



AARHUS UNIVERSITET

# Microservices and DevOps

DevOps and Container Technology  
Virtualization

Henrik Bærbak Christensen

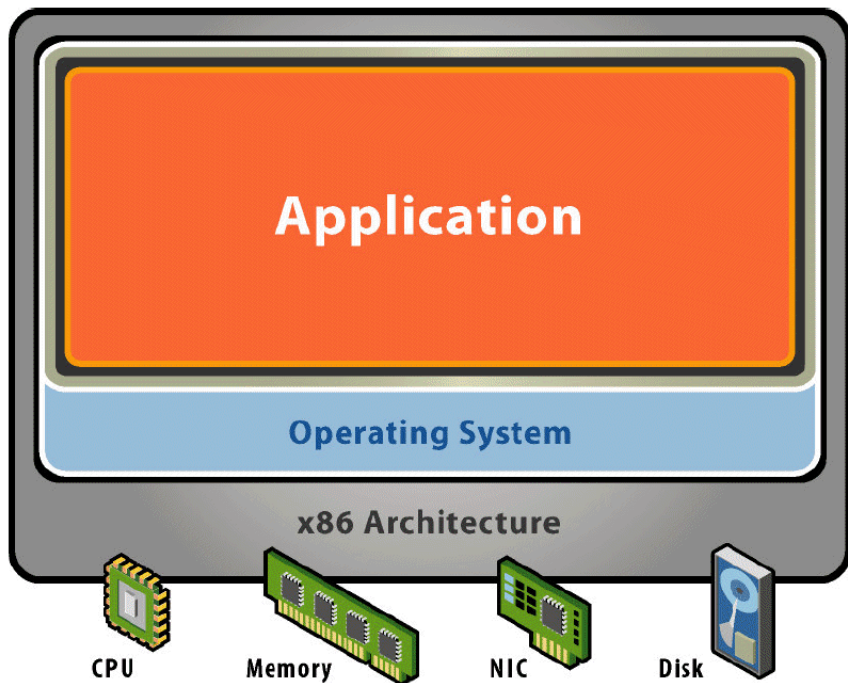
# What is it?

- **vir•tu•al (adj):**
  - existing in essence or effect, though not in actual fact



- Example
  - *ScummVM is a program which allows you to run certain classic graphical point-and-click adventure games, provided you already have their data files. The clever part about this: ScummVM just replaces the executables shipped with the games, allowing you to play them on systems for which they were never designed!*

