Big *Fast* Data, Cognitive Computing, the Cloud, IoT, and Software Defined Networks

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Topics

- Big Data
- Fast Data
- Cognitive Computing
- Cloud Computing
- Internet of Things (IoT)
- Software Defined Networks (SDN) and Network Function Virtualization (NFV)
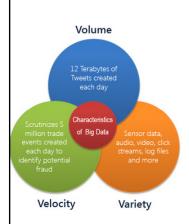- Implications

Big Data

big da·ta

noun COMPUTING

extremely large data sets that may be analyzed computationally to reveal patterns, trends, and associations, especially relating to human behavior and interactions. "much IT investment is going towards managing and maintaining big data"
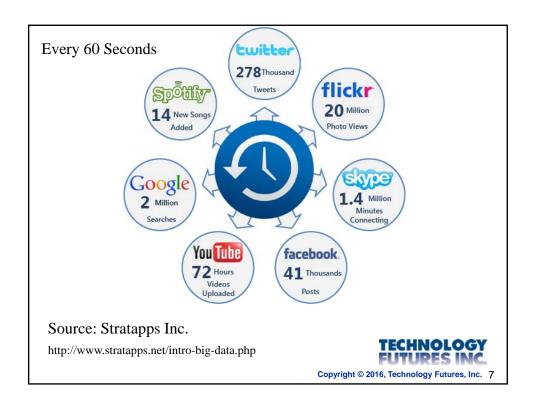
Characteristics of Big Data:

Data scientists break big data into four dimensions: volume, variety, velocity and veracity.
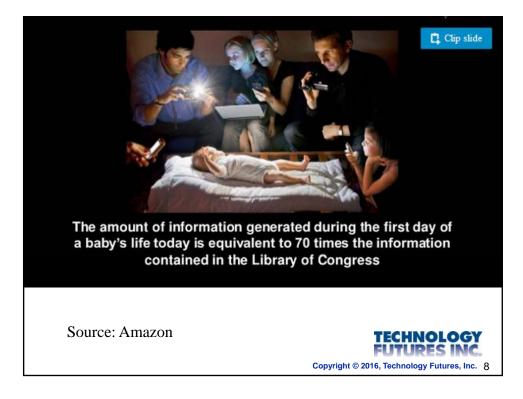
- **Volume**: BIG DATA depends upon how large it is. It could amount to hundreds of terabytes or even petabytes of information.

- **Velocity**: The increasing rate at which data flows into an organization.

- **Variety**: A common theme in big data systems is that the source data is diverse and doesn't fall into neat relational structures.

- **Veracity**: Big Data Veracity refers to the biases, noise and abnormality in data. Is the data that is being stored, and mined meaningful to the problem being analyzed.

Source: Stratapps Inc.

http://www.stratapps.net/intro-big-data.php

Every 60 Seconds

Source: Stratapps Inc.

http://www.stratapps.net/intro-big-data.php

The amount of information generated during the first day of a baby's life today is equivalent to 70 times the information contained in the Library of Congress

Source: Amazon

"If you open Facebook on your phone for 30 seconds, your activity most likely touches more than 1,000 servers."

