Software Defined Networks

Virtualization and Telecom Clouds

Dr. Walter Häffner - 8. KuVS Fachgespräch NGSDP, Hirschburg, 17 April 2013

Software Defined Networks
Virtualization and Telco Clouds – Topics

Software Defined Networks – SDN

- idea is not new but by now it hypes
- all major network suppliers jump in
- Vodafone just began some research
- What is the basic idea behind SDN?

A Telco Cloud for Internal Services

- Virtualization in Computing not new
- Promises simplification and savings
- Vodafone started Telco Cloud trials
- VF-D going to be first with NGN/IMS

Software Defined Networks
Mastering Complexity by Brute Force

No-one can really master the complexity of our IP networks anymore and it **costs us more than a fortune to keep our telco business alive**

Well, that‘s the price you‘re gonna pay for Internet, IPTV, VoIP and that App stuff. Fact is, we need **more powerful boxes and more headcount**

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Mastering Complexity: In Search of Creative Answers

I hear this year by year.
We have to stop this way of working.
Any innovative ideas?
Other diciplines do better.

Well, indeed our IT colleagues have some advantages. **IT ystems are much more modular** and in **IT innovation is faster**.

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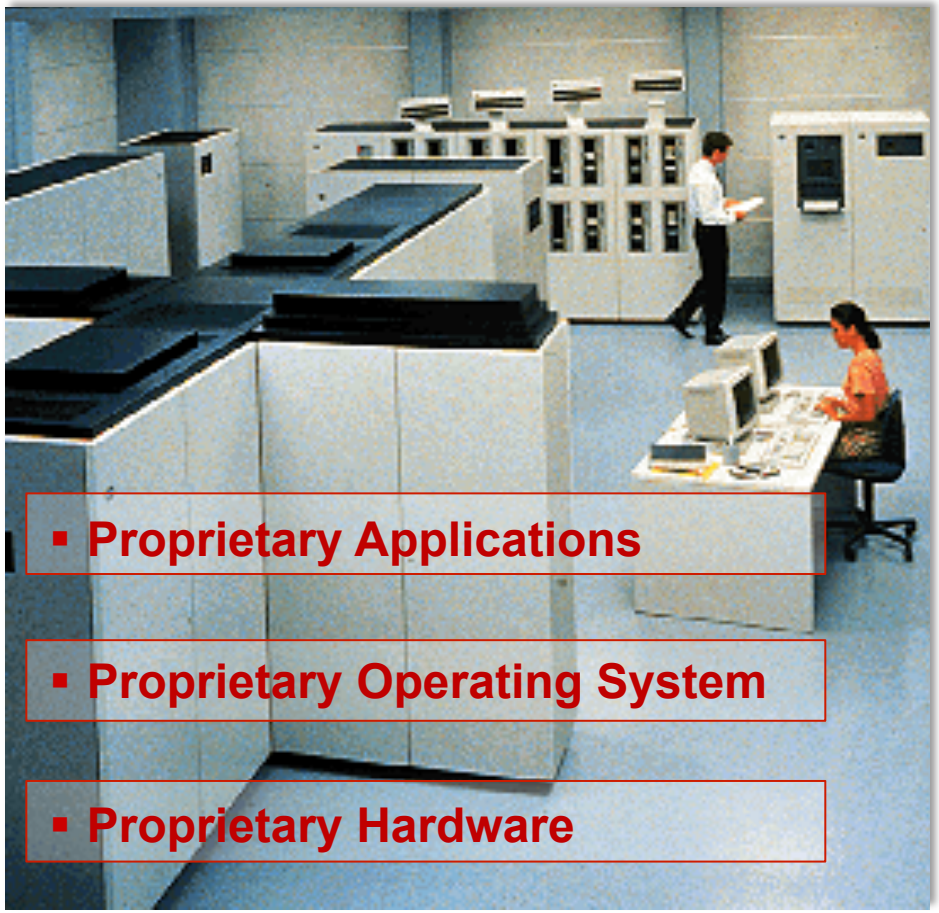
Is there any Magic behind IT Innovation Speed?

The Golden 60th: IBM System 360



In the 70th IT became modular

ORACLE SAP Wolfram Mathematica 8 OpenOffice.org

Open Interfaces

Windows 7 Linux Mac OS

Open Interfaces

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In 2013 Telco Boxes are still Monolithic Proprietary Solutions

Situation 2013

A Dream Scenario beyond 2013

Policy Compiler

VPN Creator

Other 3rd Party Apps

Open Interfaces

Control Plane

Control Plane

vmware

nicira

Still academic and industrial research

Open Interfaces

Standardized Switch/Router Module

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People, Organizations, Business behind this Approach

Martin Casado

Nick McKeown

Scott Shenker

founded in 2007

nicira networks

in 2012

vmware

founded 1998

USD 1.26 Billion

Most known buzzword in this context: OpenFlow

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Basic Idea: Separating Control and Forwarding Planes

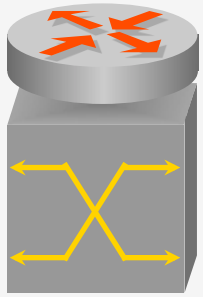
Traditional Router

OSPF Distributed System

IS-IS Distributed System

Operating System

Custom Hardware



CPU: intelligent and slow

ASIC: dumb and fast

<u>Routing is distributed computing:</u>

RFC 2328 OSPF is 244 pages,
Thereof ~100 pages on consistency

Dijkstra Algorithm for shortest path can be described on 4 pages

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Centralized OS somewhere in the Telco Cloud

OSPF Centralized System

IS-IS Centralized System

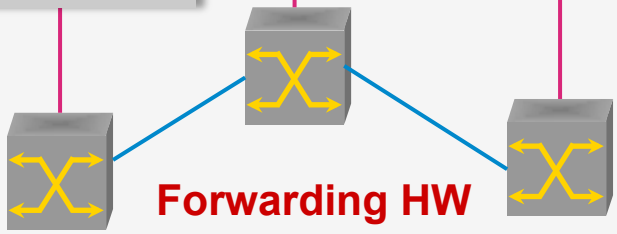
Global Network View

Network Operating System

OpenFlow

OpenFlow

OpenFlow



Forwarding HW

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It's not (only) Separation of Layers, it's about Abstraction

Information Technology Example: Transitions in Programming

- **Assembler: no abstractions**

  Mastering complexity was crucial

- **Higher level languages: OS and other abstractions**

  File systems, virtual memory, abstract data types, …

- **Modern languages: even more abstractions**

  Object orientation, garbage collection, …

- **Lessons learned: Abstractions are key to extracting simplicity**
- **Design of large systems based on abstractions as foundation of proper subsystem decompositions**

