CompSci 401: Cloud Computing

What Is Orchestration?

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Full automation of a service

- Many tasks related to offering a service

Full automation of a service

- Many tasks related to offering a service
  - Deployment

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  - Configuration

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  - Configuration
  - Updates

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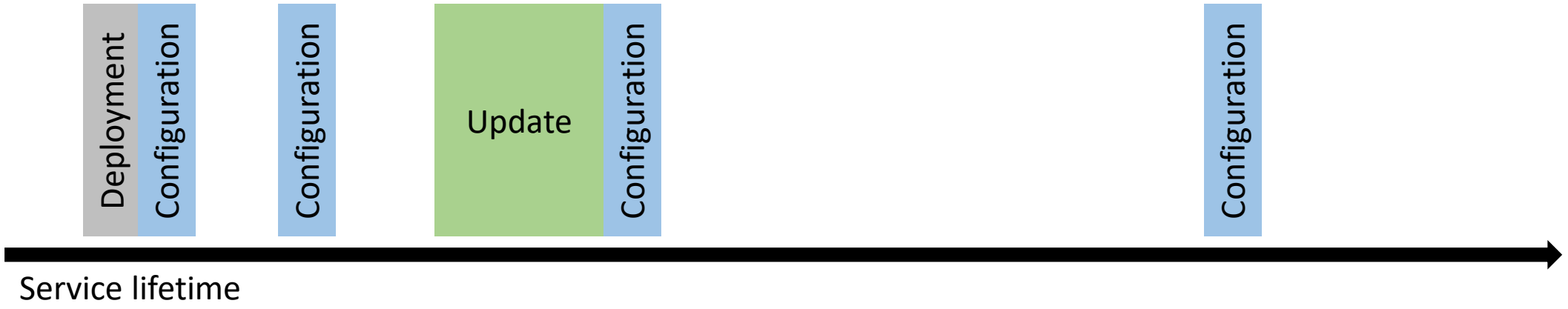
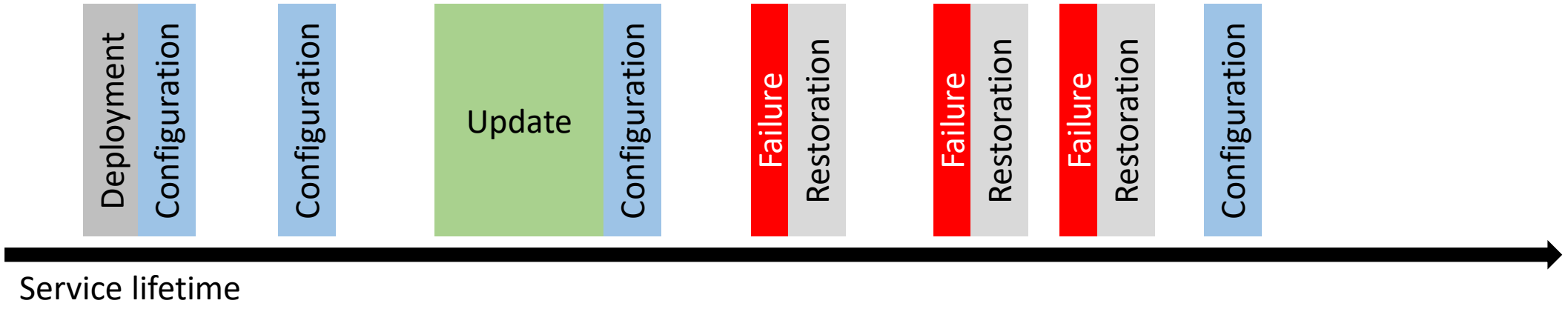


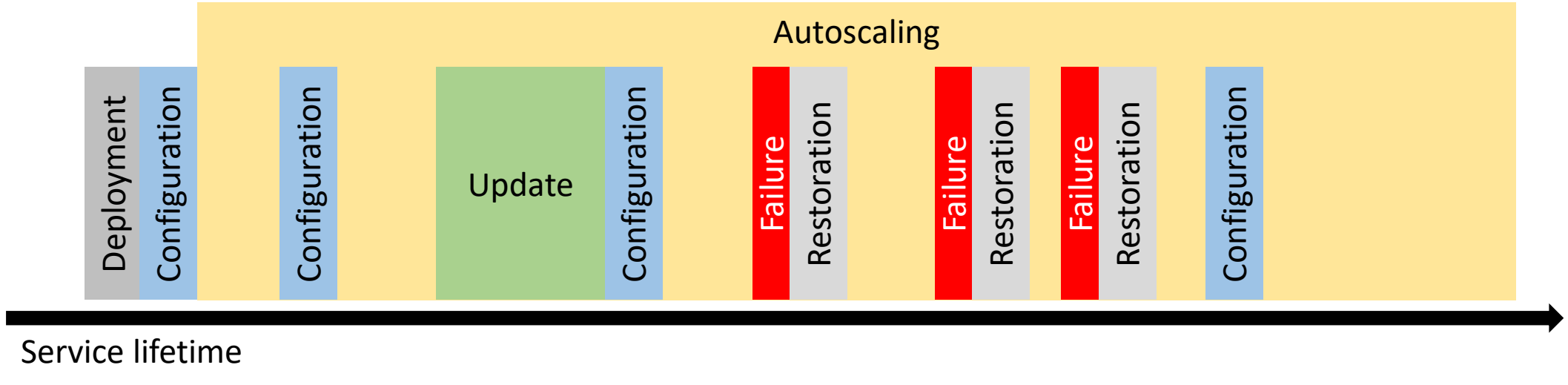
Full automation of a service

- Many tasks related to offering a service
  - Deployment
  - Configuration
  - Updates
  - Failure resilience



Full automation of a service

- Many tasks related to offering a service
  - Deployment
  - Configuration
  - Updates
  - Failure resilience
  - Autoscaling



Specify the building blocks of a service

- Orchestration assembles the building blocks
  - Support for diverse goals

Specify the building blocks of a service

- Orchestration assembles the building blocks
  - Support for diverse goals

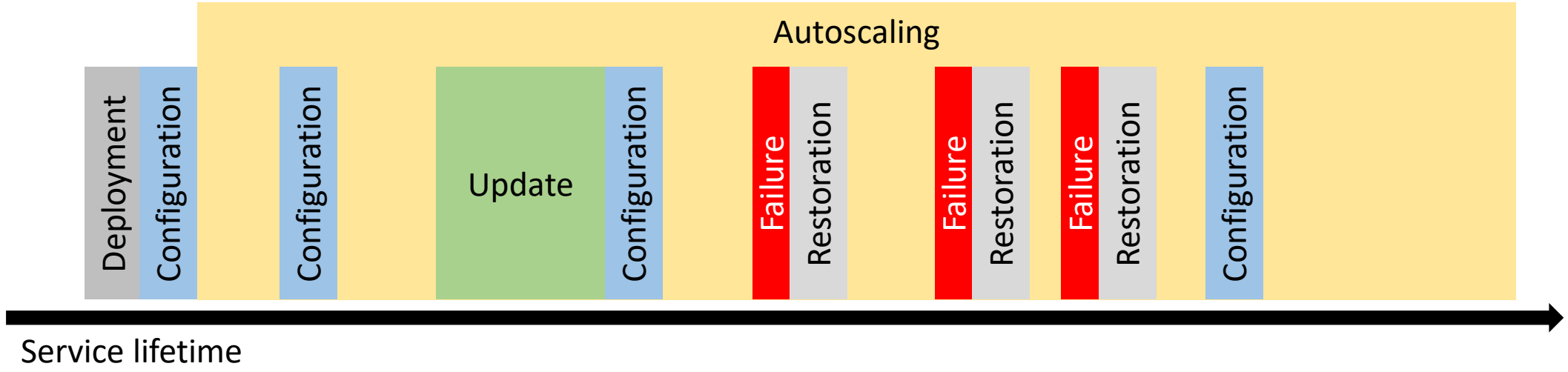
- Blocks: Map and Reduce
  - Orchestrator: Hadoop and Yarn
- Blocks: Containers
  - Orchestrator: Kubernetes
- Blocks: Virtual machines
  - Orchestrator: OpenStack

Properties of building blocks

- Ephemeral: Blocks are not permanent
  - Rapid creation
  - Short lifetime
- Can be replicated if more blocks are needed
- Can be replaced with other instances of that block
- Can be combined with other blocks

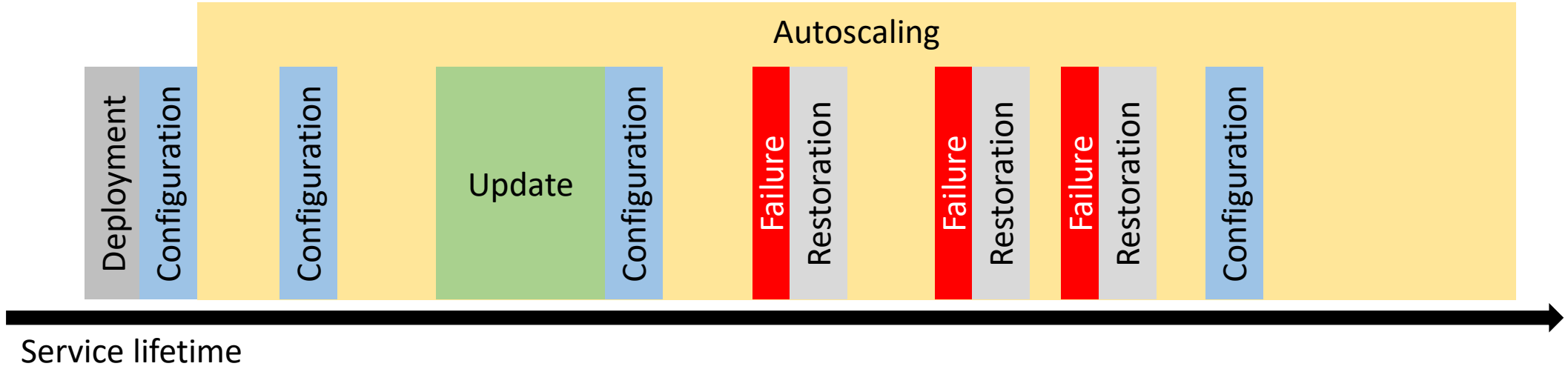
Properties of building blocks

- Ephemeral: Blocks are not permanent → Deployment, updates
- Can be replicated if more blocks are needed → Autoscaling
- Can be replaced with other instances of that block → Restoration
- Can be combined with other blocks



Properties of building blocks

- Ephemeral: Blocks are not permanent → Deployment, updates
- Can be replicated if more blocks are needed → Autoscaling
- Can be replaced with other instances of that block → Restoration
- Can be combined with other blocks → Complex services



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Orchestrator Functionalities

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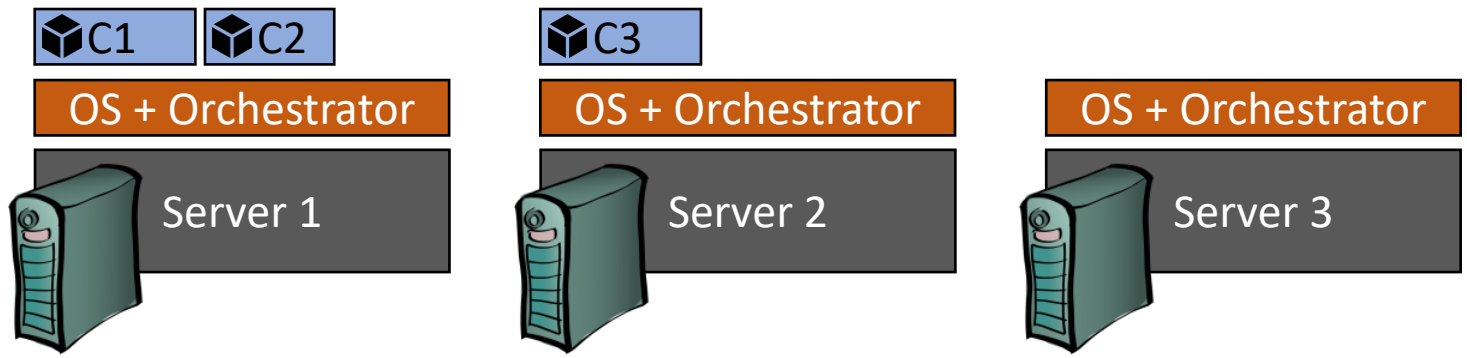
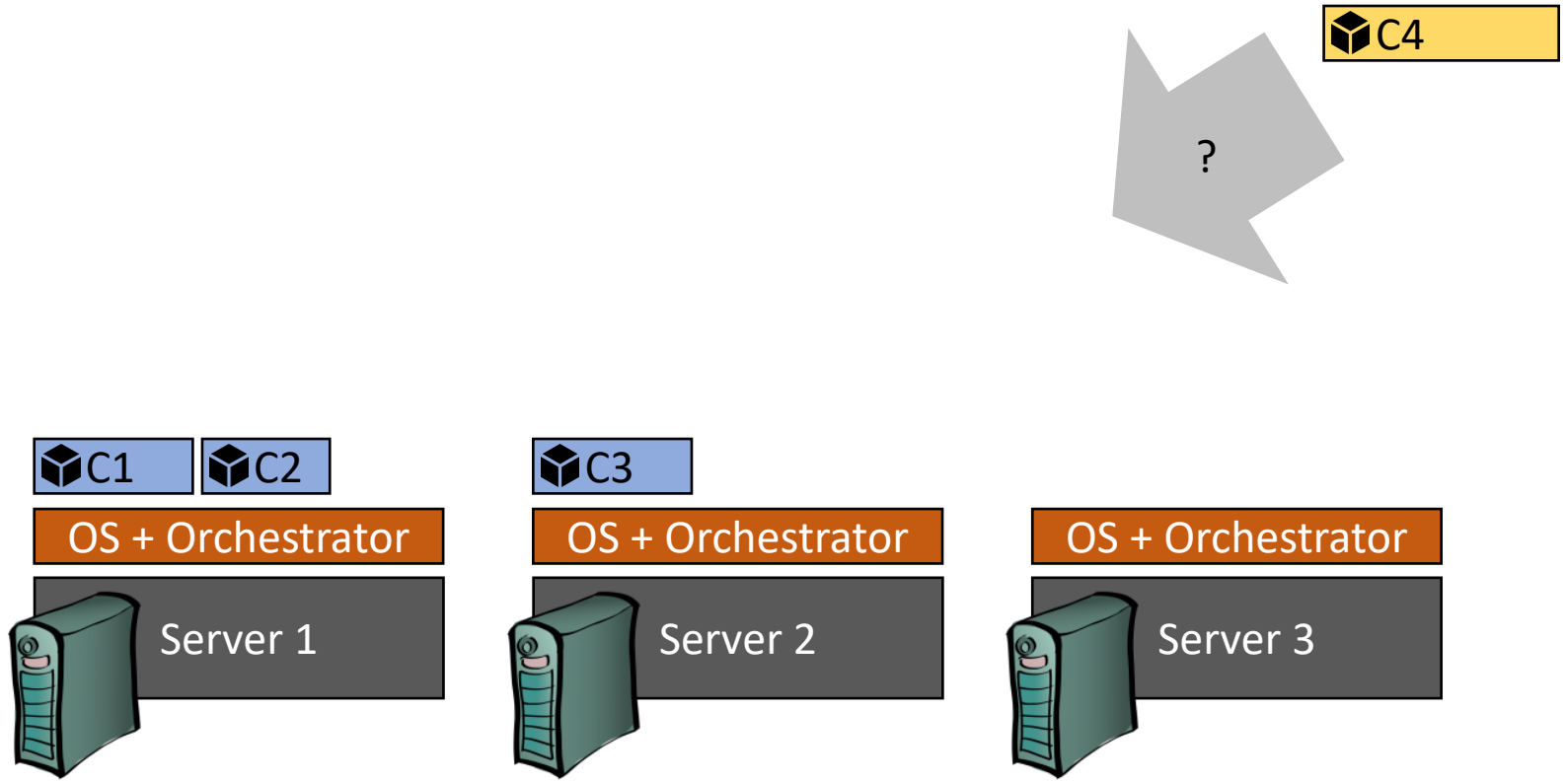
Optimized container placement



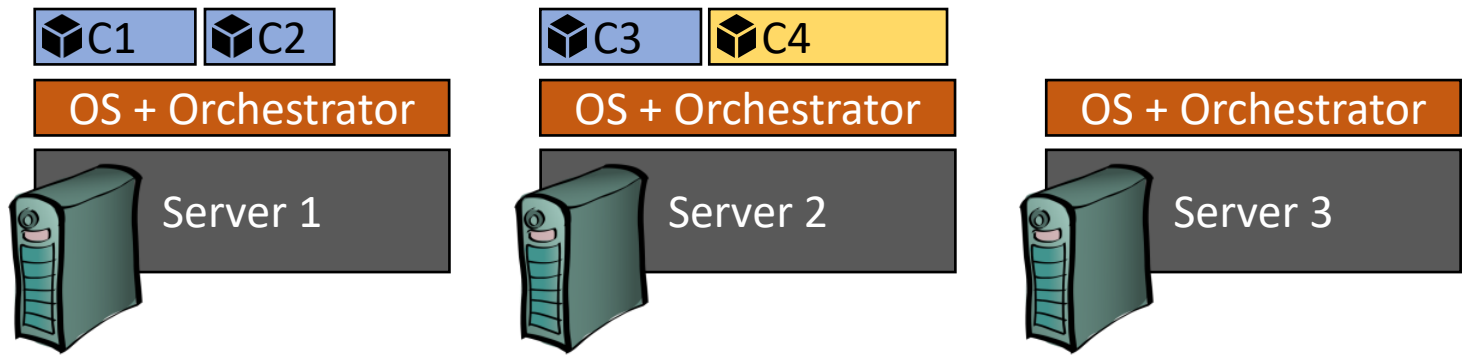
Optimized container placement

- Where to place container C4?



