Building Access Oblivious Storage Cloud for Enterprise

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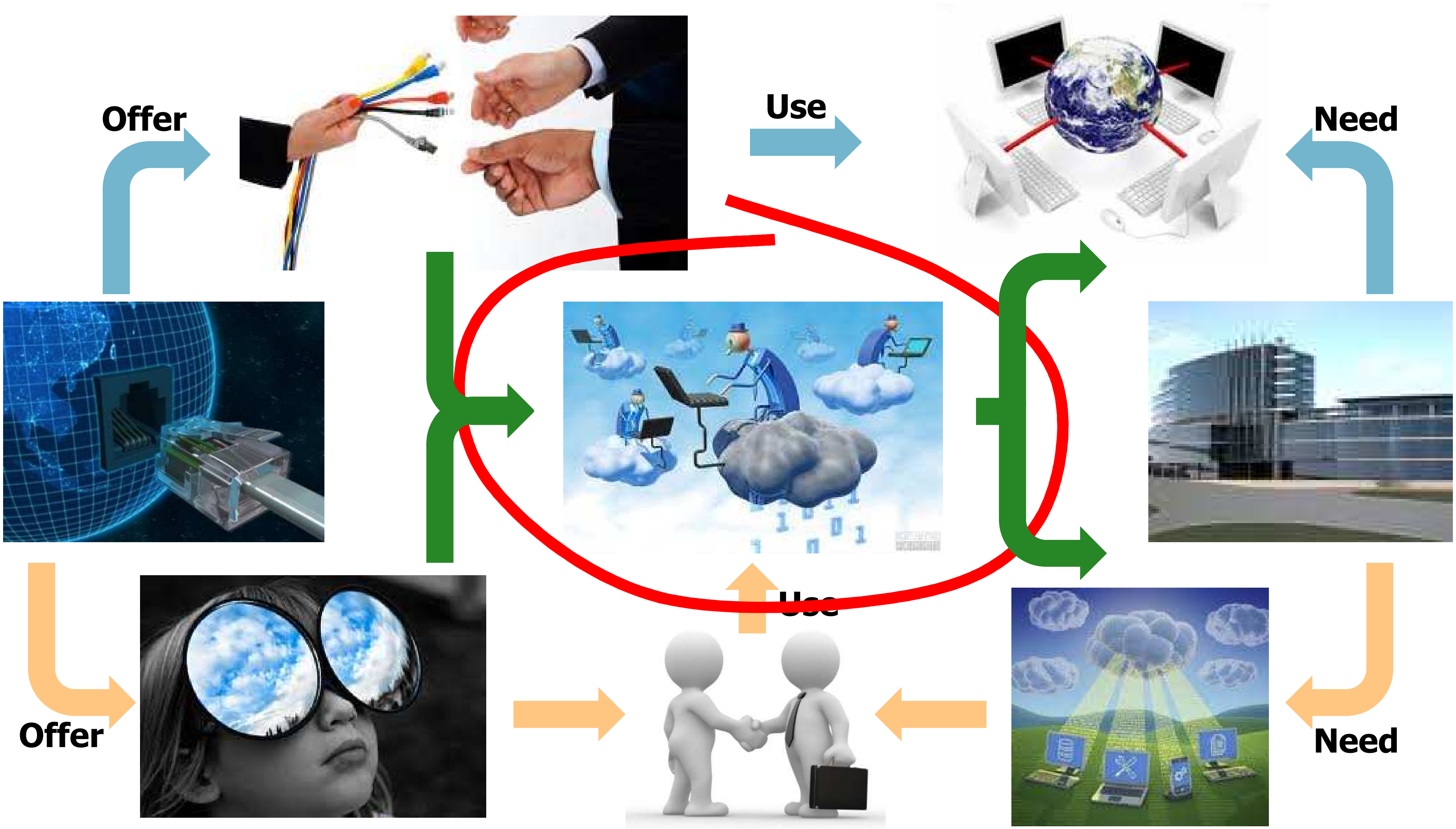
Motivation: Service Provider and Enterprise eco-system



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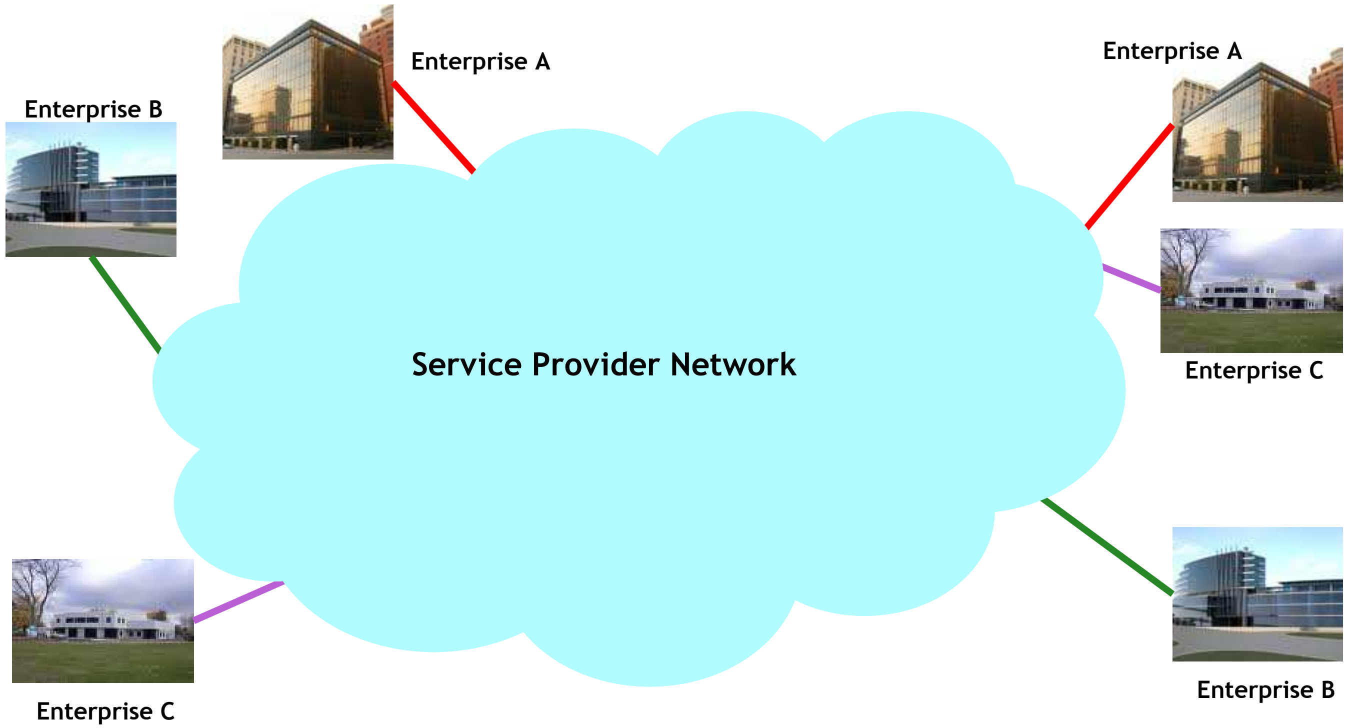
VPN interconnection: Enterprises' view



