Big Data and Hadoop

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Data is the new oil. - Clive Humby, 2006.

What Comes Next?

byte

kilobyte

megabyte

gigabyte

??

???

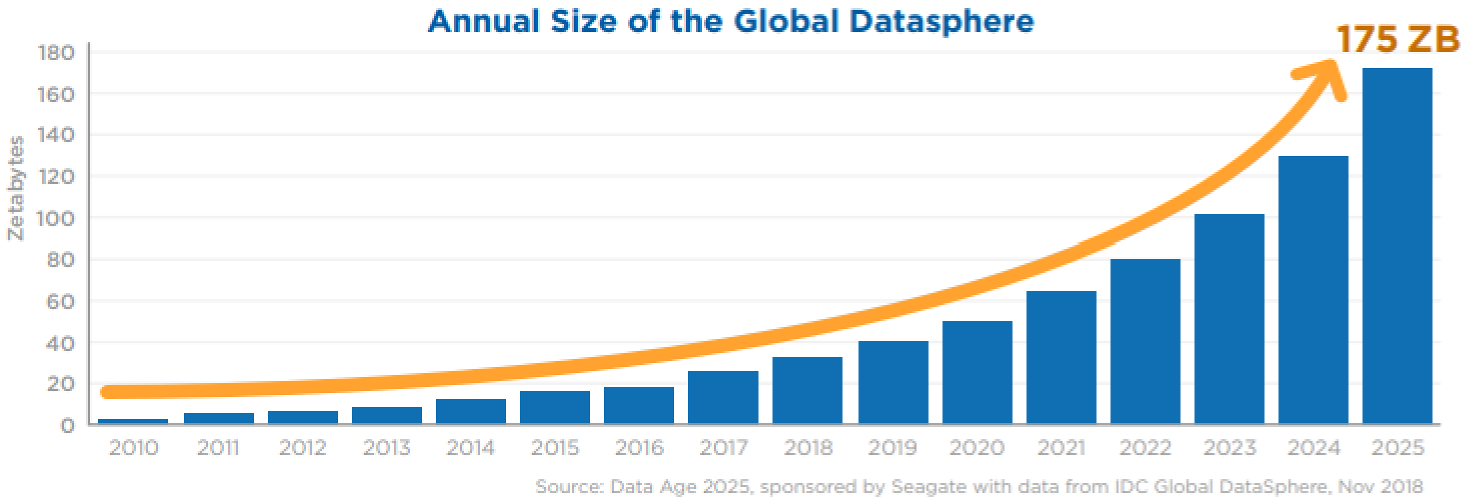
????

?????

Sizes

Name	Size
Byte	8 bits
Kilobyte	1024 bytes
Megabyte	1024 kilobytes
Gigabyte	1024 megabytes
Terabyte	1024 gigabytes
Petabyte	1024 terabytes
Exabyte	1024 petabytes
Zettabyte	1024 exabytes
Yottabyte	1024 zettabytes

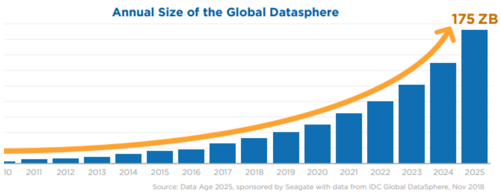
Data Growth



Mankind's quest to digitize the world!
33 ZB (2018) → 175 ZB (2025)
size of global datasphere*

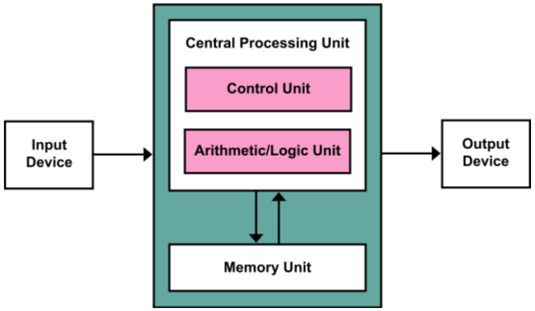
*Source: https://www.seagate.com/files/www-content/our-story/trends/files/idc-seagate-dataage-whitepaper.pdf

