Closer to the Cloud
- A Case for Emulating Cloud Dynamics by Controlling the Environment

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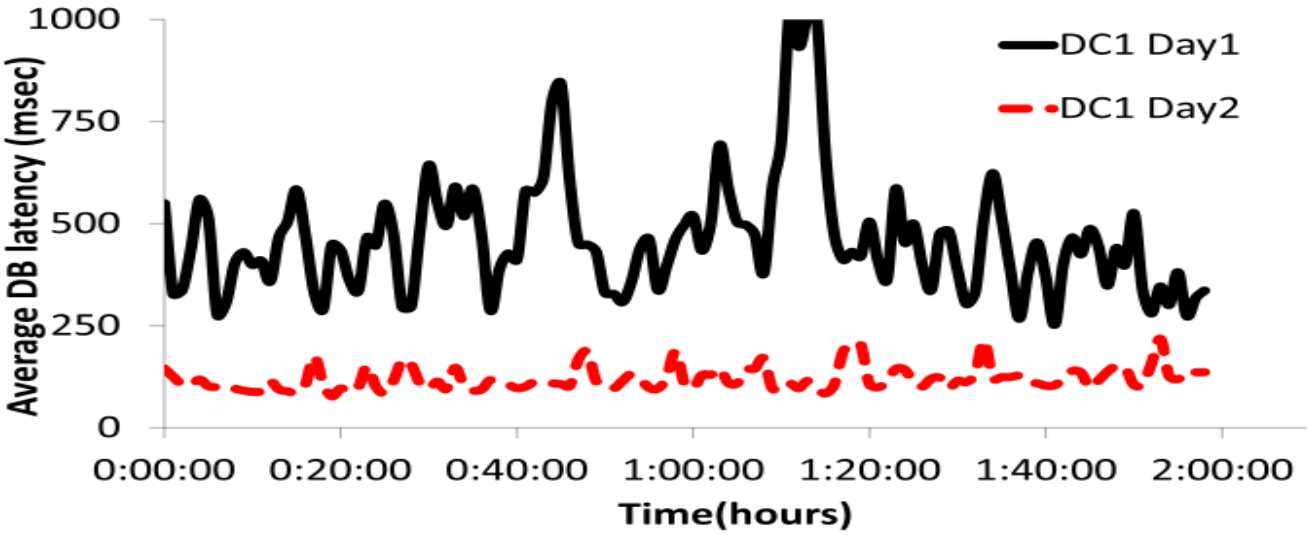
Latency-Sensitive Applications on the Cloud

