The Atomic Commit Problem

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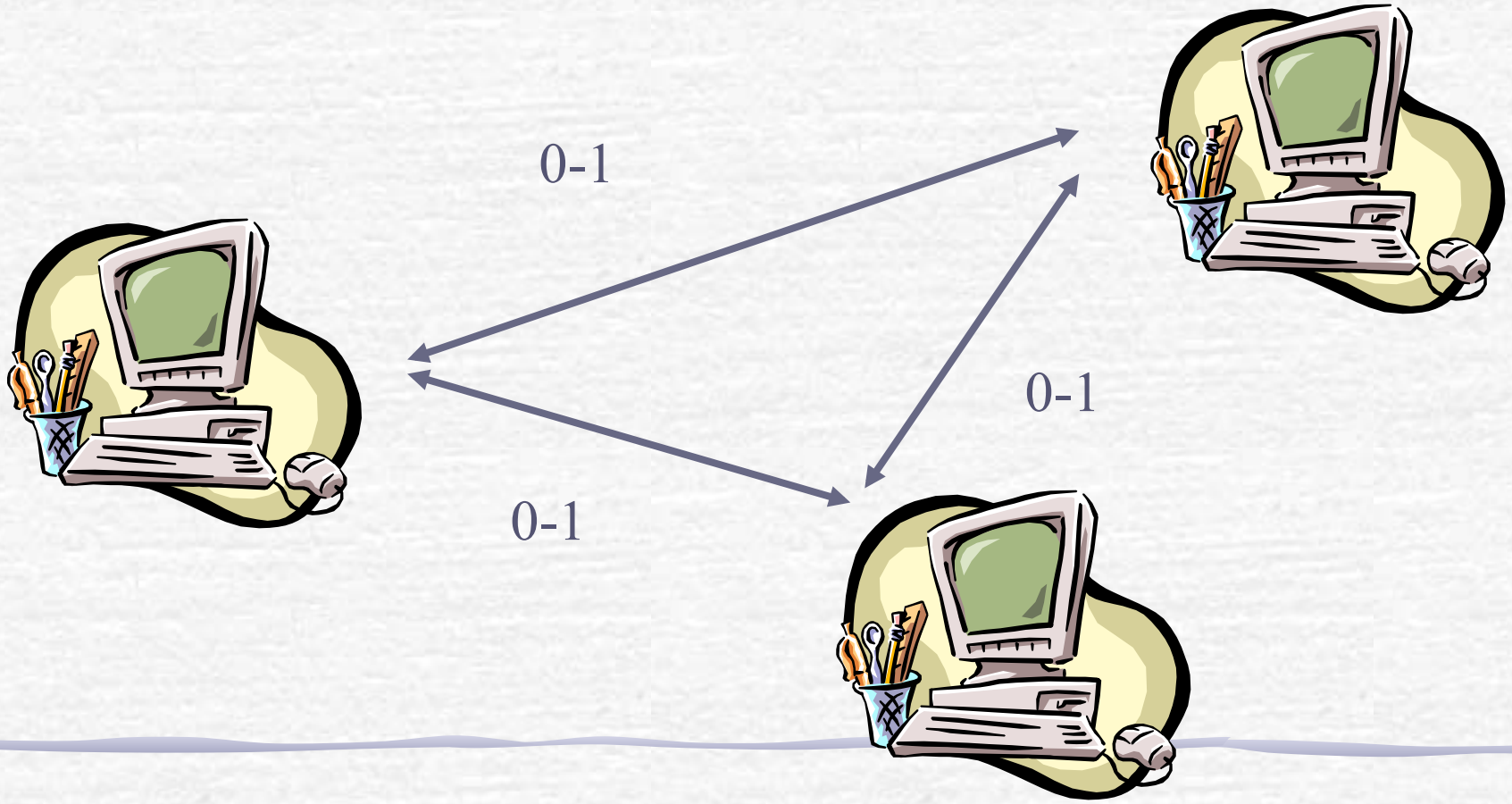
An Agreement Problem



