Grafana Labs

Where’s your money going?

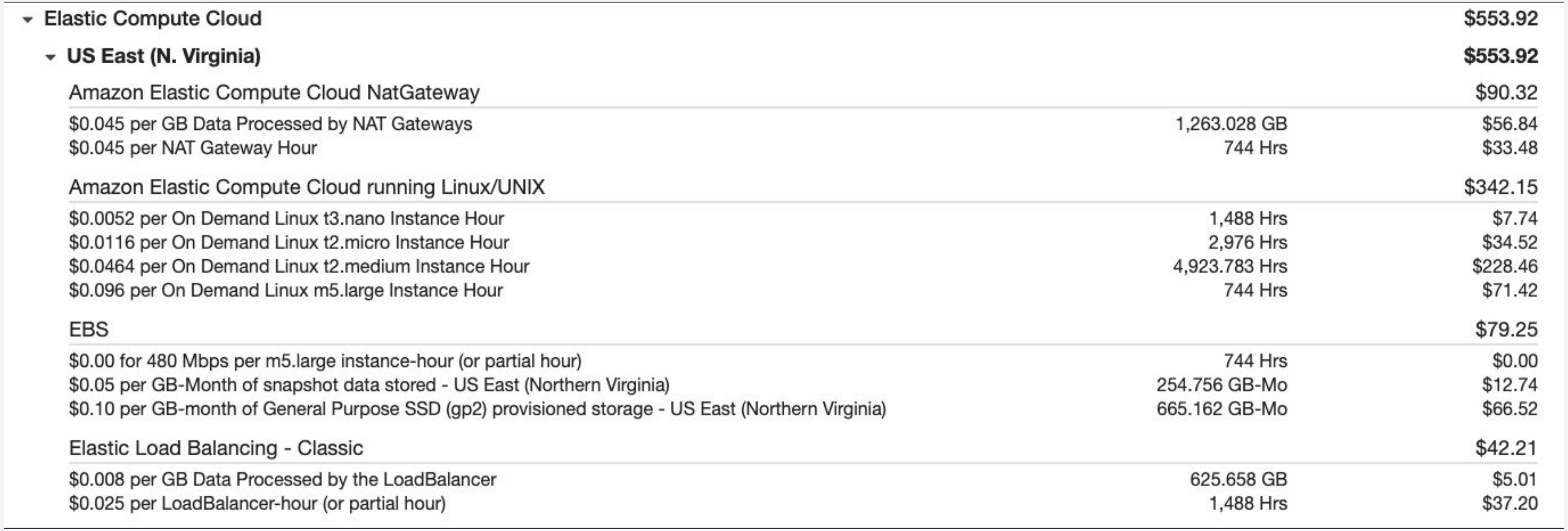
The Beginners Guide To Measuring Kubernetes Costs

Erik Sommer

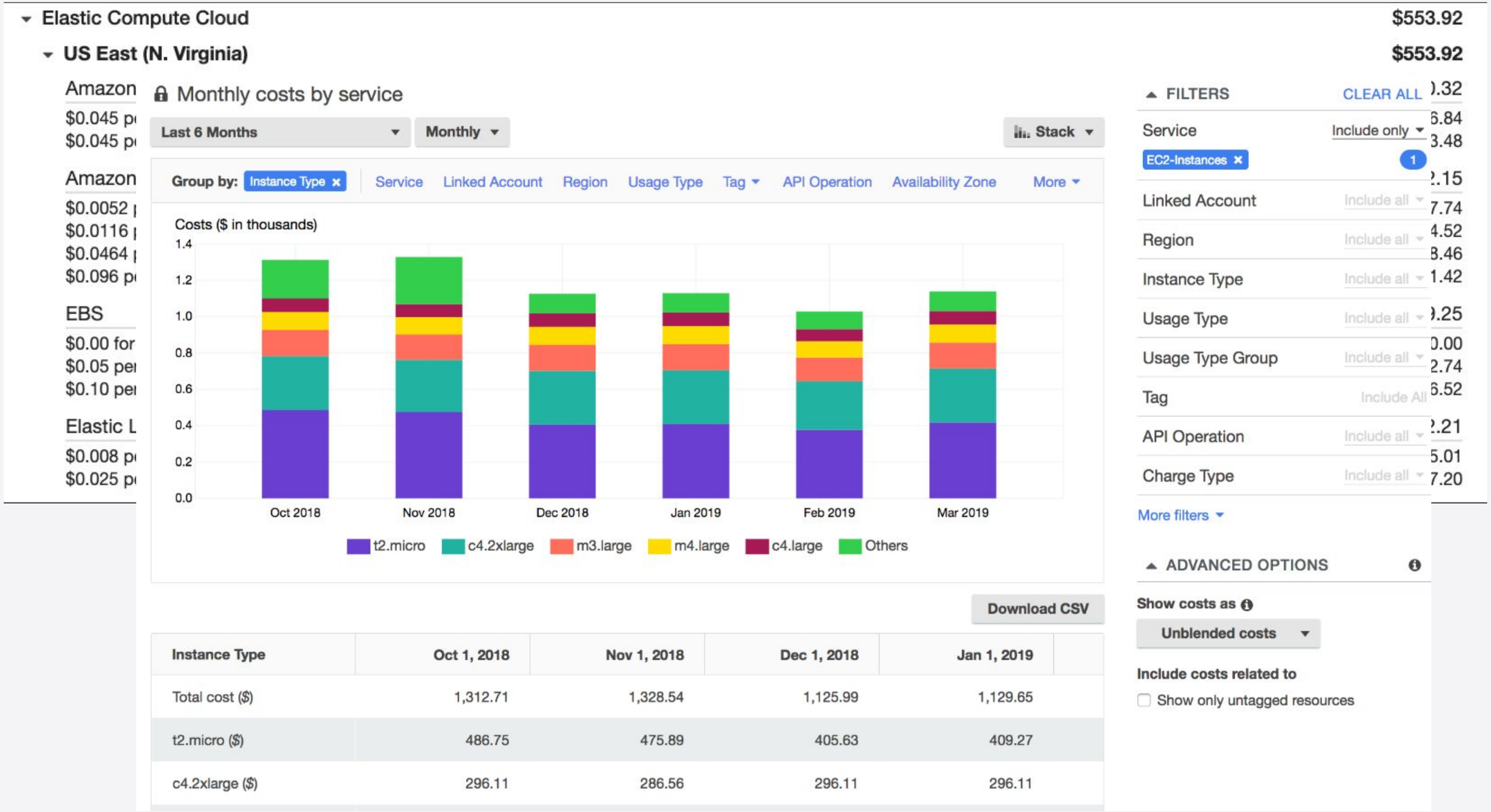
Sr. Software Engineer

What you can expect

- The Problem: When the bill doesn’t match your metrics
- Mental model to attributes costs in k8s
- How to compose PromQL queries
- Shortcomings / Where to go next



Elastic Compute Cloud		**$553.92**
US East (N. Virginia)		**$553.92**
Amazon Elastic Compute Cloud NatGateway		$90.32
$0.045 per GB Data Processed by NAT Gateways	1,263.028 GB	$56.84
$0.045 per NAT Gateway Hour	744 Hrs	$33.48
Amazon Elastic Compute Cloud running Linux/UNIX		$342.15
$0.0052 per On Demand Linux t3.nano Instance Hour	1,488 Hrs	$7.74
$0.0116 per On Demand Linux t2.micro Instance Hour	2,976 Hrs	$34.52
$0.0464 per On Demand Linux t2.medium Instance Hour	4,923.783 Hrs	$228.46
$0.096 per On Demand Linux m5.large Instance Hour	744 Hrs	$71.42
EBS		$79.25
$0.00 for 480 Mbps per m5.large instance-hour (or partial hour)	744 Hrs	$0.00
$0.05 per GB-Month of snapshot data stored - US East (Northern Virginia)	254.756 GB-Mo	$12.74
$0.10 per GB-month of General Purpose SSD (gp2) provisioned storage - US East (Northern Virginia)	665.162 GB-Mo	$66.52
Elastic Load Balancing - Classic		$42.21
$0.008 per GB Data Processed by the LoadBalancer	625.658 GB	$5.01
$0.025 per LoadBalancer-hour (or partial hour)	1,488 Hrs	$37.20