- Complex
- Multi-tiered
- SOA
- Stringent SLA

- $$$ savings
- Geo-redundancy
- Elasticity
- Scalability

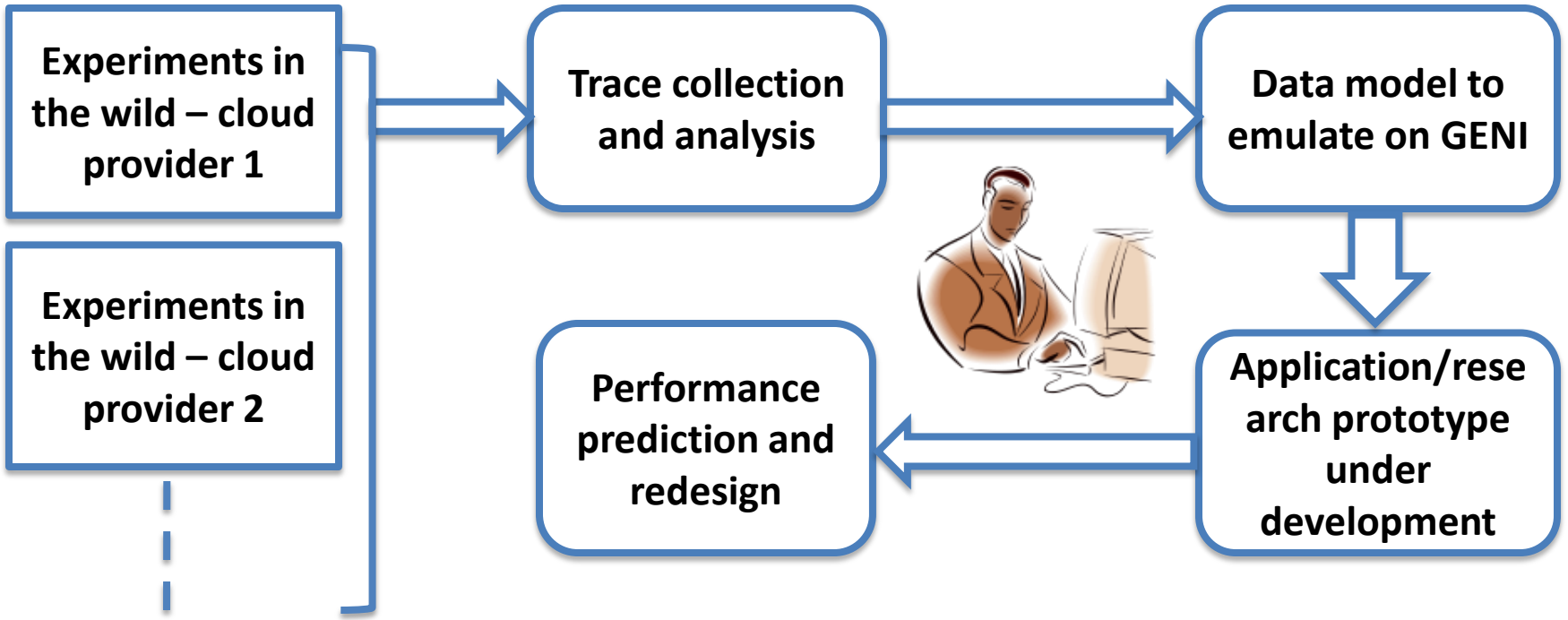
Test beds

Performance Fluctuations in Microsoft Azure



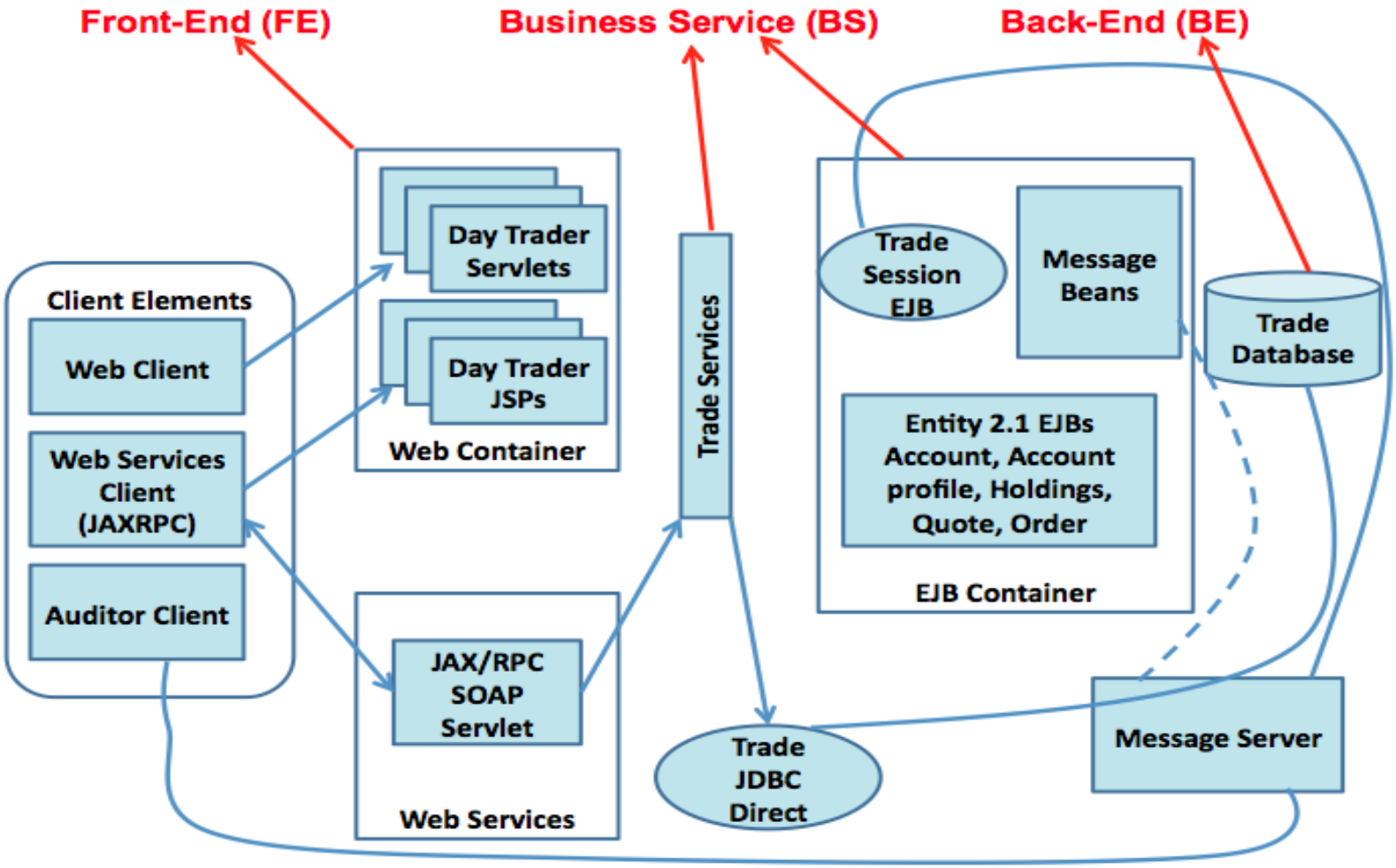
- Short-term and long-term variation in DB latency
- DB performs 100% worse on Day 1 than on Day 2
- Variation in RTT of TCP streams observed in Amazon EC2
- Our study confirms - hotcloud10 (CloudCmp), SoCC10 (YCSB)

