

IP Evolution

2016 ACE SCHOOL & RUS SYMPOSIUM
Marriott Riverwalk – San Antonio, TX

IP Evolution

Outline

1. Overview and Quotes- NFV and SDN
2. What is NFV & SDN
3. Impacts and Benefits of NFV and SDN
4. IPv6 and IoT
5. Summary

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Overview and Quotes

Martin Taylor, CTO, Metaswitch White Paper:

“NFV and SDN represent the most significant pivot in the telecom industry since the transition from TDM to packet got underway a decade or more ago”

“Single most important technology event in the telecom industry since the arrival of digital switching”

“The vision of the future will only be achieved by network operators who embrace NFV and SDN fully and are prepared to implement fundamental organizational transformation to make the most of what they enable.”

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Overview and Quotes

July 2, 2015 Light Reading:

FCC Chairman Talks Up SDN/NFV

"My conviction is that **we are on the cusp** of when our broadband networks will prove even **more transformative than the networks of the 19th century**," said Wheeler in a [speech at the Brookings Institution](#). "That belief is based upon this new fact: broadband networks are new in a new way. That new way is the **evolution from hardware-based networks to ones that are software-based** with the result that changes the nature of networks."

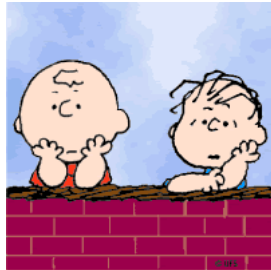
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Overview and Quotes

Remember when...

Source: Adtran

Someday, your network won't be switching circuits but rather handling packets of various lengths.



Someday, your network won't be made up of switches and routers but instead virtual machines controlling simple physical devices.



IP Evolution Overview

SDN&NFV takes advantage of lessons learned From Cloud Computing....

Automation

Centralization

Virtualization

Dynamic

Agile

Openness

Innovation- 3rd party development + IoT opportunities?

IP Evolution- What is NFV?

Adva/Overture Networks



IP Evolution- What is NFV?

Network Functions Virtualization (NFV)

- Separates the **services** and **functions** (software) from the **hardware**
- A standardized, open network, software-based approach which focuses on **services** and **function**
- Uses cloud management software such as OpenStack- software that controls large pools of compute, storage, and networking resources throughout a datacenter, managed through a dashboard or via the OpenStack API (**Uses a MANO to Instantiate Virtual Network Functions (VNFs)**)

IP Evolution-What is SDN?

Software-Defined Networking (SDN)

- The logical **separation** of the **data plane** (packet forwarding) from the **control plane** (brains) (layers 1-3)
- Control plane is pure software designed to run on industry-standard hardware (COTS)
- SDN centralized controller and uses **OpenFlow** or other API Protocols to communicate to the data plane via a secure control channel
- Data plane runs on specialized or industry-standard x86 server hardware (COTS, White Boxes)

IP Evolution-What is SDN?

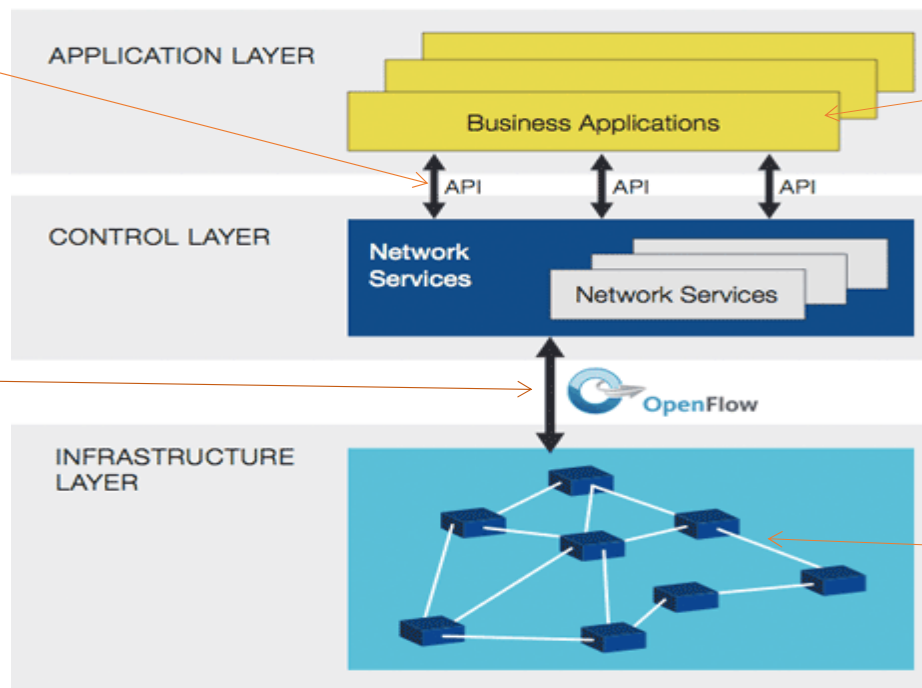
Software-Defined Networking (SDN)

- A **centralized SDN controller** controls how network devices forward packets, and provides an abstract, centralized view of the overall network.
- Network devices move packets between ports according to policies/flow tables from SDN Controllers. Packets that require special handling go to the SDN controller for processing
- **Uses Flows** (12 match fields +) and can control down to the device
- SDN tutorial:

https://www.youtube.com/watch?v=IPL_oQT9tmc

IP Evolution- What is SDN?

