





Articol științific principal despre Cloud

Above the Clouds: A Berkeley View of Cloud Computing

Michael Armbrust, Armando Fox, Rean Griffith, Anthony D. Joseph, Randy Katz, Andy Konwinski, Gunho Lee, David Patterson, Ariel Rabkin, Ion Stoica, and Matei Zaharia (Comments should be addressed to above the clouds@cs.berkeley.edu)

> UC Berkeley Reliable Adaptive Distributed Systems Laboratory * http://radlab.cs.berkeley.edu/

> > February 10, 2009

KEYWORDS: Cloud Computing, Utility Computing, I

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Cloud-ul este despre Cost \$\$\$\$

- Economie de scală (cumpără angro, în bulk).
 - Cumpăra hardware la un preț mai mic decât ar face asta chiar unele companii mari.
- Pay-as-you-go (efectiv resursele se închiriază).
 - Noutatea cloud-ului e că acest lucru se întâmplă automat.
 - Majoritatea se plătesc la nivel de ore

People are expensive

- Un cluster necesită o echipă 24/7
- Echipa trebuie să aibă oameni cu specializări diverse (hardware, <u>security</u>, networking, etc.)
- Ideal pentru start-up-uri, echipe mici, proiecte scurte
 - Cost o lună resurse puține cloud << cost cluster



Când NU cloud?



Când NU cloud?

- Date sensibile
 - Poate fi chiar ilegal să pui anumite date (medicale) pe Cloud public
- Proiect foarte mare cu durată mare.
 - cost cluster < cost multe resurse cloud * periodă timp</p>
- Nevoi de bandwidth/latență mari
 - Cloud-ul public este peste internet.

Control

Serviciile şi garanţiile se pot schimba în timp



Elasticitate

Elasticity in Cloud Computing: What It Is, and What It Is Not

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Karlsruhe Institute of Technology
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Abstract

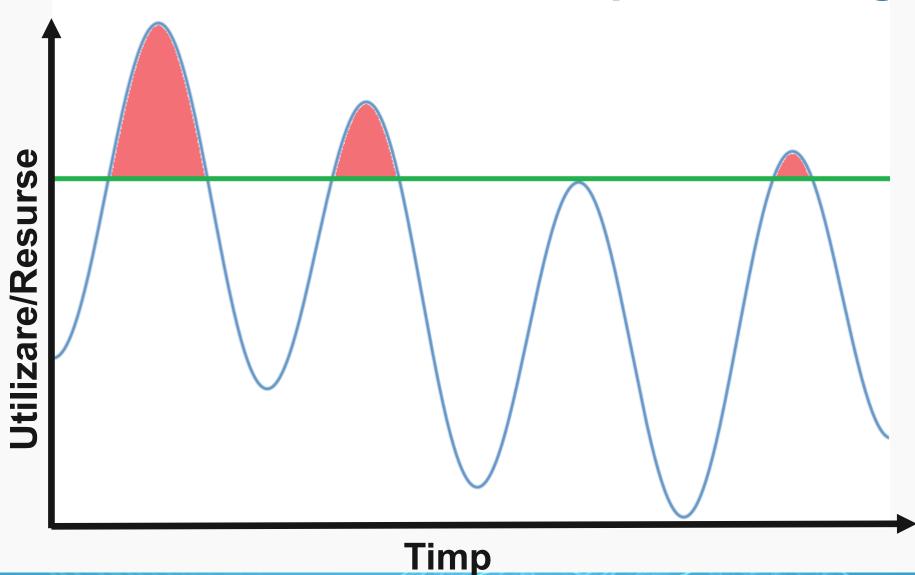
even in the naming of specific products or services. Even

Originating from term elasticity of cloud compa

Elasticity is the degree to which a system is able to adapt to workload changes by provisioning and deprovisioning resources in an autonomic manner, such that at each point in time the available resources *match* the current demand as closely as possible.