Evolution of Data and Computers

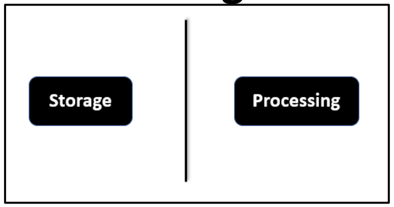


Source: Data Age 2025, sponsored by Seagate with data from IDC Global DataSphere, Nov 2018

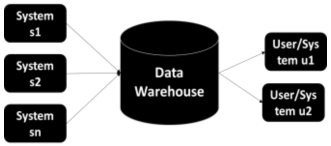
Von Neumann Arch

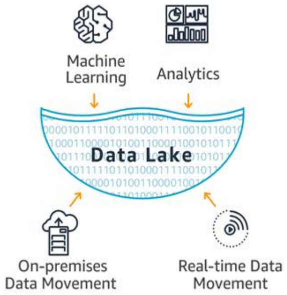


Challenges



Data Storage



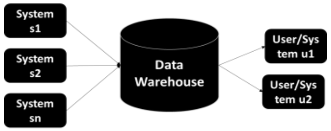


Amazon S3

STaaS

Recap

Data Storage



System s1

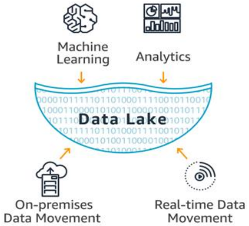
System s2

System sn

Data Warehouse

User/System u1

User/System u2



Machine Learning

Analytics

Data Lake

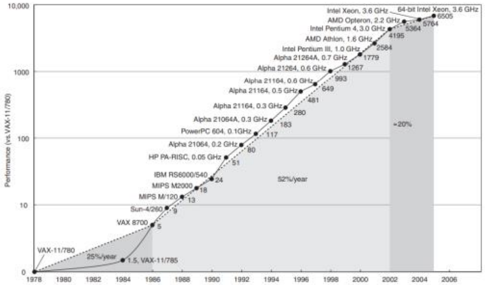
On-premises Data Movement

Real-time Data Movement

Amazon S3

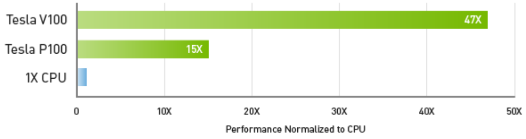
STaaS

Data Processing



CPU Performance

47X Higher Throughput Than CPU Server on Deep Learning Inference



Workload: ResNet-50 | CPU: 1X Xeon E5-2690v4 @ 2.6 GHz | GPU: Add 1X Tesla P100 or V100

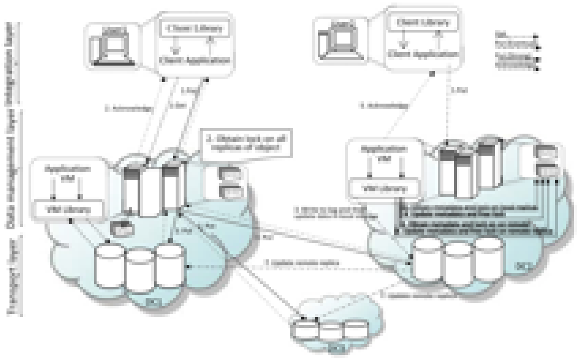
GPU Performance

SuperComputers

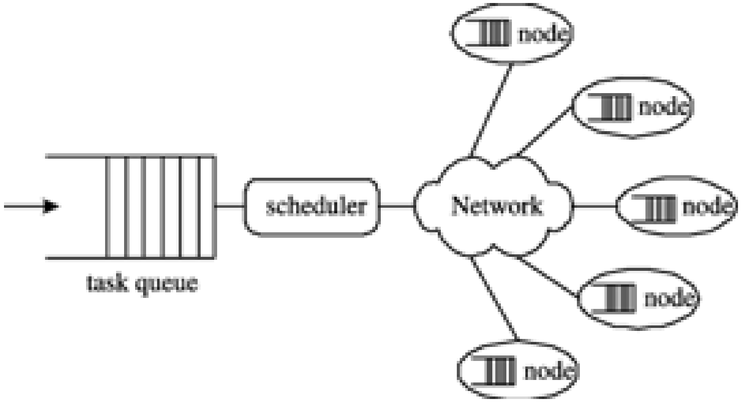
Cloud Computing

Two kinds of Big Data Opportunities

Storage



Processing



So, we have the cloud. But, how to store and retrieve data? How to process jobs?