Source: ONF



Protocols:
REST, Java,
Python, YANG,
etc.-Depends on
Controller!

OpenFlow
Protocol changes
the Flow Tables in
the OpenFlow
Enabled Devices –
12 fields which
includes the MAC
address thus can
control down to
the device

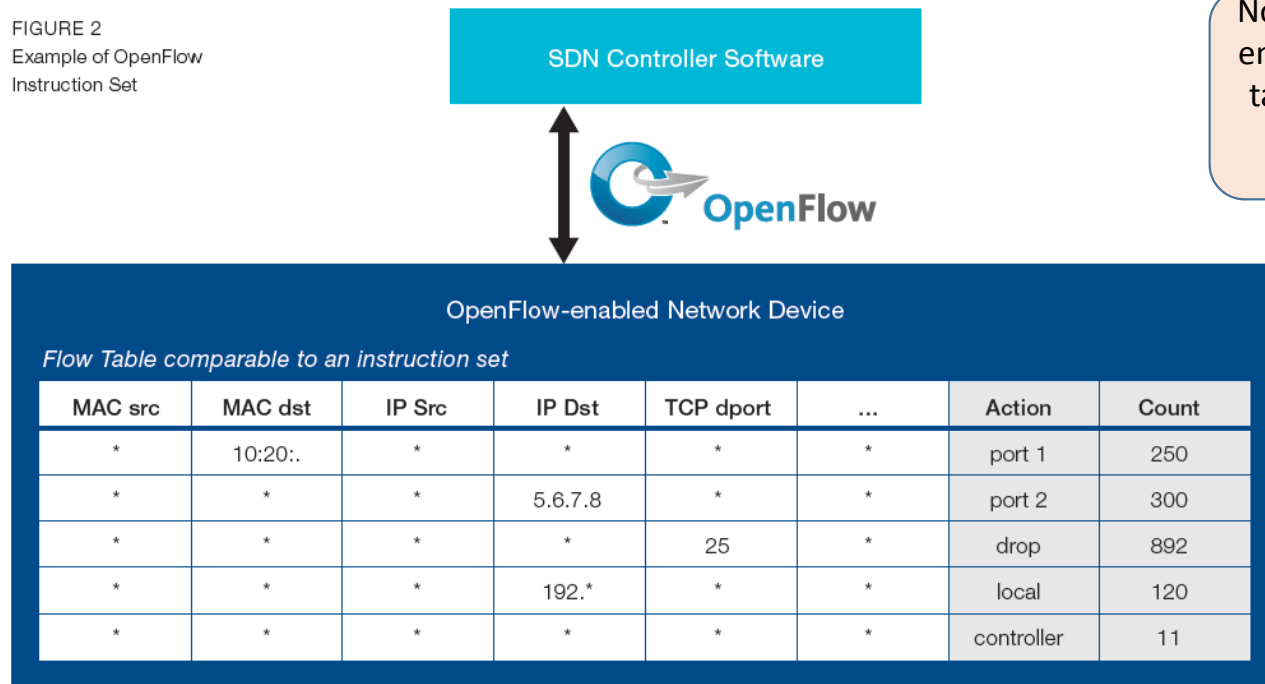
Applications
Development by 3rd
Parties – not
equipment vendors

Approximately 22
Controllers but Open
Daylight and ONOS
are predominate for
Carriers

The **Controller** has entire view
of network elements and can
change packet flow on the fly
with OpenFlow

IP Evolution-What is SDN?

FIGURE 2
Example of OpenFlow
Instruction Set



Note that SDN OpenFlow enabled devices use flow tables with flow entries to control packets forwarded

IP Evolution-What is SDN?

Five Key Traits:

1. Plane Separation
2. Simplified Devices
3. Centralized Control
4. Network Automation and Virtualization
5. Openness

IP Evolution-What is SDN?

Three Main Implementation Solutions

1. Open SDN
2. Hypervisor Overlay
3. SDN via APIs

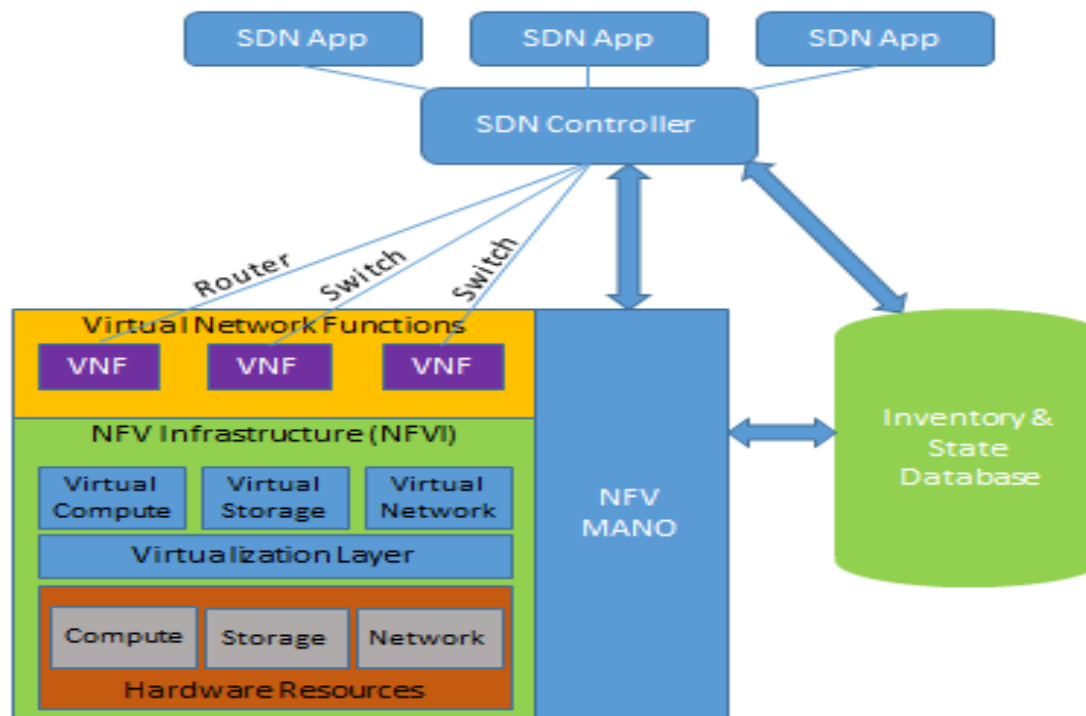
IP Evolution-What is SDN?