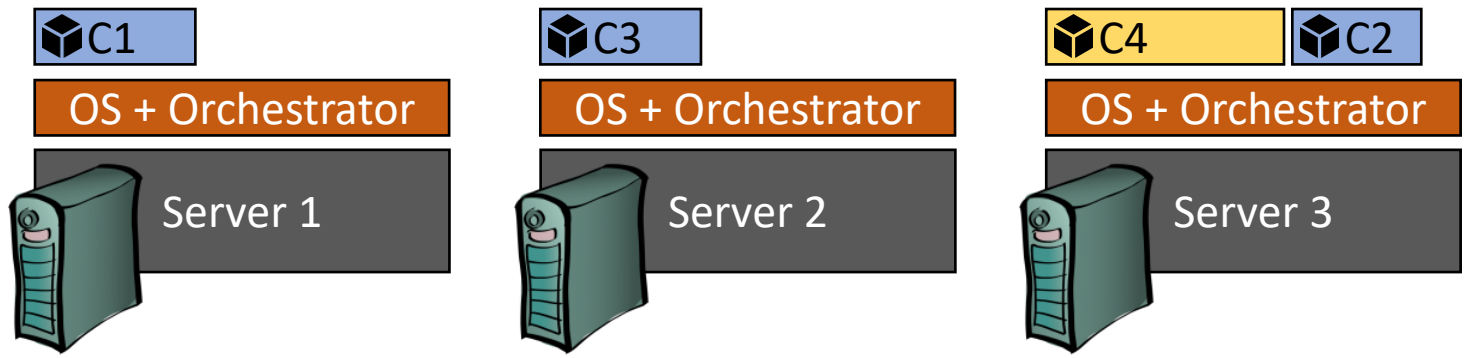
Optimized container placement

- Where to place container C4?
- Maximize server utilization
  - Place on server S2



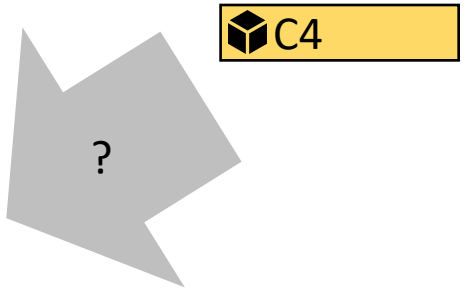
Optimized container placement

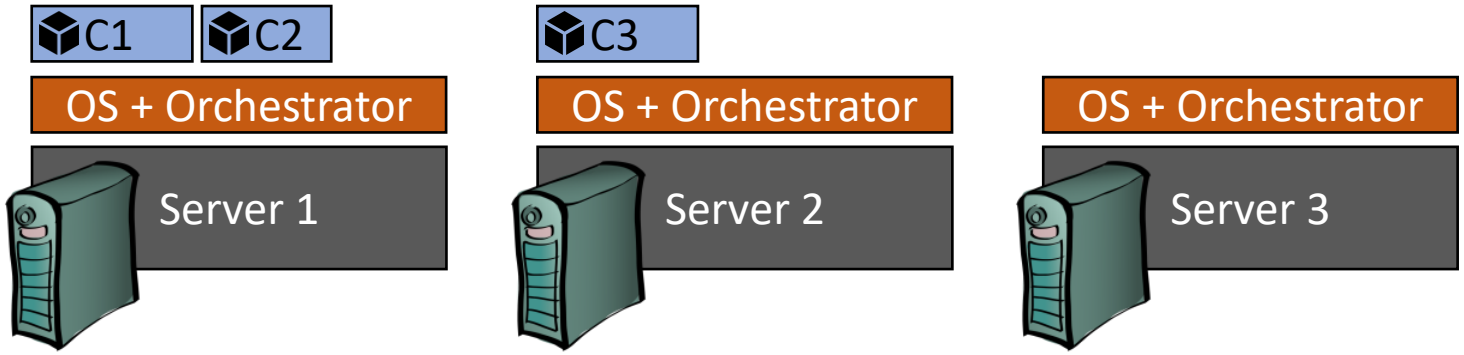
- Where to place container C4?
- Maximize server utilization
  - Place on server S2
- Make network traffic local
  - If C4 will talk to C2, co-locate on Server 3



Optimized container placement

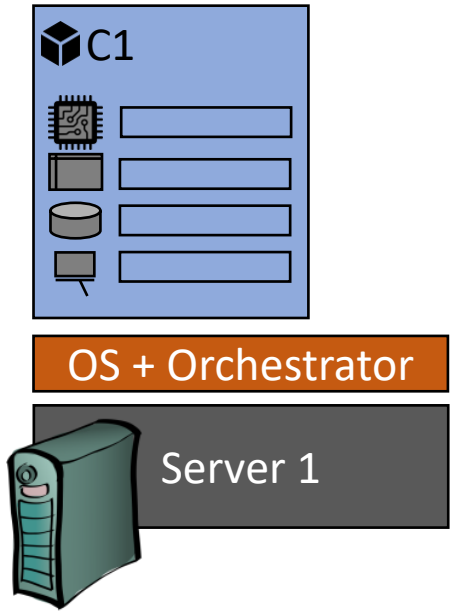
- Where to place container C4?
- Maximize server utilization
  - Place on server S2
- Make network traffic local
  - If C4 will talk to C2, co-locate on Server 3
- Satisfy container-specific demands





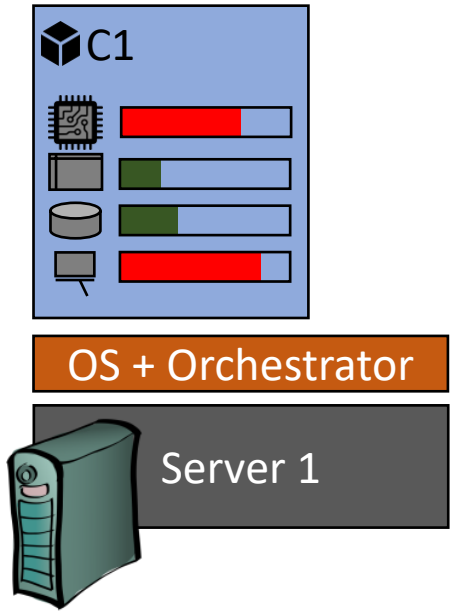
Resource utilization monitoring

- Developers and customers specify estimated resource use



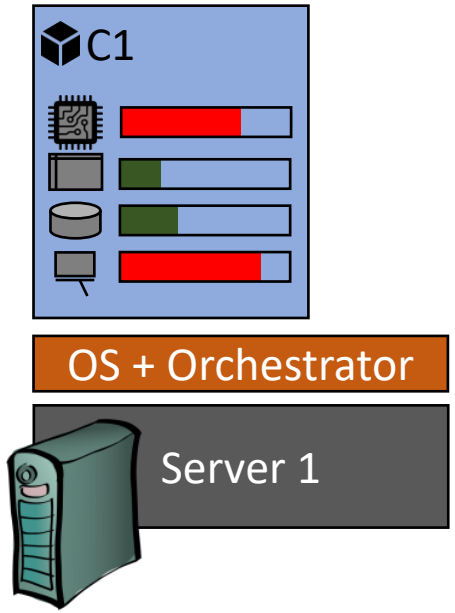
Resource utilization monitoring

- Developers and customers specify estimated resource use
- Orchestrators monitor resource use

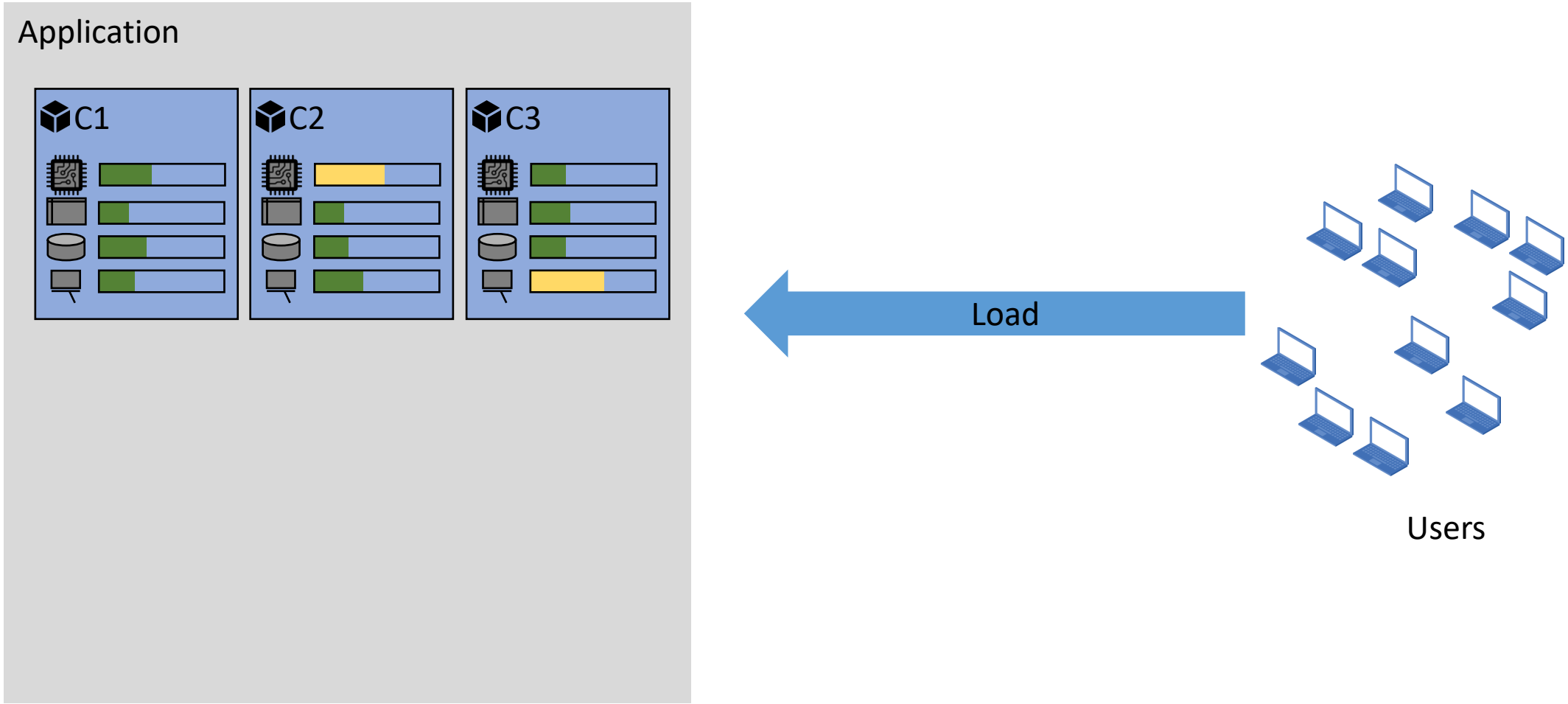


Resource utilization monitoring

- Developers and customers specify estimated resource use
- Orchestrators monitor resource use
- Many different resources can be tracked



Autoscaling



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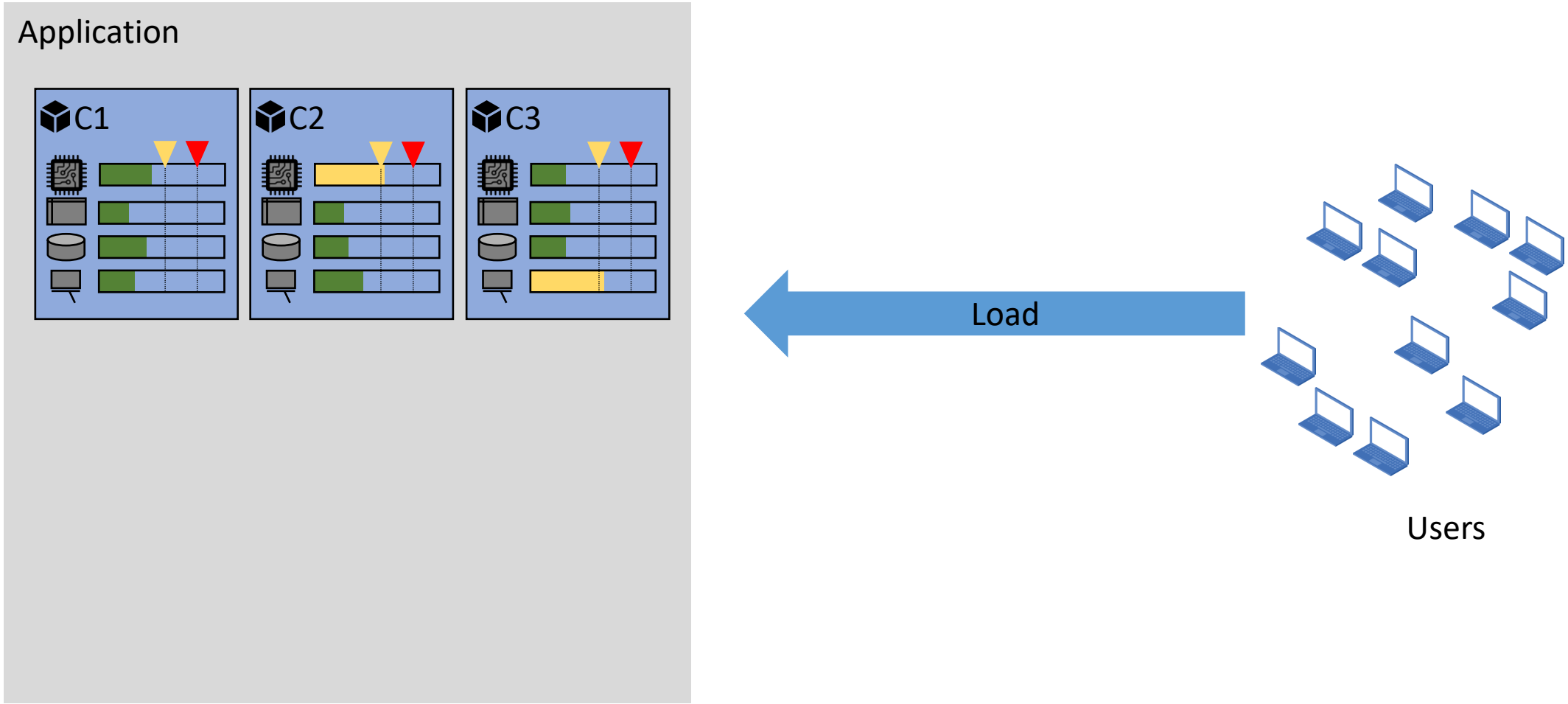

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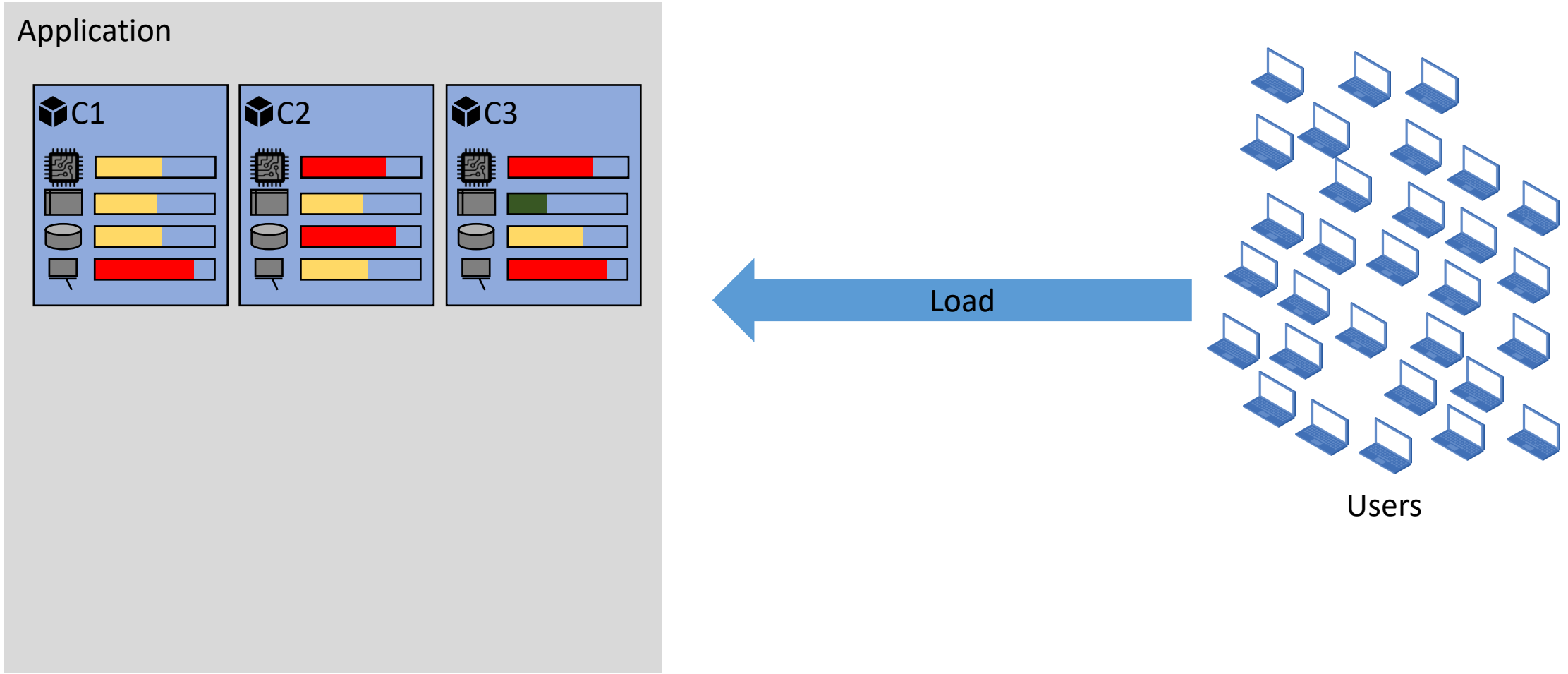

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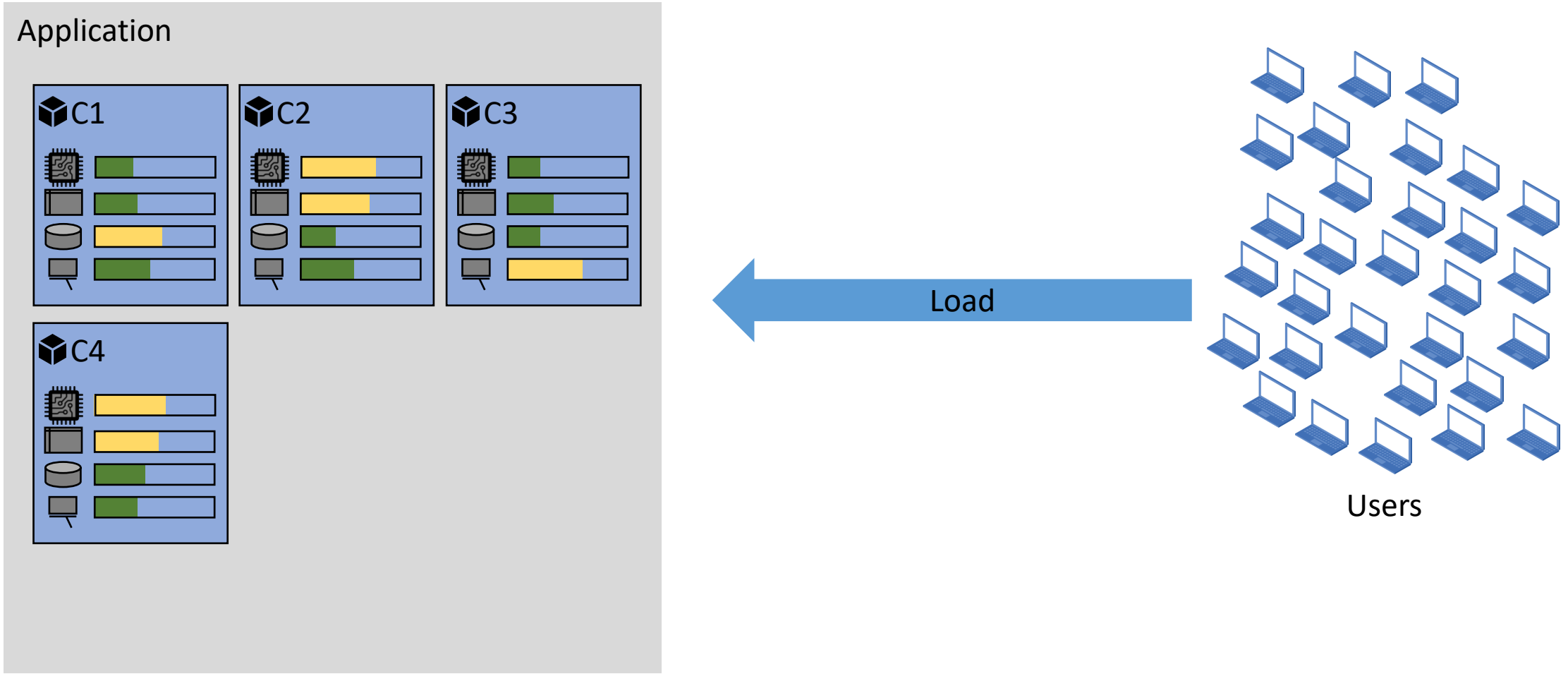