-- A Peek Inside Facebook's Massive Fort Worth Data Center

http://www.businessinsider.com/inside-facebooks-data-centers-2015-9

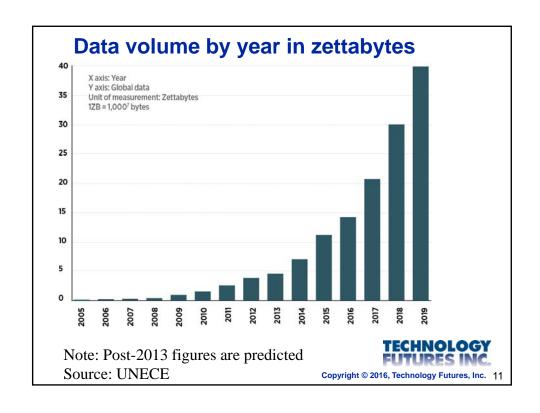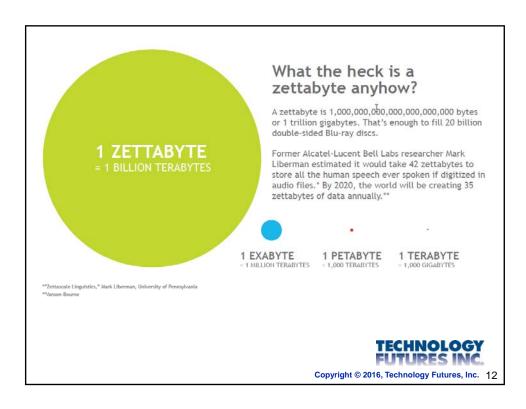**TECHNOLOGY FUTURES INC.**

"Ninety percent of the world's data has been created in the last two years"

- George Lee, chief information officer, Goldman Sachs

https://www.streamdatacenters.com/news/2015/09/the-internet-of-things-and-data-centers

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Data volume by year in zettabytes

X axis: Year
Y axis: Global data
Unit of measurement: Zettabytes
$1 ZB = 1,000^7$ bytes

Note: Post-2013 figures are predicted
Source: UNECE

What the heck is a zettabyte anyhow?

A zettabyte is 1,000,000,000,000,000,000,000 bytes or 1 trillion gigabytes. That's enough to fill 20 billion double-sided Blu-ray discs.

Former Alcatel-Lucent Bell Labs researcher Mark Liberman estimated it would take 42 zettabytes to store all the human speech ever spoken if digitized in audio files.* By 2020, the world will be creating 35 zettabytes of data annually.**

1 ZETTABYTE = 1 BILLION TERABYTES

1 EXABYTE = 1 MILLION TERABYTES

1 PETABYTE = 1,000 TERABYTES

1 TERABYTE = 1,000 GIGABYTES

*"Zettascale Linguistics," Mark Liberman, University of Pennsylvania
**Vanson-Bourne

Fast Data

■ InfoWorld

NEW TECH FORUM
By John Hugg

About
Emerging tech dissected by technologists

Fast data: The next step after big data

InfoWorld | Jun 11, 2014

The way that big data gets big is through a constant stream of incoming data. In high-volume environments, that data arrives at incredible rates, yet still needs to be analyzed and stored.

John Hugg, software architect at VoltDB, proposes that instead of simply storing that data to be analyzed later, perhaps we've reached the point where it can be analyzed as it's ingested while still maintaining extremely high intake rates using tools such as Apache Kafka.

-- Paul Venezia

http://www.infoworld.com/article/2608040/big-data/fast-data--the-next-step-after-big-data.html

Traditional Big Data

Capture ⟶ Store ⟶ Analyze

Fast Data

Capture ⟶ Analyze ⟶ Act
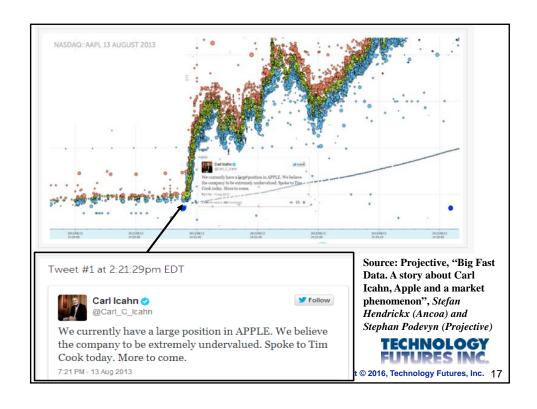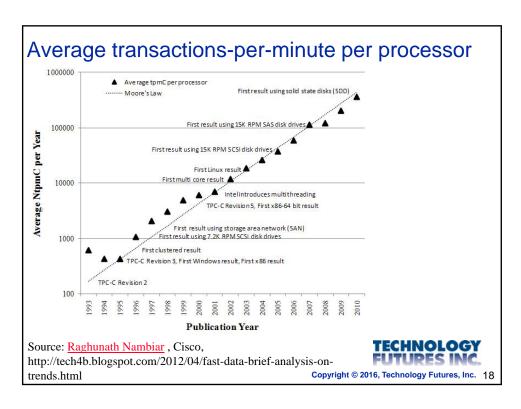
Fast Data Applications

