

רשתות מחשבים בענן

רועי מטרני

מהנדס רשתות מחשבים

מעבדת NSSL

על מה נדבר

רקע על ענן ▶

Data Centers ▶

המבנה הפיזי של הרשת ▶

סוגי עננים ▶

וירטואליזציה ▶

רשתות בענן ▶

מבנה לוגי ופיזי ▶

השוואה בין רשת בענן לרשת רגילה ▶

Software Defined Networks ▶

Network Function Virtualization ▶

Data Centers

מבט פיזי

NSA

מערכות חשמל



NSA

מערכות קירור



NSA

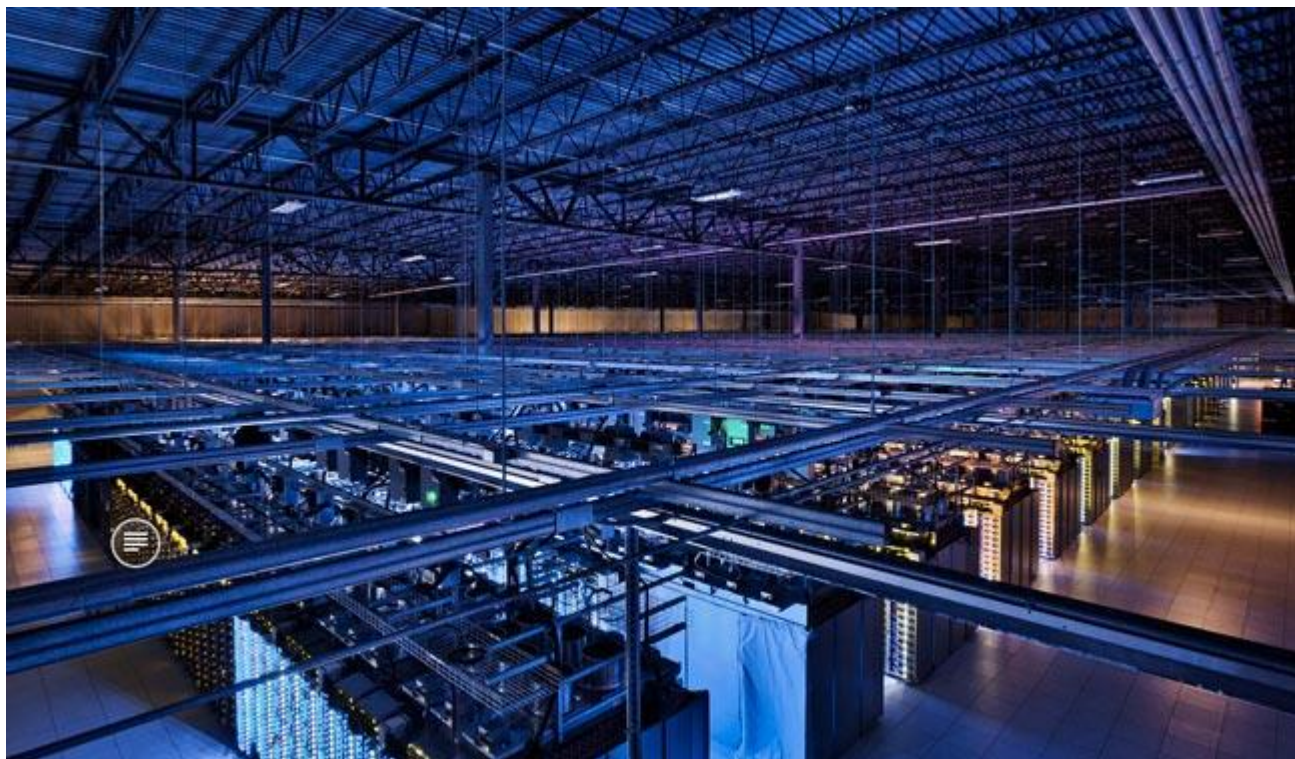
אולמות שרתים



Google



מבט פנימה



QTS

50,000 מ"ר ▶

120 מגה וואט (תחנת כח באתר) ▶



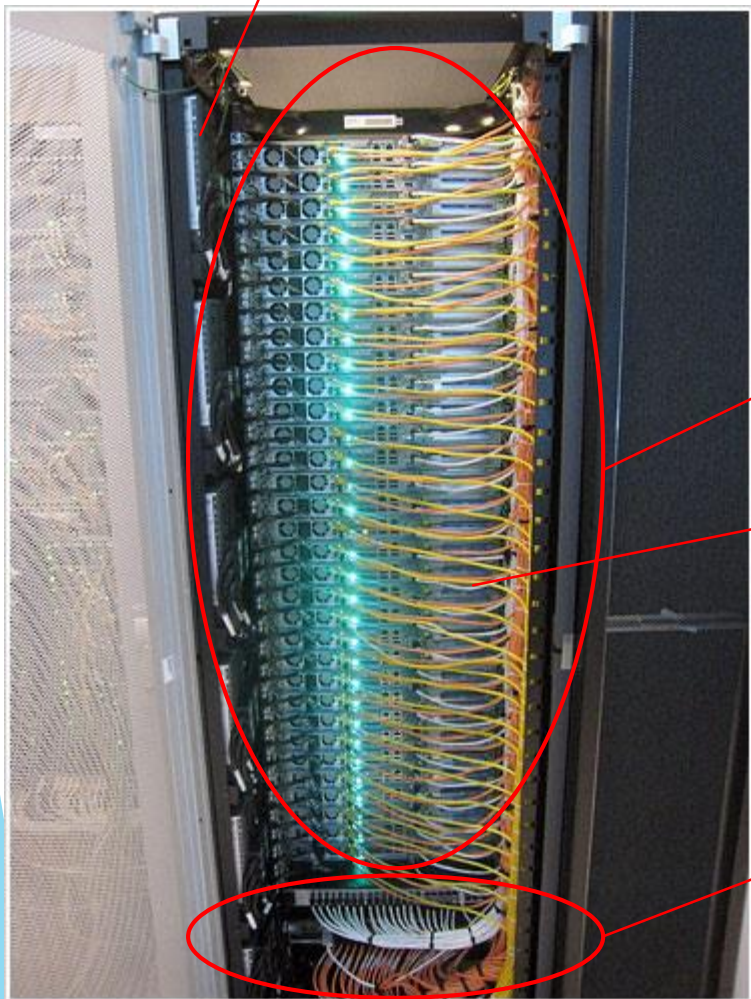


מסדרון קר/מסדרון חם



ארונות שרתים

שקעי חשמל

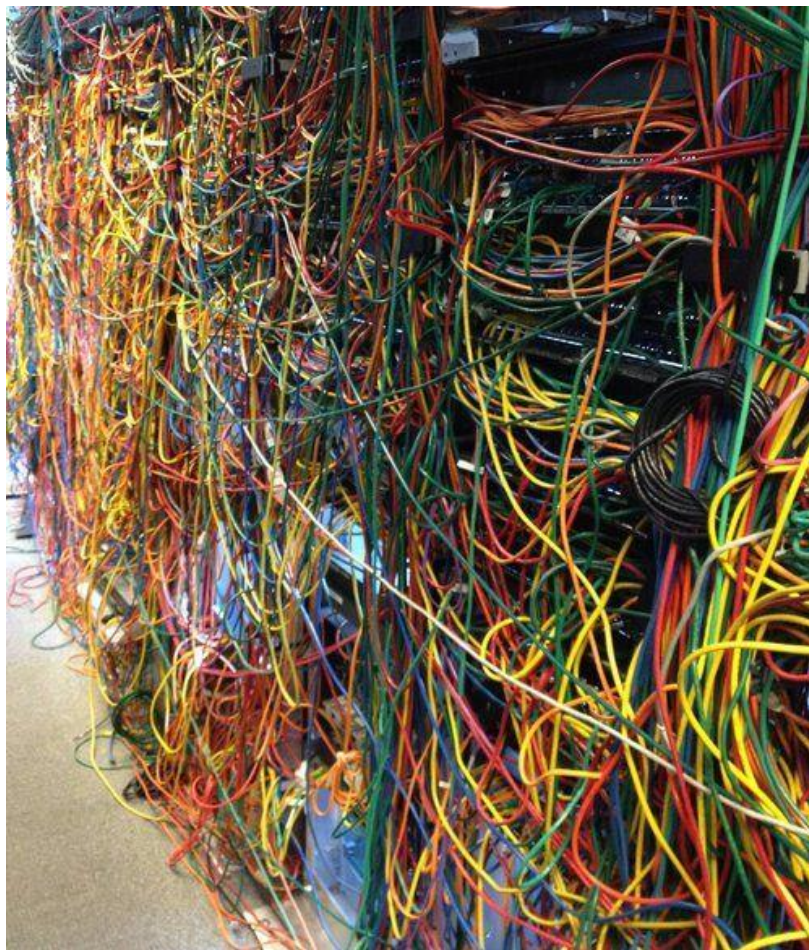


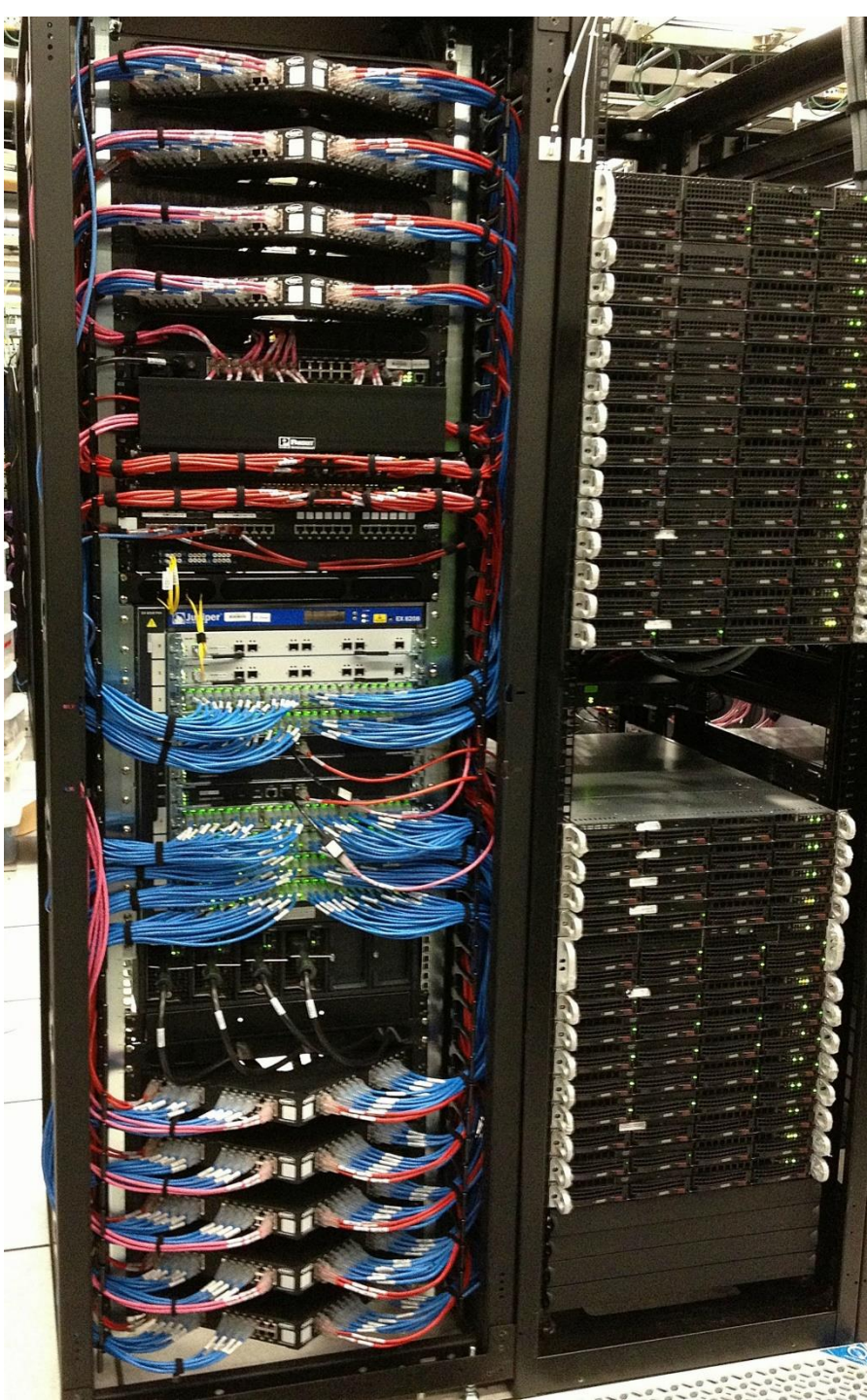
שרתי 1U

3 כבלי רשת לשרת

מתגי תקשורת

ארונות שרתים (תמונת זוועה)