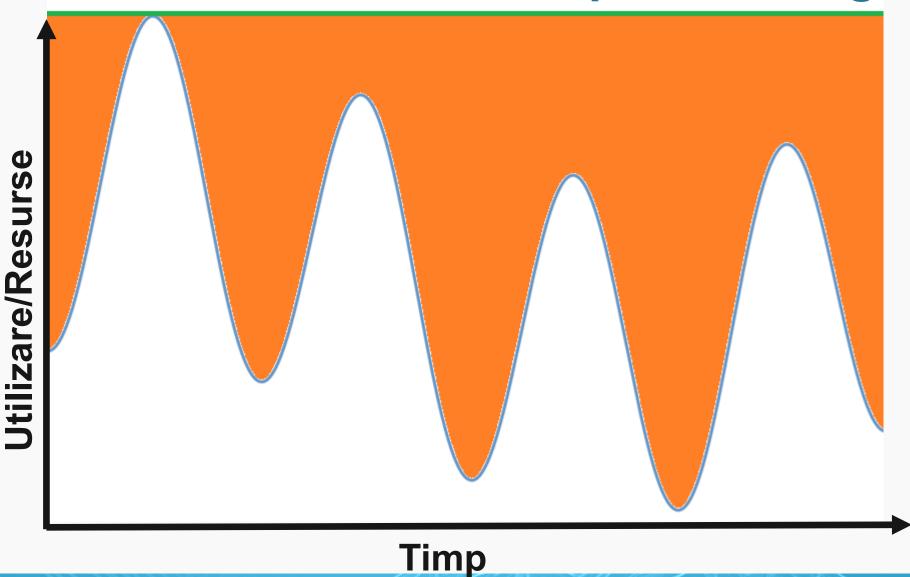


Fără elasticitate – underprovisioning

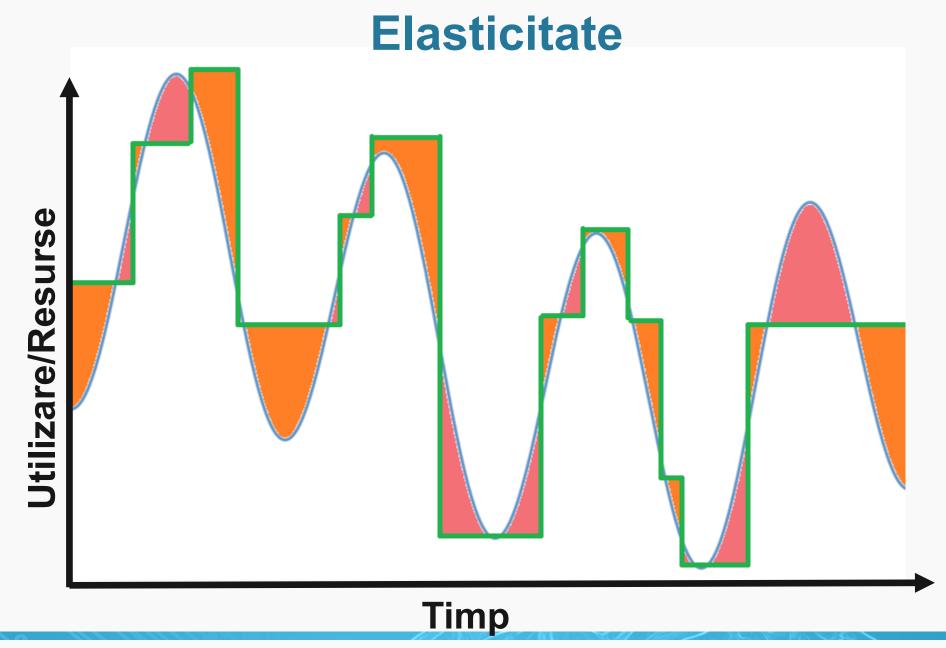




Fără elasticitate – overprovisioning









Privat vs

Public

vs Hibrid

Cloud ținut în interiorul unei instituții. Menit pentru a oferi resurse diferitelor grupuri din instituție. Necesită menținerea unui singur grup de administrare cluster.







Google Cloud

Şi mulţi alţii.....

Şi privat şi public. Când resursele private sunt epuizate se pot extinde cu cele publice. Posibil doar temporar.



SLA/QoS

- Five nines
 - Se dorește 99.999% disponibilitate (5 minute pe an down-time)

- Se obține prin securitate crescută
- Se obține prin hardware de înaltă performanță
- Se obţine prin redundanţă şi back-up
- Se obține prin mecanisme de toleranță la defecte



X as a Service

X	Exemplu Efectiv
Software as a Service	Dropbox, Slack
Platform as a Service	Baze de date
Infrastructure as a Service	Maşini virtuale
Metal as a Service	Maşini fizice
as a Service	



Metal as a Service

- Folosim direct maşinile.
- Sunt necesare servere specializate
 - Suport Intelligent Platform Management Interface (IPMI)
 - Suport Baseboard management controller
 - Suport Preboot eXecution Environment (PXE)

Combinate acestea oferă metode de power on/off, , monitorizare, remote-control, instalare OS.

Toate de la distanță





Infrastructure as a Service – mașini virtuale





Hipervizoare:









Avantaje mașini virtuale?



Avantaje mașini virtuale?