- Proactively manage threats
  - spot fraud patterns or equipment issues
- Identify opportunities –
  - act on opportunities with first-mover advantage
- Personalize customer engagement
  - create a personal interaction on-the-fly using real-time data and stored data about the customer
- Make accurate predictions.
  - combine the relevance and freshness of realtime with deep analytics on stored data

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Average transactions-per-minute per processor

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Cognitive Computing

Cognitive Computing Definition

Cognitive computing refers to systems that learn at scale, reason with purpose and interact with humans naturally. Rather than being explicitly programmed, they learn and reason from their interactions with us and from their experiences with their environment.

Source: John E. Kelly III, "Computing, cognition and the future of knowing", IBM, 2015

Cognitive Computing Tools

- Machine Learning
- Data Mining
- Pattern Recognition
- Natural Language Processing

Cognitive Computing Core Capabilities

- Create deeper human engagement
- Scale and elevate expertise
- Infuse products and services with cognition
- Enable cognitive processes and operations
- Enhance exploration and discovery

Source: John E. Kelly III, "Computing, cognition and the future of knowing", IBM, 2015

Cognition enables new classes of products and services to sense, reason and learn about their users and the world around them.

This allows for continuous improvement and adaptation, and for augmentation of their capabilities to deliver uses not previously imagined.

We see this happening already with cars, medical devices, appliances and even toys. The Internet of Things is dramatically expanding the universe of digital products and services — and where code and data go, cognition can now follow.

Source: John E. Kelly III, "Computing, cognition and the future of knowing", IBM, 2015

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≡ COMPUTERWORLD

NEWS

IBM unveils new APIs, 'experience centers' for Watson IoT unit
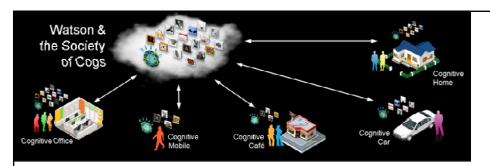
Global headquarters will be located in Munich

By Marc Ferranti   FOLLOW

IDG News Service | Dec 15, 2015 1:00 AM PT

Strengthening its push into the Internet of Things, IBM is making a range of application programming interfaces (APIs) available through its Watson IoT unit and opening up new facilities for the group.

The unit, formed earlier this year with a $3 billion investment into IoT, will have its global headquarters in Munich, IBM announced Tuesday.

IoT will soon be the largest source of data in the world but, IBM officials point out, almost 90 percent of that information is never acted on -- at least not yet.

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Watson & the Society of Cogs

Cognitive Home
Cognitive Office
Cognitive Mobile
Cognitive Café
Cognitive Car

As people inhabit and move across many physical environments, we see a fluid, coherent computing experience through space and time, connected by an ecosystem of cognitive environments inhabited by a society of specialized software agents called cogs. Cogs work in a mutually beneficial partnership with humans to enable better complex data-driven decision-making. We call these partnerships Symbiotic Cognitive Systems.

Source: "A Symbiotic Cognitive Experience Human-computer collaboration at the speed of thought", IBM Research, http://researcher.ibm.com/researcher/view_group.php?id=541

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The Human Application of Cognitive Computing and Big Data

By Shannon Kempe / May 12, 2015 / 0 Comments

by Jelani Harper
The myriad marvels of Cognitive Computing were best defined by IBM Big Data evangelist James ...[H]e called it pattern recognition facilitating automated decision making, and some of its more innovative details include:

Its propensity to revolutionize Big Data analytics...[It] can incorporate a virtually unlimited number of data sources (regardless of structure, type, and location) and provide a profound degree of predictive analytics that can expeditiously influence decision making.