Role of File Systems

Partitioning

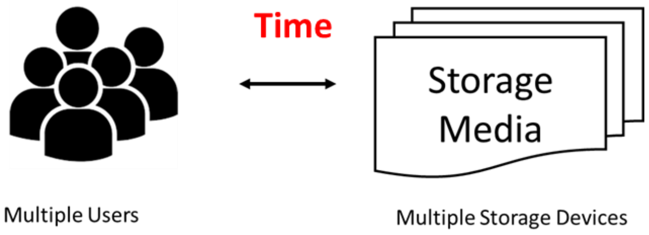
Multiple OS, Multiple File Systems

Compression

High Data Transfer Time

Defragmentation

High Seek Time



File Allocation, Free Space Management

Space Utilization

Multi-Tenancy & data privacy

Permissions and Sharing

Data Variety

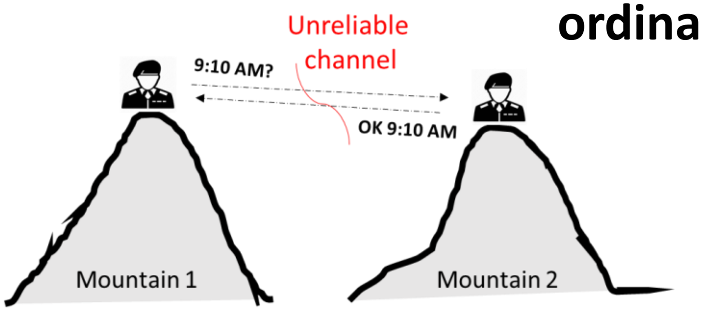
Naming Convention - Standards

File systems are key to handling data.

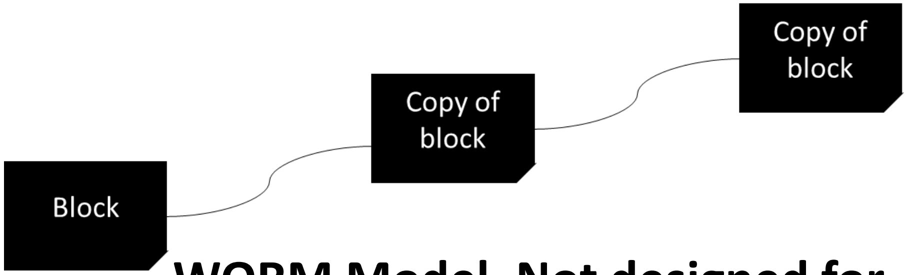
Variety of FS exist
NTFS, FAT, DOS, CDFS, NFS, …

Distributed Systems

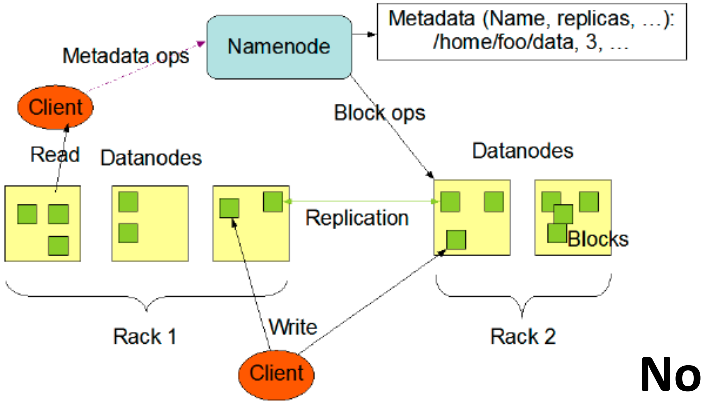
Not designed for co-ordination jobs.



General's Paradox



WORM Model. Not designed for write-many (interactive) jobs.



