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Two topics that best fit my research interests in cloud computing:

Fault Masking in the Cloud and Cloud Self-Monitoring and Autonomic Control

Current Research Activities:

Currently, we are studying some key issues related to fault-tolerance in cloud computing environment. Although many mature technologies from other domains can be used as components in cloud computing, but there are still many unresolved and open problems due to its unique characteristics which are different from distributed computing, cluster computing, grid computing, utility computing and service computing. One key issue is Fault Detection in cloud computing. Fault Detection is an essential building block for reliability, performance, load-balancing and scheduling where mobile users engage in computing using data-rich environments and multi-cloud solutions. Fault-tolerant network systems are designed to provide reliable and continuous services for wired and wireless distributed networks despite the failures of some of their components. Although there many FD algorithms available in other domains, they cannot be directly applied to cloud computing. As far as we know, most existing schemes cannot automatically adjust their parameters for dynamic or mobile conditions (including mobile users) which are common in cloud computing environments. We are developing FD schemes for cloud computing considering its unique characteristics and implement them on a cloud testbed. Performance evaluation will also be done to validate our schemes. Finally, we are developing practical Fault Detection systems in multi-cloud computing environment besides proposing theoretical models and schemes for FD in cloud computing, which we hope can also be used in other domains such as mobile computing and grid computing environments.

Future Important Research Problems I Plan to Pursue:

Think of a future: A user starts out in the morning with coffee at Starbuck's - his rich data stream drawn from his location, the surrounding stores, services and sensors, and he begins a compute processing that lasts all day long - wherever he moves. Indeed as he moves he may be changing the compute resources used. As he travels from Atlanta to Los Angeles the computing is continuously going on, being passed securely, reliably and efficiently from cloud to cloud. And the Clouds are data clouds, compute clouds and perhaps even user clouds. Of course, many mature technologies are used as components in cloud computing, but there are still many unresolved and open problems due to its unique characteristics which are different from distributed computing, cluster computing, grid computing, utility computing and service computing. The virtual tools for doing this may be software, firmware or hardware components. We seek to explore these building block components. Fault Detection is an essential building block for reliability, performance, load-balancing and scheduling where mobile users engage in computing using data-rich environments and multi-cloud solutions. Fault-tolerant network systems are designed to provide reliable and continuous services for wired and wireless distributed networks despite the failures of some of their components. As an essential building block for fault-tolerant network systems, Failure Detector (FD) plays a central role in the engineering of such dependable network systems. Fault-tolerant control schemes are designed to provide reliable and continuous services despite the failures of some resources. Effective failure detection is essential to ensure acceptable QoS for virtual network applications. For example, PlanetLab is a global cloud network that supports the development of new network services and currently consists of 1076 nodes at 494 sites. While many nodes at any time are inactive, and we may not know the exact status (active, slow, or dead), it makes services variable.

The design of dependable failure detectors (FDs) is a difficult task mainly because the statistical behavior of communication delays in cloud environments is indefinable, and asynchronous virtual computing systems make it hard to determine precisely if a remote process is failed or just very slow. To improve the QoS of FD, adaptive FDs have been proposed based on automatic control theory. In order to dynamically adapt a safety margin to unpredictable network, we would like to propose an optimization scheme over existing dynamic FDs. The implementations are expected to predict future delays and computing performance by sampling the behavior of messages sent over a connection and by averaging those samples into a “smoothed” delay estimate.

Our long term goal is to develop practical Fault Detection systems in multi-cloud computing environment. Middleware will also be developed and integrated into cloud computing systems. We believe that many technologies developed in other environments can be adapted and applied in cloud computing. We just need to introduce cloud computing to the researchers in other areas. Traditional automatic control theory and feedback information provide us an opportunity for self-tuning and automatic control in cloud computing environments. Besides fault detection schemes in cloud computing, other topics such as fault tolerance, security, scheduling, load balancing, and reliability are potential research topics to pursue.