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Abstraction: Inheritance in C++ (Modern Language?)

```
class Polygon
{
   protected int width, height;
   public void setParameters (int w,int h)
   {
      width = w;
      height = h;
   }
};

class Rectangle : public Polygon
{
   public int calculateArea ()
   {
      return (width*height);
   }
};

class Triangle : public Polygon
{
   public int calculateArea ()
   {
      return( (width*height)/2);
   }
};
```

rectangle inherits width and height from polygon

triangle inherits width and height from polygon

just for completeness: the area calculation

```
int main ()
{
   Rectangle rect;
   Triangle trgl;
   rect. setParameters (4,5);
   trgl. setParameters (4,5);
   cout << rect. calculateArea () << endl;
   cout << trgl. calculateArea () << endl;
   return 0;
 }
……..
……..
```


Software Defined Networks
It's not (only) Separation of Layers, it's about Abstraction

Network Example: There's Light and Darkness

- **OSI (or other) layer models are great abstractions**

  But this deals only with the data plane

- **Currently no powerful control plane abstractions in place**
  - Generate configuration for each physical device,

    e.g. ACLs, forwarding tables, policies, …
  - Operate without communication guarantees

    No automatic consistency check, prone for men made errors

    From time to time there are misconfigured boxes out there
  - Only people who love with complexity find this situation reasonable
  - Software engineers would immediately start to abstract

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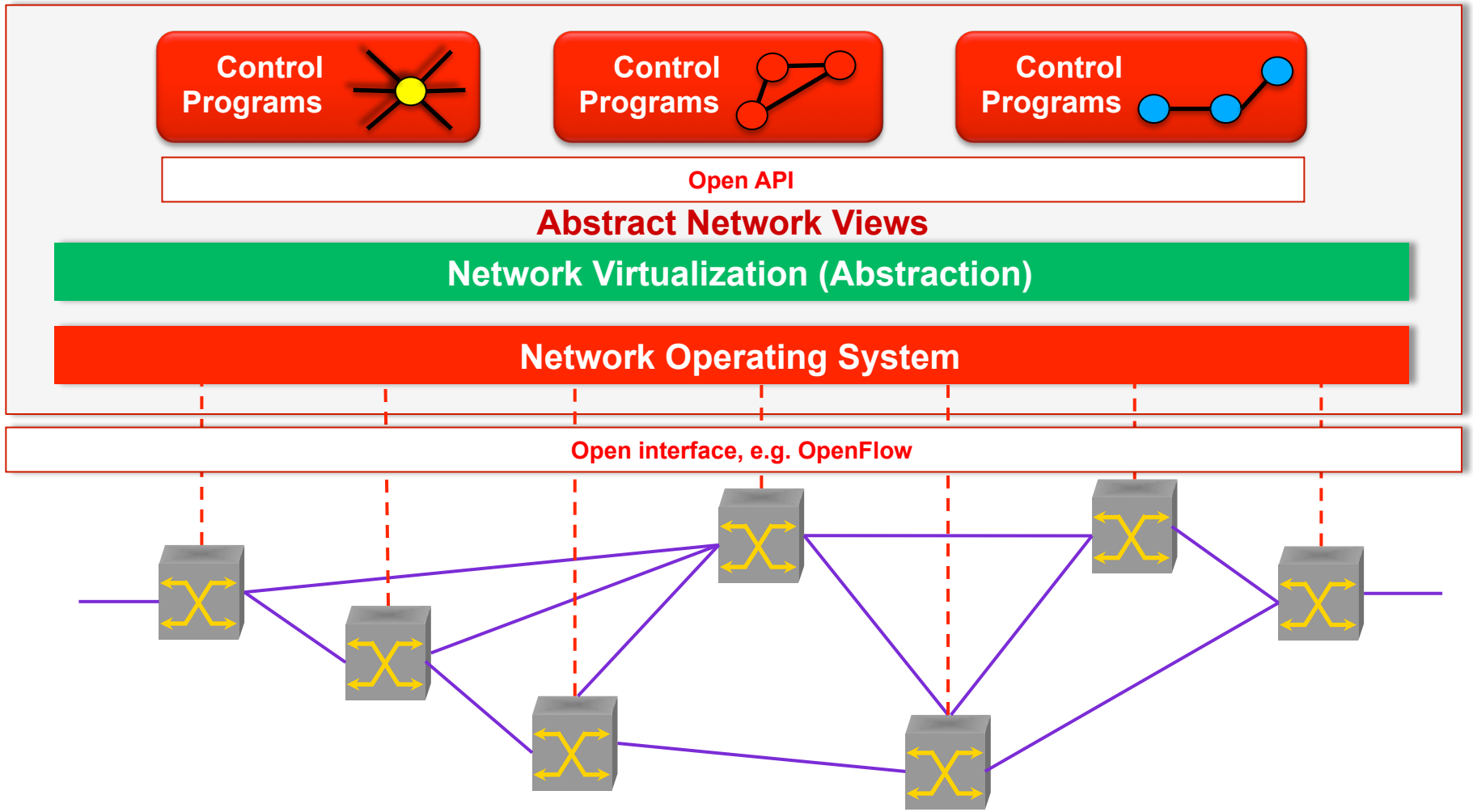
Essential Objective is an Abstraction Layer above Network OS

