Cisco and Standards

Opening the Door to Borderless Networks

Networks and related network standards have come a very long way over the last few decades. Could you imagine a world without Ethernet? Or the Internet? Or wireless? Could you imagine the not-so-distant past in which your work location, user device, communications path, destination computer, and application/information access were defined by the network and not by you? In the present, imagine not being able to collaborate across locations or across company boundaries because of mismatched networks. Flash forward and imagine not being able to take advantage of developing cloud computing services because of connection and exchange barriers between your infrastructure and the cloud—any cloud. Hard to imagine, given the connected world within which we all work, live, play, and learn.

We owe all this accepted—even assumed—ever-ready communications to the development, definition, adoption, certification, and deployment of standards-based networking technology.

Standards: Ensuring Flexibility, Establishing Baseline Functionality

Although standards are at work everywhere in our networks, we mostly take them for granted. Network operators assume that standardized systems will always just "plug and play." The fact is that a lot of work within technical committees and engineering labs and testing facilities is involved in achieving that plug-and-play status. All this work has paid off nicely, though. Think of the last time you plugged into an Ethernet wire and could not get connectivity. Think of the last time you went to the local coffee shop and could not gain access to the Internet. For network managers, think of the last time you deployed a switch in the wiring closet or a router in your WAN and it did not communicate readily to the network and neighboring devices. When standards are well defined, properly implemented, and effectively deployed, standards ease networking for all: workers and administrators, partners and customers, even friends and family.

For network operators and connected users, the rewards for standards adoption and adherence are seen in many areas:

- **Integration and testing**: Standards simplify and shorten the pilot phase of networking.
- **Deployment**: Standards enable ready and accurate installations and upgrades.
- **Operations**: Standards streamline ongoing maintenance and administration.
- **Problem resolution**: Standards speed diagnostics and reduce repair times.
- **Availability**: Standards bolster the reliability of connections and exchanges.
- **Security**: Standards help ensure the integrity of connections and connected resources.
- **Accessibility**: Standards extend network reach and ease network use.
- **Open systems**: Standards heighten technical and business flexibility.
- **Cost savings**: Standards lower capital and operating expenses.
- **Choice**: Standards promote vendor independence and product availability.

For technology vendors and service providers, there is also a strong return for standards adoption. Application of standards-based technology eases product development and testing efforts, lessens support requirements; accelerates technology innovation; and, of course, reduces the costs to design, manufacture, and deliver networking solutions.

So why the need for beyond-standard technologies within our networks?

The simple, straightforward answer is that networking standards provide for solid baseline functionality: no more, no less. Standards cover technology that is widely accepted and implemented by many technology vendors and service providers. Standards rarely cover leading-edge innovation.

In this connected world, networking requirements expand more quickly than industry standards. Network operators must respond immediately to new IT and business demands. Extending networking features and services beyond current standards enables the world's networks to deliver on their full potential by boosting performance, reliability, security, service intelligence, automation, and energy efficiency: the list goes on and on.

In addition, these vendor extensions also serve to promote technology innovation: innovation that, in turn, promotes further advancement of industry standards. Here, vendors such as Cisco must first prove that new innovations are robust and deliver real returns before they can be introduced to the standards process and become accepted by a broad coalition of vendors and customers.

Since it is not uncommon for standards definition and validation to lag real-world requirements by 3, 5, or even 10 years, examples abound of vendor extensions proving themselves well in advance of the resulting formal standards. The availability of Cisco EtherChannel preceded the corresponding IEEE's 802.3ad standard by almost 10 years. Cisco's NetFlow preceded IETF IPFIX more than 10 years. Cisco's Lightweight Access Point Protocol (LWAPP) preceded IEEE's CAPWAP by 5 years. For Power over Ethernet (PoE), Cisco's inline power technology preceded IEEE's 802.3af by more than 3 years. That is almost three decades of benefits accruing to network operators in the form of higher performance, detailed monitoring, simplified management, and power savings—and that is only across four specific Cisco pre-standard extensions.

The key for network operators and technology vendors alike is to create and operate networks that best use formal standards, while taking full advantage of defacto standards and vendor extensions. These defacto standards and vendor extensions enable operators to derive the highest value from the network in support of IT and, more importantly, business initiatives.