Where Do These Clouds and Data Centers Reside?

- That depends on your Vision, Mission and Strategy....BUT
 - Central Offices being converted to data centers/private clouds
 - At the carrier edge*
 - At the service provider edge
 - At the enterprise
 - And in The Cloud like Amazon, etc.
 - Combination of all

*Note: Carrier and Service Provider are not necessarily the same

IP Evolution-NFV vs. SDN



Source: University of Texas, Dallas
Prof. Tim Culver

IP Evolution-NFV/SDN

Business Market Ramifications

- Low End Market Value by 2018 = \$11B
- High End Market Value by 2020 = \$105B
- SDN/NFV Software Will Make Up **Three Quarters** of the Vendors Revenues in 2018

Professor Tim Culver PhD., University of Texas, Dallas

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Impacts and Benefits of NFV & SDN

- Lowers hardware cost by replacing dedicated appliances with **mass produced** commercial off-the-shelf hardware (COTS)
- Centralizes and automates processes-Orchestration
- Reduces CapEx and OpEx
- Potential CapEx savings of 30-40% in some applications based on actual business case and in addition multiple VNFs can be chained in one appliance

IP Evolution- NFV & SDN Benefits

- Positions provider to better compete with OTT (SD-WAN) and Managed Service Providers (MSPs)*
- Enables innovation of functions and services by 3rd parties thus provider is not tied to proprietary hardware and software vendors' capabilities and creativity
- In its first forecast of the **SD-WAN market**, IDC estimates that worldwide SD-WAN revenues will exceed \$6 billion in 2020 with a compound annual growth rate of more than 90 percent over the 2015-to-2020 forecast period. And they found that by the end of 2016, 13 percent of North American enterprises will be in live production of the technology, and 62 percent will be in lab trials. And **by 2018, 82 percent of respondents expect to be in live production of SD-WAN**

Source: SDxCentral

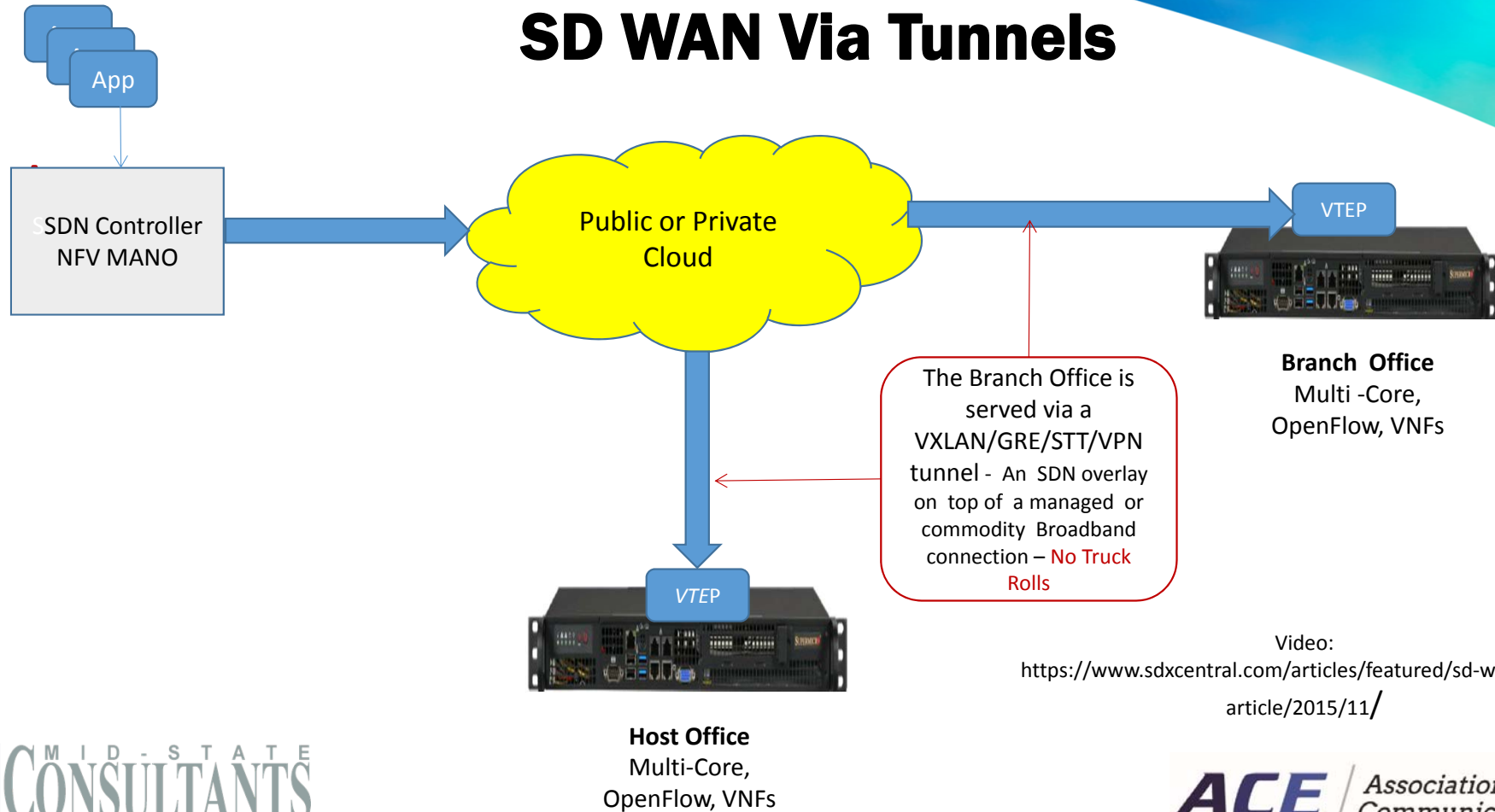
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Business Impacts of NFV & SDN

