Hybrid Cloud Resource Provisioning Policy in the Presence of Resource Failures

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Agenda

- Introduction
- System Context
- Hybrid Cloud Architecture
- Proposed Provisioning Policies
- Performance Evaluation
- Simulation Results
- Conclusions

INTRODUCTION

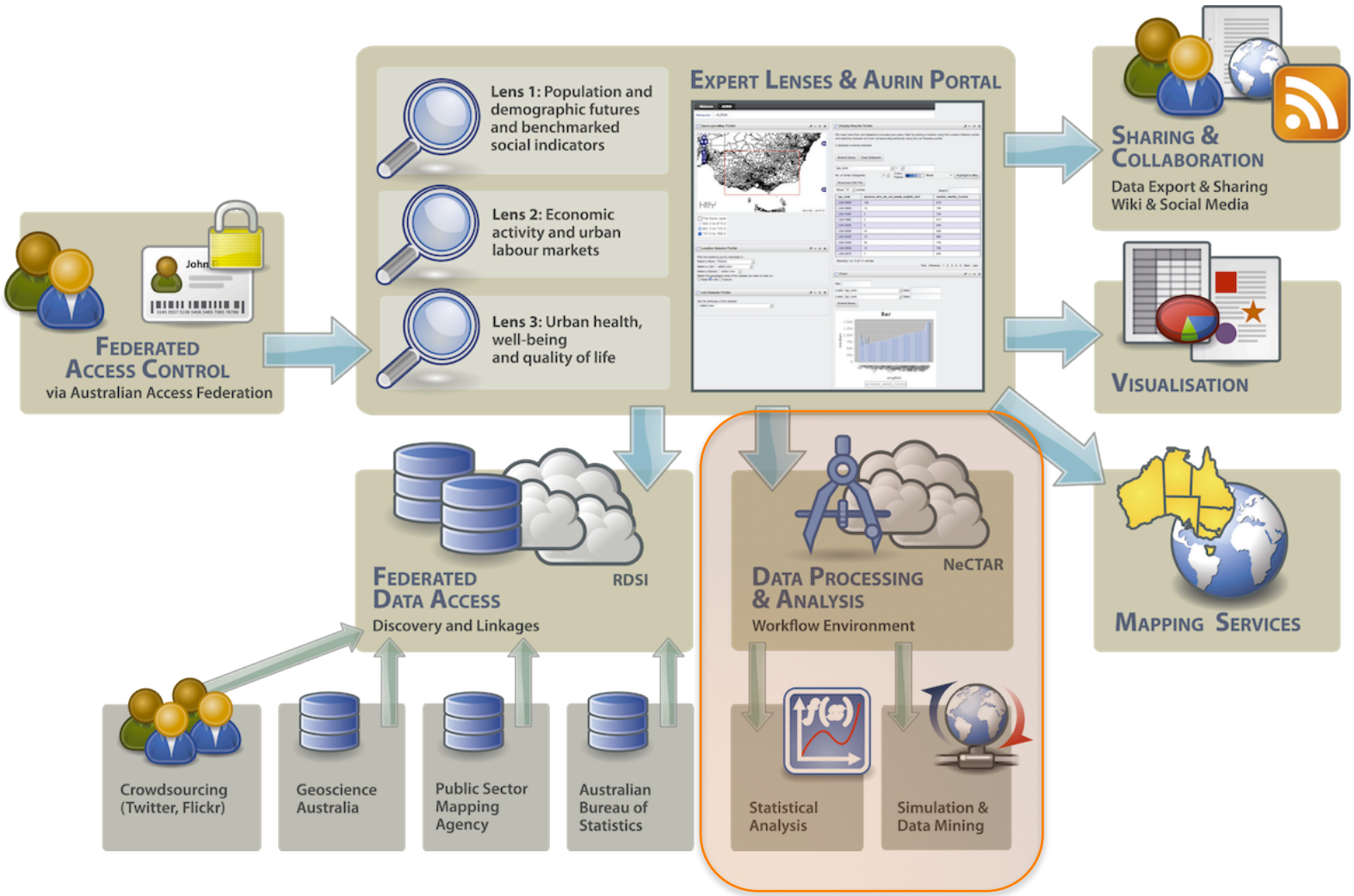
- Hybrid Cloud Systems
  - Public Clouds
  - Private Clouds
- Resource Provisioning in Hybrid Cloud
  - Users' QoS (i.e., deadline)
  - Resource failures
- Taking into account
  - Workload model → workflows in a scientific project
  - Failure correlations → real failure traces
    - *Knowledge-free approach*: not any information about the failure model

