

Arhitecturi Paralele Scurtă introducere în Cloud Computing

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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, Internet Data

Executiv

Cloud Computing IT industry, maki purchased. Deve in hardware to de provisioning for a provisioning for o with large batch-c hour costs no mor large scale, is unp



g as a utility, has the s a service and sha w Internet services pense to operate it meet their prediction missing potential c ly as their program urs. This elasticity



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

- Economie de scală (cumpără angro, în bulk).
 - Cumpăra hardware la un preţ 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, security, networking, etc.)
- Ideal pentru start-up-uri, echipe mici, proiecte scurte
 - Cost o lună resurse puţine cloud << cost cluster



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
- 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

Nikolas Roman Herbst, Samuel Kounev, Ralf Reussner
Institute for Program Structures and Data Organisation
Karlsruhe Institute of Technology
Karlsruhe, Germany
{herbst, kounev, reussner}@kit.edu

Abstract

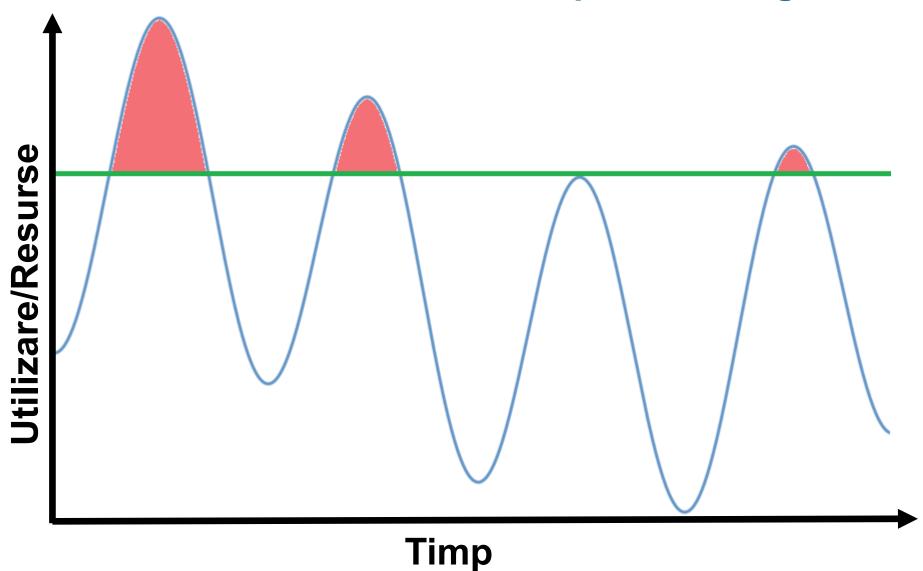
even in the naming of specific products or services. Even

Originating from term elasticity of cloud compu

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.

