Guest Editor’s Introduction

Web-Scale Datacenters

Datacenters are the “nerve centers” of the Internet. All large-scale Internet services rely on the ability to process enormous amounts of data blindingly quickly, with essentially no downtime. This requires enormous scale, geographic distribution and redundancy, finely tuned systems and networks, and many other features. As many IT consumers virtualize their computing environments and share resources hosted by large-scale cloud service providers, datacenters take various roles, supporting both single, large organizations (such as Facebook or Google) and shared tenancy (such as Amazon Elastic Compute Cloud or Microsoft Azure).

This ever-growing role for datacenters in Internet computing has given rise to several issues, especially in the areas of cloud provisioning as well as networking optimization and configuration. In particular, this special issue addresses workload isolation, recovery from transient server availability, network configuration, virtual networking, and content distribution.

Open Challenges
Even as datacenters’ scale and usage requirements increase, a parallel thrust exists toward making them more environmentally responsible. The challenge of optimizing the tradeoff between performance and resource consumption (not just energy, which is the obvious consideration given that it affects both operating costs and CO₂ emissions, but also other resources such as water) is driving numerous current efforts, some of which are represented in this issue.

One aspect of Web-scale datacenters that is important (but unfortunately isn’t covered by this issue’s articles) is security. A great deal of discussion has been under way in recent months about the desirability of some organizations to intercept communications either within or across the large enterprises that carry much of the Internet’s traffic, and which provide many consumer-facing applications such as email and chat. With the disclosure of the Heartbleed (http://heartbleed.com) vulnerability in OpenSSL shortly before this issue went to press, it became obvious that users must trust not only the providers of shared tenancy but every aspect of the complicated software systems that support them. The extent of Heartbleed’s impact on datacenter operations will undoubtedly take much time to evaluate and, if necessary, mitigate.

In This Issue
This issue presents five articles pertaining to Web-scale datacenters, covering...
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the areas of cloud provisioning as well as networking optimization and configuration.

The two articles pertaining to cloud provisioning are modified versions of papers that appeared in the 10th Usenix Symposium on Networked Systems Design and Implementation. The article “Workload-Aware Provisioning in Public Clouds,” by Yunjing Xu, Zachary Musgrave, Brian Noble, and Michael Bailey, describes a system called Bobtail. The authors note that sometimes CPU-bound and latency-sensitive tasks intermix in multitenant environments. They cause performance interference, which can result in a “heavy tail” of high network latencies. Bobtail lets customers share processors with compatible workloads and avoid contention.

“Here Today, Gone Tomorrow: Exploiting Transient Servers in Datacenters,” by Rahul Singh, Prateek Sharma, David Irwin, Prashant Shenoy, and K.K. Ramakrishnan, notes that cloud providers determine the availability and price of servers dynamically, as factors like energy costs and competition for resources affect the system’s state. Customers who are willing to use transient servers, which might be reclaimed (for instance, if their cost goes above a threshold the customer is willing to pay), can keep their overall costs much lower than if they use stable servers that are highly available. But what do they do when a transient server is reclaimed? Having just a few seconds of lead time is sufficient for their bounded-time virtual machine migration technique to back up the transient server for deployment elsewhere.

People have referred to datacenters as having “islands of data,” and data networks are the bridges and tunnels that get that data to and from each other and the rest of the world. Indeed, networking is the yang to the datacenter’s yin, as is exemplified by the focus on networking in the remaining articles. One article is about automating and simplifying datacenter network configuration, another is about using software-defined networks for isolation and performance, and a third is about dynamically integrating BitTorrent for data distribution from the cloud in cases where nearby users have much content in common.

First, I’ll describe “SWIM: A Switch Manager for Datacenter Networks,” by Chao-Chih Chen, Peng Sun, Lihua Yuan, David A. Maltz, Chen-Nee Chuah, and Prasant Mohapatra. The authors note that datacenter networks are incredibly complicated, and the situation is only getting worse over time. The diversity offered by having multiple network vendors, as well as the wide variety of network attributes that must be managed, result in a morass of complicated systems. SWIM lets network engineers use a uniform language for interacting with networking equipment in a vendor-neutral manner.

Second, in the article entitled “Virtual Slice Assignment in Large-Scale Cloud Interconnects,” Kim-Khoa Nguyen, Mohamed Cheriet, and Yves Lemieux describe how to interconnect multiple datacenters in an efficient manner. Software-defined networking is a hot area indeed, permitting network engineers to compose resources and allow isolation among shared physical networks. Their optimization technique addresses both performance and energy consumption, an important combination in modern datacenters.

Finally, Xavier León, Rahma Chaabouni, Marc Sánchez-Artigas, and Pedro García López revisit a topic familiar to IC readers, content distribution. In “Smart Cloud Seeding for BitTorrent in Datacenters,” they address the question of how cloud providers can best disseminate data to the rest of the Internet. BitTorrent has become a popular tool for some types of content distribution, but it’s most useful when it leverages overlap among the content required by nearby end-users. The authors’ system, which they integrated with OpenStack (www.openstack.org), the open source cloud computing platform, decides when to switch to BitTorrent for data delivery based on access patterns.

Web-scale datacenters have many challenges indeed. The articles in this issue address a number of them, but there is room for many more: in fact, I look forward to a follow-on special issue on the concerns surrounding cloud storage, and encourage practitioners to submit their work when the time comes.

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