System Context

- Our policies are proposed in the context of the Australian Urban Research Infrastructure Network (AURIN) project

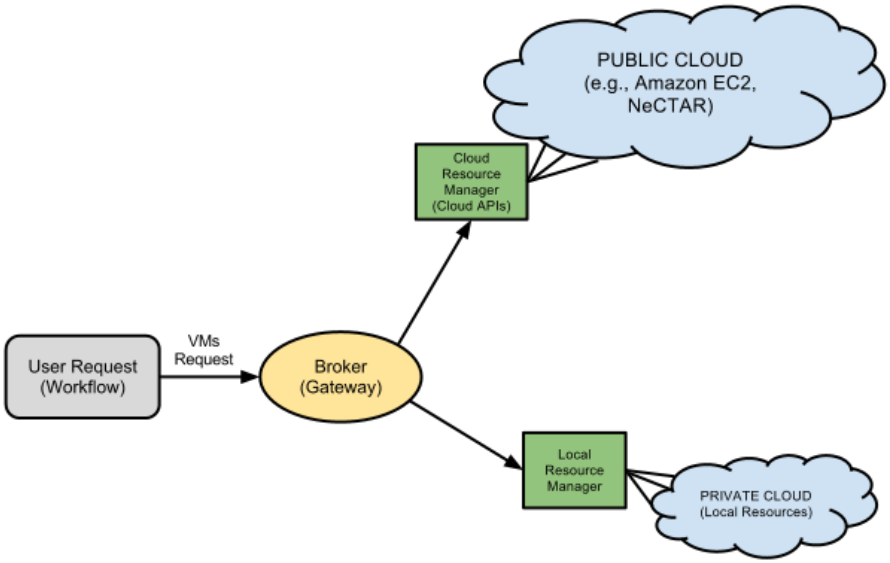
  - An e-Infrastructure supporting research in urban and built environment research disciplines
  - Web Portal Application (portlet-based)
    - A lab in a browser (http://portal.aurin.org.au)
    - Access to the federated data source
      - Web Feature Service (WFS)
    - Workflow environment based on Object Modeling System (OMS)
    - NeCTAR NSP and Research Cloud

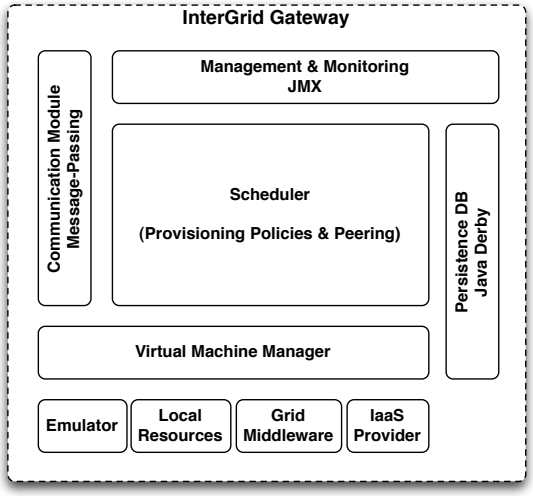
THE AURIN ARCHITECTURE



Hybrid Cloud Architecture

- Based on InterGrid components
- Using a Gateway (IGG) as the broker





IGG

Workload Model

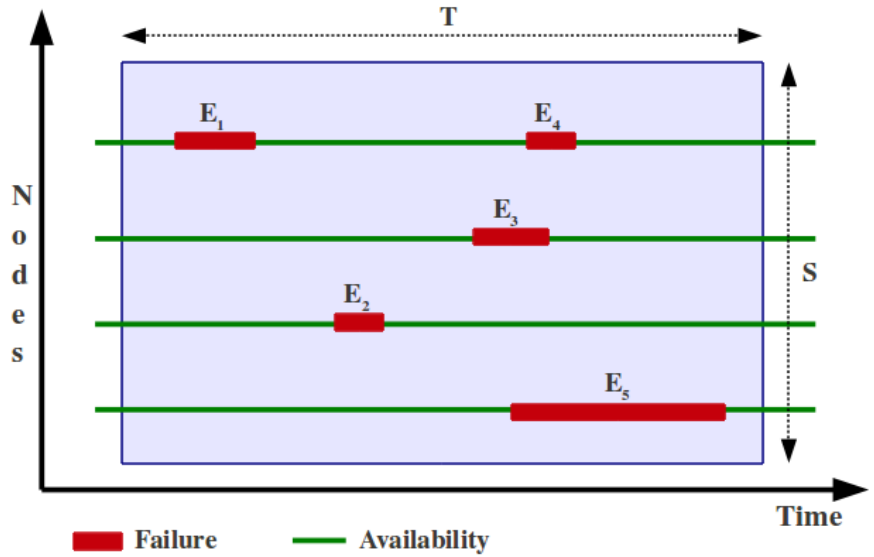
- Workflows in the AURIN project
  - Potentially large number of resources over a short period of time.
  - Several tasks that are sensitive to communication networks and resource failures (*tightly coupled*)
- User Requests
  - Type of virtual machine;
  - Number of virtual machines;
  - Estimated duration of the request;
  - Deadline for the request.

