THE TWO GENERALS PROBLEM

J. Gray,
Notes on Database Operating Systems,
In: Operating Systems: an Advanced Course,
Bayer et. al. eds., Lecture notes in Computer Science
vol. 60, Springer-Verlag, 1978, pp. 393-481
Review: The Coordinated Attack Problem

- Every process starts with an input in \{0, 1\}
  - 1 is attack (commit)
  - 0 is don’t attack (abort)

- Goal is for all processes to eventually decide 0 or 1.
  - Once a process makes a decision, it’s decision cannot be changed.
Review: System Model

- System consists of $n$ processes, arranged in arbitrary connected, undirected graph.
  - Each process knows the entire graph.
- There are no process failures.
- Messaging is not reliable (messages may be lost).

- Algorithm execution takes place in rounds.
  - Synchronous system.
Review: Correctness conditions

The algorithm must satisfy the following:

- **Agreement**: No two processes decide on different values.

- **Validity**:
  1. If all processes start with 0, then 0 is the only possible decision value.
  2. If all processes start with 1, and all messages are delivered, then 1 is the only possible decision value.

- **Termination**: All processes eventually decide.
Review: Impossibility Result

Theorem:

Let G be the graph consisting of nodes $p_1$ and $p_2$, connected by a single edge.

Then, there is no algorithm that solves the coordinated attack problem on G.

Also holds for larger graphs ($n \geq 2$).
IMPOSSIBILITY OF CONSENSUS WITH ONE FAULTY PROCESS

M. Fischer, N. Lynch, and M. Paterson
Consensus Requirements

- **Strong Consensus:**
  - **Agreement:** No two processes decide on different values.
  - **Validity:** The value that is decided was proposed by some process.
  - **Termination:** All non-faulty processes eventually decide.

- FLP Result addresses a weaker form of consensus.
  - **Termination:** Some non-faulty process eventually decides.
FLP Result

• Applies to asynchronous distributed system where at most one process fails.
  • No message loss.

• We will show that, for any consensus algorithm, there is an execution in which no process makes a decision.