Distributed Databases, Cyber: Storage

5 January 2025
Lecture 9

Topics for Today

- Distributed Databases
- Cyber: Storage and Naming

Consistent Hashing

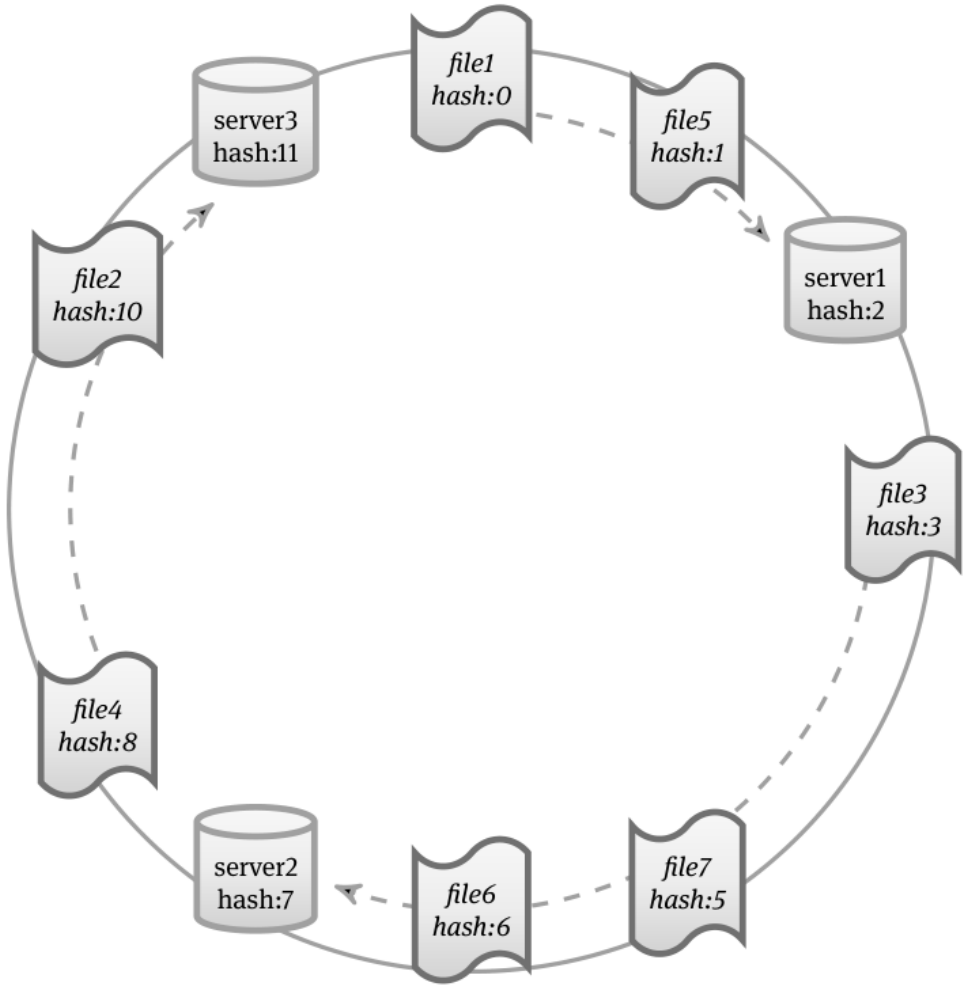


Fig. 11.3. Data allocation with consistent hashing

- Each Server gets a random ID
  - Should put things randomly in the name space
- Each Entity gets a random ID
  - Should put things randomly in the name space
- Result: Even distribution!