- Positions Carrier to better compete with **OTT** and **MSPs**
 - SD-WAN
 - Uses GRE/VXLAN/STT/VPN Tunnels with Virtual Terminal End Points (VTEP) – Automated and quickly deployed anywhere
 - **Dedicated/Special Circuits/MPLS not necessarily required**
 - Cookie Cutter MSP Edge- High Margin Business

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SD WAN Via Tunnels



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SD WAN Via GRE Tunnel

Source: Software Defined Networks -A Comprehensive Approach by Paul Gorransson and Chuck Black

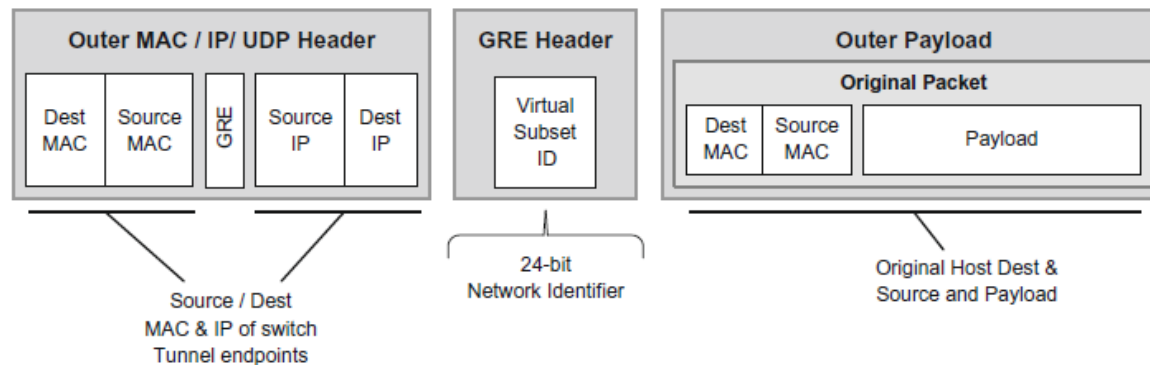


FIGURE 7.4

NVGRE packet format.

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Internet of Things- IoT

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Internet of Things- IoT

- Cisco – 24 Billion connected devices by 2019
- ESRI – 50 Billion connected devices by 2020
- Morgan Stanley – 75 Billion connected devices by 2020
- Huawei – 100 Billion connected devices by 2025
- Goldman Sachs cites the Internet of Things as a \$7 trillion opportunity by 2020

