Designing Storage Systems: An Optimization Approach Using Discrete Event Simulation

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Motivation
- Disasters are inevitable and losing information is expensive
  - Protecting data critical for businesses
- Solutions are often over/under provisioned, resulting in cost overruns
  - Determining the sweet spot for resource cost vs. penalty for unavailability and data loss
- Applications with different characteristics and requirements are often deployed in a common environment
  - Prompts different design decisions for different combinations of interacting applications
- Large number of potential options for recovery
  - Cost of exhaustively exploring the search space is prohibitive

Salient Features
- An intelligent method to explore unstructured design parameter space
  - Decomposed the search space into two hierarchical choices
  - This decomposition allows us to
    - Reduce the search space
    - Focus on the relevant regions of interest
- An improved Discrete-Event simulator that enables us to evaluate alternate design choices with a speedup of 10x-35x
- Provides a methodology to integrate stochastic simulation with model parameter optimization

Hardware resources
- capabilities & cost
- Network links, array, disk, tape library, network topology

Business objectives
- Data outage penalty rate ($/hour)
- How long before system is back up?
- Data loss penalty rate ($/hour)
- How much recent data may be discarded during recovery?

Design Space (True view)

Design Space (Search heuristic view)

Simultaneous Simulation of Alternate Design Choices

Stochastic Models
- workloads
- resources
- disk arrays
- tape backup
- network links
- data-protection techniques
- mirroring tape backup
- failure

Overall cost
- recovery time
- data loss.

Alternate design choices

Resources, Workload info, Failure rates, (configuration parameters)

Data Outage time
Data loss time

Design solver
Likelihood search

Greedy best-fit algorithm

Reconfiguration algorithm

Reliability
Less likely to explore
More likely to explore

Threats: failure types
- Focus: recovery from loss of primary copy
  - Due to “container” failure or user/application error
  - Due to site failure

Workload models
- Measured input parameters
  - Capacity
  - Average (non-unique) update rate
  - Batched unique update rate