- Assign responsibility to the Server that succeeds the Entity's ID

Consistent Hashing Entry and Exit

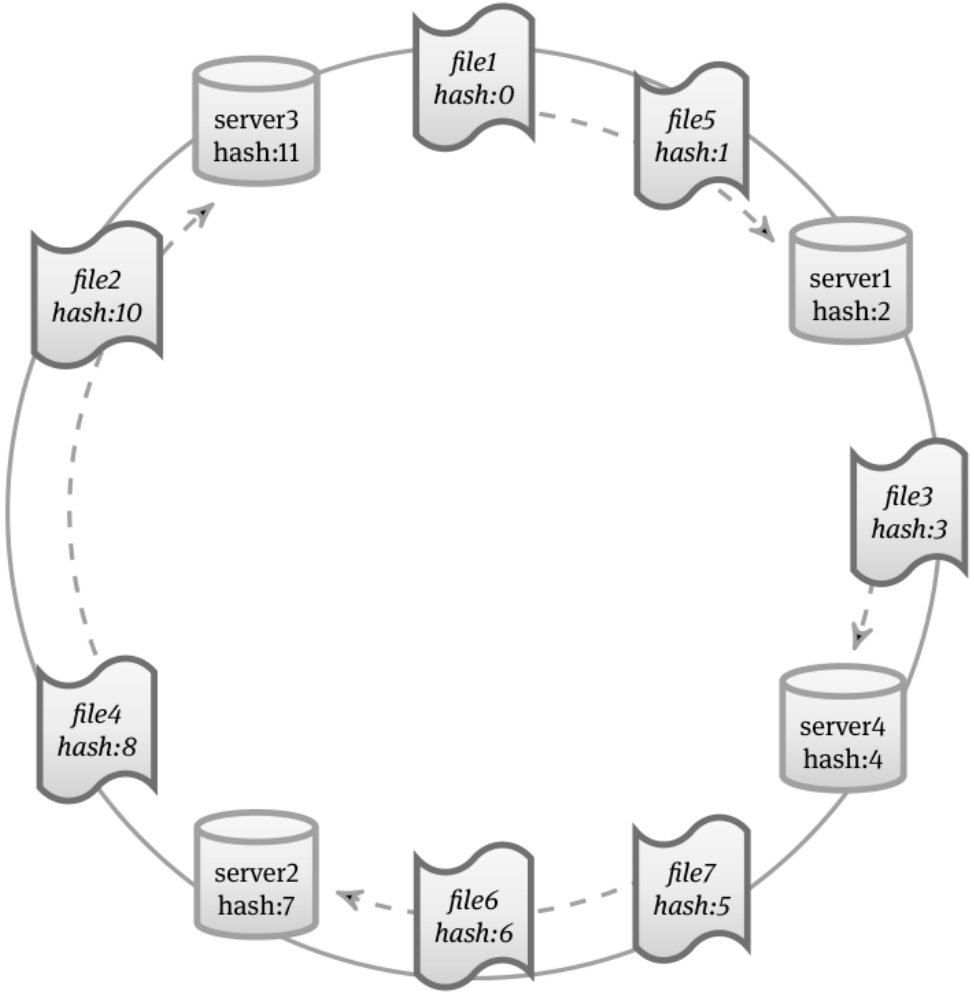


Fig. 11.5. Server addition with consistent hashing

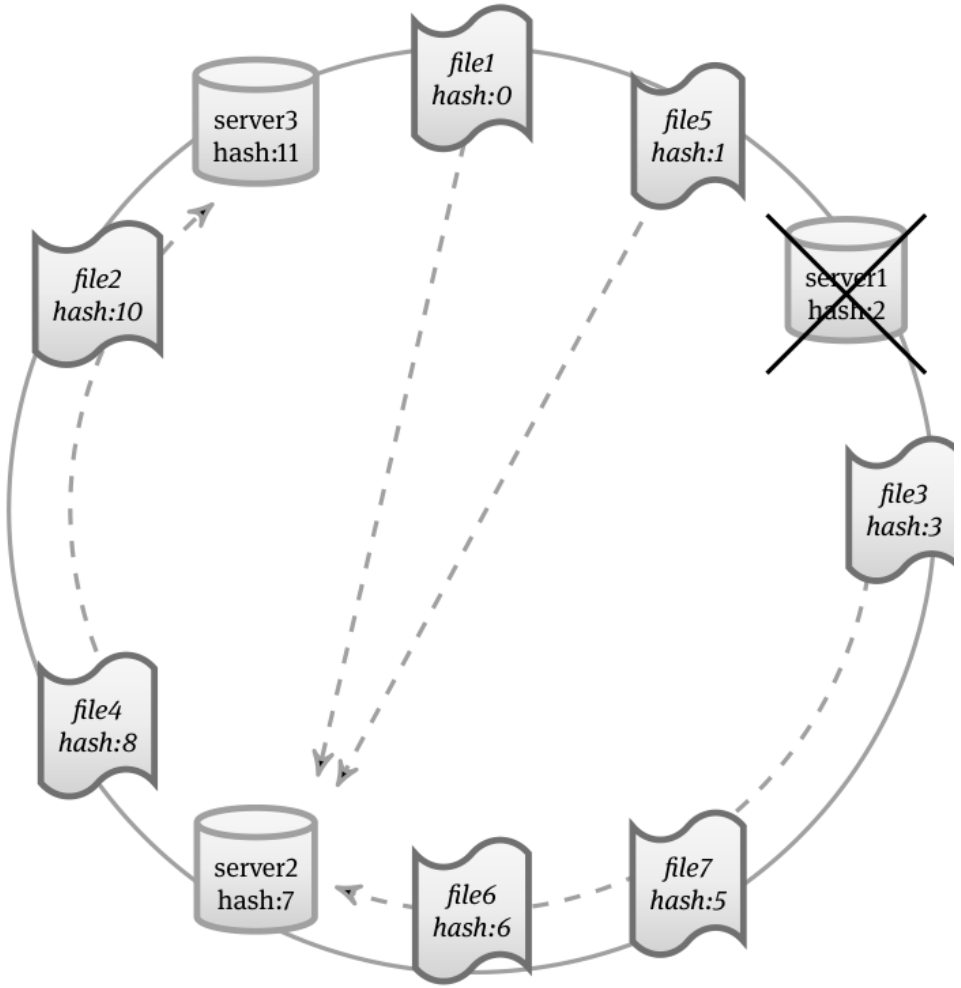


Fig. 11.4. Server removal with consistent hashing

Consistent Hashing Variations

"Virtual Servers"

- Each server has multiple IDs
- Each ID leads to responsibilities
- Stronger server → More IDs
- Weaker server → Less IDs

- Gradual entry → A new node takes IDs up bit by bit until it's full