For technology vendors, these extensions undoubtedly serve as value-add within their solutions. All vendors mix standards and extensions within their solutions. However, these extension technologies often lay the groundwork for formal standards to come: standards that serve to redefine baseline functionality in networking.

The Role of Vendors in the Standards Process

Individual standards are generally developed jointly by multiple technology vendors, service providers, and network operators. Interestingly, the best standards (that is, those that strongly deliver on all the benefits described earlier) often develop out of a close partnership among competing vendors. In its contributions to various standards-setting and certification efforts, Cisco is frequently allied with its primary competitors to the benefit of network operators and the industry as a whole. Cisco recognizes the importance of not only establishing well-defined standards, but also making sure that approved standards are strongly supported by all concerned: vendors and operators alike.

When examining the role of technology vendors within the standards process, it is important to understand that many levels of commitment and participation are possible. After all, most vendors will say they are committed to industry standards and open systems and, appropriately, list standards compliance on their product data sheets.

How does one judge the level of commitment of a vendor to open standards? The true standards bearers do the following:

- Commit senior-level technical staff to standards efforts
- Function as officers (for example, chairs) and authors in standards-setting groups
- Sponsor public and private forums focused on standards adoption and promotion

- Contribute their own extension technologies to new standards developments
- Allocate significant staff and systems resources to interoperability testing
- Closely collaborate with other vendors, and even competitors, in advancing standards
- Actively enlist customer and partner support and participation in shaping standards
- Deliver compliant products to market in a timely fashion

It is this greater commitment by technology vendors and network operators that moves standards forward more quickly, allowing standards to deliver ever-increasing value to networks, to IT systems, and to businesses overall.

Cisco: Commitment Leads to Contribution Leads to Customer Solutions

As a leader in networking, Cisco readily accepts and functions in a lead role throughout the entire standards process, from definition to product development to interoperability testing to customer deployment. We recognize that our customers and the industry as a whole achieve greater returns and success when networks and networking devices work as one. We also recognize that the success of standards and progress in the industry best results from Cisco and other contributors—partners, competitors, and customers—working together in achieving toward this ideal.

As evidence of this broad and deep influence of Cisco within the standards process, consider the following:

- Cisco is a member of more than 70 world standards bodies and forums.
- Cisco employees hold more than 30 leadership positions (for example, board members, chairs) in IETF, IEEE, ITU, Wi-Fi Alliance, and other important standards organizations.
- Cisco contributions include almost 300 RFC authors and 800 RFCs (source: www.arkko.com/tools/stats/index.html).
- Cisco representation at IETF meetings is, historically, more than twice that of the next vendor, and the difference increases exponentially over other vendors.
- Cisco received the ITU-T Commemorative Award for outstanding next-generation network (NGN) contributions.

Although Cisco's technical presence, working group leadership, corporate sponsorships, and industry awards serve to validate Cisco's position as a true standard bearer, the strongest evidence of Cisco's leadership in open industry standards runs through all of the world's networks: service providers, enterprises, small and medium-sized businesses, and homes.

The following are a sample of important standards that Cisco has served to define, develop, and enhance across many critical networking areas.

Network Connectivity: IEEE 802.3u Fast Ethernet

Introduced in 1995, Fast Ethernet increased Ethernet LAN speeds from 10 Mb/s to 100 Mb/s. Cisco's Fast Ethernet technology served as the basis for the IEEE 802.3u standard. Further Cisco contributions helped form Gigabit Ethernet, 10 Gigabit Ethernet, and now 40/100 Gigabit Ethernet, making sure that Ethernet will continue to serve as the principal connection for the vast majority of networking and networked devices.

IP Routing (Interior): IETF Open Shortest Path First and Routing Information Protocol Version 2

Open Shortest Path First (OSPF) and Routing Information Protocol Version 2 (RIP v2) are dynamic routing protocols for use within single autonomous systems, most often large enterprise networks. In leading the development of routing protocol standards, other technology vendors (for example, Proteon for OSPF) drew from Cisco's widely adopted pre-standard Interior Gateway Routing Protocol (IGRP) and Enhanced IGRP (EIGRP) technologies.