- Development în sistem de operare diferit
- Deployment mai uşor
- Dependințe mai ușor de controlat
- Scalabilitate mai ușoară (copiezi mașina virtuală)



Emulare vs virtualizare

- Simulează sistemul în software
- Fiecare instrucţiune e citită de software şi interpretată

 Ex: <u>Simulator NES</u> (Warning multiple hours of intense fun) Majoritatea instrucţiunilor sunt rulate **DIRECT** de procesor

 De citit Capitol 7 – Modern Operating Systems (4th ed) Andrew Tanenbaum



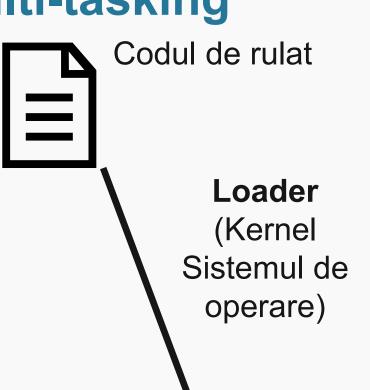
Assembly vs. machine code

Machine code bytes	Assembly language statements

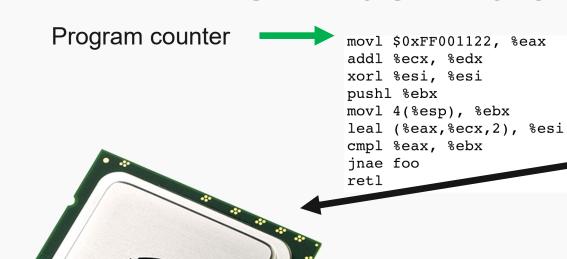
					foo:
В8	22	11	00	FF	<pre>movl \$0xFF001122, %eax</pre>
01	CA				addl %ecx, %edx
31	F6				xorl %esi, %esi
53					pushl %ebx
8B	5C	24	04		movl 4(%esp), %ebx
8D	34	48			<pre>leal (%eax,%ecx,2), %esi</pre>
39	C3				cmpl %eax, %ebx
72	EB				jnae foo
C3					retl

Instruction stream

B8 22 11 00 FF 01 CA 31 F6 53 8B 5C 24 04 8D 34 48 39 C3 72 EB C3











Program counter

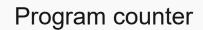


movl \$0xFF001122, %eax
addl %ecx, %edx
xorl %esi, %esi
pushl %ebx
movl 4(%esp), %ebx
leal (%eax, %ecx, 2), %esi
cmpl %eax, %ebx
jnae foo
retl







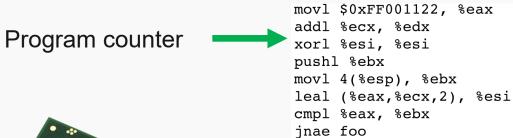


movl \$0xFF001122, %eax
addl %ecx, %edx
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pushl %ebx
movl 4(%esp), %ebx
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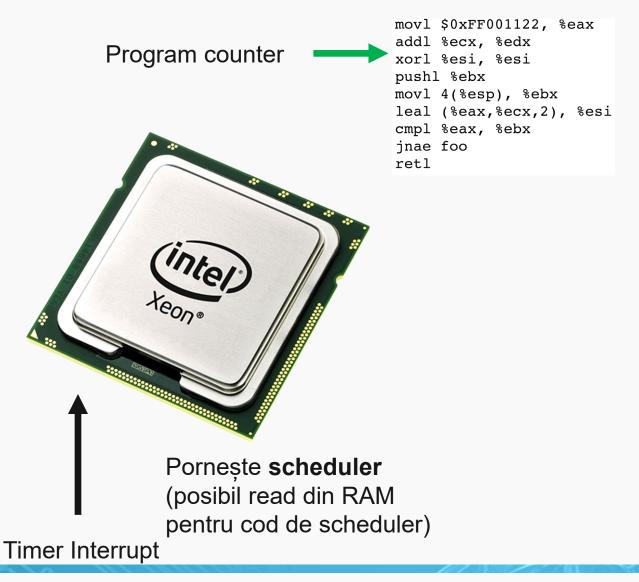
retl





