

The Rafik B. Hariri Institute for Computing at Boston University

The Massachusetts Open Cloud




Azer Bestavros
Founding Director



Spring 2014

The Hariri Institute at BU

A world-class center for discovery and innovation in computing and computational science & engineering




Home of leading scholars who advance and leverage the computational perspective for a better world

Spring 2014 The Hariri Institute: Overview of The Massachusetts Open Cloud (Azer Bestavros)

Institute = Computational Crossroads

150+ Faculty and 300+ Grad Students



Methodologies

- Computing Models & Algorithms
- Networking Software Systems
- Data Management & Mining

Application Domains

- Biological & Medical Sciences
- Engineering & Physical Sciences
- Social & Management Sciences
- Art, Communication, and Education

BU Center for Reliable Information Systems & Cyber Security BOSTON UNIVERSITY CENTER FOR COMPUTATIONAL SCIENCE BU Boston University Hariri Institute Cloud Computing Initiative Digital Learning Initiative

A collaboration network of methodology (lab) scientists, application domain (cluster) experts, and federated research centers

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Big Data: Challenges

“Big Data – Cloud – Security = Big Joke”

Data volume & velocity: Need cloud capacity

- Real-time streaming and on-demand elastic computing/networking

Data variety: Need a cloud services smorgasbord

- Open marketplace conducive to innovation & sharing

Data veracity: Need security & privacy services

- Integrity of infrastructure, data, and analytics

Fantastic basic and applied research challenges

- Massachusetts Open Cloud
- Modular Approach to Cloud Security

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Open Public Clouds: The Need

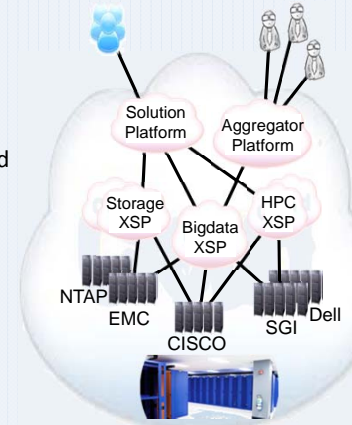
- Public clouds are “closed” and prescriptive:
 - Perform poorly on HPC and CPS applications
 - Stock hardware (e.g., hard to justify GPUs)
 - Special computational models (MapReduce, or?)
 - Irrational economic models (why fixed pricing?)
 - Operational data is not visible (limits innovation)
 - Security by obscurity
- The “Open Cloud” concept is a paradigm shift that aims to change this status quo...

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Open Cloud eXchange: The Concept

- Open economic model to create efficient marketplace
- HW/SW heterogeneity is a feature, not a bug!
- Multiple implementation and operational models
- Domain-specific aggregators suited to HPC and big data
- Modular security as services available at multiple layers
- Operational data visible to stakeholders



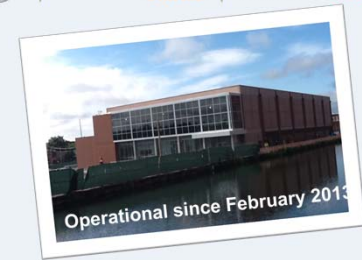
Open Cloud eXchange: The Concept

A timeline of milestones for the Open Cloud eXchange (OCX) project. The timeline is represented by a series of overlapping document-like shapes, each containing a year and a description of an event. The years shown are 2009, 2010, 2011, 2012, and 2013. The milestones include:

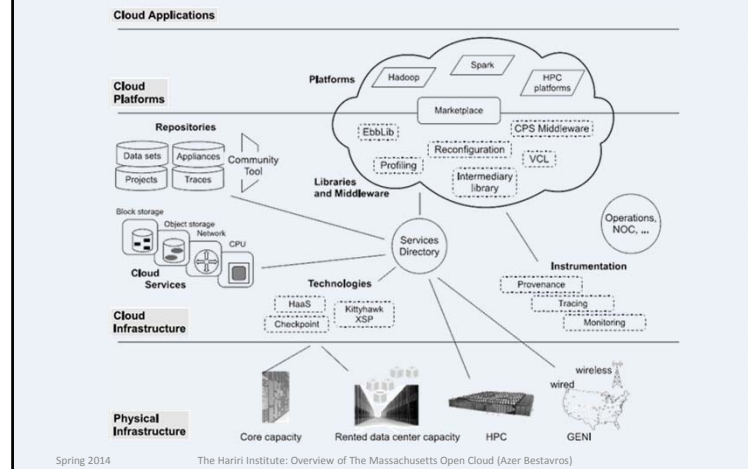
- 2009:** National Science Foundation WHERE DISCOVERIES BEGIN.
- 2010:** Award Abstract #9912145: EAGER: Towards a Marketplace for Colocation of Cloud Services.
- 2010:** Colocation as a Service: Strategic and Operational Services for Cloud Colocation.
- 2011:** Award Abstract #1012798: TCI Large Collaborative Research: Towards the Cloud.
- 2011:** Enabling a Marketplace of Clouds: VMware's vCloud Director.
- 2012:** Award Abstract #1229059: MRI Consortium: Acquisition of a Heterogeneous Instrument to Enable Science and Computer Green High Performance Computing Consortium.
- 2012:** CloudPack: Exploiting Workload Flexibility Through Rational Pricing.
- 2013:** Toward an Open Cloud Marketplace: Vision and First Steps.

