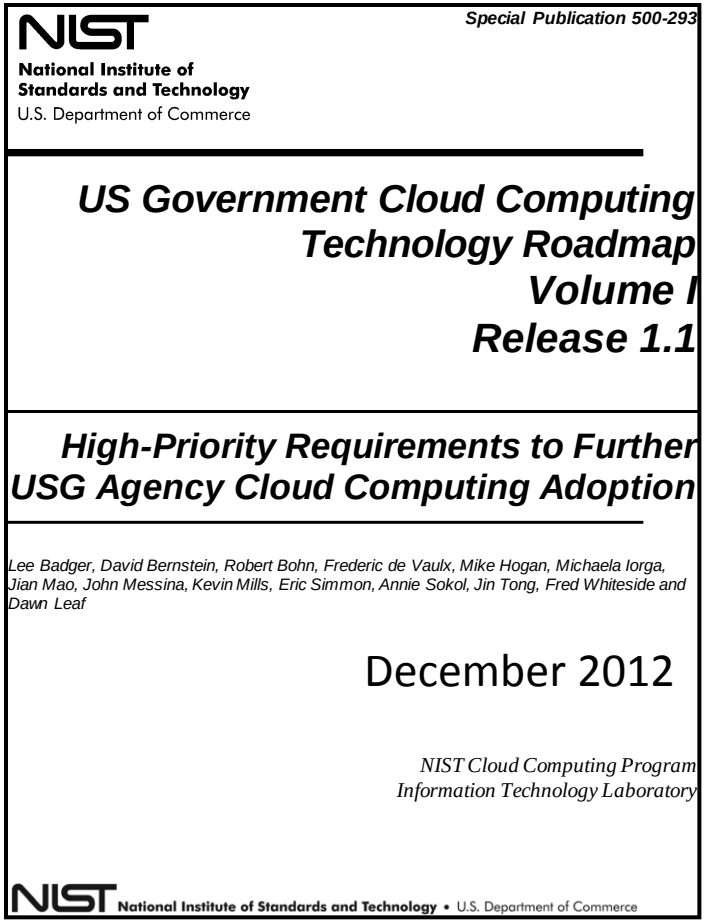
Proposed Agenda for Breakout Group on

Reliability Design Goals Research

Marija Mijic (IWGCR) and Kevin Mills (NIST)
with assistance from Scott Morgan (Energetics)

- **Review of NIST Cloud Roadmap Reqt#9: Defined & Implemented Reliability Design Goals**, K. Mills, 5 mins
- **Update on NIST Cloud Reliability Research**, K. Mills, 10 mins
- **Introduction to Activities of the International Working Group on Cloud Resiliency** (**IWGCR**), M. Mijic, 30 mins
- **General Discussion about Cloud Reliability Status and Needs**, All Participants, 15 mins

NIST Cloud Roadmap Requirement 9: Defined & Implemented Reliability Design Goals



NIST
National Institute of Standards and Technology
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Special Publication 500-293

US Government Cloud Computing Technology Roadmap Volume I Release 1.1

High-Priority Requirements to Further USG Agency Cloud Computing Adoption

Lee Badger, David Bernstein, Robert Bohn, Frederic de Vaulx, Mike Hogan, Michaela Iorga, Jian Mao, John Messina, Kevin Mills, Eric Simmon, Annie Sokol, Jin Tong, Fred Whiteside and Dawn Leaf

December 2012

NIST Cloud Computing Program
Information Technology Laboratory

NIST National Institute of Standards and Technology • U.S. Department of Commerce

Industry needs to define and implement reliability design goals, best practices, and related measurement and reporting processes.

Why: *As USG agencies increase their use of cloud computing to provide essential public services, it is essential that industry be able to ensure that design flaws do not result in catastrophic failures or significant outages over large regions or for extended periods of time.*

	Recommended Priority Action Plans (candidates for voluntary self-tasking by cloud computing community stakeholders)	***Proposed Target Date***
Cloud Providers	Formulate and publish best practices on achieving reliability.	2012 – 2014
Consortia	Develop a consensus process to measure and report industry-wide cloud reliability information to assess current and future cloud reliability.	2012 – 2017
Researchers	Define research methods for real-time measurement and monitoring to predict onset of catastrophic failure in cloud systems, and tools to identify failure vulnerabilities.	2012 - 2015

Update on NIST Cloud Reliability Research
K. Mills, NIST

For more details see – http://www.nist.gov/itl/antd/emergent_behavior.cfm

ONGOING NIST RESEARCH

How can we increase the reliability of complex information systems?