Enterprise leases VPN service from a service provider to interconnect multiple sites

- Each site gets a pre-specified bandwidth guaranteed VPN connection
- All enterprise resources are accessible from any site regardless of the resources' location
  - Enterprise is able to aggregate IT resources in one or a few locations

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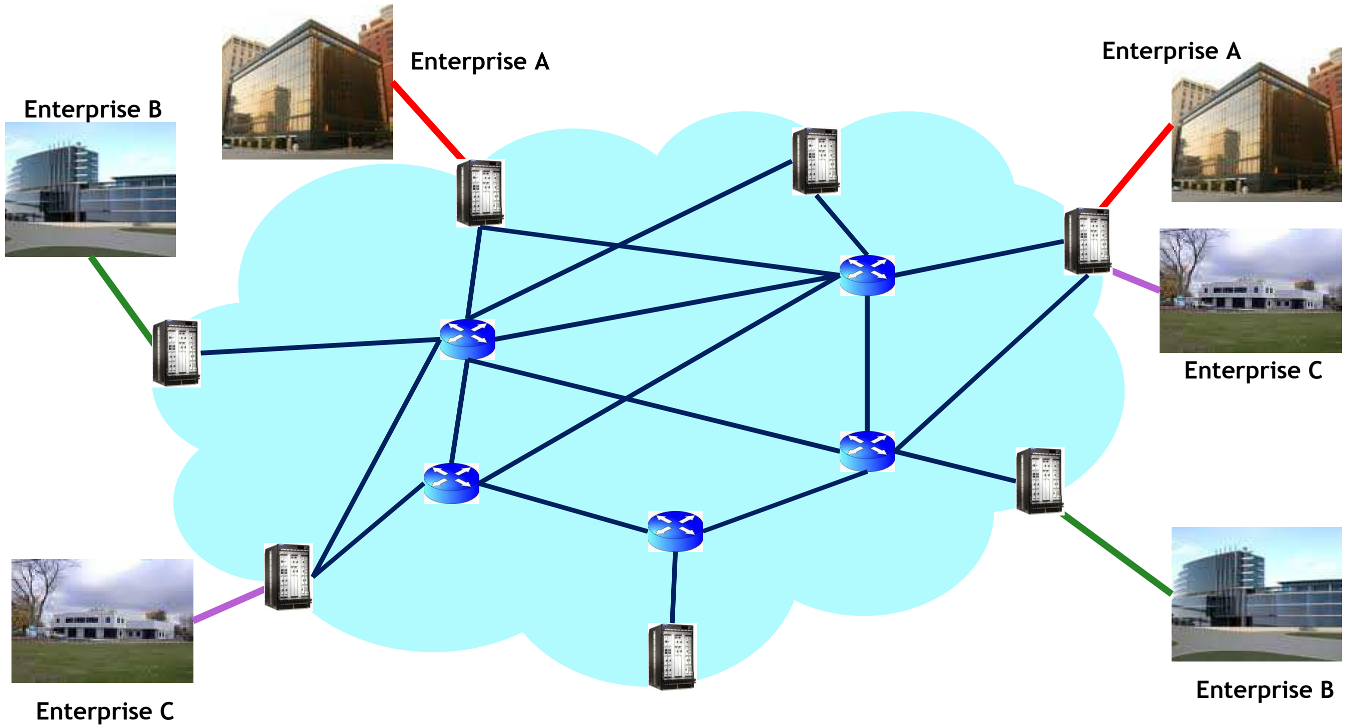
VPN interconnection: Service Providers' view



Service provider wants to provide enterprise-grade services leveraging its network

- VPN uses networking service
- Service provider intends to providing an enterprise-grade cloud solution from its network
  - Enterprise should be able to outsource IT resources and enjoy benefits of cloud service

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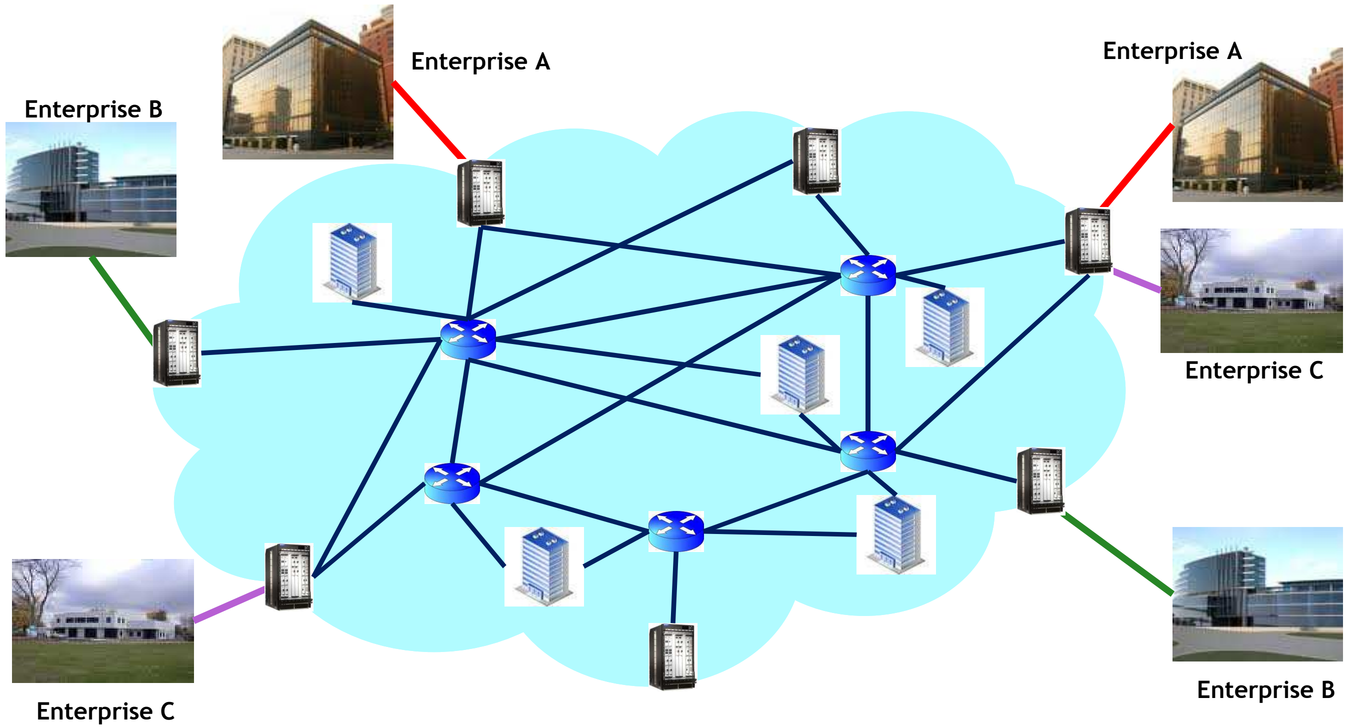
Service Providers' Cloud in the Network