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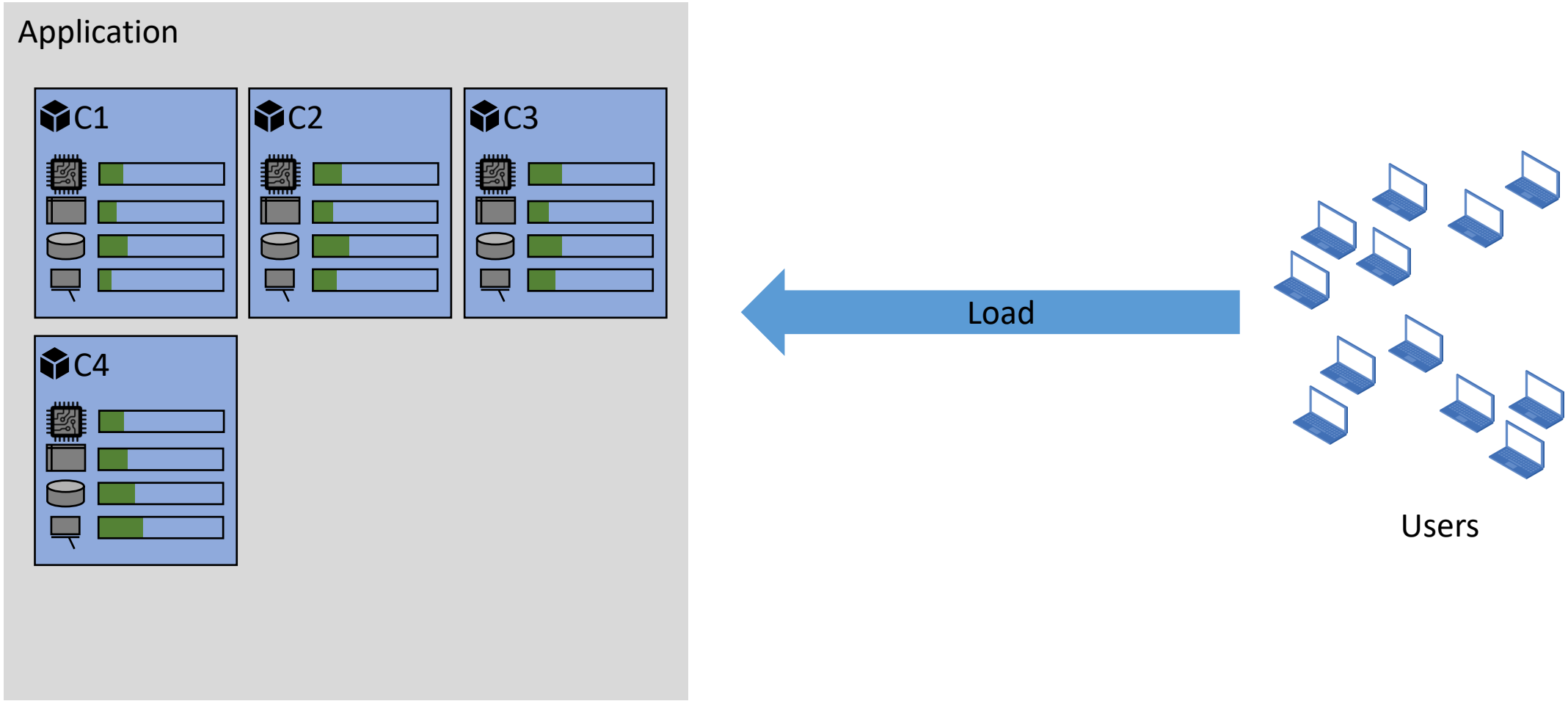

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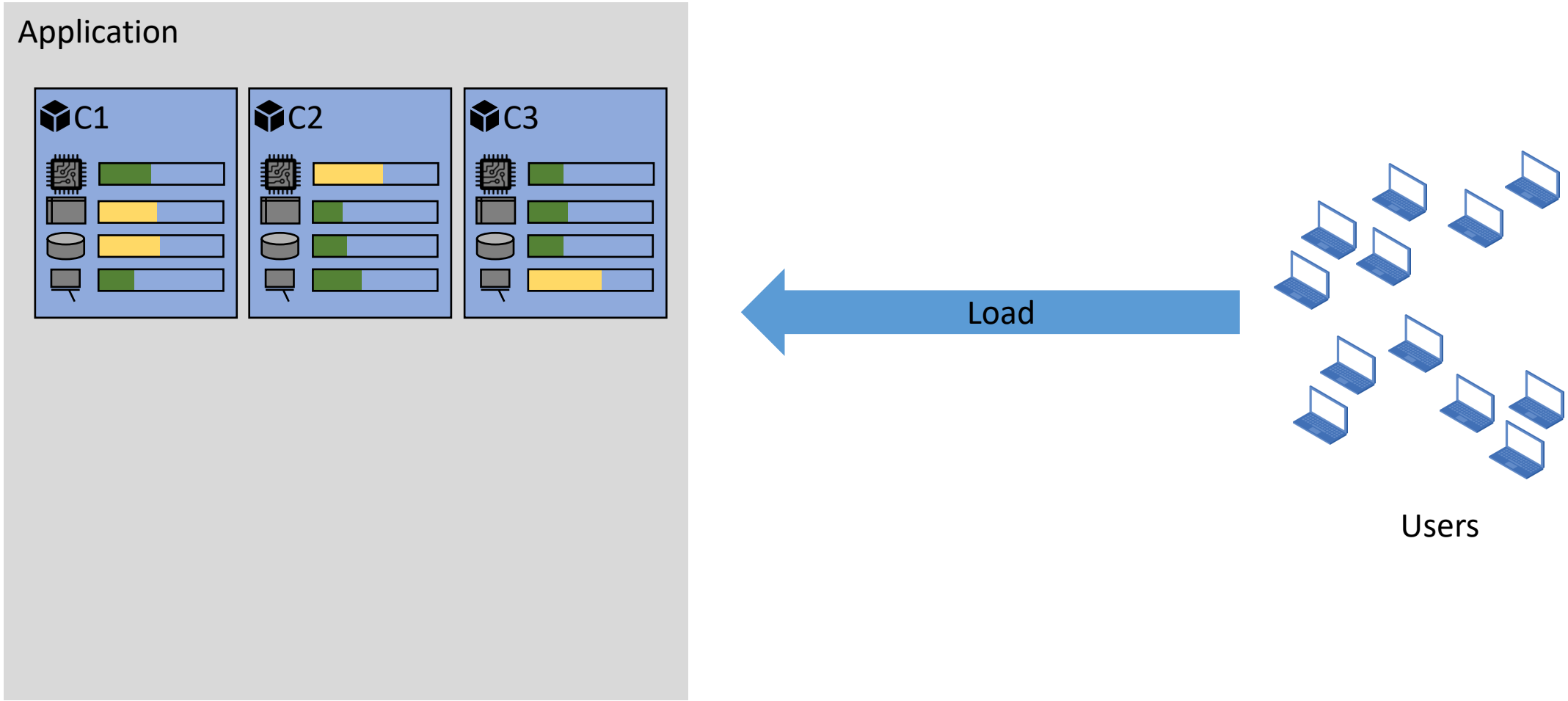
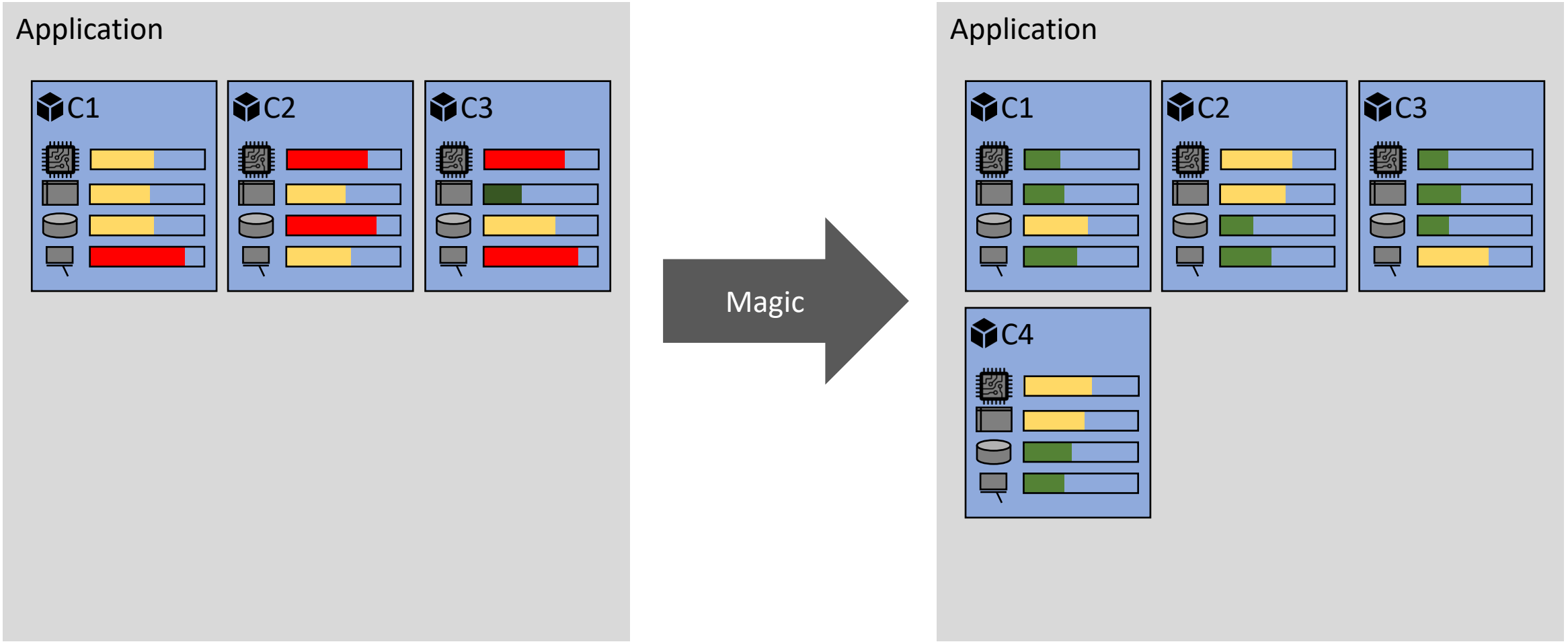


Load balancing



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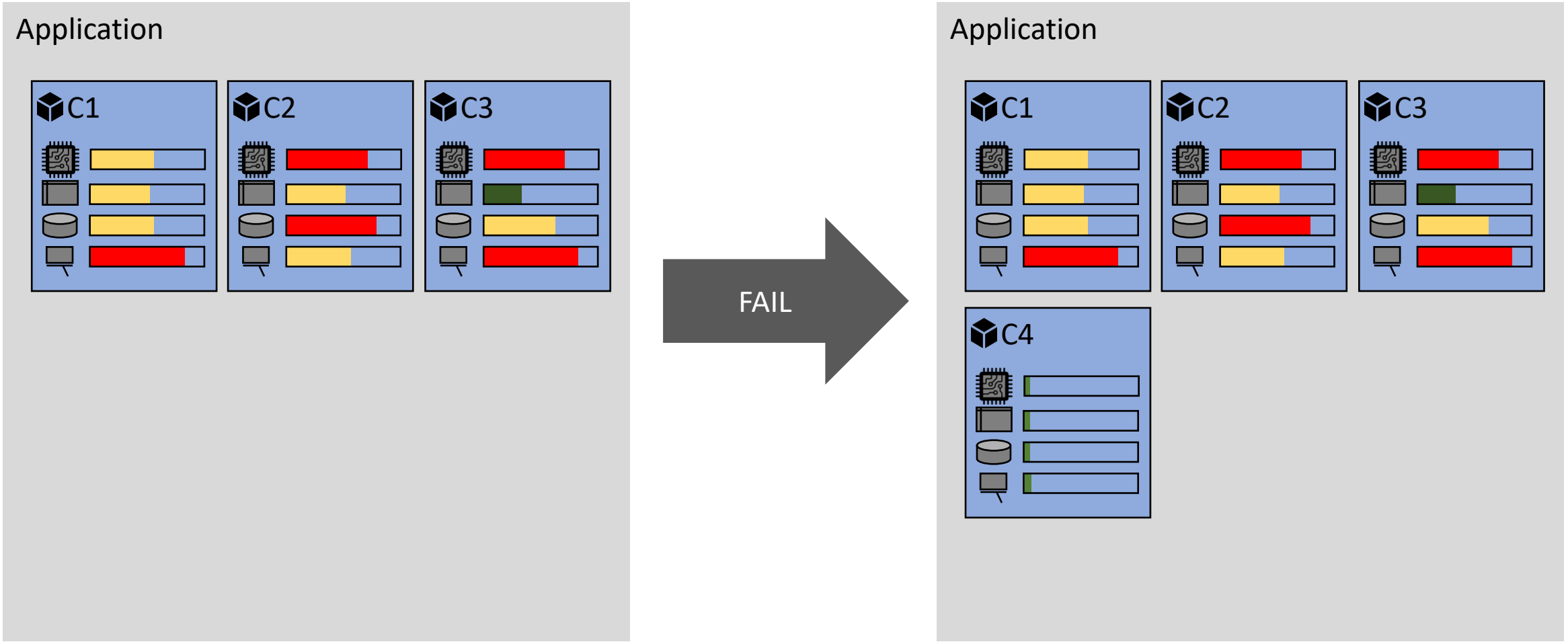

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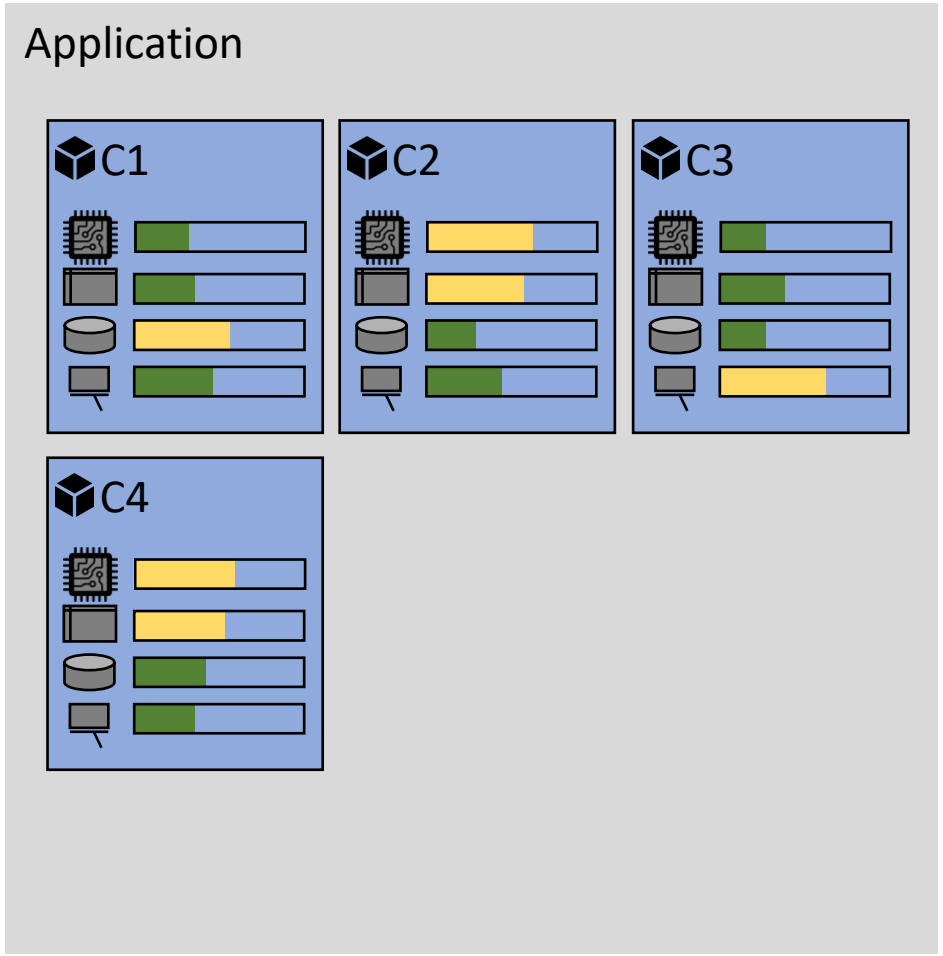

