



Infrastructure as a Service (IaaS)

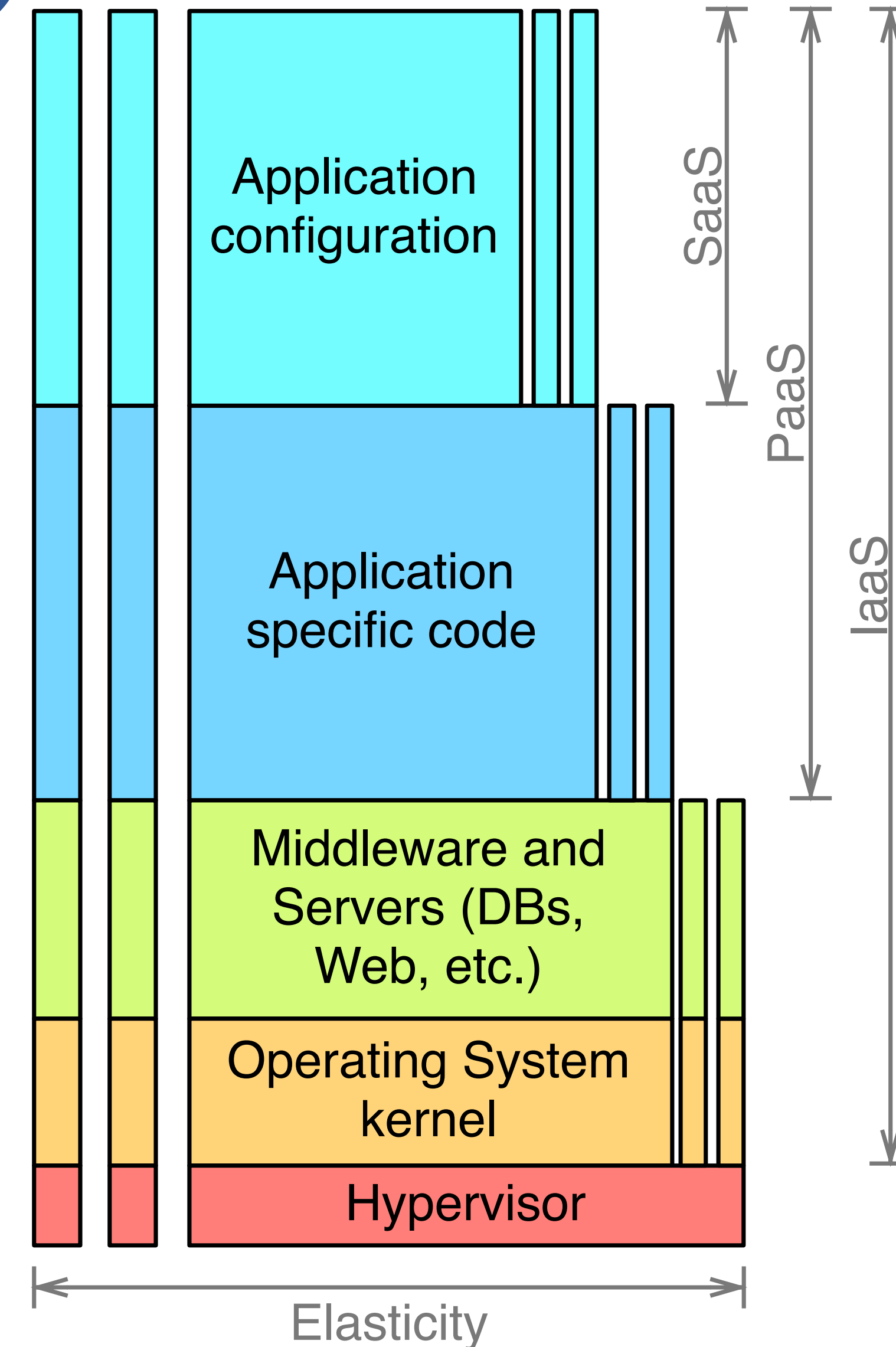
COSC349—Cloud Computing Architecture
David Eysers

Learning objectives

- Define **IaaS**
- Give examples of **public IaaS providers**
- Explain benefits and challenges using IaaS
- Describe how IaaS is usually **charged for**
- Sketch how VM **spot pricing** helps clients and providers
- Understand the core components required to be provided by an IaaS platform such as **OpenStack**

Infrastructure as a Service (IaaS)

- Infrastructure as in **physical hardware**
 - ...but with hardware **virtualised as a service**
- Computing is typical IaaS commodity
 - **Networking** also needed to reach VMs
 - **Storage** typically provided in multiple ways:
 - Install OSs from existing templates
 - Means for VMs' data to be read & written