Service providers are building data centers in their network

- Large number of small data centers spread all over the network
- Provide compute, storage, content and other bandwidth and latency sensitive services
- **We address service provider enabled storage services for enterprise**

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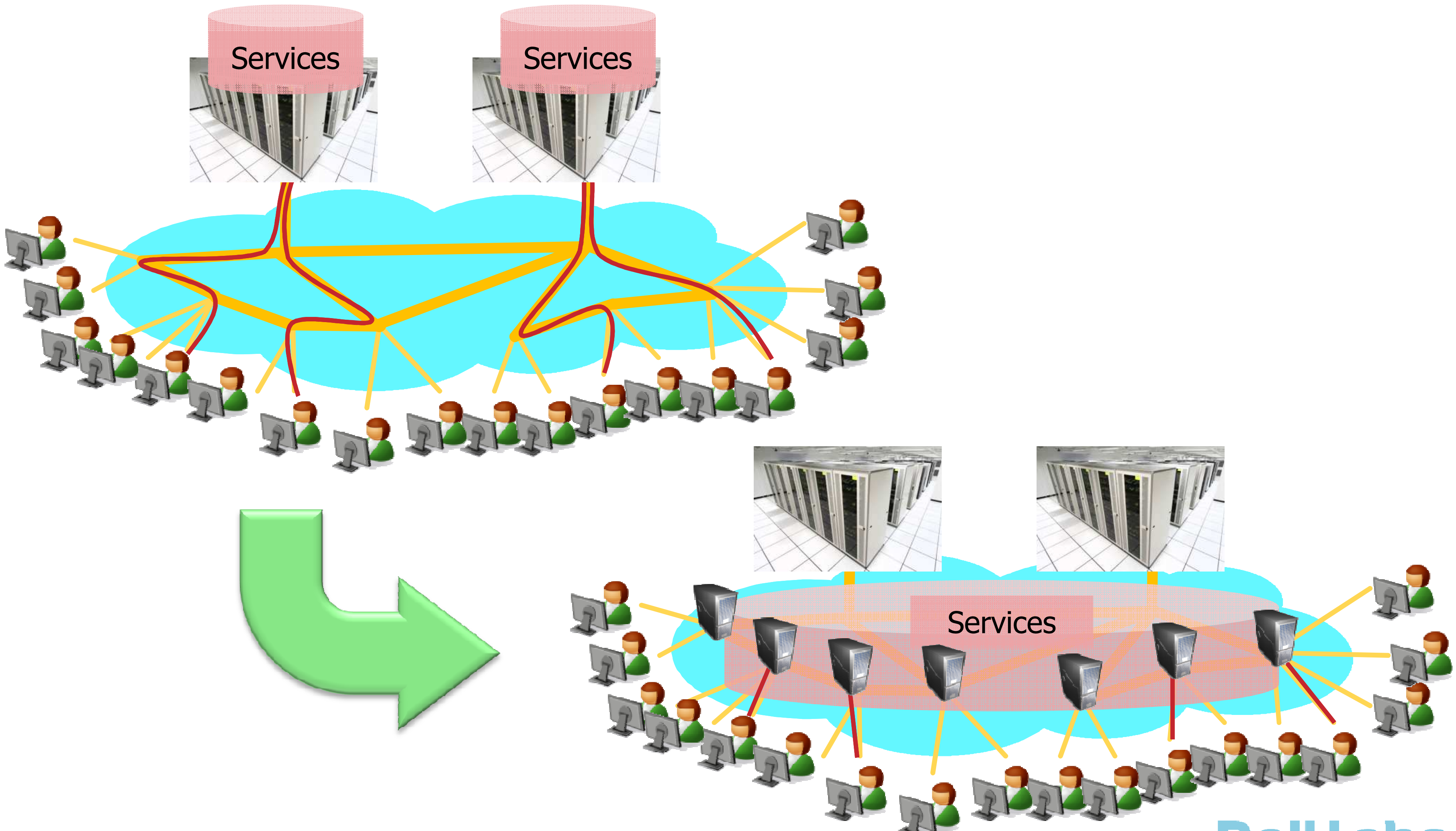
Service Providers' Networked Cloud