Dynamic Reassignment

- Divide the ring into X partitions for X servers
- Server enters → Reallocate partitions for all
- Server exits → Reallocate partitions for remaining

Backups

- Multiple assignments of IDs per entity
- Server nodes with overlapping responsibilities

Replication Techniques: Master-Slave

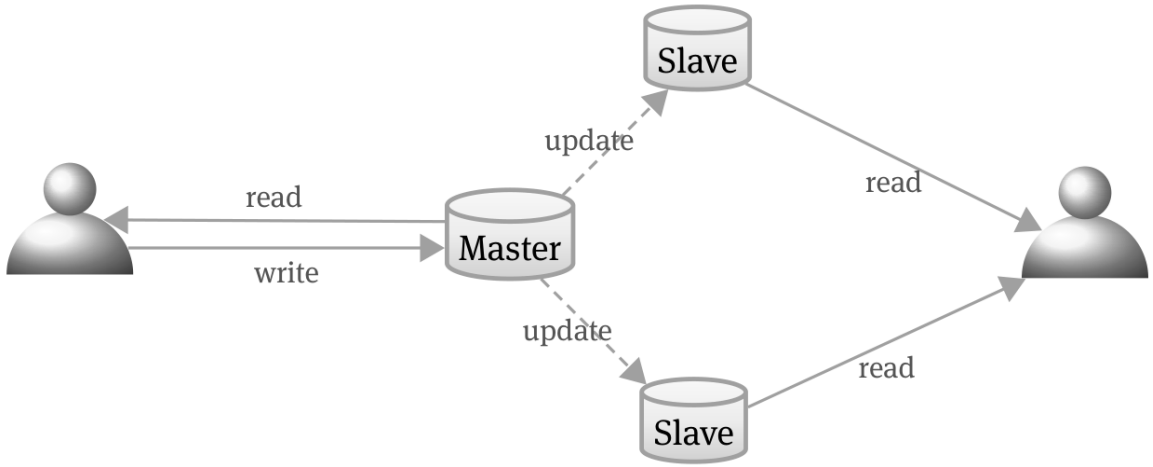


Fig. 12.1. Master-slave replication

- A single node handles all writes (master)
- It updates all replicas (slaves)
- Read from any node