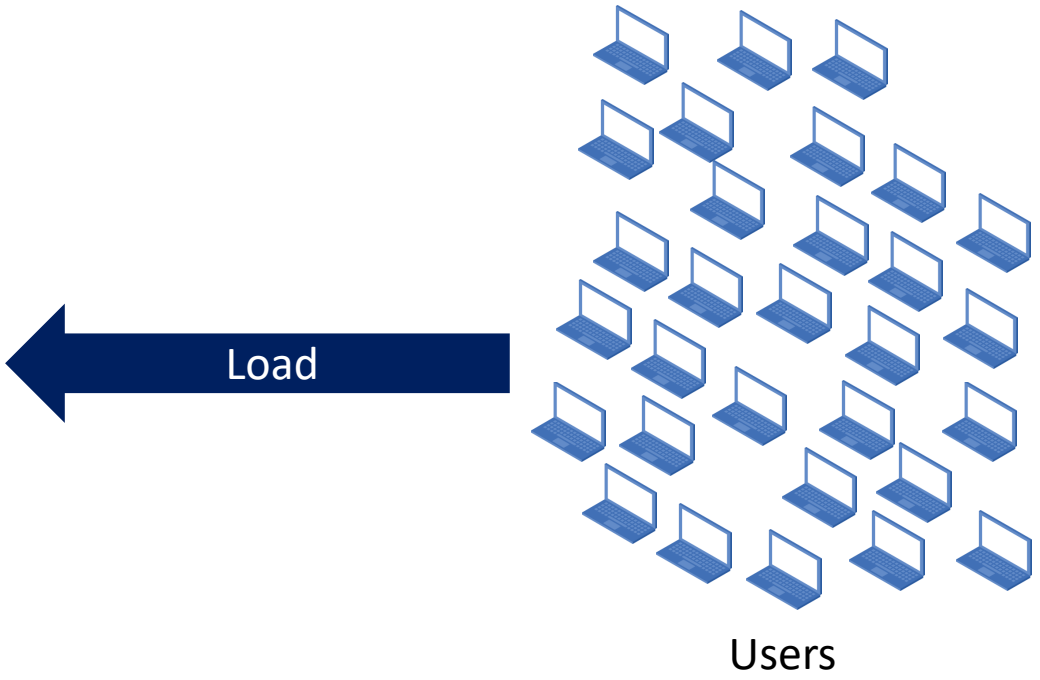

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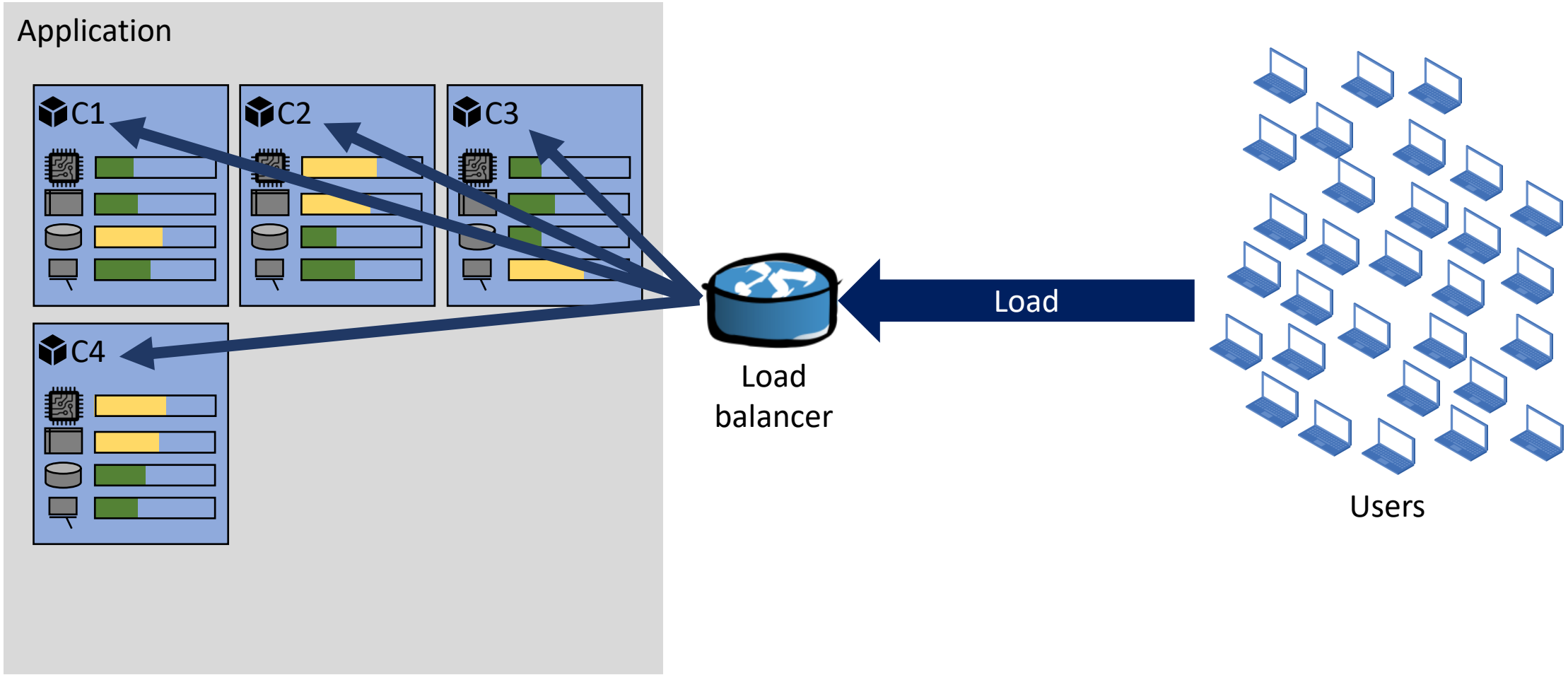
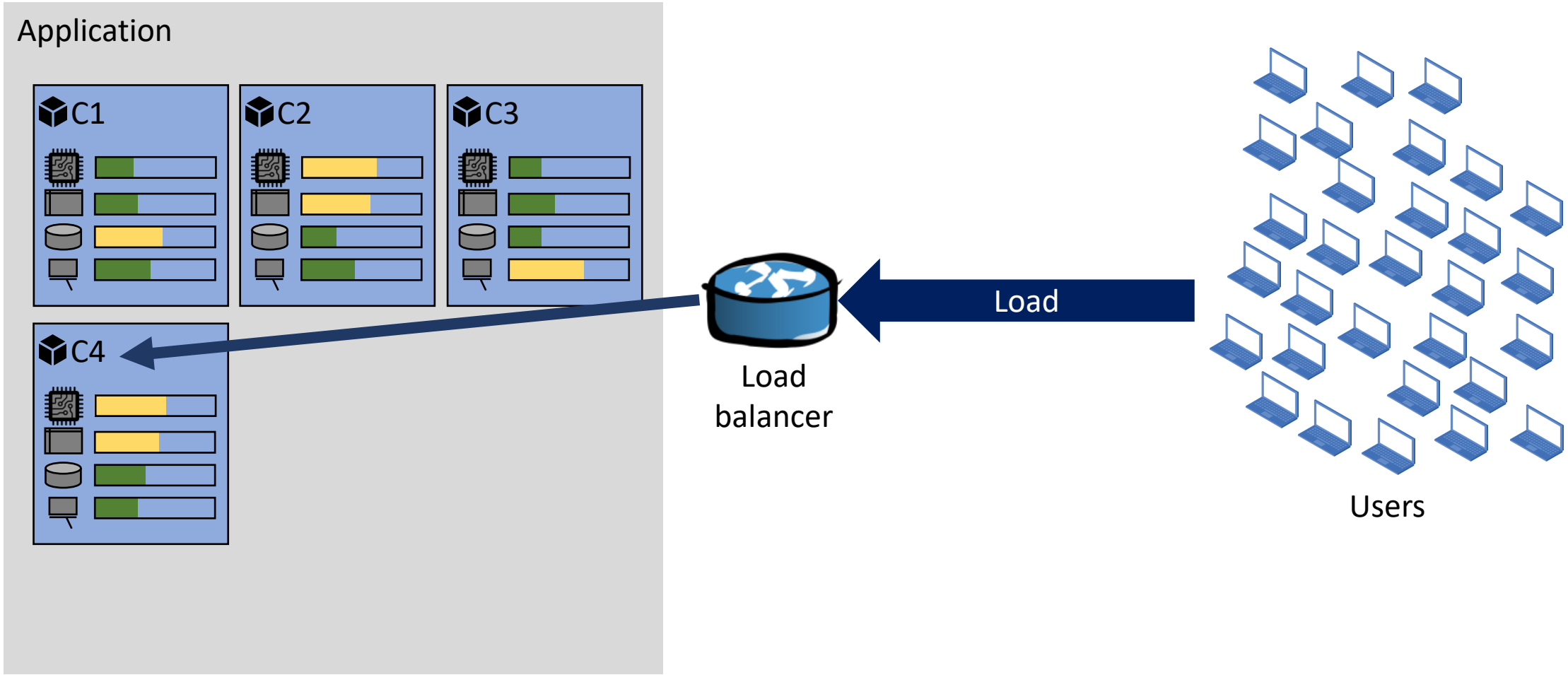


Failure recovery



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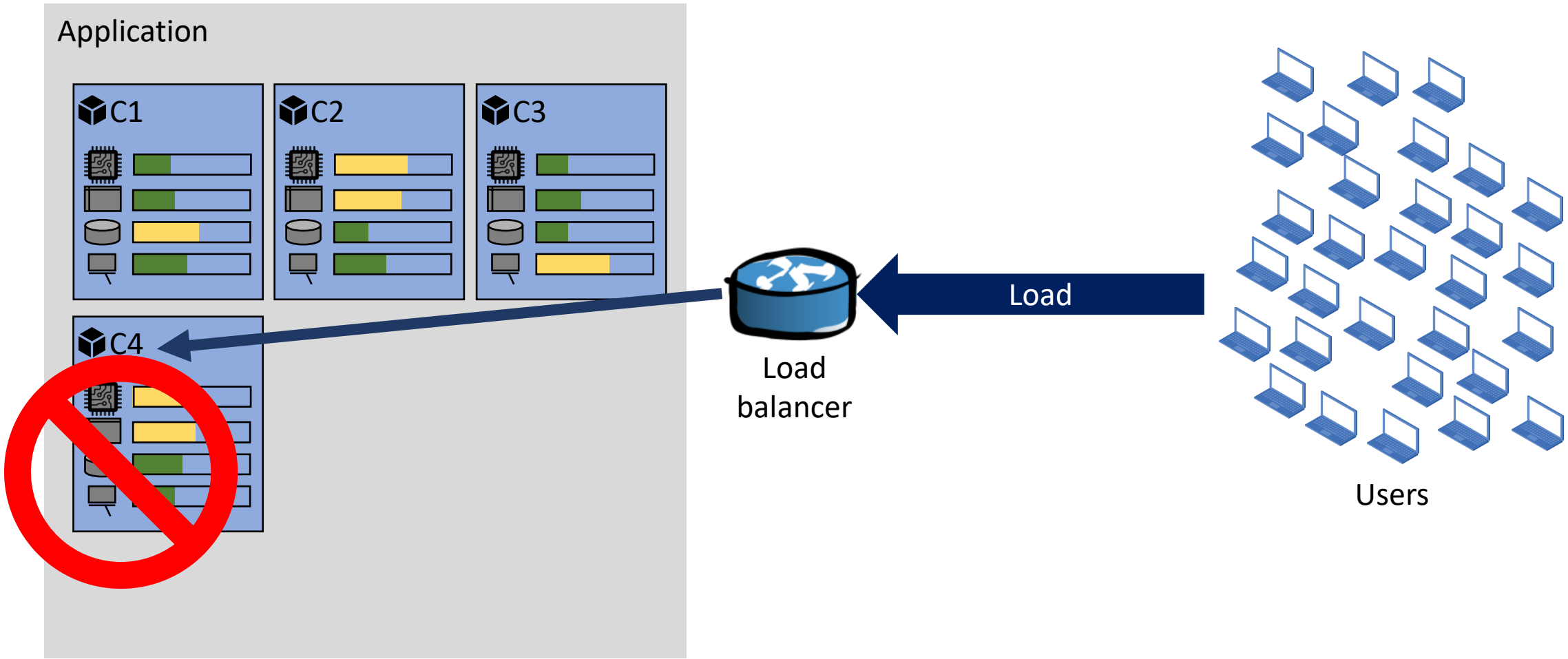

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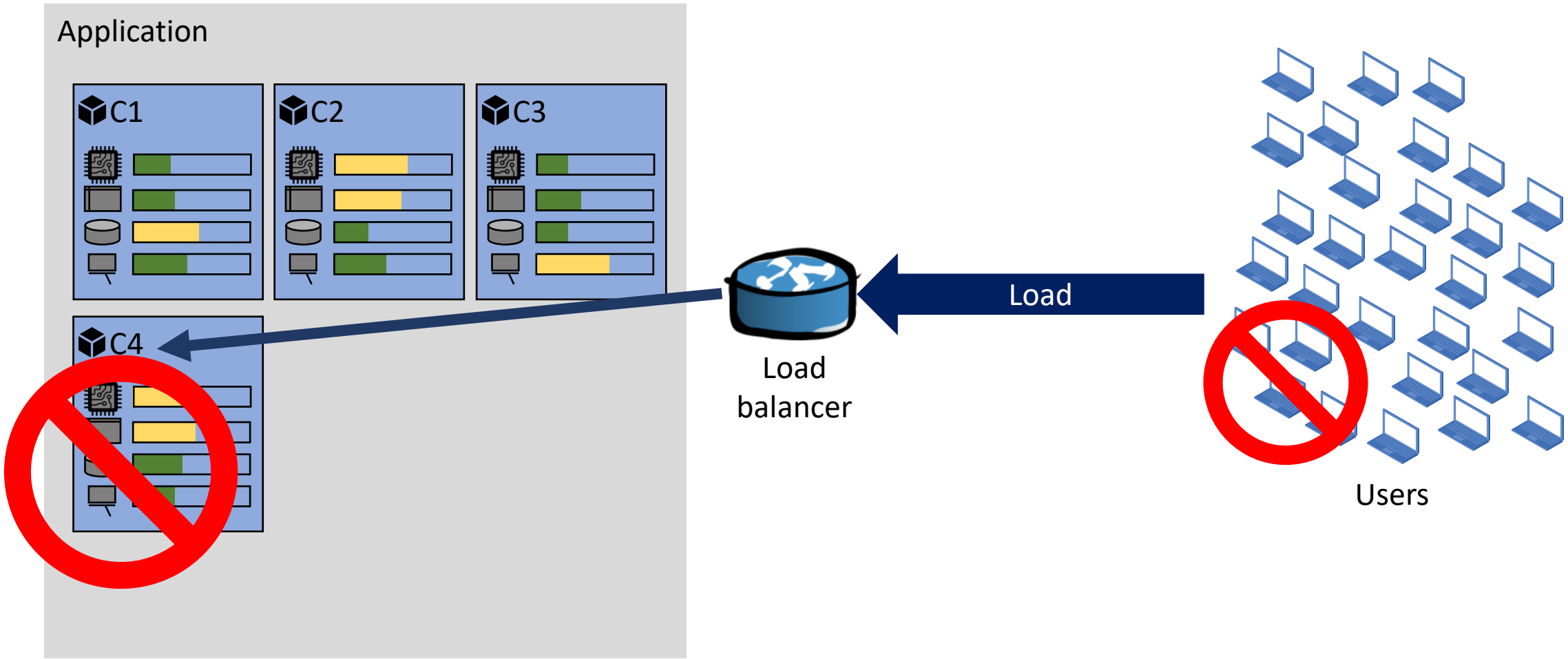

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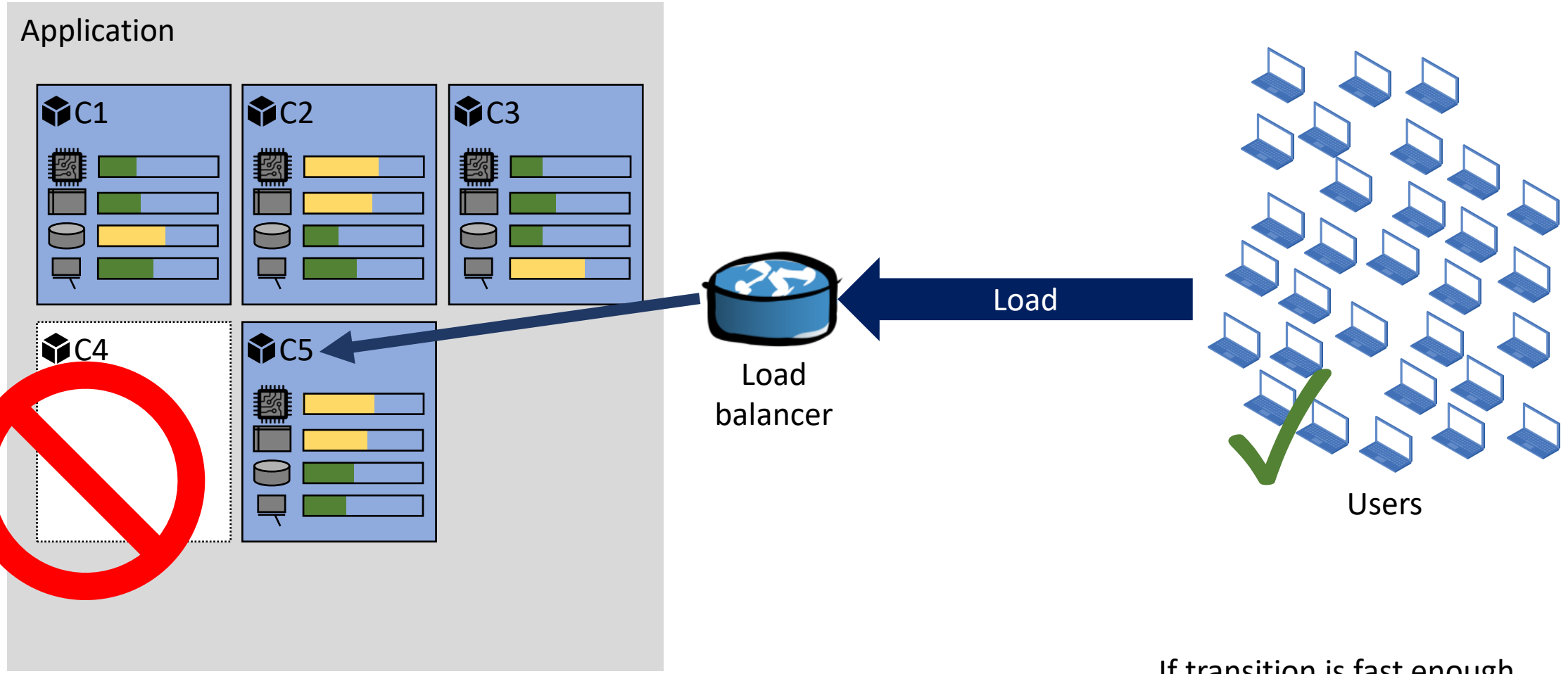
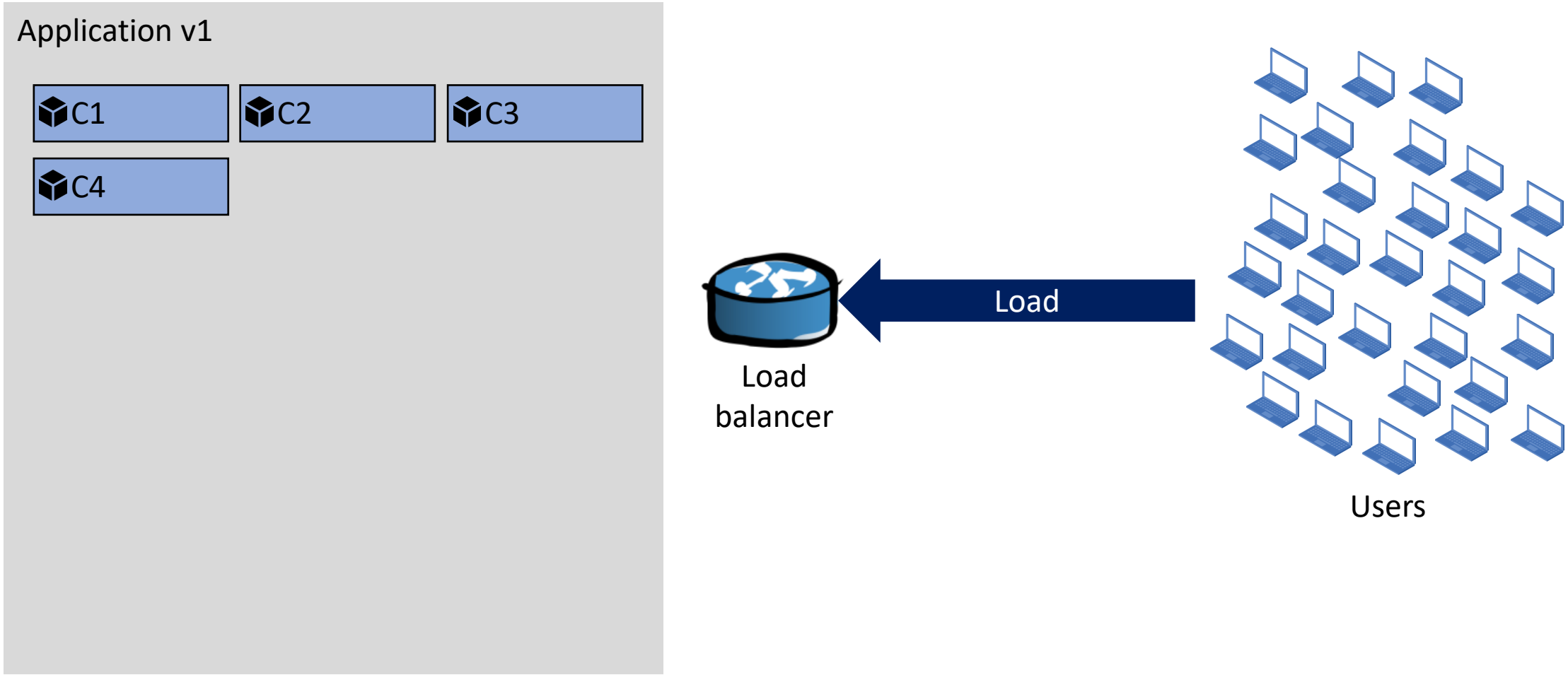


