# 3. Parallel Processing on the Cloud (25 points)

## 3.1. Public Cloud Pricing and SLAs (10 points)

Compare the Service Level Agreement (SLA) (i.e. the up-time), penalties (i.e. the credits that you'll receive if the uptime turns out to be lower than what was promised in the SLA). and on-demand pricing (for similar instance capacity with approx 2 vCPUs, 8 GIB Mem and 32 GB SSD) of four main public cloud providers:

- Amazon AWS
- Google Compute
- Microsoft Azure
- IBM Cloud

Explain what are the "nines" given by providers as availability goals? What is the maximum downtime per year?

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### Comparison of Four Services

| Main Public Cloud Provider | SLA | Penalties | On-demand pricing (2 CPU, 8GB Memory) | "Nines" | Maximum Downtime per year | Link References |
|---|---|---|---|---|---|---|

| Main Public Cloud Provider | SLA | Penalties | On-demand pricing (2 CPU, 8GB Memory) | "Nines" | Maximum Downtime per year | Link References |
|---|---|---|---|---|---|---|
| Amazon AWS | Monthly Uptime Percentage of at least 99.99%; For Single EC2 Instance, Hourly Uptime Percentage of at least 90% of the time in which that Single EC2 Instance is deployed during each clock hour (the "Hourly Commitment") | Monthly Uptime Percentage Less than 99.99% but equal to or greater than 99.0% -> 10%; Less than 99.0% but equal to or greater than 95.0% -> 30%; Less than 95.0% -> 100% | 0.0672 per hour for VM only; 4.576 per month with 32GB SSD | Monthly Uptime Percentage of at least 99.99% | 52.56 minutes of down time per year | https://aws.amazon.com/compute/sla/ |
| Google Compute | Monthly Uptime Percentage for Instances in Multiple Zones >= 99.99%; A Single Instance >= 99.5%; Load balancing >= 99.99% | Monthly Uptime Percentage for Instances in Multiple Zones 99.00% ~ < 99.99% -->10%;95.00% ~ < 99.00% -> 25%; < 95.00% -> 50%; for single instance 95.00% ~ < 99.50% -> 10%; 90.00% ~ < 95.00% -> 25%; < 90.00% -> 50% | 0.0670 per hour for VM only; 4.570 per month with 32GB SSD | Monthly Uptime Percentage for Instances in Multiple Zones 99.99% | 52.56 minutes of down time per year | https://cloud.google.com/compute/sla |

| Main Public Cloud Provider | SLA | Penalties | On-demand pricing (2 CPU, 8GB Memory) | "Nines" | Maximum Downtime per year | Link References |
|---|---|---|---|---|---|---|
| Microsoft Azure | VMs that have two or more instances deployed across two or more Availability Zones in the same Azure region -> 99.99%; VMs have two or more instances deployed in the same Availability Set or in the same Dedicated Host Group, -> 99.95%; Single Instance Virtual Machine using Premium SSD or Ultra Disk for all Operating System Disks and Data Disks -> 99.9%; Single Instance Virtual Machine using Standard SSD Managed Disks for Operating System Disk and Data Disks -> 99.5%; Single Instance Virtual Machine using Standard HDD Managed Disks for Operating System Disks and Data Disks ->95%. | for VM deployed across two or more Availability Zones in the same region: monthly uptime percentage < 99.99% -> 10%; < 99% -> 25%; < 95% -> 100%; For VM in an Availability Set, or same Dedicated Host Group < 99.95% -> 10%; < 99% -> 25%; < 95% -> 100%; For Single-Instance Virtual Machines by Disk type UPTIME PERCENTAGE (PREMIUM AND ULTRA SSD) and UPTIME PERCENTAGE(STANDARD SSD MANAGED DISK) and UPTIME PERCENTAGE(STANDARD HDD MANAGED DISK) are respectively < 99.9% < 99.5% < 95% -> 10%; < 99% < 95% < 92% -> 25%;< 95% < 90% < 90% ->100% | 0.096 per hour for VM only; 5.28 per month with 32GB SSD | VMs that have two or more instances deployed across two or more Availability Zones in the same Azure region -> Monthly Uptime Percentage 99.99% | 52.56 minutes of down time per year | https://azure.microsoft.com/en-us/support/legal/sla/virtual-machines/v1_9/ |
| IBM Cloud | IBM Cloud® provides a 99.99% availability service level for multiple instances of a platform service within a public environment | For High availability for a public environment and Other environments <99.99% and <99.9% respectively -> 10%; <99.9% and <99.0% respectively -> 25% | 0.096 per hour for VM only; 4.48 per month with 32GB SSD | 99.99% availability service level for multiple instances of a platform service within a public environment | 52.56 minutes of down time per year | https://cloud.ibm.com/docs/overview?topic=overview-slas |