- Slows things down a lot – can make a Master per partition
  - Smaller area of responsibility

Master-Slave Replication

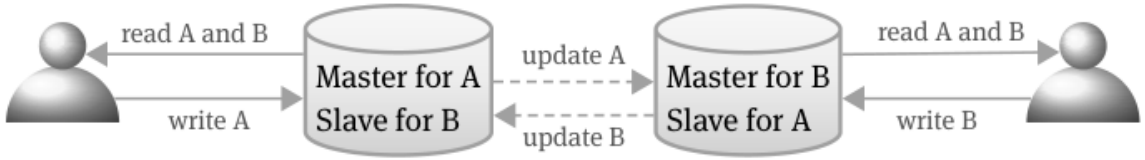


Fig. 12.2. Master-slave replication with multiple records

- Here A and B are Masters of different parts
- Can break responsibility down at different data levels
  - Table
  - Row
  - Data element

Multi-Master Replication

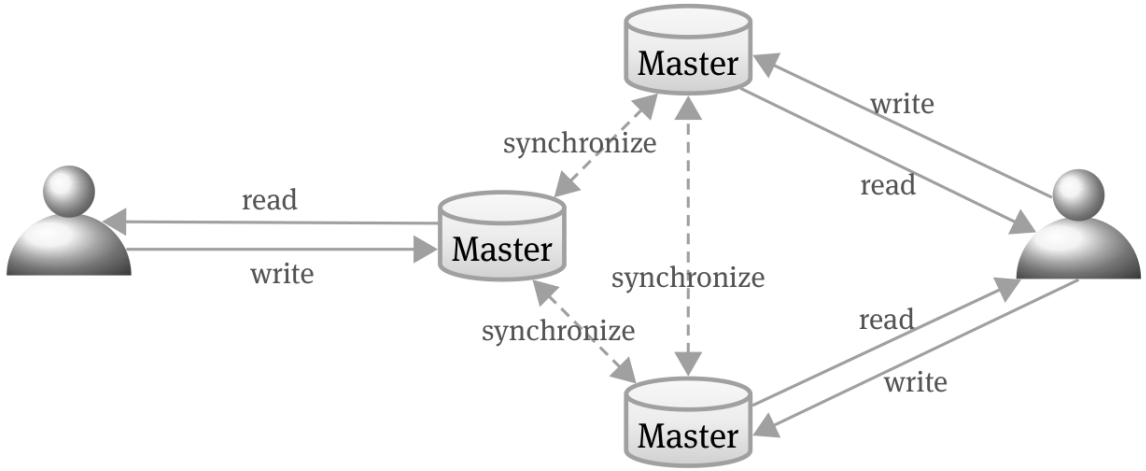


Fig. 12.3. Multi-master replication

- Peer-to-peer replication
- Any where can read or write
- Consistency?
- How do nodes update each other to prevent stale reads?
  - Remember epidemics?