Control over the Environment : A Technique

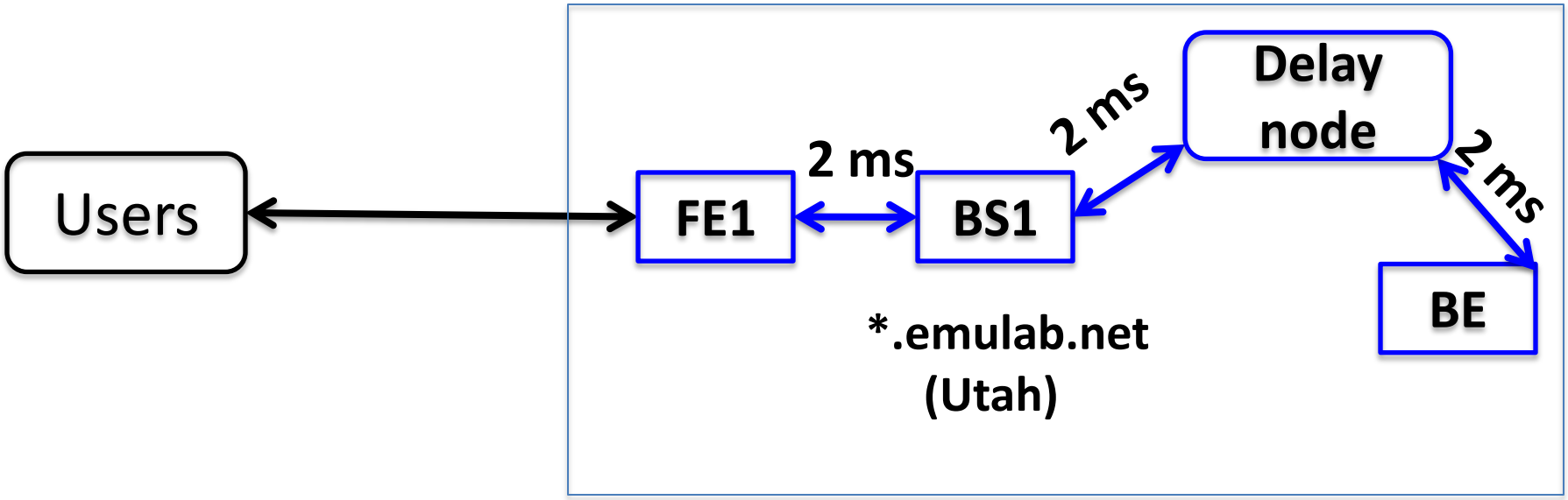


- Commercial clouds ?
  - No control over the environment and shared infrastructure
- Cloud test beds like Open Cirrus, Eucalyptus?
  - Can emulate cloud dynamics and federated, but no control over the environment

