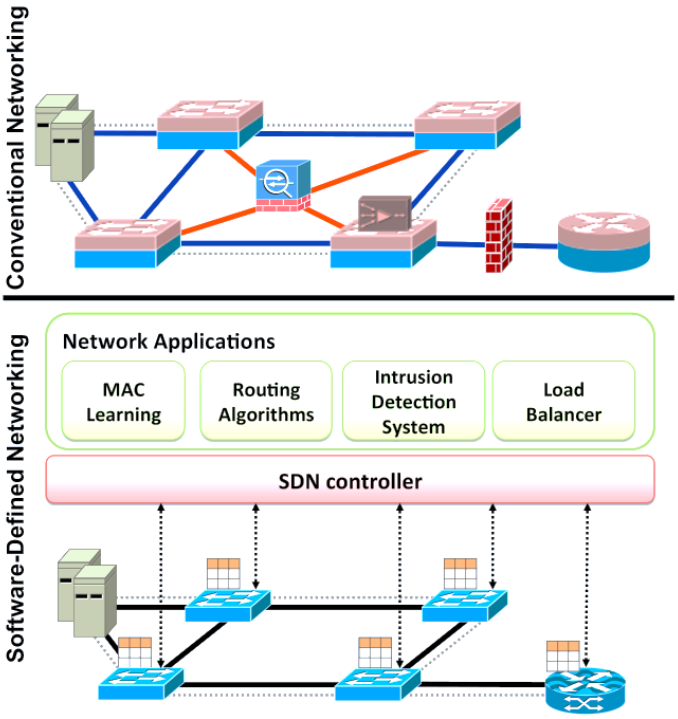
Unit 4

Software-Defined Networking



Unit Focus

Reading 1: Software-Defined Networking

Reading Strategy: Transitional Expressions

Building Vocabulary: Using Verbs as Adjectives

Language Focus: The Final -ing Clause (Result)

Reading 2: Inside OpenFlow

Before You Read

1. Read the statements on the left of the following chart and put a check mark in the boxes provided on the right.

	Yes	No	I don't know
1. In the SDN architecture, the control logic is separated from data planes. 2. The OpenFlow protocol structures communication between the control and data planes. 3. OpenFlow is the first standard interface designed specifically for SDN. 4. SDN simplifies network management and facilitates network evolution.			

2. What do you think the following text is about? Share your ideas with a partner.

Software-Defined Networking

main idea

Traditional network architectures are ill-suited to meet the requirements
unsuitable; inappropriate
of today's enterprises, carrier and end users. Software-Defined
?
the person for whom a device is designed
Networking (SDN) is transforming networking architecture.

main idea

In the SDN architecture, the control and data planes are decoupled,
disconnected; separated
network intelligence and state are logically centralized, and the
?
?
underlying network infrastructure is abstracted from the applications. As
separate
a result, enterprises and carriers gain unprecedented programmability,
?
new, novel

centralization: using a single server architecture for multiple clients

automation, and network control, enabling them to build highly scalable, flexible networks that readily adapt to changing business needs.

main idea

Elements of the SDN architecture such as the OpenFlow protocol structures communication between the control and data planes of supported network devices. OpenFlow is the first standard interface designed specifically for SDN, providing high-performance, granular traffic across multiple vendors' network devices.

granularity: level of details/ size/ scale of the data

suppliers

main idea

Figure 4-1 depicts a logical view of the SDN architecture. Network intelligence is (logically) centralized in software-based SDN controllers which maintain a global view of the network. As a result, the network appears to the applications and policy engines as a single, logical switch.

a software component that creates and enforces rules

With SDN, enterprises and carriers gain vendor-independent control over the entire network from a single logical point, which greatly simplifies the network devices themselves, since they no longer need to understand and process of thousands of protocol standards but merely accept instructions from the SDN controllers.