Centralized in a Telco Cloud



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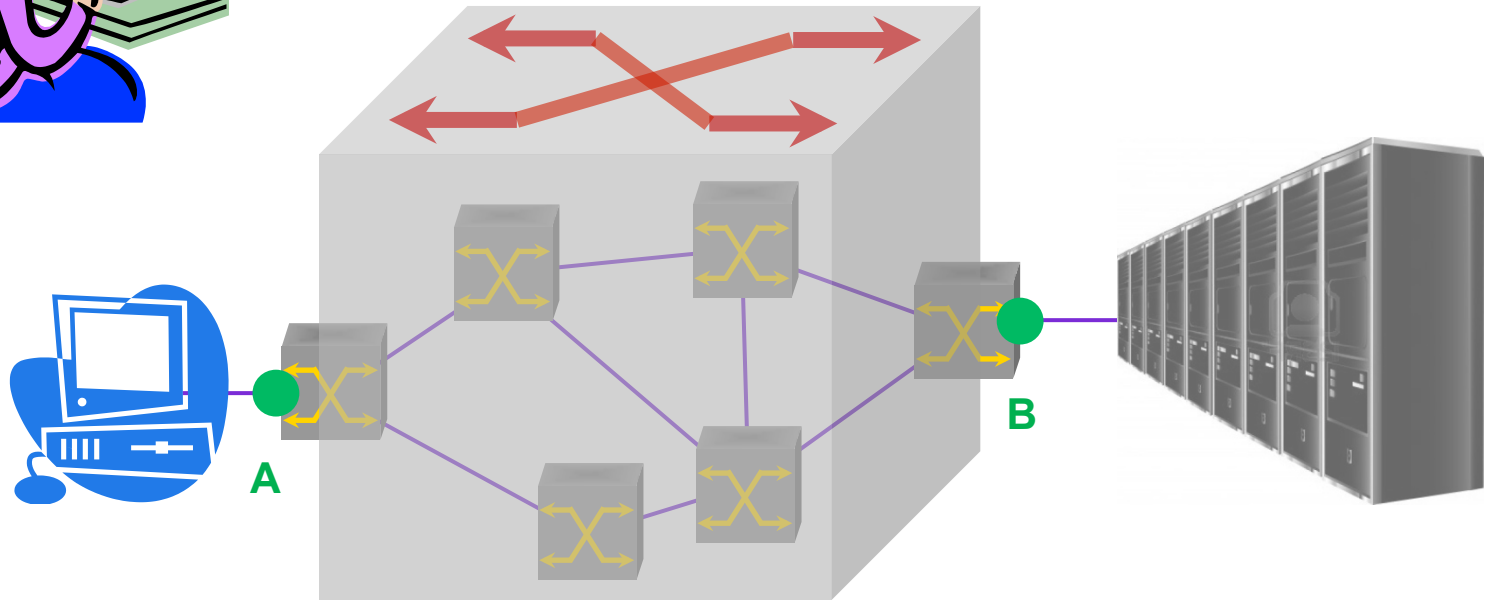
The Network looks like one big Switching Fabric

From A to B I like to have

- **just one best effort connection <OR>**
- **a single connection for VoIP traffic class <OR>**
- **a connection for video with lowest jitter <OR>**
- **a SAP connection with a back-up path**



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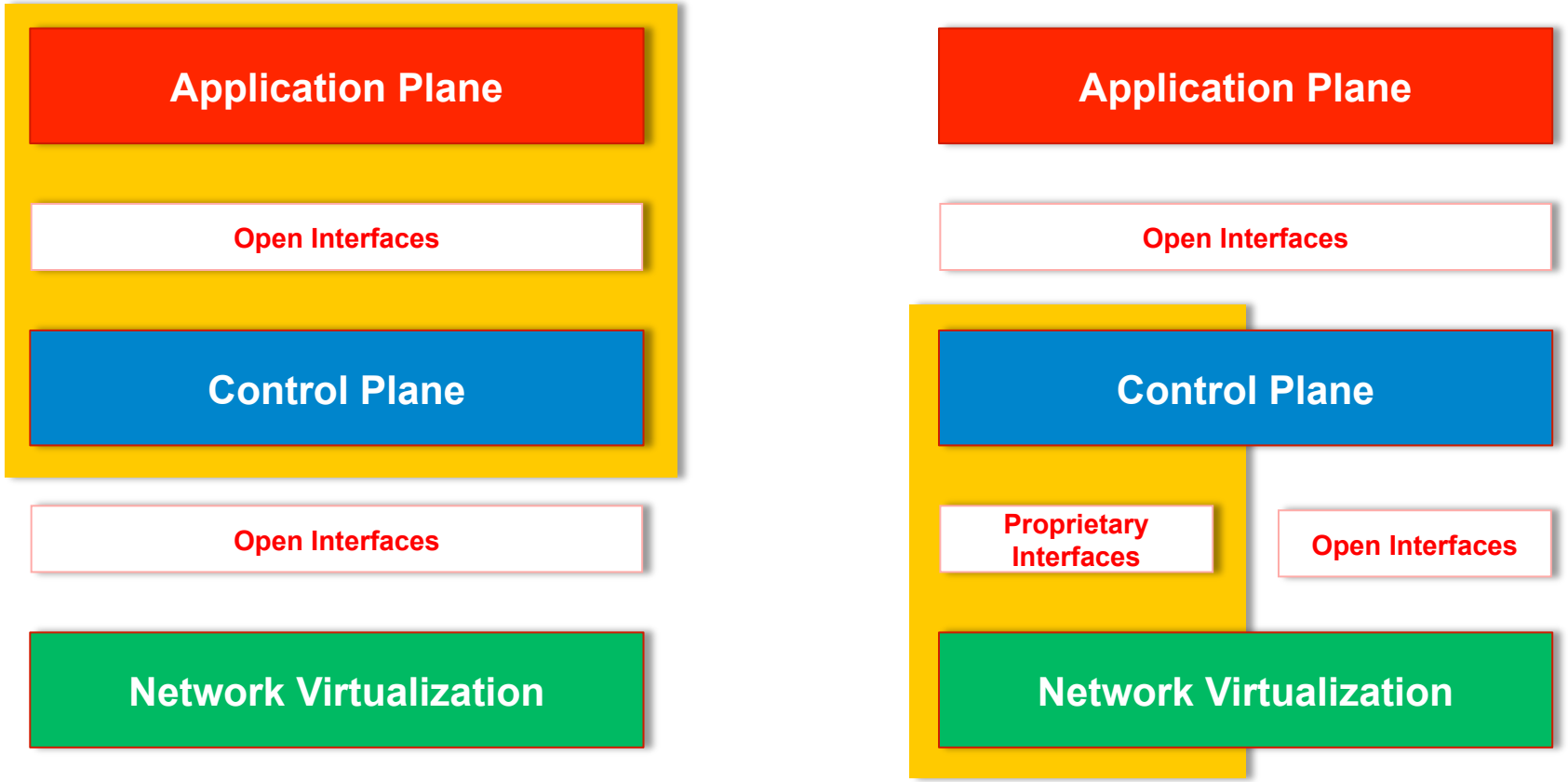
Some vendors currently try to keep decentralized Control Plane

Spectrum: From fully centralized Control Planes to more traditional Systems with open APIs