**Nines** given by provider as availability goals, it means uptime percentage of service per agree time unit (i.e. year/month/week etc);

For example,

- Four nines means 99.99%;
- Five nines means 99.999%;
- 4.5 nines means 99.995% (also be called as 4N5, 4.3 OR 4.5)

For four nines, 99.99%, the maximum downtime is 365*0.01%* 24 * 60 = 52.56 minutes of down time per year.

Pricing:

- **AWS** (https://aws.amazon.com/ec2/pricing/on-demand/)

| | | | | | |
|---|---|---|---|---|---|
| t4g.large | 2 | N/A | 8 GiB | EBS Only | $0.0672 per Hour |

SSD Disk is priced separately (https://aws.amazon.com/ebs/pricing/)

| | |
|---|---|
| **General Purpose SSD (gp3) - Storage** | $0.08/GB-month |

In total, it costs around

$$0.0672 * 30 + 0.08 * 32 = 4.576\$/month$$

- **Google Compute** (https://cloud.google.com/compute/all-pricing)

| Machine type | Virtual CPUs | Memory | Price (USD) | Preemptible price (USD) |
|---|---|---|---|---|
| e2-standard-2 | 2 | 8GB | $0.067006 | $0.020102 |

SSD Disk is priced separately (https://cloud.google.com/compute/all-pricing#localssdpricing)

## Local SSD pricing

Iowa (us-central1)