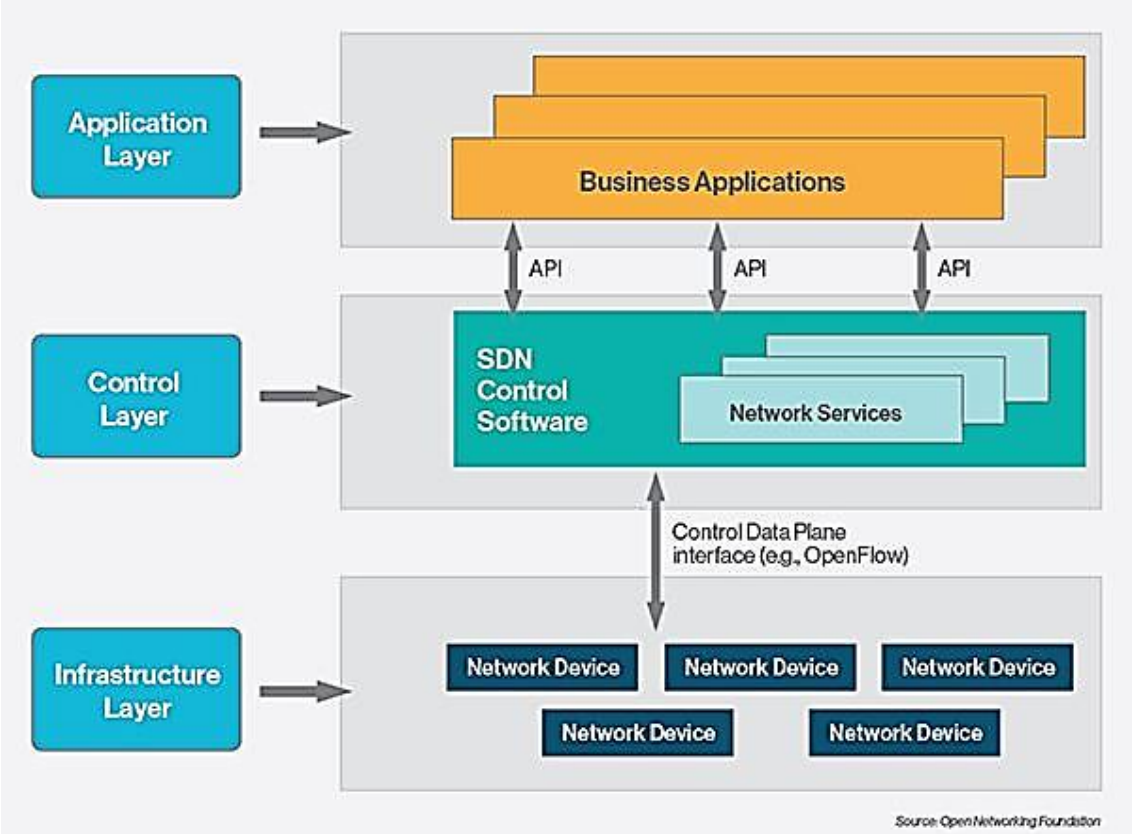


Figure 4.1. Software-defined network architecture


main idea

Perhaps most importantly, network operators and administrators can programmatically configure (arrange) this simplified network abstraction (?) rather than having to hand-code tens of thousands of lines of configuration scattered among thousands of devices. In addition, leveraging (take advantage of) the SDN controller's centralized intelligence, IT can alter network behavior in real-time and deploy (arrange; organize; use) new applications and network services in a matter of hours or days, rather than the weeks or months needed today. By centralizing network state in the control layer, SDN gives network managers the flexibility to configure, manage, secure, and optimize

network resources via dynamic, automated SDN programs. Moreover, they can write these programs themselves and not wait for features to be embedded in vendors' proprietary and closed software environments

the right to produce sth ?

in the middle of the network.

main idea

In addition to abstracting the network, SDN architectures support a set of APIs that make it possible to implement common network services,

?

application programming interfaces

including routing, multicast, security, access control, bandwidth management, traffic engineering, quality of service, processor and storage optimization, energy usage, and all forms of policy management,

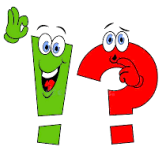
enforcing rules; giving access to databases,...

custom tailored to meet business objectives. For example, an SDN

planned according to individual needs and specifications

architecture makes it easy to define and enforce consistent policies across both wired and wireless connections on a campus.

execute



main idea

Likewise, SDN makes it possible to manage the entire network through intelligent orchestration and provisioning systems. Open APIs promote

arranging and coordinating

supply and storage

multi-vendor management, which opens the door for on-demand resource allocation, self-service provisioning, truly virtualized networking,

allowing end users to supply resources by themselves

and secure cloud services.

multi-vendor management: technology which works with many service providers to produce a single service or product

main idea

Thus, with open APIs between the SDN control and applications layers, business applications can operate on an abstraction of the network, leveraging network services and capabilities without being tied to the details of their implementation. SDN makes the network not so much "application-aware" as "application-customized" and applications not so much "network-aware" as "network-capability-aware". As a result, computing, storage, and network resources can be optimized.