Elastic Compute Cloud $553.92

US East (N. Virginia) $553.92

Amazon).32

$0.045 p 6.84

$0.045 p 3.48

Amazon 2.15

$0.0052 7.74

$0.0116 4.52

$0.0464 3.46

$0.096 p 1.42

EBS).25

$0.00 for 0.00

$0.05 per 2.74

$0.10 per 6.52

Elastic L 2.21

$0.008 p 5.01

$0.025 p 7.20

Monthly costs by service

Last 6 Months ▾ | Monthly ▾ | Stack ▾

Group by: Instance Type ✕ | Service | Linked Account | Region | Usage Type | Tag ▾ | API Operation | Availability Zone | More ▾

Download CSV

Instance Type	Oct 1, 2018	Nov 1, 2018	Dec 1, 2018	Jan 1, 2019
Total cost ($)	1,312.71	1,328.54	1,125.99	1,129.65
t2.micro ($)	486.75	475.89	405.63	409.27
c4.2xlarge ($)	296.11	286.56	296.11	296.11

FILTERS CLEAR ALL

Service	Include only ▾
EC2-Instances ✕	1
Linked Account	Include all ▾
Region	Include all ▾
Instance Type	Include all ▾
Usage Type	Include all ▾
Usage Type Group	Include all ▾
Tag	Include All
API Operation	Include all ▾
Charge Type	Include all ▾

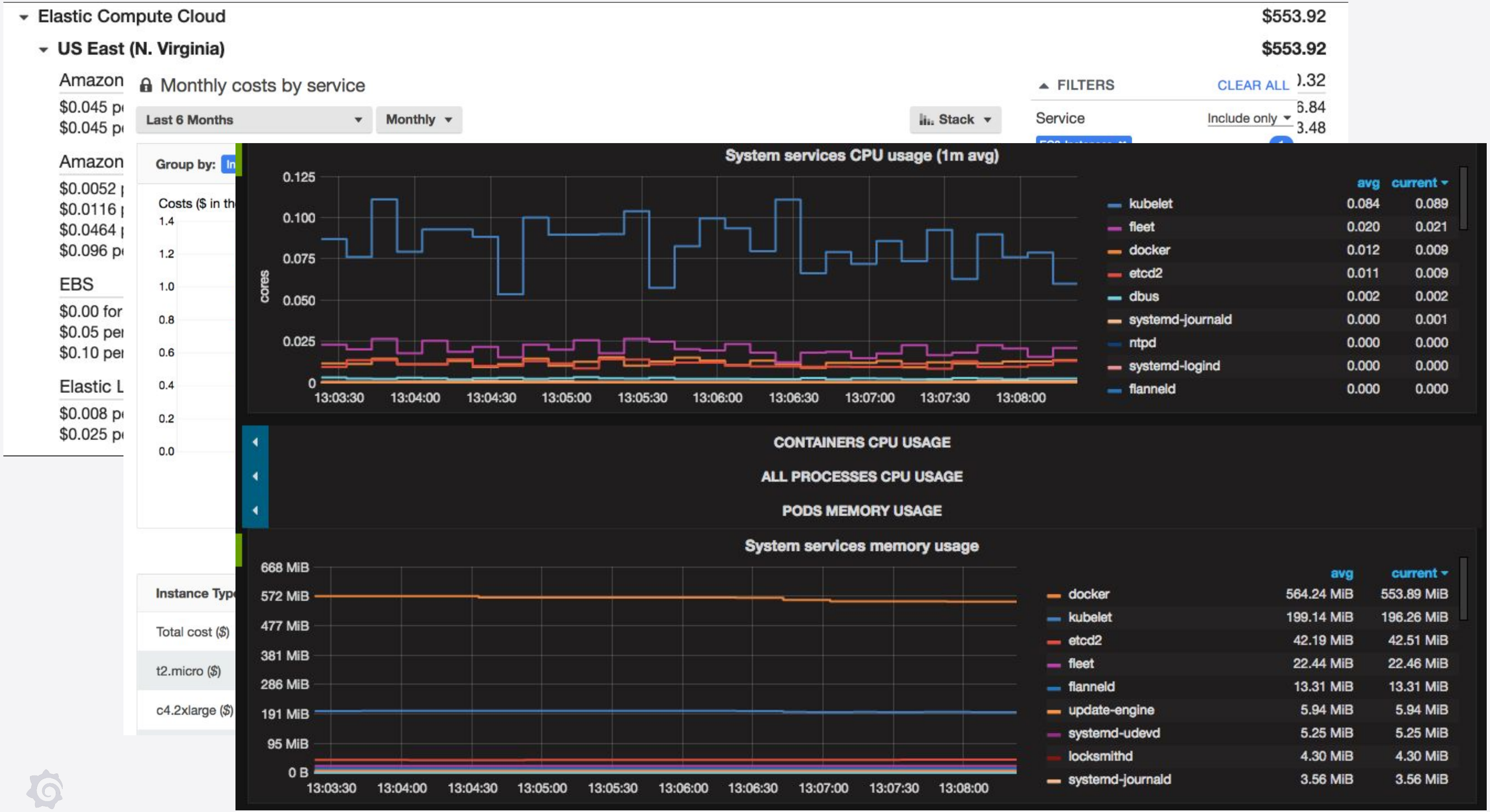
More filters ▾

ADVANCED OPTIONS

Show costs as: Unblended costs ▾

Include costs related to

□ Show only untagged resources



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Monthly costs by service

Last 6 Months ▾ Monthly ▾ Stack ▾

FILTERS CLEAR ALL

Service Include only ▾

Group by: In

Costs ($ in th

Instance Typ

Total cost ($)

t2.micro ($)

c4.2xlarge ($)

System services CPU usage (1m avg)

	avg	current ▾
kubelet	0.084	0.089
fleet	0.020	0.021
docker	0.012	0.009
etcd2	0.011	0.009
dbus	0.002	0.002
systemd-journald	0.000	0.001
ntpd	0.000	0.000
systemd-logind	0.000	0.000
flanneld	0.000	0.000