Its ability to transform Data Lakes to data streams: ...Cognitive Computing applications can transform these repositories [Data Lakes] to automate action in real time.

From Data Lakes to Data Streams

The automation capabilities of Cognitive Computing applications are highly advantageous to revamping the Data Lake format from a static repository to one which inherently creates action from real-time data... True value is produced when organizations are able to combine their real-time data in a data stream with traditional offline processed batch data to create a unified view of various business processes, products, service, customers, etc.

Cloud Computing
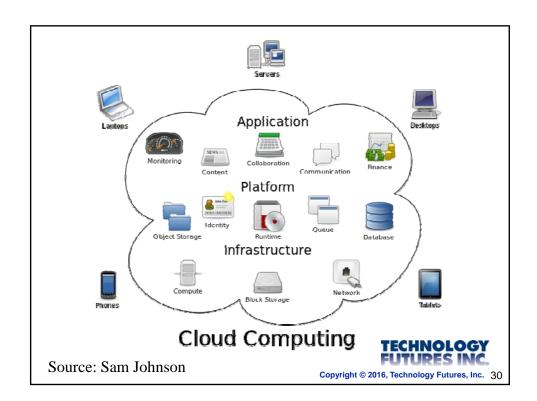
cloud com·put·ing
noun

1.the practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer.

Source: Sam Johnson

The NIST Definition of Cloud Computing

Special Publication 800-145

NIST — National Institute of Standards and Technology — U.S. Department of Commerce

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Essential Characteristics:
- On-demand self-service.
- Broad network access
- Resource pooling.
- Rapid elasticity
- Measured service.
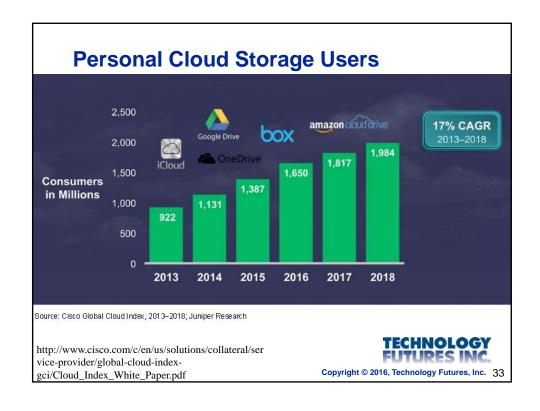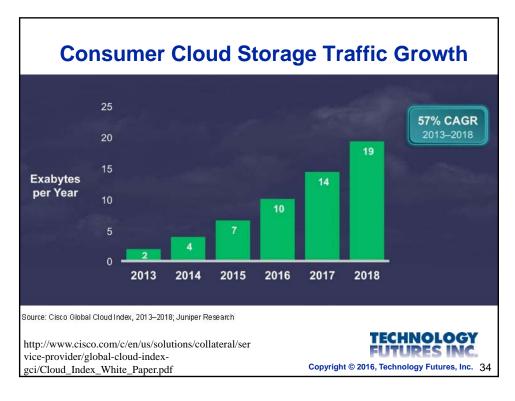
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Total Data Center Traffic Growth

Source: Cisco Global Cloud Index, 2013–2018

http://www.cisco.com/c/en/us/solutions/collateral/service-provider/global-cloud-index-gci/Cloud_Index_White_Paper.pdf

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Personal Cloud Storage Users

Source: Cisco Global Cloud Index, 2013–2018; Juniper Research

http://www.cisco.com/c/en/us/solutions/collateral/service-provider/global-cloud-index-gci/Cloud_Index_White_Paper.pdf

Consumer Cloud Storage Traffic Growth

Source: Cisco Global Cloud Index, 2013–2018; Juniper Research

http://www.cisco.com/c/en/us/solutions/collateral/service-provider/global-cloud-index-gci/Cloud_Index_White_Paper.pdf

12/29/2014
08:36 AM

9 Cloud Trends For 2015

In 2015, expect to see the cloud mature as a platform for hybrid operations, with cloud data centers achieving new efficiencies through containers.

the size of the public-facing site or the amount of traffic that uses it. Amazon remains the number-one public-facing site overall.