If transition is fast enough, clients might not perceive failure

Update rollouts and rollbacks



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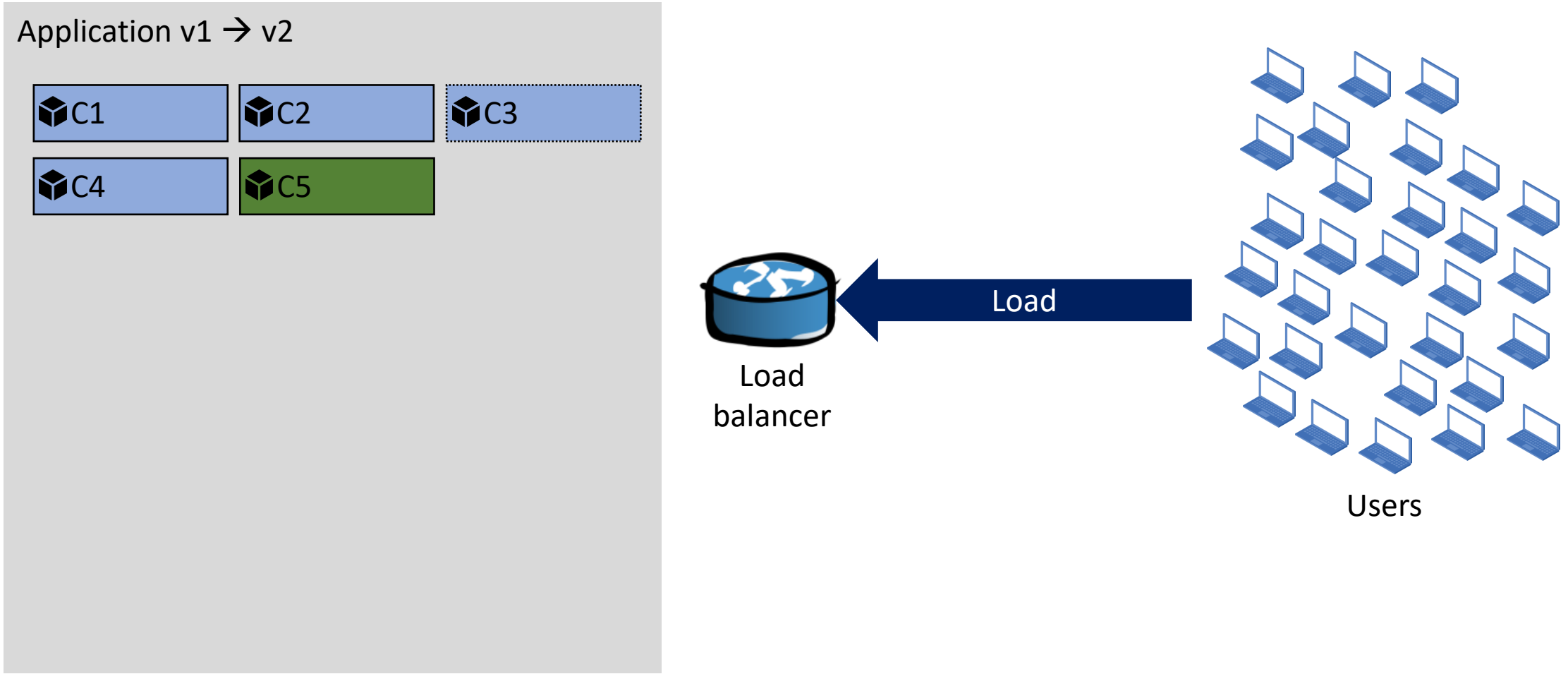

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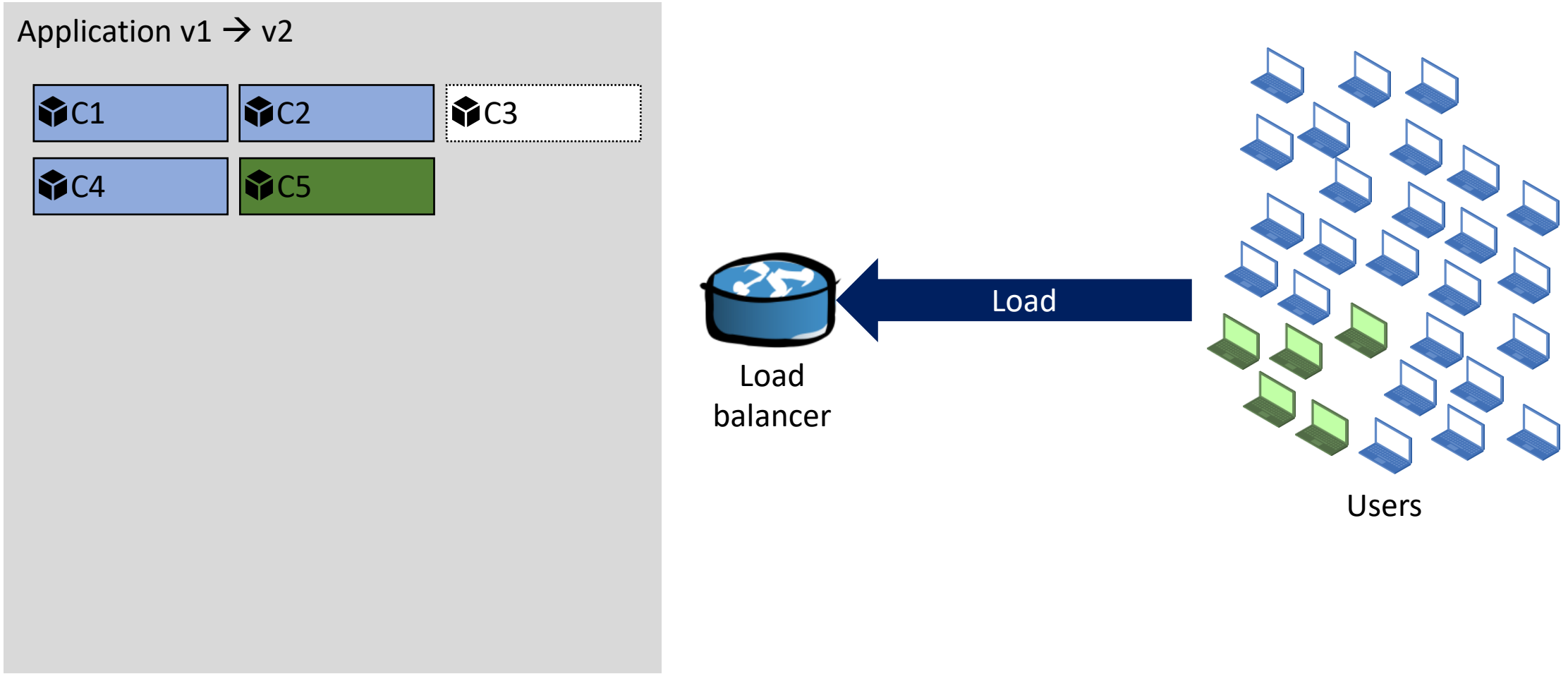

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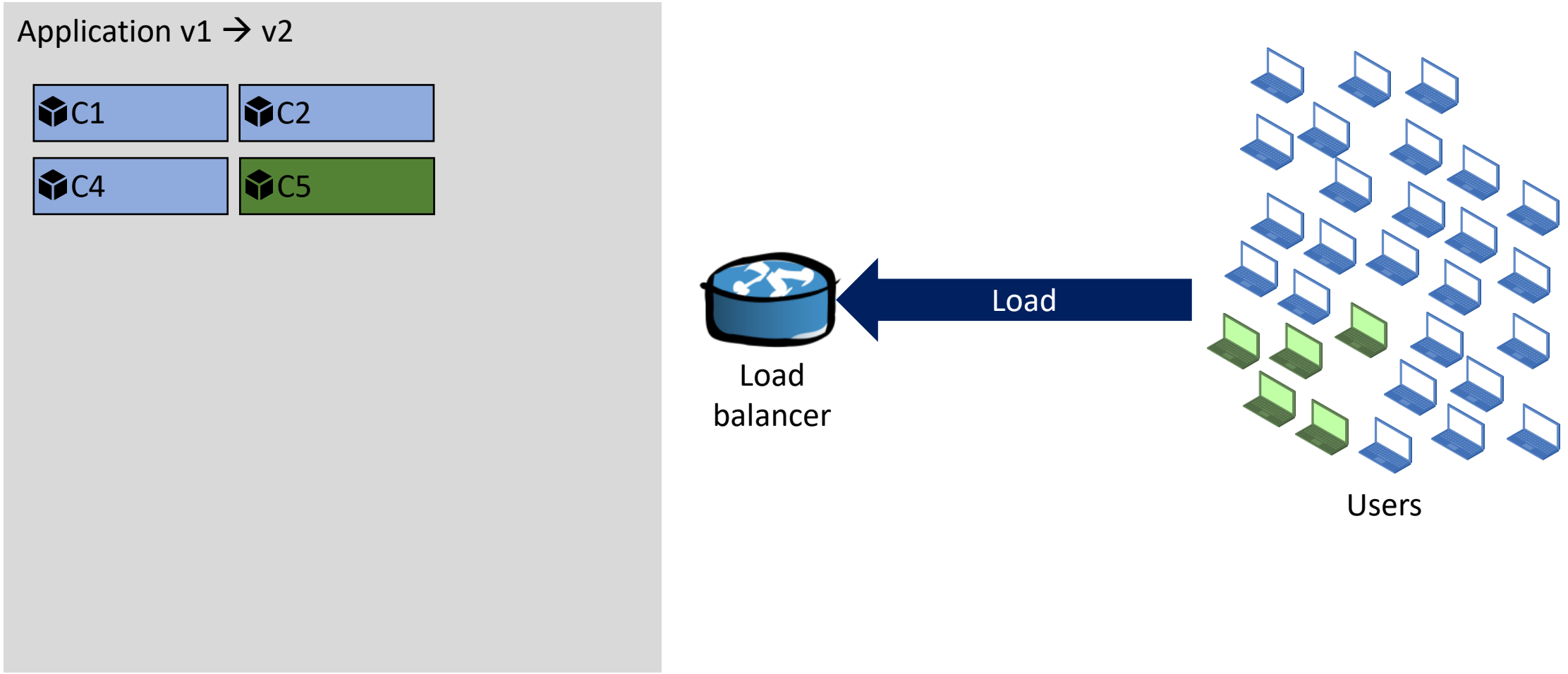

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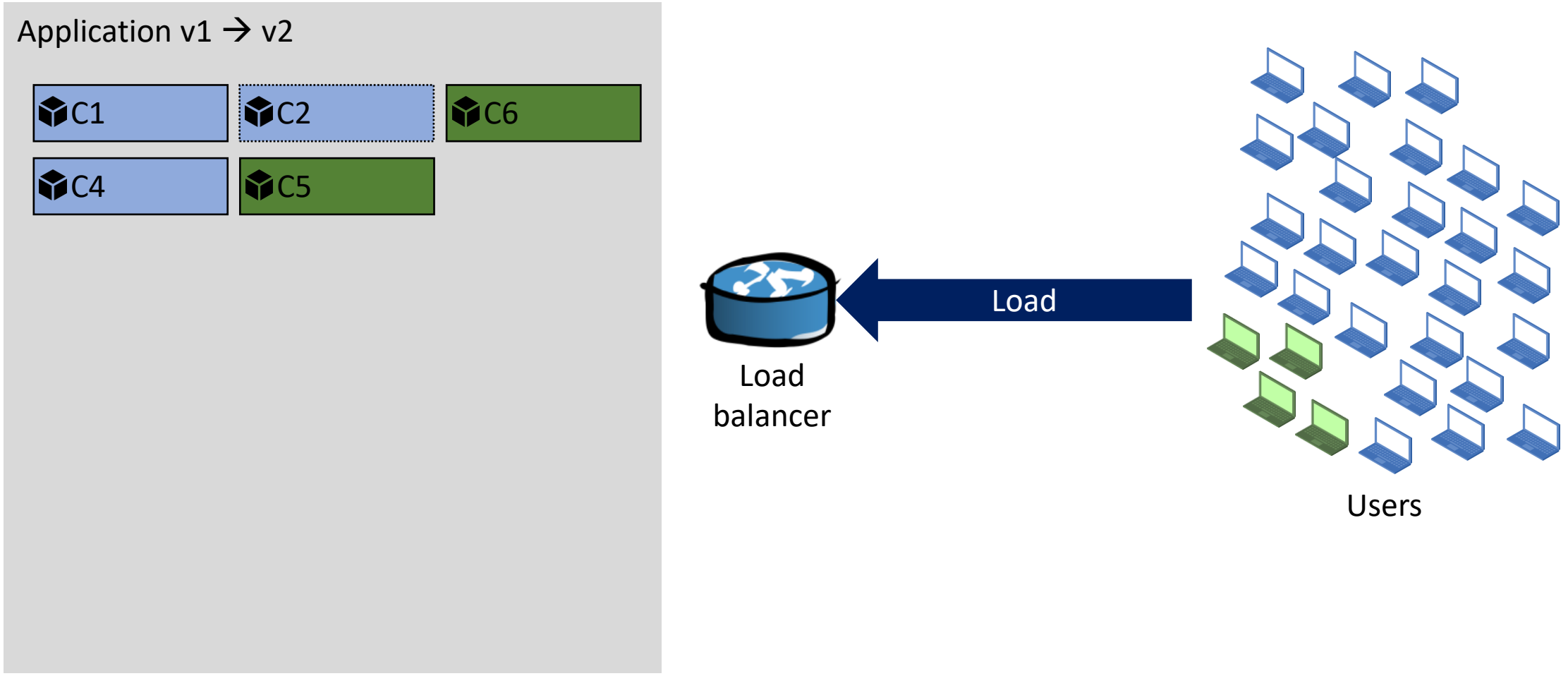

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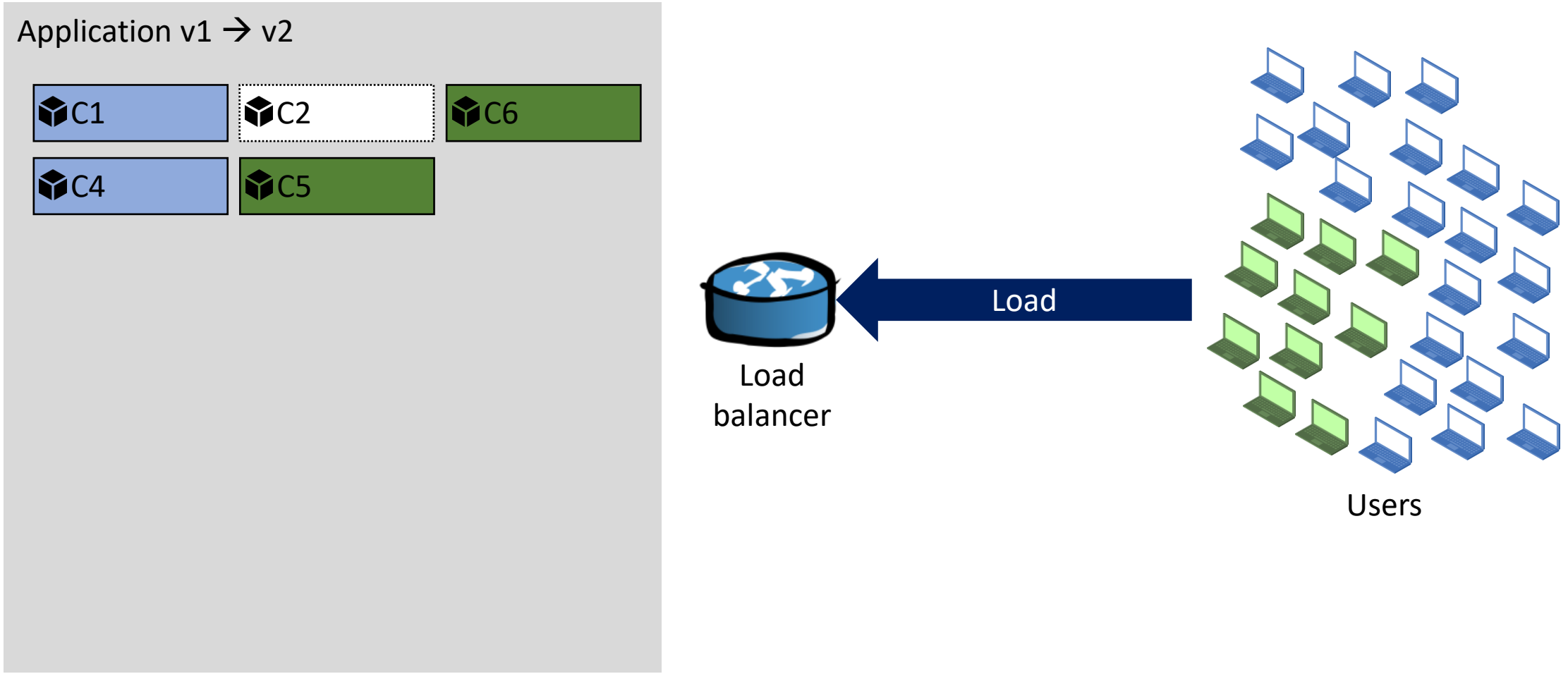