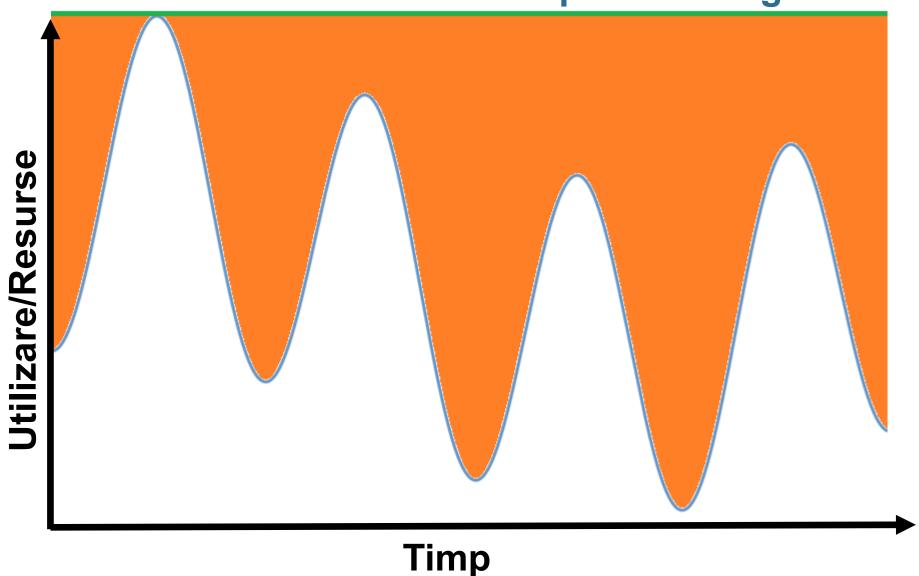


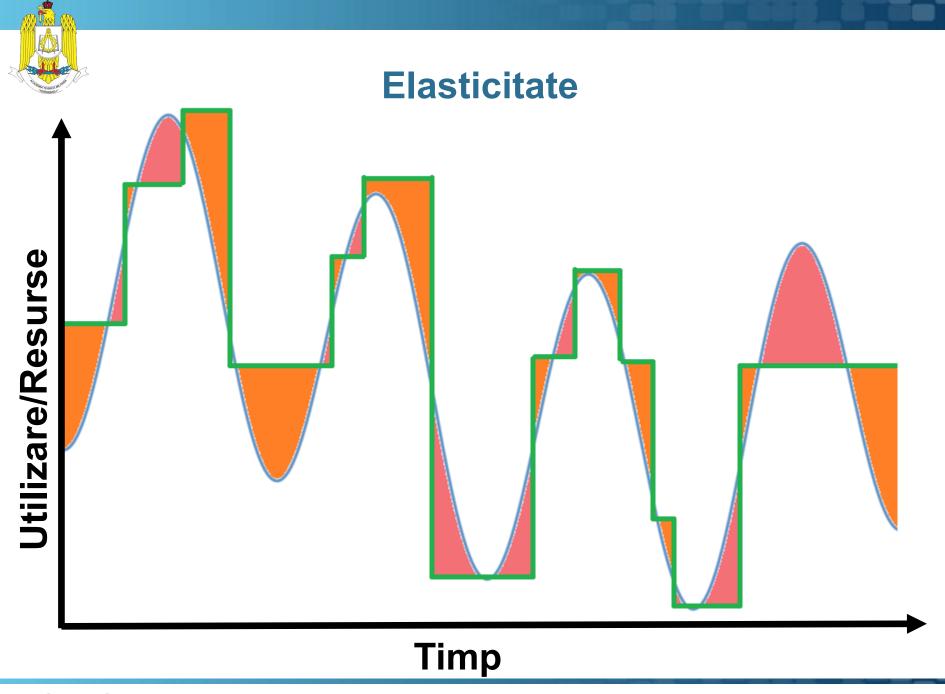
Fără elasticitate – underprovisioning





Fără elasticitate – overprovisioning







Privat vs

Public

vs Hibrid

Cloud ținut în interiorul unei instituții. Menit pentru a oferi resurse diferitelor grupuri din institutie. 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 obţine prin securitate crescută
- Se obţine prin hardware de înaltă performanţă
- Se obţine prin redundanţă şi back-up
- Se obţine prin mecanisme de toleranţă 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?

- 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 instrucțiune e citită de software și interpretată
- Majoritatea instrucțiunilor sunt rulate **DIRECT** de procesor

- multiple hours of intense fun)
- Ex: <u>Simulator NES</u> (Warning De citit Capitol 7 Modern Operating Systems (4th ed) **Andrew Tanenbaum**



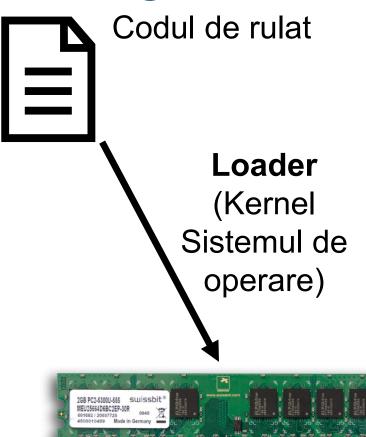
Assembly vs. machine code

Machine code bytes	Assembly language statements				
	foo:				
B8 22 11 00 FF	mov1 ¢0vFF001122 %pav				