Atomic Commit

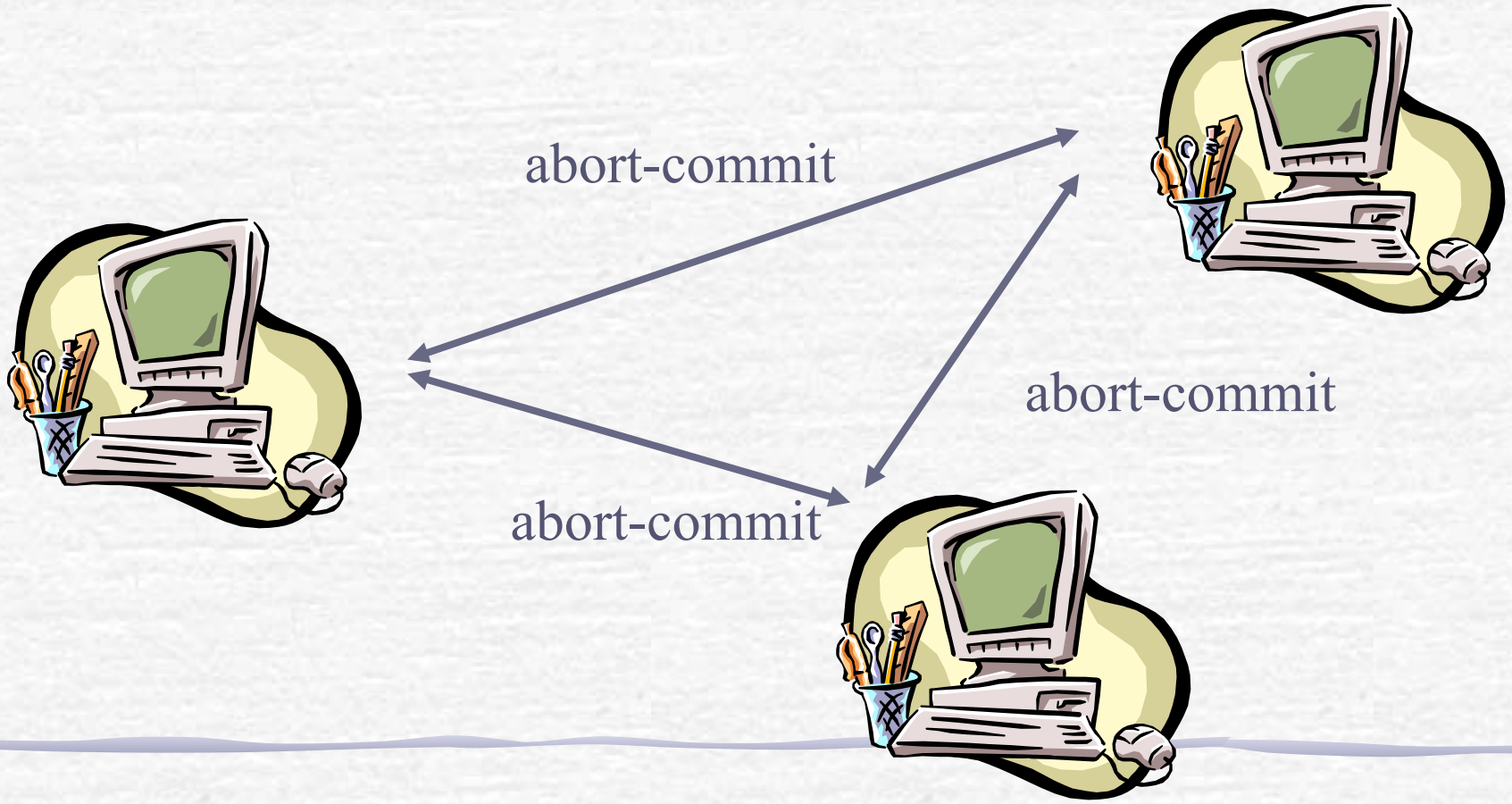
Agreement: No two processes decide differently