Synchronization Problems

Master-Slave

Master fails

Master fails before it updates all slaves

Slave takes over, the master returns

Master fails, Slave takes over, Slave fails, Master returns

Multi-Master

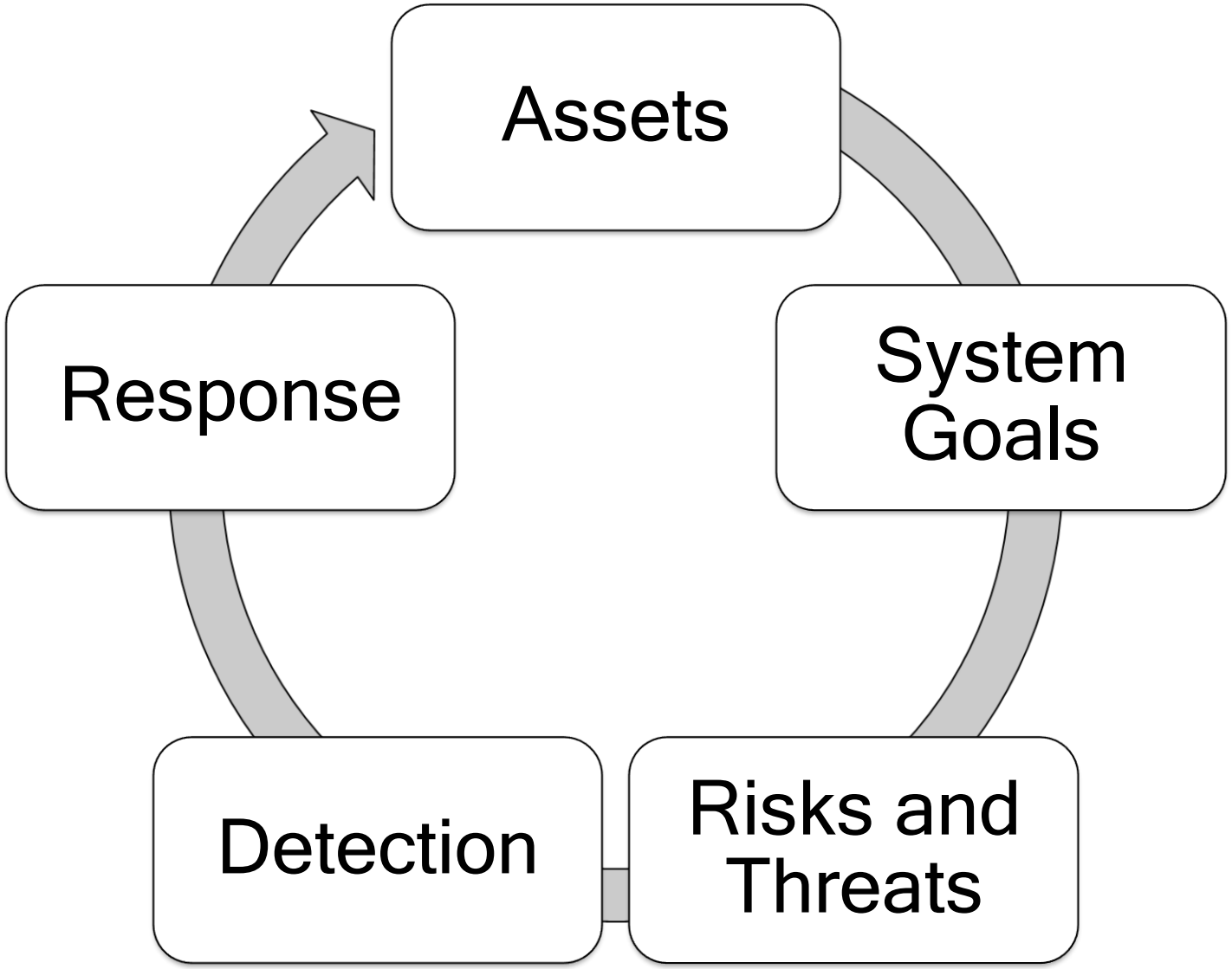
Master 1 receives update, fails before Master 2 gets update

Master 1 and Master 2 receive updates at same time

So Far

- Distributed Databases
- Cyber: Storage and Naming

Distributed Data Storage Cyber Security



Assets – Distributed Databases

Database Servers	Network Attached Storage (NAS)	Laptop hard drives	Desktop hard drives
Cloud databases	Hosted databases	File servers	Cloud document servers
	Image and media storage	Protected personal information (PII)	

Etc.

Assets – Naming Services

Name storage	Name resolution mechanisms	Name resolution servers
Mappings from names to resources	Trackers of resources and name update tools	Naming policies enforcers