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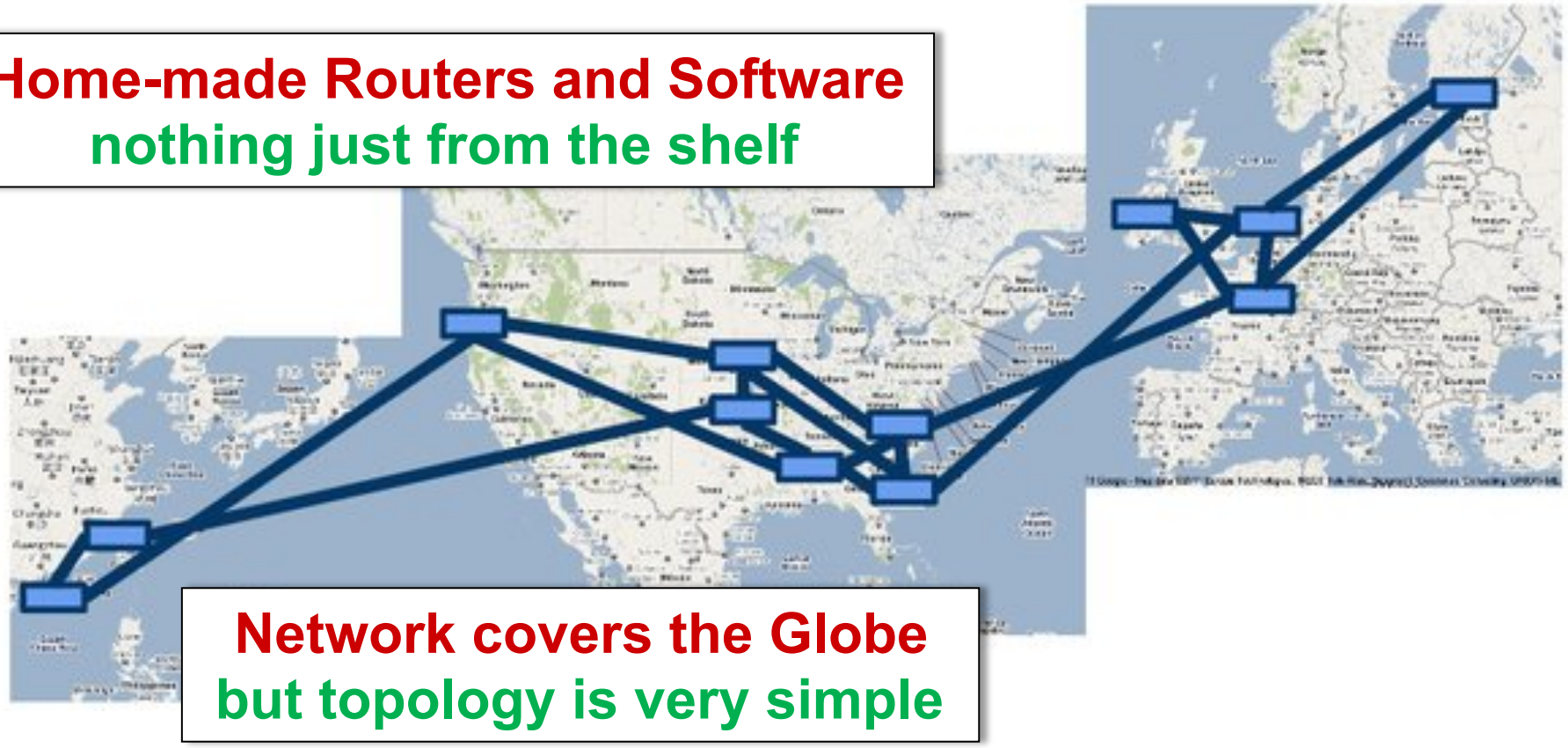
Google is using SDN Technology for their Data Distribution Network

Home-made Routers and Software
nothing just from the shelf



Network covers the Globe
but topology is very simple

OpenFlow applicable
not that much features required

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Down to Earth – SDN is some Years in the Future

.. Sounds great – but frankly, it‘s science fiction.

SDN seems to be 5 to 10 years away. Forget it!

- Well, to some extend we can go this way
- In NGN a **SIP server is a control plane** and the **IP network is the data plane**. It‘s **just another level of abstraction**
- And we **save you a lot of money** when we throw control functions whenever possible onto **cheap standardized servers**
- And it‘s **even more economical** when we put everything into **Virtual Machines**.
- Virtual machines are software and therefore easy to move

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Virtualization - Your Personal Use Case

You are proud of your MacBook and like your Mountain Lion

But sometimes you wish you had your good old bloody Windows

- Buy a piece of emulation software – friends recommend VMware or Parallels
- Install it like any other program
- Follow the instructions to install Win7 or 8

- If done properly you can run a Windows PC including disk space like any other program on your MacBook with the Mountain Lion OS
- Your new PC is a Virtual Maschine running on top of VMwares Virtualization Layer software
- You even could install more than one WinXP
- You have more Laptops for the price of one

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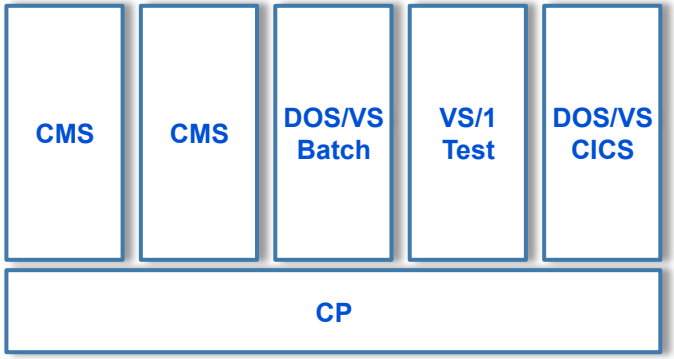
In the 70th: IBM VM/370 already supported Virtual Machines

VM/370 - a study of multiplicity and usefulness
by L. H. Seawright and R. A. MacKinnon
IBM SYST J VOL 18 NO 1 1979

"The **productivity** of data processing professionals and other professionals **can be enhanced** through the use of **interactive and time-sharing systems**. Similarly, system programmers can benefit from the use of system testing tools. A systems solution to both areas can be the **virtual machine concept**, which provides multiple software replicas of real computing systems on one real processor. Each **virtual machine** has a full complement of input/ output devices and provides functions **similar to those of a real machine**. One system that implements virtual machines is **IBM'S Virtual Machine Facility1370 (VM1370)."**

VMMs, Virtual Machine Monitors, also known as **hypervisors**, first reached prominence in the early 1970s and achieved commercial success with the **IBM 370** mainframe series. Virtualization allowed mainframes to run **multiple operating systems simultaneously**, thus making it possible **to time-share expensive hardware** without requiring software modifications to legacy systems, including single-user operating systems.