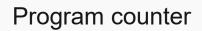
Timer Interrupt









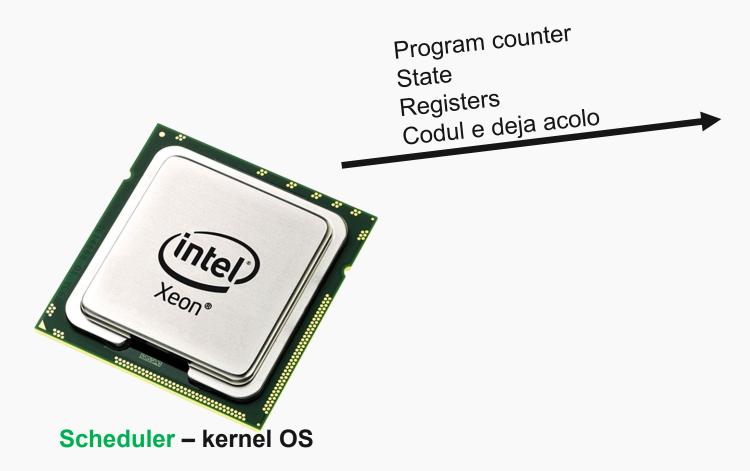


movl \$0xFF001122, %eax
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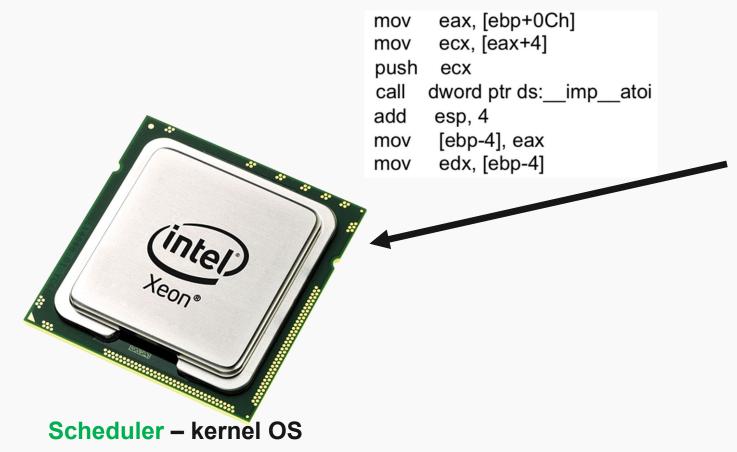






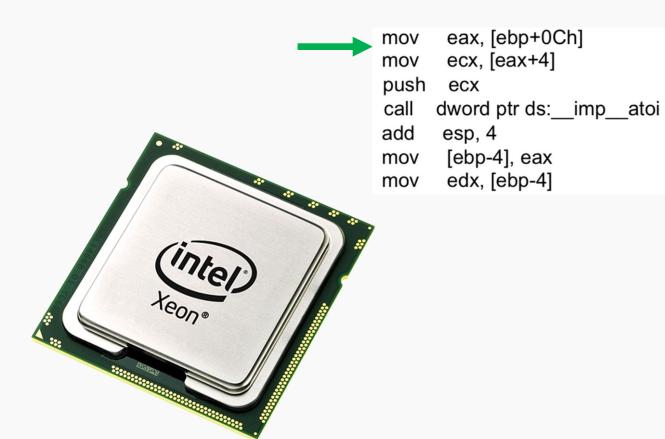








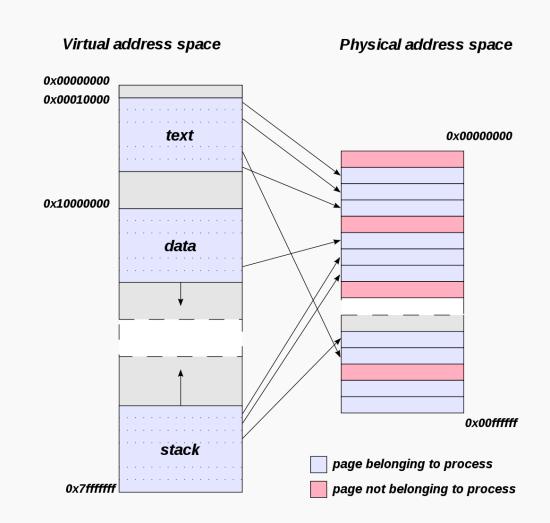






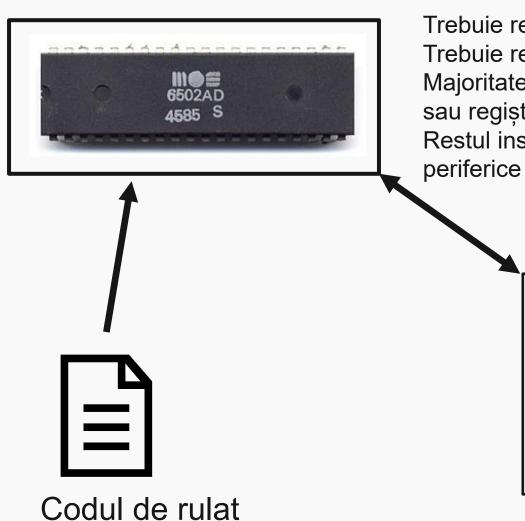


- Toate programele cred că au acces la tot RAM-ul fără spaţiu alocat kernel
- Soluția este paginarea (bucăți de RAM virtual mapate pe cel real)
- Kernel-ul şi CPU (prin MMU memory management unit şi TLB translation lookaside buffer) controlează RAM-ul prin loader, malloc, free şi tabelele de pagini