System Goals

Data accessibility by users
- on-premises
- Off-premises

Data access
- From apps
- From web

Data integrity
- Who updated
- Where updated
- Why updated

Tracking of data access

Name resolution to resources

Compliance with
- Privacy laws and rules
- Internal organizational rules

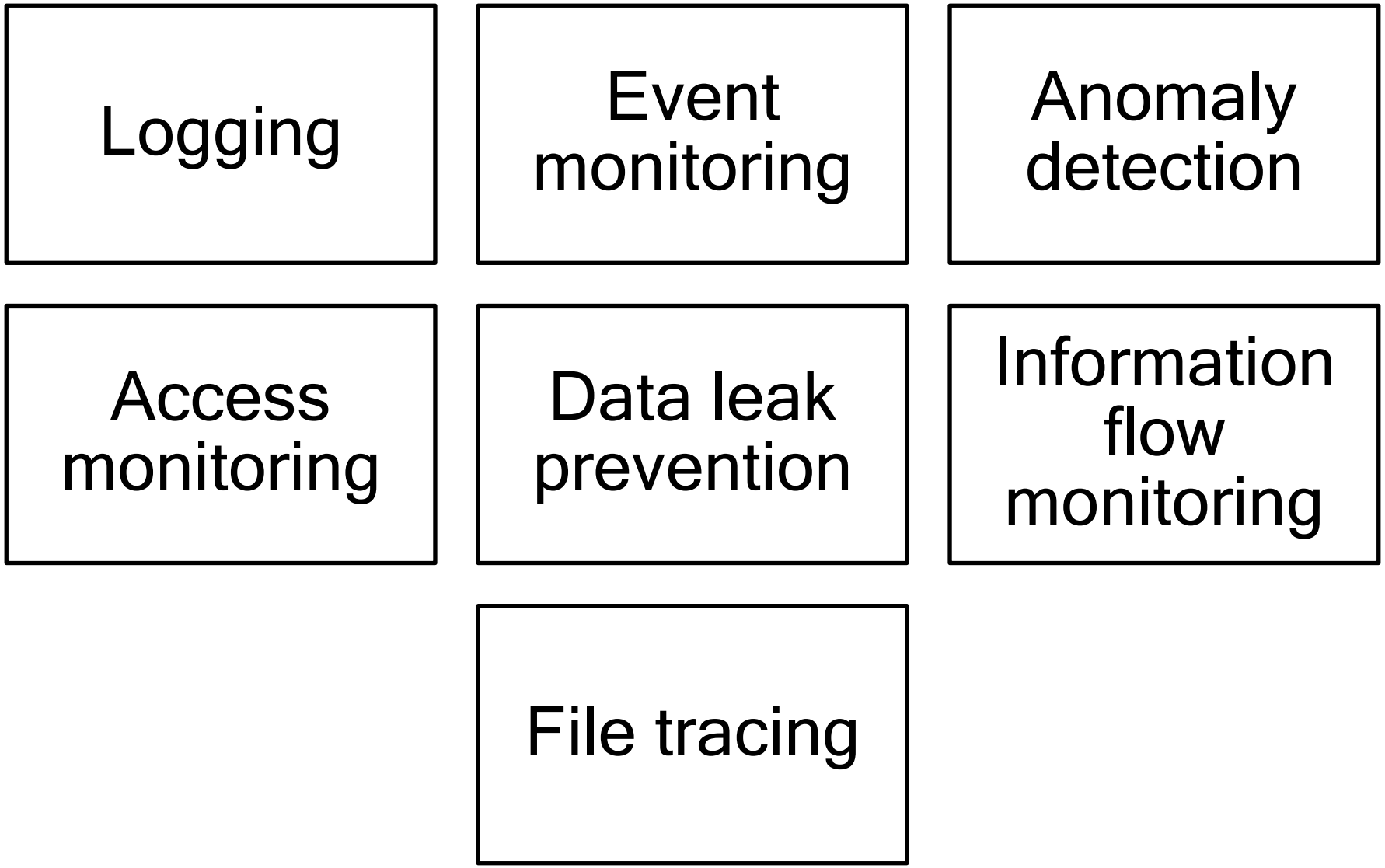
Auditing
- Access by authorized users
- Access by non-authorized users

Logging
- Event detection
- Anomaly detection
- Warnings

Risks and Threats

Unauthorized data access	Data exfiltration	Data corruption • Data encryption • Ransomware
Insider access to protected data	Inconsistent data protection policies	Insufficient data protection/encryption
Loss of data control	Loss of data access	Naming services failure

Detection


Logging
Event monitoring
Anomaly detection
Access monitoring
Data leak prevention
Information flow monitoring
File tracing

Response

Monitor network anomalies

- Close unknown connection endpoints
- Prevent large data transfers to unknown targets
- Deep packet inspection to find data exiting

Data fingerprinting to watch for exfiltration

User monitoring

Access monitoring

Automatic event notification and log notification

Some stories

+1

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Blog > Security > Ransomware Devastating MySQL Servers