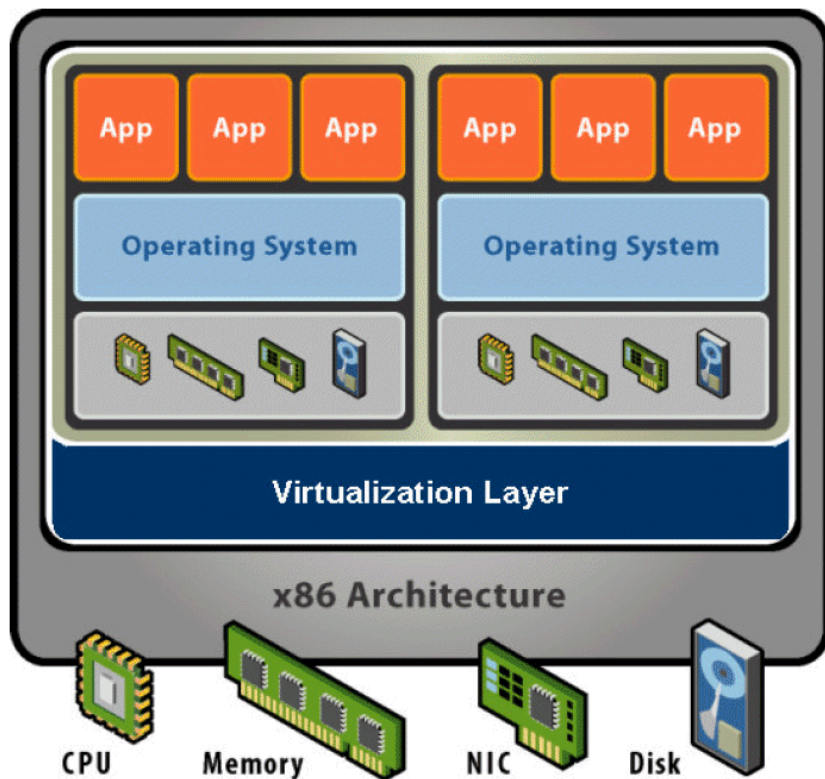
# A Physical Machine

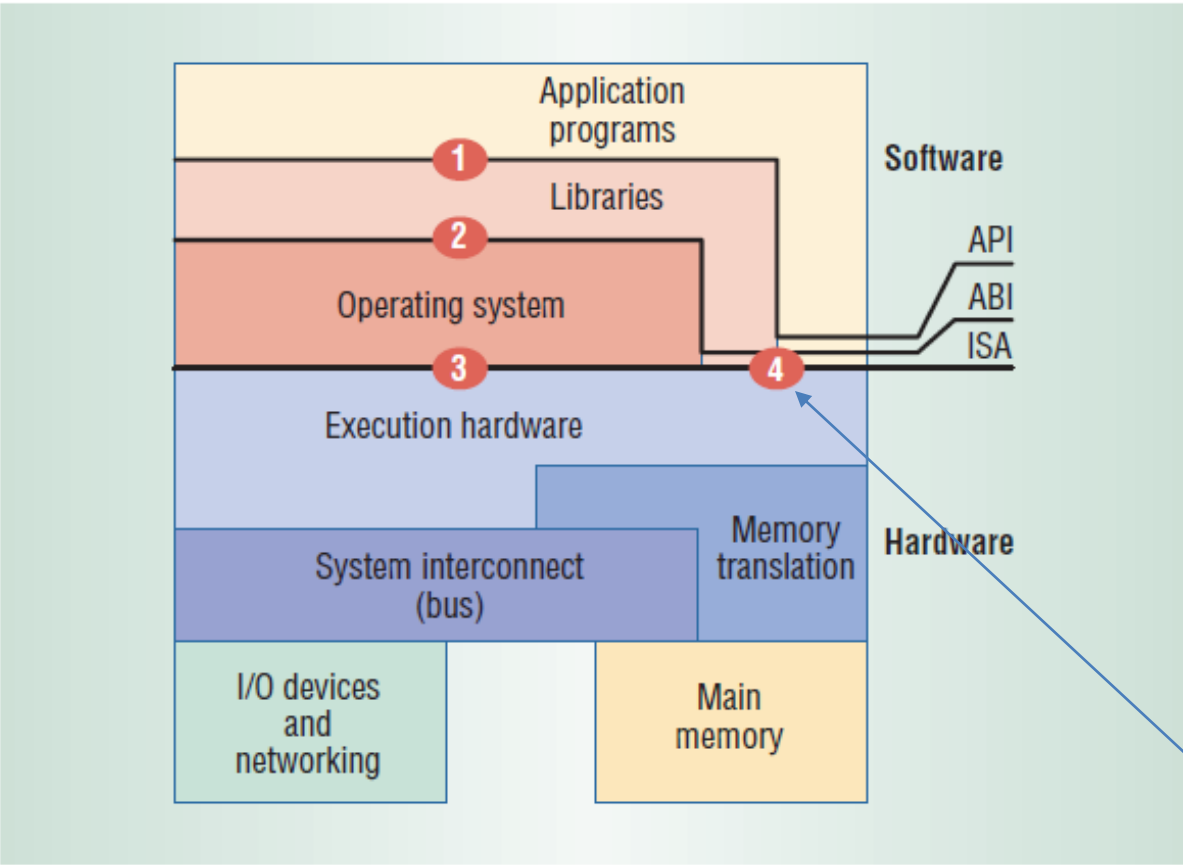


- Hardware
  - Processors, devices, memory, etc.
- Software
  - Built to the given hardware (**Instruction Set Architecture**, e.g. x86)
  - Built to given OS (**App. Programming Interface**, e.g. Win XP)
  - OS controls hardware

# A Virtual Machine

- Hardware Abstraction
  - Virtual processor, memory, devices, etc.
- Virtualization Software
  - Indirection: Decouple hardware and OS
  - Multiplex physical hardware across guest VMs





API: Library calls  
Appl Progr Interface

ABI: OS calls  
Appl Binary Interface

ISA: Machine Code

Kernel Mode

# Why VMs?

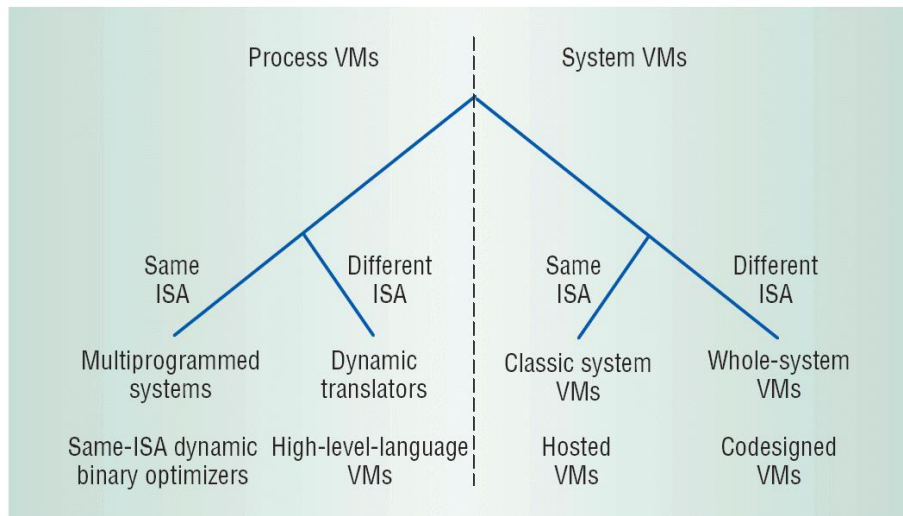
- Many advantages (often business related)
  - Utilization of resources
    - VM1 that idles automatically free resources to VM2
      - Of course not the case for physical machines
  - Isolation
    - Crash, virus, in VM1 does not propagate to VM2
  - Encapsulation
    - A VM is a **file**: (OS ,Apps, Data, Config, run-time state)
    - Content distribution: Demos as snapshots
    - Snapshot provides recovery point
    - Migration to new physical machines by snapshot/restore
      - In e.g. server farms

# Why VMs?

- More advantages
  - Maintenance costs
    - Maintain 100 Linux-based web server machines versus a few big VM platforms
  - Legacy VMs
    - Run ancient apps (like DOS or Win98 programs)
  - Create once, run anywhere
    - No configuration issues
      - E.g. complex setup of app suite of database, servers, etc.