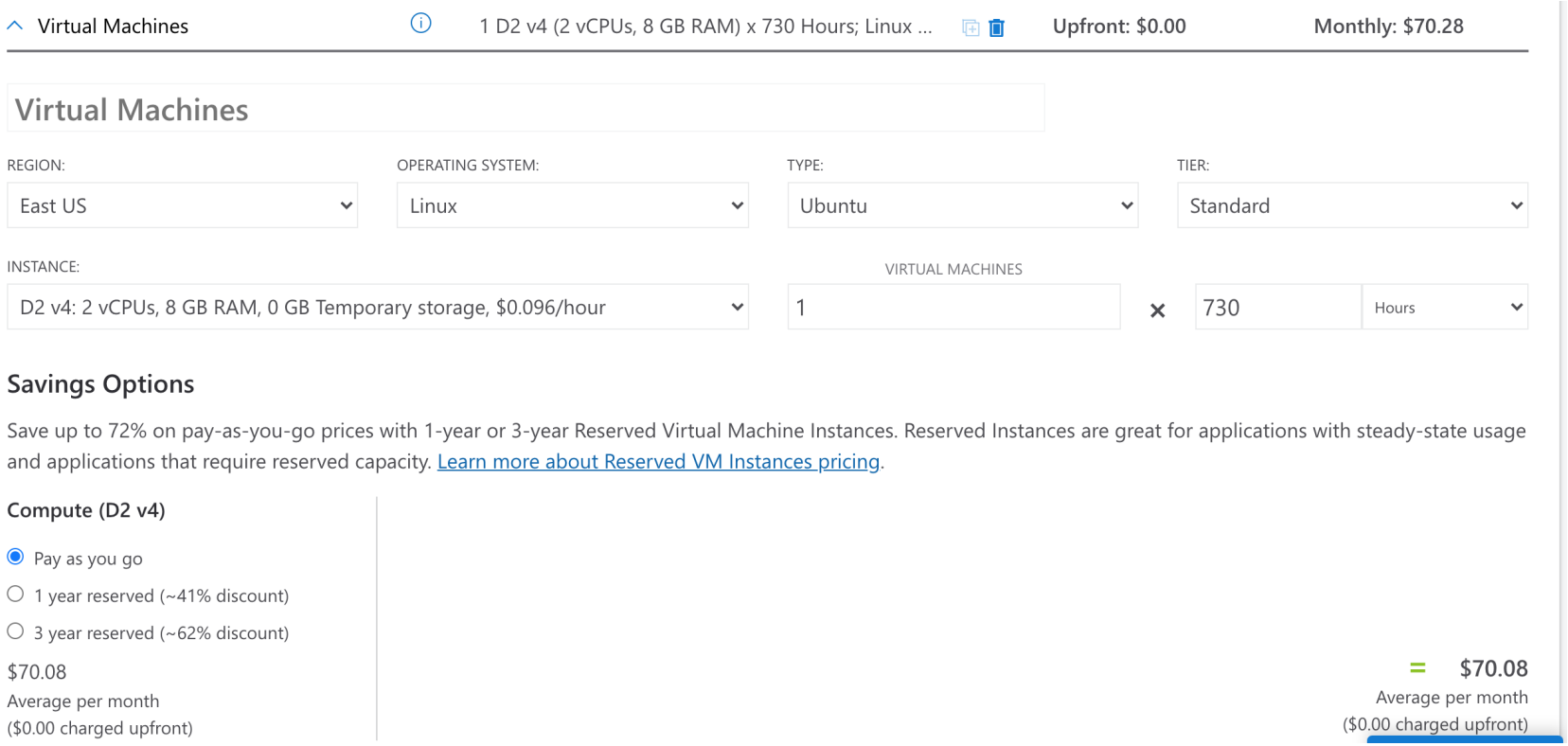
| Type | Price (per GB per month in USD) | Preemptible price (per GB per month in USD) | 1 year commitment price (per GB per month in USD) | 3 year commitment price (per GB per month in USD) |
|---|---|---|---|---|
| Local SSD provisioned space | $0.080 | $0.048 | $0.051 USD | $0.036 USD |