Popular IaaS offerings in the public cloud

- Gartner report includes 2024 IaaS market shares:
 - 37.7%—**Amazon** Elastic Compute Cloud (EC2)
 - 23.9%—**Microsoft Azure**
 - 9.0%—**Google**
 - 7.2%—**Alibaba**
 - 4.1%—**Huawei**
 - 17.9%—others
- Top-5 cover over >80% of total market share!
 - Also, Amazon's lead is significant (but slowly diminishing)

Advantages of IaaS over other models

- IaaS tenants have the greatest **power and flexibility**
 - Anything that can run virtualised can probably be deployed
- Relatively **low levels of lock-in** to any given provider:
 - Typical IaaS VM resources are largely interchangeable
 - e.g., VM images can be moved from EC2 to/from local VirtualBox
 - Amazon Linux 2023 is available as a public download
- You can ensure you have high **Quality of Service (\$\$\$)**

Downsides of IaaS

- Lots of deployment work is necessary before any application code can actually be run—**slow start-up**
 - You need to select the operating system you will use
 - Also, you must keep your operating system updated (*i.e.*, secure!)
 - VMs need to have disks, *etc.*, provisioned
- **All infrastructure management** is up to you
 - You manage scaling up your apps over multiple machines
 - You can build web application load-balancers, *etc.*, but the cloud already has them now, so you will be duplicating effort

Charging—what do you pay for in IaaS?

- CPU-wise, your use is **opaque to cloud provider**
 - Typically rate for ‘size’ of VM: number of CPU cores; RAM; *etc.*
 - Then multiply by the amount of time VM is ‘powered on’
 - Often **pay by hour units**, but AWS has per-second Linux billing
- Other resources that are likely to be charged for:
 - **Network traffic** to/from Internet & across regions
 - Amazon EC2 doesn’t charge inwards from Internet (... lock-in risk?)
 - **Block storage & snapshots**—charged regardless of VM on or off
 - Additional **public IP addresses** for your VMs

Amazon EC2 instance types

- At launch EC2 had a **one-size-fits-all** approach to VMs
 - 2007: EC2 gives choice: **small, medium & large**
 - 2020: **298+** instance types; 2021: Nearly **400** instance types
 - 2025: **850+** EC2 instance types
- Broad classifications include:
 - **General purpose**—balance CPU, RAM, storage
 - **Compute** optimised, **Memory** optimised, **Storage** optimised
 - **Accelerated**—GPGPUs, HPC and FPGAs
 - (Bare metal instance types offered also)

Amazon's VM spot pricing

- Computers don't wear down proportionally to their use
 - Thus cloud providers have incentive to **ensure high utilisation**
 - However, they need to ensure they don't violate guarantees
 - *i.e.*, claiming CPU allocations are available when they aren't
- Amazon address this (in part) using **spot pricing**
 - Heavily discounted prices on VMs... but these VMs **can be terminated** with just **two minutes' notice**!
 - You choose: hibernate; stop or terminate your VM
- AWS also discounts long-term use—**reserved instances**

‘Local’ IaaS options: Catalyst Cloud

- IaaS platforms exist within New Zealand—ideal when:
 - **data sovereignty** is a concern
 - **fast network response** times for NZ clients is crucial
- Catalyst Cloud—<https://catalystcloud.nz/>
 - Three regions within NZ (~AWS Availability Zones)
 - Likely more expensive than AWS, *etc.*, but price isn’t everything
 - Provide free credit for trying out their services
- Spark & Azure offer IaaS within NZ... soon AWS (?)...

How do you run an IaaS cloud?

- Hybrid and private cloud models require **local clouds**
- Organisations like telcos have large data centres
 - Increasingly software for those organisations will be virtualised
 - Thus offering cloud services is about **management and billing**
- Existing enterprise virtualisation platforms now do cloud
 - e.g., VMware provides tools for managing fleets of VM hosts
- Numerous open source products such as **OpenStack**
 - Key is the effecting **delegated administration**—*i.e.*, self-service

FYI: OpenStack has many components

- (Taxonomy is mine)
- **Core VM support**
 - Compute: Nova
 - Networking: Neutron
 - Block storage: Cinder
 - Image: Glance
- **Management**
 - Identity: Keystone
 - Dashboard: Horizon
 - Orchestration: Heat
- Workflow: Mistral
- Telemetry: Ceilometer
- Messaging: Zaqar
- DNS: Designate
- Search: Searchlight
- Key manager: Barbican
- Container orchestration: Magnum
- Root Cause Analysis: Vitrage
- Rule-based alarm actions: Aodh
- **Cloud Services**
 - Object storage: Swift
 - Database: Trove
 - Elastic map reduce: Sahara
 - Bare metal: Ironic
 - Shared file system: Manila