CP/CMS: Control Program/Cambridge Monitor System
CICS: Customer Information Control System
DOS/VS: Disc Operation System/Virtual Storage



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Network Infrastructures became inhomogeneous over the Decades

- **Carrier Network typically is multi-vendor**
  - Mix of modern and legacy equipment
  - Ongoing harmonization towards All-IP
  - Phase-out SDH and ATM networks
  - Phase-out legacy services like ISDN
- **IP brought many server-based functions**
  - Often applications like AAA, DNS, IMS, NGN, Web, typically reside on supplier preferred specific server platforms
  - Results finally in a zoo of hardware
  - Some servers close to idle
  - Some servers close to overload
  - Often capacity provisioning takes too long
  - Infrastructure costs going to explode

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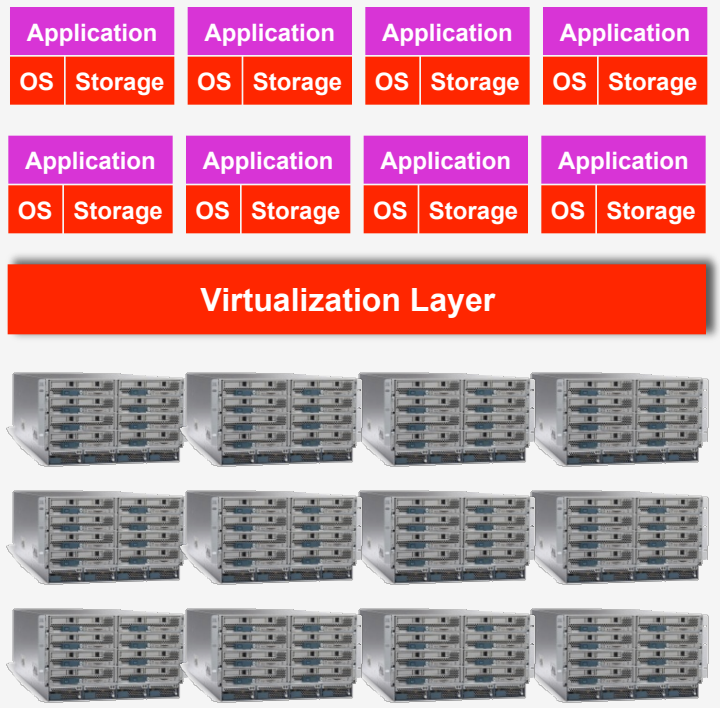
Benefits of Virtualization: Economics of Scale, Simplification, Speed

Much more Virtual Machines than Physical Servers



Larger Computer Center based on Standard Blade Servers

- **Virtualization of (legacy) servers**
  - Reduced hardware support costs
  - Reduced range of platforms supported
  - Reduced power and space requirements
  - Standardized configurations
- **Abstract application from hardware**
  - Changes to configuration will be less intrusive and time consuming
  - Dynamically change configurations according actual meet business needs
- **Improve delivery through faster build**
- **Snapshot and roll back opportunities**

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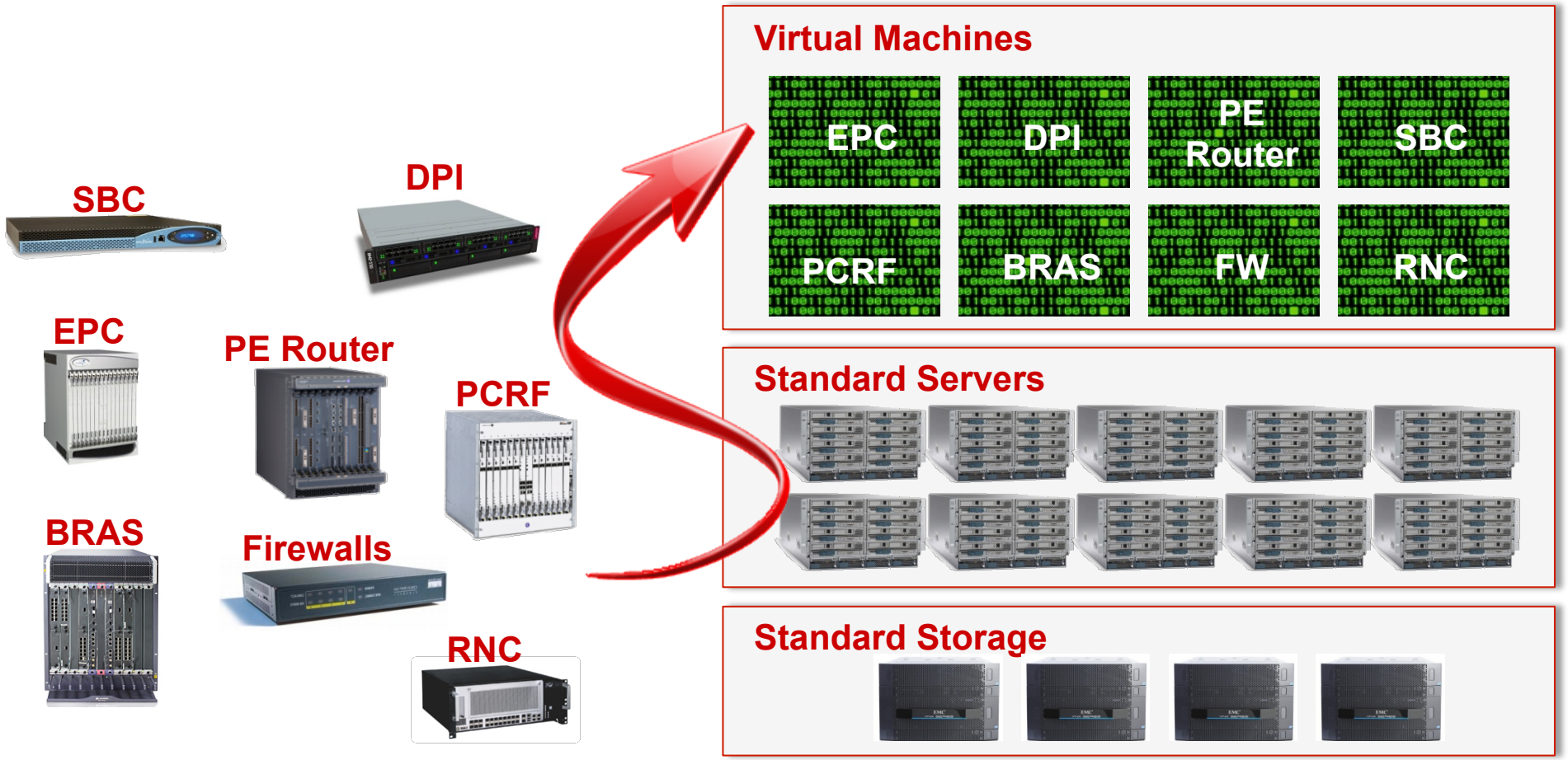
Benefits of Virtualization: Economics of Scale, Simplification, Speed



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Economical Benefits of Virtualization (Source VMware)