IOT

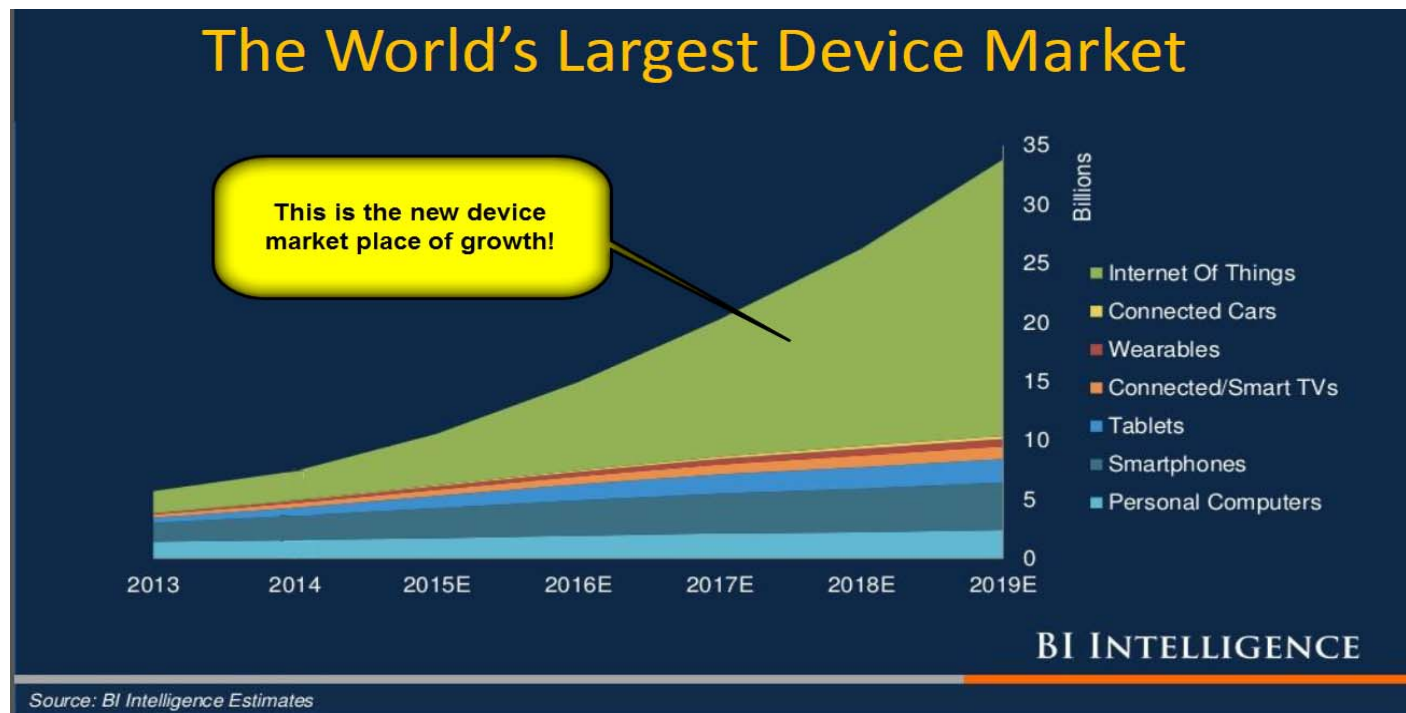
What's making the IoT Possible Today?

A driving confluence of several technologies & market trends such as:

- Ubiquitous Connectivity
- Widespread adoption of IP-based networking
- Computing Economics
- Miniaturization
- Advances in Data Analytics
- Rise of Cloud Computing
- ETSI Standard published March 2016= oneM2M Web Site

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Internet of Things



The Way IoT will change our business models

5 Ways IoT Will Create New Opportunities

FMC DIGITAL
UNIVERSE
INFOBRIEF

With Research & Analysis by IDC



New business models

The IoT will help companies create new value streams for customers, speed time to market, and respond more rapidly to customer needs.



Real-time information on mission-critical systems

Enterprises can capture more data about processes and products more quickly and radically improve market agility.



Diversification of revenue streams

The IoT can help companies monetize additional services on top of traditional lines of business.



Global visibility

The IoT will make it easier for enterprises to see inside the business, including tracking from one end of the supply chain to the other, which will lower the cost of doing business in far-flung locales.



Efficient, intelligent operations

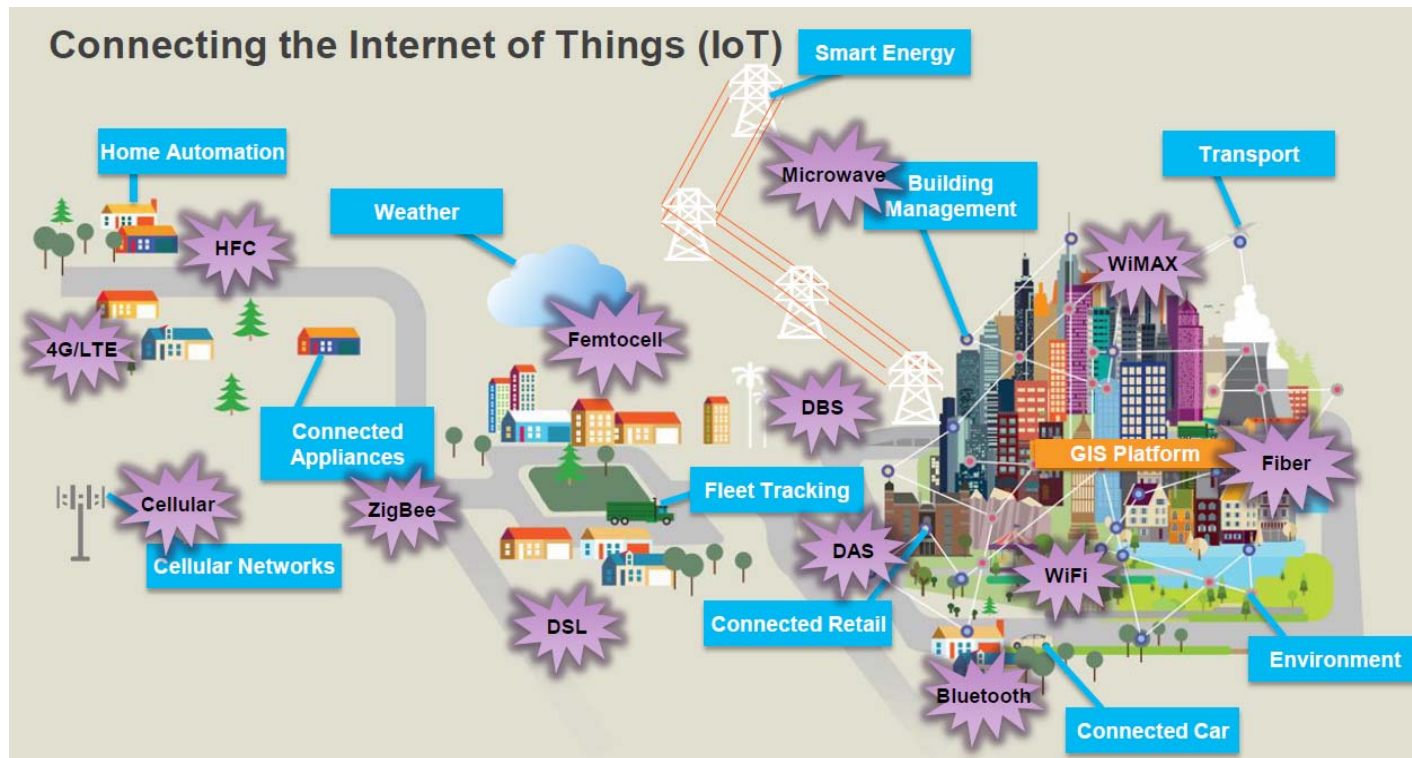
Access to information from autonomous endpoints will allow organizations to make on-the-fly decisions on pricing, logistics, and sales and support deployment.