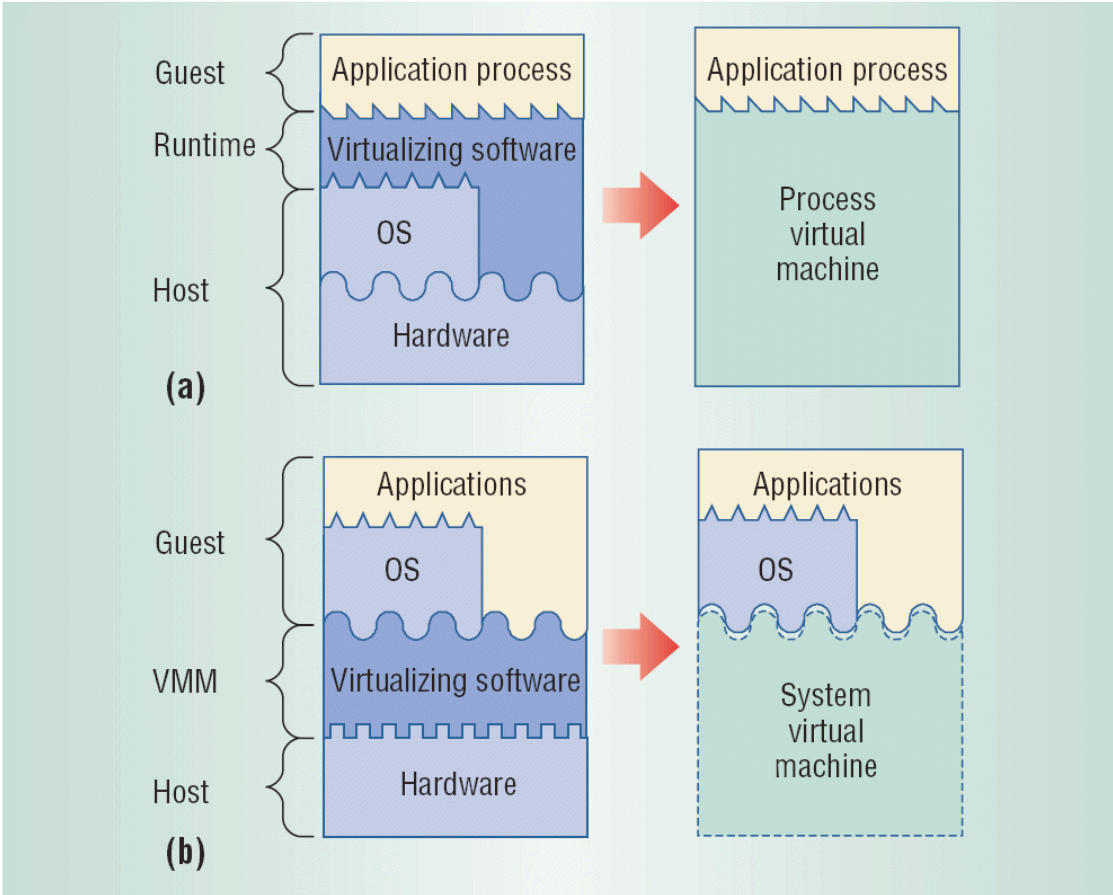
# Types of VMs

- Smith & Nair 2005
- Two super classes
  - Process VM
  - System VM
- Both can be sub classed based upon supporting virtualization of *same* or *different* ISA (Instruction Set Architecture).





# Process / System VM



# Process VM

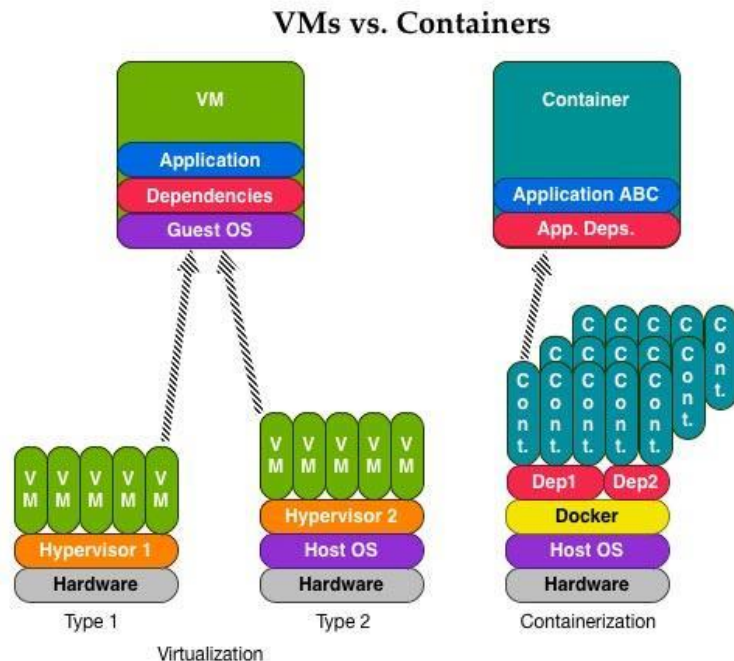
- The **process VM** puts the virtualization border line at the *process* line.
  - A application process/program executes in a
    - Logical address space (assigned/handled by the OS)
    - Using user-level instructions and registers (CPU user-mode)
    - Only do IO using OS calls or High-Level Library(HHL) calls
- Thus a process VM becomes a ***virtual OS*** in which a process may execute.
- Example: *Different ISA Process VM*
  - JavaVM defines its own ISA (stack-based) as well as normal OS operations

# System VM

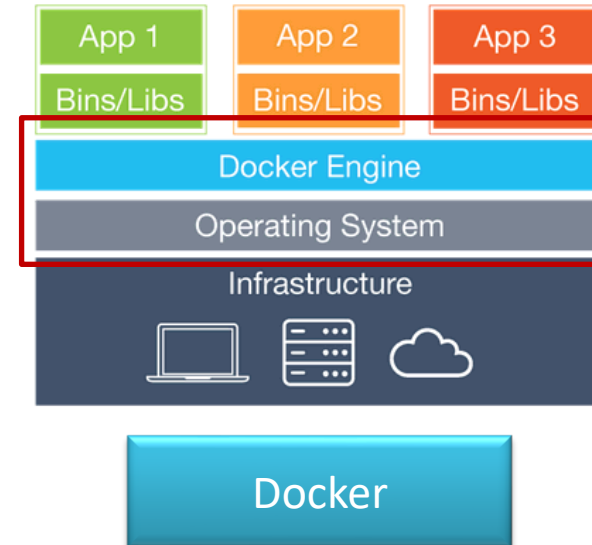
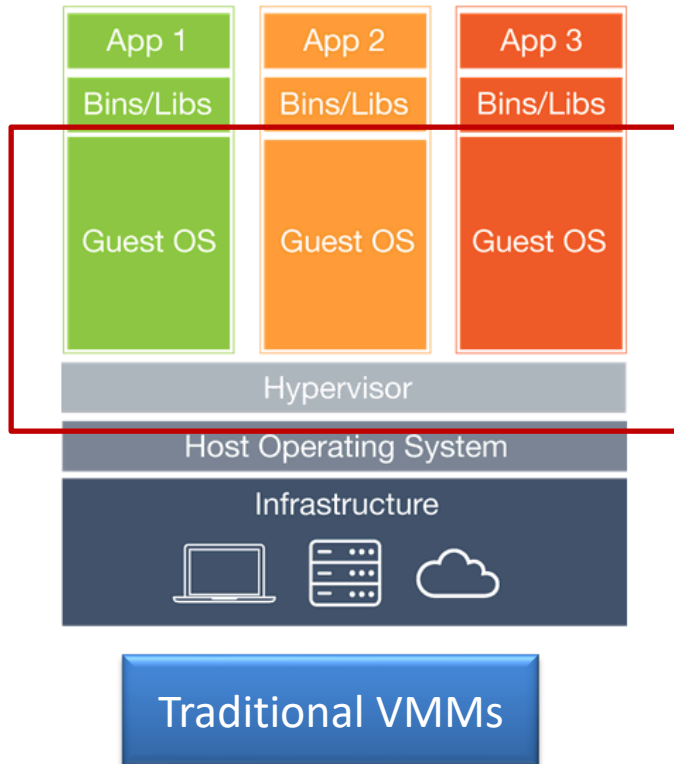
- The **system VM** sets the virtualization border at the system or hardware line
  - A system/OS executes in a
    - Physical memory space
    - Using the full ISA of the underlying machine
    - Interact directly with IO
- Thus a system VM becomes a ***virtual machine*** in which a system as a whole may execute
- Example: *Same ISA System VM*
  - VMWare: Executes Guest OS that is running on the x86 ISA.