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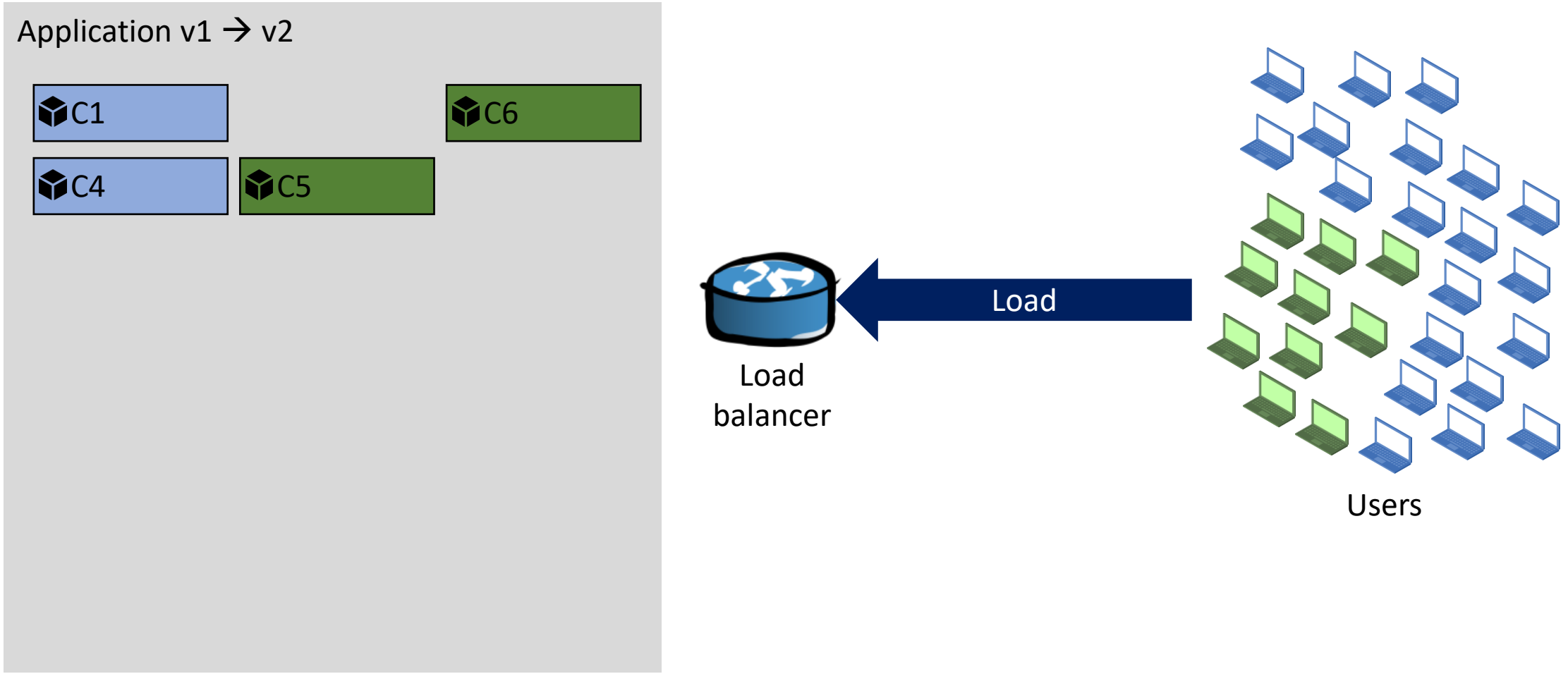

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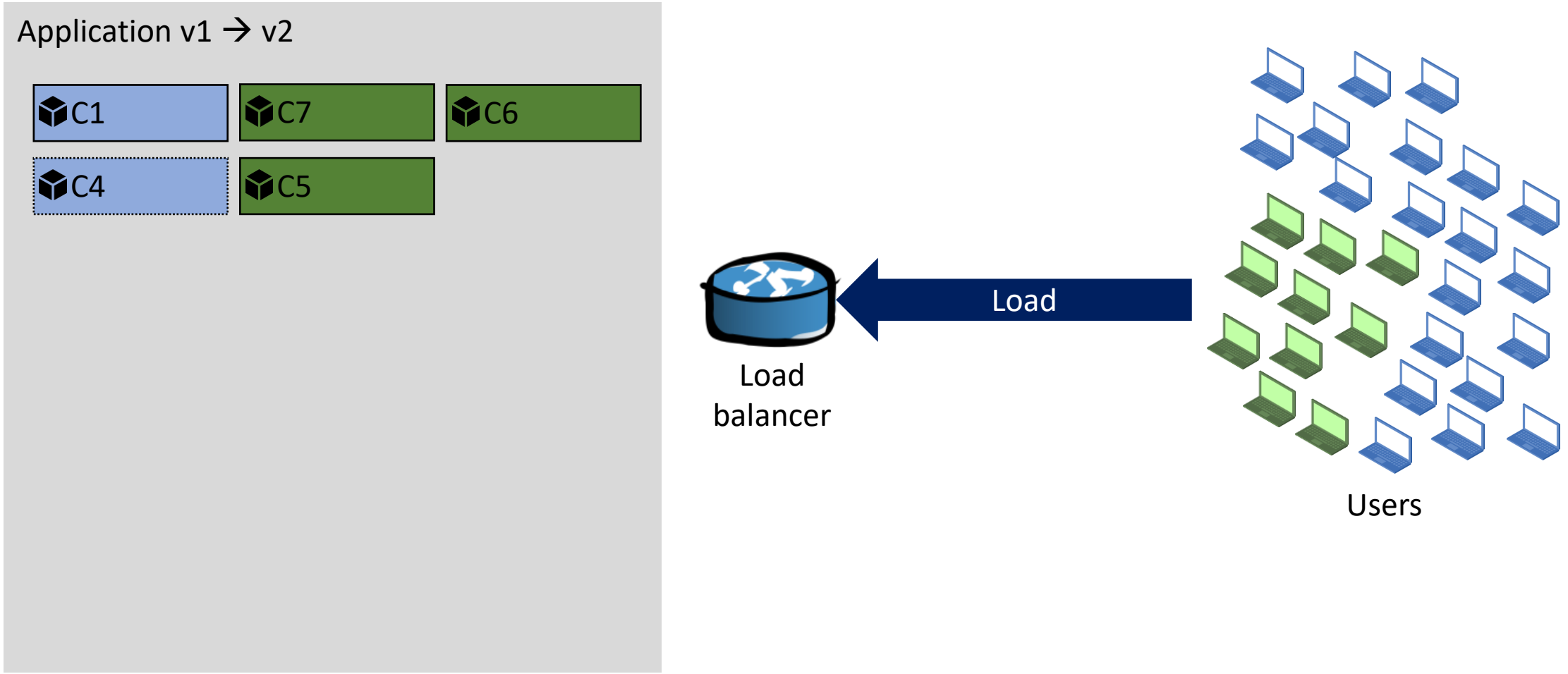

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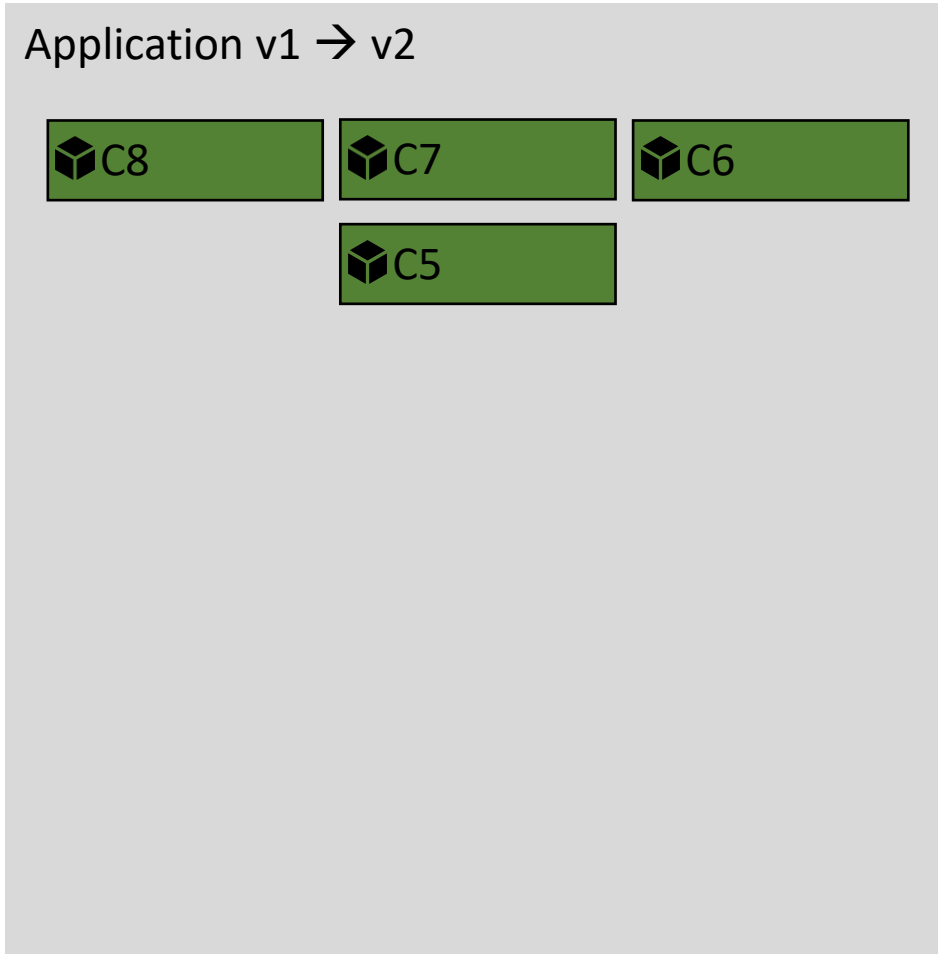
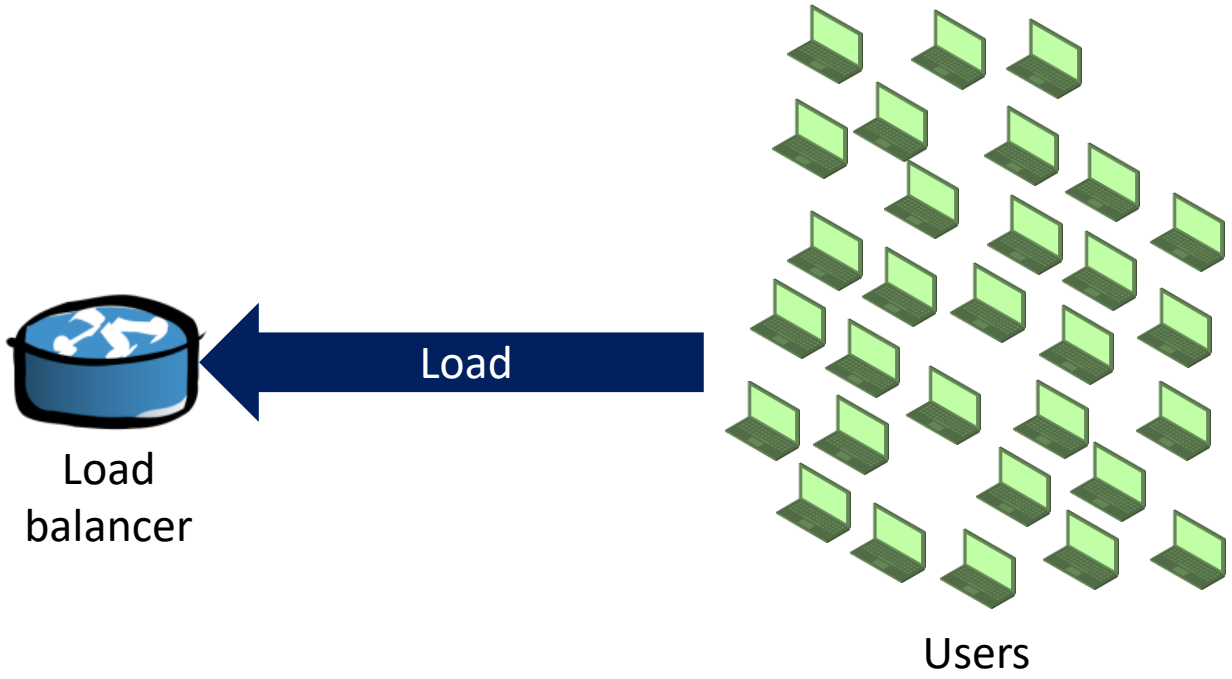
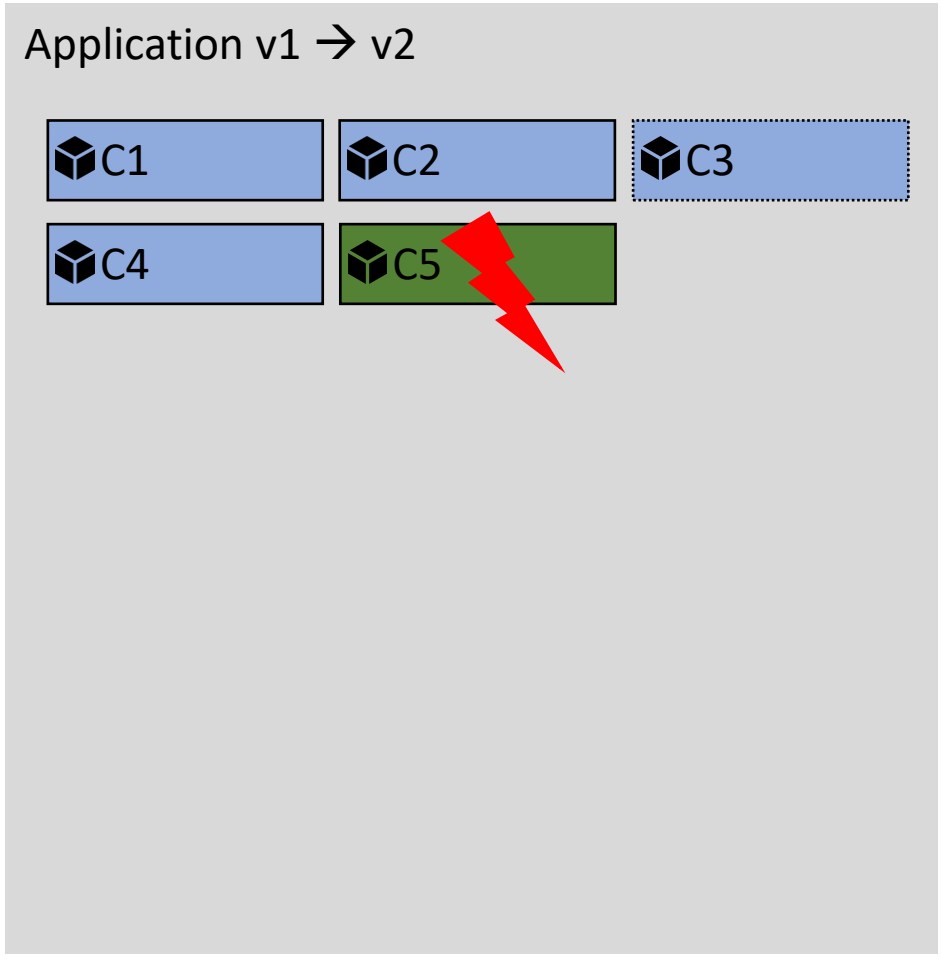
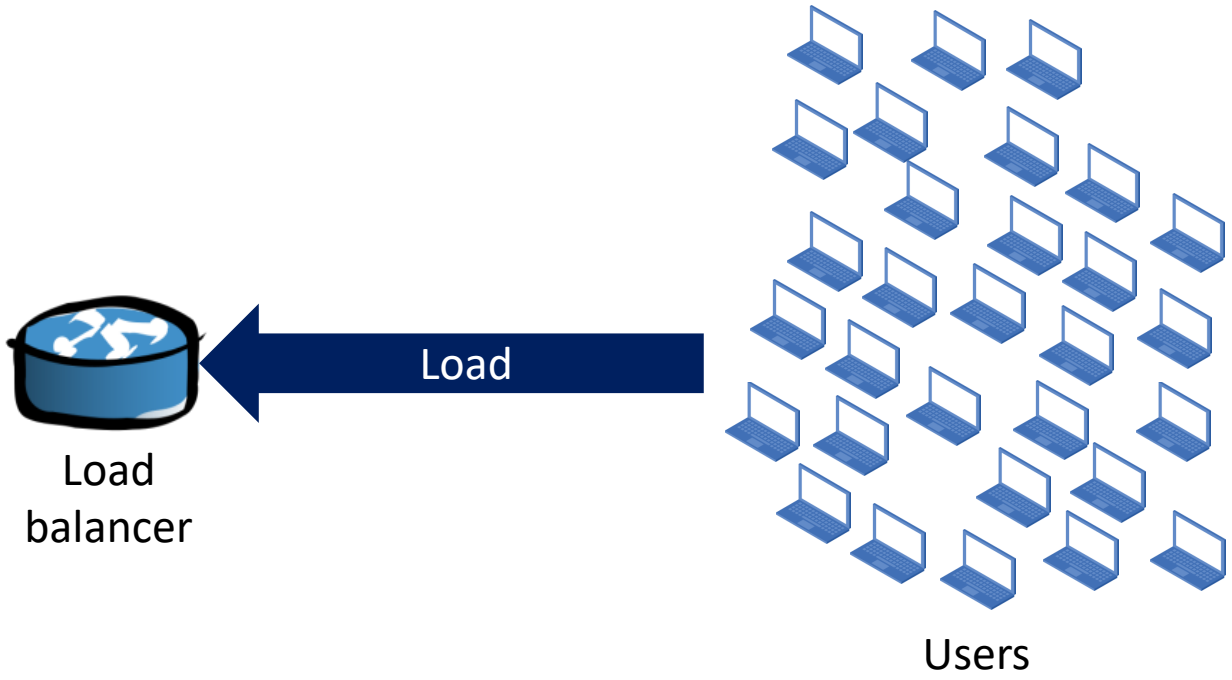




