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# RACS: a case for cloud storage diversity

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# RACS: A Case for Cloud Storage Diversity

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## ABSTRACT

Cloud storage is becoming a popular way to store data. However, cloud storage is not a single technology, but a collection of different technologies. This paper presents RACS, a system for cloud storage diversity. RACS is designed to provide a high level of availability and reliability by storing data across multiple cloud providers. RACS also provides a high level of security by encrypting data before it is stored in the cloud. RACS is implemented as a user-space daemon that runs on top of the operating system. RACS is easy to use and can be deployed on a wide range of hardware and software configurations. RACS is currently being used by several research groups and is available for download from the RACS website.

Cloud storage, availability, reliability, security, user-space daemon, operating system, hardware, software configurations, research groups, RACS website.

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vendor lock-in: 100%

## Categories and Subject Descriptors

[Computer Systems Organization] Distributed Systems; [Operating Systems] Distributed File Systems; [Operating Systems] Fault-tolerance; [Software] Fault-tolerance.

## General Terms

Algorithms

## Keywords

Cloud storage, availability, reliability, security, user-space daemon, operating system, hardware, software configurations, research groups, RACS website.

## 1. INTRODUCTION

Cloud storage is becoming a popular way to store data. However, cloud storage is not a single technology, but a collection of different technologies. This paper presents RACS, a system for cloud storage diversity. RACS is designed to provide a high level of availability and reliability by storing data across multiple cloud providers. RACS also provides a high level of security by encrypting data before it is stored in the cloud. RACS is implemented as a user-space daemon that runs on top of the operating system. RACS is easy to use and can be deployed on a wide range of hardware and software configurations. RACS is currently being used by several research groups and is available for download from the RACS website.

SoCC'10, 2010

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$$r, \text{ where } r = \frac{m}{n} < 1, \text{ then } r = \frac{1}{2} \text{ if } n = 8, m = 4$$

$$\frac{1}{r} = \frac{n}{m} = \frac{8}{4} = 2, \text{ then } m = \frac{n}{2} = \frac{8}{2} = 4$$

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Tolerating Data Loss

Adapting to Price Changes

Adapting to New Providers

Control Monetary Spending

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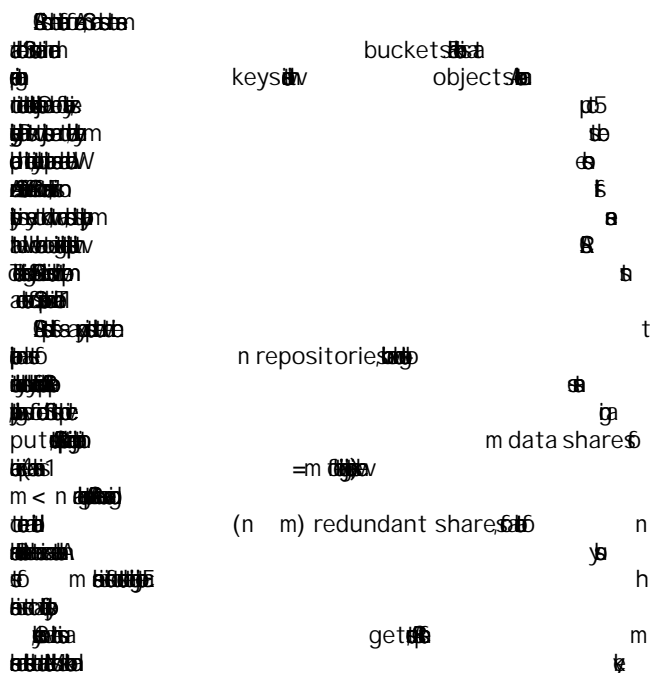
Choice in Data Recovery

Choice in Data Recovery

put	bucket, key, object
get	bucket, key
delete	bucket, key
create	bucket
delete	bucket
list	bucket
list	bucket

Table 1: Amazon S3 operations

### 3. DESIGN



$$n = m \cdot r \text{ (} r < 1 \text{)}$$

$$m = \frac{n}{r}$$

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$$r = \frac{1}{2} \text{ if } n = 8, m = 4$$