В8	22	11	00	FF	movl \$0xFF001122, %eax
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
```







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







Program counter

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movl $0xFF001122, %eax
addl %ecx, %edx
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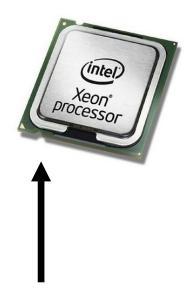




Program counter

```
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
```





Timer Interrupt



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
```





Pornește **scheduler** (posibil read din RAM pentru cod de scheduler)

Timer Interrupt



Program counter

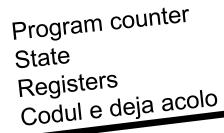
```
movl $0xFF001122, %eax addl %ecx, %edx xorl %esi, %esi pushl %ebx movl 4(%esp), %ebx leal (%eax,%ecx,2), %esi cmpl %eax, %ebx jnae foo retl
```





Scheduler - kernel OS









Scheduler - kernel OS



```
mov eax, [ebp+0Ch] mov ecx, [eax+4]
```

push ecx

call dword ptr ds:__imp__atoi

add esp, 4

mov [ebp-4], eax

mov edx, [ebp-4]



Scheduler - kernel OS



mov eax, [ebp+0Ch]
mov ecx, [eax+4]
push ecx
call dword ptr ds:__imp__atoi
add esp, 4
mov [ebp-4], eax
mov edx, [ebp-4]

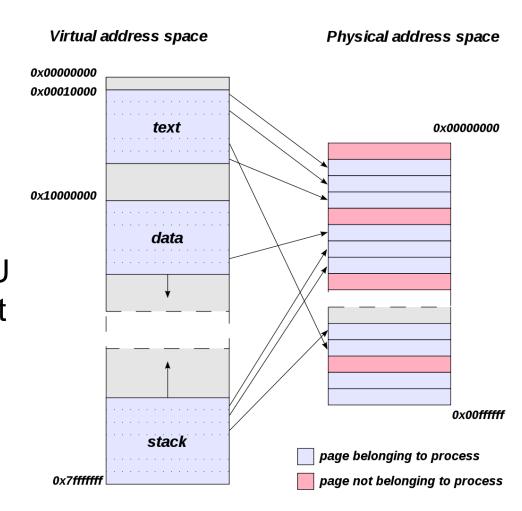






- Toate programele cred că au acces la tot RAM-ul fără spațiu alocat kernel
- Soluția este paginarea (bucăți de RAM virtual mapate pe cel real)
- Kernel-ul şi CPU (prin MMU

 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

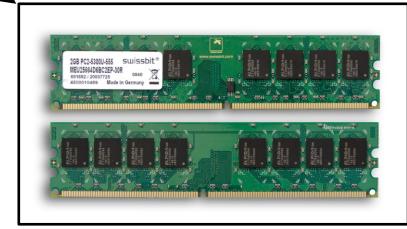
Restul instrucțiunilor sunt citiri/scrieri RAM sau periferice





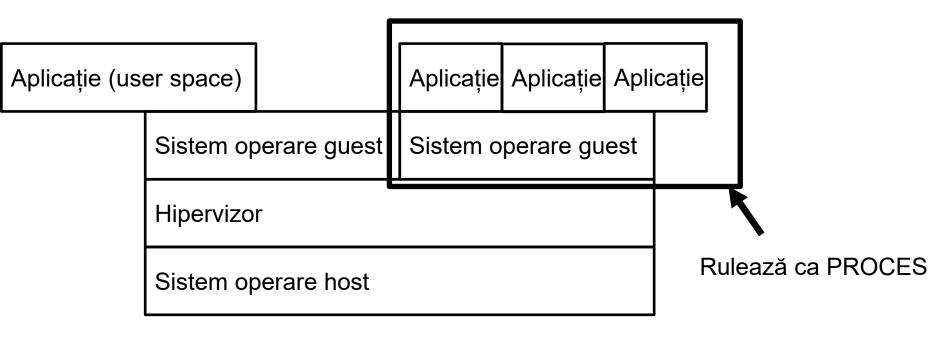
Codul de rulat

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

Sistem operare guest

Hipervizor

Sistem operare host





Virtualizare CPU – Type 2

Aplicație (user space)