ארון תקשורת

Data Centers

שימושים

On Premises

Data Center בשטחי הארגון

- ▶ קיים הרבה שנים
- ▶ עדיין רוב השרתים בעולם נמצאים בשטחי הארגון
- ▶ יכול להיות גדול מאד.

הגדולים עוברים להשתמש בטכנולוגיות ענן (הסבר בהמשך)

Co-Location

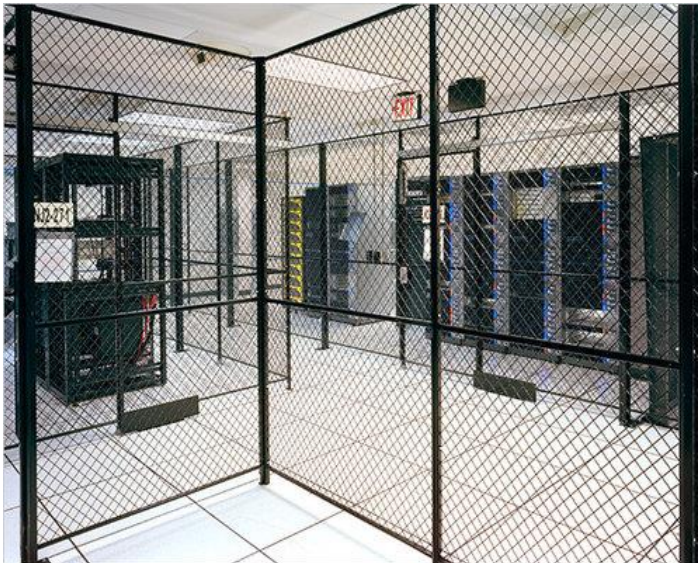
שרתים וציוד שייכים ללקוח ושוכנים ב- Data Center

שטח ▶

תשתיות חשמל, מיזוג וכו' ▶

אבטחה ▶

תחזוקה בסיסית ▶



Cloud

- ▶ הכל שייך לספק הענן
- ▶ הלקוחות יכולים לקבל (חינם או תמורת כסף)
 - ▶ תוכנות להפעלה מרחוק: SaaS
 - ▶ פלטפורמות לבניית אתרים או אפליקציות: PaaS
 - ▶ מחשבים (פיזים או וירטואלים): IaaS

Software as a Service

תוכנות שרצות בענן במקום במחשב ►



Platform as a Service

סביבת פיתוח לבניית אתר

דוגמא: WordPress

תמונות

דפים

משתמשים

The screenshot shows the WordPress dashboard with the 'Pages' section selected. The left sidebar contains various menu items, with 'Media', 'Pages', and 'Users' circled in red. Red arrows point from the Hebrew labels 'תמונות' (Media), 'דפים' (Pages), and 'משתמשים' (Users) to these items. The main content area displays a list of pages with columns for Title, Title Tag, Author, Date, and Robots Meta.

<input type="checkbox"/>	Title	Title Tag	Author		Date	Robots Meta
<input type="checkbox"/>	About	About Networked Software Systems Laboratory	roym	0	2012/11/16 Published	Index, Follow
<input type="checkbox"/>	Courses	Courses Networked Software Systems Laboratory	Alex Sherman	0	2011/12/20 Published	Index, Follow
<input type="checkbox"/>	Experiments	Experiments Networked Software Systems Laboratory	Alex Sherman	0	2011/12/20 Published	Index, Follow
<input type="checkbox"/>	Faculty	Faculty Networked Software Systems Laboratory	Alex Sherman	0	2011/12/20 Published	Index, Follow
<input type="checkbox"/>	Final Presentation	Final Presentation Networked Software Systems Laboratory	roym	0	2012/11/27 Published	Index, Follow
<input type="checkbox"/>	Industry Relationship	Industry Relationship Networked Software Systems Laboratory	roym	0	2012/02/19 Published	Index, Follow
<input type="checkbox"/>	Instructors	Instructors Networked Software Systems Laboratory	Alex Sherman	0	2011/12/20 Published	Index, Follow
<input type="checkbox"/>	Main	Main Networked Software Systems Laboratory		0	2012/01/12 Published	Index, Follow
<input type="checkbox"/>	— Awards - Draft	Awards Networked Software Systems Laboratory		0	2015/07/07 Last Modified	Index, Follow
<input type="checkbox"/>	Main	Main Networked Software Systems Laboratory	roym	0	2012/02/19 Published	Index, Follow
<input type="checkbox"/>	Mid Semester Presentation	Mid Semester Presentation Networked Software Systems Laboratory	roym	0	2012/11/27 Published	Index, Follow

Platform as a Service

סביבת פיתוח לבניית אתר

Dashboard

My Sites Networked Software Systems Laboratory + New View Page Gallery Events Howdy, roym

Screen Options Help

Edit Page Add New

There is an autosave of this post that is more recent than the version below. [View the autosave](#)

About

Permalink: <http://nssl.eew.technion.ac.il/about/> Edit View Page Get Shortlink

Add Media Add Form Add Directory

Visual HTML

At the Networked Software Systems Lab, we study, design, and implement software and network systems

We work on algorithms, architectures, models, and monitoring across all system and network layers. At the application level, we develop sophisticated distributed systems, e.g., for cloud computing and mobile devices, as well as multiprocessor/multi-core programs, storage systems, web services and others. We also work on performance tuning, user interface applications, runtime systems and compilers. In networking layers, we design and implement network algorithms, models, simulators, hardware devices, software systems, and protocols.

Our projects provide skills that are extremely valuable in the high-tech industry. The projects rely on software-engineering, algorithms, and networking courses like Introduction to Software Systems, Data Structures and Algorithms, Computer Networks and Internet 1 and 2, Operating Systems, and Object-Oriented Programming. Some projects build on advanced courses like Principles of Reliable Distributed Systems and High-Speed Network Processors.

The faculty members lead cutting-edge research groups in the areas of distributed systems, cloud computing, fault-tolerance, multi-core (parallel) programming, network design, network economics and quality of service, storage systems, wireless networks and mobility, routers, networks-on-chip, and web search. Many laboratory projects contribute to this research and build the infrastructure for future research.

Word count: 0 Last edited by roym on November 16, 2012 at 18:53

Revisions

- 6 months ago (6 October, 2015 @ 6:44:10) [Autosave]
- roym, 3 years ago (16 November, 2012 @ 18:52:52)

Publish

Preview Changes

Status: **Published** Edit

Visibility: **Public** Edit

Revisions: 3 [Browse](#)

Published on: Nov 16, 2012 @ 18:52 [Edit](#)

Move to Trash Update

Page Attributes

Parent: (no parent)

Template: Default Template

Order: 0

Need help? Use the Help tab in the upper right of your screen.

ET Page Template Settings

פיתוח

הצגה

NSSL Networked Software Systems Lab

The Lab » People » Projects » Experiments » Info » Activity » Links » search

About | Networked Software Systems Laboratory

Home » About | Networked Software Systems Laboratory

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[Edit this page](#)

Infrastructure as a Service

אספקת מחשבים ב-Data Center ▶

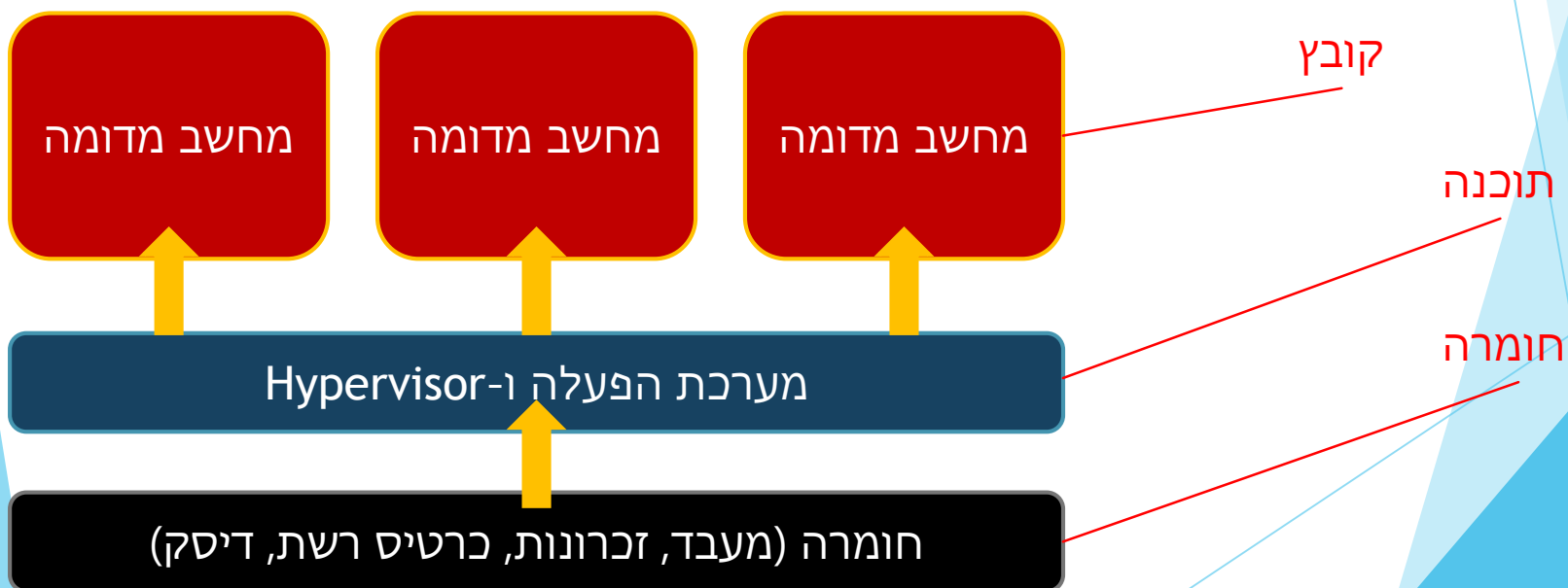
שרתים פיזים ▶

שרתים וירטואליים ▶

שרתים עם קונפיגורציה מוכנה מראש ▶

מחשב וירטואלי

- ▶ מחשב מדומה בתוך מחשב אמיתי
- ▶ המחשב המדומה לא יודע שהוא מדומה
- ▶ אפשר "להקפיא" מצב
- ▶ אפשר להזיז ממחשב מארח אחד לאחר
- ▶ אפשר לשנות משאבים