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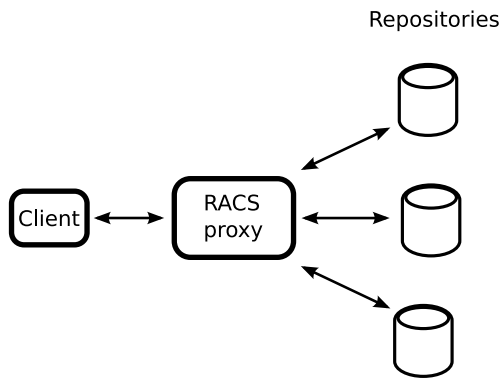


Figure 1: RACS single-proxy architecture

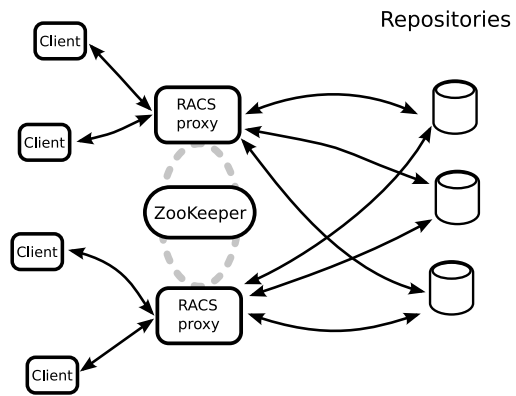


Figure 2: Multiple RACS proxies coordinate their actions using ZooKeeper

1. The client sends a request to the RACS proxy.  
 2. The RACS proxy checks the ZooKeeper for the location of the data.  
 3. The RACS proxy sends the request to the appropriate repository.  
 4. The repository returns the data to the RACS proxy.  
 5. The RACS proxy returns the data to the client.

### 3.2 Failure Recovery

1. The client sends a request to the RACS proxy.  
 2. The RACS proxy checks the ZooKeeper for the location of the data.  
 3. The RACS proxy sends the request to the appropriate repository.  
 4. The repository returns the data to the RACS proxy.  
 5. The RACS proxy returns the data to the client.

### 3.3 Policy Hints

1. The client sends a request to the RACS proxy.  
 2. The RACS proxy checks the ZooKeeper for the location of the data.  
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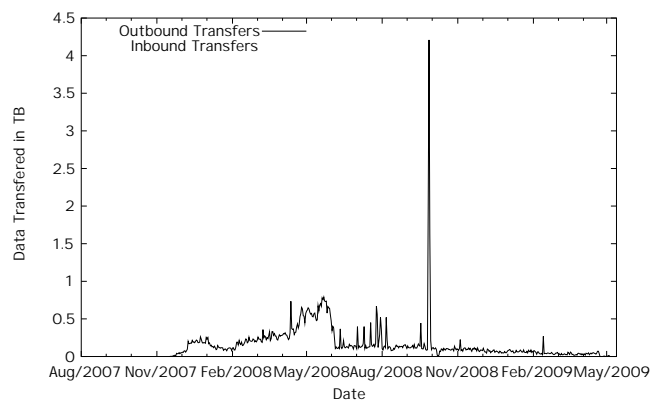
### 3.4 Repository Adapters

1. The client sends a request to the RACS proxy.  
 2. The RACS proxy checks the ZooKeeper for the location of the data.  
 3. The RACS proxy sends the request to the appropriate repository.  
 4. The repository returns the data to the RACS proxy.  
 5. The RACS proxy returns the data to the client.

### 3.5 Performance Overhead

1. The client sends a request to the RACS proxy.  
 2. The RACS proxy checks the ZooKeeper for the location of the data.  
 3. The RACS proxy sends the request to the appropriate repository.  
 4. The repository returns the data to the RACS proxy.  
 5. The RACS proxy returns the data to the client.





	\$	\$	\$	\$	\$	\$
put	\$	\$	\$	\$	\$	\$
get	\$	\$	\$	\$	\$	\$
delete	\$	\$	\$	\$	\$	\$
put list	\$	\$	*			
get list	\$	\$				

Table 2: Simplified pricing schemes of different cloud storage providers.

