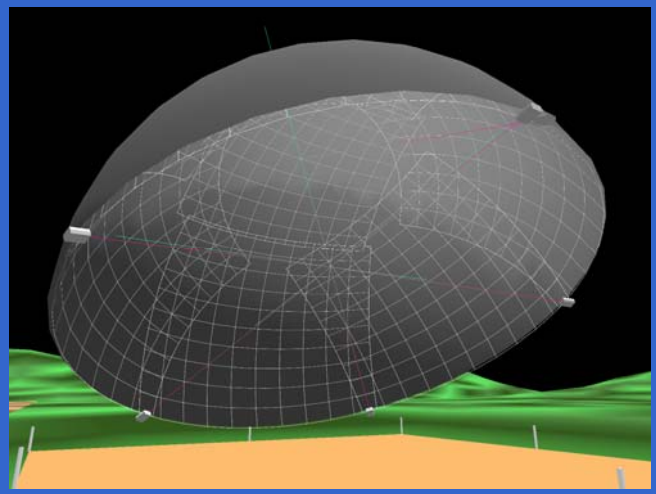
Features of visualization

- Goal: transparency into computational model and decision process.
- Consequence-flow metaphor
- Real-time user adjustable parameters
- User viewpoint control to manage complexity
- Drill-down for more details
- Animation of calculations and optimization
- Complementary sound representation of system states and dynamics
- Implemented in Flatland.