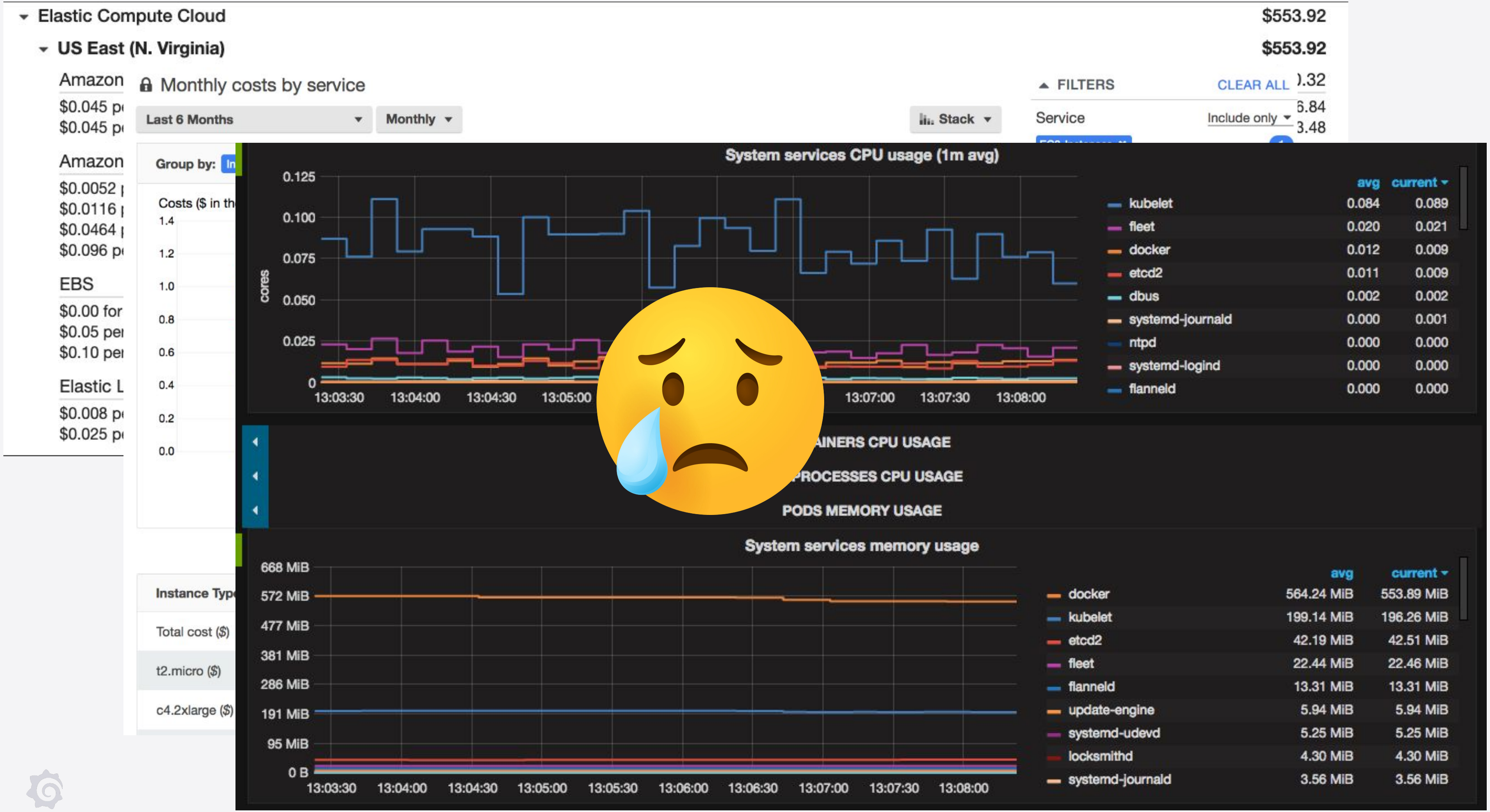
CONTAINERS CPU USAGE

ALL PROCESSES CPU USAGE

PODS MEMORY USAGE

System services memory usage

	avg	current ▾
docker	564.24 MiB	553.89 MiB
kubelet	199.14 MiB	196.26 MiB
etcd2	42.19 MiB	42.51 MiB
fleet	22.44 MiB	22.46 MiB
flanneld	13.31 MiB	13.31 MiB
update-engine	5.94 MiB	5.94 MiB
systemd-udevd	5.25 MiB	5.25 MiB
locksmithd	4.30 MiB	4.30 MiB
systemd-journald	3.56 MiB	3.56 MiB



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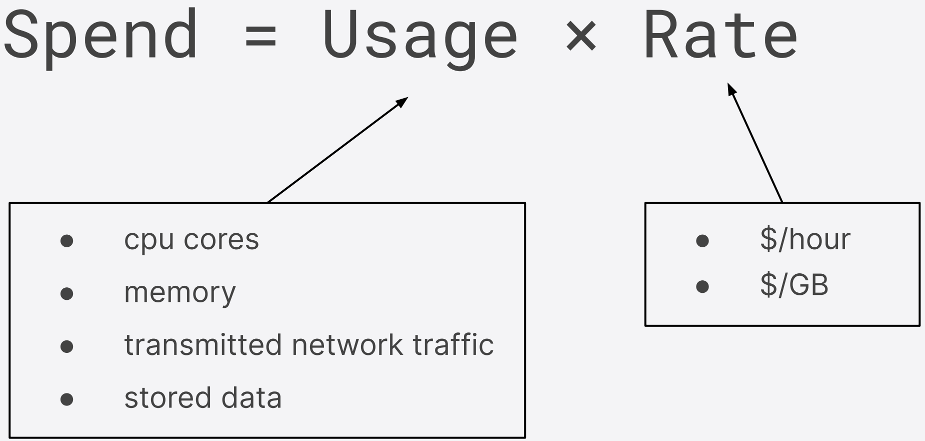
Problems

- Disconnect between billing statement and metrics
- Need to attribute costs of workloads running in Kubernetes
- Difficult to accurately measure Total Cost of Ownership (TCO) of our services