IP Routing (Exterior): IETF Border Gateway Protocol

The Border Gateway Protocol (BGP) is the core routing protocol of the Internet, maintaining a table of IP networks and making routing decisions based on path, network policies, and/or rule sets. BGP allows the Internet to function as a truly decentralized system. Cisco's Internet Gateway Protocol (IGP) served as the basis for the BGP standard.

LAN Switching: IEEE 802.3ad "EtherChannel"

Developed in the early 1990s, Cisco's EtherChannel is a link aggregation technology that allows operators to group several physical Ethernet links to create one logical Ethernet link for the purpose of providing fault tolerance and bundled high-speed connections among switches, routers, and servers. Cisco's EtherChannel served as the basis for the 802.3ad standard.

IP Traffic Direction: IETF Multiprotocol Label Switching

Multiprotocol Label Switching (MPLS) is a highly scalable, Data Link Layer–independent delivery mechanism that directs and carries data from one network node to the next. Standards work commenced in 1996, and large-scale deployments of MPLS began in 2001. Cisco's Tag Switching technology (first shipped in 1997) developed into Label Switching in collaboration with IBM Research. Label Switching then drove the final MPLS standard: a standard that plays an ever-increasing role in both service provider and large enterprise networks. Owing to this vital role MPLS plays within public and private networks, Cisco has released a number of books promoting the effective and secure use of MPLS. (See Figure 1.)

Figure 1. Sample Cisco MPLS Books

Traffic Management: IETF IP Multicast

IP Multicast is a bandwidth-conserving technology specifically designed to reduce traffic by simultaneously delivering a single stream of information to potentially thousands of corporate recipients or homes. Cisco routers were the first to implement Protocol Independent Multicast (PIM), allowing the formation of efficient distribution trees for transmitting multicast content. Today, the technology is an IETF standard, supported by multiple vendors and widely deployed in large enterprises and service providers.

Network Availability: IETF Virtual Router Redundancy Protocol

The Virtual Router Redundancy Protocol (VRRP) is designed to eliminate the single point of failure inherent in a static routed environment. Cisco's Hot Standby Router Protocol (HSRP) served as the basis for the VRRP standard.

Wireless LAN: IEEE Control and Provisioning of Wireless Access Points

Control and Provisioning of Wireless Access Points (CAPWAP) simplifies the configuring, monitoring, and troubleshooting of large wireless LANs (WLANs) through consolidated control. CAPWAP also allows network administrators to more closely monitor and analyze WLANs. Cisco's Lightweight Access Point Protocol (LWAPP) served as the basis for the CAPWAP standard.

Wireless WAN: IEEE 802.16 WiMAX

WiMAX standards are established by the IEEE 802.16 working group and WiMAX products are certified by the WiMAX Forum. Cisco contributed primary technologies to the IEEE 802.16 standard and continues to work on the next-generation 802.16m standard. Additionally, Cisco also introduced important concepts that are now mandatory in WiMAX Forum product requirements and certification tests.

Data Center Networking: American National Standards Institute T.11 Virtual Storage Area Networks

Virtual storage area networks (VSANs) are logical SANs built on a common physical fabric, easing management, while also improving security and fault isolation capabilities. Conversely, multiple switches can bundle their ports to form a single VSAN. Cisco's VSAN technology was approved as the American National Standards Institute (ANSI) virtual fabric standard by Technical Committee T.11.

Network Security: IEEE 802.1Q Virtual LANs

A virtual LAN (VLAN) is a logical group of networked devices that communicate as if they were attached to a broadcast domain, regardless of their physical location. VLANs provide for greater scalability, heightened security, and improved network management. Cisco's Inter-Switch Link (ISL) preceded the 802.1Q standards and contributed to the development and later adoption of 802.1Q.

Network Power: IEEE 802.3af Power over Ethernet

Power over Ethernet (PoE) technology safely transfers up to 15.4 watts of DC power—alongside traditional Ethernet traffic—to remote devices over Category 5 cable. Cisco first shipped PoE-capable switch ports in 2000 and laid the groundwork for the 802.3af PoE standard that was ratified in 2003. Cisco was the first vendor to ship products based on the 802.3af standard.

Network Management: IETF Internet Protocol Flow Information Export "NetFlow"

Internet Protocol Flow Information Export (IPFIX) provides a universal mechanism for formatting and transferring IP flow information between exporters (for example, routers and switches) and collectors (for example, network management systems). Cisco's NetFlow Version 9 was approved as the IPFIX standard in 2006.