Emulare CPU-RAM



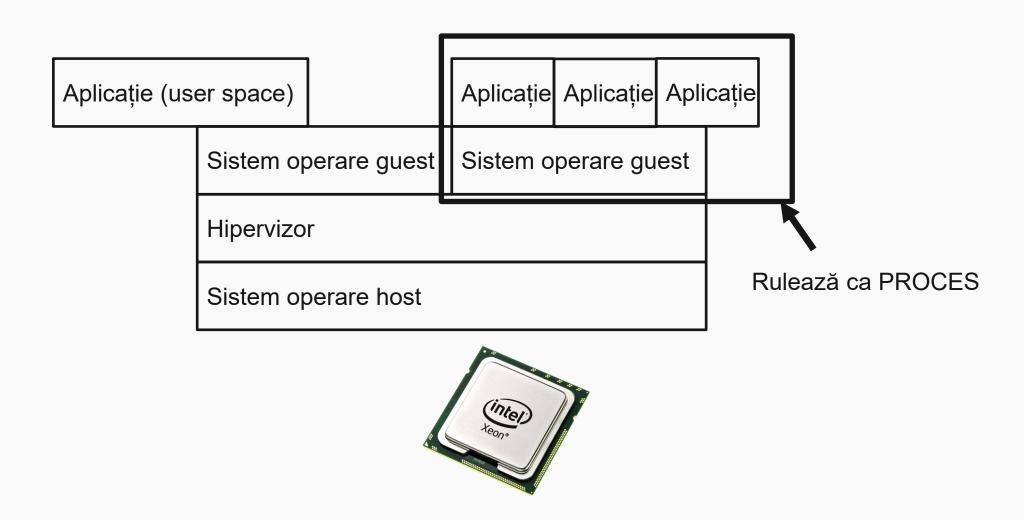
Trebuie reţinută starea (un set de variabile)
Trebuie reţinuţi regiştrii (un vector)
Majoritatea instrucţiunilor modifică starea
sau regiştrii
Restul instrucţiunilor sunt citiri/scrieri RAM sau

Un malloc mare





Virtualizare CPU





Virtualizare CPU

Formal Requirements for Virtualizable Third Generation Architectures

Gerald J. Popek University of California, Los Angeles and Robert P. Goldberg Honeywell Information Systems and Harvard University

Virtual machine systems have been implemented on a limited number of third generation computer systems, e.g. CP-67 on the IBM 360/67. From previous empirical studies, it is known that certain third generation computer systems, e.g. the DEC PDP-10, cannot support a virtual machine system. In this paper, model of a third-generation-like computer system is developed. Formal techniques are used to derive precise sufficient conditions to test whether such an architecture can support virtual machines.



Virtualizare CPU – Type 1

Aplicație (user space)

Aplicație | Aplicație | Aplicație | Aplicație |

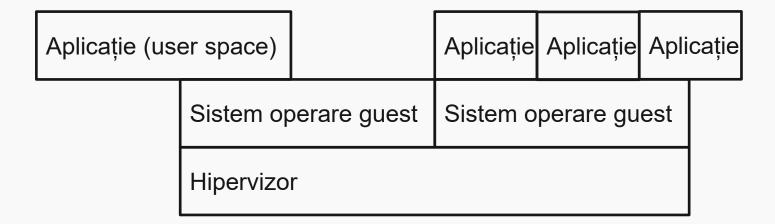
Sistem operare guest | Sistem operare guest |