# OS Level VM

- OS-Layer Virtualization (Sahoo, 2010), or
- *Operating System Level* virtualization
  - Merkel (2014)
- Ex:
  - *Docker*



- From Docker



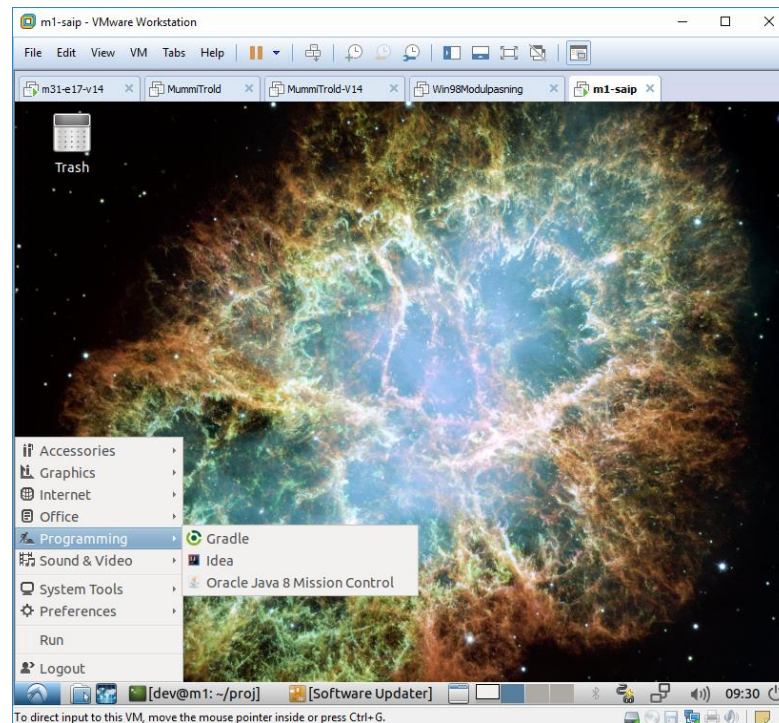
# Classic Versus Hosted VMs

- **Hosted**
- VMWare Player (free) / Workstation Pro
  - Ordinary application in Linux/Windows
- **Classic (Bare metal)**
- VMWare ESXi (free of charge!)
  - Runs on the bare machine using a minimal Linux core

# Examples

# Packages for Students

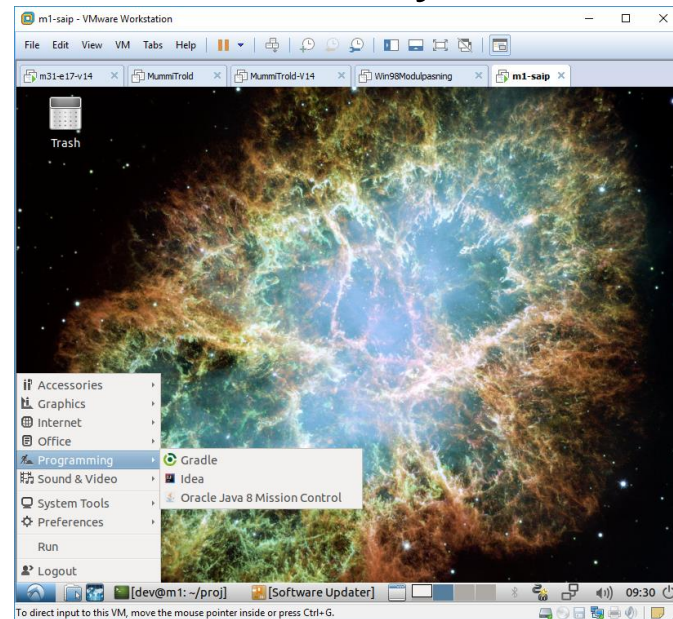
- For my course, I hand out a dedicated VM
  - Faster ‘get going’





# Avoid Poluted Machine

- The last couple of years I have removed code development from my laptop completely...
  - I *only* develop using my M1, M17, ... Virtual linux machines on my VMWare Workstation or on my ESXi hypervisors
    - One machine per course
      - Easier to switch
    - No *polution* of my laptop

