Elastic NoSQL databases over the Cloud

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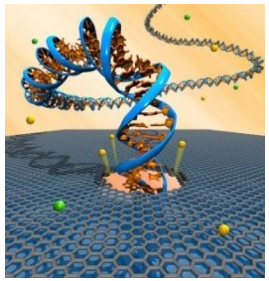
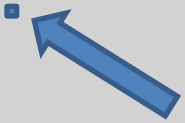
Big Data

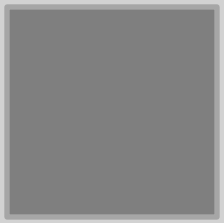
- '*Moore's*' Law: Data doubles every 18 months
- 90% of today's data was created in the last 2 years
  - Facebook: 20TB/day compressed
  - CERN/LHC: 40TB/day (15PB/year)
  - NYSE: 1TB/day
- Many more
  - Web logs, financial transactions, medical records, etc



Data Growth



1 EB (Exabyte-10^{18}) = 1000 PB (Petabyte-10^{15})
Last year (2010) US mobile data traffic



0.8 ZB (Zettabyte) = 800 EB
Entire global mass of digital data in 2009
according to IDC

35 ZB (Zettabyte-10^{21})
IDC's forecast for all digital data in 2020

Cloud Computing

- Resource provisioning “as a service”
  - CPUs, Disks, networks, developing platforms, applications, etc
  - Virtualized resources from distant data centers
- Charging model
  - “Pay as you go” model
  - OPEX instead of CAPEX
- Management model
  - Elasticity
  - Easy resource manipulation according to application needs
- Enterprise driven
  - Amazon, Google, IBM, Microsoft, etc

Motivation – the story(1)

- ‘Big-data’ processing era
  - (Web) analytics, science, social, business
  - Store + analyze everything
- Distributed, high-performance processing
  - From P2P to Grid computing
  - And now to the clouds…

- Traditional databases not up to the task
  - NoSQL databases

Motivation – the story (2)

- NoSQL
  - Non-relational
  - Horizontal scalable
  - Distributed
  - Open source
  - And often:
    - schema-free, easily replicated, simple API, eventually consistent /(not ACID), big-data-friendly, etc
  - Many, many, implementations…
    - Google's BigTable, Facebook's Cassandra, LinkedIn's Voldermort, MongoDB,
  - 120+ implementations, http://nosql-database.org/

NoSQLs + elasticity

- Column family
  - **Hbase, Cassandra**, …
- Document store
  - CouchDB, mongoDB, …
- Key-Value store
  - **Riak**, Dynamo, Voldemort, …
- Many offer **elasticity+sharding:**
  - Expand/contract resources according to demand
  - Pay-as-you-go, robustness, performance
  - Shared-nothing architecture allows that
  - Important! See recent foursquare and netflix outage
- Isn't that what PaaS offers?

thus…(end of the story)

- PaaS and NoSQLs are (or should be) inherently elastic
- How efficiently do they implement elasticity?
  - NoSQLs over an IaaS platform
    - (EC2, **Eucalyptus**, OpenStack)
  - No study that registers qualitative + quantitative results
- Related
  - Report NoSQL performance (not elasticity)
  - Cloud platform elasticity (no NoSQL)
  - Domain-specific