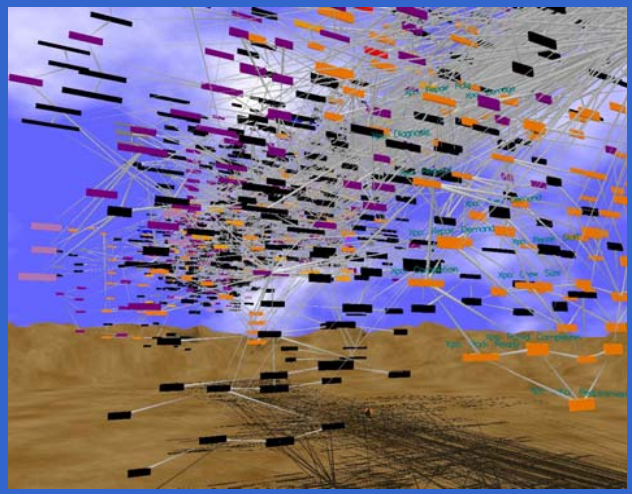
Flatland: modular applications

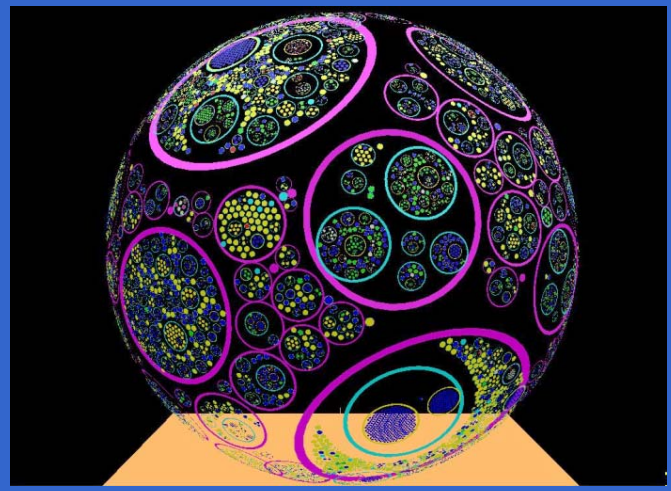


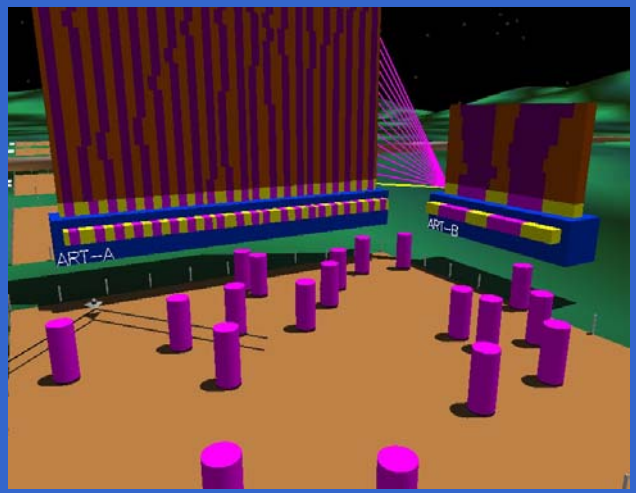
Displays: visual and sound

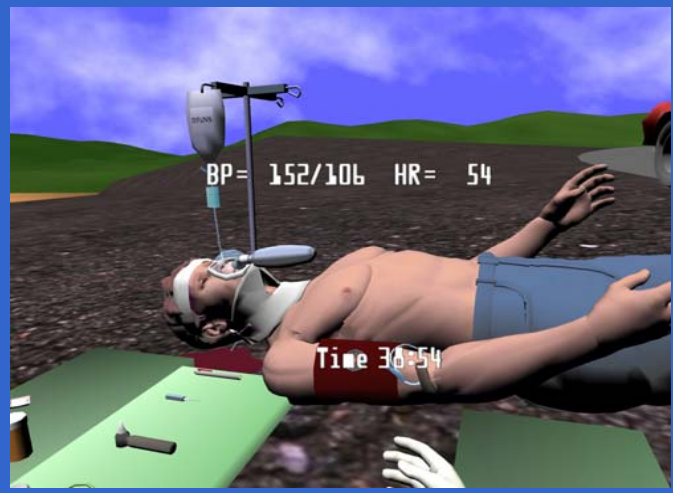