A simple formula with profound implications …

```
Spend = Usage × Rate
```

A simple formula with profound implications …



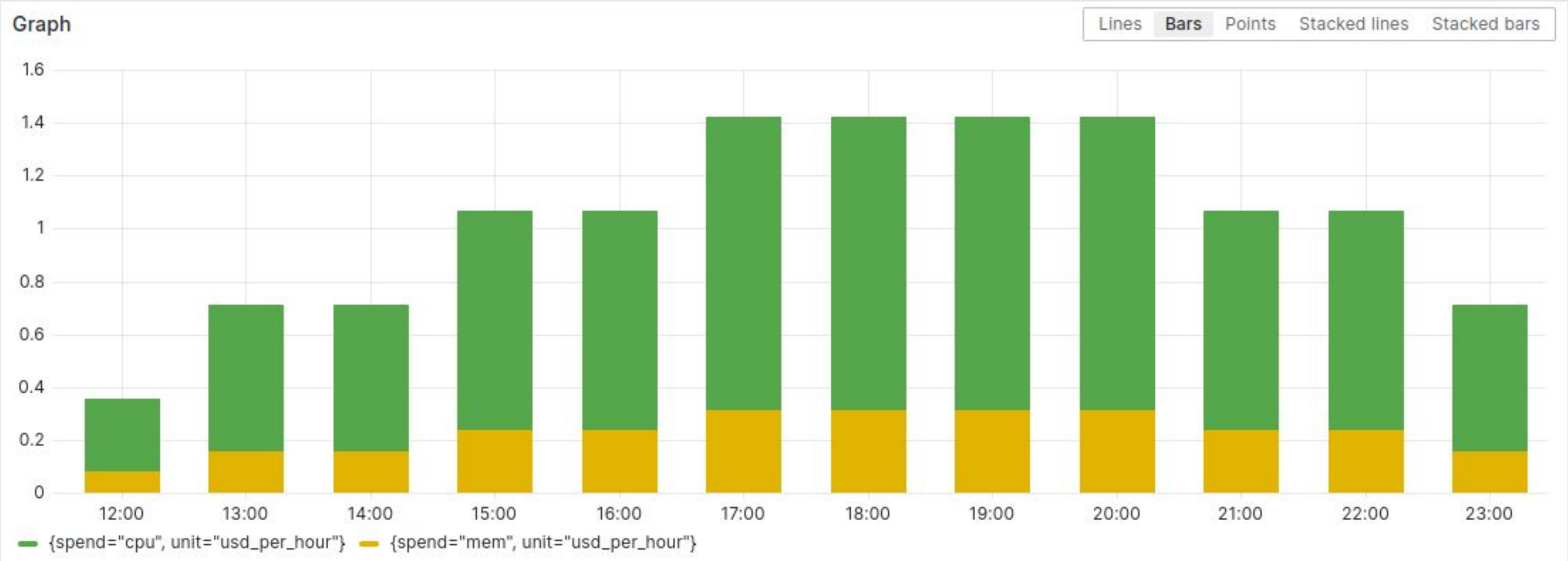
`Spend = Usage × Rate`

- cpu cores
- memory
- transmitted network traffic
- stored data

- $/hour
- $/GB

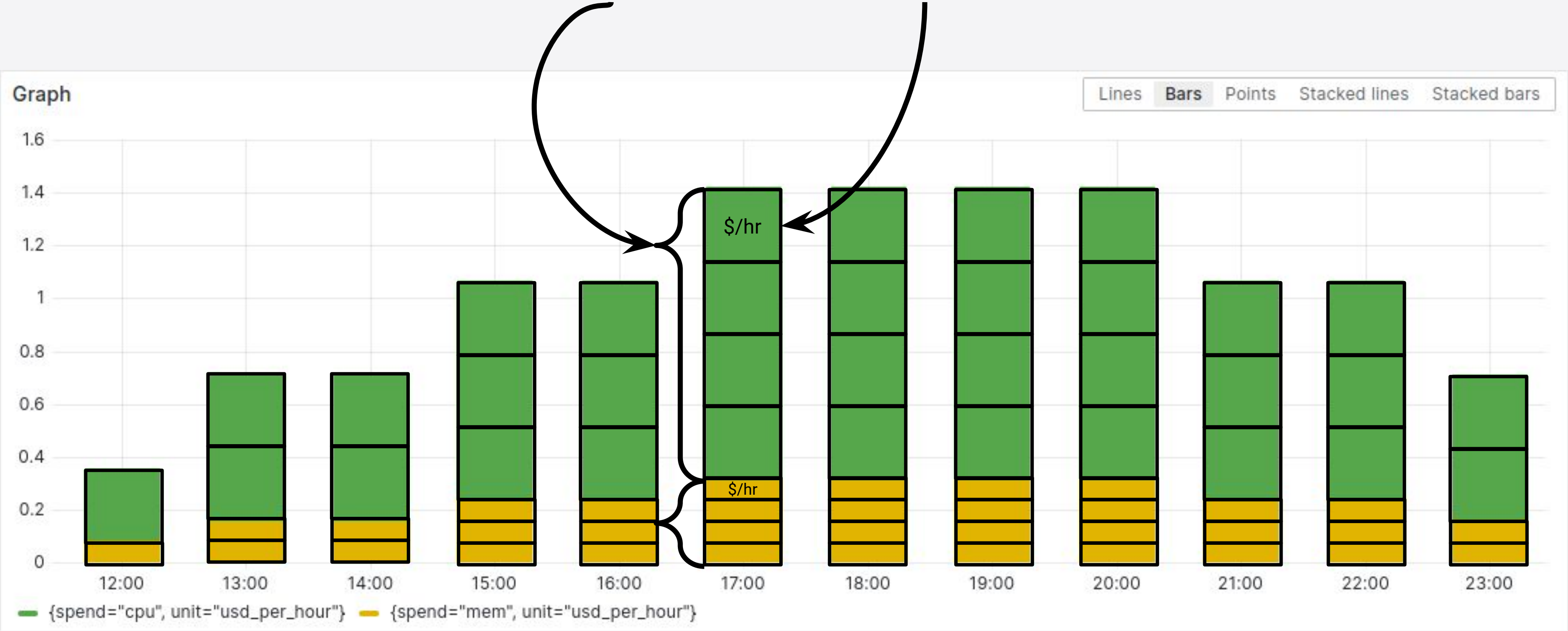
A simple formula with profound implications ...

```
Spend = Usage × Rate
```



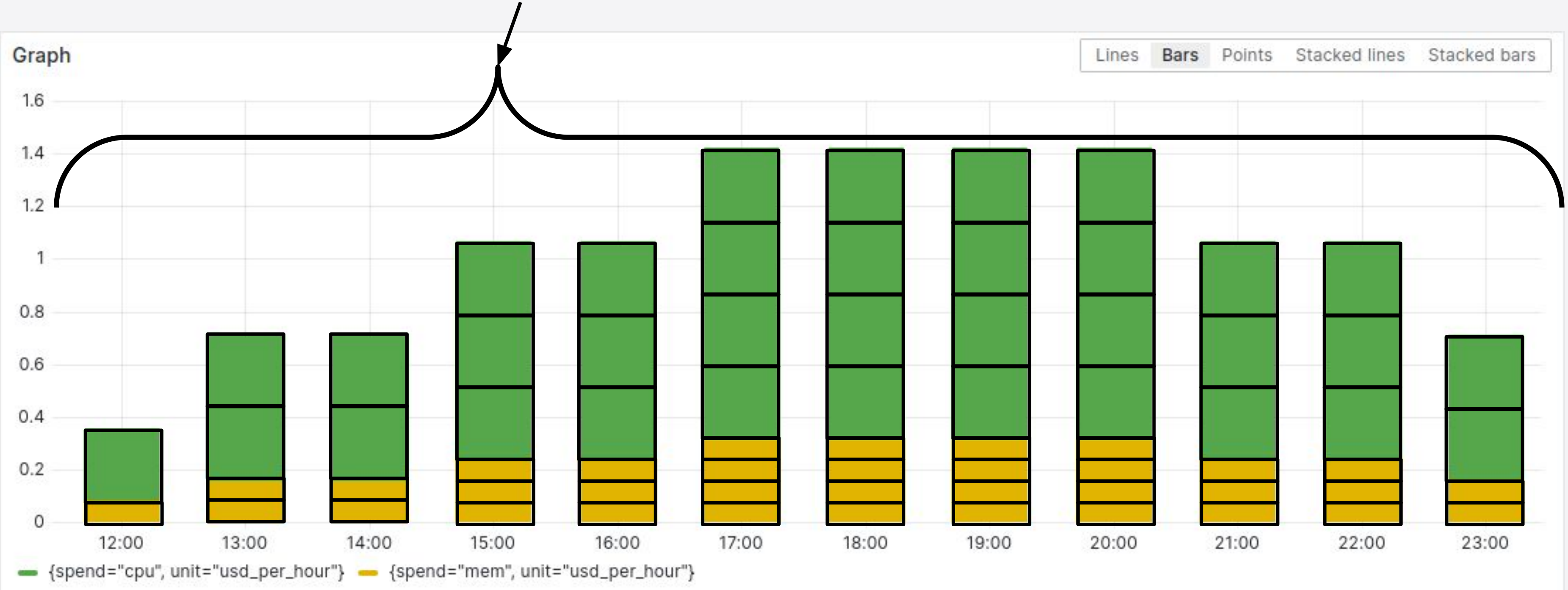
A simple formula with profound implications …

Spend = Usage × Rate



A simple formula with profound implications ...