Aplicație Aplicație Aplicație

Sistem operare guest Sistem operare guest

Hipervizor



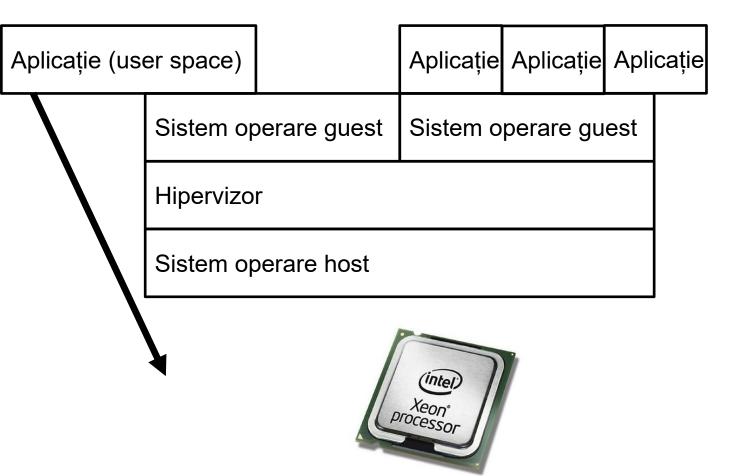


Virtualizare CPU – Paravirtualizare

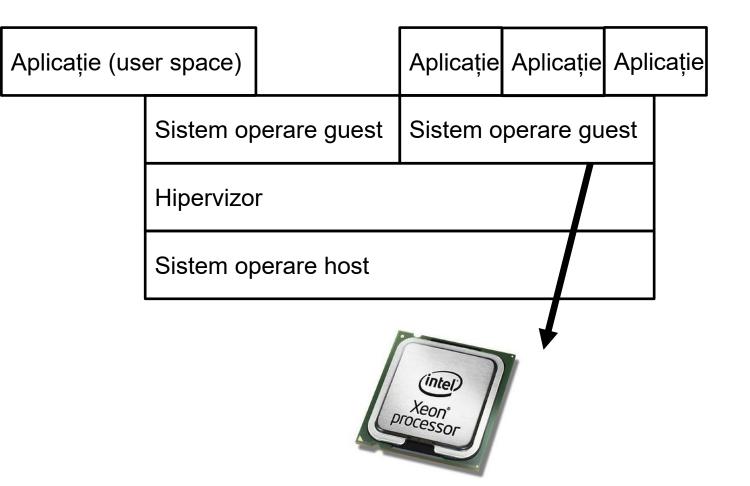
Aplicație (use	er space)		Aplicație	Aplicație		
	Sistem operare guest		Sistem operare guest		est	Ciotom operare boot
	Hipervizo	r				Sistem operare host



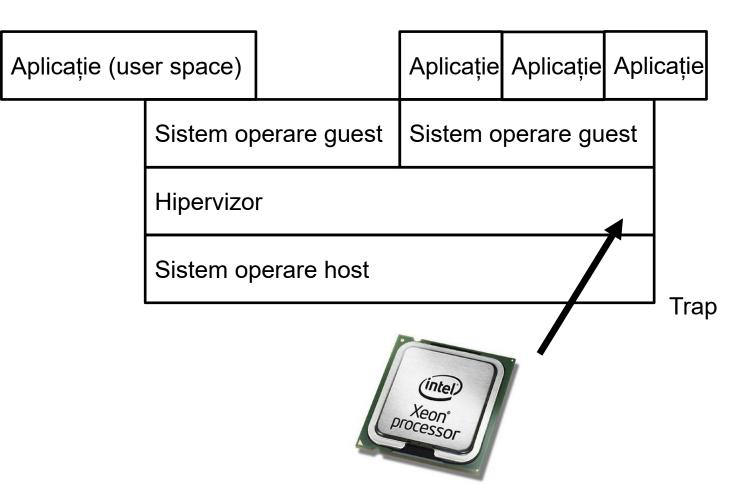
Virtualizare CPU Instrucțiuni simple (ex. add, mov din memoria sa)