דוגמא למחשב וירטואלי

The image shows a Windows desktop environment with Oracle VM VirtualBox installed. A virtual machine named "Boris_1" is running. The terminal window displays the following system information:

```
boris@boris-VirtualBox: ~  
processor      : 0  
vendor_id     : GenuineIntel  
cpu family    : 6  
model         : 60  
model name    : Intel(R) Core(TM) i7-4770 CPU @ 3.40GHz  
stepping      : 3  
microcode    : 0x19  
cpu MHz       : 3342.129  
cache size    : 6144 KB  
fdt_bug       : no  
hlt_bug       : no  
f00f_bug     : no  
coma_bug     : no  
fpu           : yes  
fpu_exception : yes  
cpuid level   : 5  
wp            : yes  
flags         : fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov  
pat pse36 clflush mmx fxsr sse sse2 syscall nx rdtscp lm constant_tsc pni monitor  
r ssse3 lah_f_lm  
bogomips     : 6684.25  
clflush size  : 64  
cache_alignment : 64  
:
```

הגדרת מחשב בענן (אמזון)

סוגי Images

Images עם Db

איזור גיאוגרפי

1. Choose AMI 2. Choose Instance Type 3. Configure Instance 4. Add Storage 5. Tag Instance 6. Configure Security Group 7. Review

Step 1: Choose an Amazon Machine Image (AMI)

	SUSE Linux Enterprise Server 12 SP1 (HVM), SSD Volume Type - ami-b7b4fedd Free tier eligible	SUSE Linux Enterprise Server 12 Service Pack 1 (HVM), EBS General Purpose (SSD) Volume Type. Public Cloud, Advanced Systems Management, W Legacy modules enabled. Root device type: ebs Virtualization type: hvm	Select
	Ubuntu Server 14.04 LTS (HVM), SSD Volume Type - ami-fce3c696 Free tier eligible	Ubuntu Server 14.04 LTS (HVM), EBS General Purpose (SSD) Volume Type. Support available from Canonical (http://www.ubuntu.com/cloud/services). Root device type: ebs Virtualization type: hvm	Select
	Microsoft Windows Server 2012 R2 Base - ami-3d787d57 Free tier eligible	Microsoft Windows 2012 R2 Standard edition with 64-bit architecture. [English] Root device type: ebs Virtualization type: hvm	Select

Are you launching a database instance? Try Amazon RDS. [Hide](#)

Amazon Relational Database Service (RDS) makes it easy to set up, operate, and scale a relational database of your choice (MySQL, PostgreSQL, Oracle, SQL Server) in the cloud. It provides cost-efficient and resizable capacity while managing time-consuming database management tasks, freeing you up to focus on your applications and business. [Learn more.](#)

[Launch a database using RDS](#)

	Microsoft Windows Server 2012 R2 with SQL Server Express - ami-ff0f0a95	Microsoft Windows Server 2012 R2 Standard edition, 64-bit architecture, Microsoft SQL Server 2014 Express edition. [English] Root device type: ebs Virtualization type: hvm	Select
	Microsoft Windows Server 2012 R2 with SQL Server Web - ami-c70b0ead	Microsoft Windows Server 2012 R2 Standard edition, 64-bit architecture, Microsoft SQL Server 2014 Web edition. [English] Root device type: ebs Virtualization type: hvm	Select

התאמת החומרה

מספר ליבות

כמות זיכרון

איכות חיבור לרשת

AWS Services Edit

Roy @ 8149-5375-7852 N. Virginia Support

1. Choose AMI 2. Choose Instance Type 3. Configure Instance 4. Add Storage 5. Tag Instance 6. Configure Security Group 7. Review

Step 2: Choose an Instance Type

Currently selected: t2.micro (Variable ECUs, 1 vCPUs, 2.5 GHz, Intel Xeon Family, 1 GiB memory, EBS only)

	Family	Type	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance
<input type="checkbox"/>	All instance types	t2.nano	1	0.5	EBS only	-	Low to Moderate
<input checked="" type="checkbox"/>	Micro instances	t2.micro Free tier eligible	1	1	EBS only	-	Low to Moderate
<input type="checkbox"/>	General purpose	t2.small	1	2	EBS only	-	Low to Moderate
<input type="checkbox"/>	Compute optimized	t2.medium	2	4	EBS only	-	Low to Moderate
<input type="checkbox"/>	GPU instances	t2.large	2	8	EBS only	-	Low to Moderate
<input type="checkbox"/>	Memory optimized	m4.large	2	8	EBS only	Yes	Moderate
<input type="checkbox"/>	Storage optimized	m4.xlarge	4	16	EBS only	Yes	High
<input type="checkbox"/>	General purpose	m4.2xlarge	8	32	EBS only	Yes	High
<input type="checkbox"/>	General purpose	m4.4xlarge	16	64	EBS only	Yes	High
<input type="checkbox"/>	General purpose	m4.10xlarge	40	160	EBS only	Yes	10 Gigabit
<input type="checkbox"/>	General purpose	m3.medium	1	3.75	1 x 4 (SSD)	-	Moderate
<input type="checkbox"/>	General purpose	m3.large	2	7.5	1 x 32 (SSD)	-	Moderate
<input type="checkbox"/>	General purpose	m3.xlarge	4	15	2 x 40 (SSD)	Yes	High
<input type="checkbox"/>	General purpose	m3.2xlarge	8	30	2 x 80 (SSD)	Yes	High

Cancel Previous Review and Launch Next: Configure Instance Details

הגדרות רשת

הגדרת מחשב בענן (אמזון)

AWS Services Edit Roy @ 8149-5375-7852 N. Virginia Support

1. Choose AMI 2. Choose Instance Type 3. Configure Instance 4. Add Storage 5. Tag Instance 6. Configure Security Group 7. Review

Step 3: Configure Instance Details

Configure the instance to suit your requirements. You can launch multiple instances from the same AMI, request Spot instances to take advantage of the lower pricing, assign an access management role to the instance, and more.

Number of instances 1 [Launch into Auto Scaling Group](#)

Purchasing option Request Spot instances

Network vpc-697d730d (10.0.0.0/16) | blah1 [Create new VPC](#)

Subnet subnet-c164e699(10.0.1.0/24) | Private subnet | us- [Create new subnet](#)
251 IP Addresses available

Auto-assign Public IP Use subnet setting (Disable)

IAM role None [Create new IAM role](#)

Shutdown behavior Stop

Enable termination protection Protect against accidental termination

Monitoring Enable CloudWatch detailed monitoring
[Additional charges apply.](#)

Tenancy Shared - Run a shared hardware instance
[Additional charges will apply for dedicated tenancy.](#)

Network interfaces

Device	Network Interface	Subnet	Primary IP	Secondary IP addresses
--------	-------------------	--------	------------	------------------------

Cancel Previous **Review and Launch** Next: Add Storage

הגדרת מחשב בענן (אמזון) הגדרות דיסק

AWS Services Edit Roy @ 8149-5375-7852 N. Virginia Support

1. Choose AMI 2. Choose Instance Type 3. Configure Instance 4. Add Storage 5. Tag Instance 6. Configure Security Group 7. Review

Step 4: Add Storage

Your instance will be launched with the following storage device settings. You can attach additional EBS volumes and instance store volumes to your instance, or edit the settings of the root volume. You can also attach additional EBS volumes after launching an instance, but not instance store volumes. [Learn more](#) about storage options in Amazon EC2.

Volume Type	Device	Snapshot	Size (GiB)	Volume Type	IOPS	Delete on Termination	Encrypted
Root	/dev/sda1	snap-f70deff0	8	General Purpose SSD (GP2)	24 / 3000	<input checked="" type="checkbox"/>	Not Encrypted
EBS	/dev/sdb	Search (case-insensit	8	General Purpose SSD (GP2)	24 / 3000	<input type="checkbox"/>	<input type="checkbox"/>

[Add New Volume](#)

Free tier eligible customers can get up to 30 GB of EBS General Purpose (SSD) or Magnetic storage. [Learn more](#) about free usage tier eligibility and usage restrictions.

Cancel Previous **Review and Launch** Next: Tag Instance

הגדרת מחשב בענן (אמזון)

הגדרות נוספות לענן

מאפיינים

רשימת המחשבים שלי

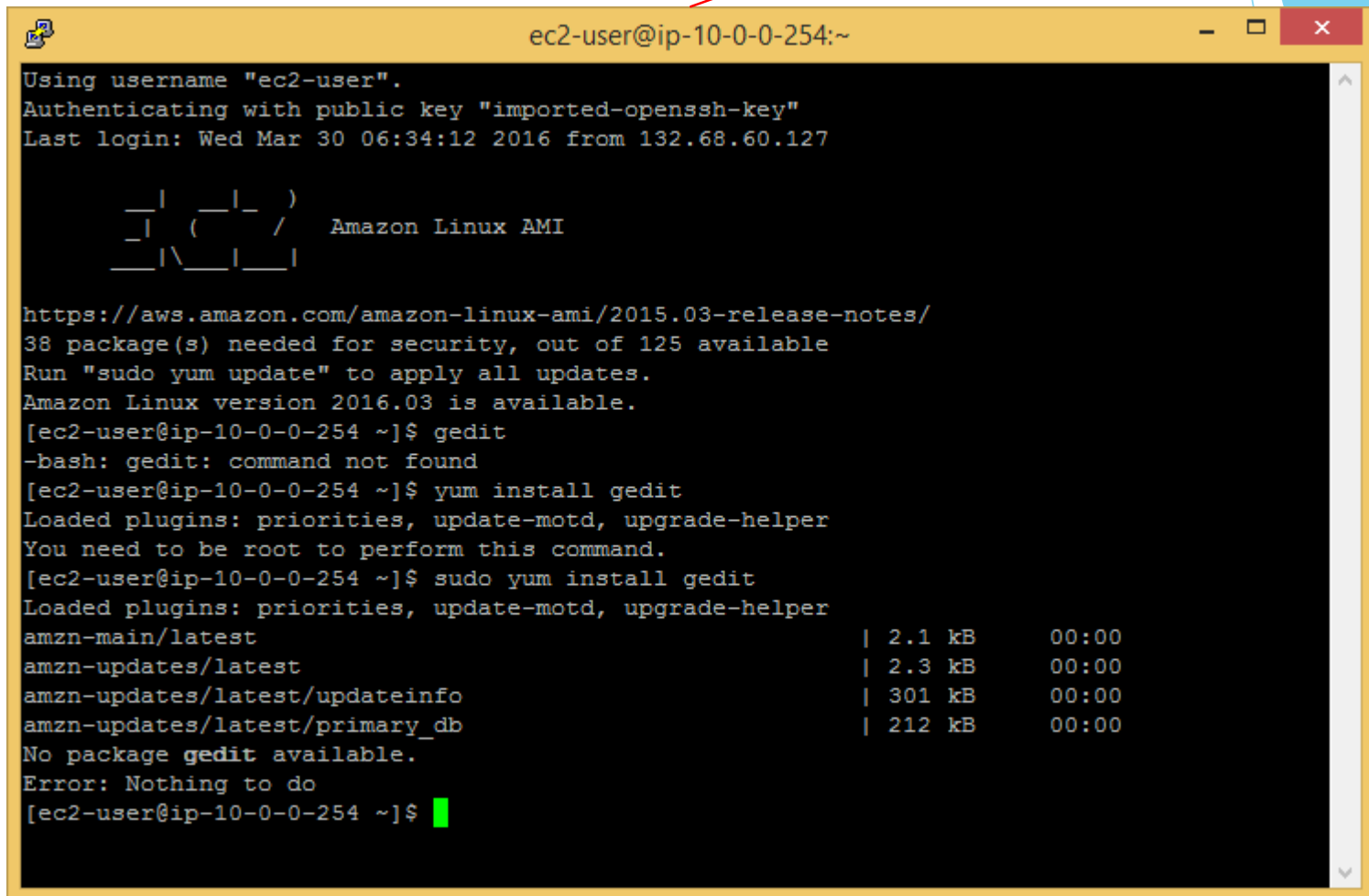
The screenshot displays the AWS Management Console interface. At the top, there are navigation menus for 'AWS Services' and 'Edit'. The main content area shows a list of EC2 instances with columns for Name, Instance ID, Instance Type, Availability Zone, Instance State, Status Checks, Alarm Status, Public DNS, and Public IP. Below the list, the 'Description' tab is selected, showing detailed configuration for a specific instance (i-4c9503d7). The details are organized into two columns: the left column lists instance-specific attributes like Instance ID, state, type, DNS, and VPC configuration; the right column lists system-level attributes like Public DNS, IP addresses, security groups, and lifecycle events.