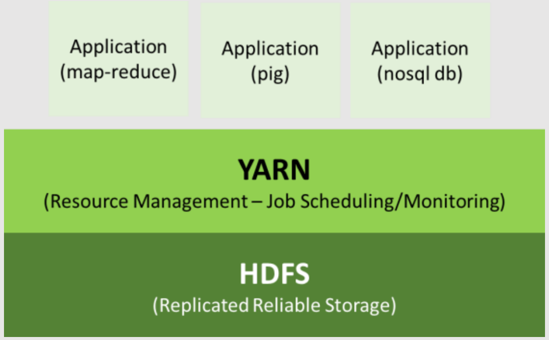
Not designed for small files.

Hadoop and Map Reduce

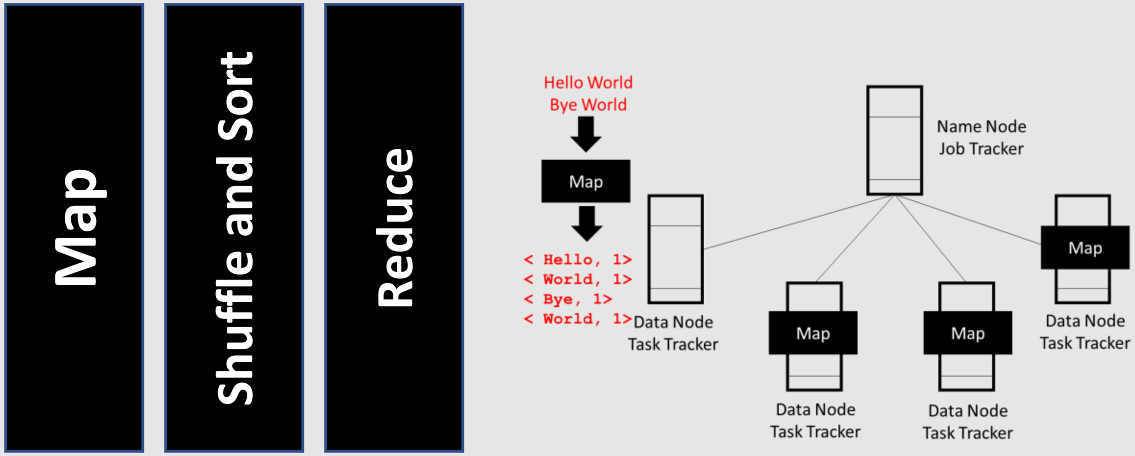
When not to use Hadoop?

No Interactive Jobs
No Jobs Requiring Co-ordination
No Small Files

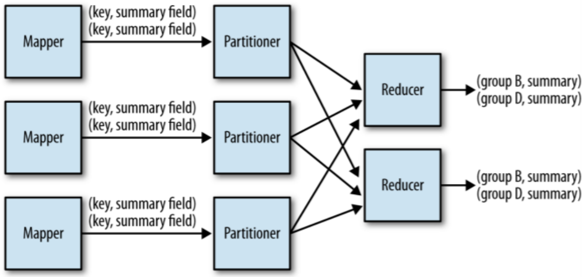
Hadoop Architecture


Application
(map-reduce)
Application
(pig)
Application
(nosql db)
YARN
(Resource Management – Job Scheduling/Monitoring)
HDFS
(Replicated Reliable Storage)