From Centralized Cloud to Distributed Cloud



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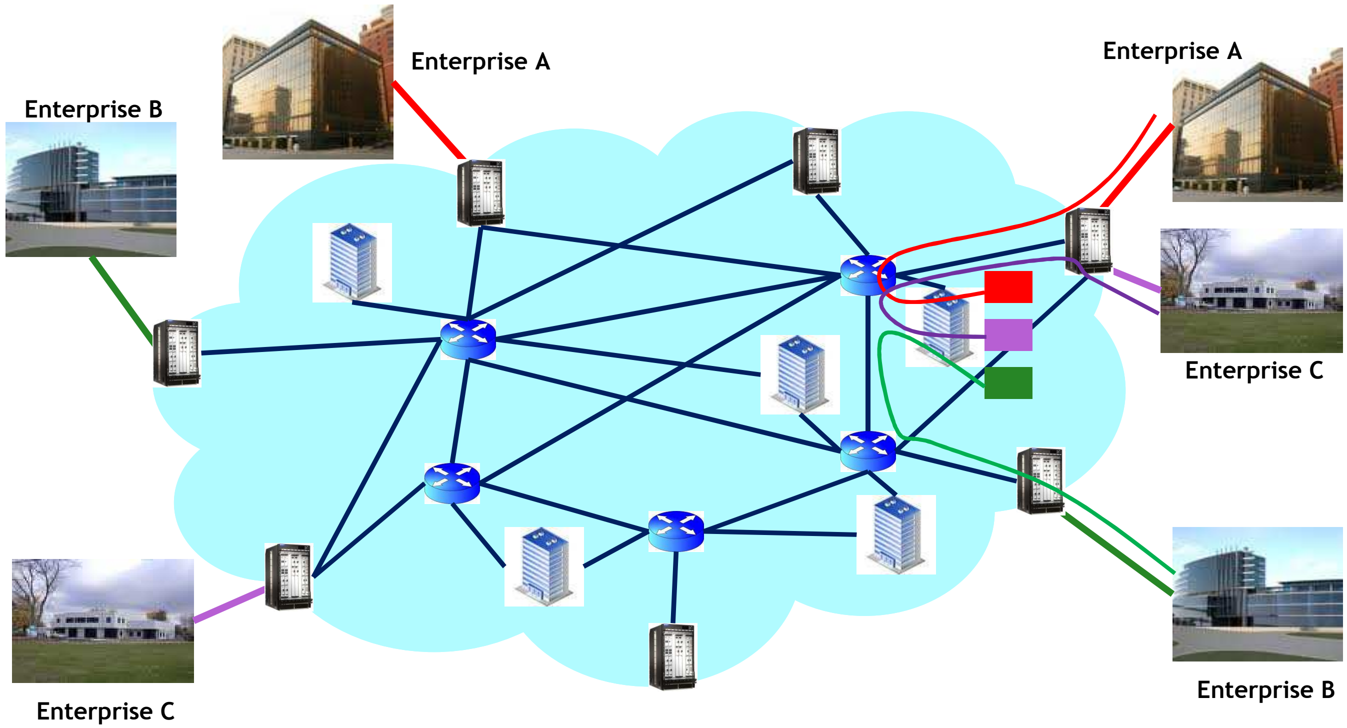
Enterprises’ expectation from Storage Cloud Service

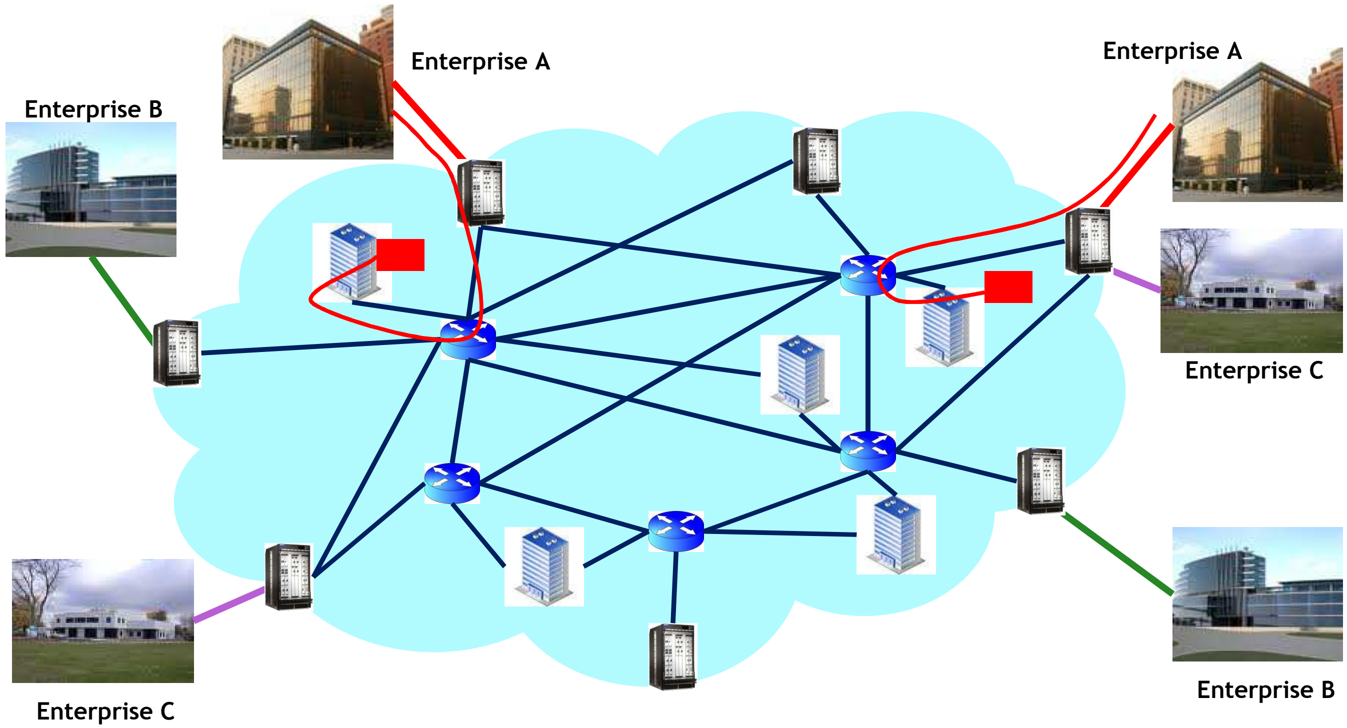
Service Isolation



The enterprise's virtual resources in the cloud must be isolated from the other users of the cloud

Enterprises' expectation from Storage Cloud Service

Location independence



The enterprise users must be able to connect to the virtual resources in the cloud from any enterprise location