Name	Instance ID	Instance Type	Availability Zone	Instance State	Status Checks	Alarm Status	Public DNS	Public IP
<input checked="" type="checkbox"/>	i-4c9503d7	t2.micro	us-east-1d	running	2/2 checks ...	None	ec2-54-165-34-39.compute-1.amazonaws.com	54.165.34.39
<input type="checkbox"/>	i-2f9c0ab4	t2.micro	us-east-1d	running	2/2 checks ...	None	ec2-52-87-112-109.compute-1.amazonaws.com	52.87.112.109
<input type="checkbox"/>	i-1879409b	m1.small	us-east-1e	running	2/2 checks ...	None	ec2-52-87-112-109.compute-1.amazonaws.com	52.87.112.109
<input type="checkbox"/>	i-12d74189	m1.small	us-east-1d	running	2/2 checks ...	None	ec2-52-86-168-67.compute-1.amazonaws.com	52.86.168.67

Property	Value	Property	Value
Instance ID	i-4c9503d7	Public DNS	ec2-54-165-34-39.compute-1.amazonaws.com
Instance state	running	Public IP	54.165.34.39
Instance type	t2.micro	Elastic IP	-
Private DNS	ip-10-0-0-6.ec2.internal	Availability zone	us-east-1d
Private IPs	10.0.0.6	Security groups	NSSL.. view rules
Secondary private IPs	-	Scheduled events	No scheduled events
VPC ID	vpc-697d730d	AMI ID	amzn-ami-hvm-2016.03.0.x86_64-gp2 (ami-08111162)
Subnet ID	subnet-c264e69a	Platform	-
Network interfaces	eth0	IAM role	-
Source/dest. check	True	Key pair name	key1
ClassicLink	-	Owner	814953757852
EBS-optimized	False	Launch time	March 29, 2016 at 5:35:55 PM UTC+3 (211 hours)
Root device type	ebs	Termination protection	False
Root device	/dev/xvda	Lifecycle	normal
Block devices	/dev/xvda	Monitoring	basic

הגדרת מחשב בענן (אמזון)

התחברות מרחוק



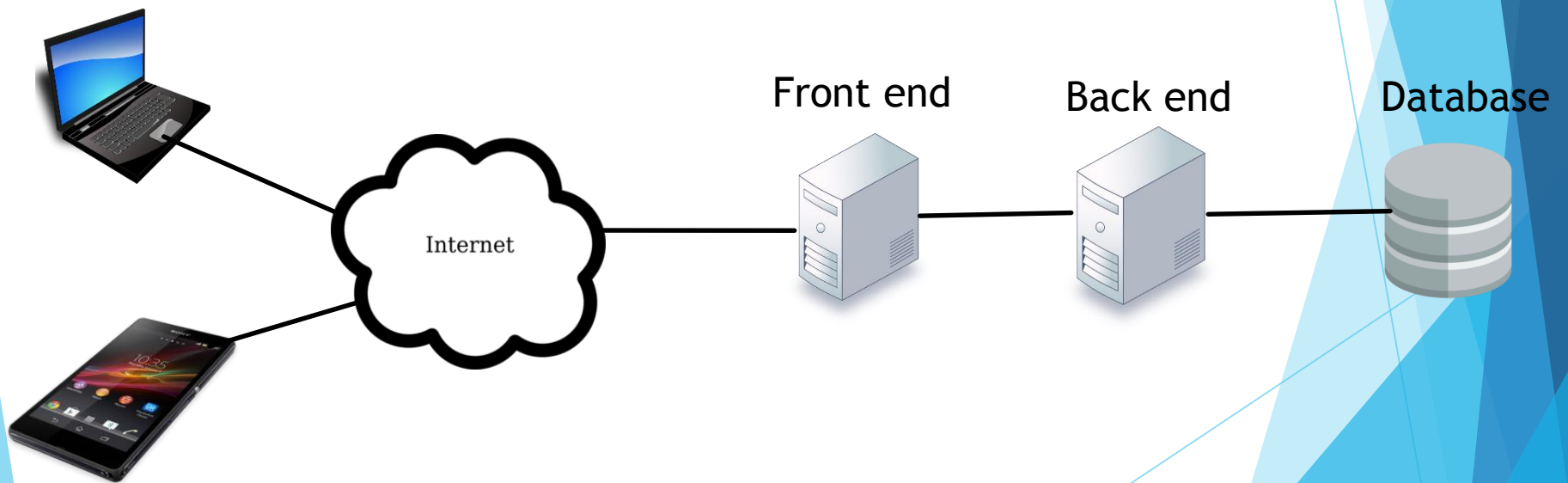
```
ec2-user@ip-10-0-0-254:~  
Using username "ec2-user".  
Authenticating with public key "imported-openssh-key"  
Last login: Wed Mar 30 06:34:12 2016 from 132.68.60.127  
  
  _ | _ | _ )  
  _ | ( _ | /   Amazon Linux AMI  
  _ | \ _ | _ |  
  
https://aws.amazon.com/amazon-linux-ami/2015.03-release-notes/  
38 package(s) needed for security, out of 125 available  
Run "sudo yum update" to apply all updates.  
Amazon Linux version 2016.03 is available.  
[ec2-user@ip-10-0-0-254 ~]$ gedit  
-bash: gedit: command not found  
[ec2-user@ip-10-0-0-254 ~]$ yum install gedit  
Loaded plugins: priorities, update-motd, upgrade-helper  
You need to be root to perform this command.  
[ec2-user@ip-10-0-0-254 ~]$ sudo yum install gedit  
Loaded plugins: priorities, update-motd, upgrade-helper  
amzn-main/latest | 2.1 kB | 00:00  
amzn-updates/latest | 2.3 kB | 00:00  
amzn-updates/latest/updateinfo | 301 kB | 00:00  
amzn-updates/latest/primary_db | 212 kB | 00:00  
No package gedit available.  
Error: Nothing to do  
[ec2-user@ip-10-0-0-254 ~]$
```

סיכום ענן

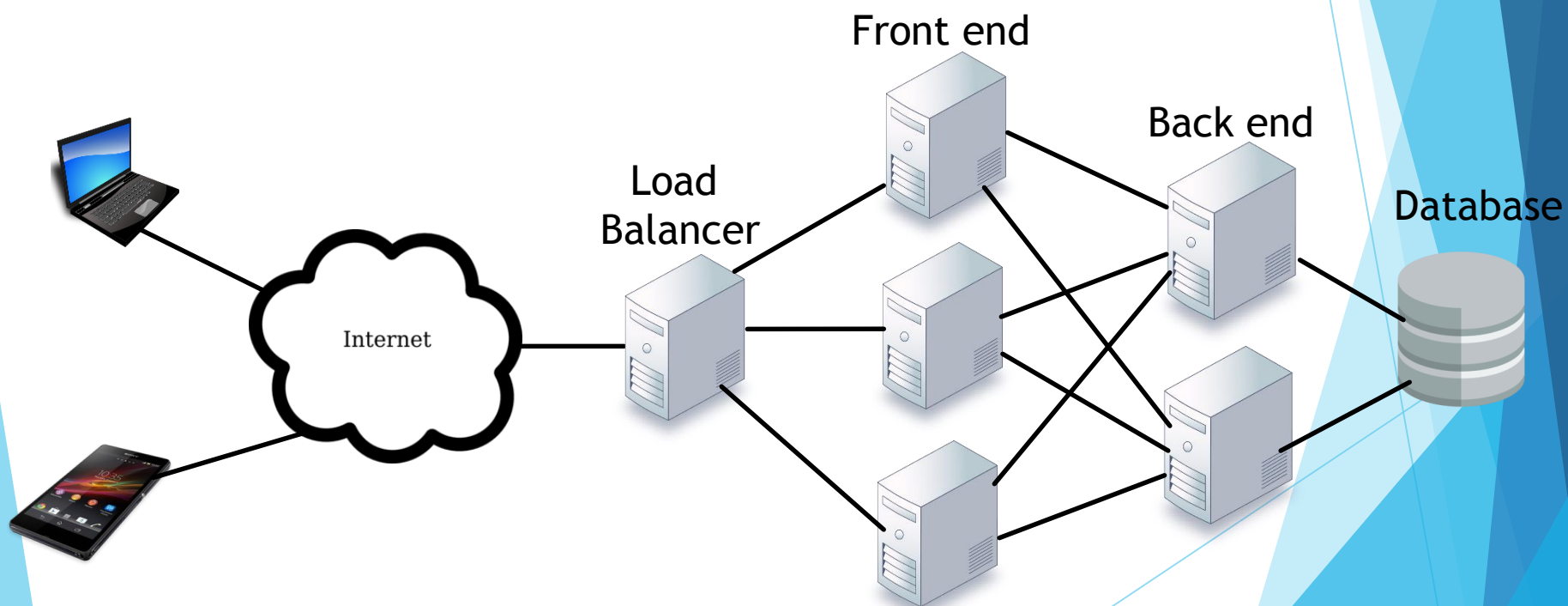
Cloud	On Premises
Self Service - לא צריך טובות של IT	ניצול משאבים קיימים
אין צורך בתהליכי רכש	זמינות בתוך הארגון
אין צורך בתשתיות פיזיות	תחושת ביטחון
גמישות במשאבי המחשוב	
קונפיגורציה ושרותים מוכנים מראש	