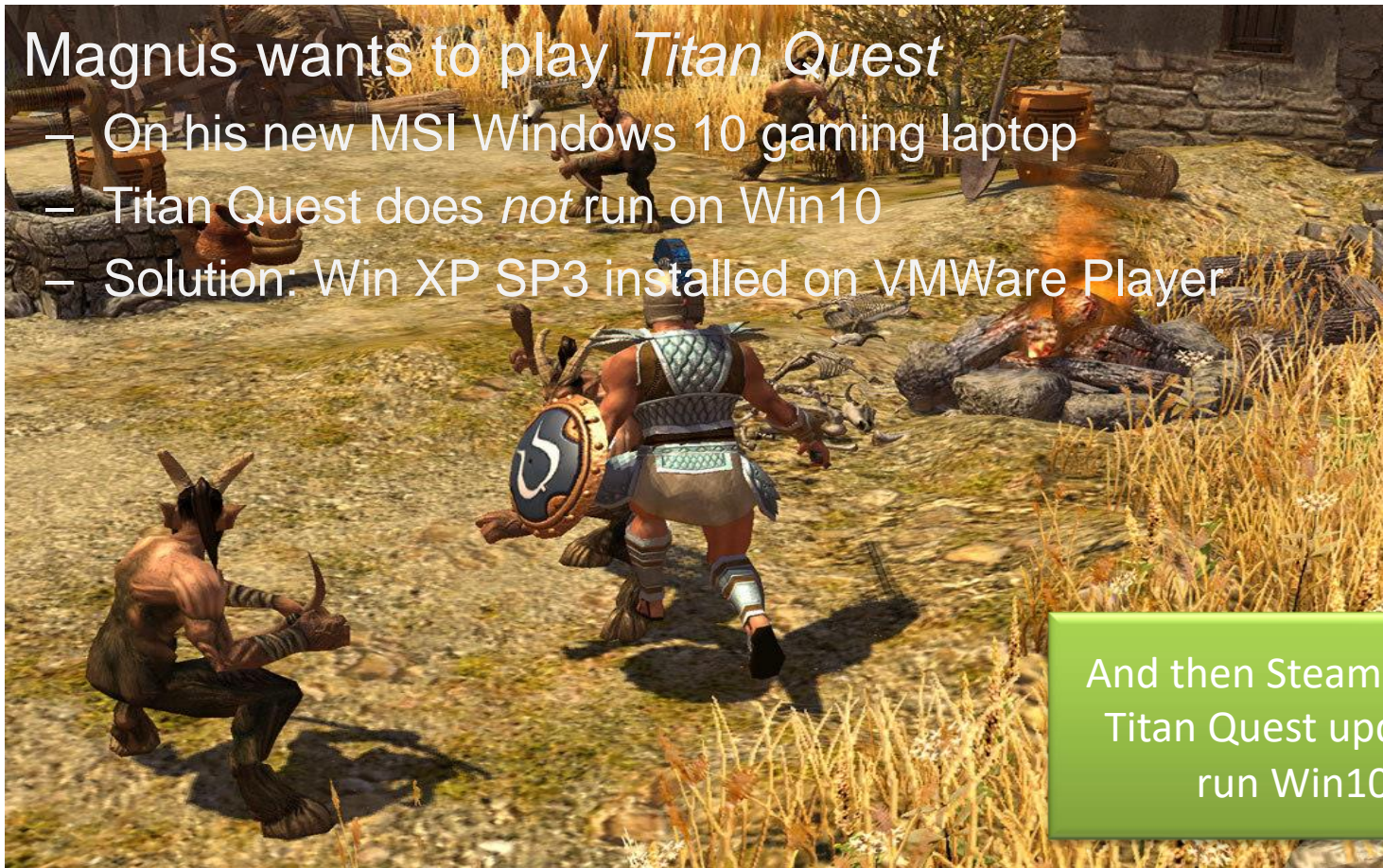


# Moving Production

- Crunch3 machine was the production machine to do *awesome* stuff in another course I am running
  - It runs on my local ESXI
  - But, but – our students could not see it!
- Moved to the AUIT vSphere infrastructure
  - VMWare converter...
- Crunch3 is highly disk IO sensitive
  - Staff moved it 'as we spoke' to a pure SSD hypervisor

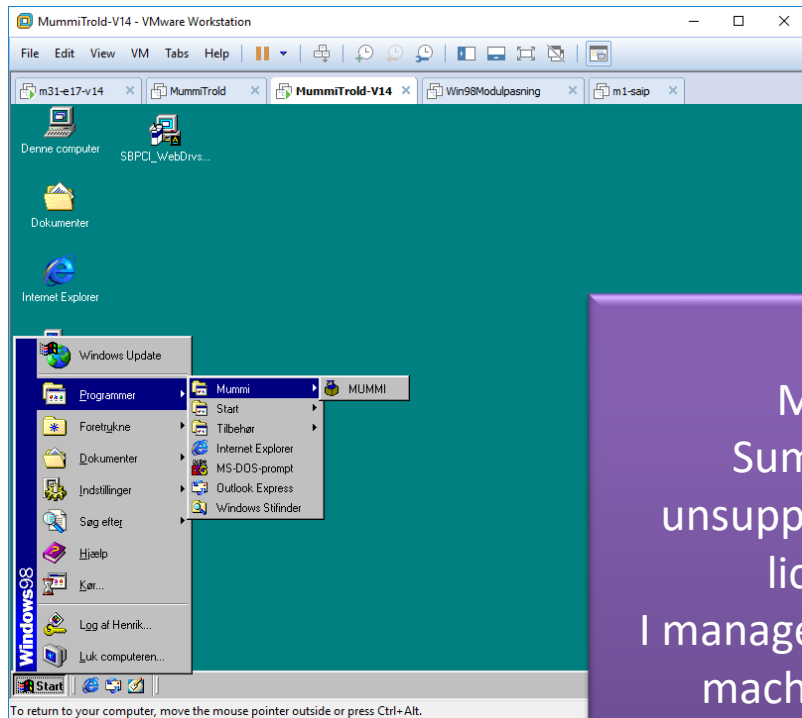
# Keep Legacy Running

- Magnus wants to play *Titan Quest*
  - On his new MSI Windows 10 gaming laptop
  - *Titan Quest* does *not* run on Win10
  - Solution: Win XP SP3 installed on VMWare Player



And then Steam released  
*Titan Quest* updated to  
run Win10 😊

# Keep Legacy Running



My company's accounting system, SummaSummerum, is a legacy system, unsupported and cannot be reinstalled due to license server has been shut down. I managed to pull license files from my company machine, and "save it" in a VM. It is called "TheArk" 😊