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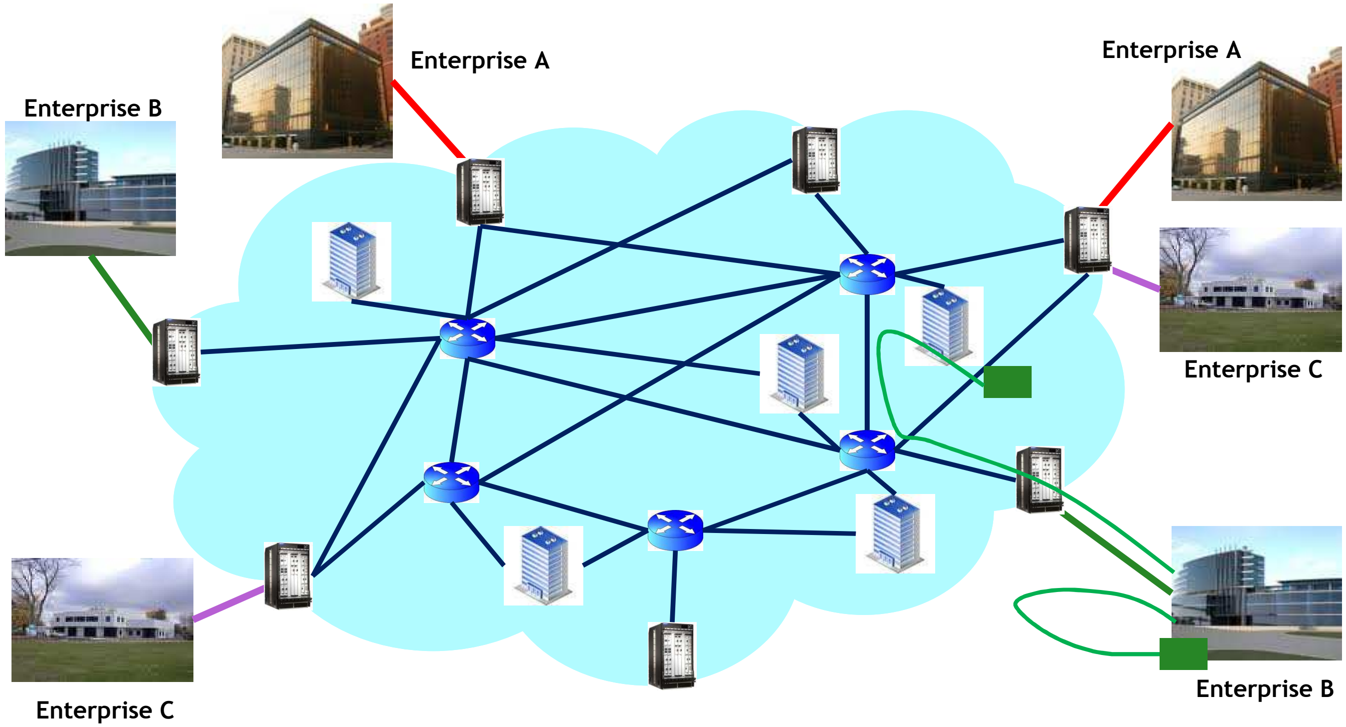
Enterprises' expectation from Storage Cloud Service

Seamlessness



An enterprise user must not see any difference between accessing an in-house resource vs. one in the cloud

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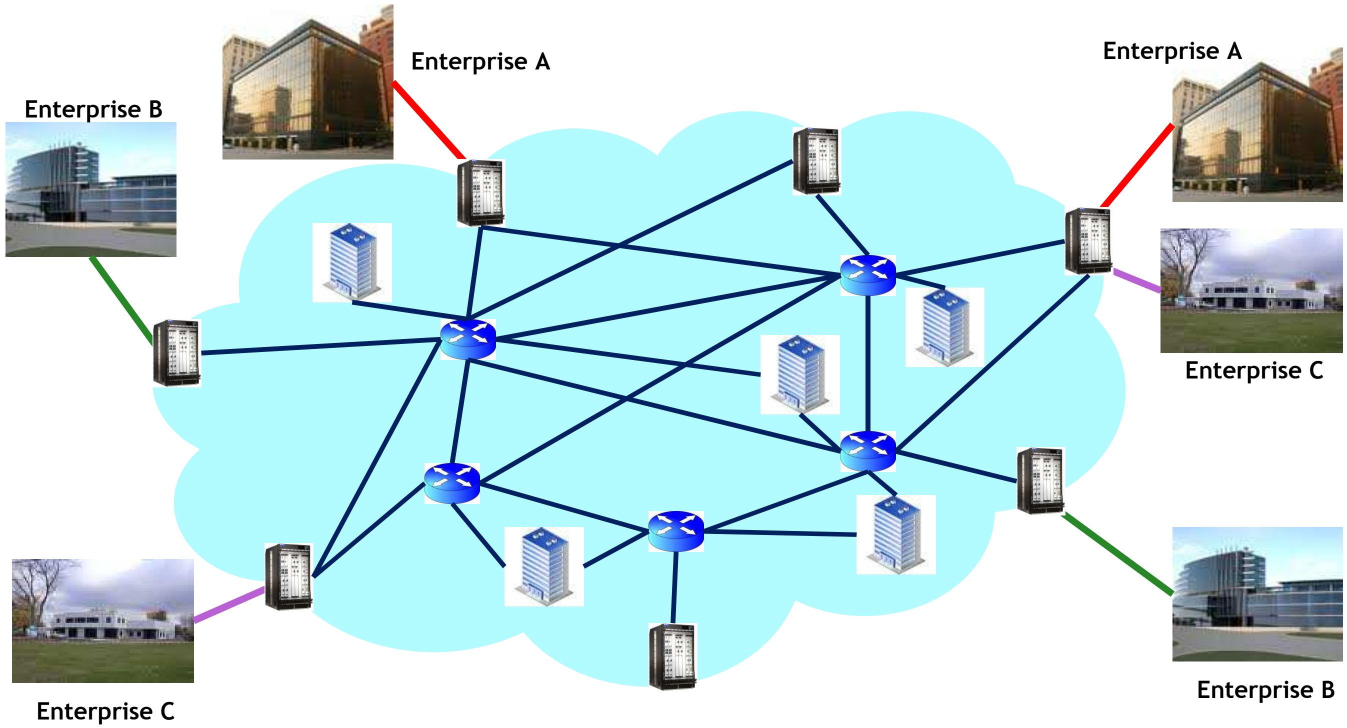
Enterprises' expectation from Storage Cloud Service