What's Digital Ocean's secret? Advanced technical infrastructure, heavily

Charles
Babcock

9. IoT meets big data.

Intel launched its Internet of Things Platform on Dec. 10 to help manage the connectivity and security of proliferating sensors and devices. The value of the secure and connected devices, however, will only increase in 2015 as the Internet of Things meets big data. As data streams into Hadoop and other big-data repositories, groups like the Industrial Internet Consortium, in which Intel, IBM, GE and Cisco are members, can collect information from large manufacturing operations and facilities and discover ways to reduce energy consumption, save time, and shave costs off manufacturing lines. Managing large buildings and individual homes will likewise benefit from analysis of data collected from local networks. It's been primarily an abstraction so far, but the Internet of Things will become real in 2015.

- http://www.informationweek.com/cloud/software-as-a-service/9-cloud-trends-for-2015/a/d-id/1318086?page_number=2

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Trend 4: Potential Cloud Catalysts—Internet of Everything

This section reviews the potential impact of IoE on the growth of cloud services. Cloud-based services are essential for most IoE applications, which increases the ability for people, data, and things to communicate with one another over the Internet.

The IoE is generating large volumes of data, and currently only a small portion of that data reaches the data center. Although data center traffic is anticipated to reach 8.6 ZB in 2018, the total volume of data generated by IoE in 2018 will be more than 400 ZB, or nearly 50 times higher than the sum total of data center traffic. For example:

- A Boeing 787 generates 40 terabytes (TB) per hour of flight, half a TB of which is ultimately transmitted to a data center for analysis and storage.
- A large retail store collects approximately 10 gigabytes (GB) of data per hour, and 1 GB of that is transmitted to a data center.
- An automated manufacturing facility generates approximately 1 TB of data per hour, and 5 GB of that is transmitted to a data center.
- A mining operation such as that of Rio Tinto can generate up to 2.4 TB per minute.

As data center capacity improves, more of the data generated locally by the IoE may be transmitted to a data center, and the remaining data may still be available for analysis through data virtualization, which enables analysis of distributed data sources.

Source: Cisco Global Cloud Index: Forecast and Methodology, 2013–2018

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The Internet of Things (IoT)

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webopedia

The **Internet of Things** (**IoT**) refers to the ever-growing network of physical objects that feature an IP address for internet connectivity, and the communication that occurs between these objects and other Internet-enabled devices and systems.

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Investments In IoT Solutions By Industry

Source: BI Intelligence Estimates

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http://lineshapespace.com/construction-site-safety/?utm_source=Outbrain&utm_medium=content%20syndication&utm_campaign=Outbrain%20OCTFY16&utm_term=2733956

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Estimated Number of Installed IoT Devices by Sector

BI Intelligence

Source: BI Intelligence Estimates

STUDY IN PROGRESS

New Telecommunications Services for Business and Society 1990-2010

To quantify new telecommunications needs and their impact on the network

Circa 1990

Objectives of the New Services Study...

To quantitatively forecast new telecommunications needs and their impact on technology adoption in the telecommunications network.

To update existing forecasts of technology adoption and obsolescence in switching, outside plant, and circuit equipment.

To communicate with regulators, policymakers, customers, suppliers, and TTFG member-company employees about the importance of new services and their network impact.

APPLICATION AREAS

Image Transmission: How will advances in technology and digital communications change the way we create, store, and communicate images? The study will address both high-speed digital facsimile and computer-to-computer graphics. Some key applications are graphic arts, medical imaging, mapping, and records management. Technologies to be examined include facsimile equipment, scanners, graphics printers, image storage and retrieval systems, and personal computers and workstations.