Open Cloud Exchange: Catalyst

- Unique academic-industry-government partnership
- 15-MW datacenter on 8.6 acres with room for growth
- Host of shared experimental sandbox for CISE research
- Incubator/sponsor of 3 projects that informed OCX vision
- Home of NSF MRI for cloud research and for HPC in the cloud
- Serving diverse big-data & HPC user communities in life, material, geo, ... sciences
- Platform to explore new model of multi-institutional IS&T operation
- Buy-in and capacity of five major research computing organizations



Open Cloud Exchange: Architecture



The Massachusetts Open Cloud Funded by \$16M (industry) + \$3M (state)



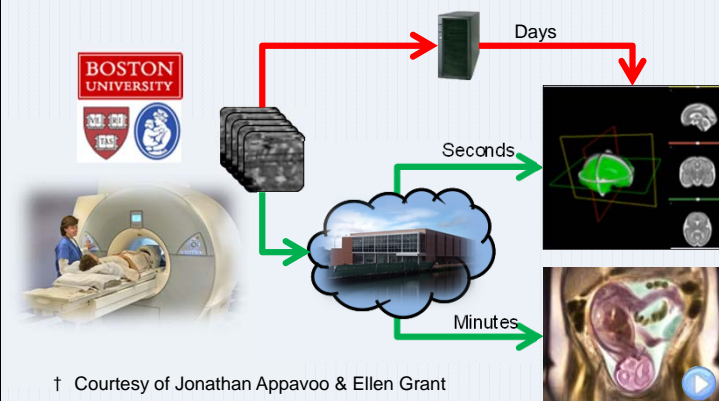
The Massachusetts Open Cloud

An open Public Cloud Exchange (OCX) leveraging 10MW of MGHPCC capacity

- Spearheaded by BU's Cloud Computing Initiative (Orran Krieger)
- Involving collaborators at Harvard, MIT, NEU & Umass + others
- Rich regional ecosystem in specialized domains: (bigdata, biotech, ...)
- Serves as a repository for regional data/big-data applications
- Vendor buy-in: \$16M from Red Hat, EMC, Cisco, SGI, Intel, Dell, ...
- Strong state support and backing: \$3M match funding pending
- Research computing buy-in: \$4.5M MLSC life sciences cloud
- Research catalyst: \$10M NSF SaTC Frontier for composable security
- Public sector catalyst: \$1M smart-city services with city of Boston

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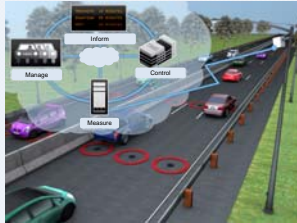
Interactive Supercomputing Real-Time 3D Reconstruction of Fetal MRI



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Cloud Platform for the Smart City

Capitalizing on pervasive real-time sensing



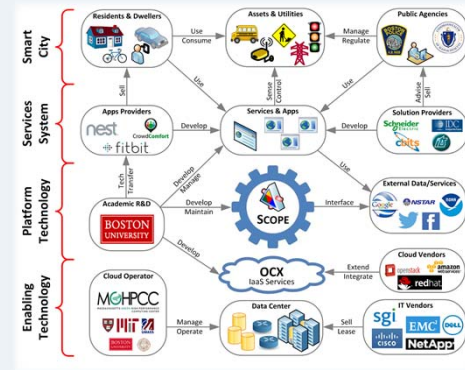
Metropolis-wide traffic control systems that minimize pollution, reduce fuel consumption, and relieve congestion

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Cloud Platform for the Smart City