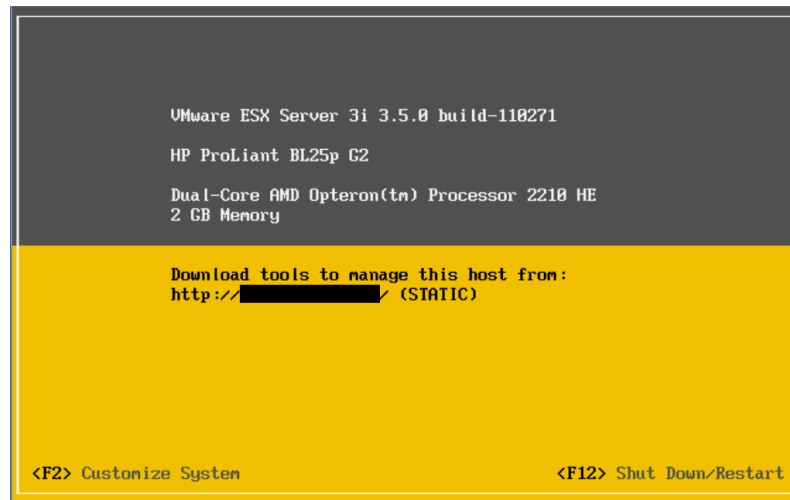


# My 'Private Cloud' ☺



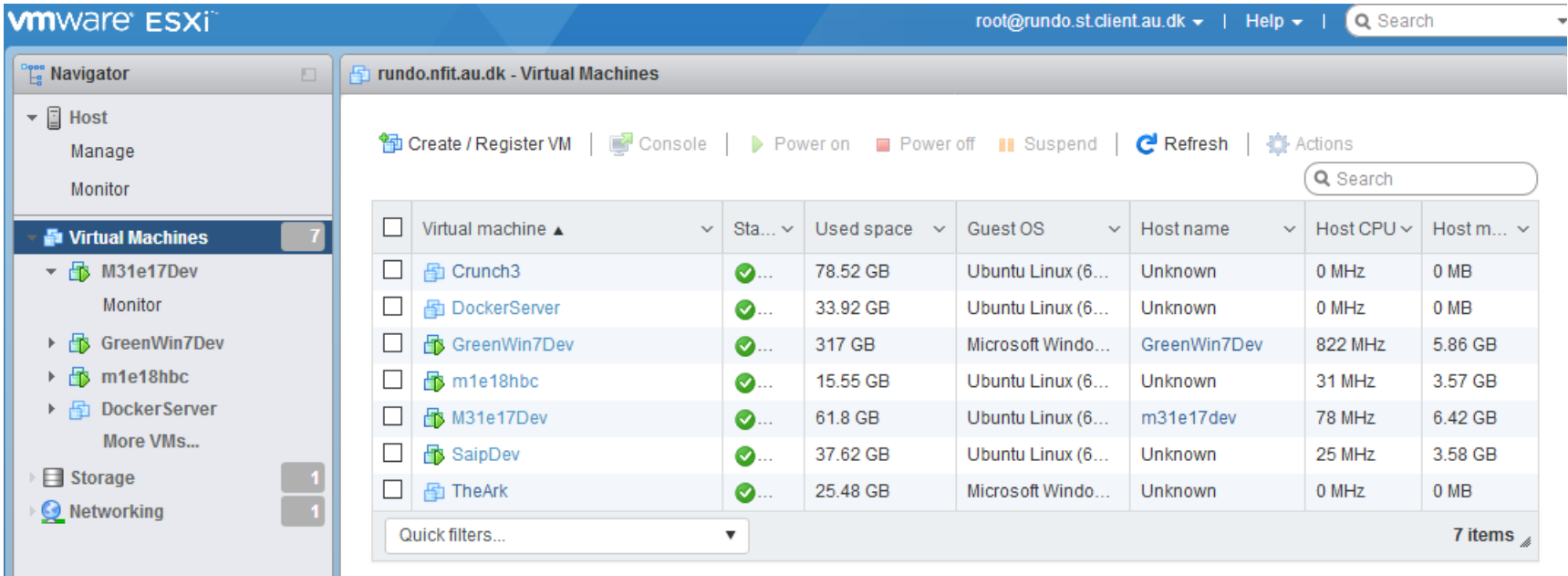
# VMWare ESXi

- (Linux based) Minimal OS
  - My 'Rundo' runs from the USB stick
  - ... and drivers were hell ☹️
- Run Mgt application from its web server