Interactive Multimedia: Systems that combine data, text, audio, image, and video in a single interactive user interface are beginning to emerge. Early systems include DVI by Intel for business applications and CD-I by Phillips for home applications. Applications will include sales demonstrations, training, education, entertainment, multimedia presentations, and information systems. Although initially provided on stand-alone systems with optical disks, multi-media systems—especially the interactive aspects—can benefit from high-speed digital communications.

LAN Interconnections: Local Area Networks (LANs) provide the backbone for distributed information processing and data communications at many business locations. Operating at very high data rates, LANs provide the instantaneous computer communications needed for interactive applications. However, connecting LANs at different locations today requires either very expensive digital private lines or very slow communications over the voice network. New services such as the Switched Multi-megabit Data Service (SMDS) may soon provide an economical, high-performance solution.

Voice/Data: New developments such as ISDN, Signalling System 7, and the enhanced network, will enable improved voice and data services. For voice, digital access promises better quality, advanced signalling capabilities, and, eventually, lower CPE and network costs. For data, it promises higher-speed, more reliable, and more economical communications compared to even the best modems at any price. A key issue: When will access costs and equipment costs fall to the level required for universal ISDN service?

Video Communications: Video communications is a reality today, albeit an expensive one. Falling costs for digital transmission, video codecs, and video and electronics components will make desktop, as well as conference room, video communications more economical. Video conference calls, complete with graphical interfaces for control, will ameliorate many of the problems with today's audio conference calls. Tried and found lacking in the 1960s, widespread video communications may finally emerge in the 1990s, a product of the continuing revolution in computers, fiber optics, and consumer video electronics.

Television: A number of important technical, economic, business, legal, and regulatory issues need to be resolved before a clear picture emerges of the telephone companies' future role in the provision of television via fiber to the home. However, both the benefits for consumers and the network impact are potentially tremendous. Although all issues will be considered, the focus will be on technological, economic, and marketing aspects of providing transport for standard CATV broadcasting and pay-per-view narrowcasting.

Advanced Television: [text partially cut off] ... tion and broad... than conventio... term ATV is u... the more fami... avoid confusi... particular syst... even greater h... standard TV, ... distant and ur... issues include... display techno... economics, ma... tance, and alte... delivery mech... including opti... systems.

**Software Defined Network (SDN)
and
Network Function Virtualization (NFV)**

webopedia

Software defined networking (**SDN**) is an approach to using open protocols, such as OpenFlow, to apply globally aware software control at the edges of the network to access network switches and routers that typically would use closed and proprietary firmware.
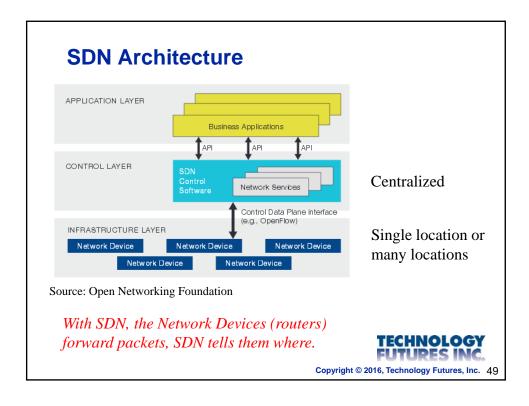

SDN Definition

Software Defined Networking (SDN) is an emerging network architecture where network control is decoupled from forwarding and is directly programmable.

This migration of control, formerly tightly bound in individual network devices, into accessible computing devices enables the underlying infrastructure to be abstracted for applications and network services, which can treat the network as a logical or virtual entity.

Source: Open Networking Foundation

SDN Architecture

APPLICATION LAYER

Business Applications

API   API   API

CONTROL LAYER

SDN Control Software

Network Services

Control Data Plane interface (e.g., OpenFlow)

INFRASTRUCTURE LAYER

Network Device   Network Device   Network Device

Network Device   Network Device

Centralized

Single location or many locations

Source: Open Networking Foundation

With SDN, the Network Devices (routers) forward packets, SDN tells them where.