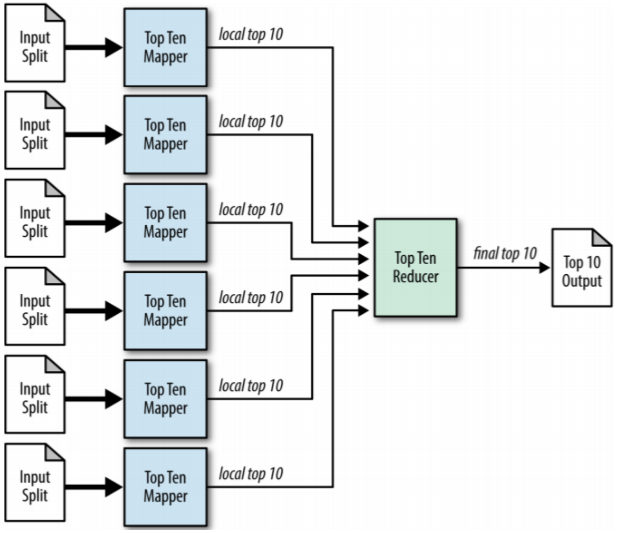
Map-reduce Model



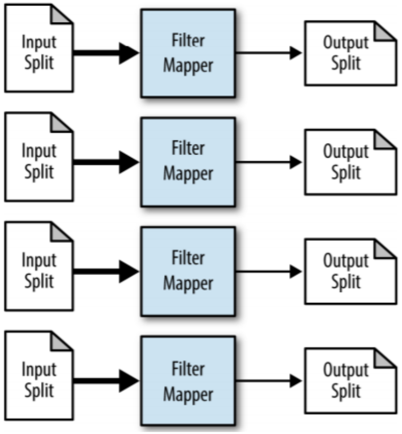
Map-Reduce Patterns



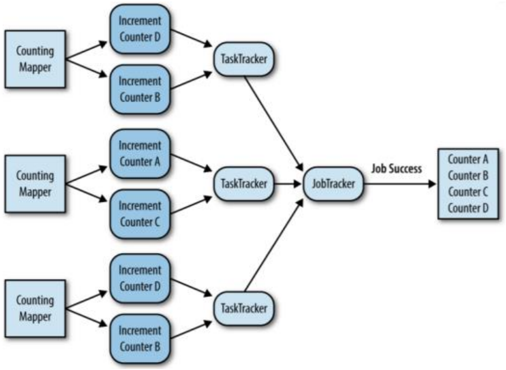
Summarization



Top 10

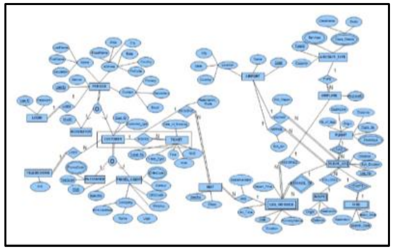


Filtering



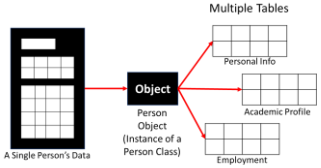
Counting

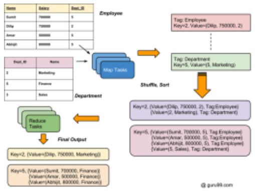
NoSQL



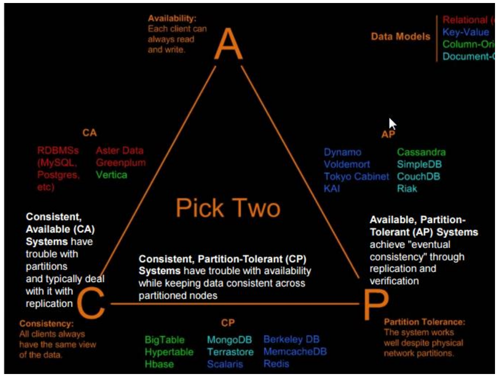
Schema-based Relational Model - maintenance problems

Impedance Mismatch




Employee
Department
Map Tasks
Tag: Employee Key=2, Value=(Dilip, 750000, 2)
Tag: Department Key=5, Value=(5, Marketing)
Shuffle, Sort
Key=2, (Value=(Dilip, 750000, 2), Tag:Employee) (Value=(2, Marketing), Tag: Department)
Key=5, (Value=(Sumit, 700000, 5), Tag:Employee) (Value=(Amar, 500000, 5), Tag:Employee) (Value=(Abhijit, 800000, 5), Tag:Employee) (Value=(5, Sales), Tag: Department)
Reduce Tasks
Final Output
Key=2, (Value=(Dilip, 750000, Marketing))
Key=5, (Value=(Sumit, 700000, Finance)) (Value=(Amar, 500000, Finance)) (Value=(Abhijit, 800000, Finance))
@ guru99.com

Scale-up Challenges


Availability: Each client can always read and write.
A
Data Models
Relational (
Key-Value
Column-Ori
Document-(
CA
RDBMSs (MySQL, Postgres, etc)
Aster Data
Greenplum
Vertica
AP
Dynamo
Voldemort
Tokyo Cabinet
KAI
Cassandra
SimpleDB
CouchDB
Riak
Pick Two
Consistent, Available (CA) Systems have trouble with partitions and typically deal with it with replication
Available, Partition-Tolerant (AP) Systems achieve "eventual consistency" through replication and verification
Consistent, Partition-Tolerant (CP) Systems have trouble with availability while keeping data consistent across partitioned nodes
C
P
Consistency: All clients always have the same view of the data.
CP
BigTable
Hypertable
Hbase
MongoDB
Terrastore
Scalaris
Berkeley DB
MemcacheDB
Redis
Partition Tolerance: The system works well despite physical network partitions.