Termination: Every correct process eventually decides

Commit-Validity: 1 is only decided if all propose 1

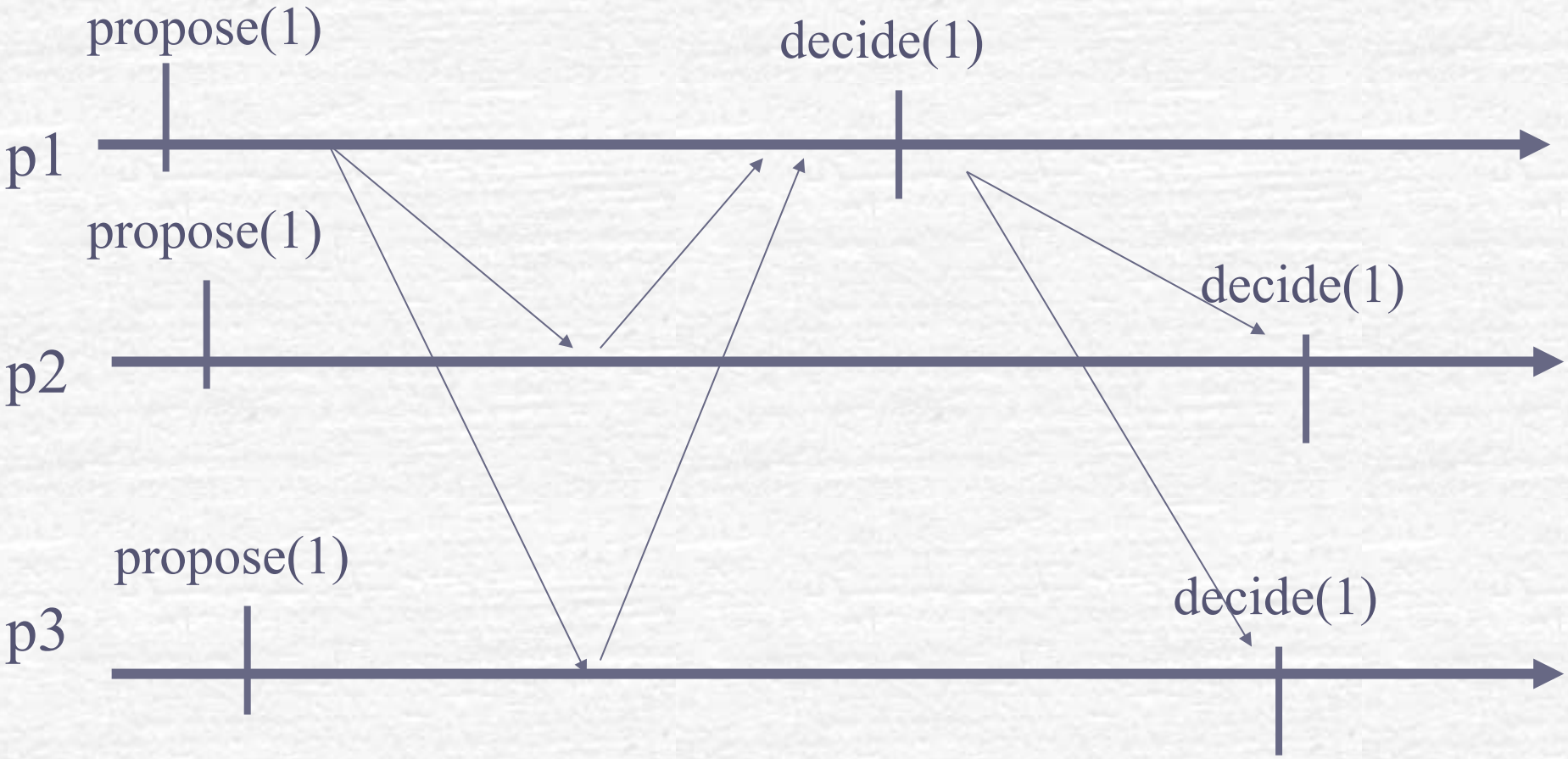
Abort-Validity: 0 is only decided if some process proposes 0 or there is a failure