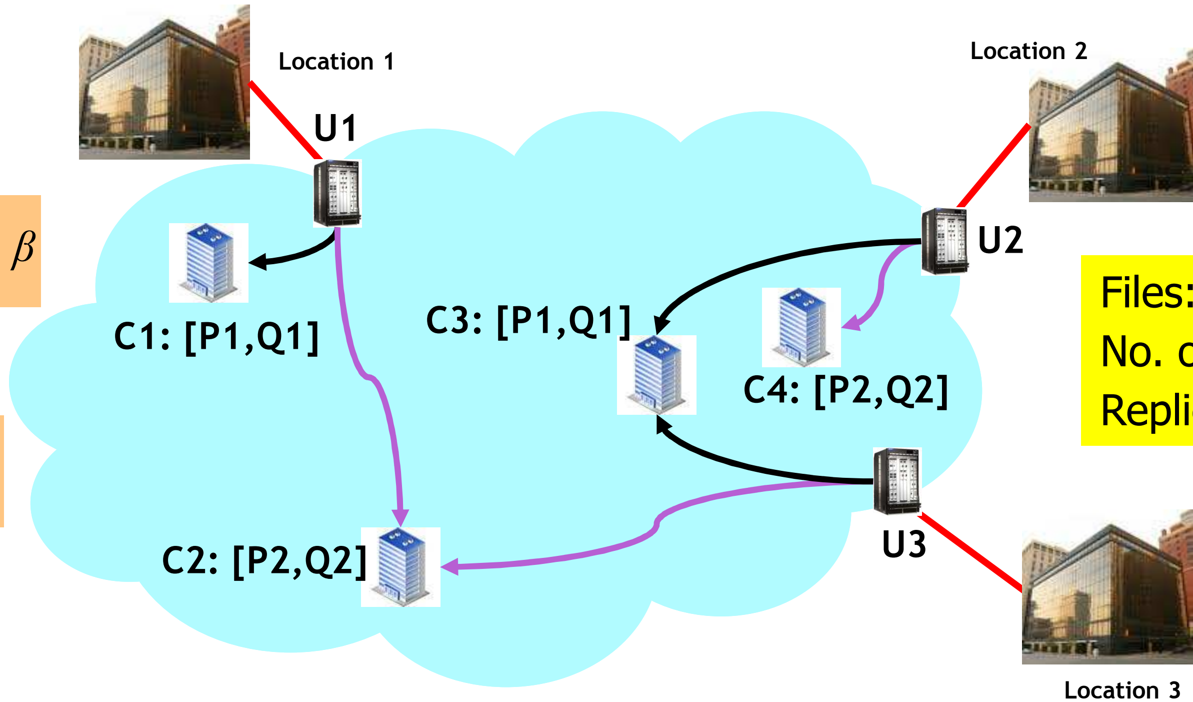


Isolation	Location Independence	Seamlessness
Solutions exist	Addressed in this paper	

Distributed Storage Provisioning and File Access in Cloud

$$\frac{\text{size(P1)}}{\text{size(P2)}} = \frac{\text{size(Q1)}}{\text{size(Q2)}} = \beta$$

$$\frac{\text{traffic(U1,C1)}}{\text{traffic(U1,C2)}} = \beta$$



Files: P and Q
No. of chunks: 2
Replication: 2

$$\min \lambda$$

$$\begin{aligned} \sum_{(G_j,e)\in H(e)} \beta_j D_u &\leq \lambda\, c(e)\ \forall e \in E. \\ \sum_j \beta_j &= 1 \\ \beta_j &\geq \frac{1}{p}\ \forall j. \end{aligned}$$

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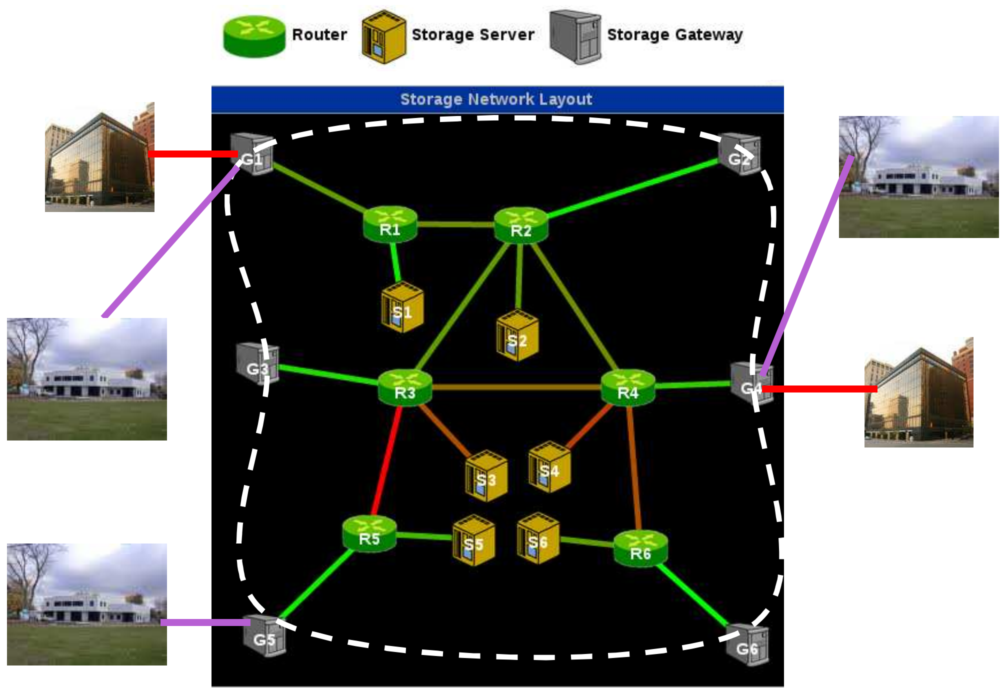
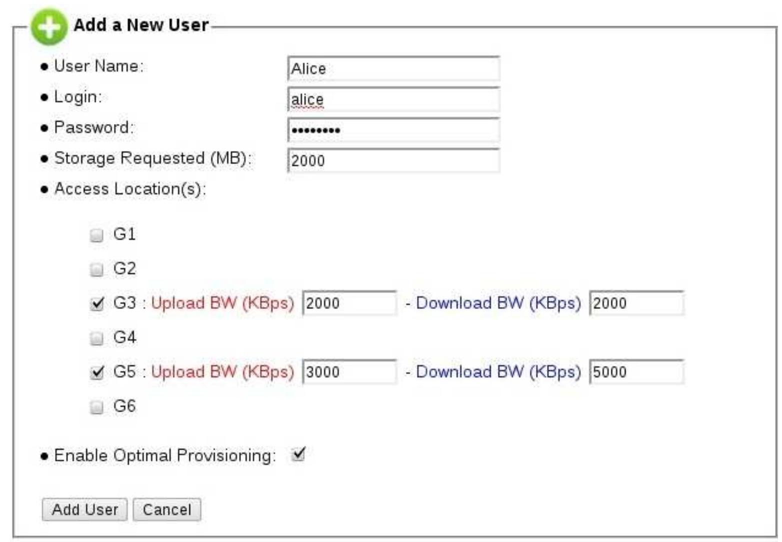
Prototype Implementation of Distributed Storage Cloud