# A Small VMM

- Remote client to access the VMM

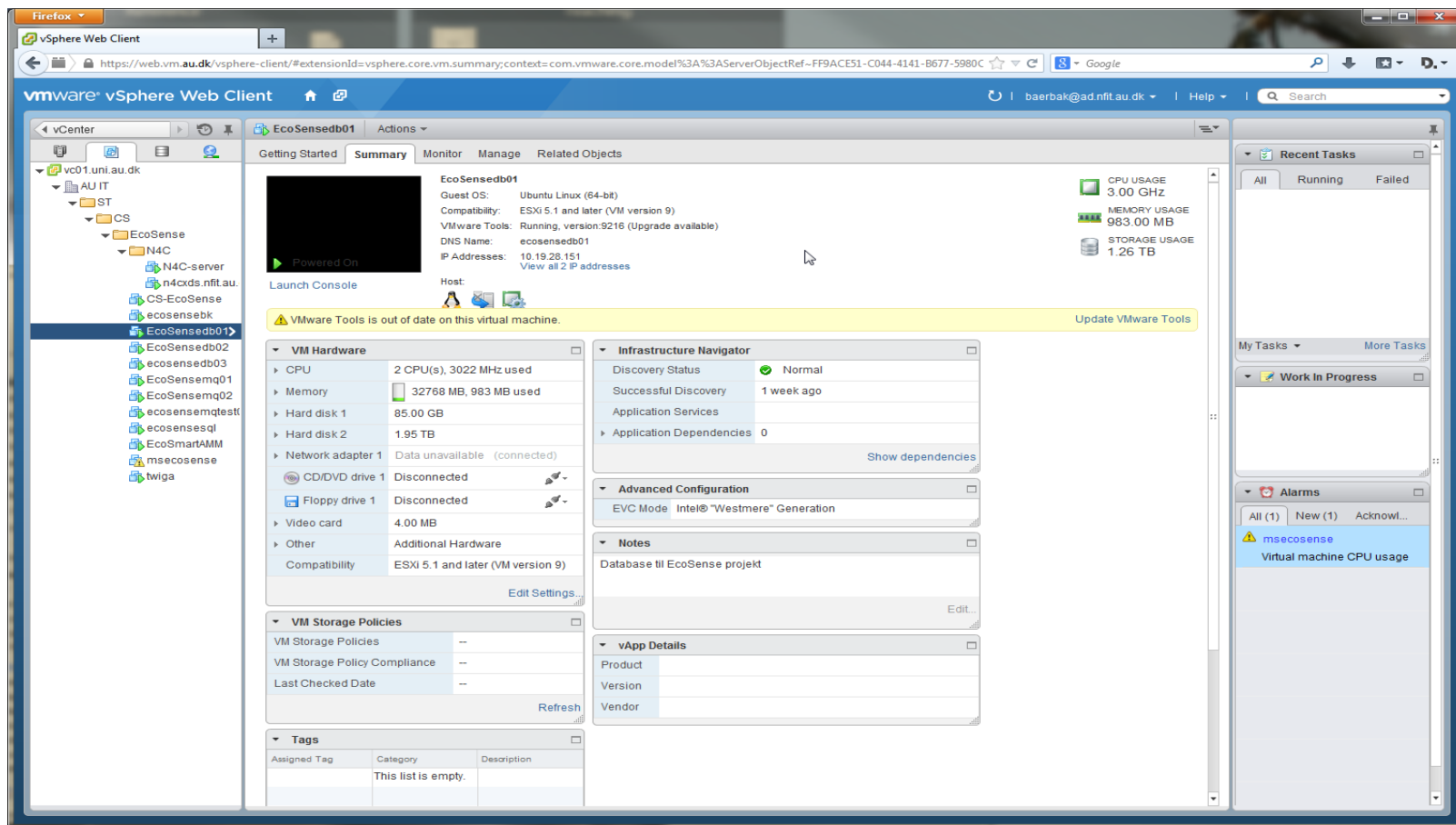


The screenshot shows the VMware ESXi web interface. The top bar displays the user 'root@rundo.st.client.au.dk' and a search bar. The left sidebar shows the 'Virtual Machines' section with 7 items. The main area displays a table of virtual machines with columns for name, status, used space, guest OS, host name, host CPU, and host memory.

Virtual machine	Status	Used space	Guest OS	Host name	Host CPU	Host memory
Crunch3	✓	78.52 GB	Ubuntu Linux (6...)	Unknown	0 MHz	0 MB
DockerServer	✓	33.92 GB	Ubuntu Linux (6...)	Unknown	0 MHz	0 MB
GreenWin7Dev	✓	317 GB	Microsoft Windo...	GreenWin7Dev	822 MHz	5.86 GB
m1e18hbc	✓	15.55 GB	Ubuntu Linux (6...)	Unknown	31 MHz	3.57 GB
M31e17Dev	✓	61.8 GB	Ubuntu Linux (6...)	m31e17dev	78 MHz	6.42 GB
SaipDev	✓	37.62 GB	Ubuntu Linux (6...)	Unknown	25 MHz	3.58 GB
TheArk	✓	25.48 GB	Microsoft Windo...	Unknown	0 MHz	0 MB

Quick filters... 7 items

# A Much Bigger VMM

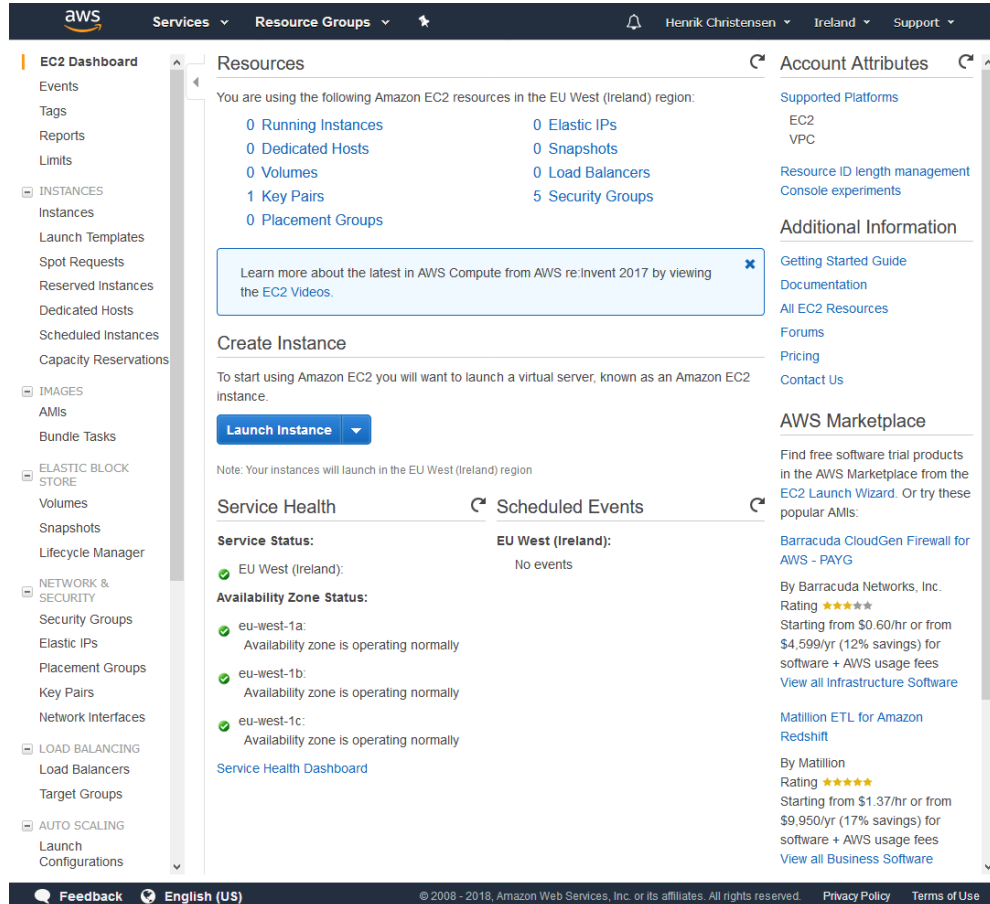


The screenshot displays the VMware vSphere Web Client interface in a Firefox browser. The main content area shows the 'Summary' tab for a virtual machine named 'EcoSensedb01'. The interface is divided into several sections:

