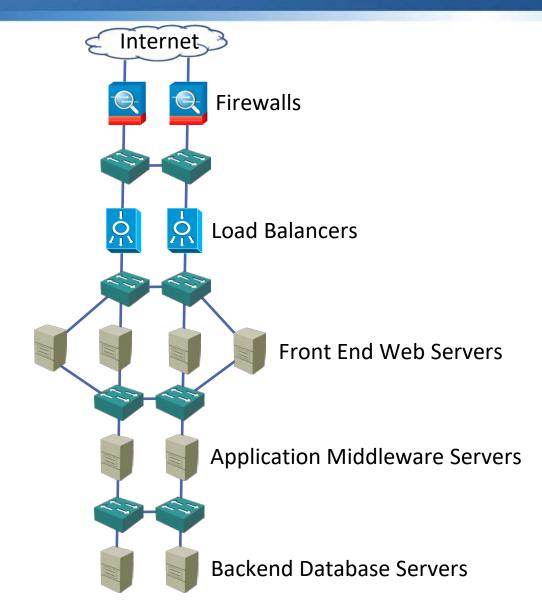
## Virtualization

- Virtualization is one of the main enablers of Cloud Computing
- It allows for resource pooling where multiple customers share the underlying hardware
- Virtualization has been around a lot longer than Cloud Computing though
- This lecture focuses on server virtualization because it was the first type available, but the same principles can be applied to virtualize network infrastructure equipment

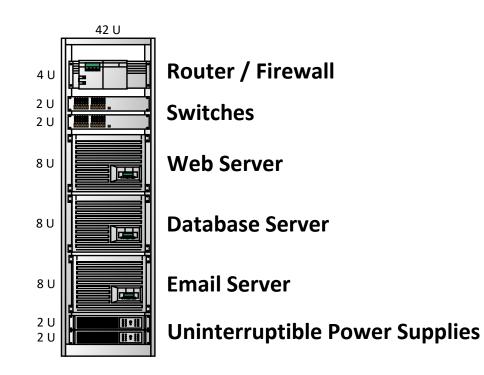


# Virtualization



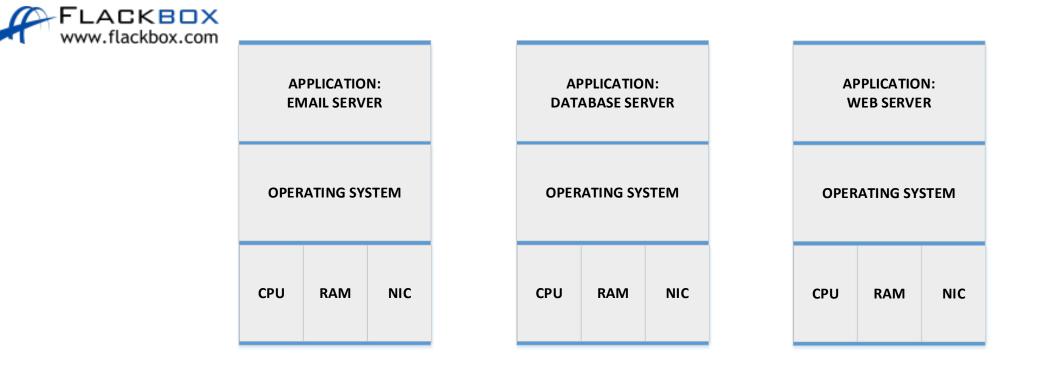
- The cloud provider does not provision
  separate physical hardware for every
  customer
- A customer can sometimes deploy
  selected dedicated hardware devices at additional cost.

### **Before Virtualization**





# **Before Virtualization**



- Server utilization (CPU, RAM, NIC etc.) around 15%
- You have to pay for each separate server, and they're all using power, space and cooling

# Multiple Applications on Same Server

- Putting multiple applications on the same server would improve utilization
- But it is very bad practice, because if you have a problem with any of your applications they will all be affected

| APPLICATION:<br>EMAIL SERVER | APPLICATION:<br>DATABASE SERVER | APPLICATION:<br>WEB SERVER |  |  |
|------------------------------|---------------------------------|----------------------------|--|--|
| OPERATING SYSTEM             |                                 |                            |  |  |
| CPU                          | RAM                             | NIC                        |  |  |



### Server Virtualization

| VIRTUAL MACHINE 1            | VIRTUAL MACHINE 2               | VIRTUAL MACHINE 3          |  |  |
|------------------------------|---------------------------------|----------------------------|--|--|
| APPLICATION:<br>EMAIL SERVER | APPLICATION:<br>DATABASE SERVER | APPLICATION:<br>WEB SERVER |  |  |
| OPERATING SYSTEM:<br>WINDOWS | OPERATING SYSTEM:<br>WINDOWS    | OPERATING SYSTEM:<br>LINUX |  |  |
| HYPERVISOR                   |                                 |                            |  |  |
| CPU                          | RAM                             | NIC                        |  |  |



# Popular Type 1 (Bare Metal) Hypervisors

Type 1 Hypervisors run directly on the system hardware

- VMware ESXi (part of the vSphere suite)
- Microsoft Hyper-V
- Red Hat KVM
- Oracle VM Server
- Citrix XenServer



# Popular Type 2 Hypervisors

Type 2 Hypervisors run on top of a host operating system

- VMware Workstation, Player and Fusion
- VirtualBox
- QEMU
- Parallels



# Type 2 Hypervisor

### VIRTUAL MACHINE 1 **VIRTUAL MACHINE 2 APPLICATION: APPLICATION: EMAIL SERVER** DATABASE SERVER APPLICATIONS **OPERATING SYSTEM: OPERATING SYSTEM:** WINDOWS WINDOWS HYPERVISOR DESKTOP OPERATING SYSTEM NIC CPU RAM



# Type 1 vs Type 2 Hypervisor

| CPU                          | RAM                             | NIC                        |  |
|------------------------------|---------------------------------|----------------------------|--|
| HYPERVISOR                   |                                 |                            |  |
| OPERATING SYSTEM:<br>WINDOWS | OPERATING SYSTEM:<br>WINDOWS    | OPERATING SYSTEM:<br>LINUX |  |
| APPLICATION:<br>EMAIL SERVER | APPLICATION:<br>DATABASE SERVER | APPLICATION:<br>WEB SERVER |  |
| VIRTUAL MACHINE 1            | VIRTUAL MACHINE 2               | VIRTUAL MACHINE 3          |  |