Customers connect to the cloud through the Gateways and specify the bandwidth needs

- Distributed storage cloud automation layer optimally provisions the customer
  - ✓ Determines the customer’s attachment points into the Provider’s network
  - ✓ Attachment points act as the Gateways into the distributed storage cloud
  - ✓ Provisions storage for the customer at the optimal storage locations
  - ✓ Built in Linux kernel as a Unix-based file system (Ceph)
  - ✓ Exports NFS interface through the Gateway

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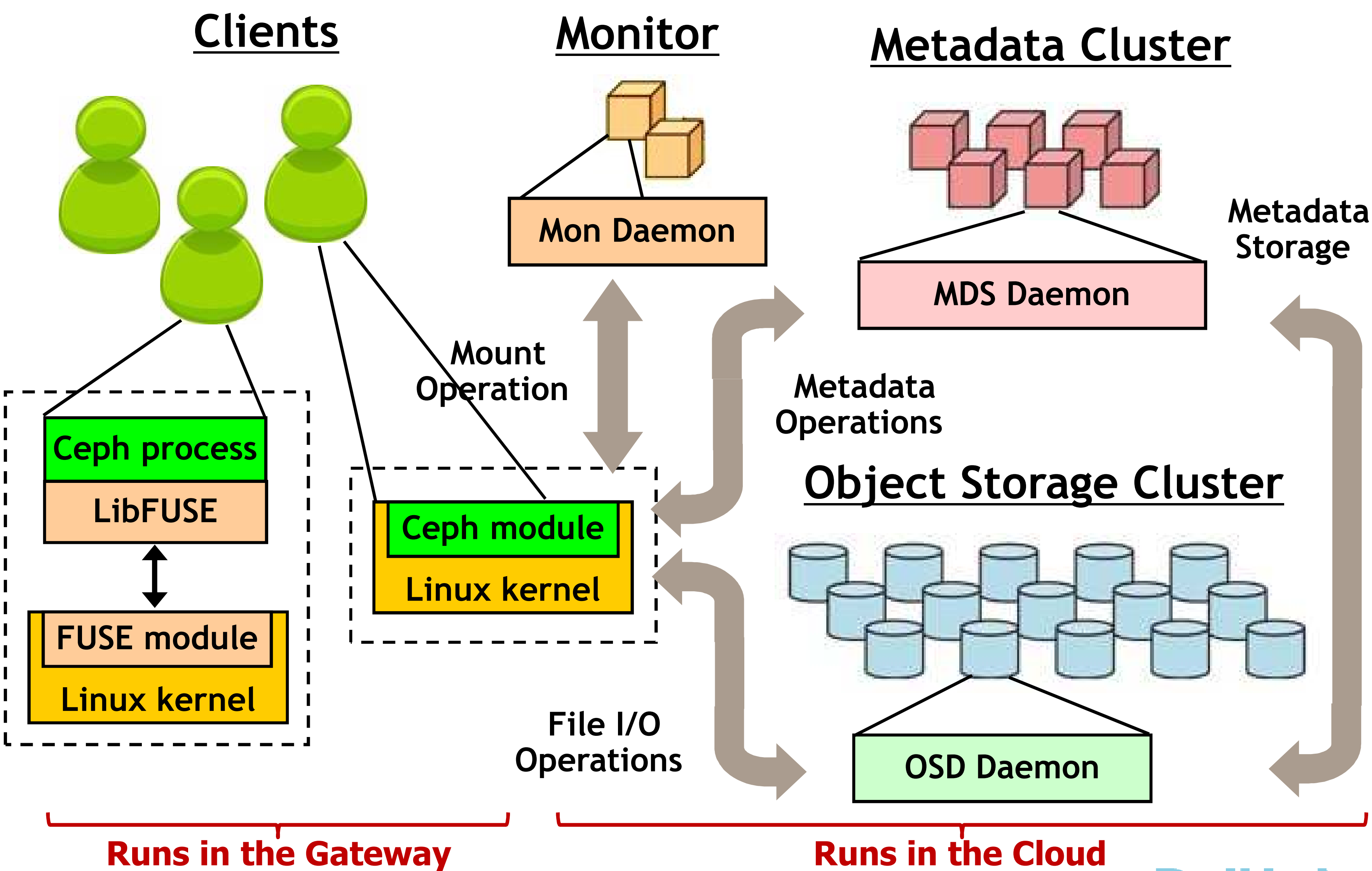
Ceph Distributed File System Architecture