Sample Enterprise Application Day Trader

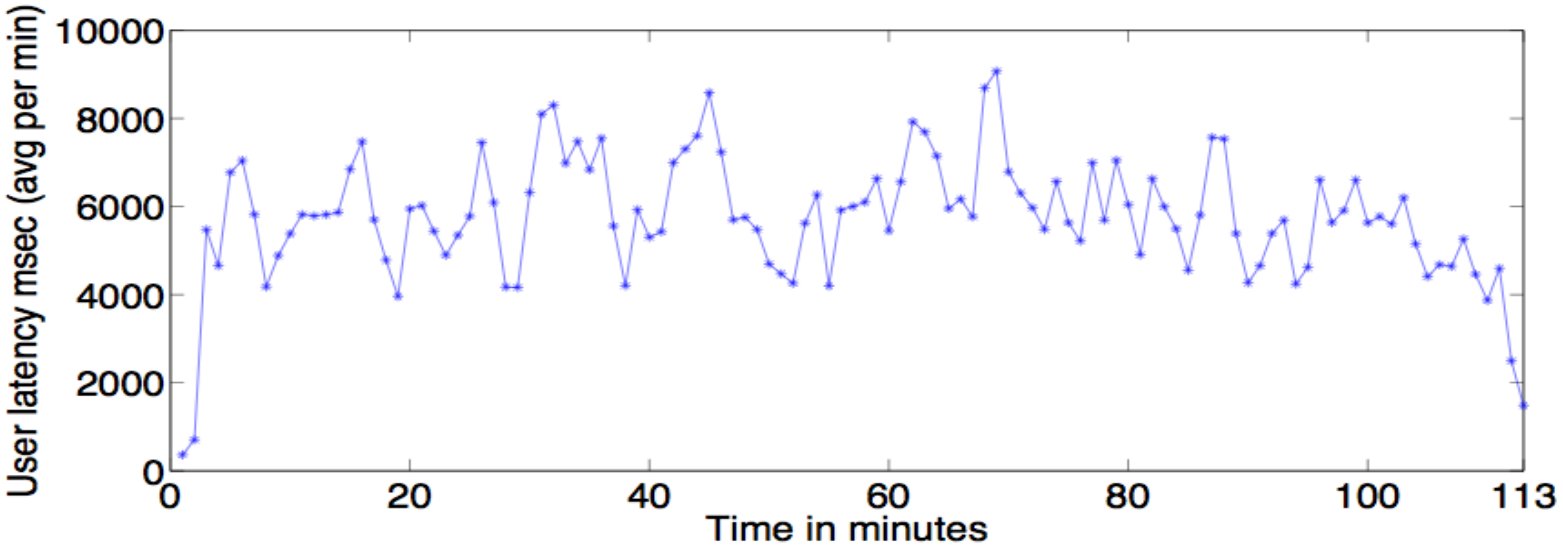


Single Data Center Deployment on GENI



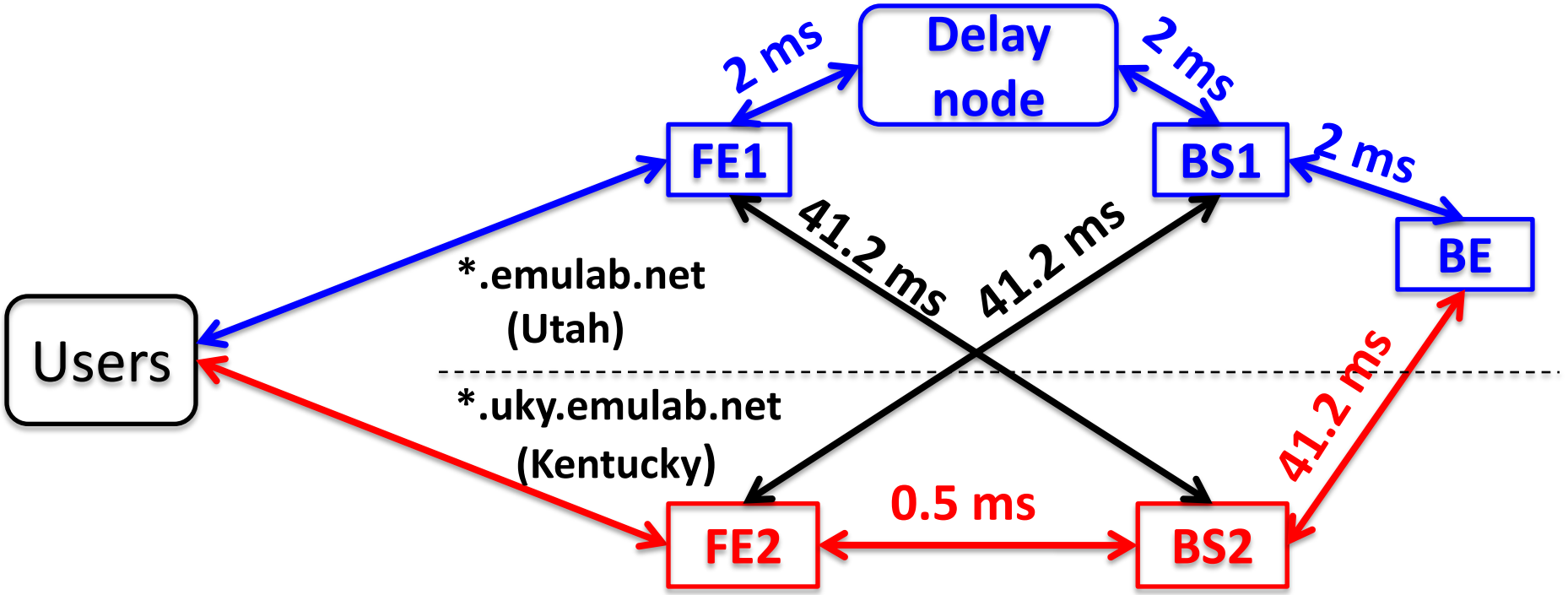
- Test bed
  - User workload generator (grinder) running in Purdue
  - Workload from DaCapo benchmark for Enterprise apps
  - Application instances running on nodes from Utah
  - Delay node between BS1 and BE

Predicting Performance of Applications by Replaying Trace



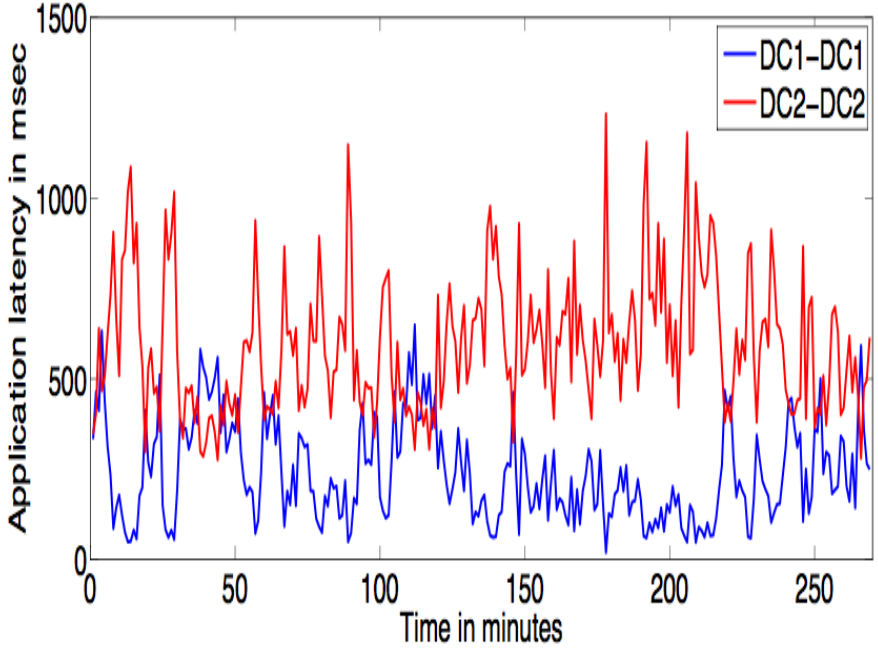
- DB latency trace from Azure (slide 3) replayed between BS and BE
- Total application response time for each user request plotted
- More or less follows network delay between BS and BE
- Also measured error percentage – always within 1 %