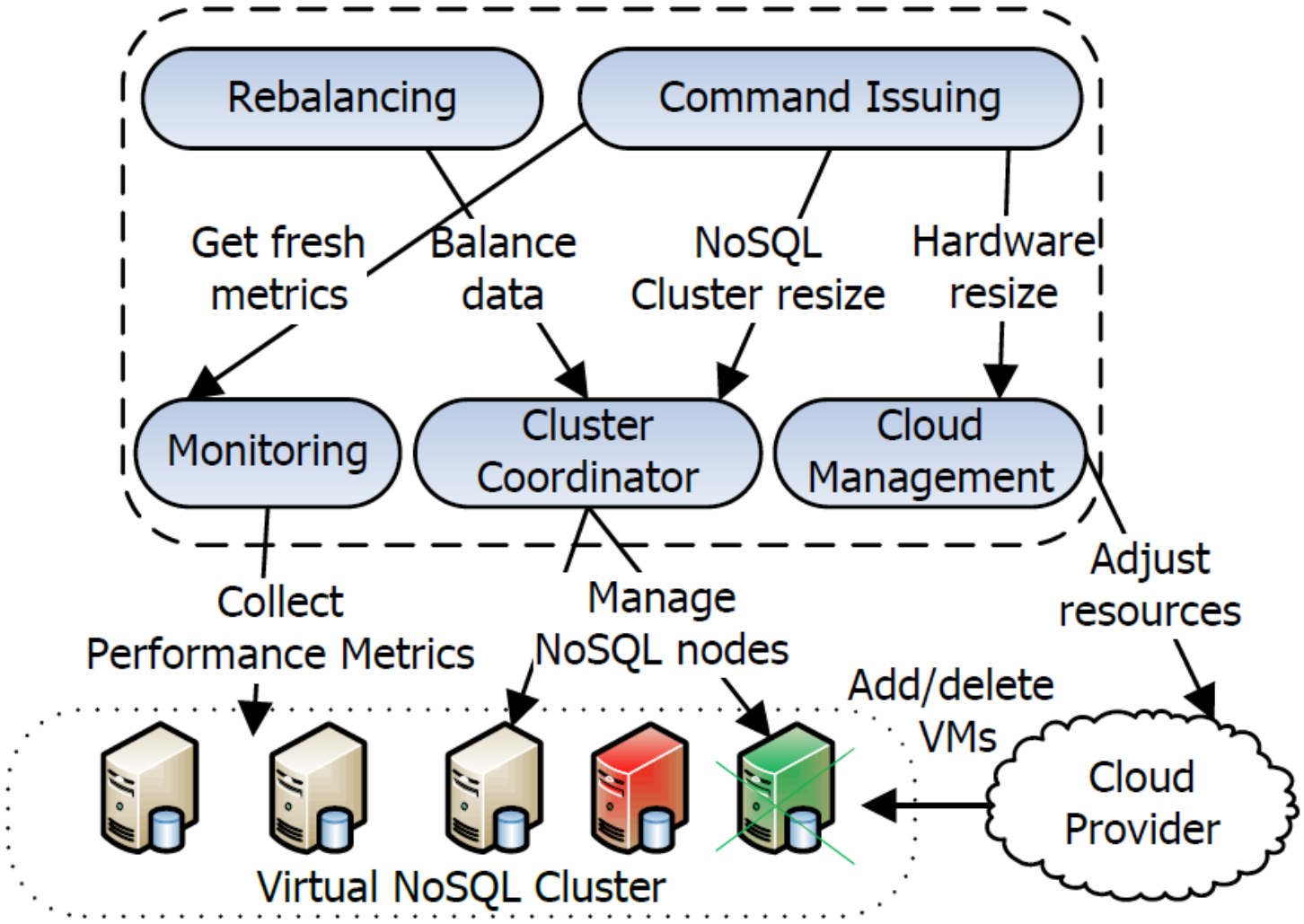
Contribution (1)

- VM-based framework for NoSQL cluster monitoring
- For a cluster resize, identify and measure
  - Cost, gains
  - In terms of:
    - Time, effort, increase in throughput, latency, …?
- Ultimate goal: Provide a generic platform
  - **any** NoSQL engine
  - User-defined policies
  - Automatic resource provisioning
- Example towards this goal
  - Tiramola

Contribution (2)

- Coding + infrastructure
  - 2K lines open source python code (GFOSS + google code)
  - **http://tiramola.googlecode.com**
- Using cloud-based client tools, platform-agnostic
  - EucaTools guarantee execution in numerous cloud platforms
- Cassandra, Hbase and Riak implementation
  - almost Voldemort
- How-to, best practices, glitches, erroneous assumptions, …

Framework architecture



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Architectural considerations

- Robustness
  - Daemon process that checkpoints and can be restarted
  - State is provided from the IaaS Cloud and the Monitoring module.
  - Applicable timeouts (not realtime systems!)
- Modularity
  - Different interchangeable components
  - APIs that utilize primitives (NoSQL and Policies)
- Expandability
- Speed
- Written in Python