All clients running updated version, zero downtime

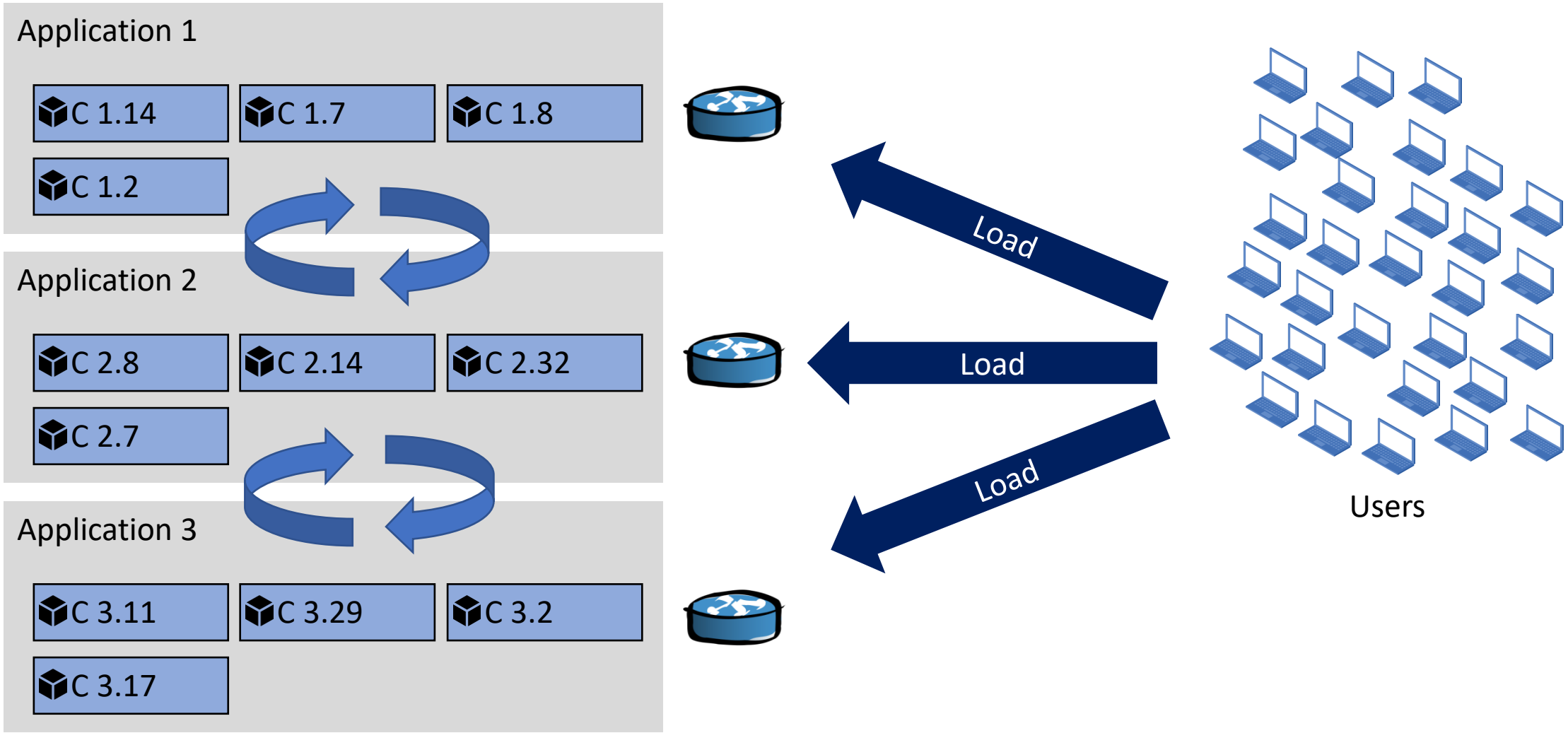
Early error detection during rollouts





Stop rollout if C5 misbehaves

Naming and discovery



Functionalities

- Optimized placement
- Resource monitoring
- Autoscaling
- Load balancing
- Failure recovery
- Update rollout and rollback
- Naming and discovery

CompSci 401: Cloud Computing

Kubernetes

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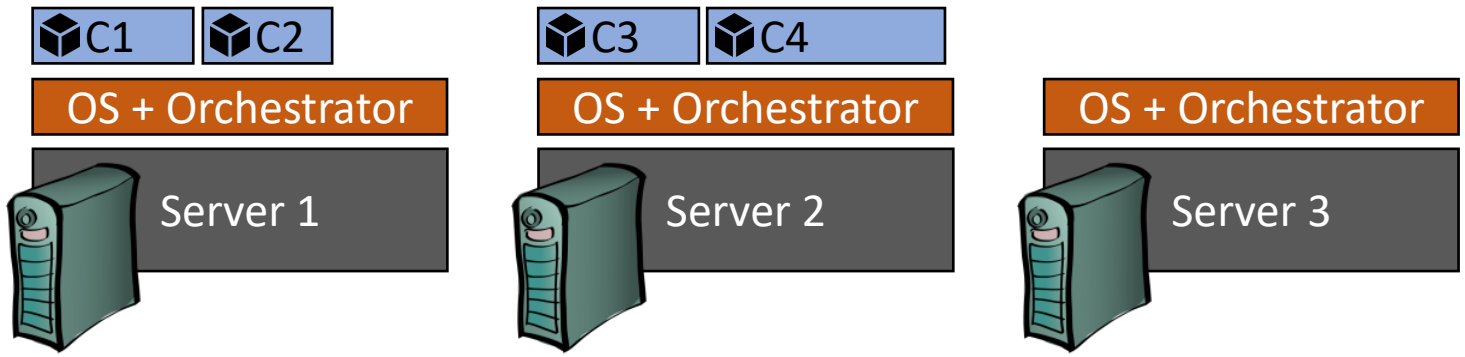
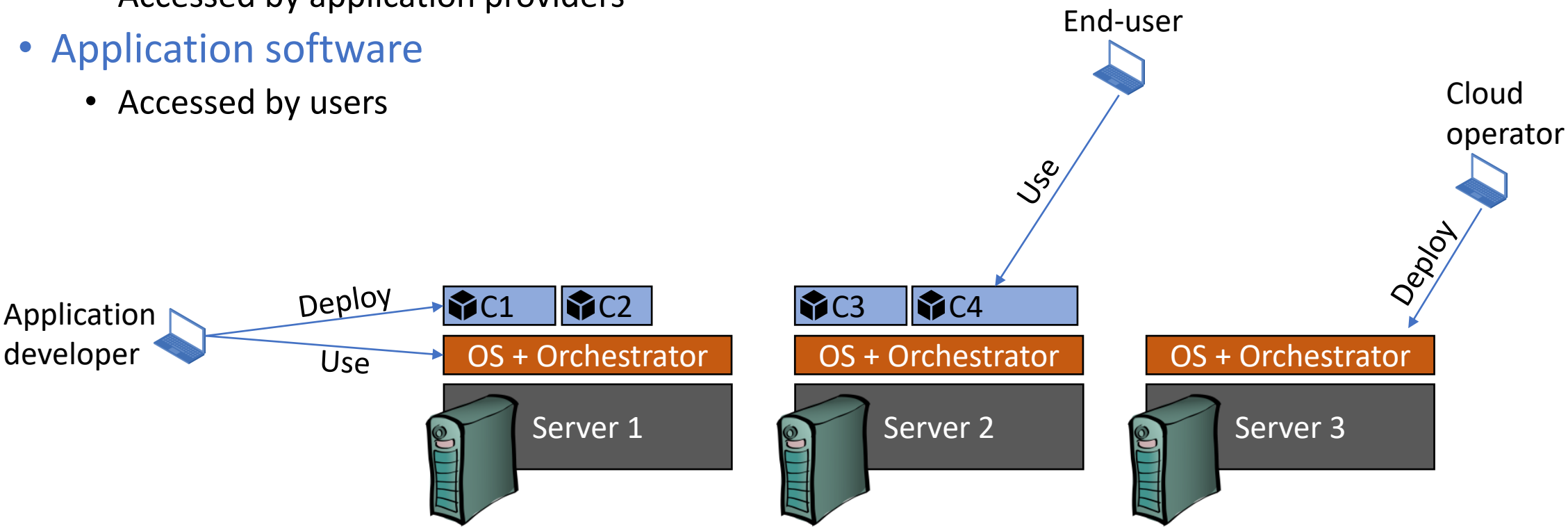
Kubernetes cluster model

- Container orchestration
- Kubernetes is complex and has many functionalities
- It helps to understand the terminology is uses
  - Cluster: Set of containers and orchestration software, number of containers limited by demand and hardware



Kubernetes cluster model

- Two layers of software in Kubernetes
  - Orchestration software
    - Accessed by application providers
  - Application software
    - Accessed by users

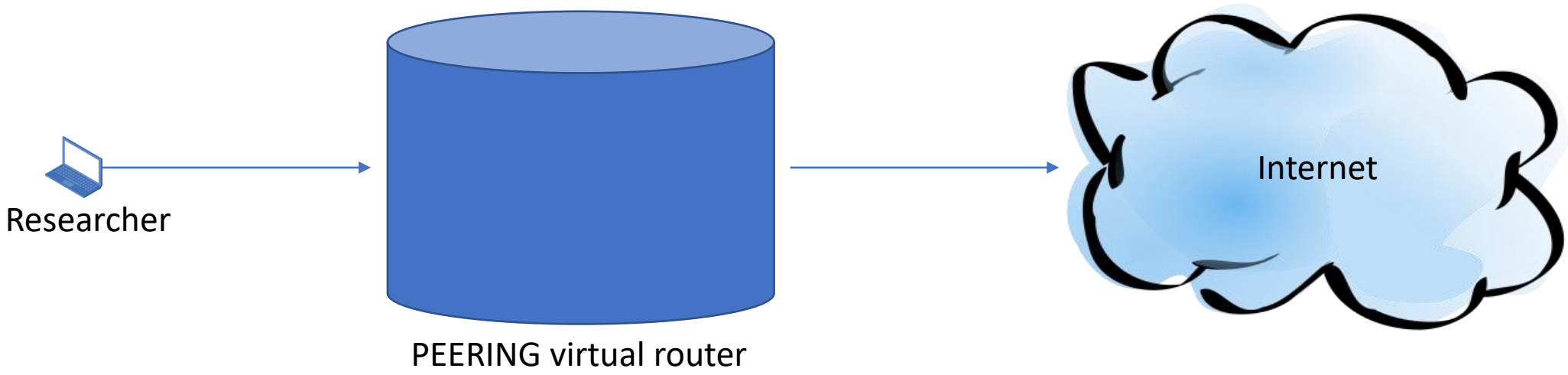


Kubernetes pods

- Kubernetes manages pods, not individual containers
  - The pod is the smallest unit that can be managed
- A pod provides a well-defined functionality
  - A set of tightly coupled containers, but single-container pods are typical
  - Containers in a pod deployed on the same server
  - Containers in a pod communicate over the host's local "network"
    - Naming and discovery provided by the orchestrator

PEERING pod

- PEERING provides a “virtual router” that researchers can use to interact with the Internet
  - Components are packaged in containers
  - Containers cooperate to implement the virtual router



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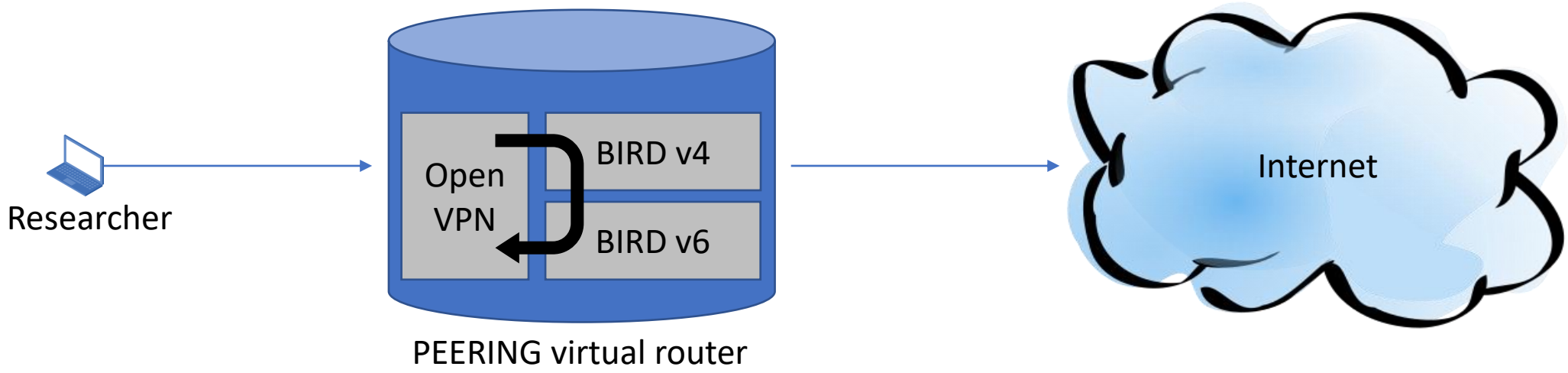
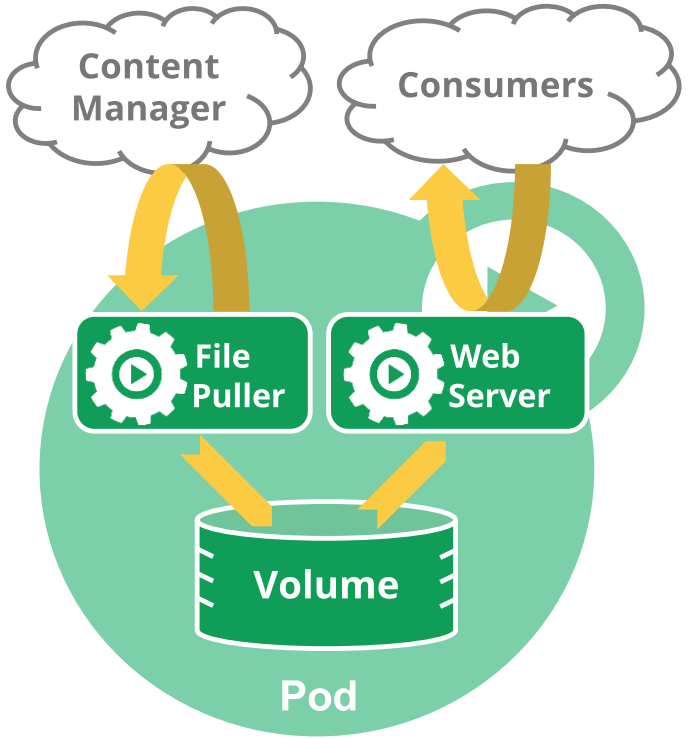


Web pod

- Web server for user requests
- Auxiliary container updates content on the website
- Both containers share a disk volume



Pod specification and creation

- Pods are specified in a Kubernetes-defined API
  - JSON or YAML
- A pod has a specification
  - Name and image of containers
  - Environment variables
  - Network ports
- Pods are instantiated following specification
- A pod can have metadata attached to it
  - Used to search and as management targets