Drivers for SDN

OPEN NETWORKING FOUNDATION

- Changing Traffic Patterns
  - e.g. Client/Server to Multiple Server
- The Consumerization of IT
  - e.g. Bring your own device
- The Rise of Cloud Services
- Big Data means More Bandwidth

Source: Open Networking Foundation

SDN Benefits

- Centralized control of multi-vendor environments
- Reduced complexity through automation
- Higher rate of innovation
- Increased network reliability and security
- More granular network control:
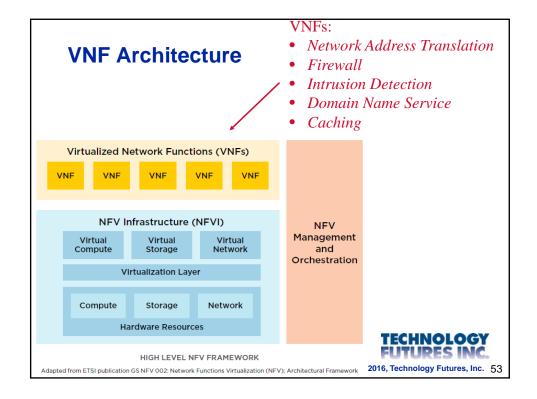- Better user experience

Source: Open Networking Foundation

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NFV Definition

Network Functions Virtualization (NFV) decouples network services from the hardware that delivers them. As a result, functions, such as network address translation (NAT), firewalling, intrusion detection, domain name service (DNS) and caching, can be delivered in software and deployed on general purpose appliances. This gives organizations a lot more flexibility in the way they design, deploy and manage their network services.

Source: SDxCentral

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VNF Architecture

VNFs:
- *Network Address Translation*
- *Firewall*
- *Intrusion Detection*
- *Domain Name Service*
- *Caching*

Virtualized Network Functions (VNFs)

| VNF | VNF | VNF | VNF | VNF |

NFV Infrastructure (NFVI)

| Virtual Compute | Virtual Storage | Virtual Network |

Virtualization Layer

| Compute | Storage | Network |

Hardware Resources

NFV Management and Orchestration

HIGH LEVEL NFV FRAMEWORK

Adapted from ETSI publication GS NFV 002: Network Functions Virtualization (NFV); Architectural Framework

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NFV Benefits

- **Reduce Capital Expenditures**
- **Reduce Operational Expenditures**
- **Accelerate Time-to-Market**
- **Deliver Agility and Flexibility**

Source: SDxCentral

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Reduce Operational Expenditures

- Use of commodity servers
- Built in redundancy and availability
- Shared infrastructure from a cloud provider(s)

"A side benefit of using less expensive commodity hardware is that an organization can potentially cycle the hardware more often to improve the overall performance of the network. By upgrading the network every 2 to 3 years, instead of the traditional 5 to 7, an organization can continue to effectively address the changing demands placed on their network and increase the value captured throughout the lifetime of those servers."

Source: SDxCentral

Reduce Operational Expenses

- No need to deploy, manage and maintain specialized hardware.
- Reduced space, power and cooling costs
- Greater flexibility and less complexity in management; organizations can quickly and easily templatize deployments

"Common automation and operating procedures utilized by commodity hardware simplifies roll out and ongoing management. Standardized hardware, as well as standardized software, such as hypervisors and orchestration systems, often use automation scripts and platforms that deliver, on average, management efficiencies between 1:10/1:100 to 1:1000."

Source: SDxCentral

FierceTelecom

NEWS   TOPICS   ANALYSIS   FEATUR

Topics: Service Provider Strategies

AT&T accelerates SDN vision by extending network on demand capability to 100 cities

April 7, 2015 | By Sean Buckley

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AT&T (NYSE: T) has taken another step forward with its software-enabled service vision, announcing that its switched Ethernet service with its Network on Demand capability is available in more than 100 U.S. cities.

By using the Network on Demand feature, businesses can go to an online portal to order additional ports, add or change services, or increase bandwidth to accommodate fluctuating needs and manage their network.