IDC
INFORM THE FUTURE

9

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The Internet of Things



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Device-to-Gateway Model

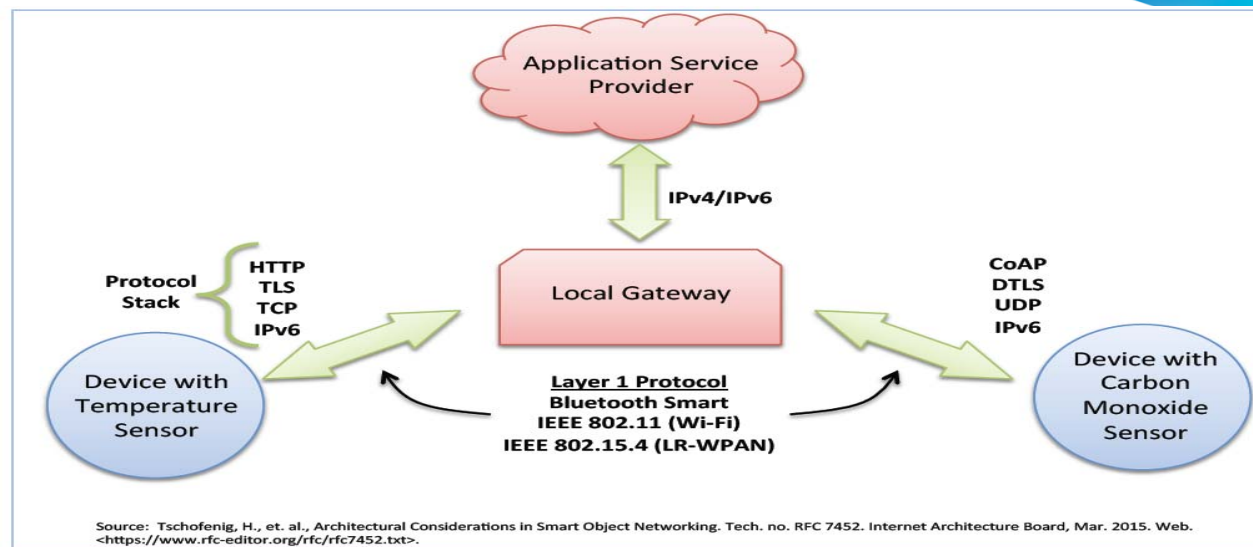
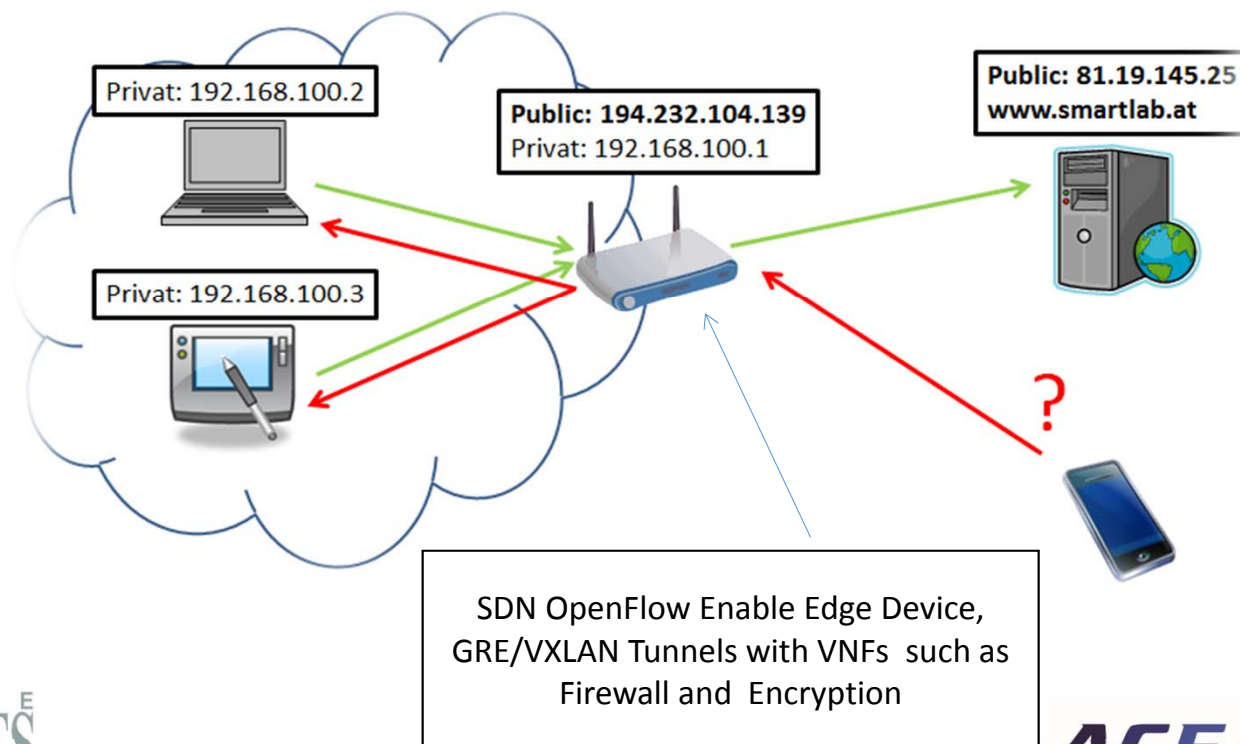