$$\text{Spend} = \sum \text{Usage} \times \text{Rate} \quad \Delta t$$

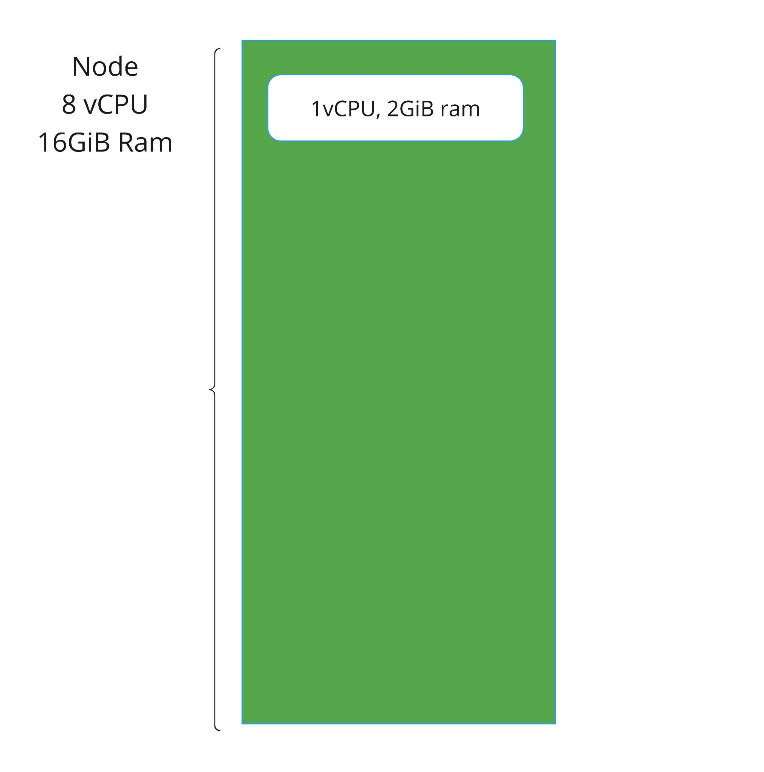


What drives k8s costs

Web service

1vCPU, 2GiB ram

What drives k8s costs



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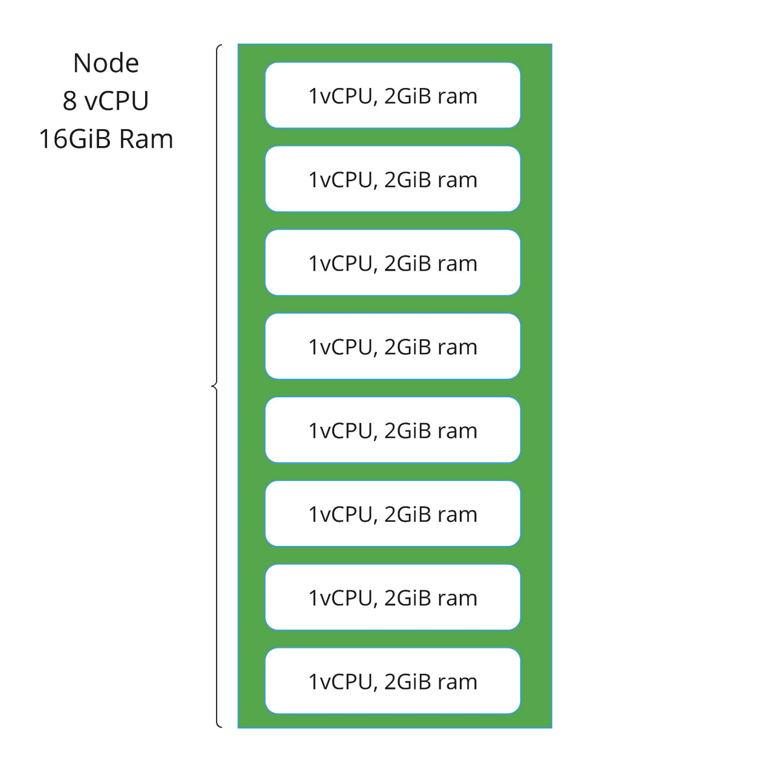

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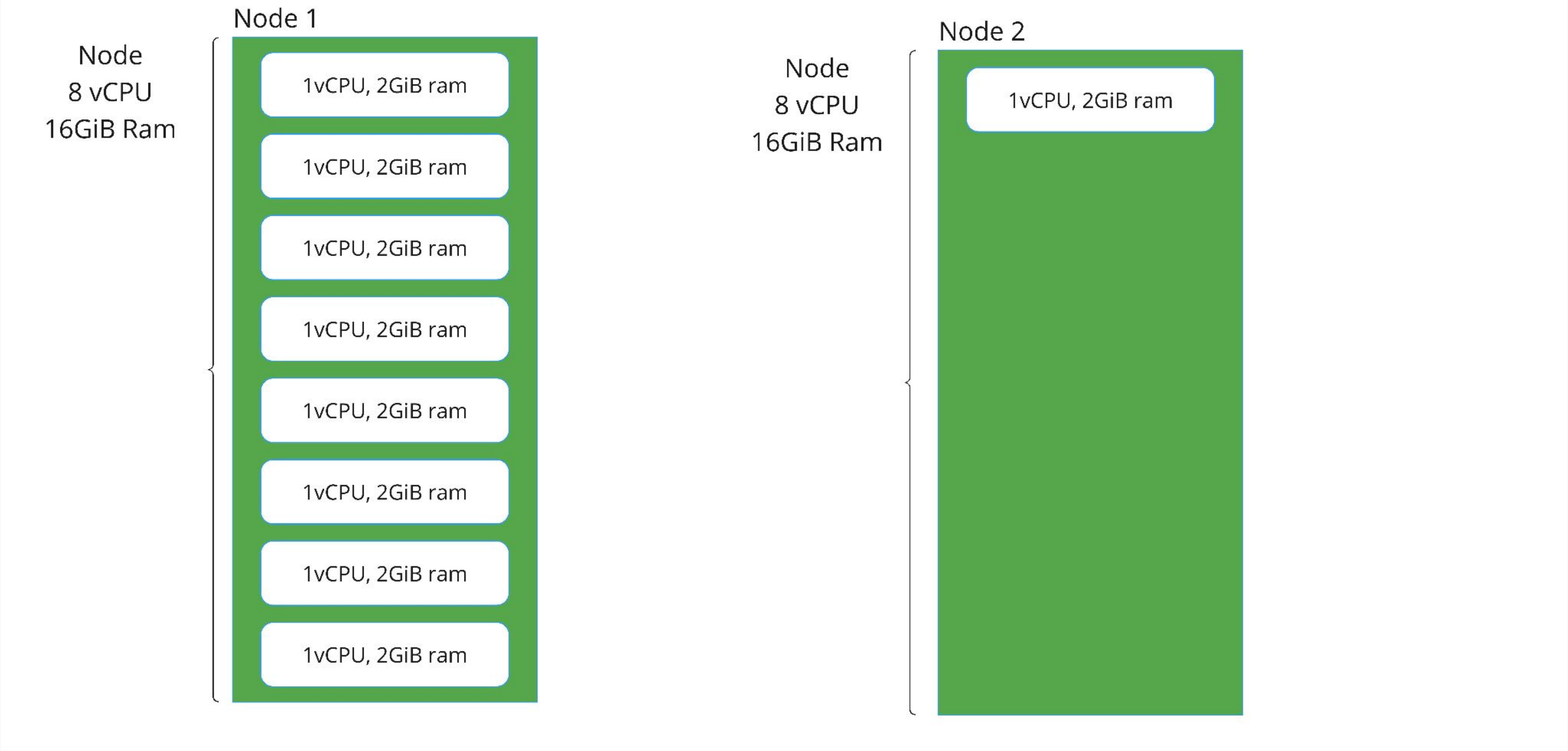


How to measure usage

- cpu|memory of nodes

- cpu|memory requests of workloads

How to measure usage

cpu|memory of nodes

```
kube_node_status_capacity{cluster, resource, node}
```

cpu|memory requests of workloads

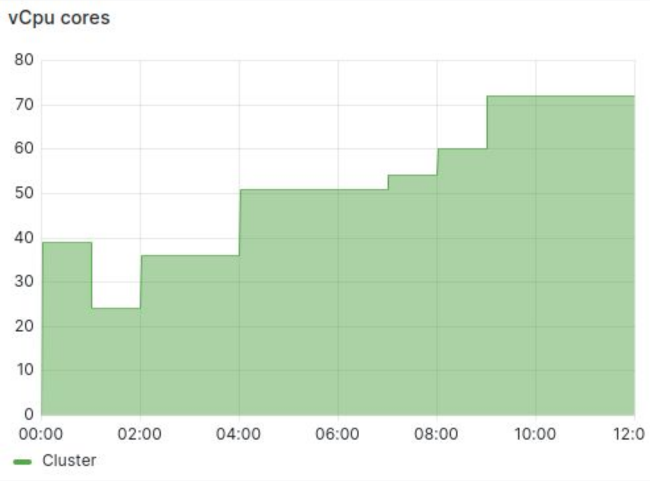
```
kube_pod_container_resource_requests{cluster, resource, node, namespace}
```