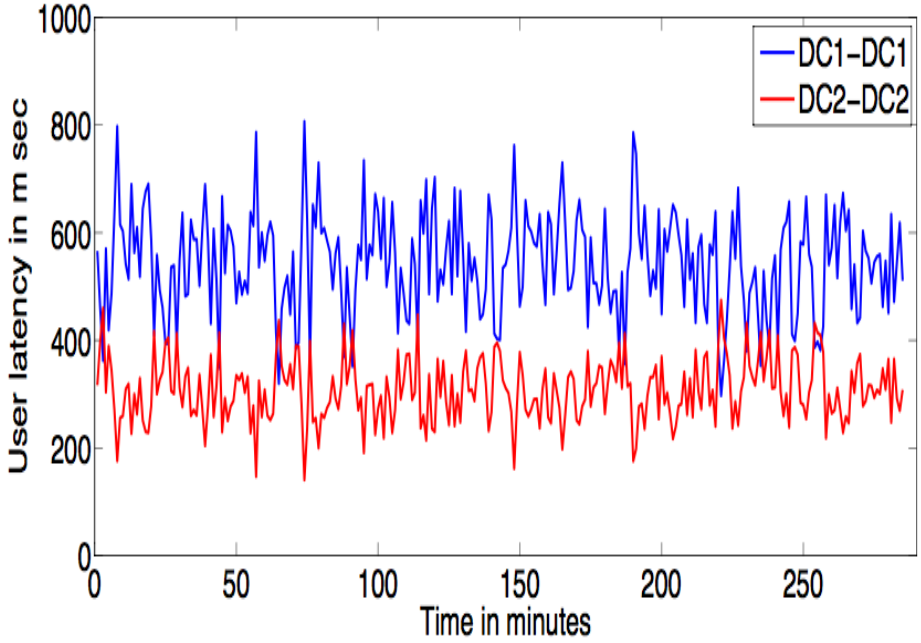
Multi Data Center Deployment on GENI



- Test bed
  - User workload generator in Purdue
  - Two instances of the application components
  - One deployment in Utah and another in Kentucky
  - Delay node between FE1 and BS1 in Utah

What –if Analyses on Application





- No delay : DC2 slower than DC1
- Delay 250 ms : DC1 slower than DC2

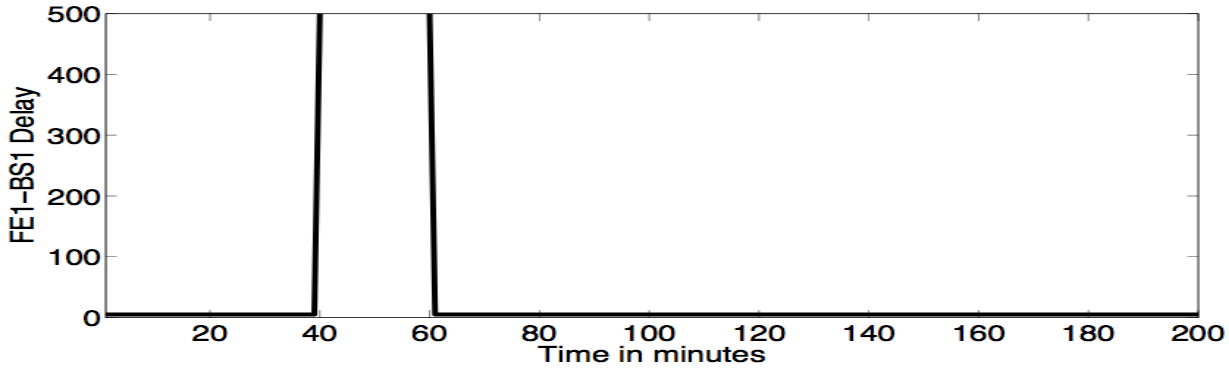
- DC1 – DC1 : FE1 – BS1 in Utah & DC2 – DC2 : FE2 – BS2 in Kentucky