Failures in User Requests

- Resource failure is inevitable
  - Redundant components in public Clouds
    - highly reliable service
  - Leads to service failure in private Clouds

- Correlation in Failures → *overlapped failures*
  - Spatial
  - Temporal

Failures in User Requests (cont.)



- The sequence of overlapped failures

$$H = \{F_i \mid F_i = (E_1, ..., E_n), T_s(E_{i+1}) \leq T_e(E_i)\}$$

- Downtime of the service

$$D = \sum_{\forall F_i \in H} (max\{T_e(F_i)\} - min\{T_s(F_i)\})$$

Proposed Policies

- Size-based Strategy
  - Spatial correlation : multiple failures occur on different nodes within a short time interval
  - Strategy: sends wider requests to more reliable public Cloud systems
  - Mean number of VMs per request
    - P_1: probability of one VM
    - P_2: probability of power of two VMs

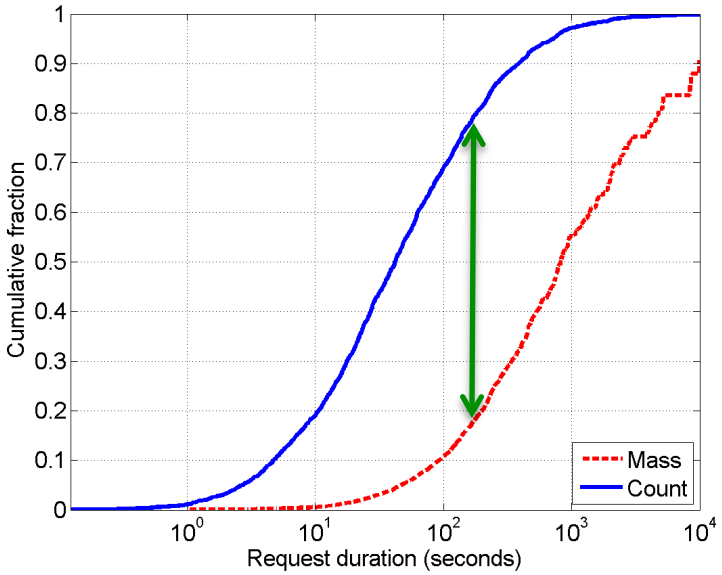
$$\overline{S} = P_1 + 2^{\lceil k \rceil}(P_2) + 2^k\,(1 - (P_1 + P_2))$$

    - Request size: two-stage uniform distribution (l,m,h,q)

$$k = \frac{ql + m + (1-q)h}{2}$$

PROPOSED POLICIES (CONT.)

- Time-based strategy
  - Temporal correlation: the failure rate is time-dependent and some periodic failure patterns can be observed in different time-scales
  - Request duration: are *long tailed*.



- The mean request duration
  - Lognormal distribution in a parallel production system

$$\overline{T} = e^{\mu + \frac{\sigma^2}{2}}$$

PROPOSED POLICIES (CONT.)

- Area-based strategy
  - Making a compromise between the size-based and time-based strategy
  - The mean area of the requests

$$\overline{A} = \overline{T} \cdot \overline{S}$$

  - This strategy sends long *and* wide requests to the public Cloud,
  - It would be more conservative than a *size-based* strategy and less conservative than a *time-based* strategy.

Scheduling Algorithms

- Scheduling the request across private and public Cloud resources
- Two well-know algorithms where requests are allowed to leap forward in the queue
  - Conservative backfilling
  - Selective backfilling

$$XFactor = \frac{W_i + T_i}{T_i}$$

- VM Checkpointing
  - VM stops working for the unavailability period
  - The request is started from where it left off when the node becomes available again

Performance Evaluation

- CloudSim Simulator
- Performance Metrics
  - Deadline violation rate
  - Slowdown

$$Slowdown = \frac{1}{M}\sum_{i=1}^{M}\frac{W_i + max(T_i, bound)}{max(T_i, bound)}$$

  - Cloud Cost on EC2

$$Cost_{pl} = (H_{pl} + M_{pl} \cdot H_u)\, C_n + (M_{pl} \cdot B_{in})\, C_x$$

  - Workload Model
    - Parallel jobs model of a multi-cluster system (i.e., DAS-2)

Input Parameters	Distribution/Value
Inter-arrival time	Weibull ($\alpha = 23.375, 0.2 \leq \beta \leq 0.3$)
No. of VMs	Loguniform ($l = 0.8, m, h = log_2 N_s, q = 0.9$)
Request duration	Lognormal ($2.5 \leq \mu \leq 3.5, \sigma = 1.7$)
P_1	0.02
P_2	0.78

Performance Evaluation (cont.)