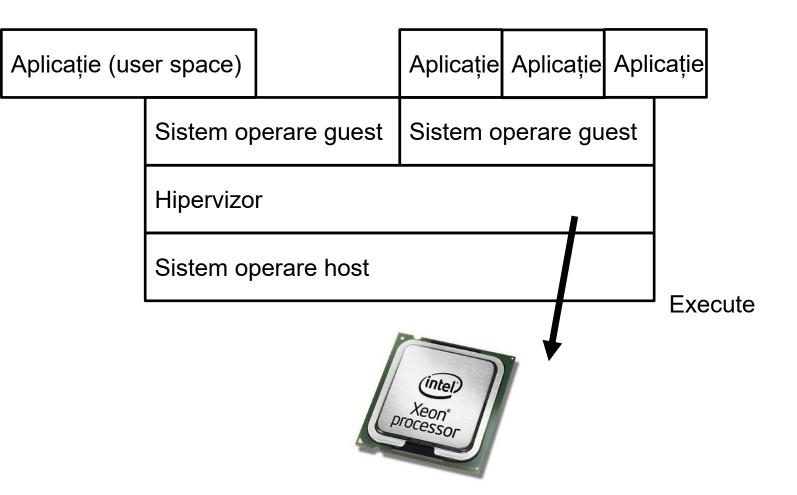
Virtualizare CPU – trap and execute Instrucțiuni kernel (ex. umblat cu I/O, sist întreruperi)



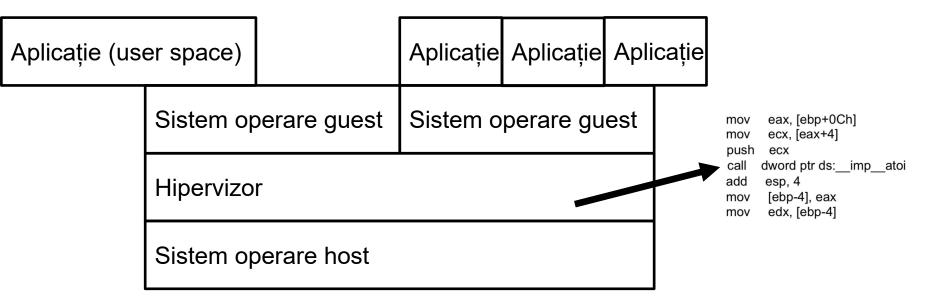
Virtualizare CPU – trap and execute Instrucțiuni kernel (ex. umblat cu I/O, sist întreruperi)



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)





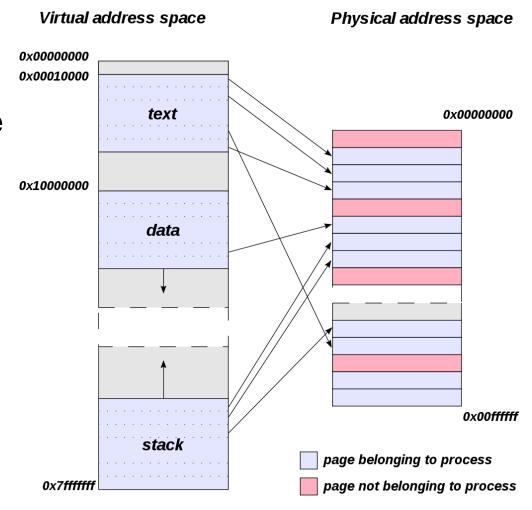
Înainte să ajungă să fie executate instrucțiunile sunt modificate (per bloc de instrucțiuni) Inclusiv branch e modificat