How to measure your nodes

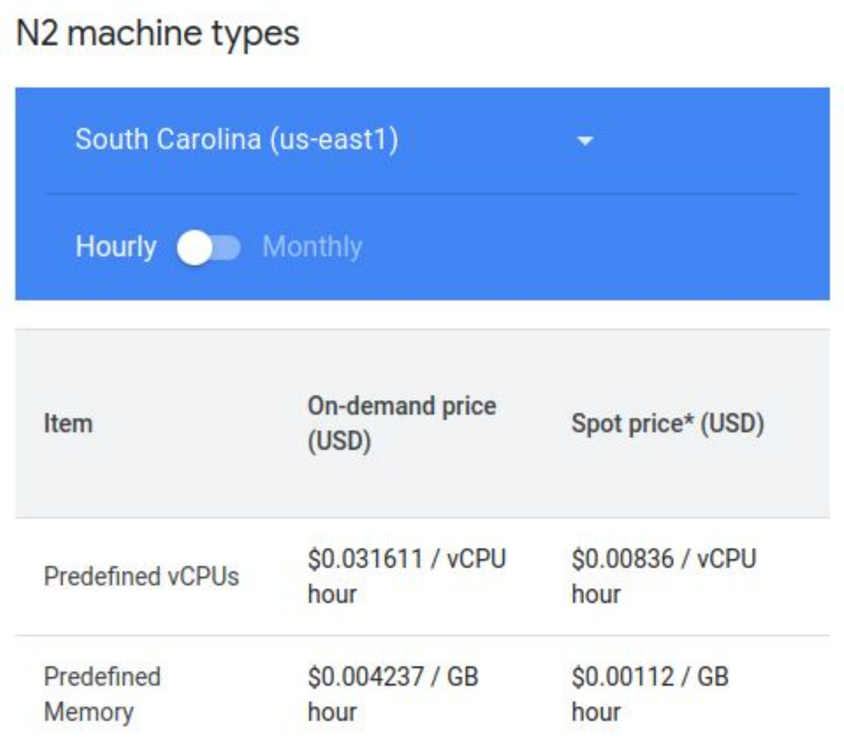
```
sum (
  usage
  *
  rate
)
```

How to measure your nodes

```
sum (
  kube_node_status_capacity(resource="cpu"}
  *
  rate
)
```



How to measure your nodes



N2 machine types

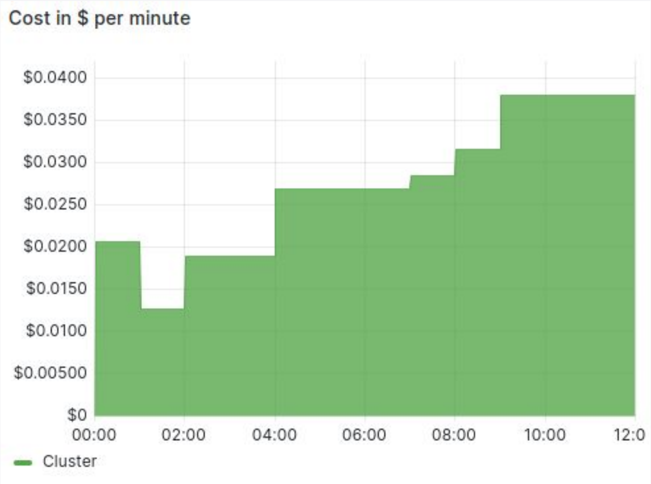
South Carolina (us-east1) ▾

[✓ Hourly] Monthly

Item	On-demand price (USD)	Spot price* (USD)
Predefined vCPUs	$0.031611 / vCPU hour	$0.00836 / vCPU hour
Predefined Memory	$0.004237 / GB hour	$0.00112 / GB hour

How to measure your nodes

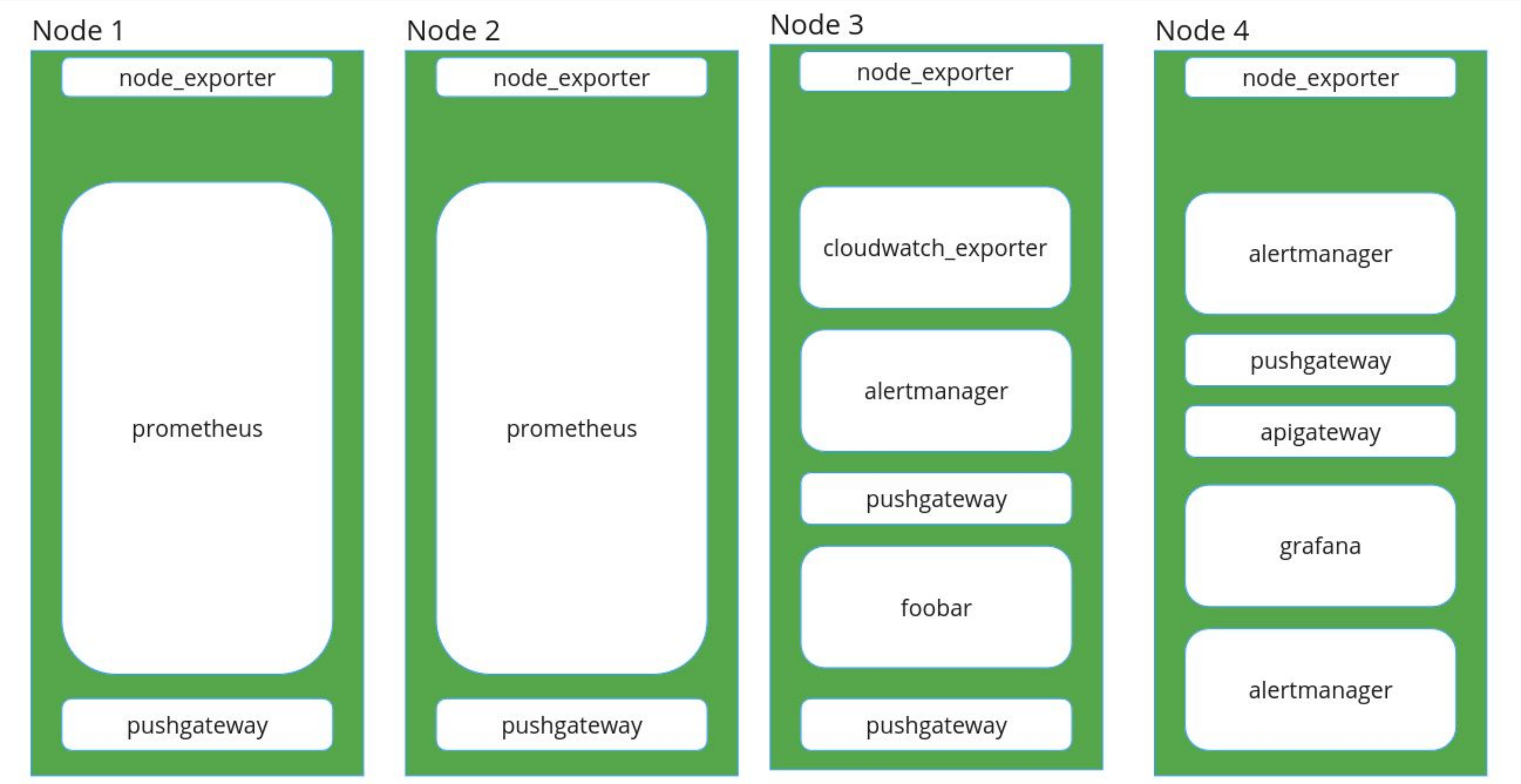
```
sum (
  kube_node_status_capacity(resource="cpu"}
  *
  (0.031611 / 60)
)
```



How to measure your nodes

```
- record: cluster:cost_per_minute:sum
  expr: |
    sum by (cluster) (
      kube_node_status_capacity(resource="cpu"}
      *
      (0.031611 / 60)
    )
  labels:
    resource: "cpu"
```

What drives k8s costs (or who)

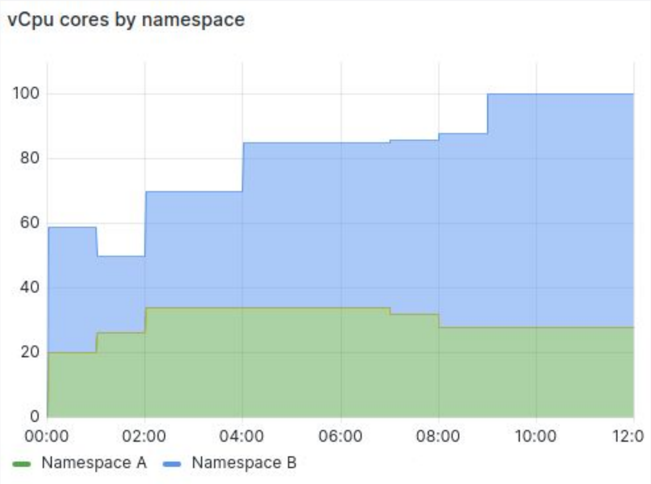


How to measure your workloads impact

```
sum by (namespace) (
  requests
  *
  rate
)
```