אפשר שניהם ביחד!
למשל OpenStack - ענן פרטי

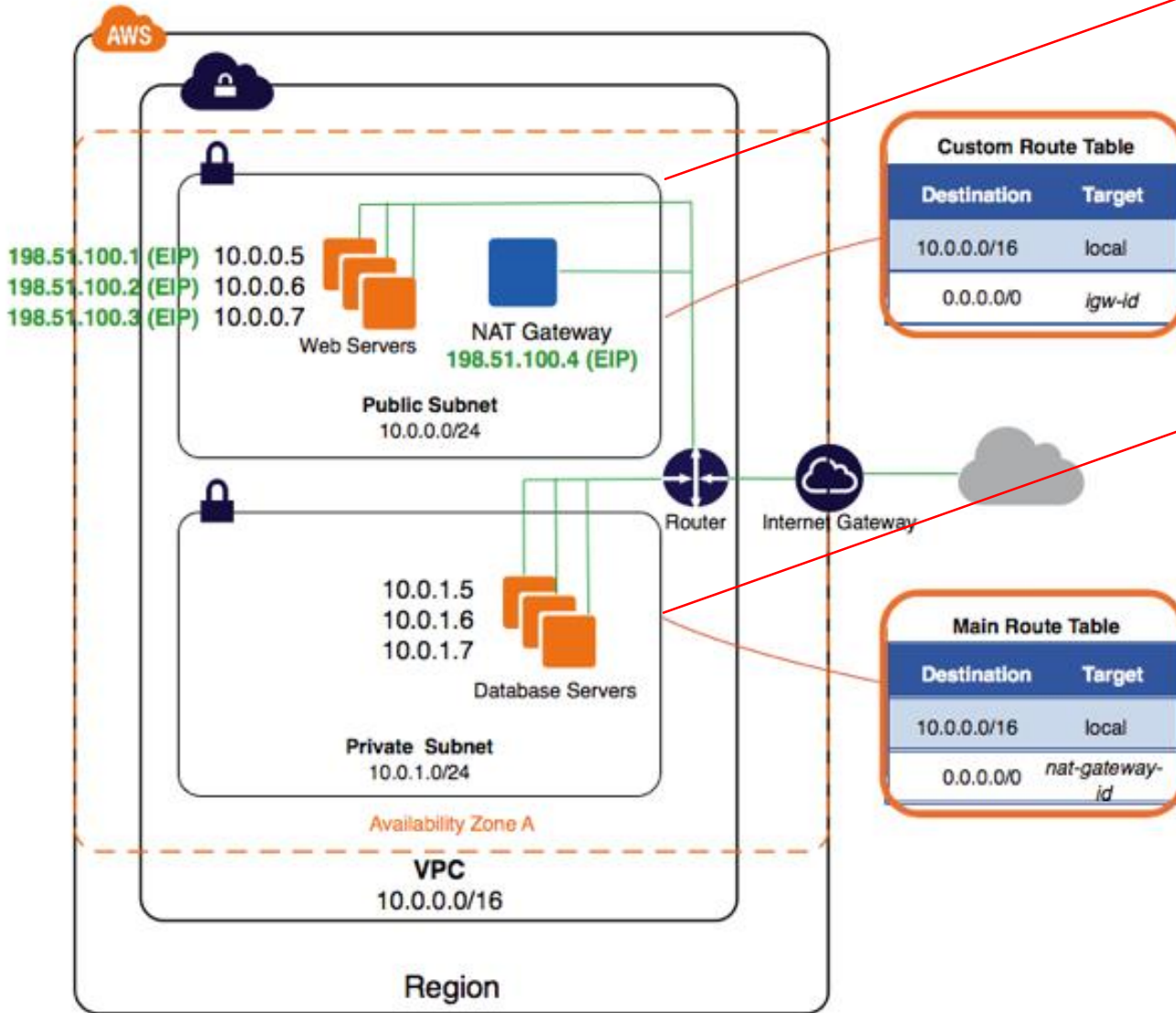
דוגמא: אתר קניות באינטרנט



דוגמא: אתר קניות באינטרנט פסח מתקרב!!!



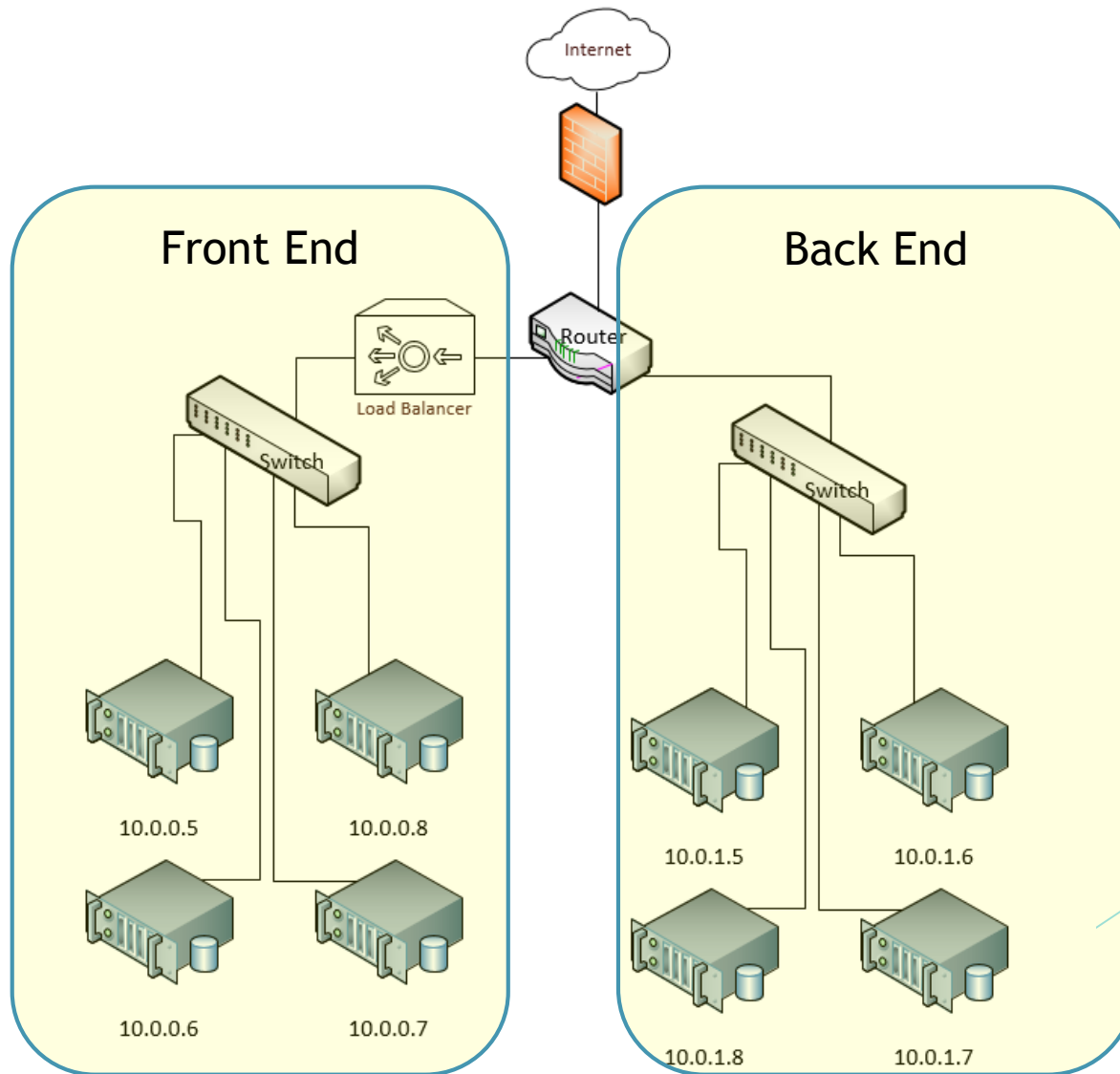
רשת מחשבים בענן



רשת עם גישה
לאינטרנט
Front-end

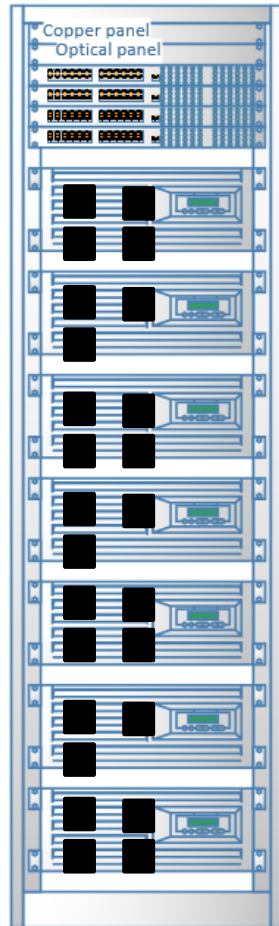
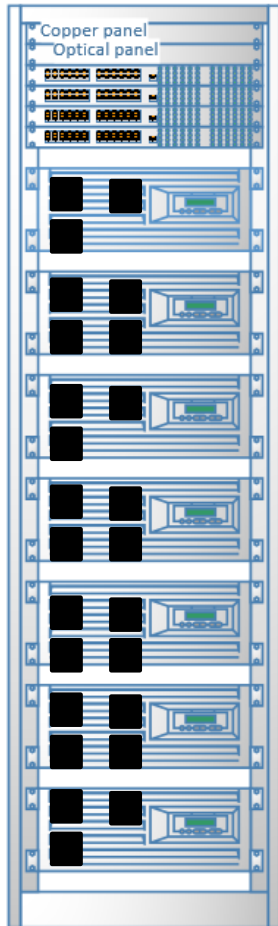
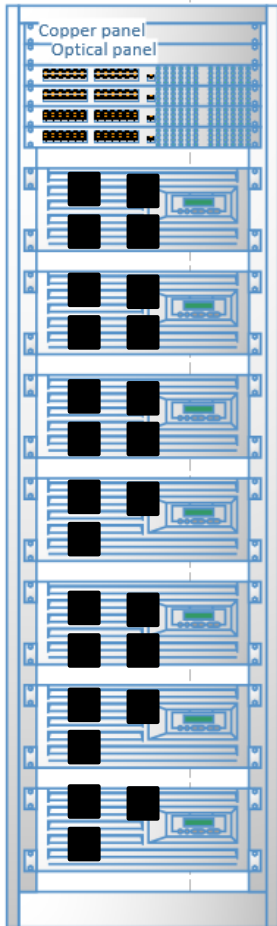
רשת בלי גישה
לאינטרנט
Back-end

רשת פיזית דומה



רשת וירטואלית

איפה המתגים? הנתב? ה-FW? הכבלים?



Eth switch
IB Switch
IB Switch
IB Switch

■ Other tenants

■ Front End

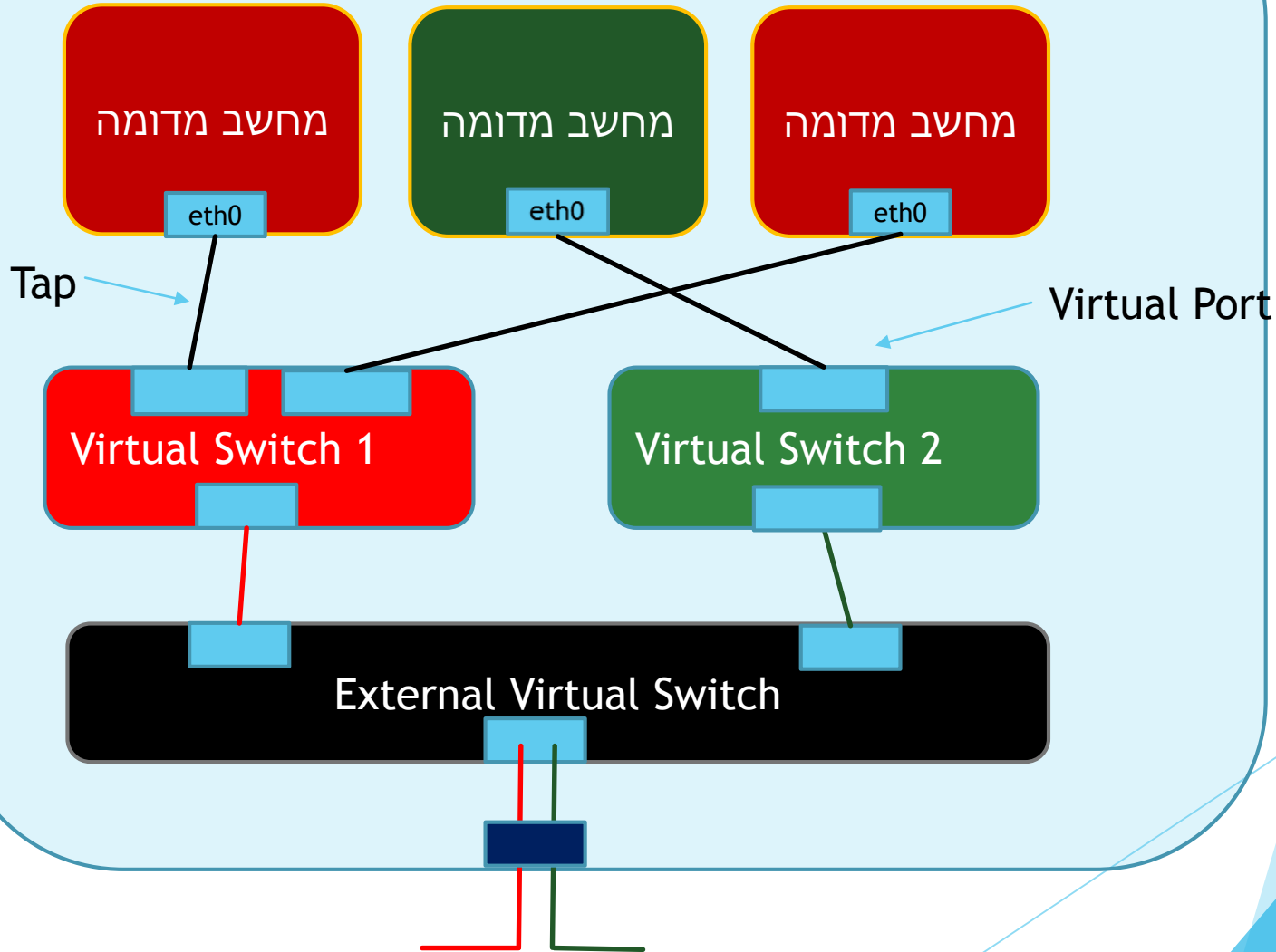
■ Back End

רשת וירטואלית

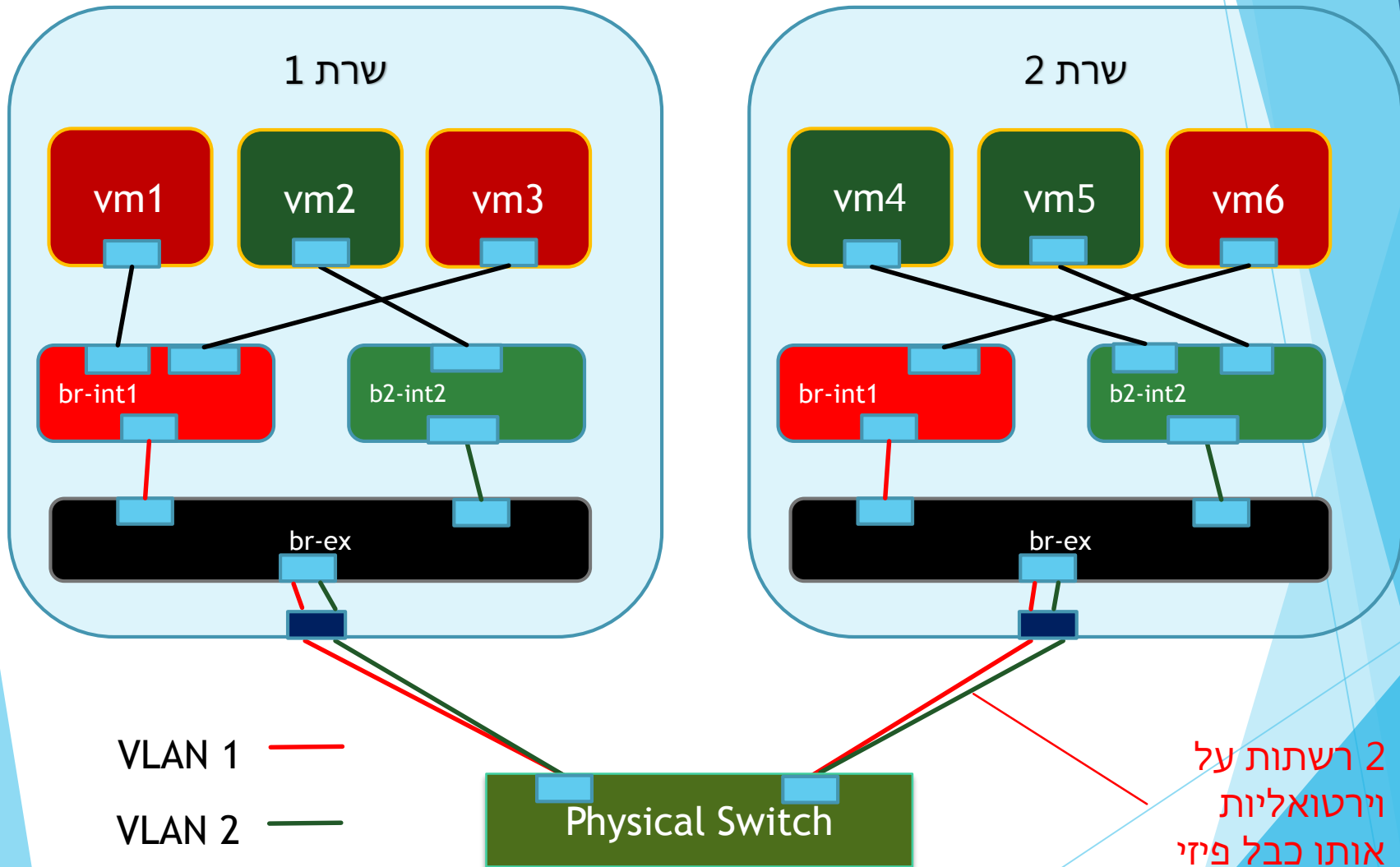
- ▶ מתג לדוגמא: (OVS) Open vSwitch
- ▶ שימוש בכבלים וירטואלים בלינוקס (tun/tap)
- ▶ Virtual Interfaces