Virtualizare RAM

Shadow page tables

Suport direct în hardware



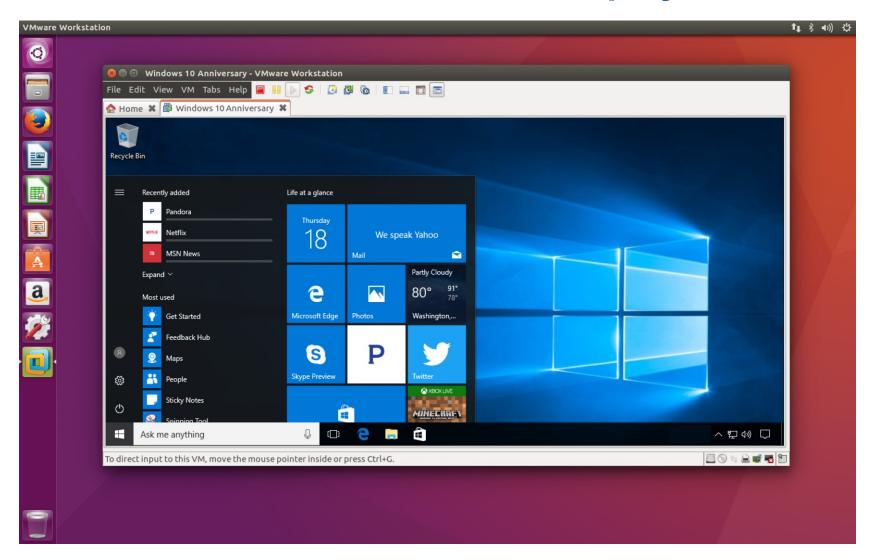


Virtualizare Emulare HDD





Virtualizare Emulare Display





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 maşina 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

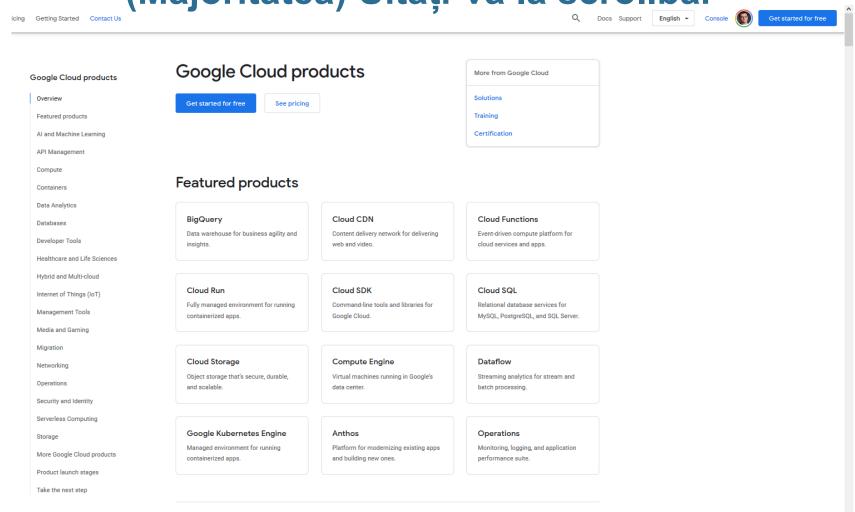


Platform as a Service – Azure Majoritatea icoanelor sunt PaaS

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Platform as a Service – GCP (Majoritatea) Uitați-vă la scrollbar



Al and Machine Learning



Platform as a Service – AWS (Majoritatea) Toate se deschid



Analytics



Application Integration



AWS Cost Management



Blockchain



Business Applications



Compute



Containers



Customer Engagement



Database



Developer Tools

Amazon Connect

Cloud-based Contact Center

Amazon Pinpoint

Personalized User Engagement Across Channels

Amazon Simple Email Service (SES)

Email Sending and Receiving



End User Computing



Front-End Web & Mobile



Game Tech



Internet of Things



Machine Learning



Management & Governance



Media Services



Migration & Transfer



Networking & Content Delivery



Quantum Technologies



Robotics



Satellite



Security, Identity & Compliance



Serverless



Storage



VR & AR



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