An Adaptive System - Dealer

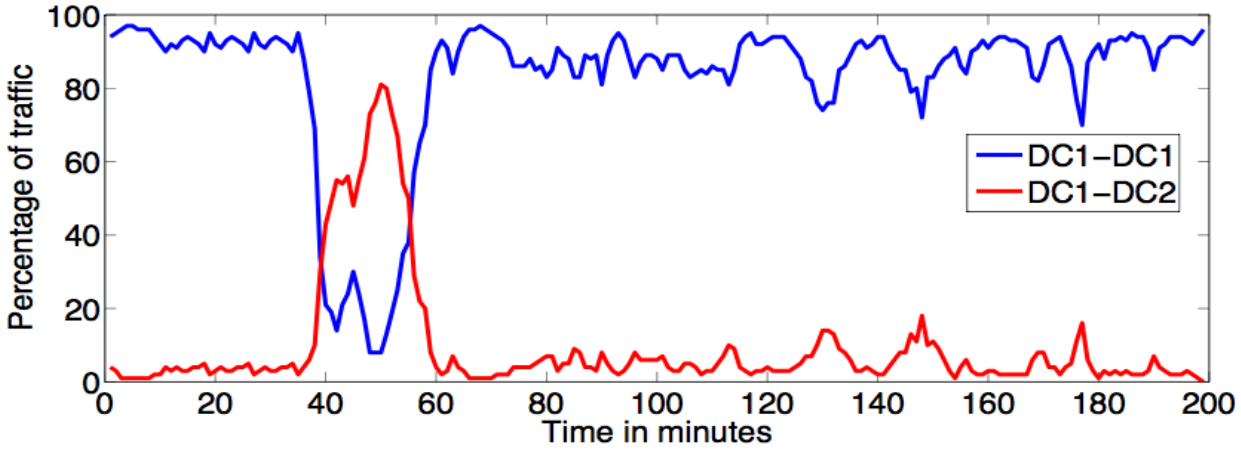
- Cloud environment is highly dynamic
  - Problem isolated to one component in a DC
- Current redirection mechanisms
  - Abandon entire deployment
- ***Dealer*** : Adapts to cloud dynamics
  - Components deployed on multiple DCs
  - Fine-grained component level redirection
  - Optimally suggests path based on latencies

Evaluation of the Adaptive System

- Control Input : Step



- Output : Dealer path change



- DC1 – DC1 : FE1 – BS1 & DC1 – DC2 : FE1 – BS2

Conclusions

- To open up new avenues in cloud research
  - Control over test bed environment – critical
- Can be used as a technique by developers and researchers for
  - emulating real cloud dynamics to
    - predict application performance
    - compare cloud providers
    - what-if analyses on application
    - develop solutions for performance problems

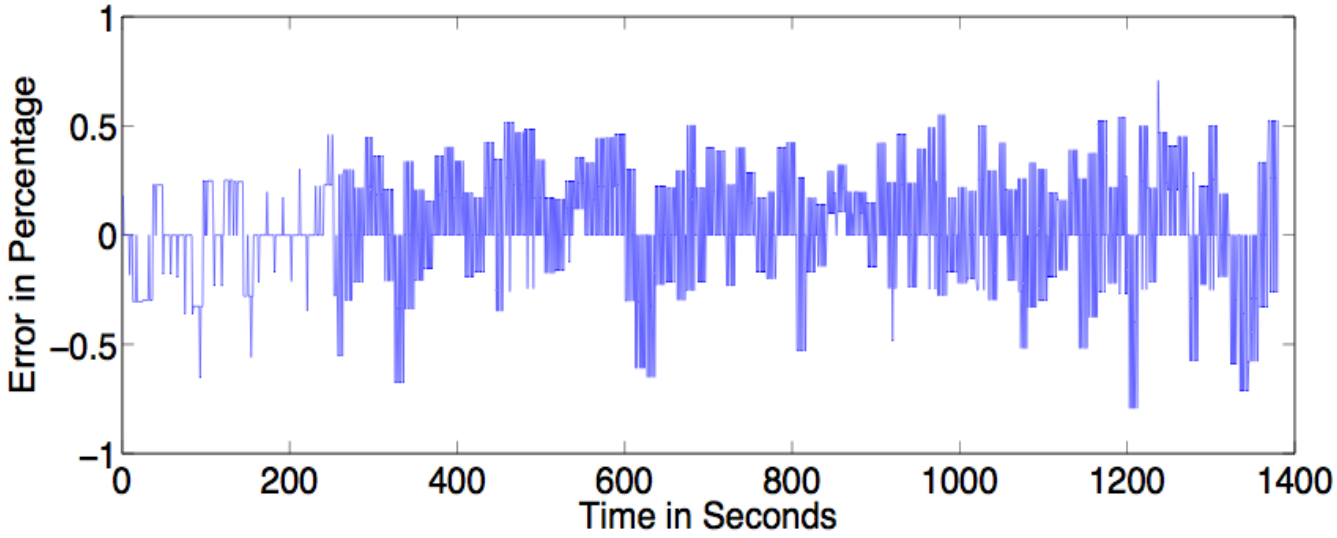
Q & A

Back up slides

Future Directions

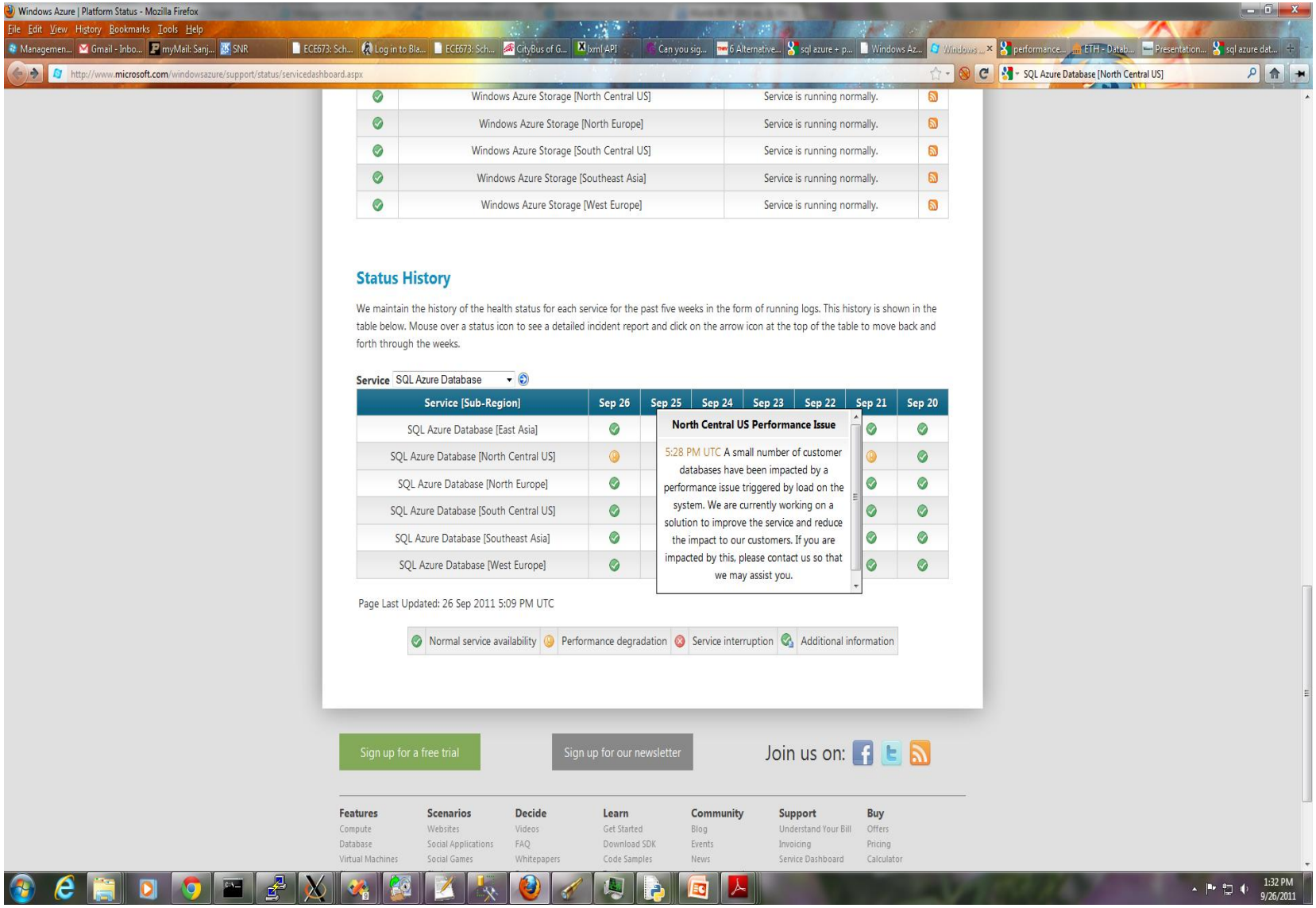
- Dynamically change the delay
  - Multi data-center deployment like Emulab
- Emulating cloud data stores
  - Blobs, Queues, Big-Table provided as service
- Installing and running Cassandra on GENI