- Reduce the varieties of server models and configurations
- Reduce the range of spare parts to be kept on site in case of failure
- Reduce the complexity of the computing center
- Improve the performance per watt ratio of the computing center
- Reduce hardware and operating costs by as much as 50% and energy costs by 80%, saving more than $3,000 per year for every server workload virtualized
- Reduce the time it takes to provision new servers by up to 70%
- Decrease downtime and improve reliability with business continuity and built-in data disaster recovery
- Deliver IT services on-demand now and in the future, independent of hardware, OS, application or infrastructure providers

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First Steps: Migrate VoIP Services into a Telco Cloud

- **Over the last 20 years a variety of voice service platforms appeared**
  TDM (GSM, UMTS, ISDN), IP Packet (fixed NGN, mobile IMS)
- **Life cycle costs and operational complexity of voice increased rapidly**
- **Older service platforms like ISDN switches are end of life until 2020**
- **Target is one VoIP platform in place for fixed and mobile services**
- **Start migration into internal Telco Cloud with server-based platforms**
  SIP proxies, DNS, AAA, media gateway control functions
- **Drive development to enable migration of systems with proprietary designs**
  SBC, PCRF, BRAS/BNG, …. Often complete new vendor re-designs required

Standard Blade Server Hardware as Platform for Virtual Machines

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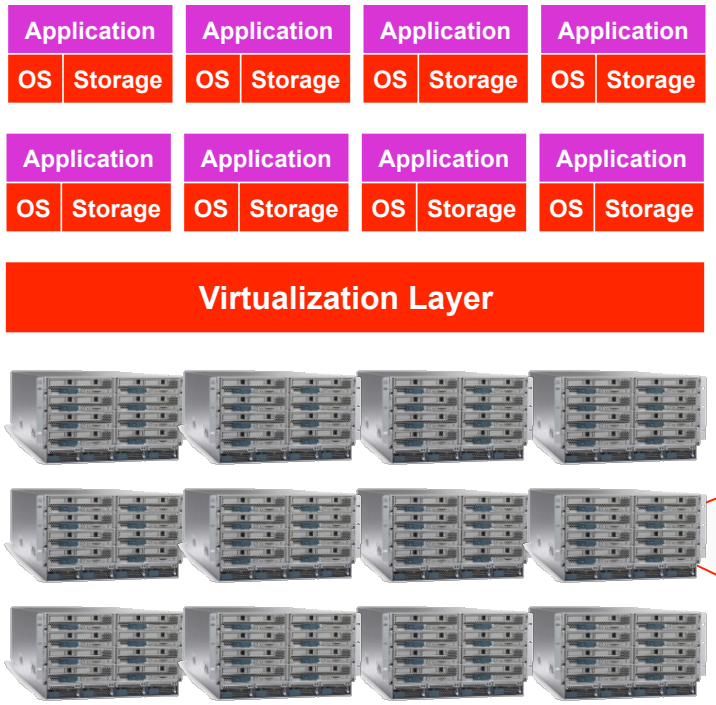
Virtualization – On a larger Scale

Much more Virtual Machines than Physical Servers



Larger Computer Center based on Standard Blade Servers

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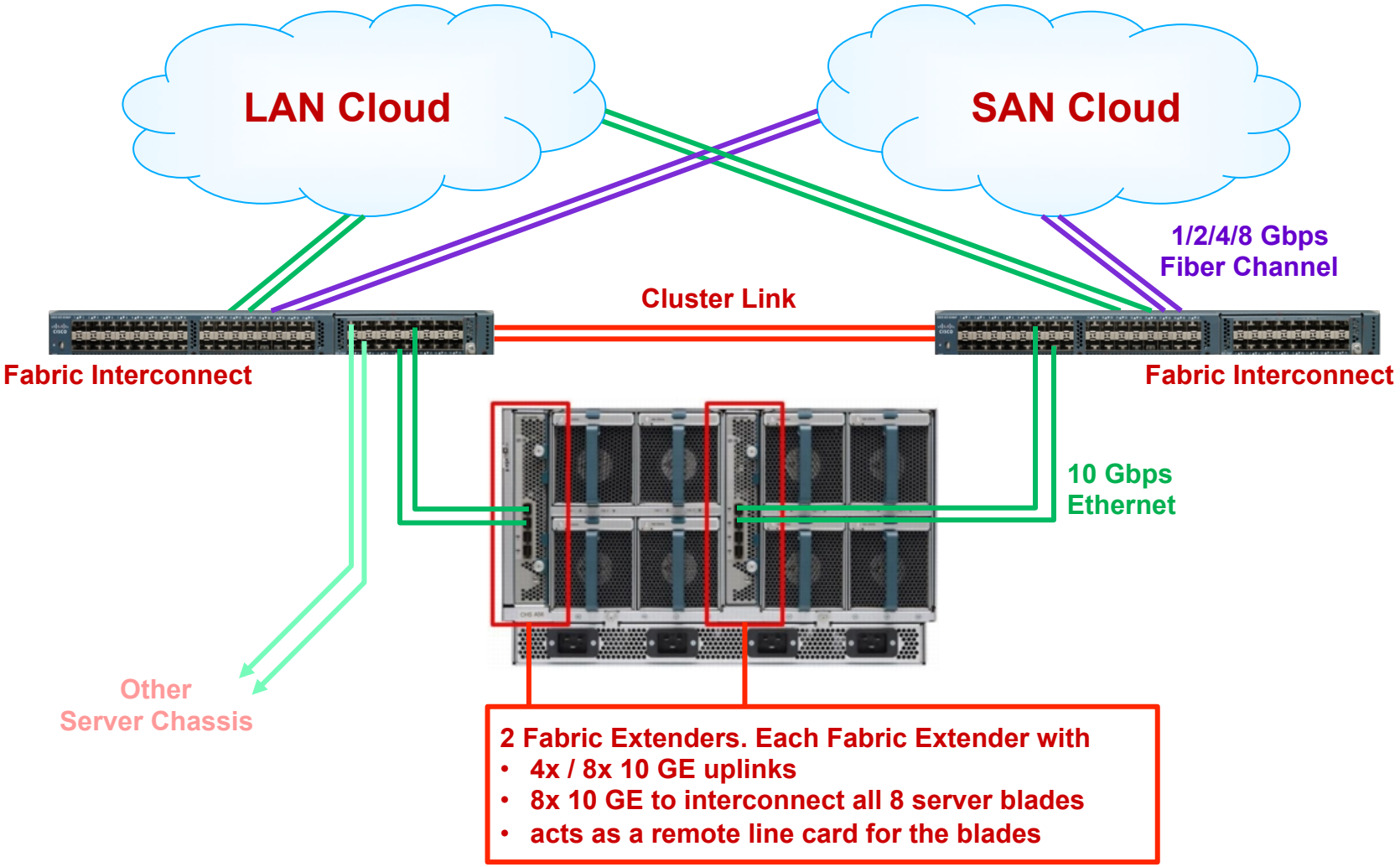
Redundant Blade Server Integration



