

How Software-Defined Access Empowers the Application Developer



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Tens of thousands of commuters going home from work pass a store that is part of an upscale grocery chain and is located next to a major interstate. A wireless carrier serving the area knows when subscribers are on that highway because the cell transmitters gather that intelligence. The network collects that data and instantly publishes the information (targeted mobile subscribers) in a queue and sends it to the chain. The chain is then able to identify attractive prospects who are coming into range of the cell transmitter closest to the upscale grocery store. The grocery uses the carrier's network to dispatch discount coupons to attractive prospects' mobile phones for them to see as soon as they arrive home.

Welcome to the monetized network. This network is the key to finding new business opportunities and even new markets and ways of doing business. It is a strategic asset instead of a drain on organizational resources.

This network is truly programmable—from the core and cloud right to the edge. While that may seem like it's big news only for network engineers and administrators, it's just as exciting for application developers.

An intent-based network anticipates needs. It constantly learns from the context of the data that surrounds businesses. With the advent of the cloud, analytics, the Internet of Things (IoT), and the industrial IoT (IIoT), mobility, and virtualization, today's network needs to change. It must go beyond a manual, time-intensive, static approach. That simply won't cut it any longer. Now the last programming element needed to make this huge network leap has finally arrived. It's known as software-defined access (SD-Access).

The potential of SD-Access to provide powerful capabilities for application developers is just beginning to unfold. This white paper:

- Looks at the developments impacting and changing the network
- Explains SD-Access and its place in the network
- Explores how SD-Access transforms the network
- Introduces the benefits and capabilities that SD-Access brings to the role of application developer
- Discusses the certifications and training Cisco offers to help validate those skills so that developers can take full advantage of this advance in networking

The programmable network

If you are an application developer, you may be wondering why you should pay attention to the network. But this is not yesterday's network. Today's changes, both to what networks are expected to do now and to how they go about getting it done, are of great importance to application developers.

The network of the digital era must become programmable to the point of being intuitive, or it will be overwhelmed and collapse.

Today's digital networks must cope with the soaring impact of digitization. A torrent of data from billions of mobile subscribers and their access devices is being joined by a tsunami of data from billions of attached machines and sensors in the IoT.

The digital network must link applications located in the cloud to users or machines located at the edge. This network must make sense of everything that is happening within and around it, and then anticipate the organization's next moves.

The network of the digital era must become programmable to the point of being intuitive, or it will be overwhelmed and collapse. This is actually really great news for application developers.

Here's a thumbnail overview of the IP network at the dawn of digitization, when it wasn't fully programmable. This familiar network was defined to the greatest extent by its hardware. Routers. Switches. Middle boxes. Cable. Fiber. Copper. End nodes. And so on.

By and large, application developers didn't pay a lot of attention to network hardware unless they were focused on the software inside those boxes. But the network is advancing in dramatic ways, and it has the application developer directly in its path.

IP networks are groaning under the exploding demands of the cloud, mobility, and the IoT. It's no surprise that programmable networking is spreading fast. The worldwide programmable network market will have a compound annual growth rate of nearly 54 percent between 2014 and 2020¹, when it will be worth almost \$12.5 billion.

The missing link to total programmability

Network programmability enables dynamic updates of software services on demand, without worrying about any of the hardware. It turns what was a static network into a flexible resource under centralized control. It bridges the gap between network management by hand and automation through software programs. That is a big competitive difference.

Until recently, however, the advantages of programmability didn't yet extend to access networks. Access networks are where people—employees, partners, customers, consumers—hook into the network. To take advantage of cloud services, stream videos, or even just send a text message, people use access networks. The same goes for devices, machines, and sensors.

Customer premises equipment (CPE) hardware makes that network access possible. It's probable that network operators will not want to pay for replacing existing CPEs with next-generation models. That is precisely why SD-Access is such a critical breakthrough. It makes all of the Internet programmable, from the core right to the edge, without reference to the underlying hardware.

1. IDC, "[SDN Market to Experience Strong Growth over Next Several Years, According to IDC](#)," February 2016.

SD-Access is a central part of the Cisco Digital Network Architecture (DNA). It represents a fundamental shift and potentially exponential impact on how we design, build, and manage networks.