Ransomware Devastating MySQL Servers

Ophir Harpaz

https://www.akamai.com/blog/security/please-read-me-opportunistic-ransomware-devastating-mysql-servers

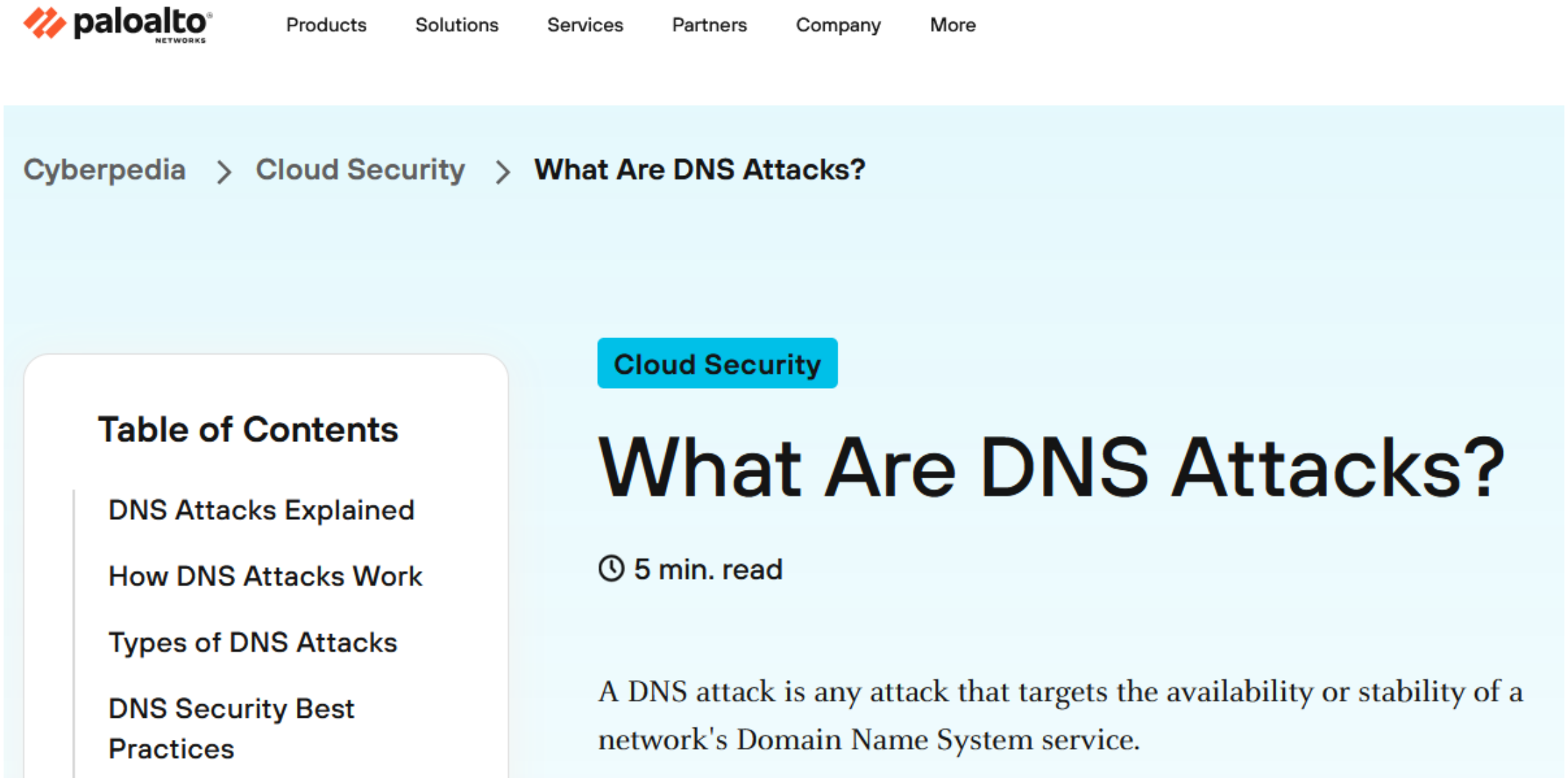
Ransomware attacks on storage happen all the time