Energy Management: IEEE 802.3az Energy Efficient Ethernet

Cisco was a primary sponsor of the Energy Efficient Ethernet project that became the IEEE 802.3az standard. Cisco continues to lead this project and also actively contributes to energy conservation programs within such key organizations as ITU-T, European Commission's Energy-Using Products (EuP), Japan's Ministry of Economy, Trade, and Industry (METI), Alliance for Telecommunications Industry Solutions (ATIS), The Green Grid, and the U.S. Environmental Protection Agency (EPA).

Application Hosting: Linux OS

Cisco's Application eXtension Platform (AXP) functions as a Linux-based server residing within a Cisco Integrated Services Router (ISR). AXP hosting saves network operators from having to deploy dedicated servers in support of remote applications. The AXP's Linux OS enables the use of all Linux-supported programming environments and the ready deployment of both off-the-shelf and custom Linux applications within the Cisco ISR.

Messaging and Presence: IETF Extensible Messaging and Presence Protocol

Since the late 1990s, Jabber technologies have been synonymous with open instant messaging, presence, Extensible Markup Language (XML) routing, and real-time collaboration. Since 2001, Jabber technologists have led the way in forming the Extensible Messaging and Presence Protocol (XMPP) standards. Through its acquisition of Jabber in late 2008, Cisco has assumed a leadership role in the Jabber/XMPP developer community.

Voice Communications: IETF Session Initiation Protocol

The Session Initiation Protocol (SIP) is a signaling protocol, widely used for controlling multimedia communication sessions such as voice and video calls over IP networks. Cisco's contributions to SIP advancement and adoption are wide ranging. Cisco chairs multiple SIP-related working groups, and 11 Cisco engineers have authored 44 SIP documents—more than one-third of the SIP titles available from the IETF. Additionally, Cisco is a founding member and current board member of the SIP Forum. On the product side, Cisco offers SIP-compliant phones, and Cisco's latest Unified Communications Manager 5.0 served to deliver years of SIP development efforts.

Video Communications: Multivendor Video Conferencing

Although formal standards-setting activities relating to telepresence technology are just commencing, Cisco has already established multivendor interoperability within the Cisco TelePresence 3000 and 1000 systems. These Cisco endpoints are able to deliver a video stream that can be displayed on video conferencing endpoints supporting H.323, SIP, or Skinny Client Control Protocol (SCCP) standards. Conversely, Cisco TelePresence systems can display video streams received from endpoints supporting these same standards.

Hardware Components: Low Latency Dynamic Random Access Memory 3

Low Latency Dynamic Random Access Memory 3 (LLDRAM3) provides very short random access times, higher bandwidth, lower host port pin count, and lower power draw when compared with other low-latency DRAM technologies. This next-generation specification was codeveloped by Cisco, GSI Technology, and NEC Electronics and all three companies have published an intellectual property assurance letter to stand behind their commitment to make LLDRAM3 an open technology.

The technologies just described all serve as solid proof that Cisco helps move networking and the IT industry forward through timely delivery of standards-compliant solutions and continued advancement of networking technologies that develop into tomorrow's standards.

Standards: An Enhancement Evolution

The work on standards is a continuous process. Network requirements continue to advance in scale and scope. So too must networking standards. Cisco, as it has demonstrated throughout its history, will continue to lead the industry in offering standards-based networking solutions, while also extending standards in order for networks to do more and save more for operators.

One final word: When discussing standards with your technology vendors, make sure they are investing the time, energy, and resources necessary to push your network to new heights in performance, reliability, reach, and service intelligence using standards development and deployment. This is the only way for all—not just some—of the world's networks to succeed in delivering on all the promise of a borderless and boundless connected world.

Americas Headquarters
Cisco Systems, Inc.
San Jose, CA

Asia Pacific Headquarters
Cisco Systems (USA) Pte. Ltd.
Singapore

Europe Headquarters
Cisco Systems International BV
Amsterdam, The Netherlands

Cisco has more than 200 offices worldwide. Addresses, phone numbers, and fax numbers are listed on the Cisco Website at **www.cisco.com/go/offices.**

Printed in USA C11-569150-00 11/09