Accuracy and Repeatability Requirements

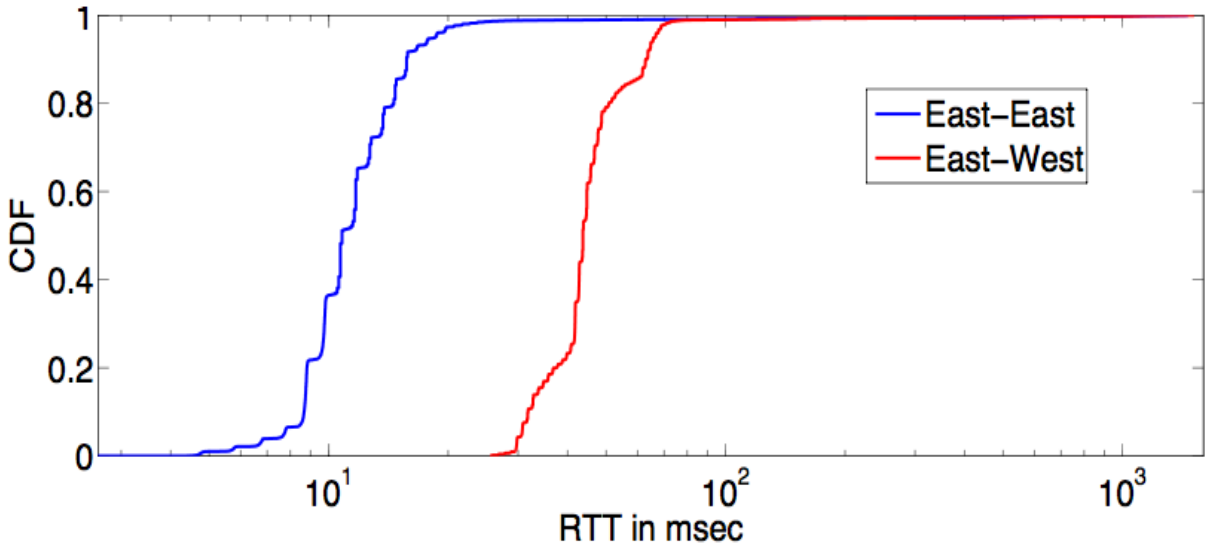


- Error percentage :
  - (observed latency – expected latency)/expected latency in %
  - observed – ping , expected – delay applied
  - always within +- 1% error bound
- Require such high degree of accuracy and repeatability

SQL Azure Performance Issue Snapshot (6 Days)

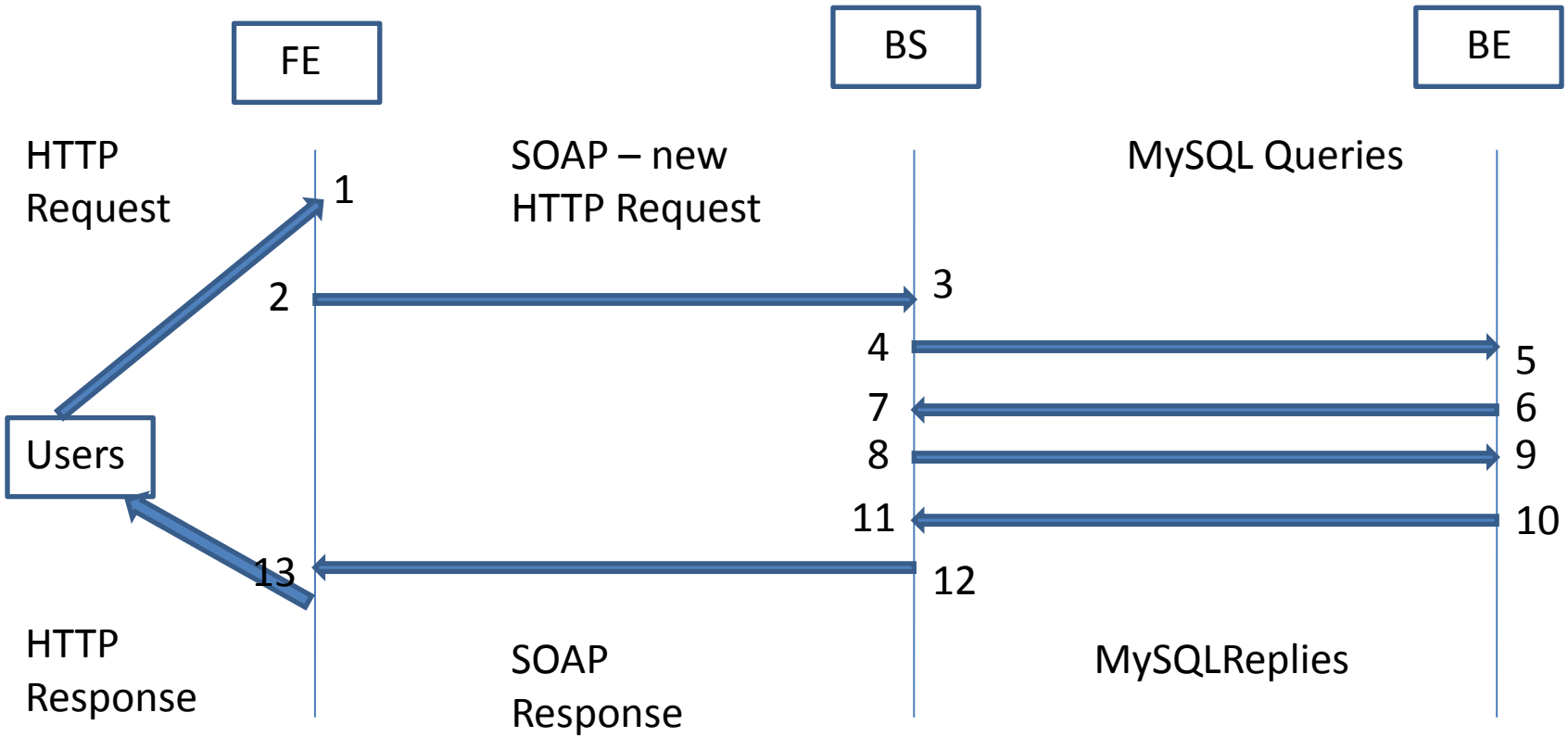


Performance Fluctuations in Amazon EC2



- Simple Experiment
  - RTT measured for a TCP stream
  - Both inter and intra DC show variation

Day Trader Communication Pattern



- Response time = component latency + communication latency
- Multiple calls between components for a given user request