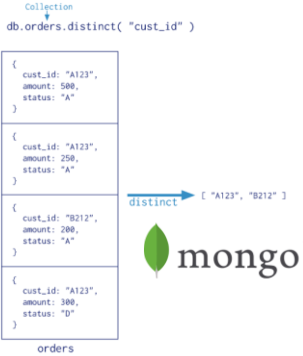
CAP Theorem

Types of NoSQL datastores

Key-Valuecv

```
redis> GET nonexisting
(nil)
redis> SET mykey "Hello"
"OK"
redis> GET mykey
"Hello"
redis>
```

Doc-based

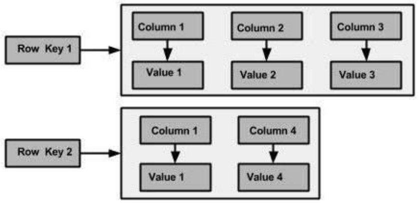


```
db.orders.distinct( "cust_id" )
```

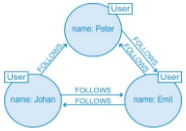
```
{
  cust_id: "A123",
  amount: 500,
  status: "A"
}
{
  cust_id: "A123",
  amount: 250,
  status: "A"
}
{
  cust_id: "B212",
  amount: 200,
  status: "A"
}
{
  cust_id: "A123",
  amount: 300,
  status: "D"
}
```

```
[ "A123", "B212" ]
```