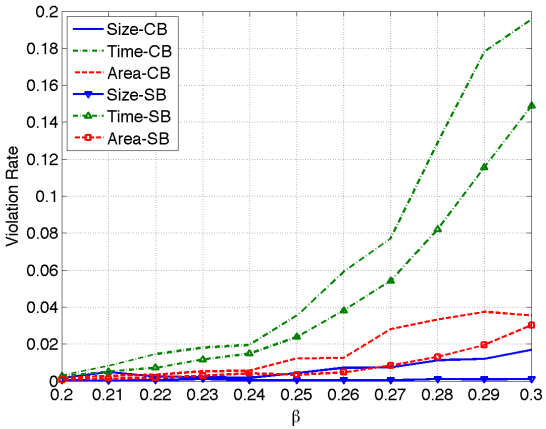
- Failures from Failure Trace Archive (FTA)
  - Grid'5000 traces
    - 18-month
    - 800 events/node
    - Average availability: 22.26 hours
    - Average unavailability: 10.22 hours
- Synthetic Deadline

$$d_i = \begin{cases} st_i + (f \cdot\ ta_i), & \text{if } [st_i + (f \cdot\ ta_i)] < ct_i \\ ct_i, & \text{otherwise} \end{cases}$$

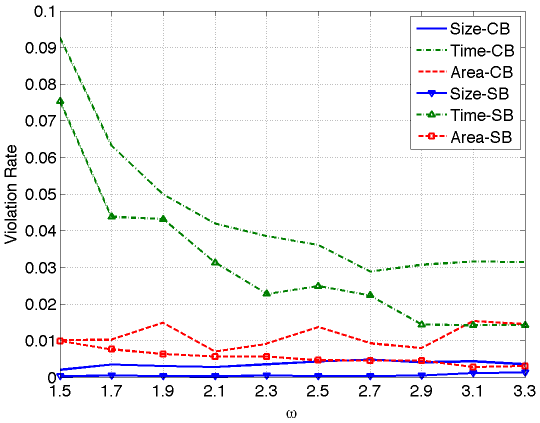
  - f: stringency factor
  - f>1 is normal deadline (e.g., f=1.3)
- $N_s = N_c = 64$