Hipervizor | Sistem operare host |





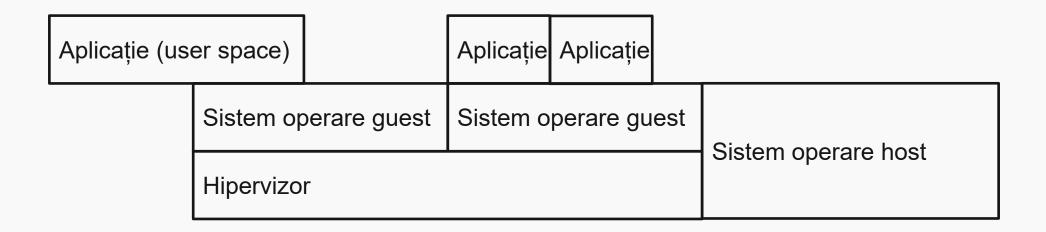
Virtualizare CPU – Type 2







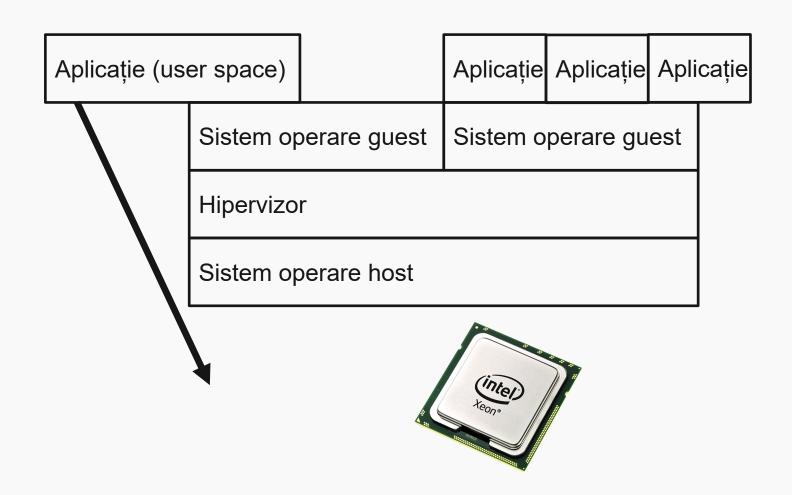
Virtualizare CPU – Paravirtualizare







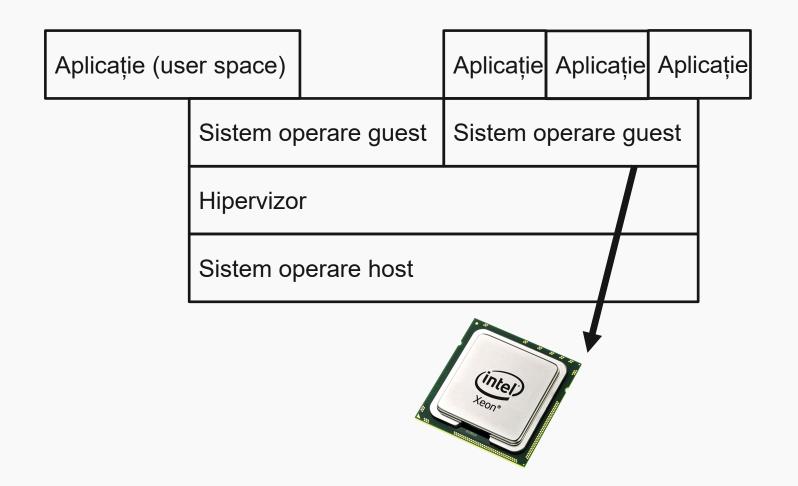
Virtualizare CPU Instrucțiuni simple (ex. add, mov din memoria sa)





Virtualizare CPU – trap and execute

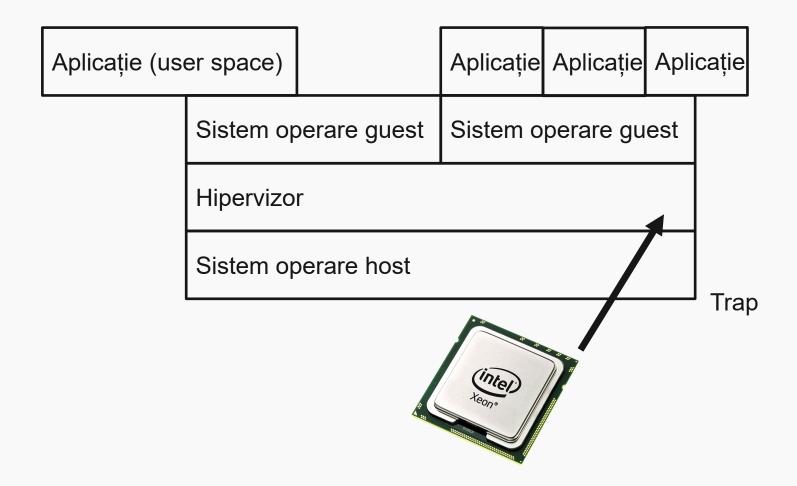
Instrucțiuni kernel (ex. umblat cu I/O, sist întreruperi)





Virtualizare CPU – trap and execute

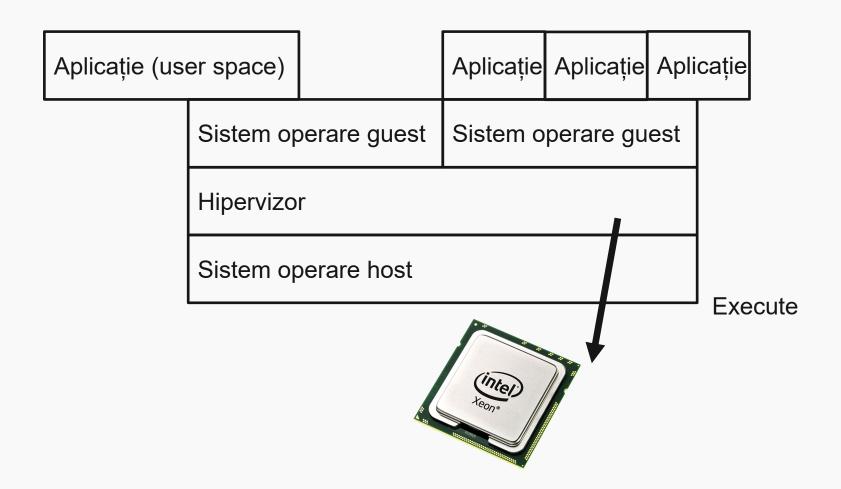
Instrucțiuni kernel (ex. umblat cu I/O, sist întreruperi)