https://spin.ai/resources/ransomware-tracker/

Name	State or Country	Date	Type
SRP Federal Credit Union	South Carolina	12/23/2024	Finances
Telecom Namibia	Namibia	12/16/2024	Communication Technologies
Compass Communications	New Zealand	12/13/2024	Communication Technologies
Rhode Island State Benefits System	Rhode Island	12/13/2024	Government
Taylor Regional Hospital	Georgia	12/13/2024	Healthcare
Ainsworth Game Technology	Australia	12/12/2024	Manufacturing
WACER	Australia	12/12/2024	Cleaning
Fresh Produce Safety Centre Australia & New Zealand	Australia	12/12/2024	Food
National Museum of the Royal Navy	UK	12/12/2024	Museum

DNS under attack

https://www.paloaltonetworks.com/cyberpedia/what-is-a-dns-attack



DNS under attack

Bright Product Resources Partners Company

Resources > Blog > What is DNS Attack and How To Prevent Them

Published: May 29, 2022

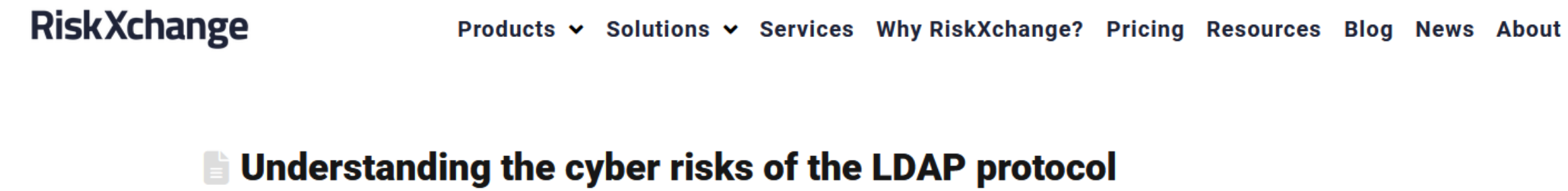
What is DNS Attack and How To Prevent Them

Admir Dizdar

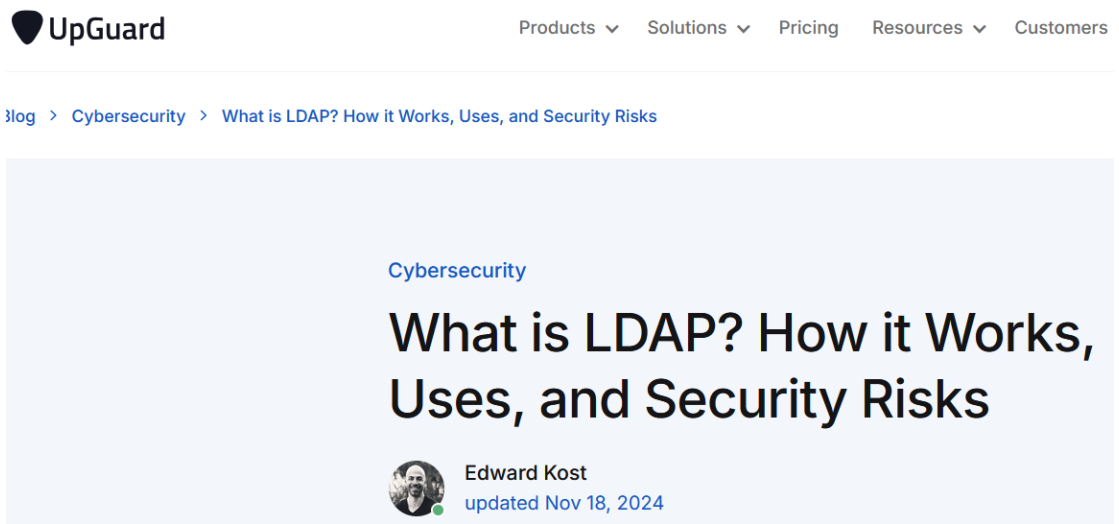
AppSec Testing

https://brightsec.com/blog/dns-attack/

LDAP Security Risks



https://riskxchange.co/4821/cyber-risks-of-ldap-protocol/



https://www.upguard.com/blog/ldap

Conclusion

- Distributed Databases
- Cyber: Storage and Naming