Platform Setup

- 16 physical nodes
  - 2xQuadCore E5520 Intel Xeon® Hyperthreading (@2.27Ghz)
  - 48GB RAM, 2 SAS – RAID 1
- Virtual Machines
  - Similar to an Amazon EC2 large instance
  - 4-core processor, 8GB RAM, 50GB disk space
  - QCOW image: 1.6GB compressed, 4.3GB uncompressed
    - Available for download from googlecode
  - VM root fs instead of EBS (Netflix outage)
- Cluster
  - Eucalyptus 2.0.0 with dedicated Cloud/cluster controller

Experiments overview

- Indentify which DB metrics are affected under various loads
  - Consider both server-side and client-side metrics
- Identify costs + gain for a cluster resize
  - Cost of adding/removing nodes
  - Gains of increasing cluster size (how many nodes?)
- Check automated cluster resize
  - Using Hbase

Cluster Resize Time considerations

- VM initialization
  - 3min for addition, negligible for removal (few secs)
- Node configuration
  - Config files and propagation (at most 30 sec cycle)
- Region rebalance
  - Actively participate in the NoSQL cluster
  - Cassandra more efficient, Hbase depends on data, #nodes,…
- Data rebalance
  - Optional
  - Hbase: data / cluster-size dependent (+2h)
  - Cassandra: individual `loadbalance` signals

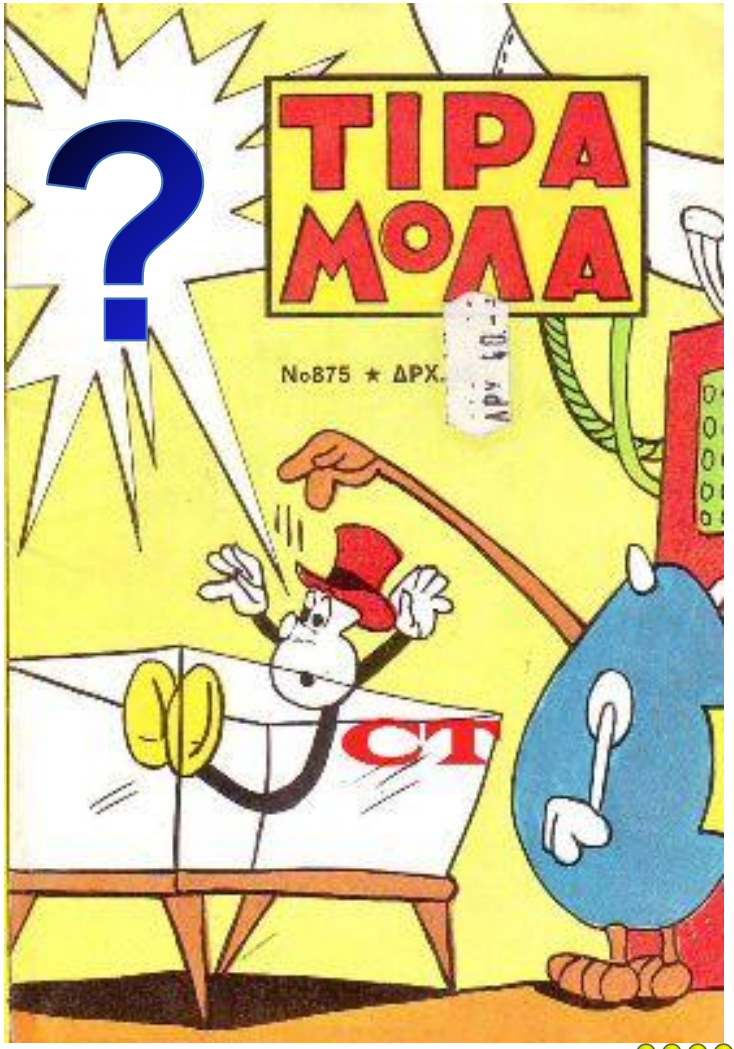
Conclusions – best practices (1)

- Choose the right DB for your application/workload (when in doubt, go with the one you're familiar with)
- HBase is a better all-rounder; Cassandra is handicapped by slow read performance and absence of shared FS.

Conclusions – best practices (2)

- **TIRAMOLA** is robust and in principle can be expanded for any kind of NoSQL DB or application by writing ~100 lines in Python.
- Building PaaS over IaaS is critical for the Cloud – most users won't have the knowledge, inclination, time or money to do it themselves, but need PaaS tools (in our example, elastic NoSQL databases).

Questions



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