What all of this means is that customers can more effectively plan and quickly react to changes in their business needs. A user can immediately increase bandwidth in just a few minutes, a process that once took weeks of manual processes.

Will connect 75% of network to SDN by 2020; 5% in 2015

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FierceTelecom

NEWS   TOPICS   ANALYSIS   FEATURES

Topics: Service Provider Strategies

Verizon's SDN strategy will migrate aging wireline platforms to software

April 28, 2015 | By Sean Buckley

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Verizon (NYSE: VZ) is implementing software-defined networking throughout its networks to improve service timelines. For the company's wireline network, the initial focus will be on migrating legacy elements and functions onto software-based platforms.
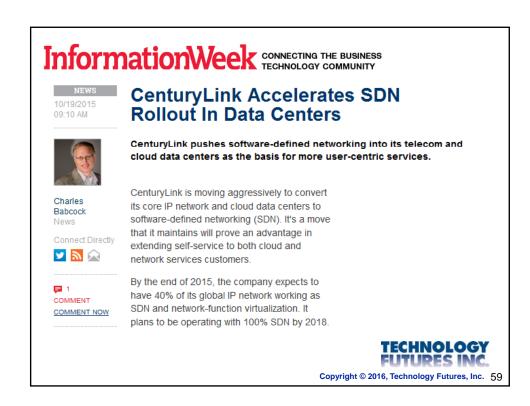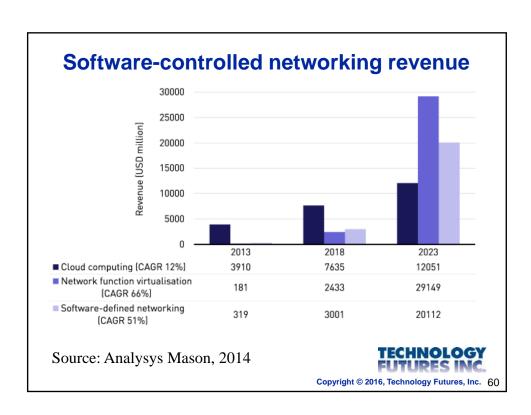
To assist in its SDN network vision, the service provider has employed the help of five of its key vendor partners: Alcatel-Lucent (NYSE: ALU), Cisco, Ericsson (NASDAQ: ERIC), Juniper Networks and Nokia (NYSE:NOK).

Brian Higgins, Verizon's vice president of network planning, told *FierceTelecom* that from a wireline perspective, SDN will to be used to replace aging hardware-based network elements with software.

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InformationWeek CONNECTING THE BUSINESS TECHNOLOGY COMMUNITY

NEWS
10/19/2015
09:10 AM

CenturyLink Accelerates SDN Rollout In Data Centers

CenturyLink pushes software-defined networking into its telecom and cloud data centers as the basis for more user-centric services.

Charles Babcock
News

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CenturyLink is moving aggressively to convert its core IP network and cloud data centers to software-defined networking (SDN). It's a move that it maintains will prove an advantage in extending self-service to both cloud and network services customers.

By the end of 2015, the company expects to have 40% of its global IP network working as SDN and network-function virtualization. It plans to be operating with 100% SDN by 2018.

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Software-controlled networking revenue

	2013	2018	2023
■ Cloud computing (CAGR 12%)	3910	7635	12051
■ Network function virtualisation (CAGR 66%)	181	2433	29149
■ Software-defined networking (CAGR 51%)	319	3001	20112

Source: Analysys Mason, 2014

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Mutually Supporting Trends

- Big Data
- Fast Data
- Cognitive Computing
- Cloud Computing
- Internet of Things (IoT)
- Software Defined Networks (SDN) and Network Function Virtualization (NFV)

Implications

- Rapid innovation across data centers, networks, and premises
- Interdependence between data centers and networks
- Rapidly increasing performance requirements
- Rapidly improving technologies
- Widespread and massive investments
- Frequent upgrades and rapid obsolescence

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