Columnar DB

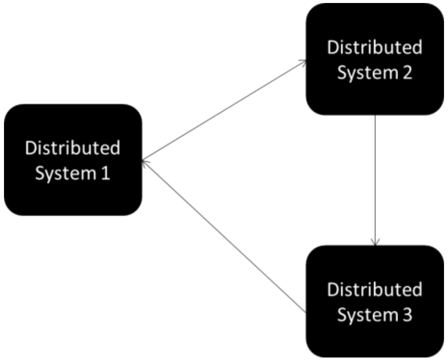


Graph DB

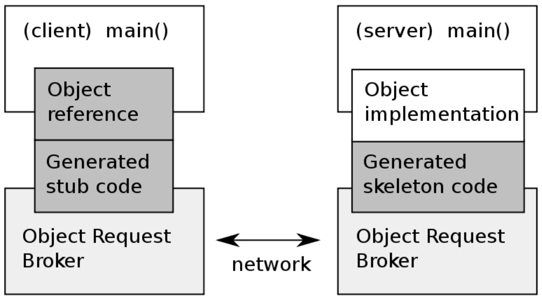


Web Services

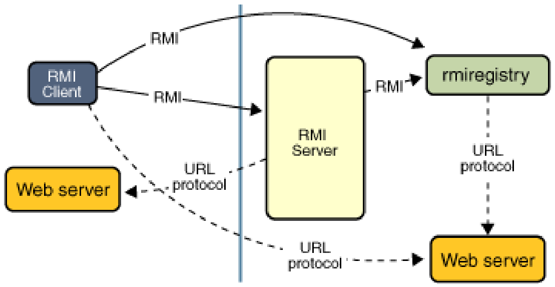
Interoperability



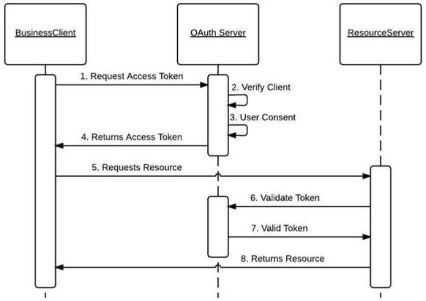
CORBA



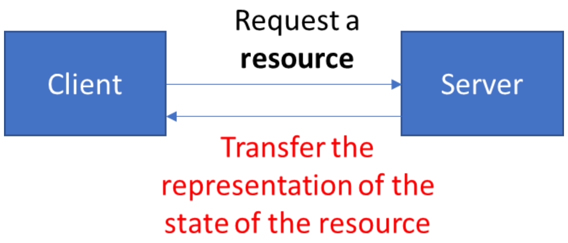
RMI

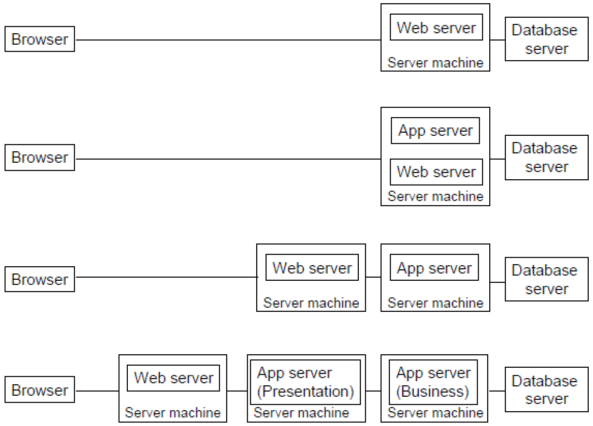


oAuth



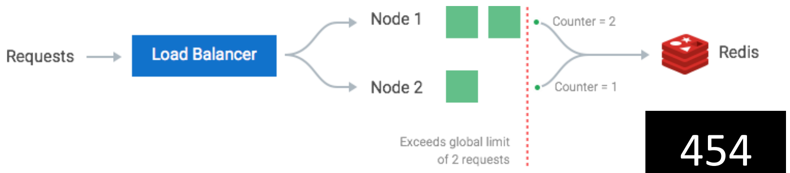
Web Services with REST API



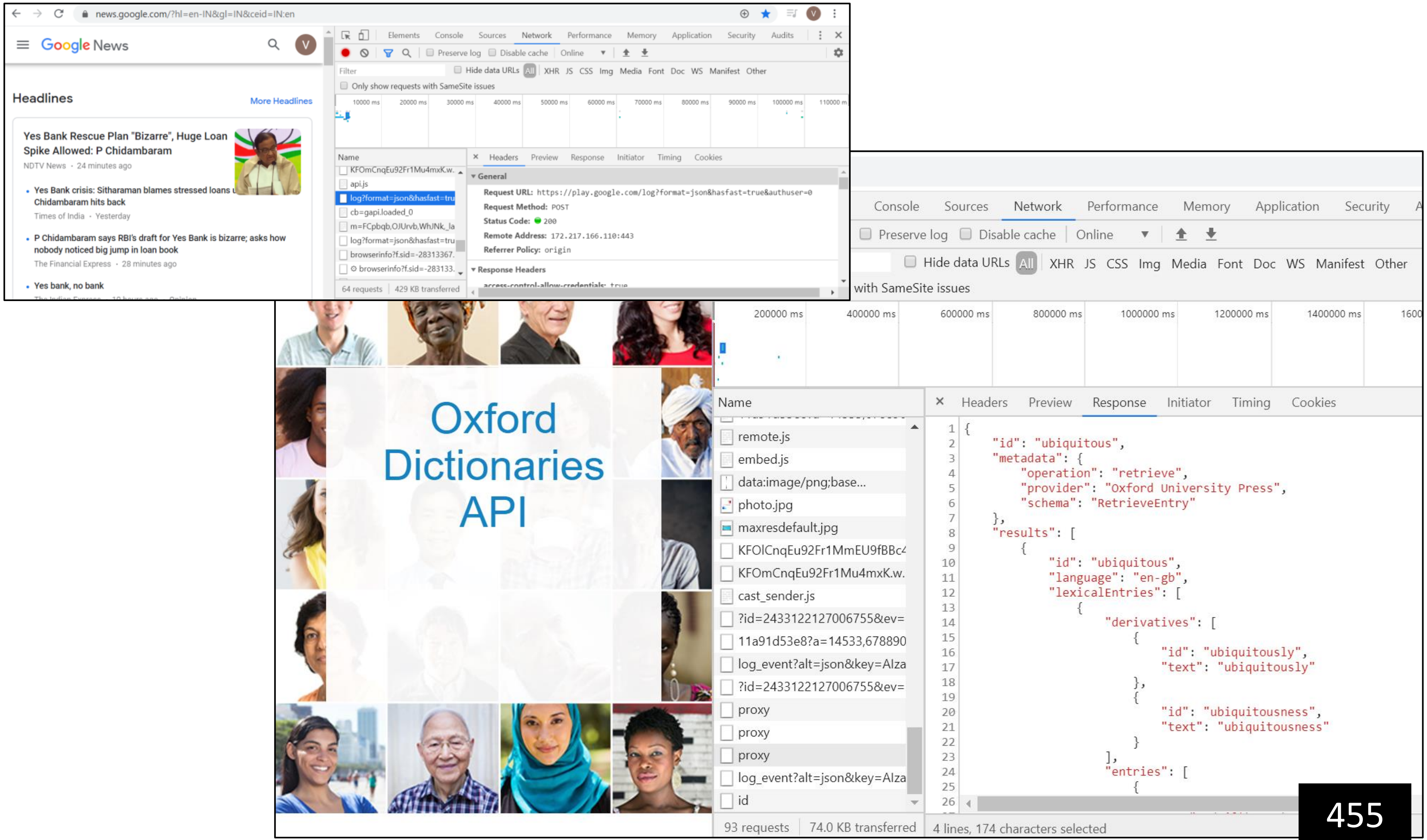


Evolution of Web and App Servers

Rate Limiting



Building Web Services



news.google.com/?hl=en-IN&gl=IN&ceid=IN:en

Headlines

More Headlines

Yes Bank Rescue Plan "Bizarre", Huge Loan Spike Allowed: P Chidambaram
NDTV News · 24 minutes ago

- Yes Bank crisis: Sitharaman blames stressed loans u Chidambaram hits back
  Times of India · Yesterday
- P Chidambaram says RBI's draft for Yes Bank is bizarre; asks how nobody noticed big jump in loan book
  The Financial Express · 28 minutes ago
- Yes bank, no bank

□ Preserve log □ Disable cache Online ▼

□ Hide data URLs All

□ Only show requests with SameSite issues

Name
- KFOmCnqEu92Fr1Mu4mxK.w.
- api.js
- log?format=json&hasfast=tru
- cb=gapi.loaded_0
- m=FCpbqb,OJUrvb,WhJNk,_la
- log?format=json&hasfast=tru
- browserinfo?f.sid=-28313367.
- browserinfo?f.sid=-283133.

64 requests | 429 KB transferred

▾ General

Request URL: https://play.google.com/log?format=json&hasfast=true&authuser=0
Request Method: POST
Status Code: ● 200