? being dependent on

able to maintain info about applications that connect to it

made according to specifications of applications

react to changing network conditions

(https://www.opennetworking.org)

After You Read

Understanding the Text

A. For each item below, circle the best answer.

1. Which of the following mostly distinguishes SDN from traditional network architectures?

a. its configuration complexity b. its reliance on networking devices

c. its independent controllability d. its vertical integration

2. All of the following can be concluded about SDN from the text EXCEPT ..... .

a. it breaks vertical integration

b. it separates the network's control logic from the underlying switches

c. it configures the network according to predefined policies

d. it promotes centralization of network control

help; advance

3. As we understand from the text, SDN ..... .

a. produces the ability to program the network

b. is complex and hard to manage

c. bundles the control and data planes together

gather together

d. is difficult to reconfigure

4. Which of the following can be inferred from the text?

a. SDN cannot satisfy the current needs.

b. SDN offers vender-specific commands.

c. SDN simplifies network management and facilitates network evolution.

d. SDN cannot adapt to load changes.

adjust

5. The 2nd sentence of the 2nd paragraph notifies the fact that the network intelligence is centralized in SDN controllers causing ..... .

a. the network to appear as a single logical unit

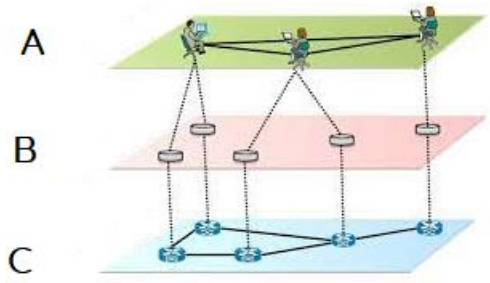
b. the network to be simplified

c. the network devices to directly accept instructions from the SDN controllers

d. all of the above

B. The following figure represents the three planes of SDN networking functionality. Write the name of the planes in the blanks.

capability



A. .....

B. .....

C. .....

Figure 4-2. the layered view of networking functionality (Source: The Internet: SDN: A comprehensive survey, IEEE.).

B. Consider the issues.

1. The author states that traditional network architectures are ill-suited to meet the requirements of today's enterprises, carriers, and end users. Explain what he means by this. What has been done to change the state of affairs?

2. In paragraph 2, it is stated that enterprises can build highly scalable, flexible networks that readily adapt to changing business needs. Do you agree or disagree? Justify your answer.

1. Answer the following questions.

1. How would the SDN architecture put the operators and administrators in a better position?

2.How could network centralization help managers?

3. What makes implementation of common network devices possible?

4. In paragraph 4, what does the example support?

5. What makes optimization of network resources possible?

Reading Strategy

Transitional Expressions

Transitional expressions are words and phrases that signal connections among ideas. By signaling how ideas relate to each other, coherence is achieved in paragraphs. Commonly used transitional expressions are listed in the chart below. Transitional expressions are usually set off with commas. Here are some illustrations from the reading:

Continuity by addition

Network operators can programmatically configure this simplified network abstraction rather than having to hand-code tens of thousands of lines of configuration scattered among thousands of devices. In addition, leveraging the SDN controller's centralized intelligence, IT can alter network behavior in real-time.

Continuity by result

1n the SDN architecture, the underlying network infrastructure is abstracted from the applications. As a result, enterprises gain unprecedented programmatically.

Common transitional expressions and the relationships they signal	
Relationships	Words
Addition	Also, in addition, moreover, and, furthermore, finally
Example	For example, as an illustration, namely
Contrast	But, however, on the other hand, nevertheless, in contrast, at the same time, conversely
Comparison	Similarly, likewise, in the same way
Result	Therefore, as a result, so, accordingly
Summary	Hence, in short, in conclusion, finally
Time sequence	First, second, third, next, then, finally, afterwards, before, soon, later, meanwhile, subsequently, eventually, currently

Fill in the blanks using the transitional expressions the box. There are more options than needed.

At the same time, namely, first, finally, hence, and, in contrast to, before

Within the enterprise data center, traffic patterns have changed significantly. .....1..... client-server applications where the bulk of communication occurs between one client and one server, today's applications access different databases .....2..... servers. creating a flurry of
a sudden occurrence
"east-west" machine-to-machine traffic .....3..... returning data to the end user device in the classic "north-south" traffic pattern. .....4....., users are changing network traffic patterns as they push for access to corporate
collective; shared
content and applications from any type of device, connecting from anywhere at any time. .....5....., many enterprise data center managers are contemplating a utility computing model which might include a private
think about
cloud, public cloud, or some kind of both. resulting in additional traffic across the wide area network.