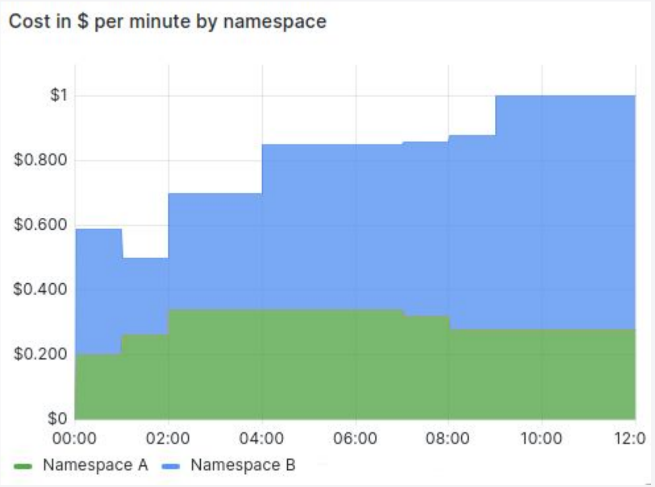
How to measure your workloads impact

```
sum by (namespace) (
  kube_pod_container_resource_requests{resource="cpu"}
  *
  rate
)
```



How to measure your workloads impact

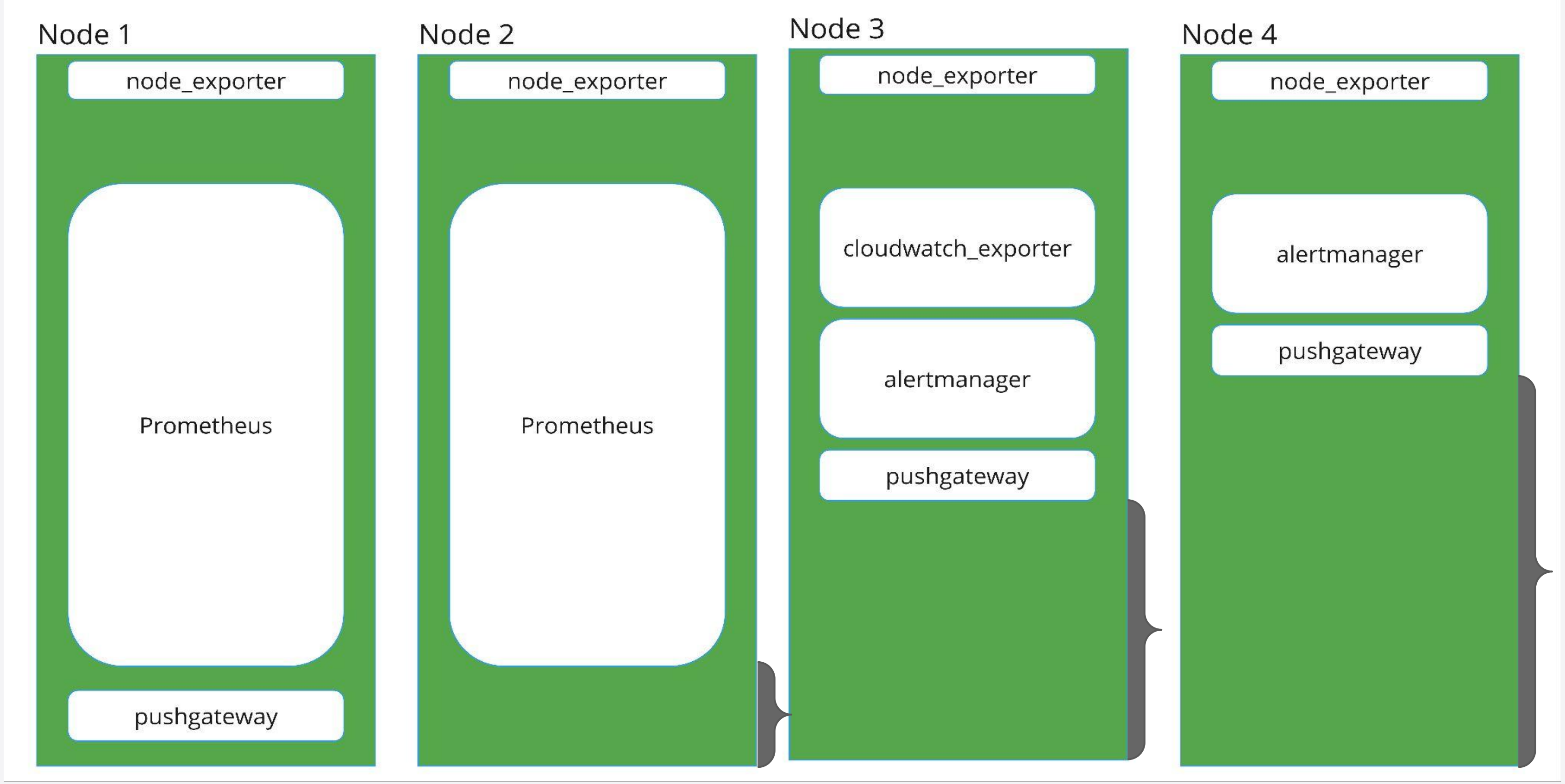
```
sum by (namespace) (
  kube_pod_container_resource_requests{resource="cpu"}
  *
  (0.031611 / 60)
)
```



How to measure your workloads impact

```
- record: cluster_namespace:cost_per_minute:sum
  expr: |
    sum by (cluster, namespace) (
      kube_pod_container_resource_requests{resource="cpu"}
      *
      (0.031611 / 60)
    )
  labels:
    resource: "cpu"
```

What drives k8s costs (realistic)

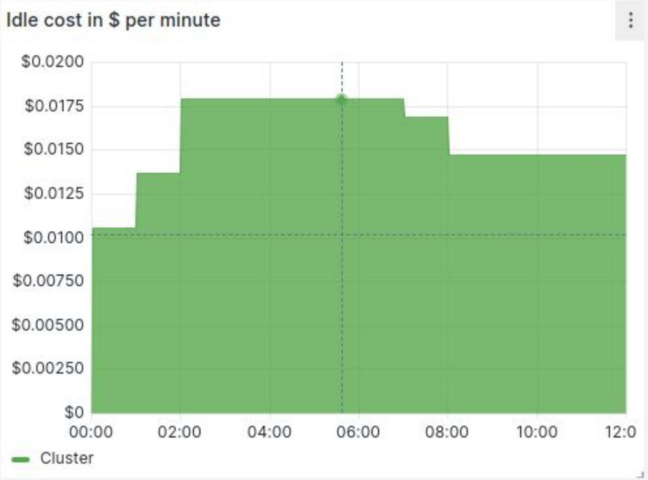


How to measure idle resources

```
sum (
  (
    capacity
    -
    requests
  )
  *
  rate
)
```

How to measure idle resources

```
sum (
  (
    sum by (node) (
      kube_node_status_capacity{resource="cpu"}
    )
    -
    sum by (node) (
      kube_pod_container_resource_requests{resource="cpu"}
    )
  )
  *
  (0.031611 / 60)
)
```



How to measure idle resources

```
- record: cluster_namespace:cost_per_minute:sum
  expr: |
    sum by (cluster) (
      (
        sum by (cluster, node) (
          kube_node_status_capacity{resource="cpu"}
        )
        -
        sum by (cluster, node) (
          kube_pod_container_resource_requests{resource="cpu"}
        )
      )
      *
      (0.031611 / 60)
    )
  labels:
    resource: "cpu"
    namespace: "__idle__"
```

Shortcomings

- This approach only works for homogeneous clusters
- Takes only compute resources into account
- Not all CSPs will give you the breakdown on compute resources costs
- Doesn’t reflect savings plans