- Left Sidebar:** A tree view showing the vCenter hierarchy, including 'vc01.uni.au.dk', 'AU IT', 'ST', 'CS', 'EcoSense', 'N4C', 'N4C-server', 'n4cxds.nft.au.', 'CS-EcoSense', 'ecosensebk', and 'EcoSensedb01' (which is selected).
- Summary Page:**
  - Getting Started:** Shows a 'Powered On' status with a green play button and a 'Launch Console' link.
  - Summary:** Displays key information about the VM:
    - Guest OS: Ubuntu Linux (64-bit)
    - Compatibility: ESXi 5.1 and later (VM version 9)
    - VMware Tools: Running, version: 9.216 (Upgrade available)
    - DNS Name: ecosensedb01
    - IP Addresses: 10.19.28.151 (View all 2 IP addresses)
    - Host: (link to view host)
  - Monitor:** Shows resource usage:
    - CPU USAGE: 3.00 GHZ
    - MEMORY USAGE: 983.00 MB
    - STORAGE USAGE: 1.26 TB
  - Manage:** Contains a yellow warning banner: 'VMware Tools is out of date on this virtual machine.' with an 'Update VMware Tools' link.
  - Related Objects:** Contains several expandable sections:
    - VM Hardware:** Lists CPU (2 CPU(s), 3022 MHz used), Memory (32768 MB, 983 MB used), Hard disk 1 (85.00 GB), Hard disk 2 (1.95 TB), Network adapter 1 (Data unavailable), CD/DVD drive 1 (Disconnected), Floppy drive 1 (Disconnected), Video card (4.00 MB), and Other (Additional Hardware).
    - Infrastructure Navigator:** Shows Discovery Status (Normal), Successful Discovery (1 week ago), Application Services, and Application Dependencies (0).
    - Advanced Configuration:** Shows EVC Mode (Intel® Westmere® Generation).
    - Notes:** Contains a note: 'Database til EcoSense projekt'.
    - vApp Details:** Shows Product, Version, and Vendor.
  - VM Storage Policies:** Shows VM Storage Policies, VM Storage Policy Compliance, and Last Checked Date.
  - Tags:** A table with columns 'Assigned Tag', 'Category', and 'Description'. It shows 'This list is empty.'
- Right Sidebar:**
  - Recent Tasks:** Shows a list of tasks with filters for All, Running, and Failed.
  - My Tasks:** Shows a list of tasks with a 'More Tasks' link.
  - Work In Progress:** Shows a list of tasks.
  - Alarms:** Shows a list of alarms, including one for 'msecosense' with the description 'Virtual machine CPU usage'.

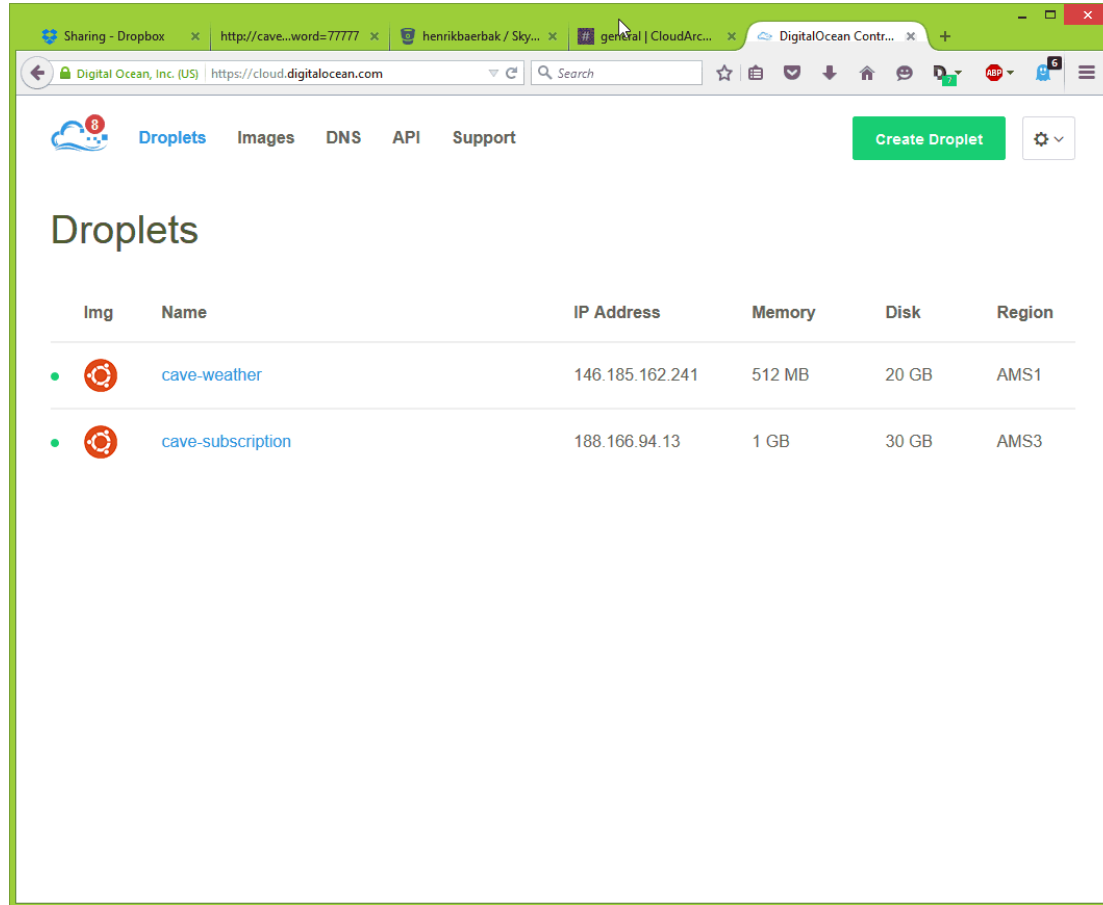


# Amazon EC2 Dashboard





The screenshot shows the Amazon EC2 Dashboard for the EU West (Ireland) region. The top navigation bar includes the AWS logo, 'Services', 'Resource Groups', and user information for Henrik Christensen. The left sidebar lists various EC2-related services like INSTANCES, IMAGES, ELASTIC BLOCK STORE, NETWORK & SECURITY, LOAD BALANCING, and AUTO SCALING. The main content area is divided into several sections: 'Resources' showing counts for Running Instances, Elastic IPs, Dedicated Hosts, Snapshots, Volumes, Load Balancers, Key Pairs, Security Groups, and Placement Groups; 'Create Instance' with a 'Launch Instance' button; 'Service Health' showing the status of the EU West (Ireland) region and its availability zones; 'Scheduled Events' showing no events; and 'Account Attributes' and 'Additional Information' on the right. A 'Feedback' button is located at the bottom left of the dashboard.

# DigitalOcean Dashboard



The screenshot shows the DigitalOcean dashboard in a web browser. The browser's address bar displays the URL `https://cloud.digitalocean.com`. The dashboard's navigation bar includes links for Droplets, Images, DNS, API, and Support, along with a 'Create Droplet' button and a settings icon. The main content area is titled 'Droplets' and features a table with the following data:

Img	Name	IP Address	Memory	Disk	Region
	cave-weather	146.185.162.241	512 MB	20 GB	AMS1
	cave-subscription	188.166.94.13	1 GB	30 GB	AMS3