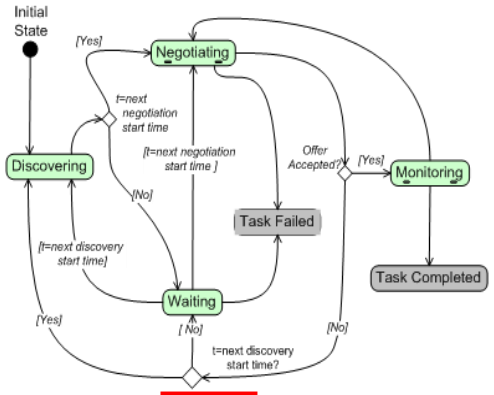
- **Research Goals**: (1) develop and evaluate **design-time methods** that system engineers can use to detect existence and causes of costly failure regimes prior to system deployment and (2) develop and evaluate **run-time methods** that system managers can use to detect onset of costly failure regimes in deployed systems, prior to collapse.

- **Recent**: investigating **design-time methods** –
  a. **Markov Chain Modeling + Cut-Set Analysis + Perturbation Analysis** (e.g., Dabrowski, Hunt and Morrison, "Improving the Efficiency of Markov Chain Analysis of Complex Distributed Systems", NIST IR 7744, 2010).
  b. **Anti-Optimization (AO) + Genetic Algorithm (GA)** (e.g., Mills, Dabrowski, Filliben and Ressler, "Combining Genetic Algorithms and Simulation to Search for Failure Scenarios in System Models", *Proceedings of the 5th International Conference on Advances in Simulation*, October 2013).

- **Proposed:** investigate **run-time methods** based on approaches that may provide early warning signals for critical transitions in large networks (e.g., Sarkar, et al. "Understanding phase transition in communication networks to enable robust and resilient control", *Proceedings of the American Control Conference*, June 2009.).

Design-Time Method: Combining Markov Chains, Cut-set Analysis and Perturbation Analysis to Search for Failure Scenarios in System Models

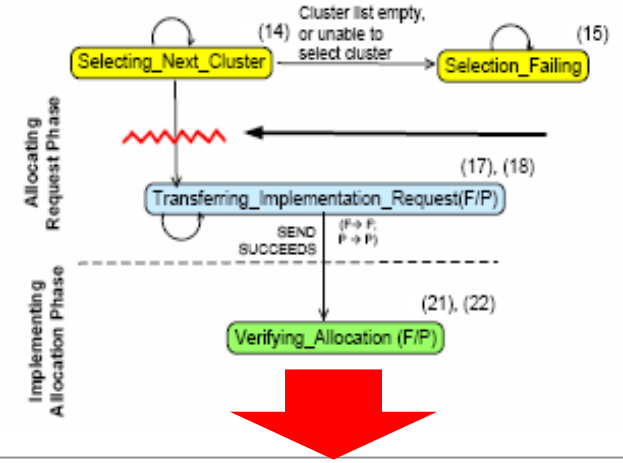
EXTRACT FINITE-STATE MACHINE (FSM) FROM SIMULATION MODEL OR SYSTEM

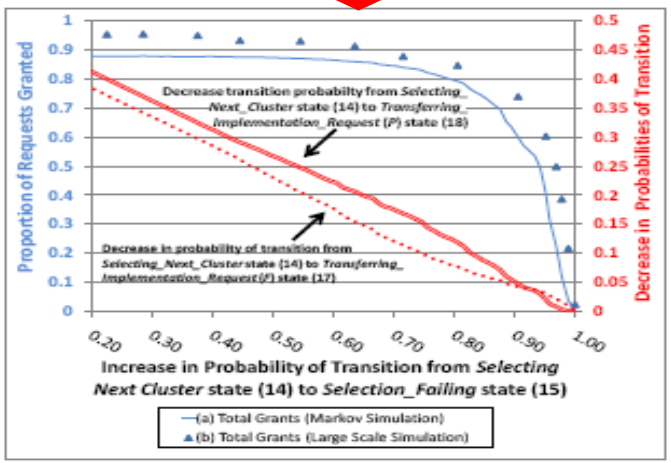


	Initial	Wait	Disc	Ngt	Mon	Compl	Fail
Initial	0.9697	0	0.303	0	0	0	0
Wait	0	0.7958	0.0634	0.1375	0	0	0.0033
Disc	0	0.1211	0.7387	0.1402	0	0	0
Ngt	0	0.1375	0.0190	0.2933	0.1950	0	0.0001
Mon	0	0	0	0.0003	0.9917	0.0080	0
Compl	0	0	0	0	0	**1.0**	**0**
Fail	0	0	0	0	0	**0**	**1.0**

