# 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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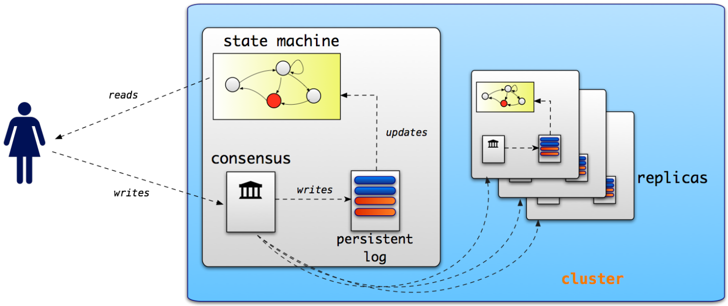
- Generals can be killed and not respond anymore
- There is a traitor!

## Basic Architecture



## 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?

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The 8 Fallacies of Distributed Computing

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7. Transport cost is zero.
8. The network is homogeneous.

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- Distributed Fault-Tolerant data stores (eg. ZooKeeper, Spanner)
- Distributed Locking (eg. Google's Chubby)

## Practical Consensus

## The Leader: Paxos

The Part-Time Parliament, *L.Lamport*

> *Recent archaeological discoveries on the island of Paxos reveal that the parliament functioned de- spite 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 forget- fulness of their messengers.*

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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.*

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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

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- Friendly (Apache 2.0) License, *Pull Requests* are welcomed

## Demo

## Questions?

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