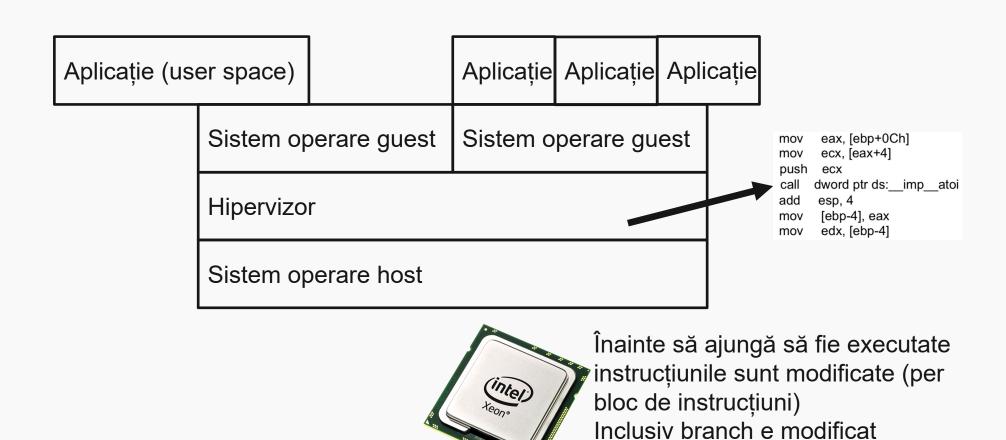
Virtualizare CPU – trap and execute

Instrucțiuni kernel (ex. umblat cu I/O, sist întreruperi)





Virtualizare CPU – rescriere instrucțiuni (emulare) Instrucțiuni kernel (ex. umblat cu I/O, sist întreruperi)

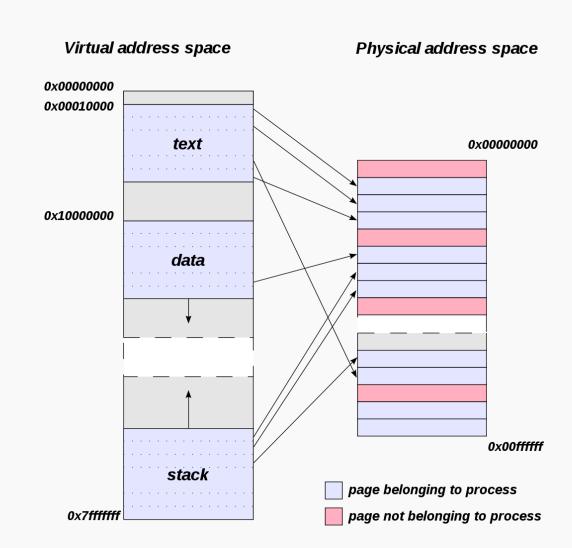




Virtualizare RAM

Shadow page tables

Suport direct în hardware



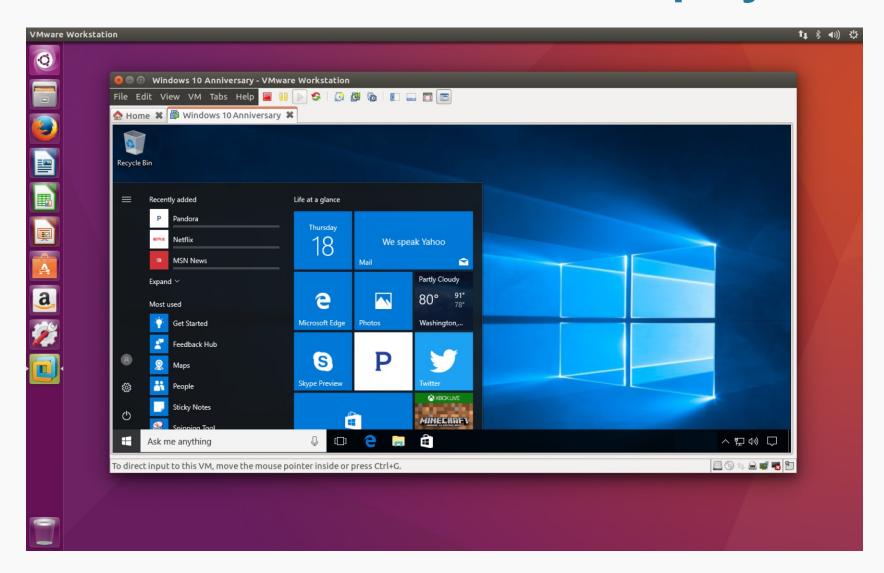


Virtualizare Emulare HDD





Virtualizare Emulare Display





Virtualizare Emulare I/O

Mouse/Tastatură ?



Virtualizare Emulare I/O

- Mouse/Tastatură ?
- Idem Display

- Multe avantaje când vine vorba de drivere
 - Dacă există sistem de operare host se pot folosi driverele acestuia pentru periferice
 - Pentru sistemul de operare guest se poate oferi un singur dispozitiv virtual (un singur driver)
 - Portabilitate se poate modifica hardware fără să modifici mașina virtuală



Platform as a Service

Cea mai mare dezvoltare în ultimii ani.