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: nginx
spec:
  containers:
  - name: nginx
    image: nginx:1.14.2
    ports:
    - containerPort: 80
```

Init containers

- A pod can specify an init container
- Init container runs before the other containers in the pod
- Performs initial setup or verifications
  - Common use: check the environment before starting other containers

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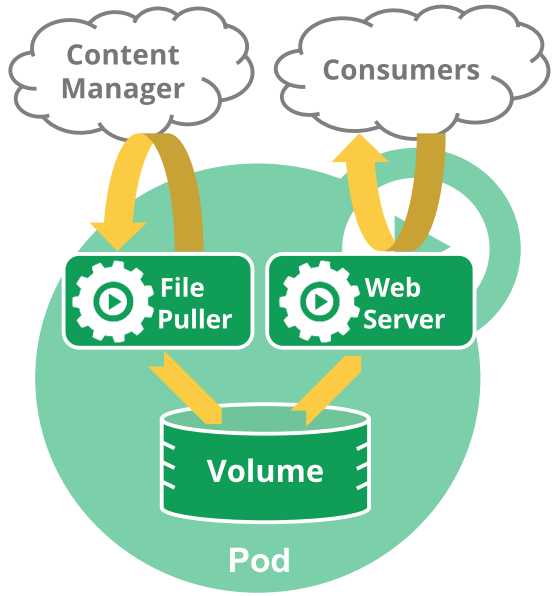

Init containers

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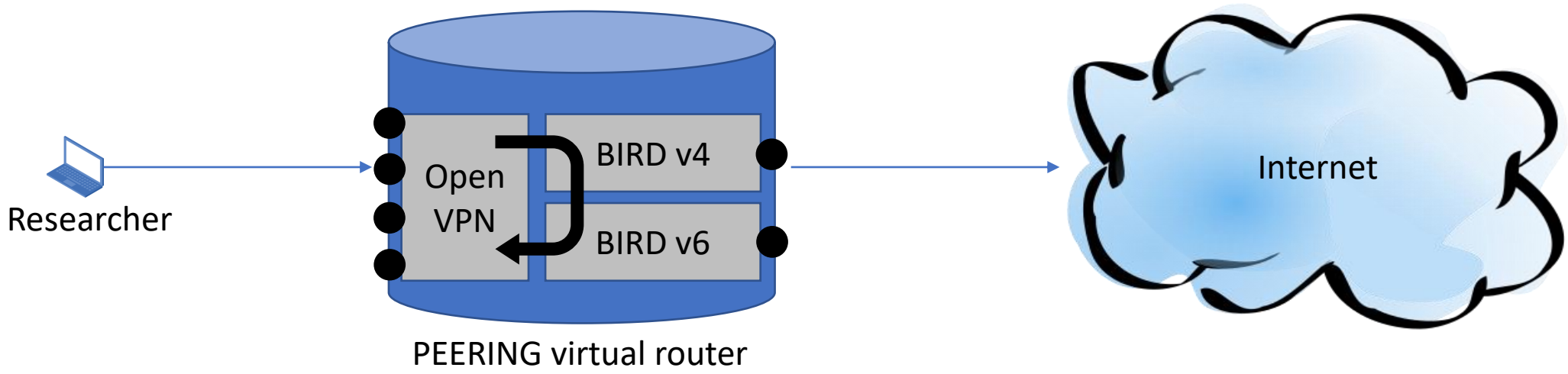
- Performs initial setup or verifications
  - Common use: check the environment before starting other containers
  - PEERING's init container sets up the networking for the app containers



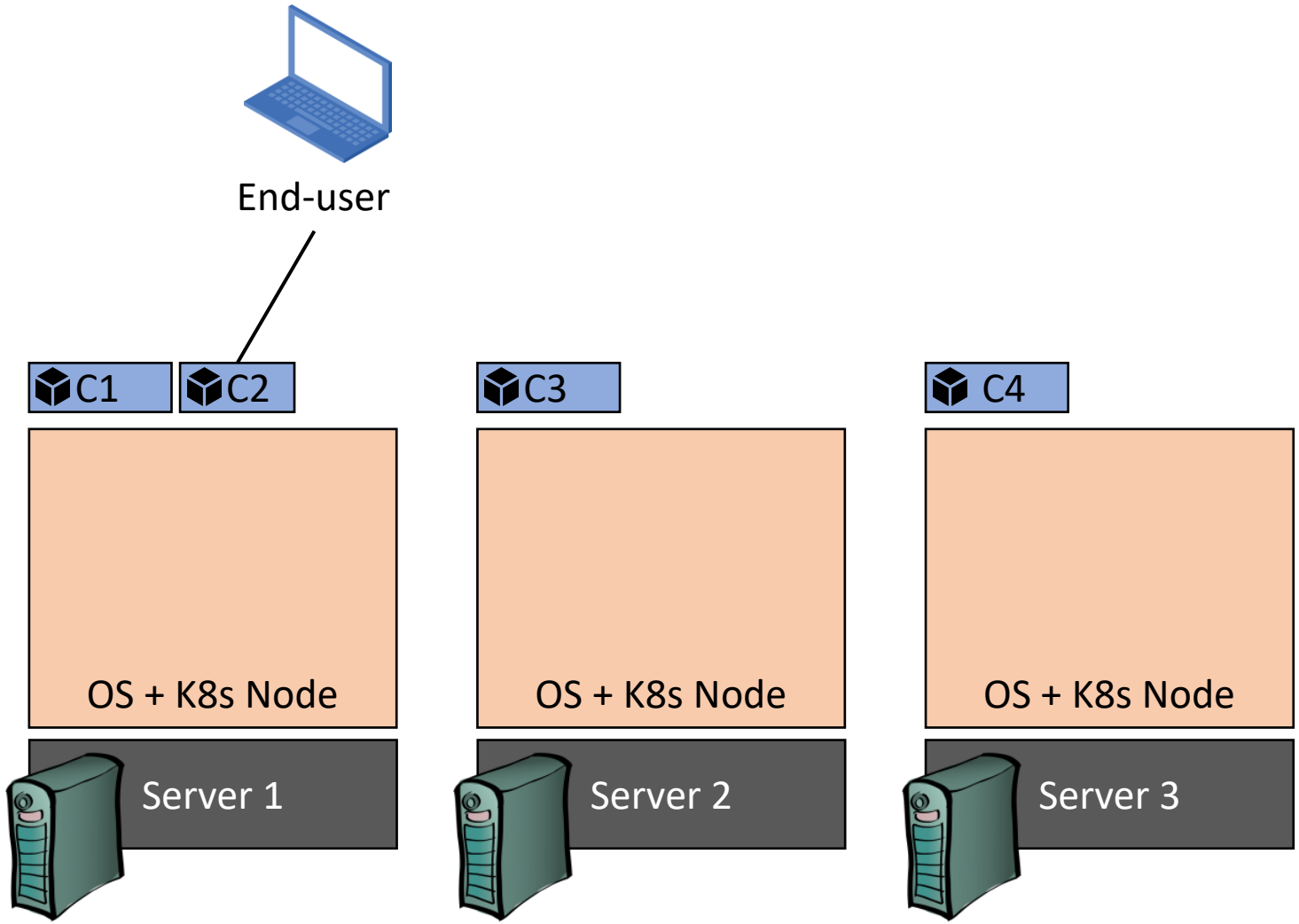
CompSci 401: Cloud Computing

K8s Nodes and Control Plane

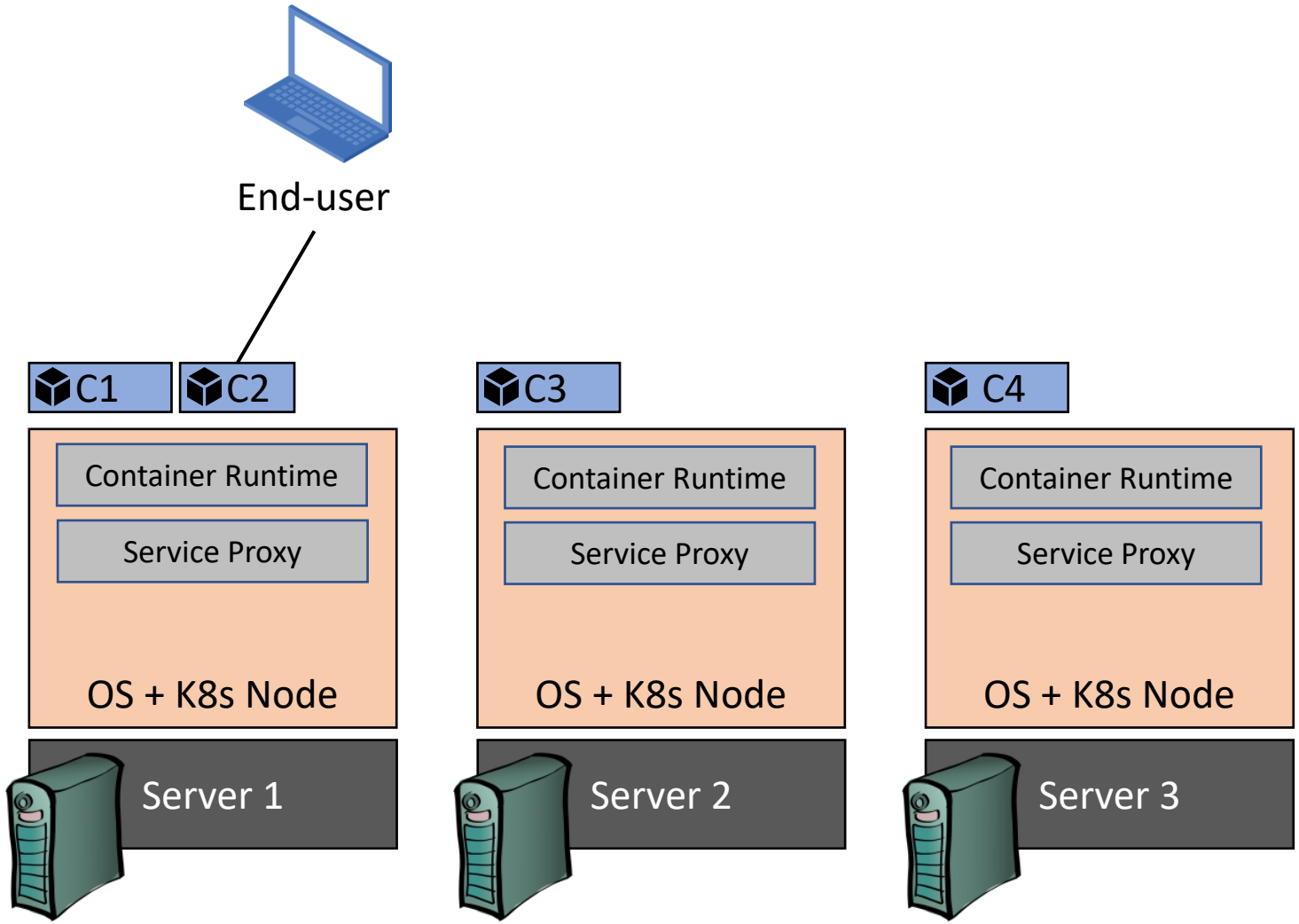
Prof. Ítalo Cunha

昆山杜克大学
DUKE KUNSHAN UNIVERSITY

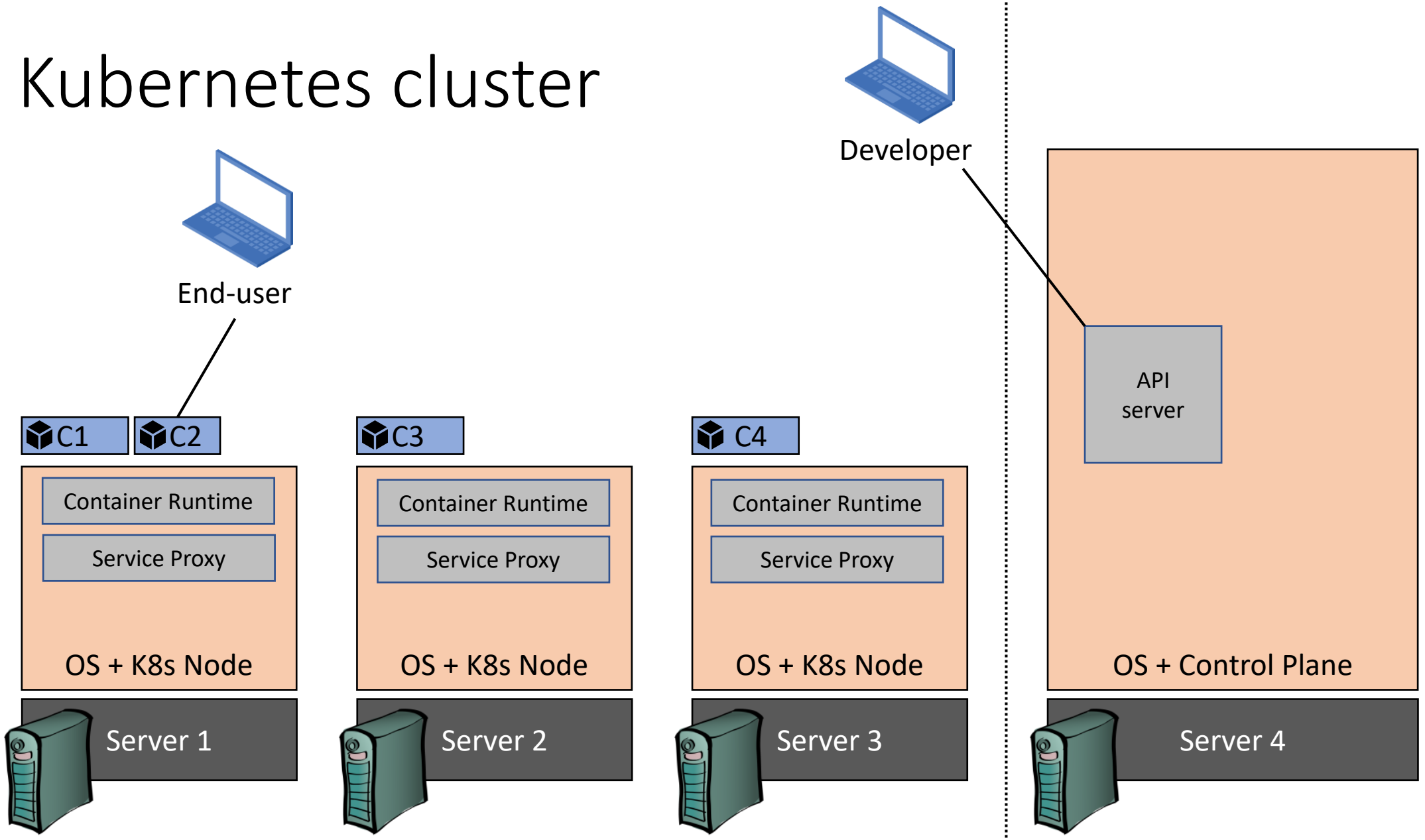
Kubernetes cluster



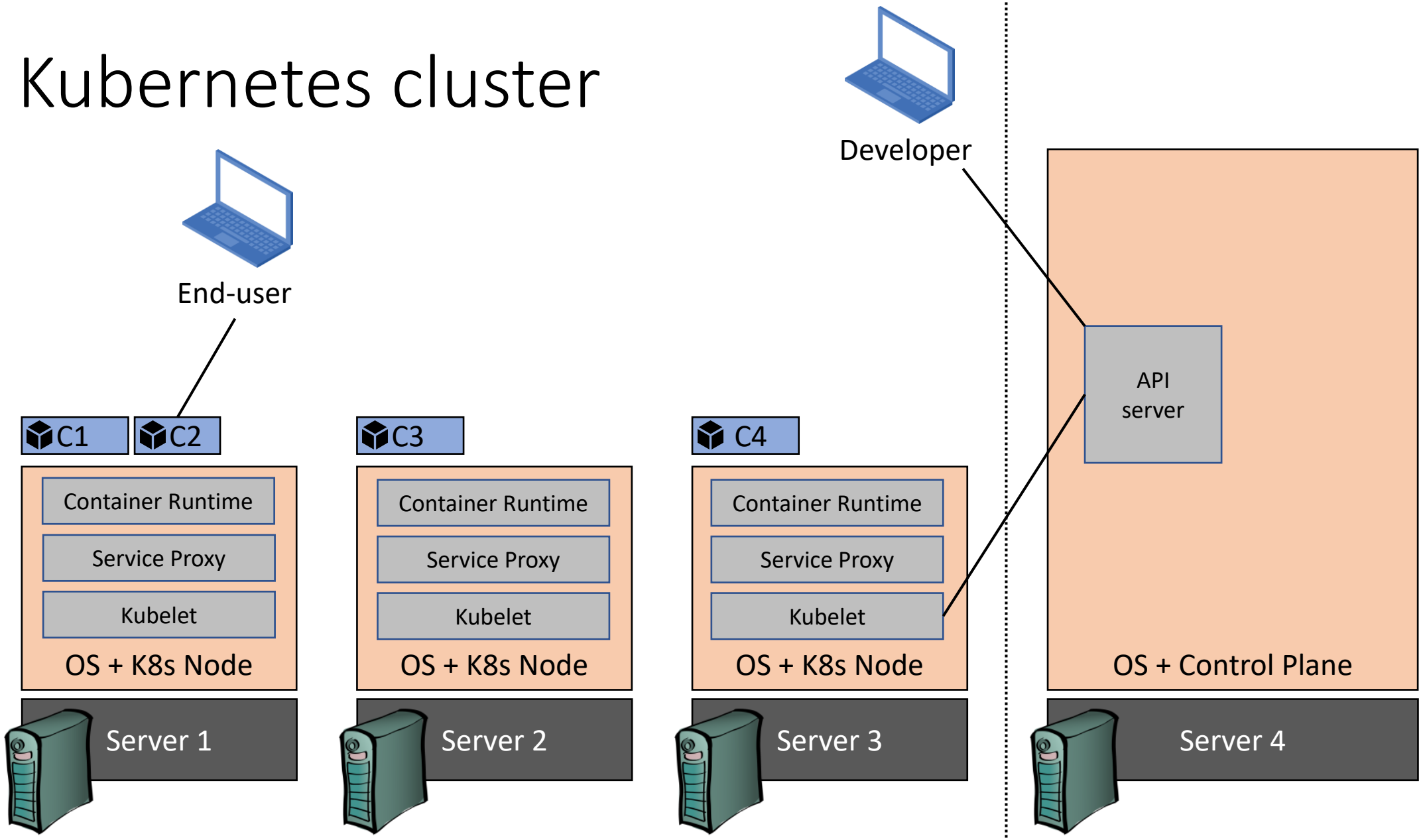
Kubernetes cluster



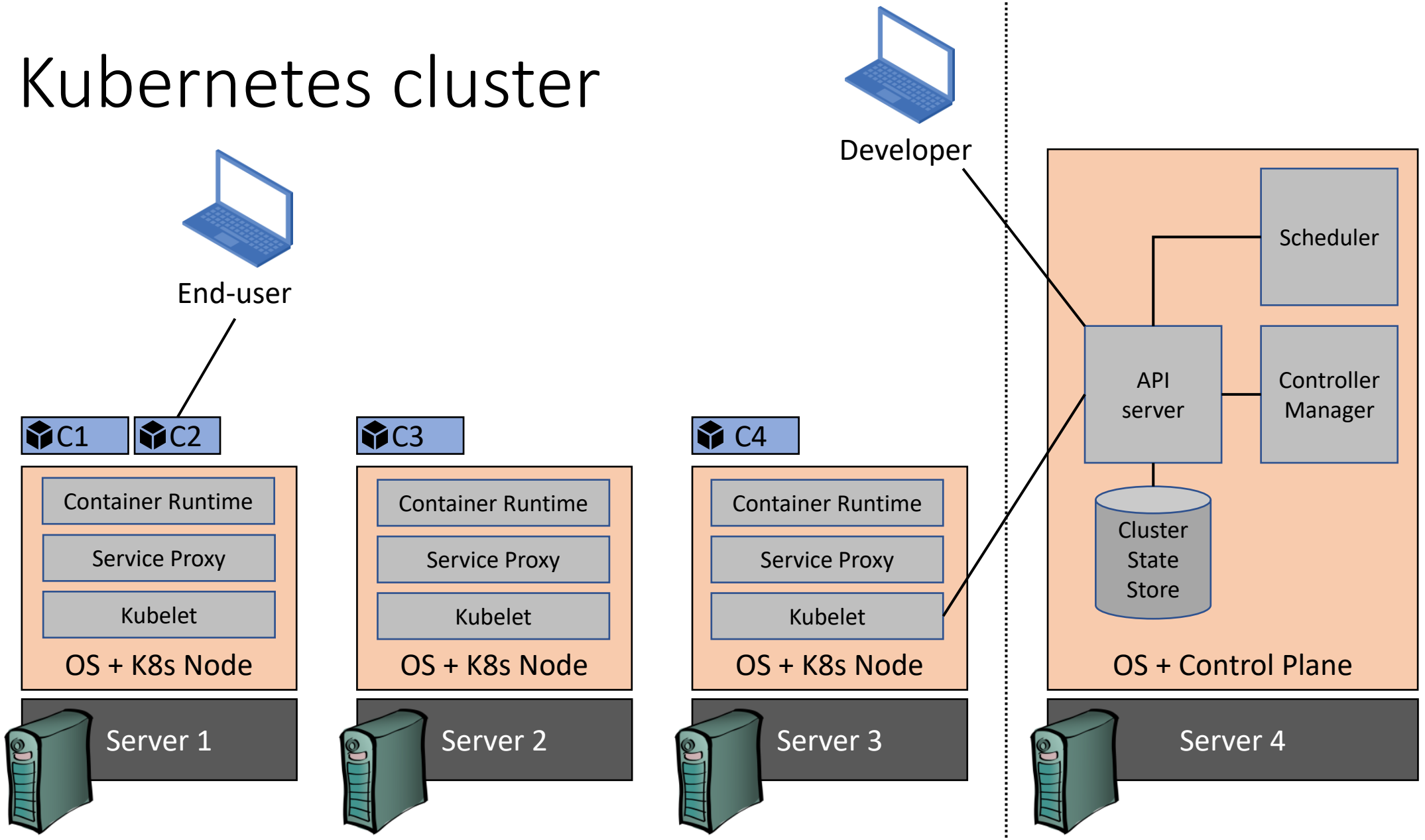
Kubernetes cluster



Kubernetes cluster



Kubernetes cluster



Kubernetes cluster