The gains of core-to-edge network programmability are substantial and have great significance for application developers. Core-to-edge programmability allows services to be connected end to end, making it much easier, faster, and cheaper to set up and launch new services across the network. This is done by programming the software across the network, rather than replacing hardware or firmware and patching software, hoping it will all work smoothly together and scrambling when it doesn't.

Core-to-edge programmability enables simplified network operations through a single point of automation, orchestration, and management of network functions. An automated network can monitor traffic conditions and make changes when and where they are needed. As noted at the start of this white paper, automated networks can be programmed to fulfill an endless variety of strategic and everyday tasks, such as sending a sales promotion to potential shoppers who are in the vicinity of a grocery store.

Cisco estimates that SD-Access cuts the time needed to adapt the network by 67 percent. It boosts issues resolution by 80 percent and lowers the impact of security breaches by 48 percent. All that means a 14 percent drop in capital expenditures for the network and a 61 percent cut in network operating expenses.

SD-Access and Cisco DNA

So, what is SD-Access?

SD-Access is a central part of the Cisco Digital Network Architecture (DNA). It represents a fundamental shift and potentially exponential impact on how we design, build, and manage networks. SD-Access can enable enterprise customers to reduce operating expenditures (OpEx) and risk, while creating an agile infrastructure that delivers consistent policies and services over wired, wireless, and hybrid networks.

Additionally, SD-Access provides policy-based automation from the edge of the network to the cloud. It offers secure segmentation for users and things enabled through a single network fabric. Plus, it allows various secure corporate, facilities, and IoT, as well as guest user devices, to be kept separate and secure while on the same network infrastructure. This approach drastically simplifies and scales operations while providing complete visibility and delivering new services quickly.

On the whole, Cisco DNA goes beyond the ecosystem of network technologies that make up SDN and focuses on bringing these technologies together into a holistic architecture to achieve business outcomes. Cisco DNA is a way to make network services relevant and easy to use. This architectural suite includes ready-to-use applications as well as easily consumed APIs. Cisco is committed to helping our customers successfully evolve to SDN while maximizing their investment protection.

Where SD-Access truly changes the networking game is its strategic implications. It is the missing link of programmability that will transform the entire network into an intelligent, continually evolving system, becoming smarter and more responsive.

SD-Access is the foundation of Cisco DNA, enabling network access in minutes for any user or device to any application, without compromise.² With SD-Access the established policies automatically follow the user across all network domains.

By automating day-to-day tasks such as configuration, provisioning, and troubleshooting, SD-Access reduces the time it takes to adapt the network, improves issue resolution, and reduces the impact of security breaches. This results in significantly simpler operations and lower costs.

Automation and simplicity result in increased productivity, which enables IT staff to innovate early and be an industry leader in transforming to a digital enterprise, increasing operational effectiveness.

But where SD-Access truly changes the networking game is its strategic implications. It is the missing link of programmability that will transform the entire network into an intelligent, continually evolving system, becoming smarter and more responsive.

This intelligent system can understand the world it is connecting. It can detect and respond much faster to threats—and opportunities. It is based on new silicon and hardware designs that support high-speed analytics, complete and constant network visibility, and new software capabilities. This intelligent, automated system is transparent from end to end and designed to deliver business insights.

More advantages of this system include:

- Applied intelligence. Harness the vast network and connected device information for understanding that yields new markets or business models.
- Threat perception. Uncover previously invisible threats better and faster to keep sensitive data and users safe. The intelligent system turns the network into a sensor.
- Time back to IT. With mundane tasks automated, such as adding users, what once needed days of work now takes hours at most.

Unique to Cisco, SD-Access is part of a slate of products designed to deliver intent-based networking through an intelligent, intuitive system that is fully programmable. It includes Cisco's Digital Network Architecture Center. This DNA hub manages the entire network from a single place and is also the locus for programming network changes, policy, security, or anything else. Cisco's TrustSec and Identity Services Engine (ISE) technology turn the network into a sensor. Cisco Catalyst 9K switches take care of advanced persistent threats and make it possible to detect attacks even among encrypted traffic.

