Distributed Consensus for Dummies The Raft Protocol

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How to Win Austerlitz?
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- The emperor and its generals communicate with each other using messengers that carry orders
- The emperor issues one order to any general, either attack or defend
- The goal is to ensure they all have the same order when asked to act, ie. they reach consensus
Let’s Try It!
Possible Assumptions

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- There is a traitor!
Basic Architecture

[Diagram of a basic architecture with components labeled]

- State machine
- Consensus
- Persistent log
- Replicas
- Cluster

(reads and writes arrows indicated)

[Image]
Fundamental Impossibility
In an Asynchronous Network...

It is not possible to reach distributed consensus with arbitrary communication failures
Distributed Algorithms, Nancy Lynch, 1997, Morkan-Kaufmann
In a Partially Synchronous Network...

*It is possible to reach consensus assuming f processes fail and there is an upper bound d for all messages provided the number of processes is greater than 2f.*

*Nancy Lynch, op.cit.*
And in Practice?
Distributed Consensus is Hard…

The 8 Fallacies of Distributed Computing

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7. Transport cost is zero.
8. The network is homogeneous.
... but We Need It

- Distributed transactions coordination
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  - Several processes should agree on commit or rollback some operation

Distributed Fault-Tolerant data stores (eg. ZooKeeper, Spanner)
Distributed Locking (eg. Google's Chubby)
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Practical Consensus
The Leader: Paxos

The Part-Time Parliament, *L. Lamport*

*Recent archaeological discoveries on the island of Paxos reveal that the parliament functioned despite the peripatetic propensity of its part-time legislators. The legislators maintained consistent copies of the parliamentary record, despite their frequent forays from the chamber and the forgetfulness of their messengers.*
Paxos Principles

- Core algorithm is called *Single-Decree Synod* and describes how a single proposed value is accepted by the distributed processes.
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- ... Lamport omits a lot of details!
Paxos Implementation

While Paxos can be described with a page of pseudo-code, our complete implementation contains several thousand lines of C++ code. Converting the algorithm into a practical, production-ready system involved implementing many features and optimizations – some published in the literature and some not.

Paxos Made Live - An Engineering Perspective, T. Chandra et al.
The Challenger: Raft

- In Search of an Understandable Consensus Algorithm, D. Ongaro and J. Osterhout, 2013
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- Novel algorithm designed with *understandability* in mind
- Dozens of implementations in various language
Principles of Operation

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- Leader orchestrates safe log replication to its followers
Non-Core Features

- Supports cluster membership changes w/o service interruption
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- Log compaction for efficient operations
Java Implementation: Barge

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- Still very young but usable, provides 2 transport methods: Raw TCP and HTTP
- Feature complete w.r.t base protocol but missing cluster reconfiguration and log compaction
- Friendly (Apache 2.0) License, Pull Requests are welcomed
Demo
Questions?
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