Open Educational Resources

Hunter College

2020

CSCI 49378: Lecture 3: Synchronization, Consistency and Replication

Bonan Liu
CUNY Hunter College

NYC Tech-in-Residence Corps

Synchronization, Consistency and Replication

Bonan Liu
Tech-In-Residence Member, Hunter College, CUNY

Spring 2020

Disclaimer

The content of this presentation is being provided for educational and informational purposes only. The views, thoughts, and opinions expressed in this presentation belong solely to the author, and not necessarily to the author's employer.

The content of this presentation is not endorsed by the author's employer.

Agenda

- Clock Synchronization
- Data Replication
- Consistency Models
- Review Tiny URL service
- Assignment 1

Synchronization

The key problem in synchronization is to identify the order of the events happened in different nodes in a distributed system.

Clock Synchronization

Clock Synchronization is a common effort to synchronize independent clocks in a distributed system.

- Physical Clock
    - Two clocks on different nodes do not agree
    - Physical clocks will drift due to physical factors (temperature, humidity or age of the hardware)
    - It is not a good idea to set time back
- Logical Clock

Clock Synchronization

Various Clock Synchronization Algorithm

- Naive Solution
  - Client sends a request to the central server
  - Did not count the network latency
- Cristian Algorithm
  - Assumption: network delays are symmetric
  - $T_{new} = T_{server} + (T_1 - T_0) /2$

Clock Synchronization

Various Clock Synchronization Algorithm

- Berkeley Algorithm
  - Obtain average of all nodes’ time
  - Two Steps
    - Obtain time from all nodes
    - Send offset to all nodes
- Precision Time Protocol (PTP)

Replication

- The reasons for replication
  - Availability
  - Correctness (Reliability)
  - Performance
- Challenges
  - Maintenance Cost
  - Consistency

Replication Management

- Reliability Downgrade during Maintenance
- Validation Job
- Client cache for two-round-trip problem

Weak and Strong Consistency

- Weak Consistency: All accesses are seen by different nodes in the same order across a distributed system.
- Strong Consistency: Different nodes in a distributed system may perceive variables in different states.

How do you implement them in a data storage system?

Eventual Consistency

When the clients stop issuing new write requests, all read requests will return the most recently results.

- ACID
  - Atomicity, Consistency, Isolation, Durability
- BASE
  - Basically Available
  - Soft state
  - Eventual consistency

How do you implement them in a data storage system?

Case Study

Design a sync mechanism for a payment system.

Review Tiny URL Service

- Scope of the Design
    - Goals and Non-Goals
    - service-level objective or capacity estimation
- Basic Architecture
    - Details of API Design
    - Database Design
    - Service Algorithm

Review Tiny URL Service

- Performance Consideration
  - Replication
  - Data Partitioning
  - Maintenance Job
  - Runtime Performance
  - Availability
  - Security
- Operation and Analytics

Readings

Liskov, B. (1993). Practical uses of synchronized clocks in distributed systems, Distributed Computing. Vol. 6, No. 4, pp. 211-19.

Davidson, S.B. (1984). Optimism and consistency in partitioned database systems. ACM Transactions on Database Systems, Vol. 9, No. 3, pp. 456-81.