- Baze de date cu capabilități diverse (sql/no-sql, diferite nivele de acid, diferite nivele de scalabilitate, diferite nivele de consistență)
- Analytics
- Blockchain
- Inteligență artificială
 - Face detection
 - Chat bots
 - GTP-3

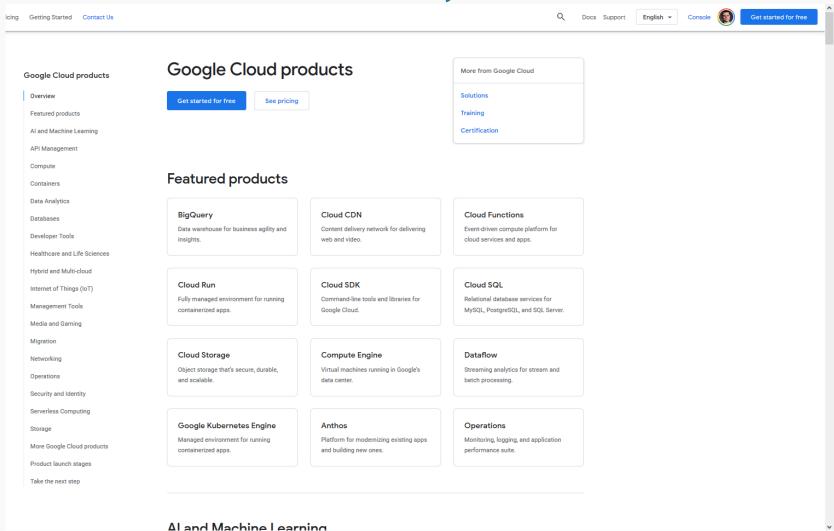


Platform as a Service – Azure Majoritatea icoanelor sunt PaaS

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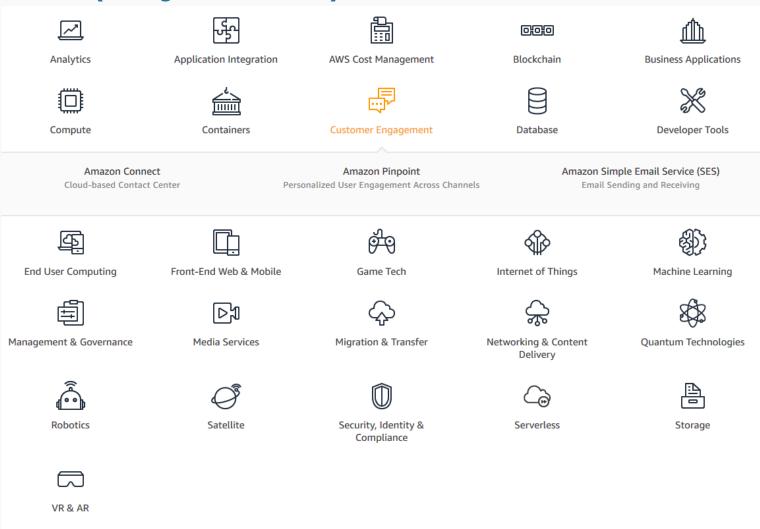


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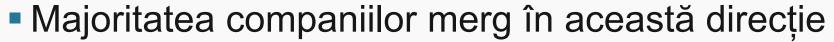


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Software as a Service















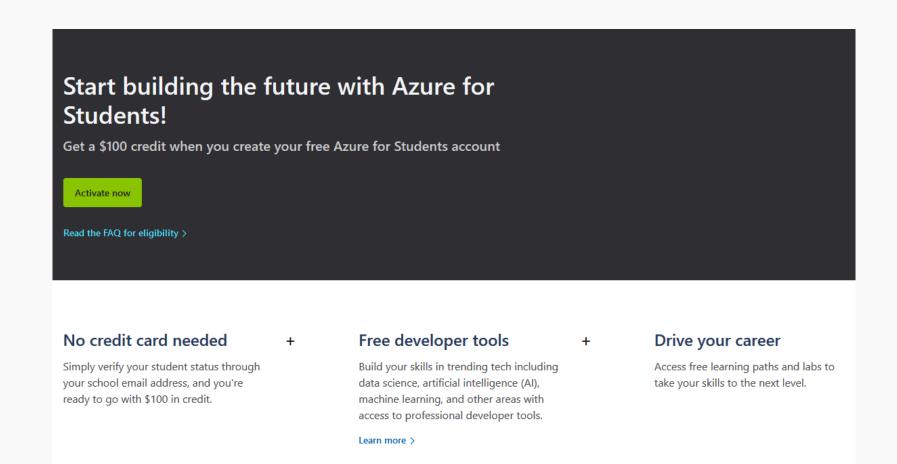






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