Simulation Results

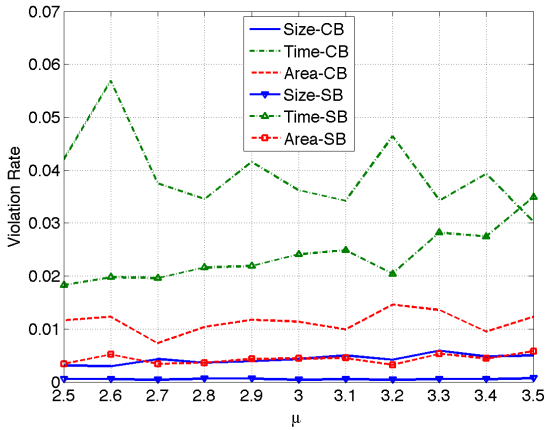
- Violation rate



Request arrival rate



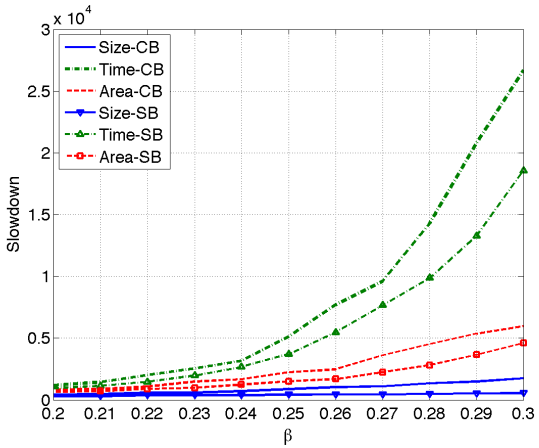
Request size



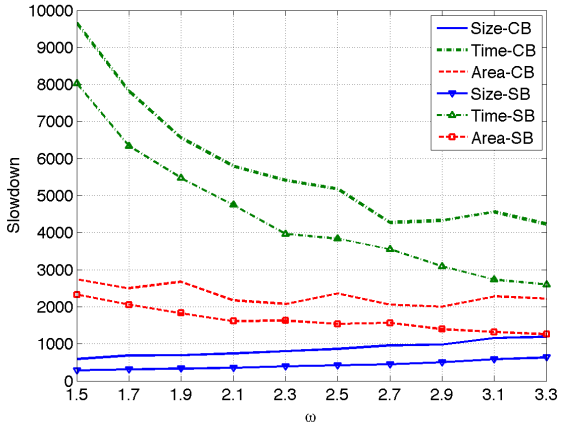
Request duration

Simulation Results (cont.)

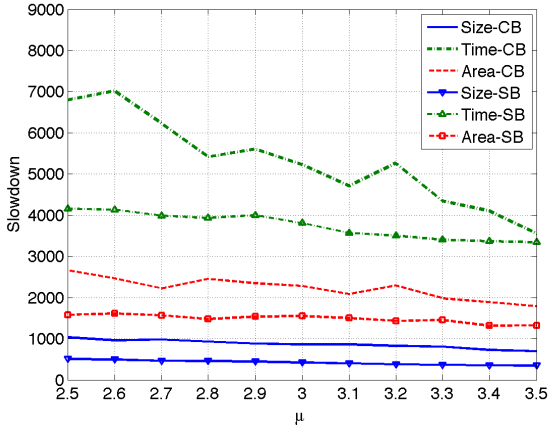
- Slowdown



Request arrival rate



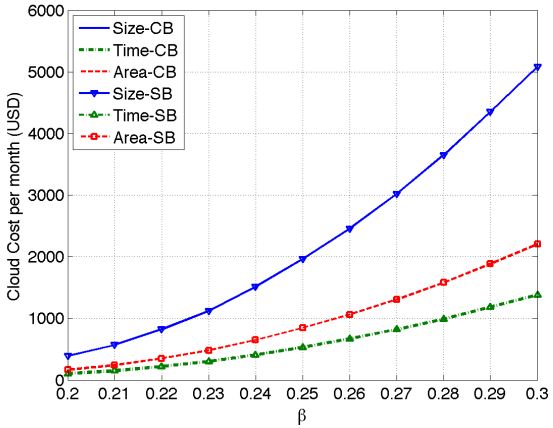
Request size



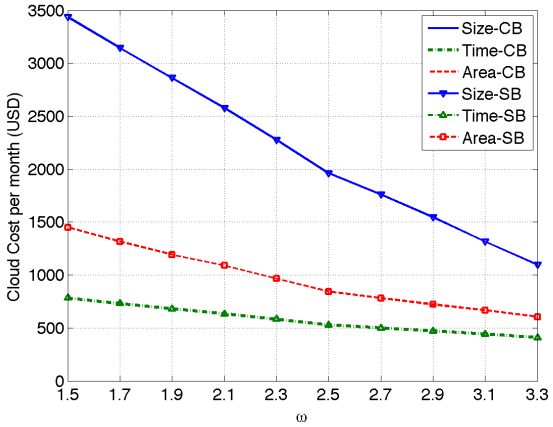
Request duration

Simulation Results (cont.)

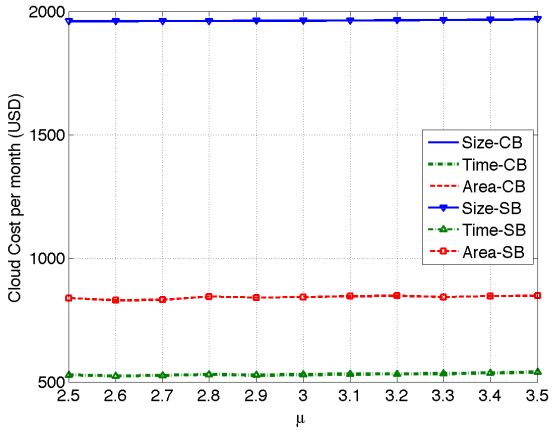
- Cloud Cost on EC2



Request arrival rate



Request size



Request duration

Conclusions

- QoS-based resource provisioning in a failure-prone hybrid Cloud system
- Three different *flexible* brokering strategies based on failure correlation and workload model
- Knowledge free approach
- Using time-based strategy (high load),
  - 20% violation rate
  - ~1200 USD per month on EC2
- Future Work
  - Use a set of real workflow applications from the AURIN project and run real experiments.

Thank You