



A Smart City needs an Open Cloud

Enabling Smart and Connected Urban Living through an Open Big-Data Cloud Platform

Azer Bestavros


Founding Director, Hariri Institute for Computing
Professor, Computer Science Department
Boston University




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Enabling a Smart City

Goals & Metrics



- Use a specific set of analytical tools to improve the lead time for predictions of certain critical regional indicators by a given percentage.
- Given a specific set of high value data sets that were previously siloed and, therefore, usable only within a single research group or institution, make them available to a broader set of groups, or to the public at large, along with appropriate privacy and access control mechanisms.
- Adapt specified Big Data technologies to automate previously tedious and manual data collection and curation processes for specific types of data in a given field of science.
- For a specific genre of data, introduce new types of (automated) analytics—which were previously tedious to perform and manual in nature—that can be performed with minimal human intervention.

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What makes a city/community smart?



Smart

- Quick to learn, act, and react
- Showing good judgment

Attributes

- Operates at multiple time scales to “learn” and to “react”
- Context aware by collecting any and all relevant data
- Adaptive to apply “good judgment” in new contexts
- Programmable (as opposed to optimized or special-purpose)

A Smart City is a Software-Defined City

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Towards a Software-Defined City



What constitutes the **data plane**?

- Sources (e.g., sensors) vs sinks (e.g., data stores, actuators)
- Individual (e.g., mobile) vs infrastructural (e.g., roads)
- Private (or proprietary) vs public
- Communication links and networks
- ...

Need to not only manage “big data” volume/velocity/veracity challenges, but most importantly **expose the variety of data**

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Towards a Software-Defined City



What about the (programmable) **control plane**?

- Real-time/interactive vs batch “in the cloud”
- Local/mobile “at the edge” vs remote “at the backend”
- Special purpose vs general purpose
- Proprietary vs standard APIs and protocols
- ...

Need **scalable computational platforms** that extend from the backend to the edge

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Economics of Urban Data Mechanics



Cloud computing value proposition

- Use virtualization to commoditize the control plane
- Leverage economies of scale for elasticity
- Move computation to where the (big) data is
- Scale and improve management, security, and administration

Can't we just use existing compute clouds as smart-city clouds?

Not quite!

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Smart-City Clouds: The Need




Today's cloud offerings: Closed & Prescriptive


- Not set up for sharing open data assets from multiple sources
- Perform poorly on “boutique” (special-purpose) CPS/DoT applications
- Stock hardware; does not leverage, embrace, or expose heterogeneity/choice
- One-size-fits all computational models, e.g., MapReduce, Hadoop, ...
- Opaque economic models that benefit provider, e.g., off-cloud traffic pricing
- Invisible operational data & immutable software underlays; limits innovation
- Uniform “security by obscurity”


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The Open Cloud Alternative



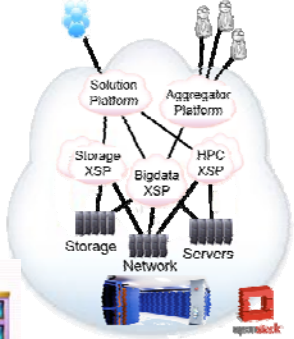



2010 Cloud@Scale
Enabling a Marketplace of Clouds: VMware vCloud Director

2011 Cloud@Scale
Exploiting Workload Flexibility Through Rational Pricing

2012 Cloud@Scale
Exploiting Workload Flexibility Through Rational Pricing



2013 Toward an Open Cloud Marketplace
Vision and First Steps



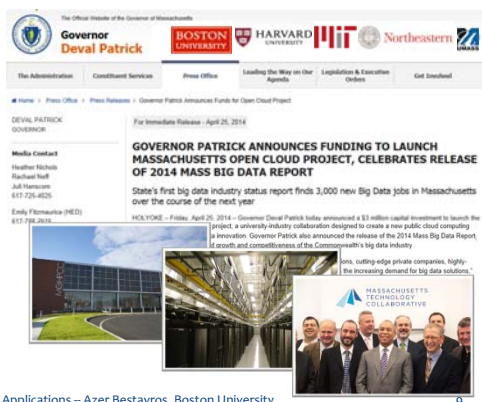
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Catalyst: The Mass Open Cloud








- Unique academic, industry, and local government partnership
- Spearheaded by BU's Cloud Computing Initiative at the Hariri Institute
- Industry buy-in: \$20M+ from Red Hat, Intel, Cisco, Lenovo, Brocade, Dell, ...
- Strong state support: \$3M match funding awarded in 2014
- An "open cloud" marketplace that leverages 15MW of MGHPCC capacity
- Serves as a repository for regional data/big-data applications

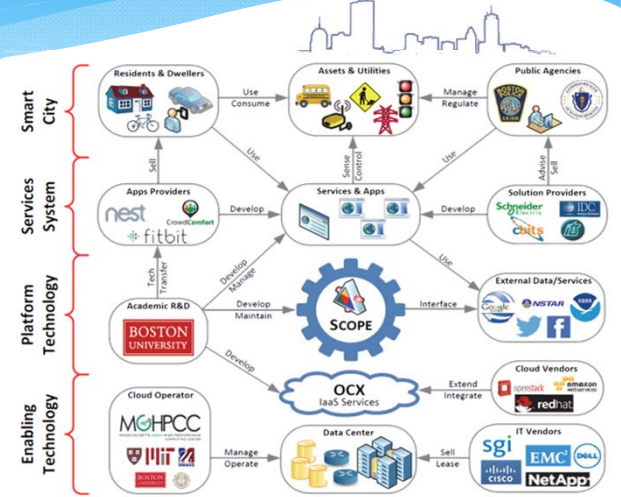


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Proof of Concept: SCOPE



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