Figure 3. Device-to-gateway communication model diagram.

- An application software operating on a local gateway device, which acts as an intermediary between the device and the cloud service.
- Integrates legacy networks; Non-IP based systems, (IPV4/IPV6)
Multiple API's

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IoT- SDN Playing Key Role



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IoT- Security

Example- Not an endorsement!

- HIPswitch does more than put a Band-Aid on existing approaches to network security. Unlike IP addresses, these identities can't be spoofed
- Creates an identity-based overlay network with AES-256
- Uses Host Identity Protocol (HIP), which replaces IP addresses
- It makes a compelling model for securing **Internet of Things** devices on the network.



Source: TechTarget – Network Evolutions 3/16

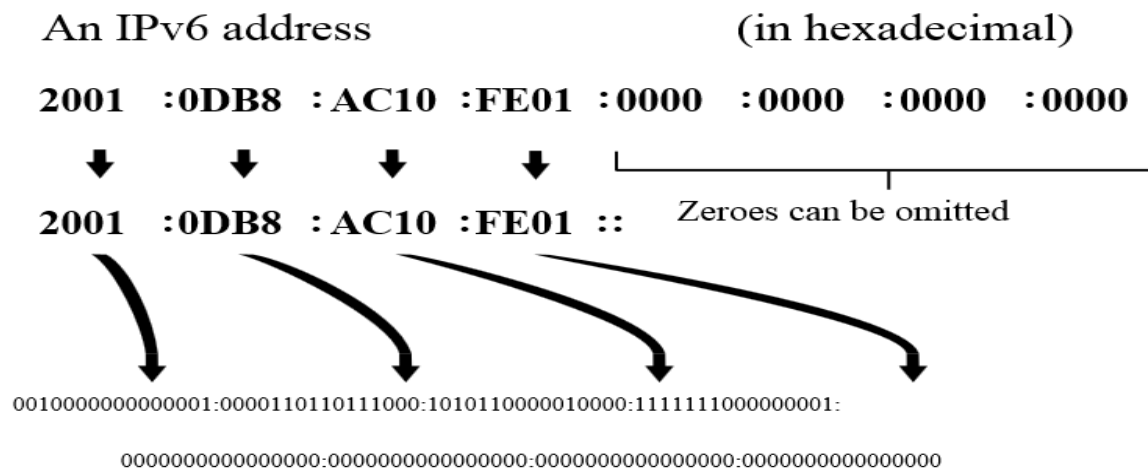
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IP v6

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IPv4 vs. IP v6

- IPv4 = supports 4.3 Billion Devices
- IPv6 = supports approx. 340 Trillion, Trillion , Trillion addresses



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IP v6

IPv6 adoption by country-by rank left to right:

35.9 % -Belgium	22.5% -Greece	21% -Switzerland	20.9% -Germany
20.4% -Portugal	17.4%- USA	16.3%- Luxembourg	12.9%- Ecuador
12.6%- Malaysia	12.4% -Estonia	9.4%- France	8.6% - Japan

<https://www.stateoftheinternet.com/trends-visualizations-ipv6-adoption-ipv4-exhaustion-global-heat-map-network-country-growth-data.html#networks> 3/29/2016

