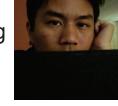


Below the Clouds A Berkeley IT Operator's View of Cloud Computing



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Cloud: (n) A Pay-As-You-Go computing service with no upfront cost to the user that provides on-demand scaling with the illusion of infinite resources. What does this mean? It is deceptively simple yet carries several implications

The Cloud User's View From Above the Clouds

Interface for computation •VMs: EC2 /AWS - flexible, generic

•Domain Specific: App Engine,

SalesForce, Cloudera

•In-Between: Azure

Provisioning and Management

•How to request and return resources •Virtualized Network Topologies •Resource Constraint Policy •Automated control?

Business Support

•Billing •Tech Support •Legal •What Else?

The Cloud Operator's View From Below the Clouds

Datacenter(s)

•Shelter, Physical Security, Power, AC •Network, Storage •O(10,000) Bare Metal Systems •MgmtM/onitoring (Ganglia, Nagios, etc) •Storage, Network, what else?

Datacenter(s): Solved Problem(s)?

•O(10-100K) systems = lots of engineering •Modular/Containerized DCs are not a panacea ·Still need a physical shelter •They encourage density but is it a good idea? •Tight physical constraints (HW and Operator) •Racks on Wheels? Try that with 500+kg •Network HW and Airflow requirements •A rack of 35 systems means: •2 network switches •3 "smart" power control strips. •9-10 dozen cables (power and network) •Lots of Velcro, "Creative" Cabling Topologies •24 doz. rack screws (and three drill batteries for them all) •Density × Service Accessibility = Constant ·Little rack level engineering, let alone at DC Level •Blade servers go partway •Cabinet sized box - the wrong direction? •Need holistic design from node through DC scale And that's just the Bare Metal Infrastructure

Virtualization •More generally, it's Resource Abstraction

•What sort? Xen/VMWare? Higher Level?

•Provisioning? VMware VI, Eucalyptus, EC2

System Installation

•Monitoring Systems

Storage

•Gotta have a "Storage Story," a good one.

•How to get Software Stack into the Cloud

•How to get data into and out of The Cloud

•S3, HDFS, MS Cosmos, Others?

Software Stack •Platform SW/OS •Cluster Infrastructure

MapReduce/Hadoop, Dryad End-user Applications

•Monitoring/Instrumentation Chukwa, X-trace, LogMining

•Usage Accounting

Pervasive Infrastructure

•Identity Management/AuthNZ

From Bare Metal System to Prêt-à-Utiliser **Potential New Trends** •Impact of many-core (10+) systems •Would like to think that this is 'solved' •CPU/RAM usage isolation exists •How to handle it for O(10-100K) systems •Network BW guarantees possible ·How to handle different install images •Memory/IO BW guarantees? •Change and configuration management (CCM) essential •Can memory/IO keep up? •Essential at the O(1000)scale already •Turn off cores to aid IO isolation? Integrate with base installation •Use some only for low IO BW work •Does it matter? Maybe only for VM •Nagios/Ganglia – do they scale past O(1000)? •Need for debugging tools •Need more than service check/system metrics Some tools exist •X-trace - instrumenting software •Virtualization confounds debugging •Chukwa / LogMining - post event data collection/analysis •How to deal with non-determinism? Automated response – speed matters Tackle with statistics/ML •Need more unified interface to these systems •Expose lower layers to higher •Separate systems - hard to keep a global view •VM network topology still simple •Over lap in data collection •Is this a bad thing? •Multiple ways to view data, but one framework •Will they (over)grow in complexity? ·Operators need toolkits, not monolithic 'solutions' •Exposing limits of "real" network

Clouds change with the weather

Security: Not just keeping10k systems secure

Beyond the VMM

•VMMs are shrinking tip of the iceberg Is it just Multi-Tenancy? •Middleware, Mgmt, CCM SW? •Entropy doesn't virtualize

Approaches

•Treat like Internet "just a transport"? •Crypto is part of but not the answer •Be like Mulder – Trust no one?

Forensics

•Bad things still happen •What audit trail exists? •End-user access? Cloud provider support?

"Private" Clouds?

•More Business Continuity Control Still have to keep up internal walls •How to verify work done on the cloud? •What happens when you "Surge"? •Still need to self-audit

Does this really change IT operations?

Reality

 Internal /Private Cloud Service •Shed load to Public Cloud Concerns Inter-cloud compatibility? •Cross-domain auth? Data Integrity/Security Reactions •Oh No! Lack of data control!

Example: Surge Computing

The Dial Tone has become a lot more complex

•Have to take all these measures! data go off the reservation.

Those measures we might take to deal with any perceived dangers of putting non-trivial data into the loud are ones we should be taking anyway even 'on the reservation'.

Where one might get 'lazy' when everything is kept local, one has to clean up one's act when one lets

Major players (Google, Microsoft, Amazon, others) have figured out (some, a lot, most?) of this but in ways specific to their needs, and they haven't shown all (or even all that many) of their 'latest and greatest', In many ways, the "answers" themselves are not so important as the questions and challenges faced and why they chose to deal with them as they did – a handbook There may not be a lot of new technology – putting it all together is the challenge.