With SD-Access, network management becomes easier. Issues and network updates are faster and smoother. The organization's productivity rises because it can focus on gaining business intelligence from the network instead of trying to deal with a network that is hamstringing the analytics

2. Cisco FAQ document, [Software-Defined Access](#), 2017.

“SDN has the potential to transform the network from a collection of discrete devices, each configured individually with files and scripts, into a powerful virtualized platform for developers to use for building innovative applications...”

applications. Meanwhile, programmers use the DNA hub to adjust or add functionality to the network with code, not command lines.

It's a programmer's network

In short, programmable networks are slowly morphing into programmers' networks. As mentioned at the outset, the roles of network engineer and administrator and application developer are becoming much more similar. This blending will speed up as programmable networking matures.

One veteran network applications developer sums it up this way.³ Programmable networking “...is appealing for network applications developers like me because it allows the capabilities of network devices to be accessed remotely and in a fairly unified way.”

This developer adds, “SDN has the potential to transform the network from a collection of discrete devices, each configured individually with files and scripts, into a powerful virtualized platform for developers to use for building innovative applications...”

Such innovative applications would encompass this paper's initial example of finding potential customers while they're close by a grocery store and then sending shopping invitations to their cell phones before they leave the area.

So, what else can application developers make programmable networks do? The jury won't be in on that for some time, but a few examples of what programmable networks can achieve are emerging.⁴ Companies are taking advantage of programmable networking to automate network operations that previously needed time and manual effort to set up and manage. Customer software sets up and manages network resources by means of an interface to the network controller. Customers can optimize the network for a video conference and then for a bulk data transfer.

Programmable networking so far has been focused in the data center and the cloud, but SD-Access makes it possible to branch out, literally. That is about to happen at Kanazawa University Hospital in Japan. Hospital networks must be available at all times. Hundreds of IP-connected devices are attached to them, such as CT scanners and patient monitors. Traditional IP networks can take one to two minutes to recover from a failure while the network sorts out new routes. However, even that short a time can be dangerous if life-saving equipment is shut off due to a network glitch.

The hospital also needs to add, update, or replace network-connected equipment all the time. When nurses or other hospital workers plugged a device into a port, the action often created a network loop and caused problems in the hospital's IP network.

3. Virtualization & Cloud Review, “[Developer Explains How to Design a Software-Defined Networking App](#),” April 2014.

4. TechTarget, Essential Guide, “[SDN Application Examples Emerge as SDN Continues to Mature](#),” June 2017.

Honing key network programming skills is how developers will tap into network intelligence and build powerful new network-enabled applications through open application programming interfaces (APIs).

To address this, the hospital replaced its traditional IP network with a programmable one and found that it takes much less time to recover. The hospital now can add new devices or machines to the programmable network without disruption, such as when switching monitors from room to room as patients move. The programmable network enabled the hospital to set up four distinct virtual networks on top of one physical network to keep patient information secure. Soon, the hospital expects to be able to follow patients as they return home by extending its programmable network using wireless 3G and LTE mobile networks.

A universe of programming possibilities

If you are a programmer, then programmable networks are a career bonanza for you.

When the first smart phone appeared, it opened a universe of opportunities for developers to create applications that enable these smart phones to do nearly anything. Mobile banking. Mobile ride sharing. Mobile detours around traffic jams. Mobile games of all kinds.

Now, SD-Access is opening up the same universe of programming potential on the networking side. Honing key network programming skills is how developers will tap into network intelligence and build powerful new network-enabled applications through open application programming interfaces (APIs).

While Cisco has always been a leader in IP networking, we have advanced our DNA solution so that it evolves the network to be automated and driven by software. With DNA and SD-Access, the network is an application developer's innovation engine. By providing APIs into the network, an application developer can innovate quickly and easily. Just as early developers of apps for smart phones gained big competitive benefits, those developers who polish their network programming skills will have big career advantages.

Programmability provides a way for applications to communicate directly with the network. This empowers developers to get the resources they need fast to build supercharged applications that span IoT, augmented and virtual reality, and data science. A programmable network is an entirely new application ecosystem. It recasts full stack developers as the unicorns of the next decade.

Application developers are taking notice of what we are doing with programmable networks. In 2014, Cisco set up DevNet to foster a developer community that uses the network as a platform to devise applications for managing network infrastructures and for end-users. DevNet also helps network engineers and application developers learn to speak a common language.

As networks become more and more programmable with innovations like SD-Access, DevNet's growing community of 450,000+ developers will come together to solve challenges and take advantage of opportunities that arise when applications meet network foundations. Members of that community will use their expanding knowledge of programmable networking to bring more value to network applications than ever before.