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Data Center Building Blocks – Example: Cisco Computing Pot UCS-C1

UCS-C1

- Max. 48 x B230 M1 Blade Server @ 128GB RAM
- Dual Xeon X6550 130W processors/blade
- 2 x Cisco virtual interface card/blade
- 6 x 5108 blade enclosures
- 6140 fabric interconnect
- 60+ VM/server possible

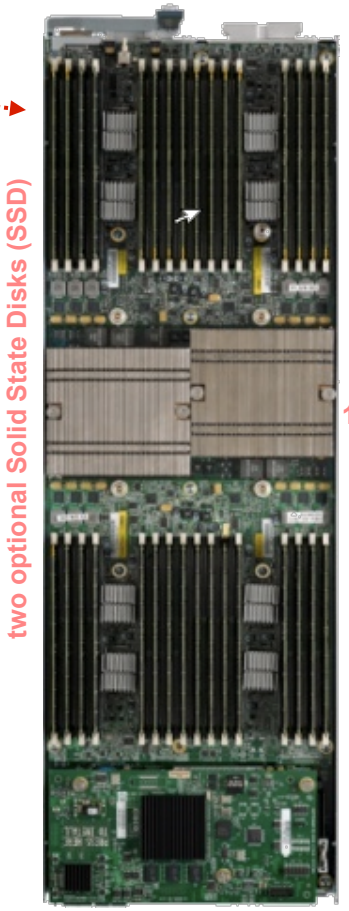
UCS-C1 POD properties

- 12 x 10GE Interfaces to aggregation layer
- 12 x 8G Fiber Channel Interfaces to SAN
- 1 rack space used
- 12.500 W (typical)

UCS Capacity (this example)

- 768 physical CPU cores. physical memory 6.144 TB
- 1.536 Advanced VMs @4GB/VM av. (4 vCore/VM) or
- 3.072 Standard VMs @2GB/VM av. (2 vCore/VM) or
- 6.144 Basic VMs @1GB/VM av. (1 vCore/VM)
- Calculation @ 8:1 vCore/pCore

B230 M1 Blade



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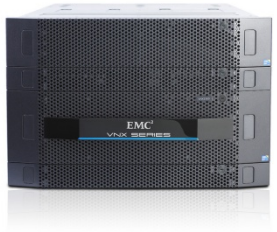
Data Center Building Blocks – Example: EMC2 VNX Storage Family

VNX5100
max. 75 Drives



VNX5300
max. 125 Drives

VNX5500
max. 250 Drives

VNX5700
max. 500 Drives

VNX7500
max. 1.000 Drives

- Disk Types: SAS, NL-SAS, Flash
- Protocols: FC, iSCSI, FCoE

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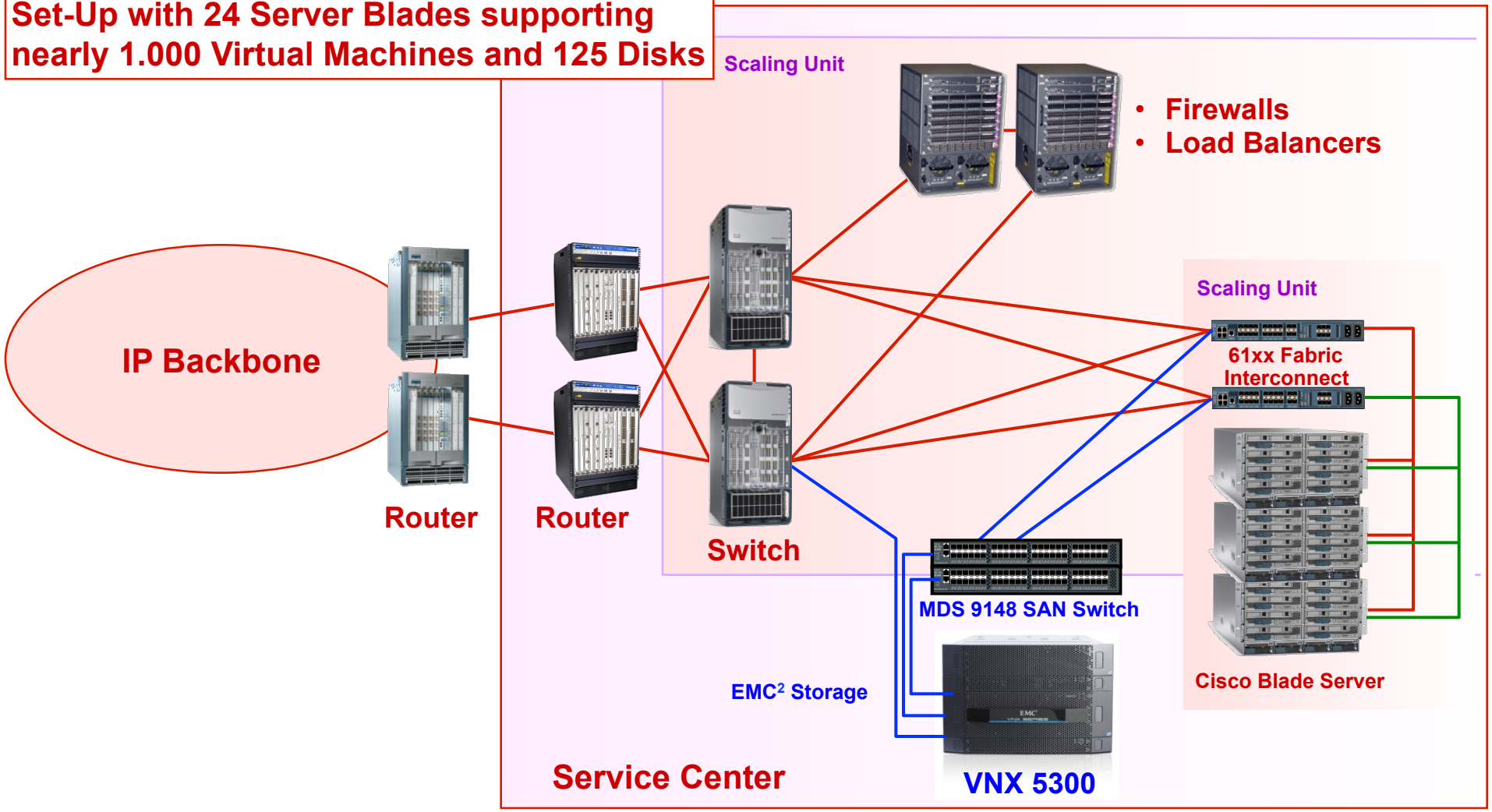
Putting all together – Example for a typical Sevice Center Layout