Remote Address: 172.217.166.110:443
Referrer Policy: origin

▾ Response Headers

access-control-allow-credentials: true

□ Preserve log □ Disable cache Online ▼

□ Hide data URLs All

with SameSite issues

Name
- remote.js
- embed.js
- data:image/png;base...
- photo.jpg
- maxresdefault.jpg
- KFOlCnqEu92Fr1MmEU9fBBc4
- KFOmCnqEu92Fr1Mu4mxK.w.
- cast_sender.js
- ?id=2433122127006755&ev=
- 11a91d53e8?a=14533,678890
- log_event?alt=json&key=AIza
- ?id=2433122127006755&ev=
- proxy
- proxy
- proxy
- log_event?alt=json&key=AIza
- id

93 requests | 74.0 KB transferred

```
{
    "id": "ubiquitous",
    "metadata": {
        "operation": "retrieve",
        "provider": "Oxford University Press",
        "schema": "RetrieveEntry"
    },
    "results": [
        {
            "id": "ubiquitous",
            "language": "en-gb",
            "lexicalEntries": [
                {
                    "derivatives": [
                        {
                            "id": "ubiquitously",
                            "text": "ubiquitously"
                        },
                        {
                            "id": "ubiquitousness",
                            "text": "ubiquitousness"
                        }
                    ],
                    "entries": [
                        {
```

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Thank You

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