INSTRUMENT MODEL AND BUILD MARKOV CHAIN

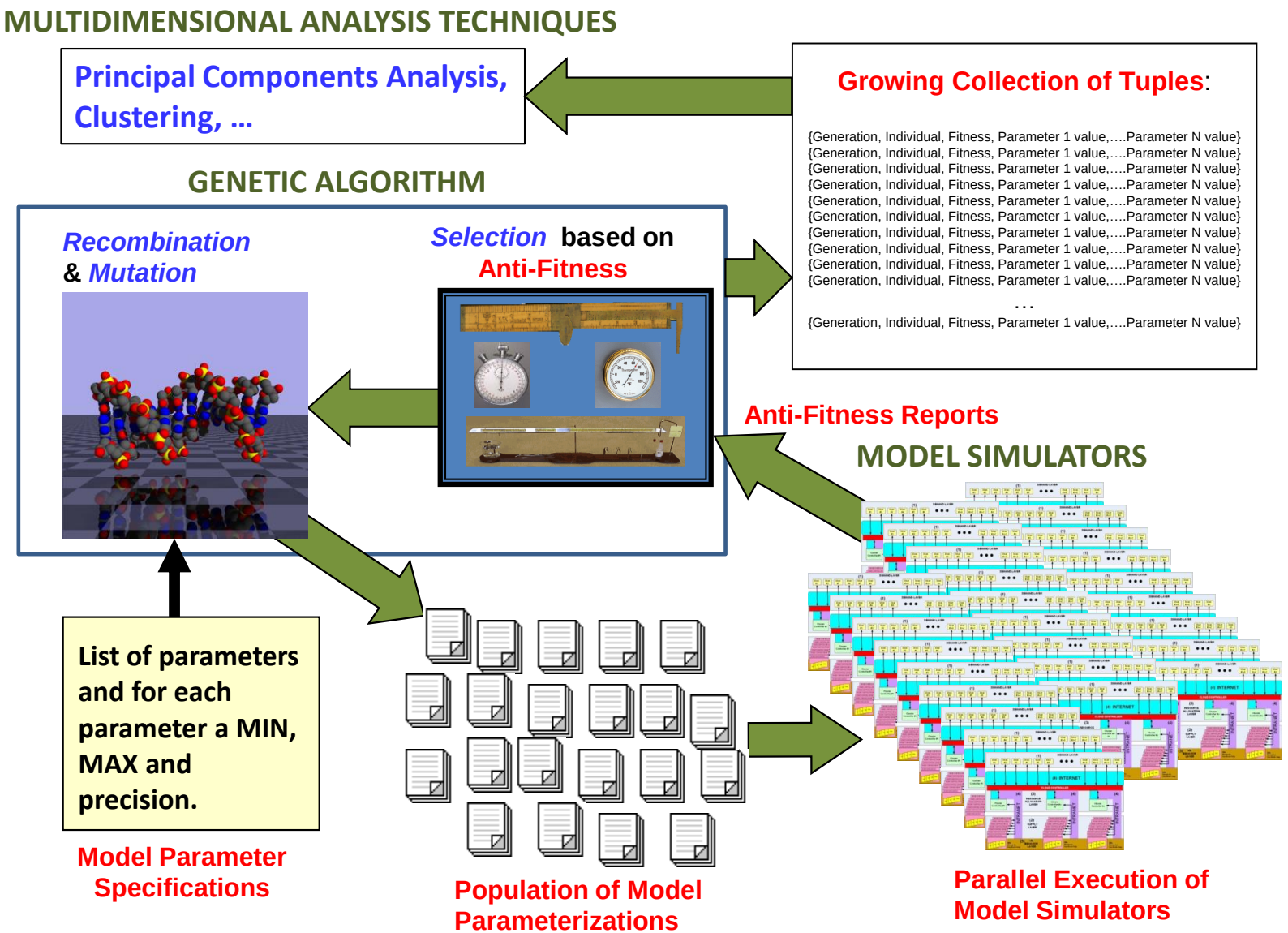
TREAT FSM AS GRAPH AND CONDUCT CUT-SET ANALYSIS





PERTURB MARKOV CHAIN AT CUTS

Design-Time Method: Combining Genetic Algorithms and Simulation to Search for Failure Scenarios in System Models



PROPOSED RESEARCH PROJECT ON RUN-TIME METHODS

Measurement-based Prediction of Catastrophic Events in Networked Systems

K. Mills, C. Dabrowski, J. Filliben, F. Hunt & B. Rust

Slogan: "Early Warning of Network Catastrophes"

- **Problem:** Network outages cost billions/year, and increasing
- **Opportunity:** A decade of theoretical studies show network outages manifest as phase transitions, with precursor signals, ***but*** those studies:
  - Rely on abstract models, lacking in realism
  - Use measurement methods unsuited to real networks
- **Plan:** We propose to bridge gaps between theory and practice
  - Determine conditions under which theories apply (or not) in realistic network models, laboratory networks and, ultimately, deployed networks
  - Design and develop practical measurement methods, deployable in real nets
  - Evaluate measurement methods through collaborations with net operators
- **Impact if successful:**
  - Remove critical barriers to practical early-warning methods for networks
  - Fill a vacuum in commercial network control and management systems
  - Reduce societal costs from consequences of network failures

Now on to Marija

Discussion Questions

- Are there published best practices on achieving cloud reliability?
- Are other consortia working toward processes to measure and report industry-wide cloud reliability information or to assess current and future cloud reliability?
- Are other research projects working toward run-time measurement and monitoring methods to predict and prevent impending failures in clouds, or toward design-time tools to identify failure vulnerabilities?
- Any other questions?