Set-Up with 24 Server Blades supporting nearly 1.000 Virtual Machines and 125 Disks



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Summary

- Even if we already observe some sporadic promising early SDN applications (Google), for most of us SDN is some years away.
- Currently equipment suppliers try to position themselfes with different interpretations of what SDN means. Related Standards on SDN are not yet stable. It‘s still a moving target in the industry.
- SDN in ist original meaning seems to be a bonanza for start-up companies while established telecom vendors like to protect their business by their interpretation of SDN.
- Meanwhile operators focus more on Telco Clouds (network function virtualization) to keep operational costs low while improving and accelerating deployment of new services.


thank you for listening
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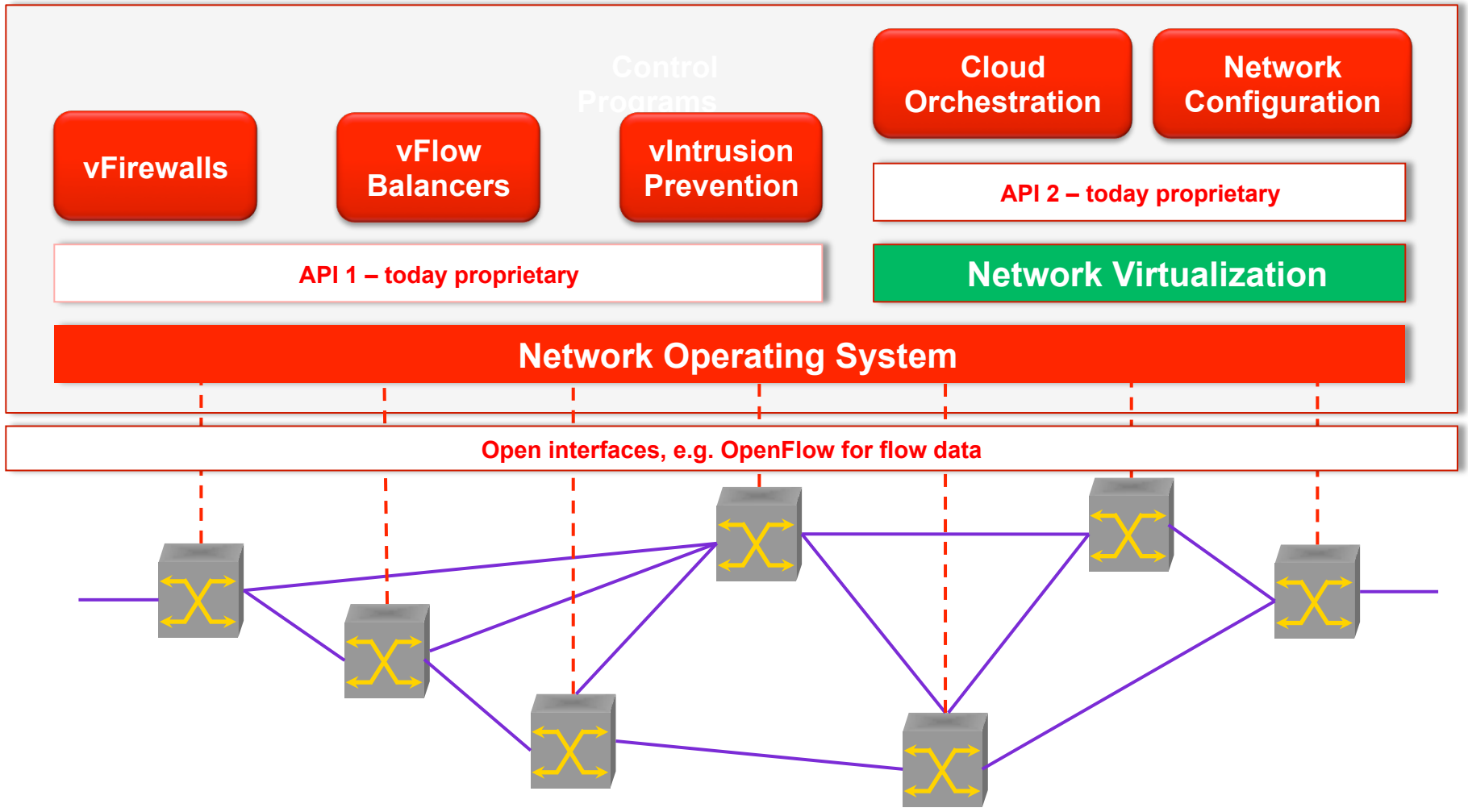
Today Controller and Apps are glued together in a proprietary System

Control plane centralized in a Telco Cloud



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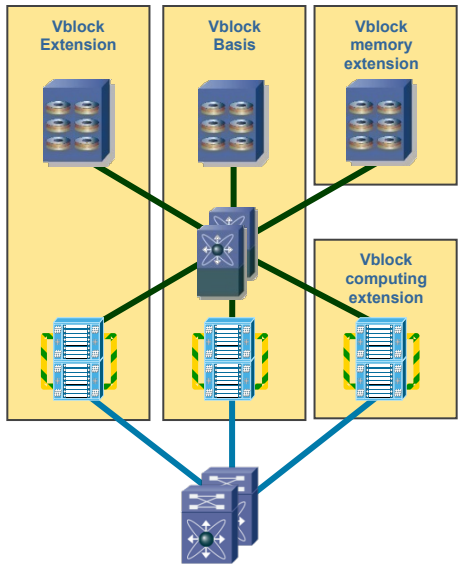
Cisco‘s Customizable Cloud Infrastructure - VBLOCKs



- Simple and scalable extensions
- additional memory and CPU according market demand
- fits seamlessly into Vodafone‘s CompanyNet Central Service architecture
- In-service upgrades possible
- Separate storage area network architecture (SANs) with known and standardized platforms
- supports fiber channel over IP (FCoIP), storage and encryption services as well as virtualization services

- **Vblock 2** (from 3.000 VMs to more than 6.000 VMs) for High End Configurations
  most ambitious IT requirements for ERP or CRM systems
- **Vblock 1** (from 800 VMs to more than 3.000 VMs) as Mid Size Configuration
  for many apps, shared services – email, print-shares, virtual desktops
- **Vblock 0** (from 90 VMs to about 800 VMs) as a typical smaller entry configuration
  preferable for software development platforms or test platforms