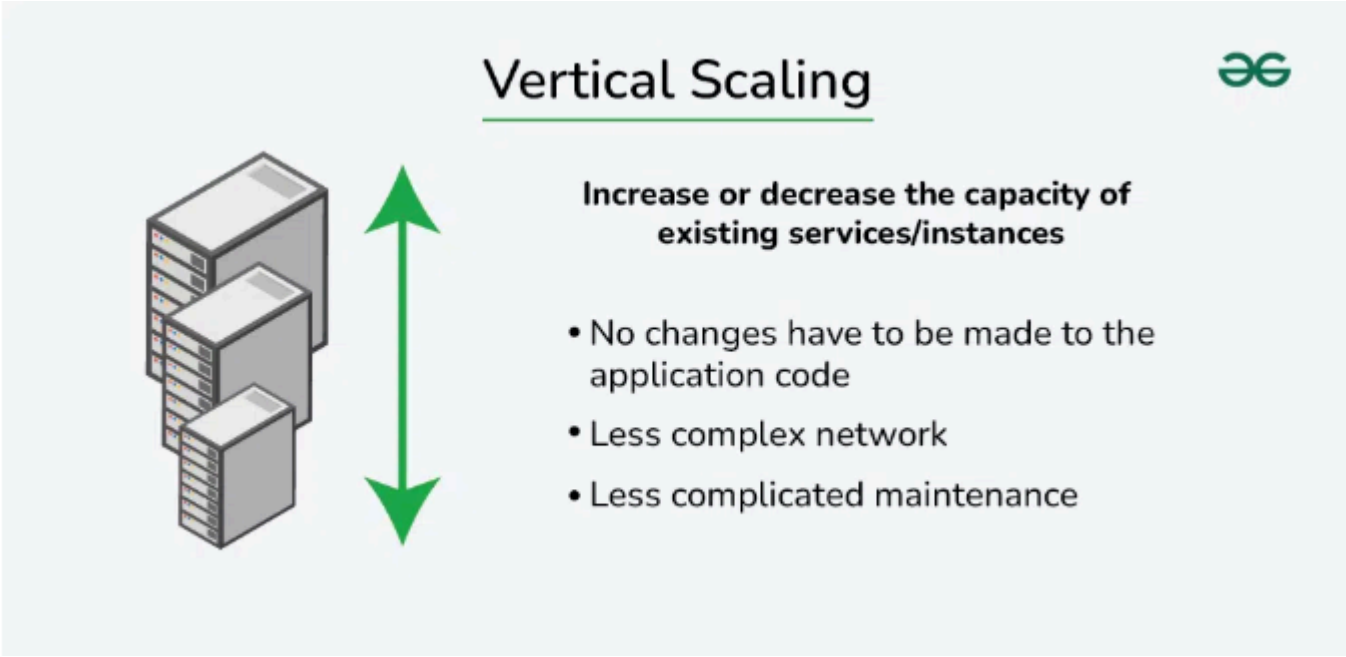
Horizontal vs. Vertical Scaling – System Design

Scalability refers to a system's ability to handle increasing workloads efficiently. It is crucial in system design to maintain performance and prevent bottlenecks. The two main types of scaling are:

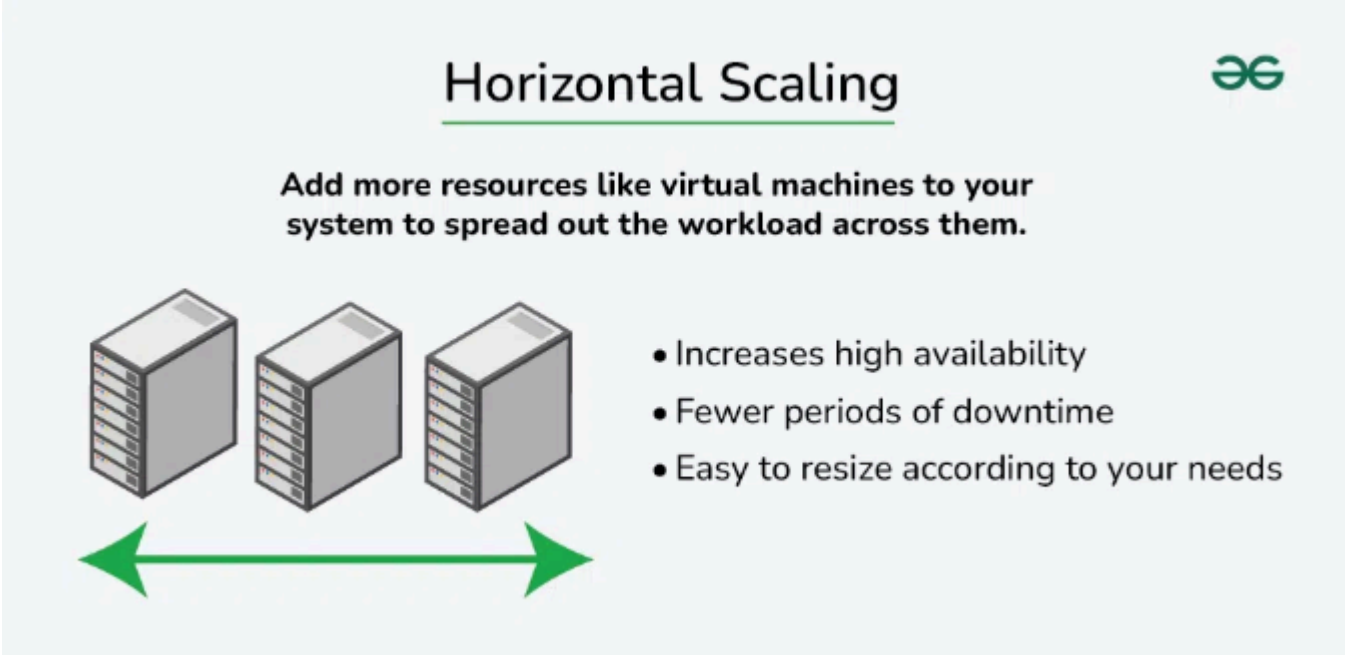
1. Vertical Scaling (Scale-Up)

- Involves upgrading a single server's resources (CPU, RAM, storage).
- Simple to implement, no changes in system architecture.
- **Pros:** Easy management, maintains application compatibility.
- **Cons:** Limited by hardware constraints, costly, single point of failure.
- **Examples:** MySQL, Amazon RDS.



2. Horizontal Scaling (Scale-Out)

- Increases capacity by adding more servers to distribute the load.
- Supports high availability and failover.
- **Pros:** Improved fault tolerance, better performance, cost-effective for large-scale systems.
- **Cons:** Complex management, requires load balancing.
- **Examples:** Google, Facebook, MongoDB, Cassandra.



Key Differences

Aspect	Horizontal Scaling	Vertical Scaling
Resource Addition	Adds more servers	Enhances a single server
Cost	Cost-effective long-term	Becomes expensive over time
Fault Tolerance	High due to distributed workload	Low, as failure affects the system
Performance	Scales by adding machines	Limited by hardware capacity
Complexity	Requires distributed system management	Easier to manage

Choosing the Right Approach

- **Use Vertical Scaling** for applications needing high processing power on a single machine.
- **Use Horizontal Scaling** for applications requiring redundancy, scalability, and high availability.
- **Hybrid Approach** combines both for optimal performance and resilience.