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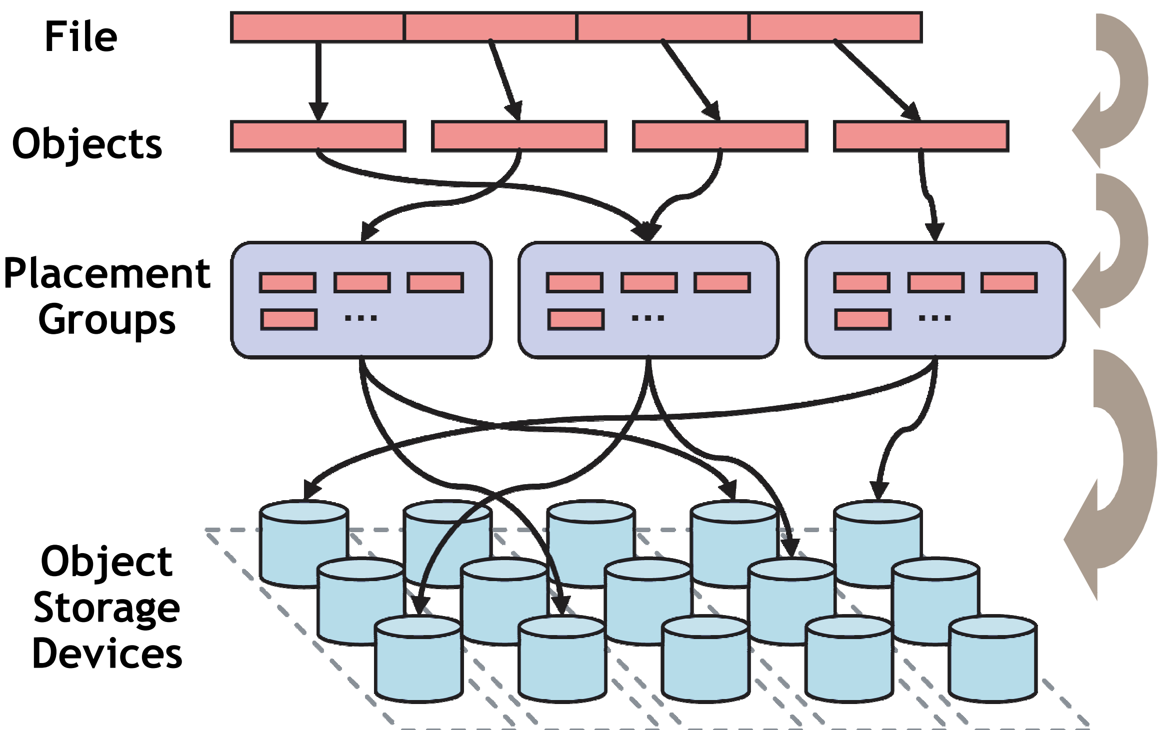
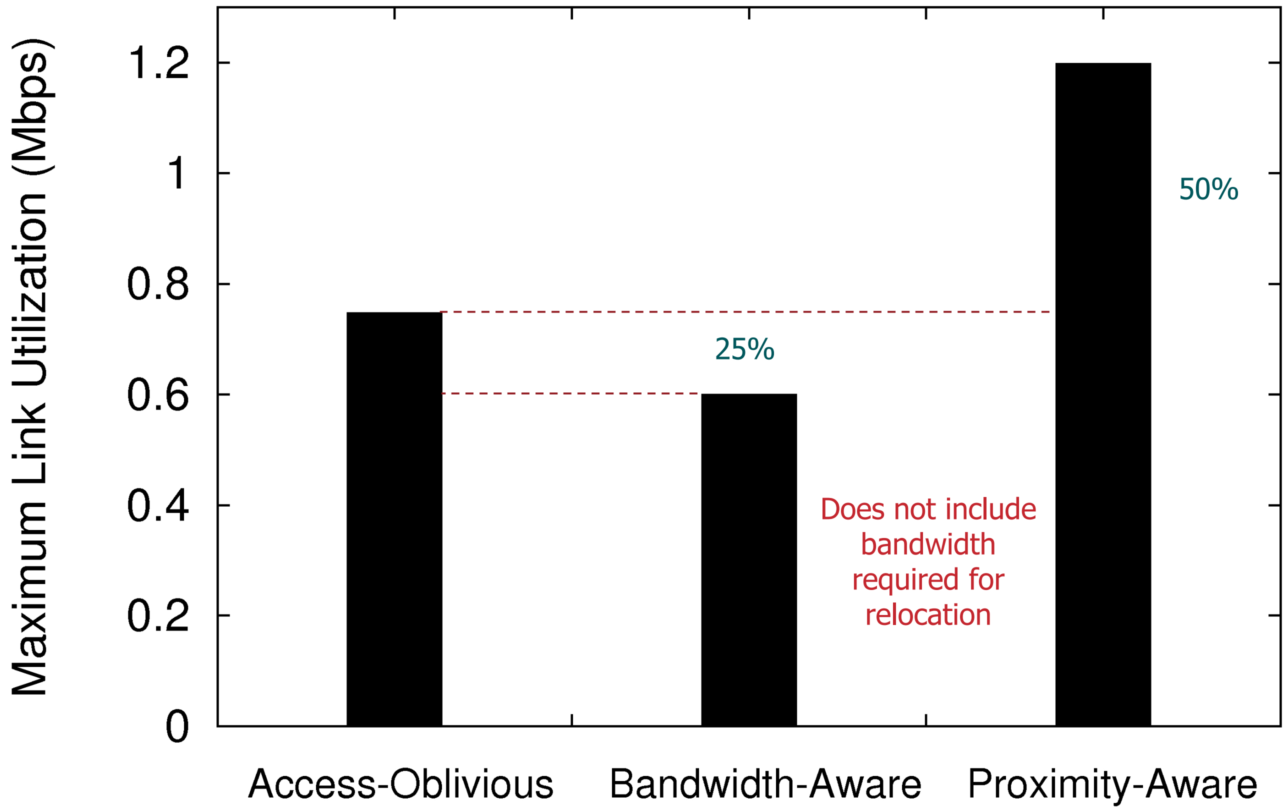
Data Placement in Distributed Storage Cloud



Ceph	Storage Cloud
ObjectID = (Inode, Object#)	ObjectID = (Inode, Object#)
PGID = hash (ObjectID)	PGID = UserLookup (UserID, MountLocation)
Placement(Object) = (osd1, osd4, osd5)	Placement(Object) = (osd1, osd4, osd5)

Experimental Results



- RocketFuel's router-level ISP maps with uniform link capacity
- YouTube access traces containing 1000 distinct users and 7,465 distinct video sessions, covering 6 hours
- Simulated using GTNetS

- **Bandwidth-Aware Provisioning:** Determines the optimal chunking and replication per-file such that the maximum link utilization remains minimized with changing access patterns.
- **Proximity-Aware Provisioning:** Splits and places files as close as possible (in terms of network hops) to the edge nodes accessing them, without considering link capacity constraints.

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Conclusion

- Enterprise-grade storage system tailor-made for a service provider's cloud
    - ✓ Custom design and architecture to exploit service providers' networked cloud
    - ✓ Implementation on Linux platform with popular file system interface for users

- Benefits of the proposed architecture
  - ✓ Storage provisioning with guaranteed performance using marginally extra bandwidth
    - New users can join easily at any location and new content can be ingested into the cloud so long as the bandwidth demands remain within the service limits
  - ✓ Significant reduction of operating costs of running a storage cloud by eliminating the need for shuffling content in the cloud to meet performance requirements with changing access patterns
  - ✓ Easy determination of provisioning request admission into the cloud

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