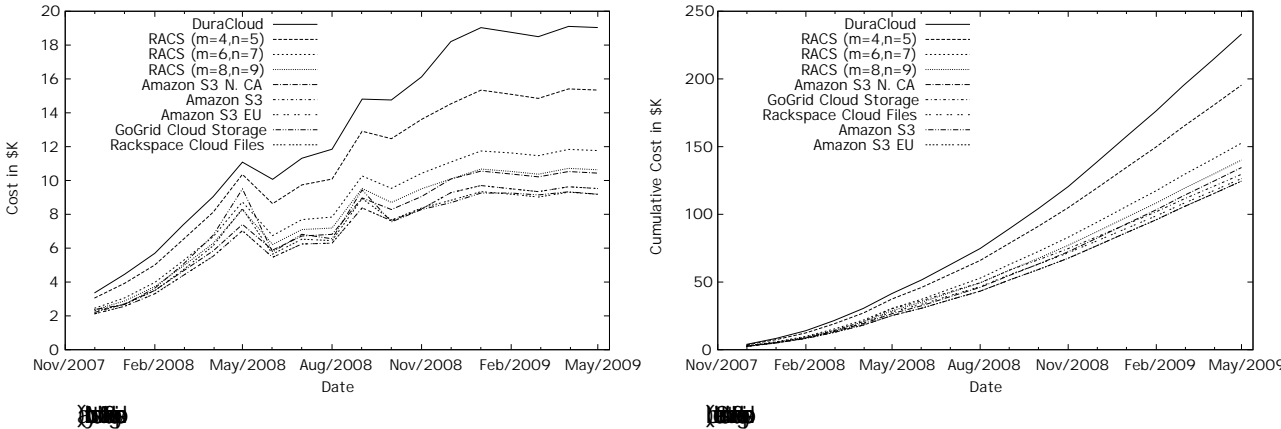


Figure 5: Estimated monthly and cumulative costs of hosting in the cloud

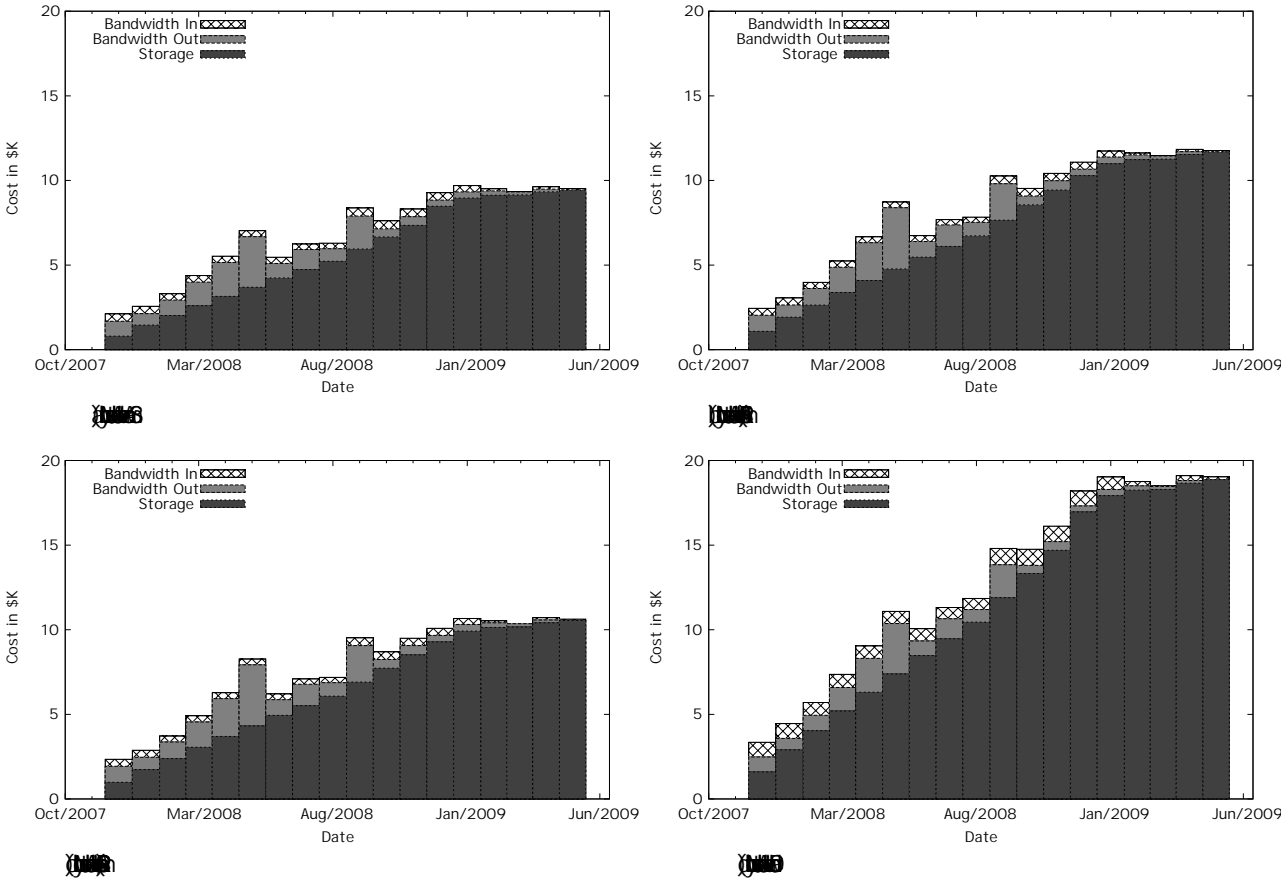


Figure 6: Breakdown of cloud storage costs



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					P	P	P	P
put	list			2	3	0	7	
get				0	8	8	8	
add	9	8	8	6				
del	0		3	3	2			
top	0	0	0	0				
pop	0	0	0	0				
push		0	0	0	0			
peek			1	5	3	5		
empty			1	5	2	8		

Table 3: Upload Snapshot Benchmark. Amazon S3 and estimated Rackspace (RS) costs. Monthly cost is the same for both

	put	list	get	del	del	del	del
put	1	0	0	0	0	0	0
list	0	1	0	0	0	0	0
get	0	0	1	0	0	0	0
del	0	0	0	1	0	0	0
del	0	0	0	0	1	0	0
del	0	0	0	0	0	1	0
del	0	0	0	0	0	0	1

Table 4: Restore Snapshot Benchmark. Amazon S3 and estimated Rackspace (RS) costs.

# Vendor Migration Impact

Restore snapshot **2/2**

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~~Page 5~~

Family  
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 Employment

1. **Introduction**  
 2. **Methodology**  
 3. **Results**  
 4. **Discussion**  
 5. **Conclusion**

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Table 5: Vendor Migration Benchmark. Amazon S3 and estimated Rackspace (RS) costs.

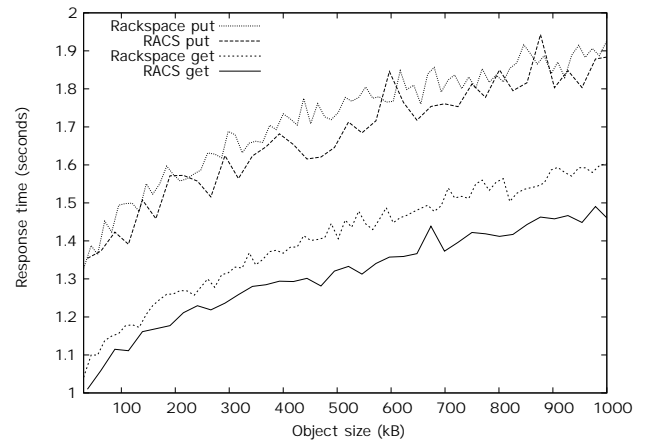


Figure 9: How long it takes RACS and Rackspace to handle object put and get requests, as a function of object size. All response times averaged over four runs.

## 5.2 Performance

## 6. RELATED WORK

[illegible]

## 7. CONCLUSIONS

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## 8. FUTURE WORK

[illegible]

## 9. AVAILABILITY


  
 The McGraw-Hill Companies

## 10. ACKNOWLEDGMENTS

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