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Cisco training for developers

Cisco has always been a leader in training and certifications for network engineers. But as programmability became more widespread in the network, we saw the need to help application developers learn network programming. In response, we set up the Network Programmability Developer Specialist training and certification.

With the rollout of Cisco DNA and now SD-Access, we have updated this program. The coursework is ideal for application developers, software engineers, network programmers, network automation engineers, and network developers.

The Network Programmability Developer Specialist program provides all of these IT professionals with a complete course in building their network infrastructure programming skills. It meets the needs of software engineers who automate network infrastructure and/or use APIs to handle SDN controllers and individual devices. It also covers the basics of networking, IPv4 and IPv6 addressing and subnetting, and the functions of various network components.

In addition, the course covers Cisco Application Centric Infrastructure (ACI), Application Policy Infrastructure Controller-Enterprise Module (APIC-EM), and open programmable controller technologies and conceptual frameworks. It also covers how to make REST, Python, and YANG requests. The course teaches the Cisco Network Services Orchestrator (NSO) framework plus how to interpret and produce code to launch configurations to multiple devices using RESTConf and NETConf. It identifies available sample code, network programmability tools for developers, and Cisco virtual platforms.

Candidates may take the course as instructor-led workshop training through Cisco Learning Partners. It is also available as self-paced interactive training that includes videos, labs, and assessments from the Cisco Platinum Learning Library.

Frankly, the network is moving to full programmability so fast that application developers and other IT professionals do not have many places to go to keep their skills current with all of the changes. There just isn't that much help available out there, and few sources exist to lay out a roadmap for acquiring the training and skills needed for programmable networks.

Fortunately, Cisco is a networking expert and has the training and certifications that application developers need to transition into network programming—one of the biggest career opportunities available right now.

Looking ahead

Look at the really big picture for just a moment: namely, the wider social impact of programmable networking, which makes the IIoT possible. As the foundation of the IIoT, programmable networking will help bring on “the next economic revolution.”⁵

5. Visual Capitalist, “[The Industrial Internet of Things as the Next Big Growth Driver?](#)” July 2016.

With the huge needs of the IIoT and other digitization demands, you will be dealing with a network sooner rather than later.

Ultimately, the IIoT “is a once-in-a-lifetime business disruption.”⁶ It is beginning to reshape just about every human endeavor, from agriculture to urban life to making products. It will foreseeably usher in more ways to innovate, and create entire industries as yet unimagined.

The Visual Capitalist offers just a few examples.⁷

- **Cities.** Municipalities will gain by linking people, processes, data, and things. The IIoT could connect public libraries, transit systems, power plants, water supply networks, waste management systems, police, and hospitals—all sharing data over the IIoT. Analyzing this data will help local governments understand incidents and activities in the city and trends over time.
- **Farming.** Agriculture produces vast amounts of data, including crop yields, soil mapping, fertilizer applications, weather, and machinery, along with supporting animal health and herd growth. The IIoT gathers all of this information so it can be analyzed to improve yields and cut costs.
- **Energy.** Improve power generation or oil production by hooking sensors together with machines and the environment. Track equipment conditions and weather status. A wind farm could adjust turbine direction based on a change in wind direction. An oil field could shut down a rig when a crack develops in a critical valve, averting a spill. This is just the beginning of the impact the IIoT can have in this industry.

All of that happens thanks to programmable networking made possible by SD-Access. As Princeton University Engineering Professor Jennifer Rexford pointed out, “Aspiring networking pros need to know both networking and software to have long-term careers in the field.”⁸

It does not matter if you are an application developer who has never tackled a network before. With the huge needs of the IIoT and other digitization demands, you will be dealing with a network sooner rather than later. Cisco can help make that happen for you right away.

To learn more about your role in this new ecosystem, visit the [Network Automation, Analytics, and Virtualization page](#) on the Cisco Learning Network.

6. PwC, [The Industrial Internet of Things](#), June 2016.

7. Visual Capitalist, “[The Industrial Internet of Things as the Next Big Growth Driver?](#)” July 2016.

8. TechTarget, Essential Guide, “[Learn SDN in School, Experts Urge Today's Networking Students](#),” October 2016.