מודל פשטני

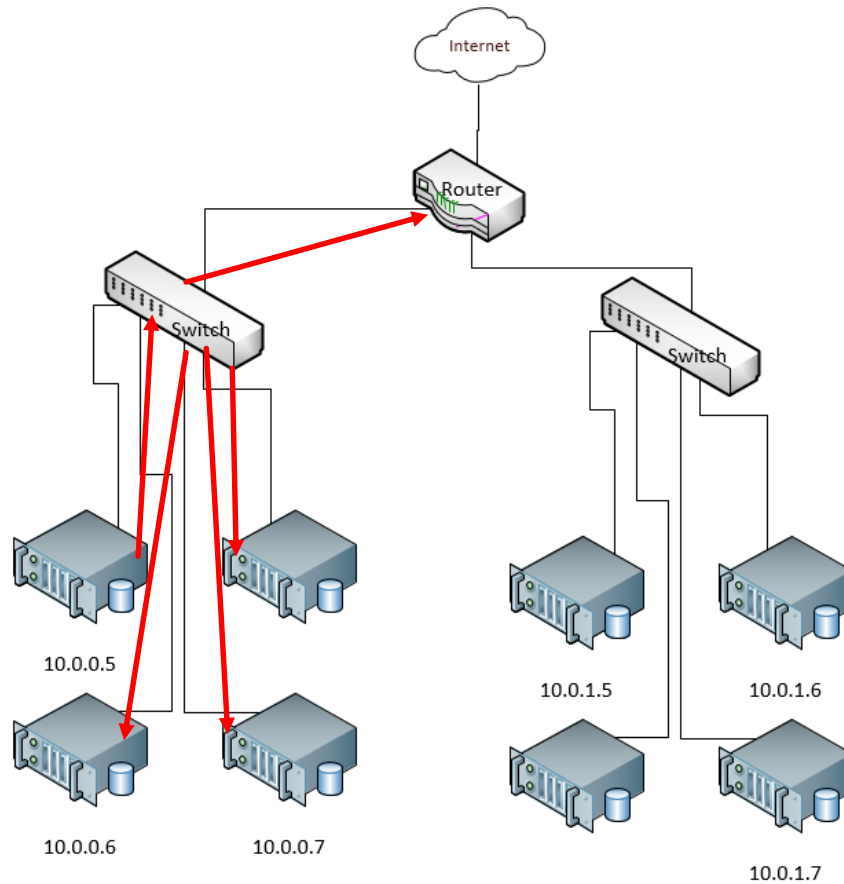
שרת



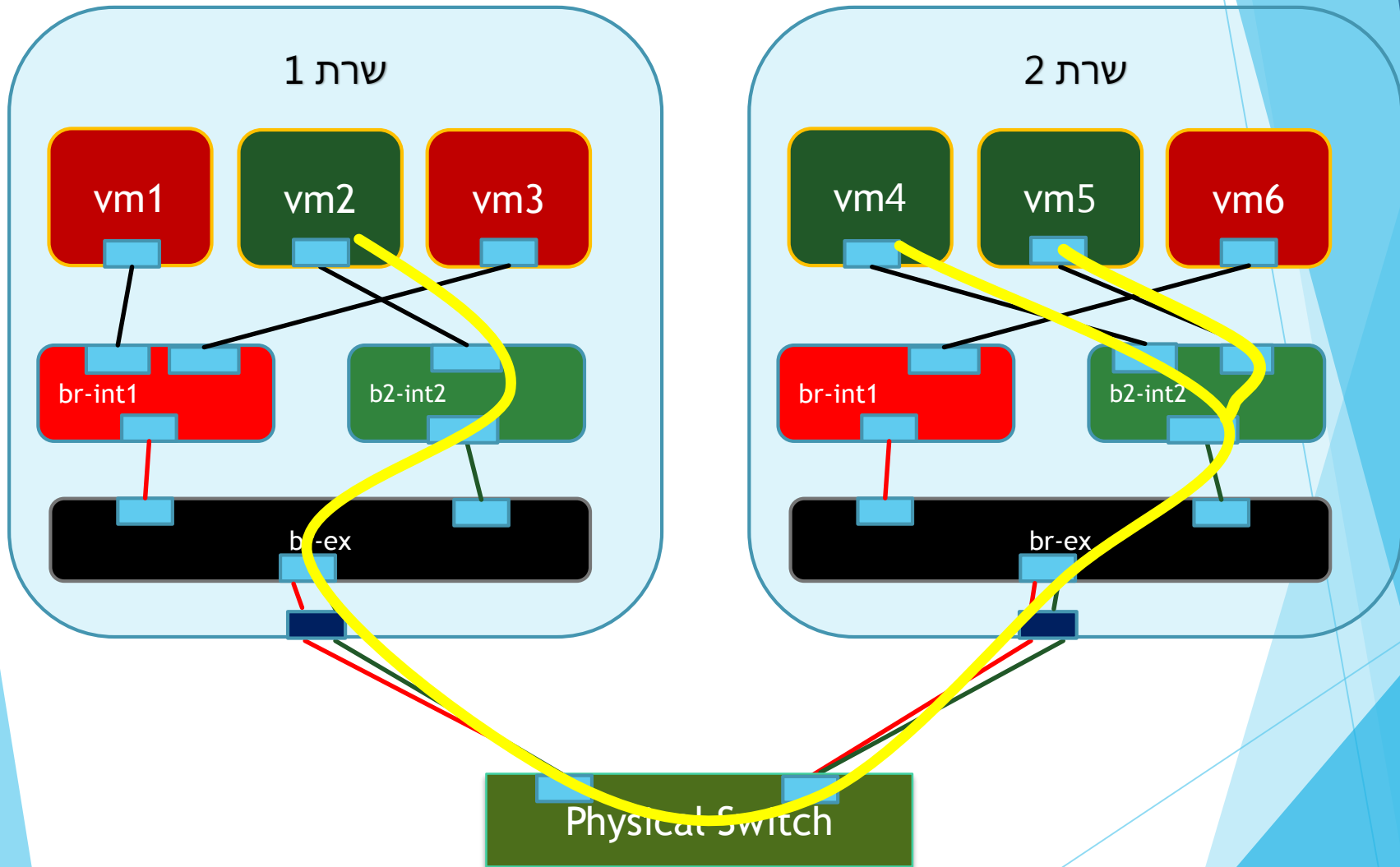
תעבורת רשת בין שרתים



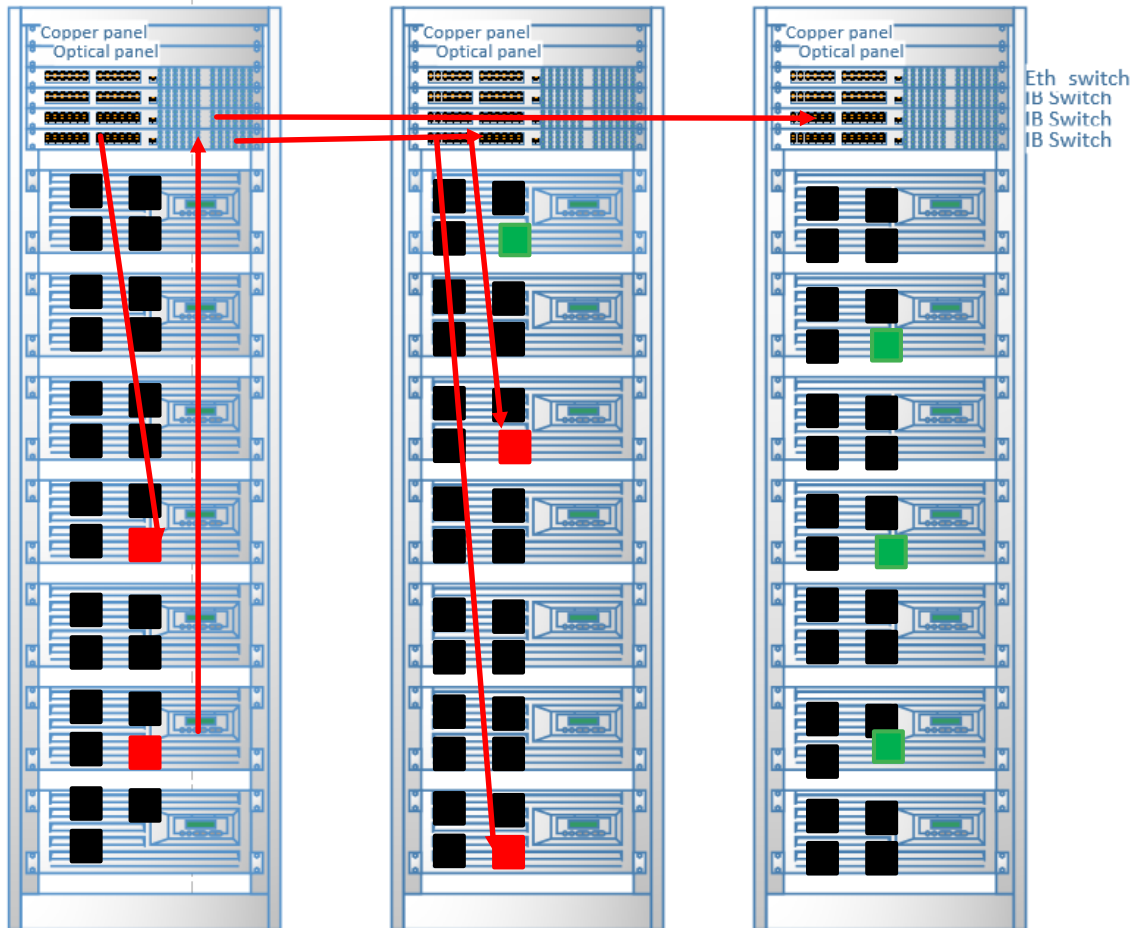
Broadcast - רשת רגילה



ענן - Broadcast



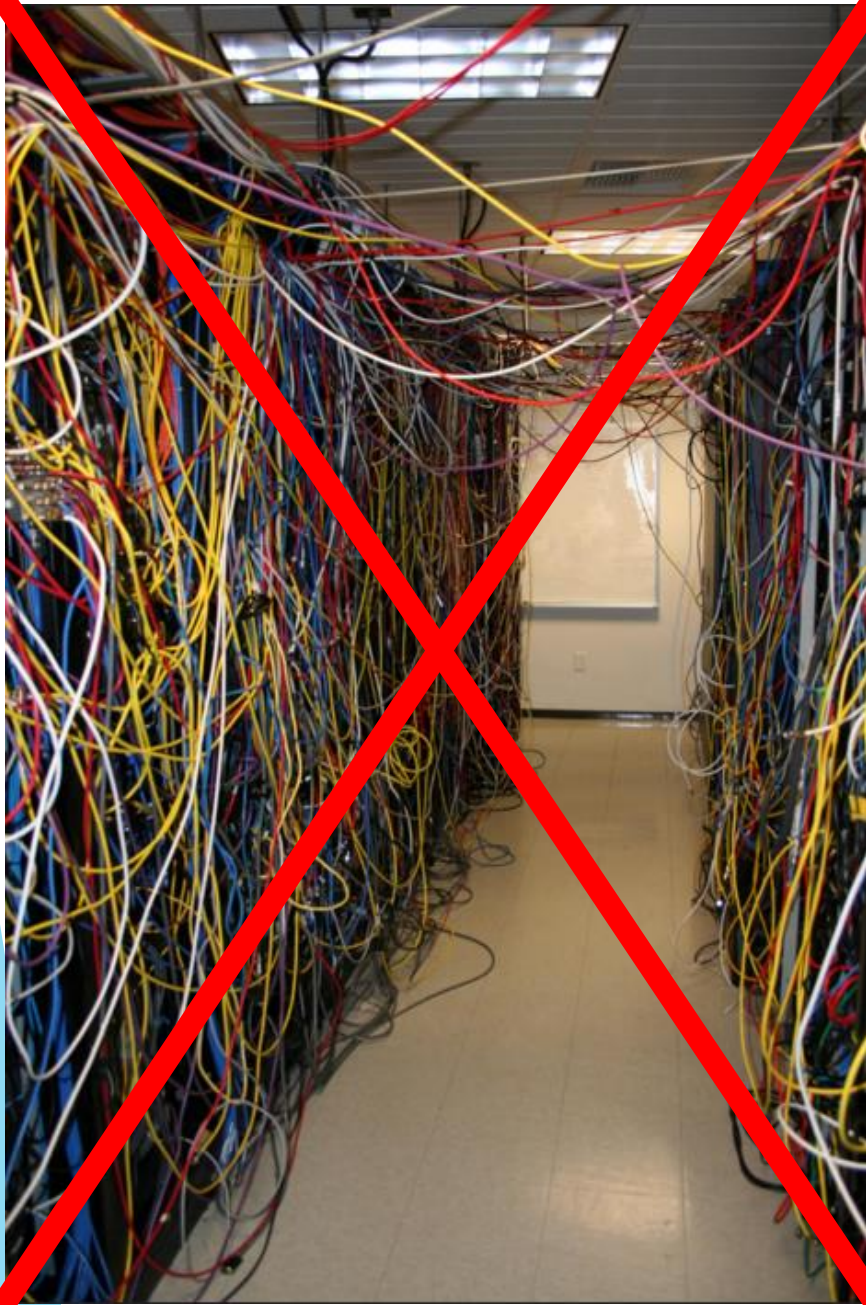
Broadcast - רשת וירטואלית



■ Other tenants

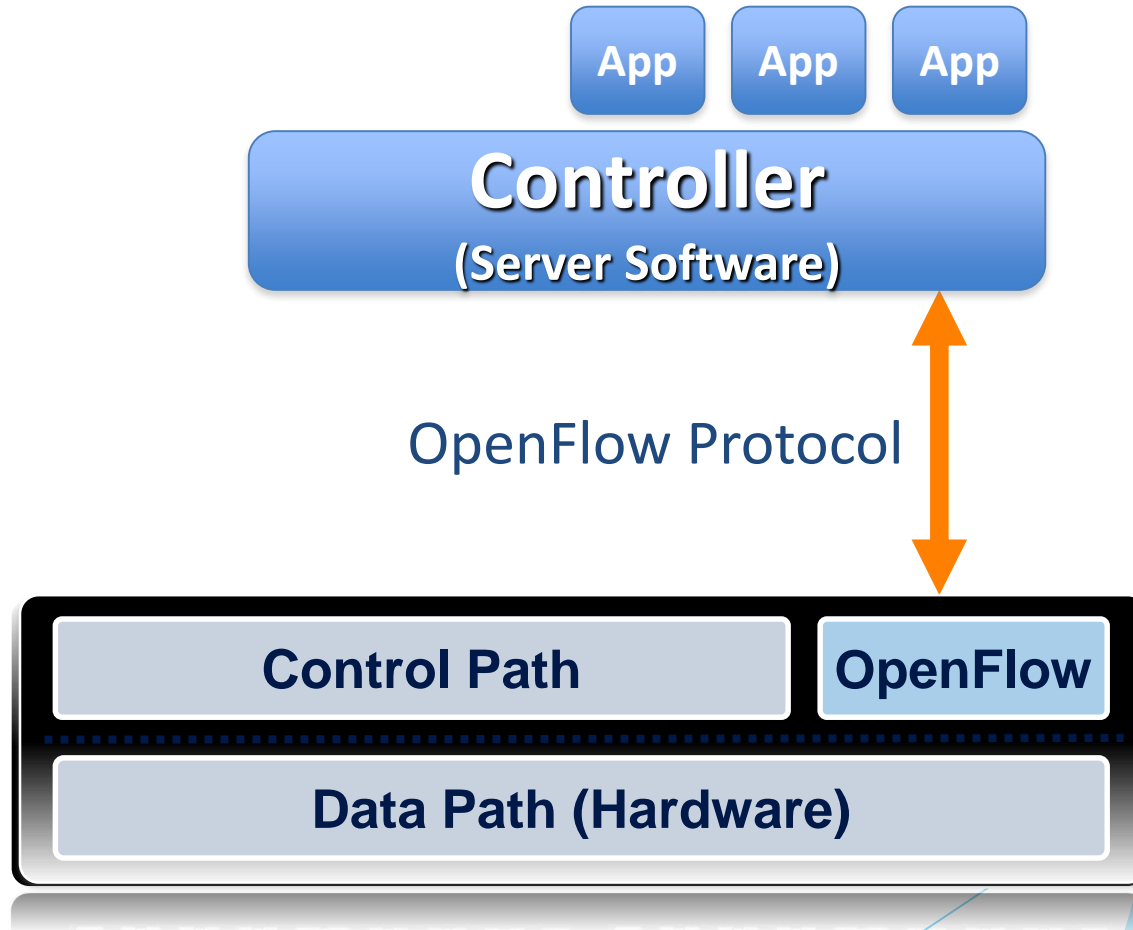
■ Front End

■ Back End



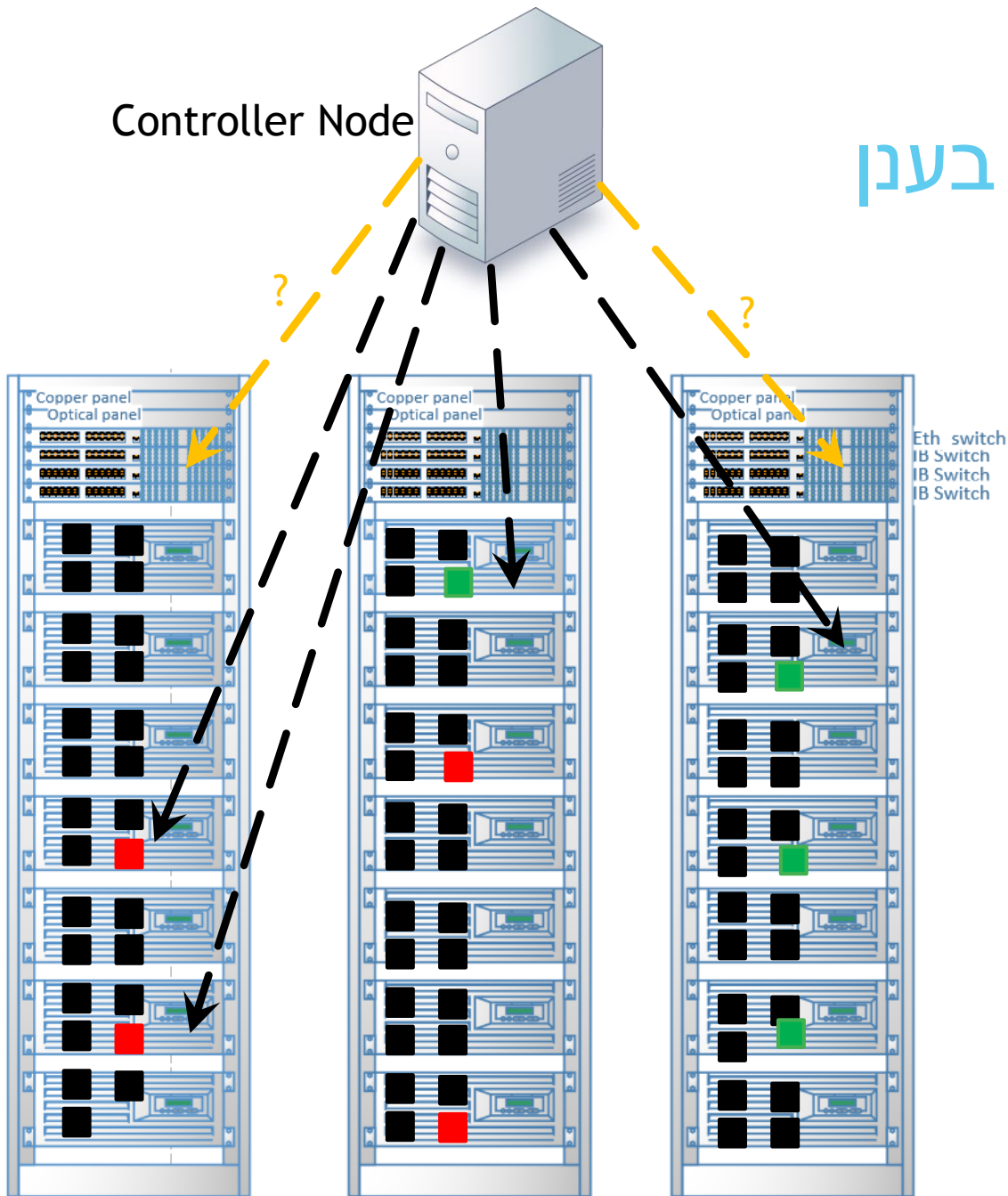
חסל סדר בלגן
בכבילה!

איך מבצעים שינויים ברשת? Software Defined Networks



Controller Node

SDN בענן



■ Other tenants

■ Front End

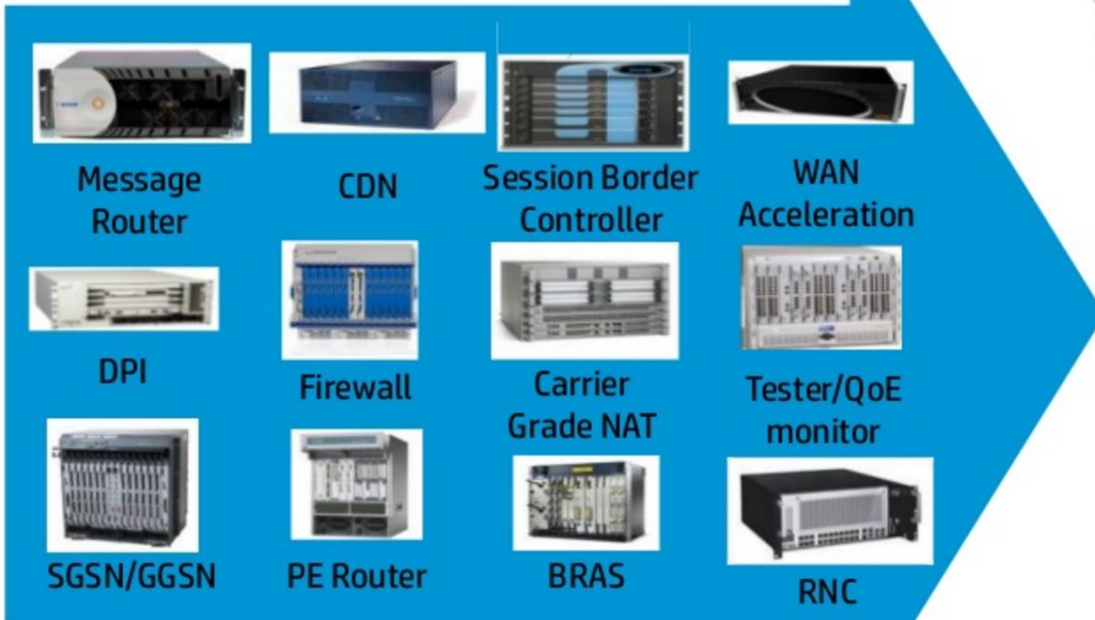
■ Back End

עוד וירטואליזציה - NFV

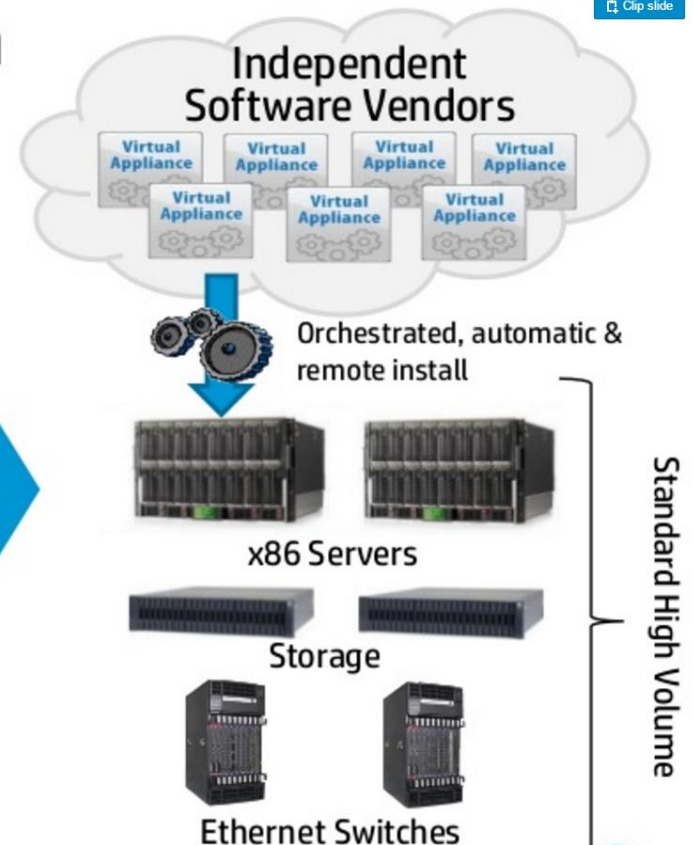
למה לעצור בנתבים ומתגים? ▶



BT Network Virtualization POC



Classical Network Appliances



NFV Network Function Virtualization

The slide features a white background with a decorative graphic on the right side. This graphic consists of several overlapping, semi-transparent blue triangles and polygons in various shades of blue, ranging from light sky blue to a deep navy blue. The shapes are arranged in a way that they appear to be layered, creating a sense of depth and movement. The overall aesthetic is clean, modern, and professional.

סיכום

- ▶ הענן כבר כאן, אבל ממשיך להתפתח
- ▶ לרשת חלק נכבד בהצלחת הענן
- ▶ לענן חלק נכבד בהתפתחות הרשת בשנים האחרונות
- ▶ מילות מפתח

- OpenStack
- Open vSwitch
- Amazon AWS and EC2

- Data Center
- SDN and NFV
- OpenFlow

תודה על
ההקשבה!