East-West traffic: network traffic among devices within a specific data center

North-South traffic: network traffic flowing into and out of a data center

(https://www.opennetworkjng.org)

Building Vocabulary

Using Verbs as Adjectives

Adjectives can be formed from many verbs by adding -ing or -ed. Note the difference in meaning.

The **underlying** network infrastructure is abstracted from the applications.

Administrators can programmatically configure this **simplified** network abstraction.

A. Choose a word from the box to complete each sentence. Change the word into an adjective ending in -ing or -ed and write ·it in the sentence.

increase	change	provide	compute
visualize	network	reduce	

1. SDN makes it possible to manage the entire network through intelligent orchestration and ..... systems.

2. The explosion of mobile devices and content and advent of cloud services are among the trends driving the ..... industry to reexamine traditional network architecture.

3. IT's planning for cloud services must be done in an environment of ..... security, compliance, and auditing requirements.

examination

doing what you are asked to do

4. Faced with flat or ..... budgets, enterprise IT departments are trying to squeeze the most from their networks using device-level management tools and manual processes.

fixed

to get from sth by great effort

5. In today 's ..... data centers, traffic patterns are incredibly dynamic and therefore unpredictable.

6. As the scope of end-user applications increases, the number of .....,.... elements explodes and data-set exchanges among compute nodes can reach petabytes.

10^{15}

7. Carriers and enterprises seek to deploy new capabilities and services in rapid response to ..... business needs or user demands.

B. Pair Work. Work with a partner on the word families and complete the table. Use a dictionary if necessary.

Noun	Verb	Adjective	Adverb
	Provide		
Network			
		Virtual	
	Require		

			Architecturally
Configuration			
		Underlying	

C. Use the information in the table above to complete the sentences.

1. Handling today 's "big data" or mega databases ..... massive parallel processing on thousands of servers, all of which need direct connections to each other.

simultaneous processing of several computer demands

2. Meeting current market requirements is ..... impossible with traditional network architectures.

3. ..... technology to date has consisted largely of discrete sets of protocols designed- to connect hosts reliably over arbitrary distances, link speeds, and topologies.

free; optional

4. To implement a network-wide policy, IT may have to ..... thousands of devices and mechanisms.

5. Service ..... employ large-scale parallel processing algorithms and associated datasets across their entire computing pool.

a collection of resources kept ready for use

6. Software-Defined Networking is an emerging network ..... where network control is decoupled from forwarding and is directly programmable.

data plane

7. Software-Defined Networking separates the network's control logic from the ..... routers and switches.

Word Magnifier

The word "abstract" has got two different meanings in the passage.

1. In the SDN architecture, the control and data planes are decoupled, network intelligence and state are logically centralized, and the underlying network infrastructure is abstracted from the applications.
2. Network operators and administrators can programmatically configure this simplified network abstraction rather than having to hand-code tens of thousands of lines of configuration scattered among thousands of devices.

In the first sentence, "abstracted" means "removed; separated", whereas in the second sentence "abstraction" means "composition".

Final -ing clause is one that technical writers are very fond of using. One common way is to show the result or consequence of the first statement. The subject of the second part is normally the same as the subject of the first part, so that it is not stated. Frequently the words *thus* or *thereby* are added to **emphasize** the meaning. For example,

> "OpenFlow is the first standard interface designed for SDN, **providing** high- performance, granular traffic control across multiple vendors' network devices."

Join these statements together in the same way, using the -ing form of the verb.

1. The control plane and the data plane are bundled inside the networking devices. This reduces flexibility and hinders innovation and evolution of the networking infrastructure.

2. With the separation of control and data planes, the control logic is implemented in a logically centralized controller. This simplifies policy enforcement and network (re)configuration and evolution.

3. A myriad (extremely great in number) of specialized components and middleboxes, such as firewalls, proliferate in current networks. This alleviates (diminish) the lack of in-path functionality within the network.

4. With SDN, cloud-based applications can be managed through intelligent and provisioning systems. This reduces operational (working; running) overhead (costs).

5. SDN controllers provide complete visibility and control over the network. This ensures that access control and other policies are enforced consistently across the network infrastructure.

6. OpenFlow-based SDN architecture abstracts the underlying infrastructure from the applications that use it. This allows the network to become as programmable and manageable at scale as the computer infrastructure that it increasingly resembles.

7. An SDN approach fosters network virtualization. This enables IT staff to manage their servers, applications, storage, and network with a common approach and tool set (a collection of software devices).