Capitalizing on pervasive real-time sensing

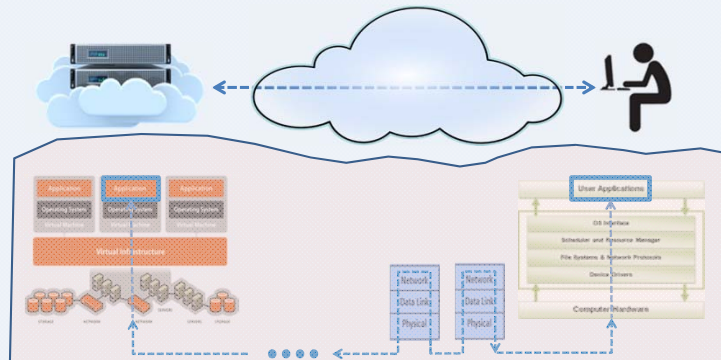


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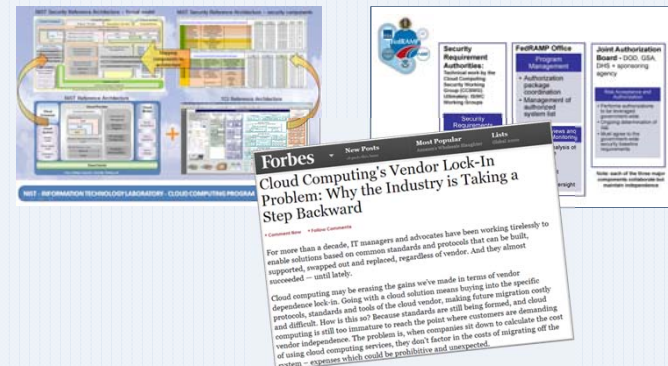
Cloud Platform for Modular Security

Security as a (multi-layer) Service



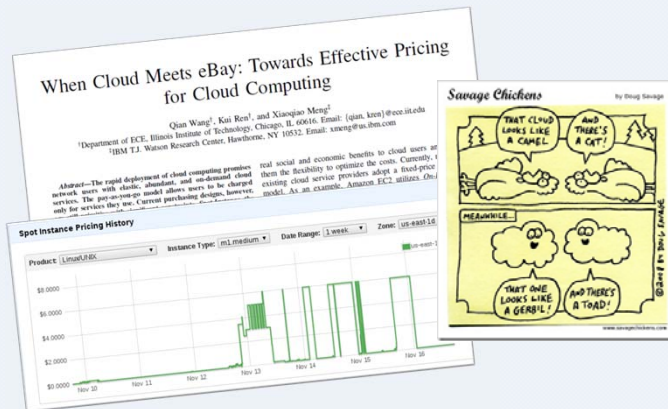
Why an OCX Testbed?

Too early for Standards and Ossification



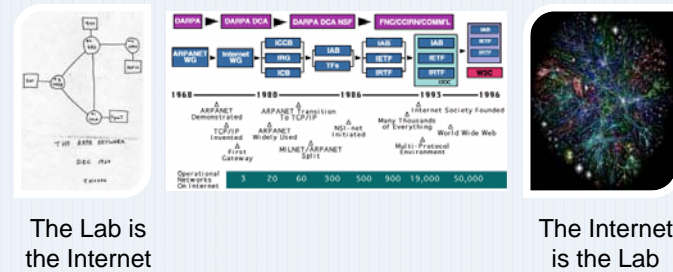
Why an OCX Testbed?

Need to Expose and Resolve Tussles



Don't just build a cloud testbed... Build a Cloud Marketplace

*If you build it (the right way);
they will come (and sustain it)*



More Info at <http://www.bu.edu/hic>

Boston University Rafik B. Hariri Institute for Computing and Mathematical Science & Engineering

leveraging the computational perspective

Institute News

MOC and Cloud Testbeds or Cloud Landscapes?
[MOC Ranked at Open Stack Summit](#)
[Lavin elected to the American Academy of Arts & Sciences](#)
[The Chandra River Workshop on Privacy Analysis of Social Networks](#)
[Northwestern University on MOC & Big Data](#)
[HPC, Time, Open Cloud Test-Bed Business Big Data Implications](#)
[Daily Line Privacy, BCU awarded \\$2M to build Mass. Open Cloud](#)

The Rafik B. Hariri Institute for Computing and Computational Science & Engineering includes catalyzes, and promotes collaborative, interdisciplinary research and training initiatives for a better society by promoting (a) discovery and innovations through the use of computational and data-driven approaches, and (b) advances in the science of computing inspired by challenges in arts and sciences, engineering, and management disciplines.

Massachusetts Open Cloud

Privacy Year

Get Involved