



The Spectrum of Failure Models

Learn about failures in distributed systems and the complexity of dealing with them.

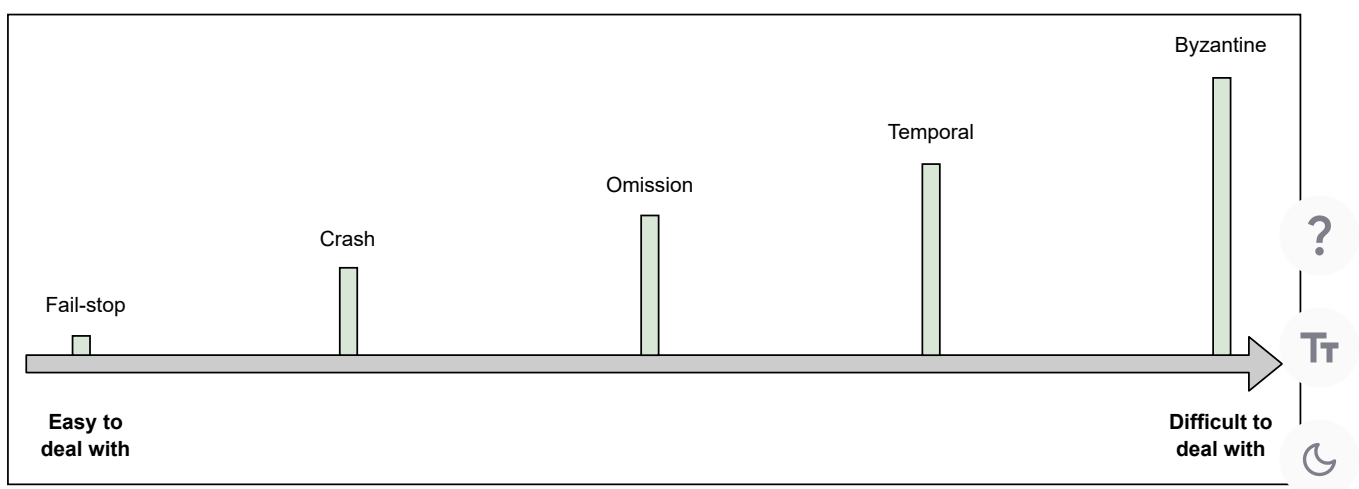
We'll cover the following

- Fail-stop
- Crash
- Omission failures
- Temporal failures
- Byzantine failures

Failures are obvious in the world of distributed systems and can appear in various ways. They might come and go, or persist for a long period.

Failure models provide us a framework to reason about the impact of failures and possible ways to deal with them.

Here is an illustration that presents a spectrum of different failure models:



This is a spectrum of failure models. The difficulty level when dealing with a failure increases as we move to the right

Fail-stop



In this type of failure, a node in the distributed system halts permanently. However, the other nodes can still detect that node by communicating with it.

From the perspective of someone who builds distributed systems, fail-stop failures are the simplest and the most convenient.

Crash

In this type of failure, a node in the distributed system halts silently, and the other nodes can't detect that the node has stopped working.

Omission failures

In **omission failures**, the node fails to send or receive messages. There are two types of omission failures. If the node fails to respond to the incoming request, it's said to be a **send omission failure**. If the node fails to receive the request and thus can't acknowledge it, it's said to be a **receive omission failure**.

Temporal failures

In **temporal failures**, the node generates correct results, but is too late to be useful. This failure could be due to bad algorithms, a bad design strategy, or a loss of synchronization between the processor clocks.



Byzantine failures



In **Byzantine failures**, the node exhibits random behavior like transmitting arbitrary messages at arbitrary times, producing wrong results, or stopping



midway. This mostly happens due to an attack by a malicious entity or a software bug. A byzantine failure is the most challenging type of failure to deal with.

[← Back](#)[Next →](#)

Spectrum of Consistency Models

Availability

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