In total, it costs around

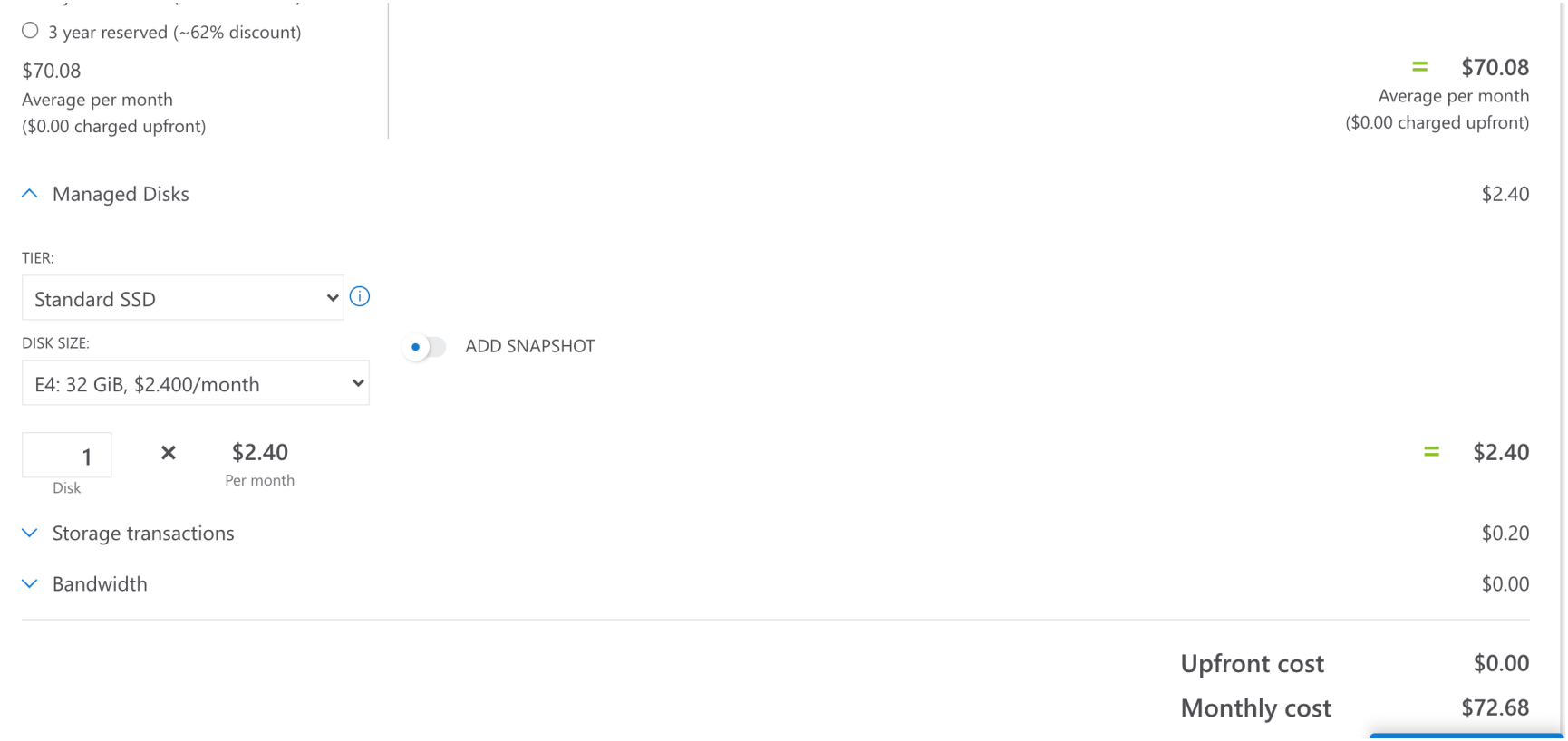
$$0.0670 * 30 + 0.08 * 32 = 4.57\$/month$$

- **Microsoft Azure** (https://azure.microsoft.com/en-us/pricing/details/virtual-machines/linux/; https://azure.microsoft.com/en-us/pricing/calculator/)

| Add to estimate | Instance | vCPU(s) | RAM | Temporary storage | Pay as you go | 1 year reserved (% Savings) | 3 year reserved (% Savings) | Spot (% Savings) |
|---|---|---|---|---|---|---|---|---|
| ⊕ | D2 v4 | 2 | 8 GiB | N/A | $0.096/hour | $0.0567/hour (~41%) | $0.0365/hour (~62%) | $0.012/hour (~88%) |




Disk is billed separately at $2.4/month for 32GB SSD:




In total, it costs around

$$0.0960 * 30 + 2.4 = 5.28/month$$

- **IBM Cloud** (https://cloud.ibm.com/gen1/infrastructure/provision/vs)

| | | | | | | |
|---|---|---|---|---|---|---|
| ◉ | BL2.2x8 | Balanced local storage | 2 | 8 GB | SSD | $0.096 |

Balanced local storage | BL2.2x8 View all profiles

| 2 | 8 GB | SSD | $0.096 |
|---|---|---|---|
| vCPU | RAM (GB) | Storage type | Price |

Disk pricing: (https://www.ibm.com/cloud/block-storage/pricing)

| IOPS Tier | 0.25 IOPS/GB | 2 IOPS/GB | 4 IOPS/GB | 10 IOPS/GB |
|---|---|---|---|---|
| Monthly price | USD 0.05 | USD 0.12 | USD 0.16 | USD 0.48 |
| Hourly price | USD 0.00007 | USD 0.00017 | USD 0.00022 | USD 0.00067 |

In total, it costs around

$$0.0960 * 30 + 0.05 * 32 = 4.48/month$$

In [ ]: