Disaster Recovery as a Cloud Service:
Economic Benefits and Deployment Challenges

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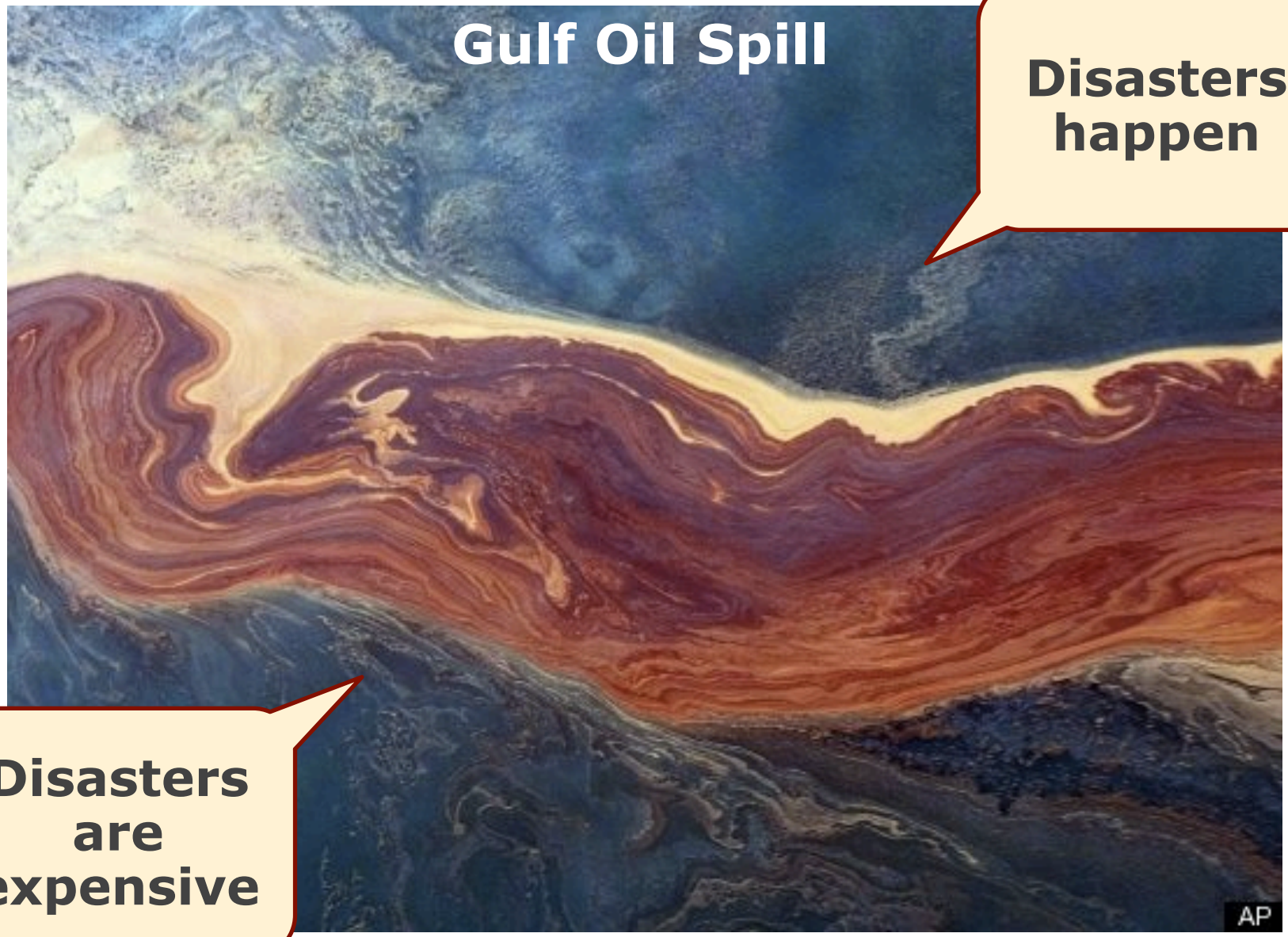

Gulf Oil Spill
Disasters happen
Disasters are expensive
AP

Data Center Disasters

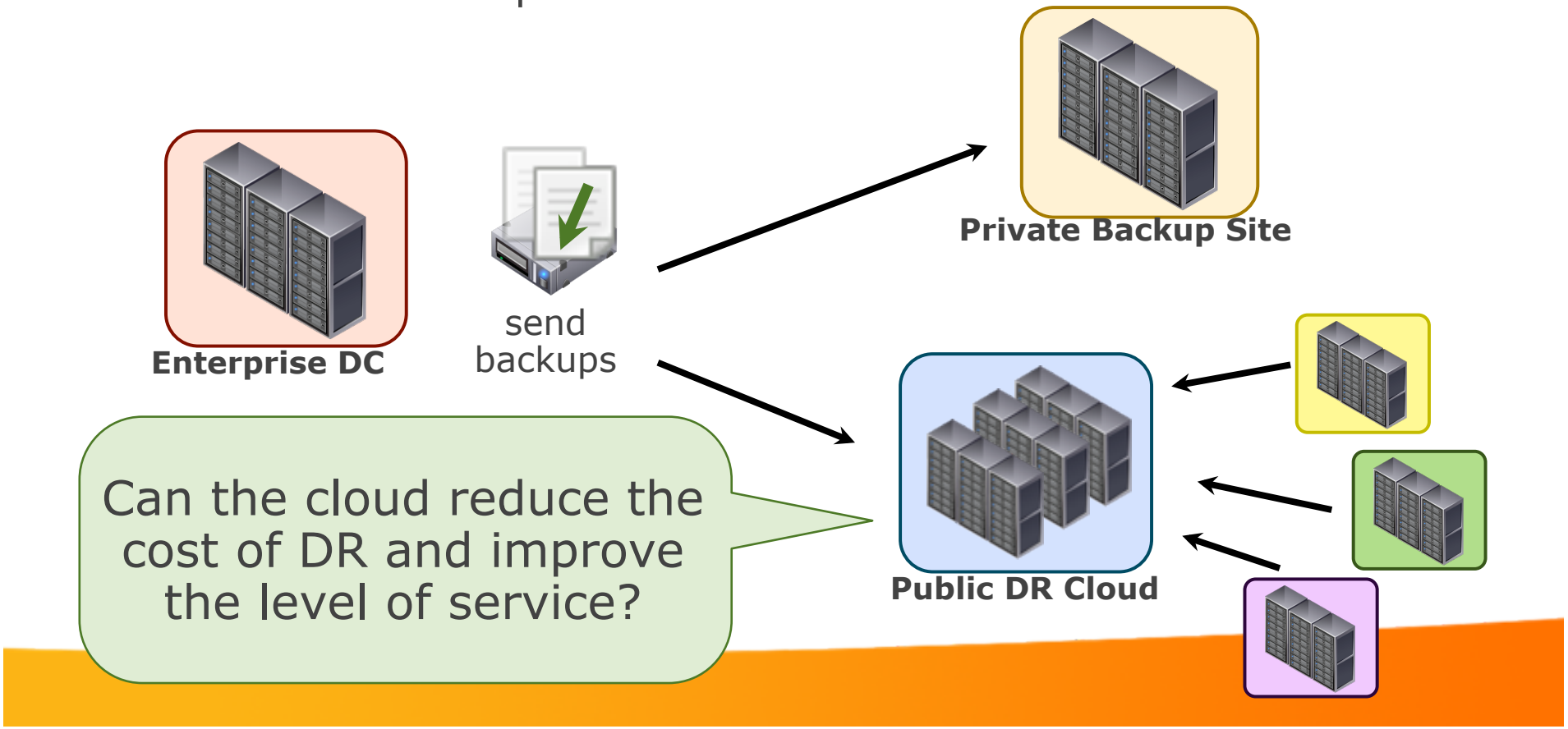
- Disasters cause expensive application downtime

- Truck crash shuts down Amazon EC2 site (May 2010)
- Lightning strikes EC2 data center (May 2009)
- Comcast Down: Hunter shoots cable (2008)
- Squirrels bring down NASDAQ exchange (1987 and 1994)

Need plans and systems in place to recover from disasters

Disaster Recovery

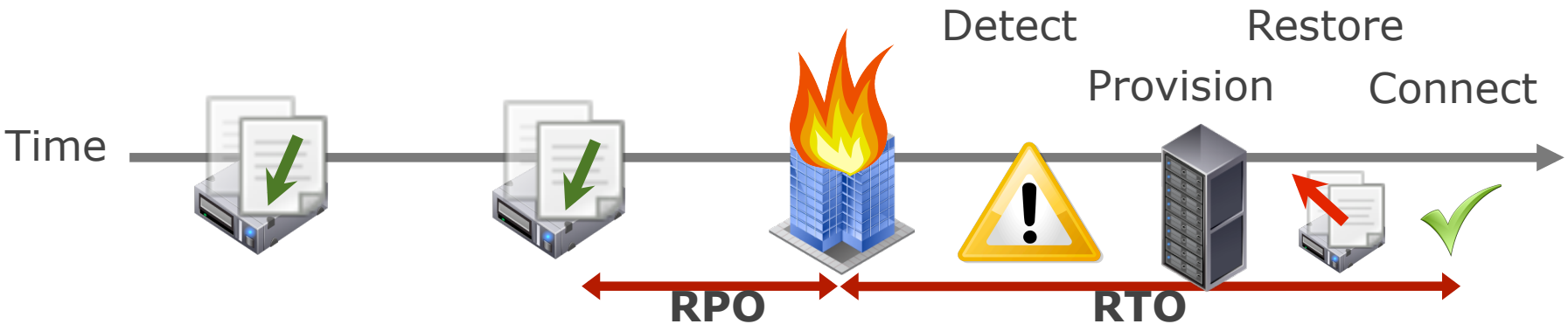
- Use DR services to prevent lengthy service disruptions
- Long distance data backups + failover mechanism
  - Periodically replicate state
  - Switch to backup site after disaster



DR Metrics

- DR Goal: minimize data loss, downtime, and cost

- Recovery Point Objective (RPO)
  - Amount of tolerable data loss
- Recovery Time Objective (RTO)
  - Acceptable system downtime



We focus on RPO and RTO > 0

Why DR Fits in the Cloud

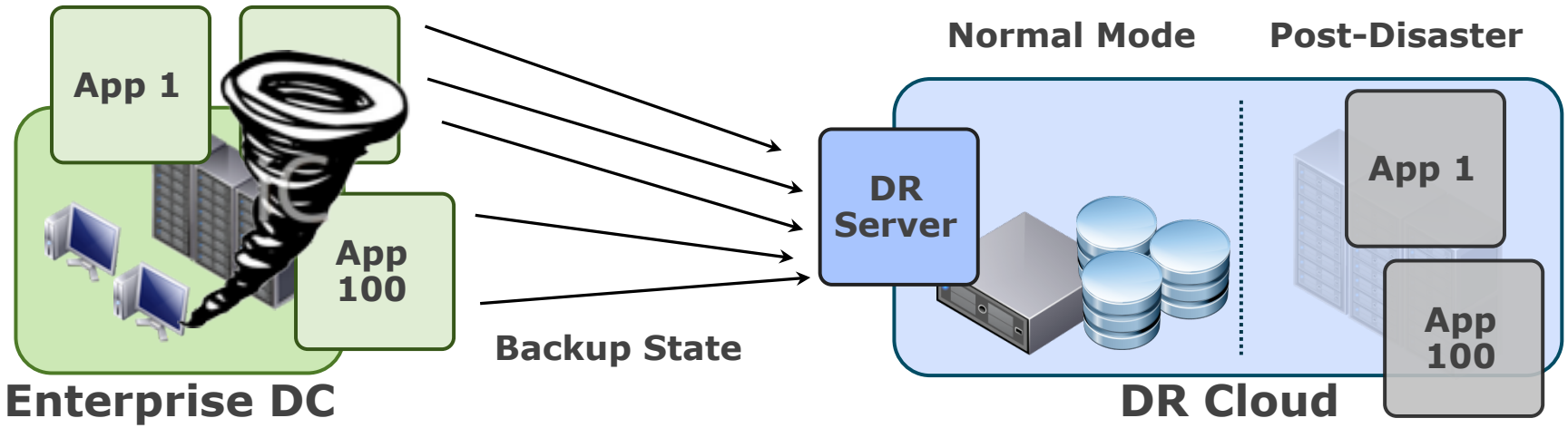
- **Customer**: pay-as-you-go and elasticity
  - "Normal" case is cheap (need few resources to make backups)
    - Lower cost for a given RPO
  - Can rapidly scale up resources after disaster is detected
    - Cloud's virtualized infrastructure reduces RTO
    - Can allow for **business continuity**
- **Provider**: High degree of multiplexing
  - Customers will not all fail at once
  - Can offer extra services like disaster detection

Is the cloud an economical platform for DR today?

What additional features are needed?

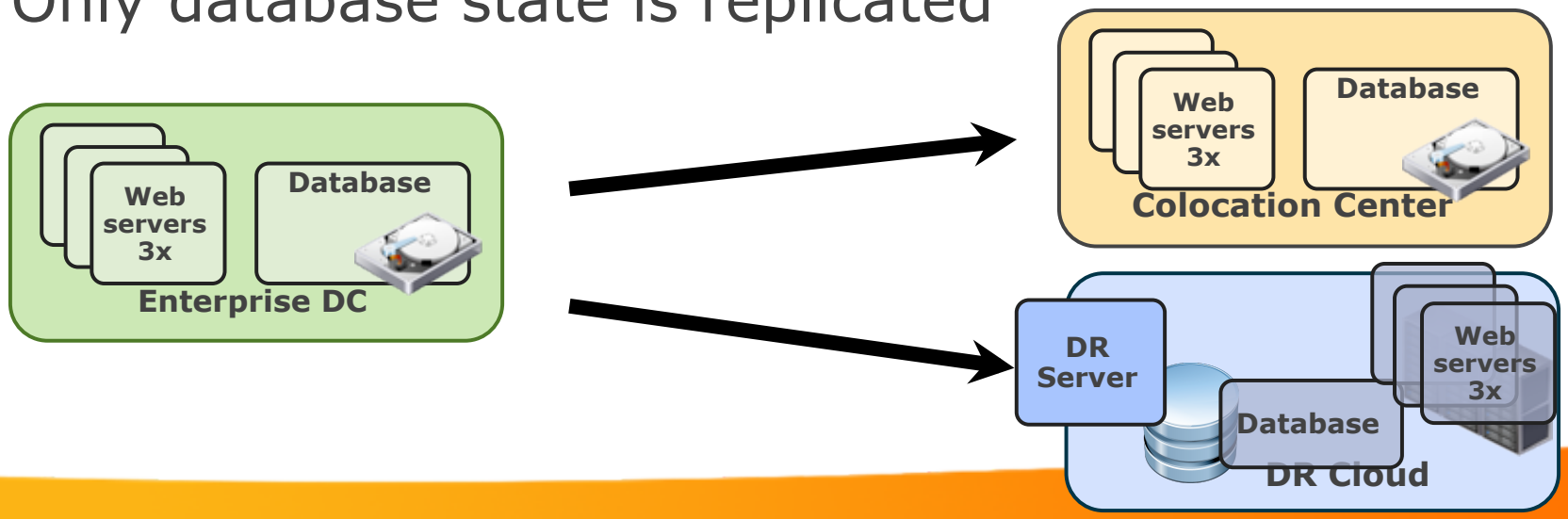
DR on Demand

- Warm Backup Site
  - Cheaply synchronize state during normal operation
  - Obtain additional DR resources on demand after failure
  - Short delay to provision and initialize applications



Cost Analysis Scenario

- Compare the cost of DR in Colocation center to Cloud
- Colo case pays for servers and space at all times
- Cloud DR only pays for resources as they are used
- Case 1: RUBiS ebay-like multi-tier web application
  - 3 web front ends
  - 1 database server
- Only database state is replicated

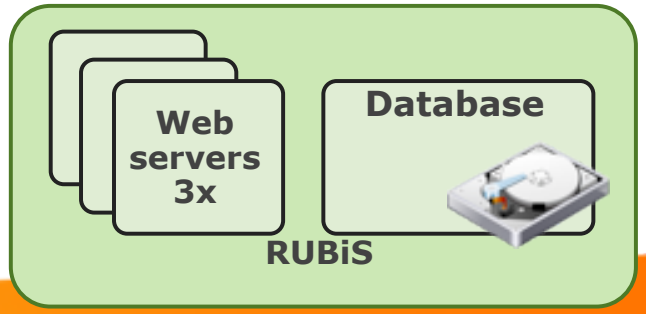


Cost Analysis: Colocation vs Cloud

- **Normal Case**
  - Resources needed to replicate DB state
- **Post-Disaster**
  - Resources needed to run all application components

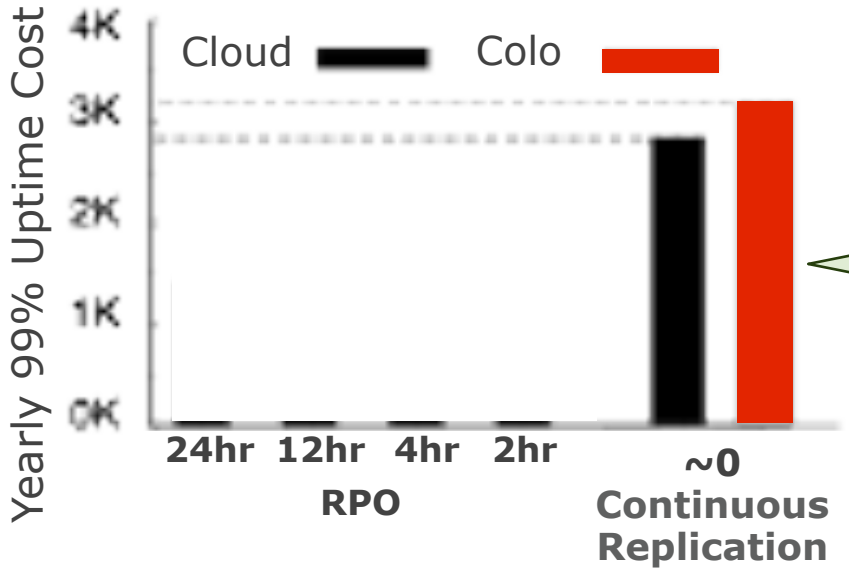
	Normal Case	Post-Disaster
Servers	colo = 4 servers cloud = 1 VMs	colo = 4 servers cloud = 5 VMs
Network	5 GB/day	180 GB/day
Colocation:	$28.04/day	$66.01/day
Cloud:	$3.80/day	$52.03/day

- **99% Uptime cost (3 days of disaster per year)**
  - Colo: **$10,373 per year**
  - Cloud: **$1,562 per year**



RPO vs Cost Tradeoff

- Case 2: Data Warehouse
  - Post-disaster twice as expensive with Cloud
    - Cloud charges premium for high powered VM instance
  - Cloud still cheaper overall due to lower normal case costs
- Cloud allows tradeoff between RPO and cost
  - Only pay for DR server during periodic backups in cloud



Colo center pays server and space costs regardless of RPO!

Cost Analysis Summary

- Benefits of cloud computing depend on:
  - Type of resources required to run application
  - Variation between normal mode and post-disaster costs
  - RPO and RTO requirements
  - Likelihood of disaster

Cloud has greatest benefit when **post disaster** cost much **higher** than **normal mode**

Provider Challenges

- **Revenue Maximization**
  - Mainly makes income from storage in "normal" case
    - But must pay for servers and keep them available
  - Can use pricing mechanism such as **spot instances**
    - Rent resources but be able to quickly reclaim for DR
  - Rent **priority resources** at higher cost that are guaranteed to be available

- **Correlated Failures**
  - Large disasters could affect many customers simultaneously
  - Cloud provider must
    - Use a risk model to decide how many resources to own for DR
    - Spread out customers to minimize impact of correlated failures

More DR Challenges

- **Planning**
  - Use models to help understand tradeoff between cost and RPO/RTO for a given application and workload
- **Efficient state replication**
  - Minimize the bandwidth and cloud server costs in the normal case
- **Post Disaster Failover**
  - Enable business continuity by minimizing recovery time
  - Automated/virtualized cloud infrastructure can lower RTO

Summary

- Cloud based Disaster Recovery
  - Can substantially reduce cost for customer
    - Particularly when server cost varies before/after disaster
  - Provides flexible tradeoff between cost and RPO
  - Can lower recovery time, enable business continuity
  - Provider must handle correlated failures

- Open challenges
  - How many resources must provider reserve for DR?
  - How to seamlessly transfer network connections?
  - How to fail back to primary site after disaster passes?

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Cost Details

RUBiS	Public Cloud		Colocation	
	Replication	Failover	Replication	Failover
Servers	$2.04	$32.64	$26.88	$26.88
Network	$0.54	$18.00	$1.16	$39.14
Storage	$1.22	$1.39	–	–
Total per day	$3.80	$52.03	$28.04	$66.01
Total per year	$1,386	$18,992	$10,234	$24,095
99% uptime cost	**$1,562 per year**		**$10,373 per year**	

Data Warehouse	Public Cloud		Colocation	
	Replication	Failover	Replication	Failover
Servers	$4.08	$12.00	$8.51	$8.51
Network	$0.10	$0.12	$0.22	$0.26
Storage	$3.50	$3.92	–	–
Total per day	$7.68	$16.04	$8.73	$8.77
Total per year	$2,802	$5,853	$3,186	$3,202
99% uptime cost	**$2,832 per year**		**$3,186 per year**	

Enabling Business Continuity

- Business continuity allows applications to keep working after a disaster
  - Crucial for critical business/government services
- Virtualized cloud infrastructure can lower RTO
  - Automates VM creation and cloning
  - Cloud can also help with disaster detection
- Many remaining challenges
  - How to ensure application is revived in a consistent/correct state?
  - How to redirect traffic to failover site?

DR Requirements

- Recovery Point Objective (RPO)
  - Amount of tolerable data loss
- Recovery Time Objective (RTO)
  - Acceptable system downtime
- Performance
  - Impact on normal operation and after recovery
- Consistency
  - Correctness of application data and outputs
- Geographic Separation
  - DR site should not be affected by same disaster

What is the cloud good for?

- Cloud platforms are best for users who have variable needs over time
  - Customers only pay for what they use
  - Providers get economy of scale and can multiplex resources for many customers
- Applications well matched for the cloud:
  - Web sites with growing or variable demand
  - Infrequent compute intensive jobs (monthly payroll)
- and...
  - **Disaster recovery!**