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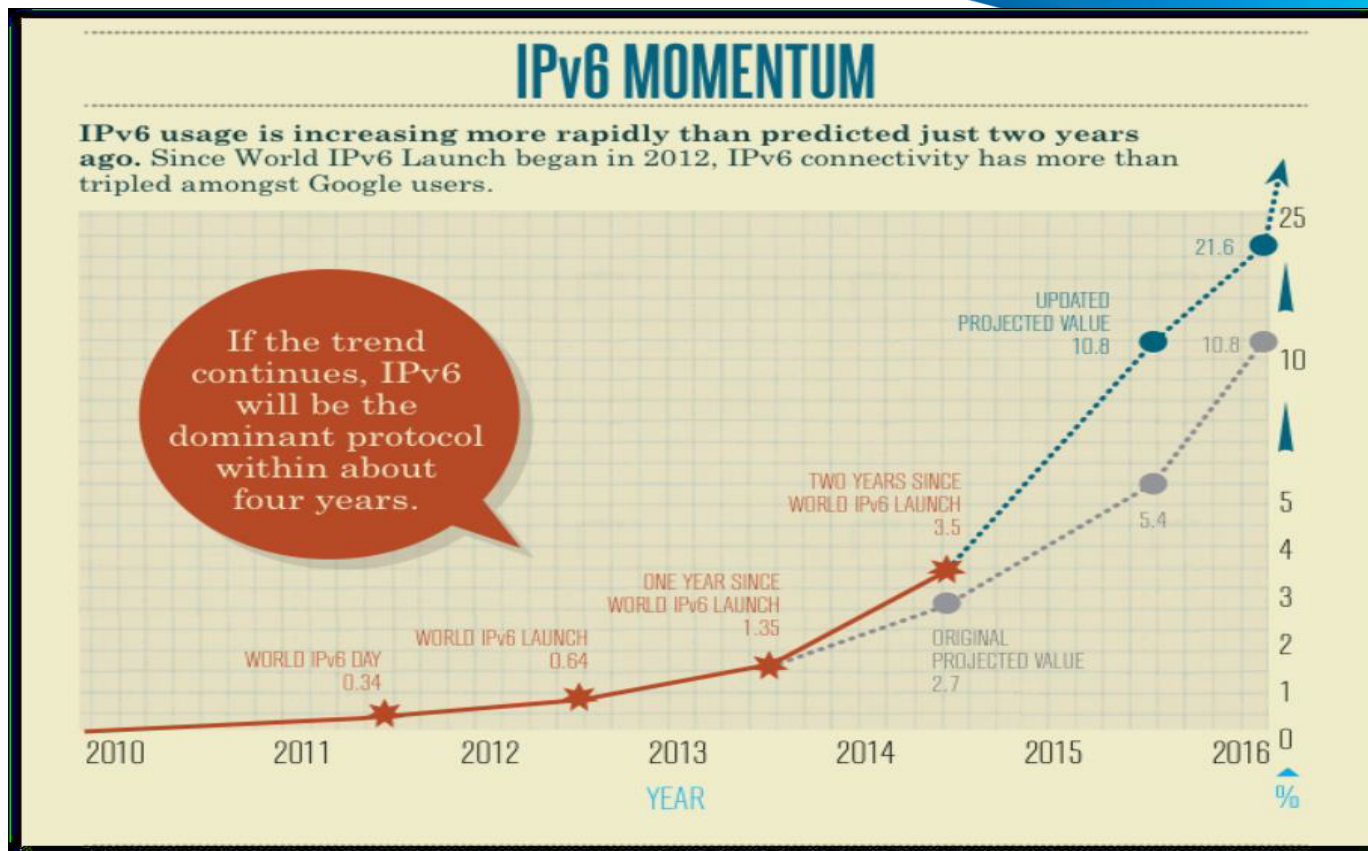
IP v6

IPv6 adoption by network-by rank left to right:

39.9% -Comcast	41.4% -AT&T	16.4%- Virtua (Brasil)	13.9% -Intelektu
18.3% -Time Warner	67.7% -Verizon	16.3%- Telekom Malaysia	97.4%- Facebook
26.6% Duetsche Telekom	16.3% -UPC	28.5%- Eucador	49.7%-T Mobile

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2015 Global Knowledge
Training

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IPv6

2015 Global Knowledge Training LLC

- Mobile providers, T-Mobile, AT&T, and Verizon are all moving rapidly toward IPv6-only deployment.
- John Curran, president and CEO of the American Registry for Internet Numbers (ARIN)- **“customers attempting to reach an IPv4-only website via a smartphone or tablet are increasingly likely to be forced through transition gateways as more mobile providers turn to IPv6 to grow their networks. “**

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IPv6

2015 Global Knowledge Training LLC

- He cites research by the Aberdeen Group, stating that just a **one-second delay in page-load time results in 11 percent fewer page views, and a 16 percent decrease in customer satisfaction.** To remain competitive in today's marketplace, businesses must update their public-facing websites to support IPv6—or else they risk loss of revenue and customer loyalty.

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Summary

- NFV and SDN are still evolving but substantial 2016 deployment
- NFV is separation of functions and services from hardware
- Promises to substantially reduce CapEx and OpEx
- Commercial hardware (COTS) replaces purpose-built hardware

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Summary

- More service applications at a faster pace and does not require new hardware
- SDN is separation of the control plane from the data plane
- SDN promises programmable, centralized control end to end and has a entire topology view
- SDN hybrid solutions are expected for legacy networks via APIs
(Not OpenFlow enabled- Still Proprietary)

IP Evolution Summary

- IOT- The Saga continues- many gateways and software solutions are likely- New standard check out: www.onem2m.org

Also check out protocols:

- CoAP

-DTLS

- IPv6- Saga continues and concerns remain but IPv6 is picking up momentum

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Questions?

Thank You!

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