What comes next

- Different nodes have different costs
- Projects like OpenCost can help you getting these cost metrics per node

What comes next

```
- record: cluster_namespace:cost_per_minute:sum
  expr: |
    sum by (cluster, namespace) (
      kube_pod_container_resource_requests{resource="cpu"}
      *
      rate
    )
  labels:
    resource: "cpu"
```

What comes next

```
- record: cluster_namespace:cost_per_minute:sum
  expr: |
    sum by (cluster, namespace) (
      kube_pod_container_resource_requests{resource="cpu"}
      *
      on (node) group_left node_cpu_hourly_cost / 60
    )
  labels:
    resource: "cpu"
```

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Thank you

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Core Concepts

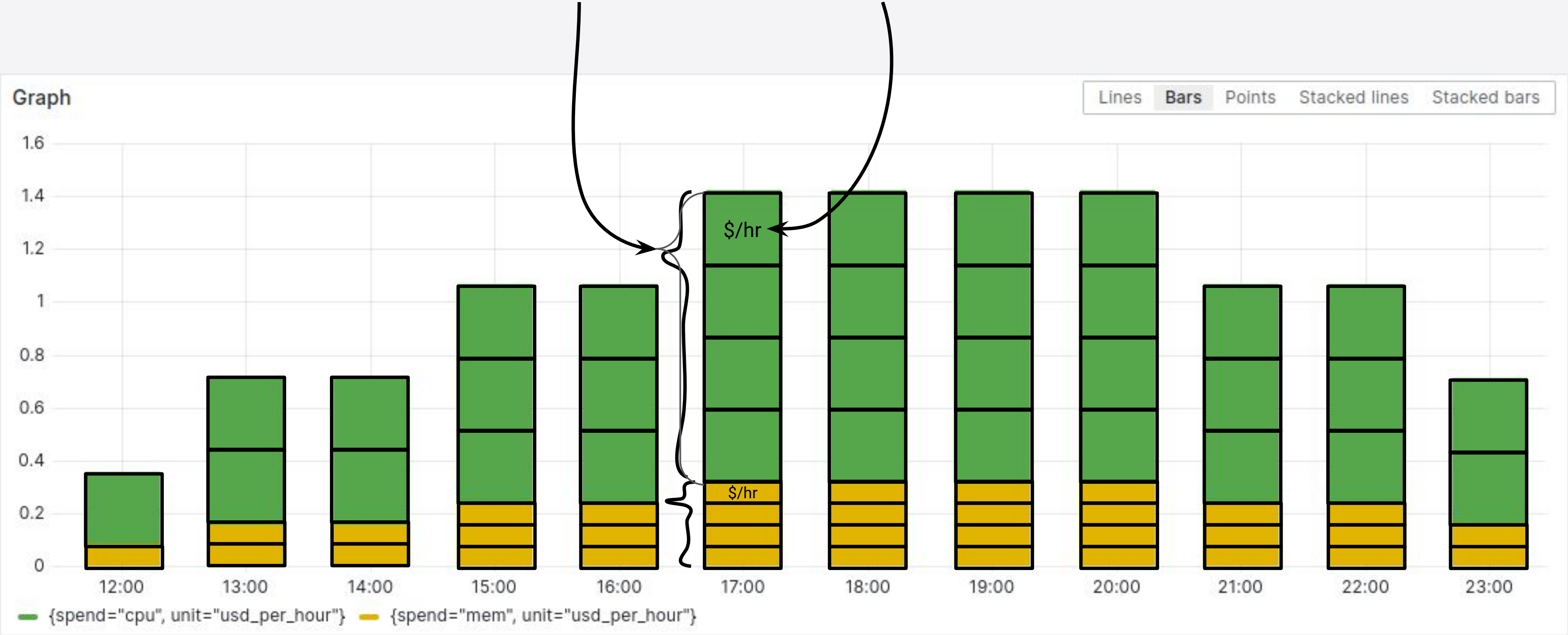
- What drives the costs
- How to measure this
- There is overhead

~~Rough~~ Solid Plan

- 25 minutes:
- 2 Intro slide
- 1 ~~intro matrix for usage and rate~~ just explore the formular rate x usage
- 2 explanation of utilization, usage and allocation
- 2 Where does the cost of a cluster comes from
  - Magic -> boils down to “It’s the nodes
  - Sum of the requests is driving the number of nodes‘
- 1 Establish k8s context
- 2 How to measure nodes -> KSM
- 2 How to measure your workloads impact -> KSM
- 2 Idle resources ….
  - Benefit: reduce idle resources
- 2 Simple step estimate memory/cpu for a node
- 2 combine everything together
  - Benefit: show costs for all workloads
- 2 OpenCost or alternatives

A simple formula with profound implications ...

$$\text{Spend} = \text{Usage} \times \text{Rate}$$



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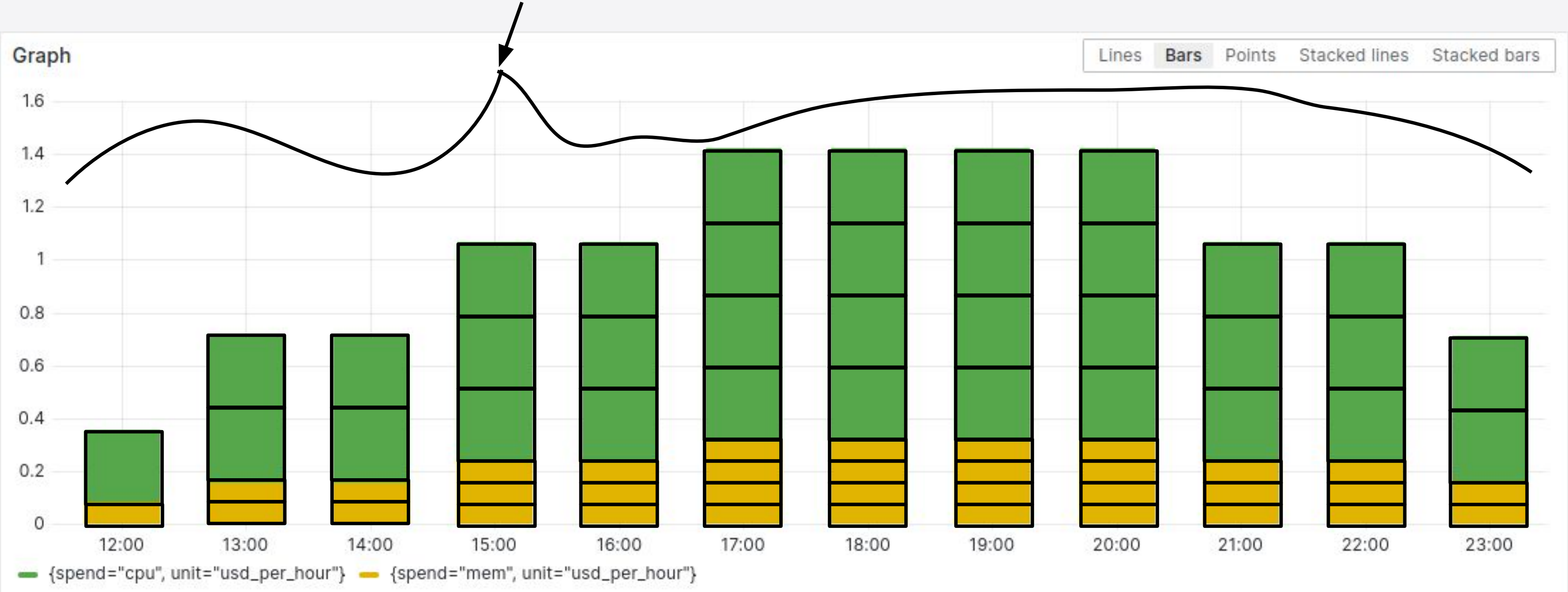
Graph
Lines
Bars
Points
Stacked lines
Stacked bars
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
🟩 {spend="cpu", unit="usd_per_hour"}
🟨 {spend="mem", unit="usd_per_hour"}