Widely applied

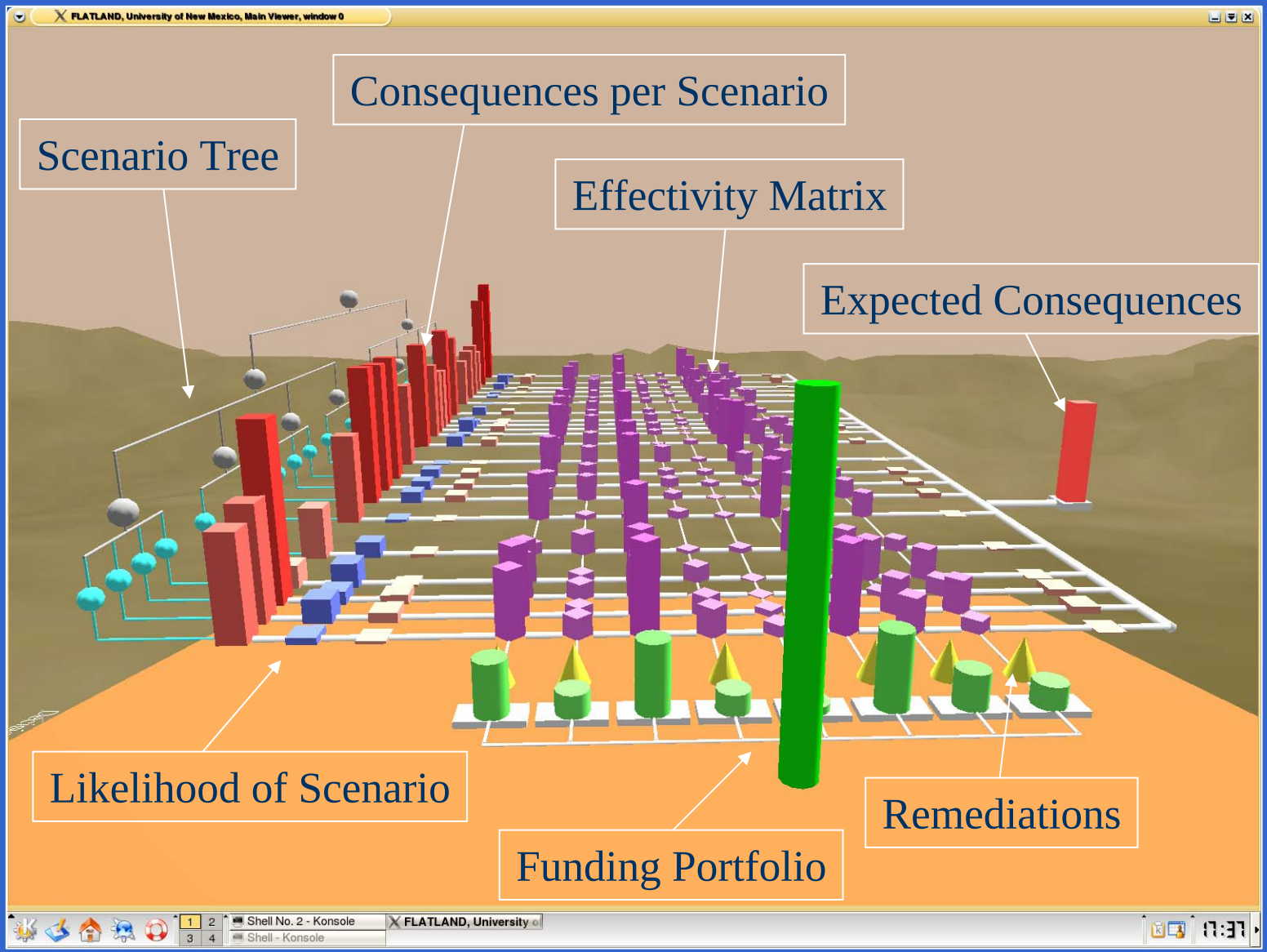








Visualization of Mockup System



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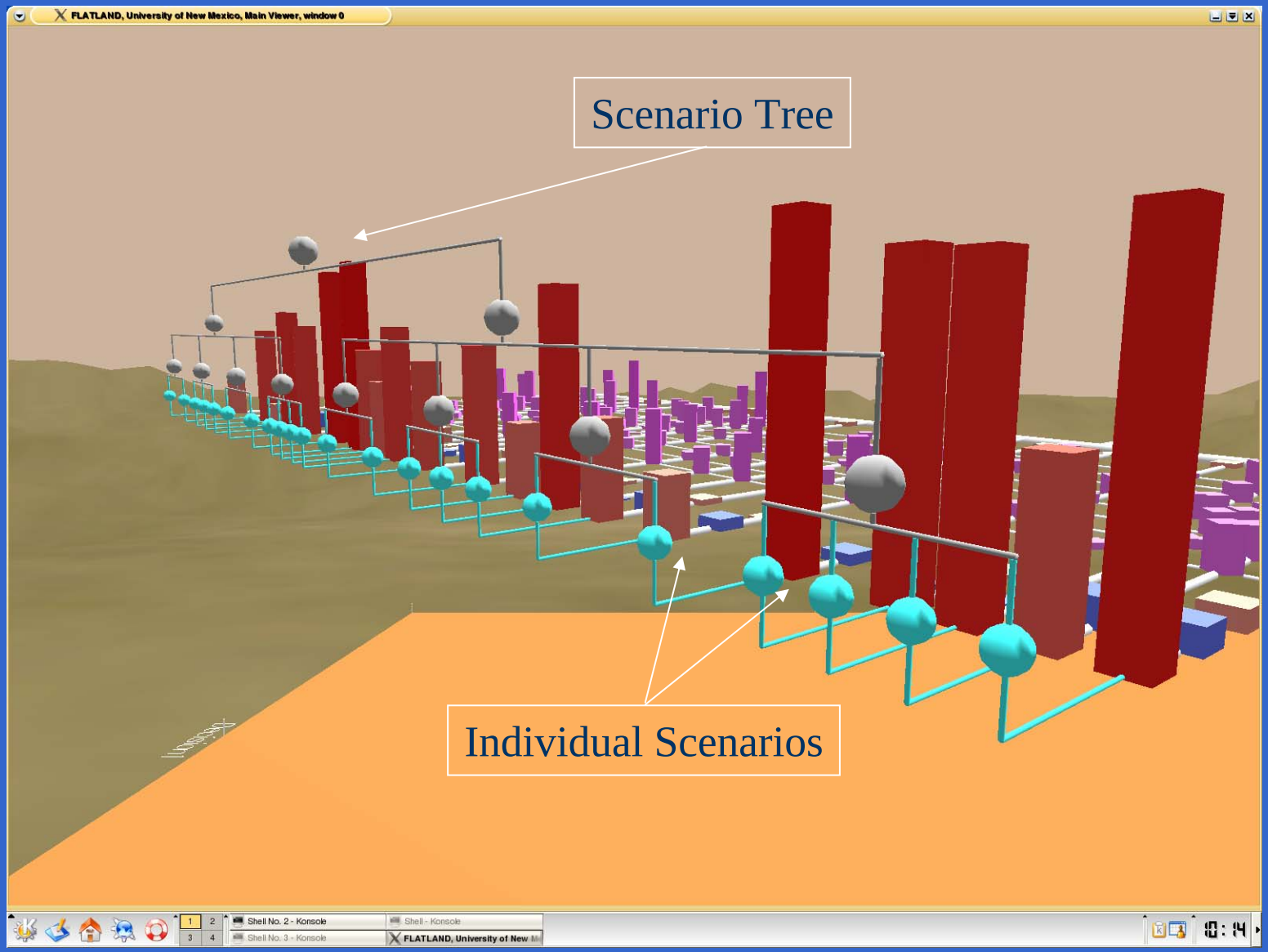

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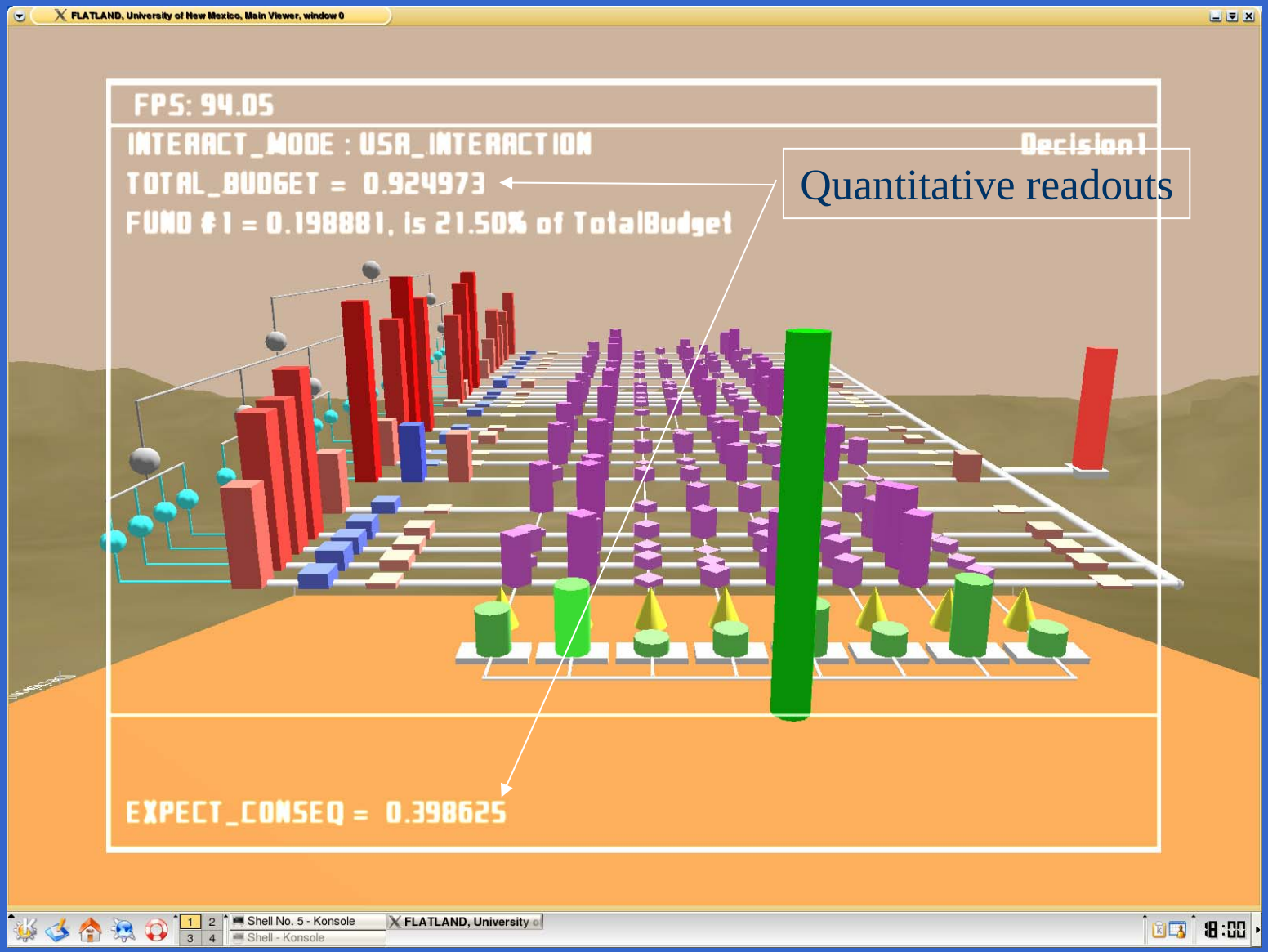

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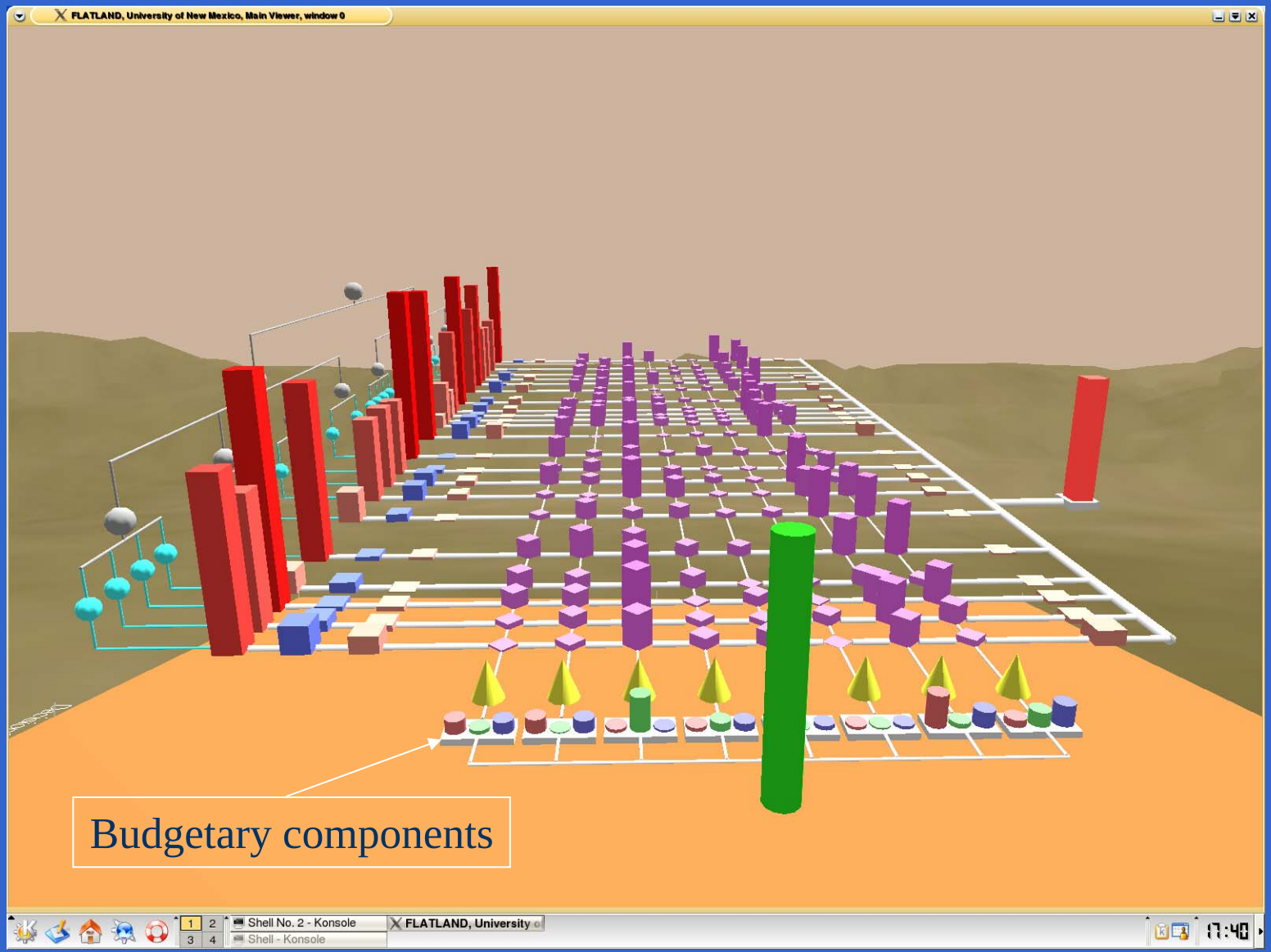

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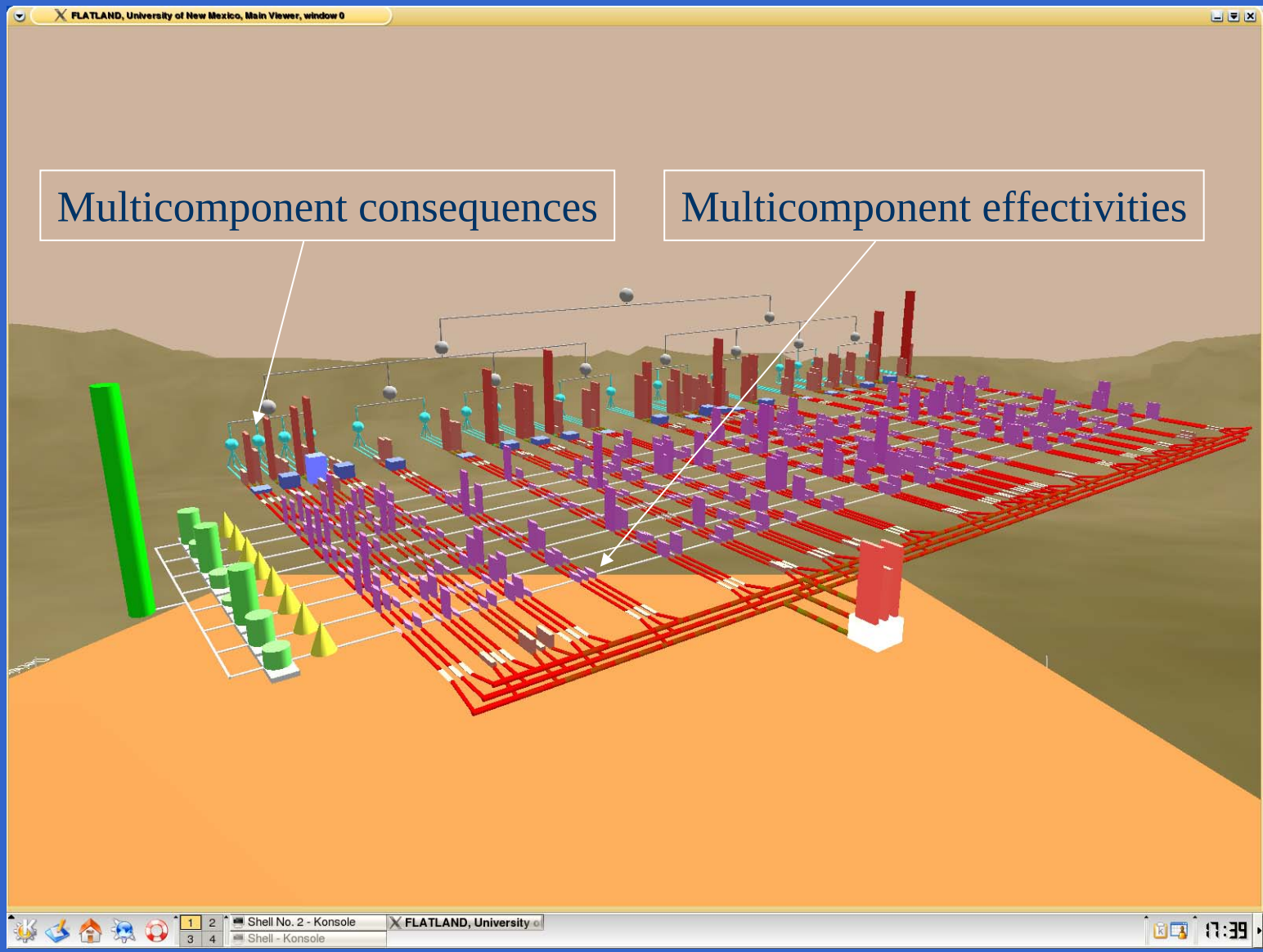

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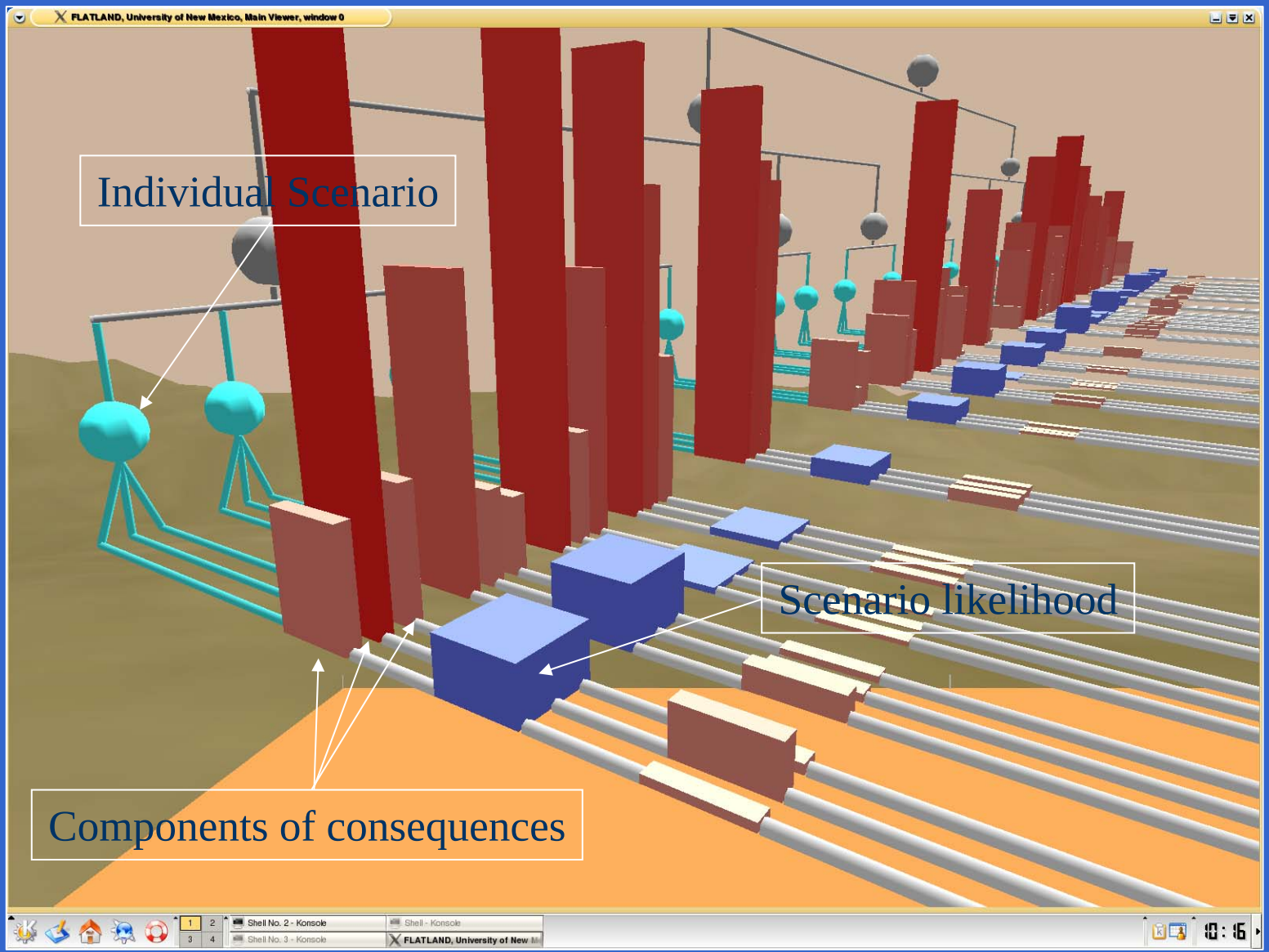

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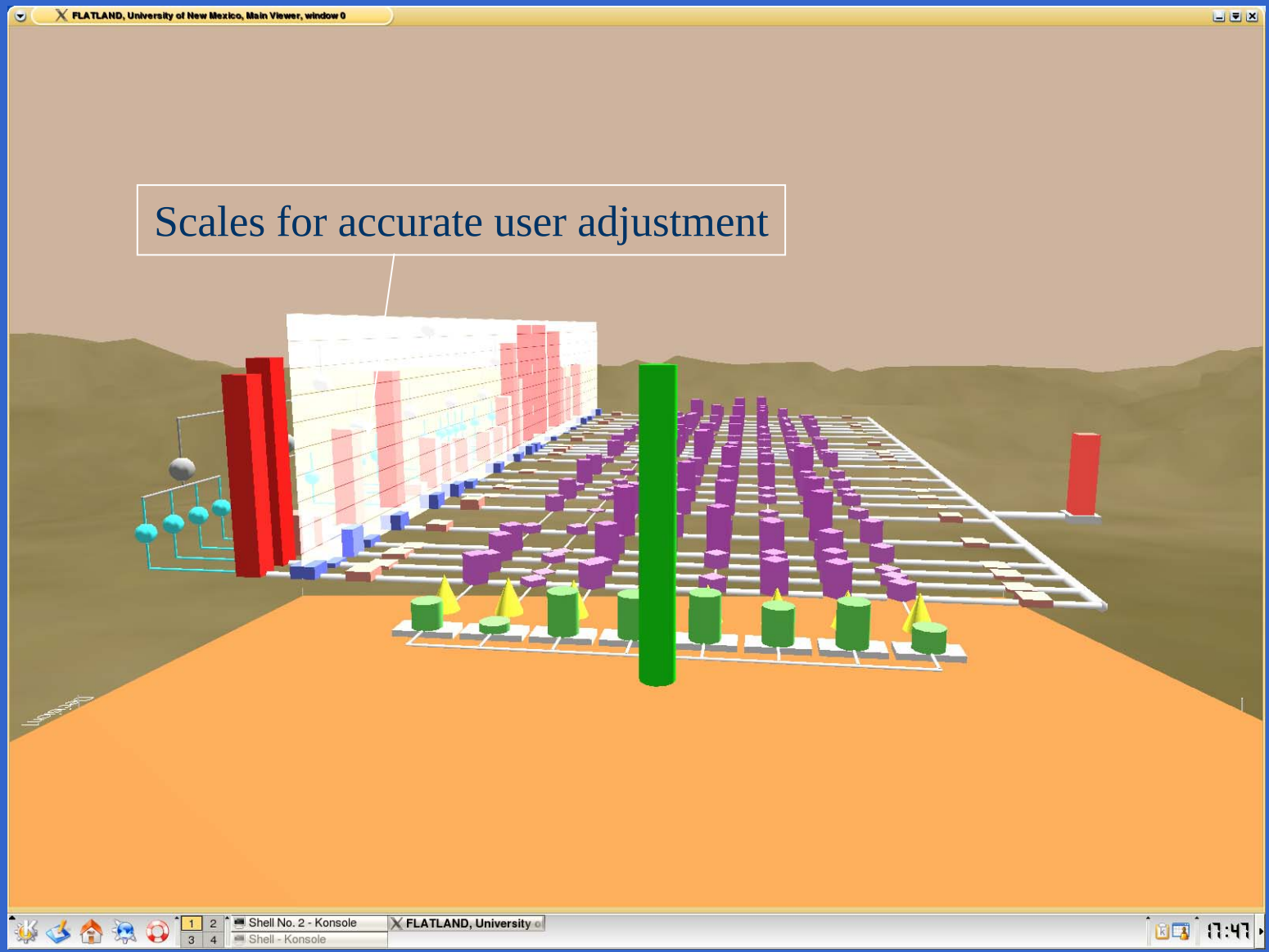

Future advancements

- Integration with models and optimization,
- Integration with scenarios,
- Scalable scenario & remediation representations,
- Effectivity model representations,
- Quantitative measures of performance.

Invitation to demonstration
at the
University of New Mexico
Visualization Laboratory
Center for High Performance Computing

- Thursday -

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