Distributed Transaction

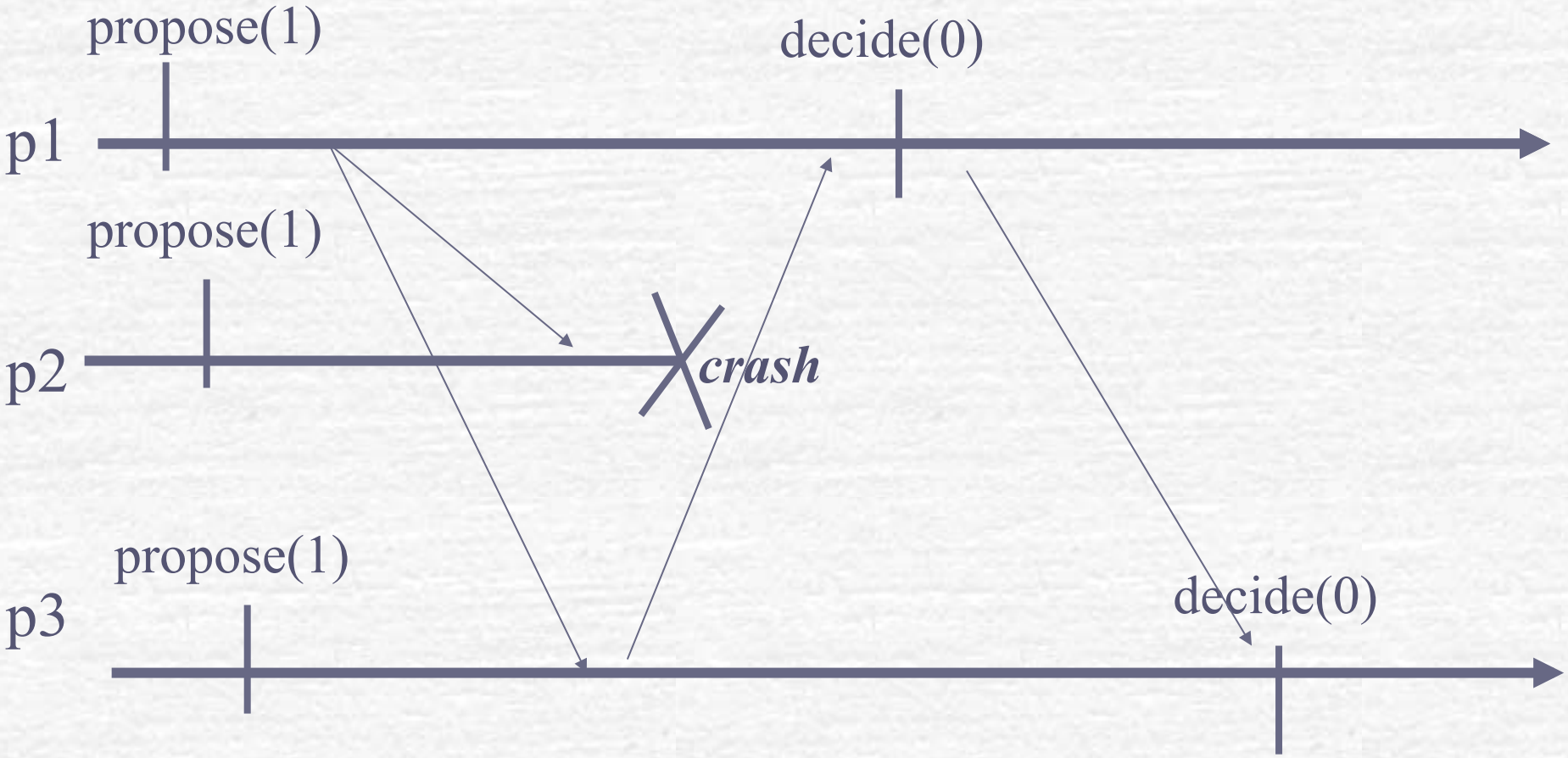


- *70's : Lampson/Gray (1st protocol)*
- *80's : Skeen/Dwork (1st result)*
- *90's: Hadzilacos/Guerraoui (problem)*
- *2000's: Kuznetsov (computability)*
- *2017: Wang (complexity)*

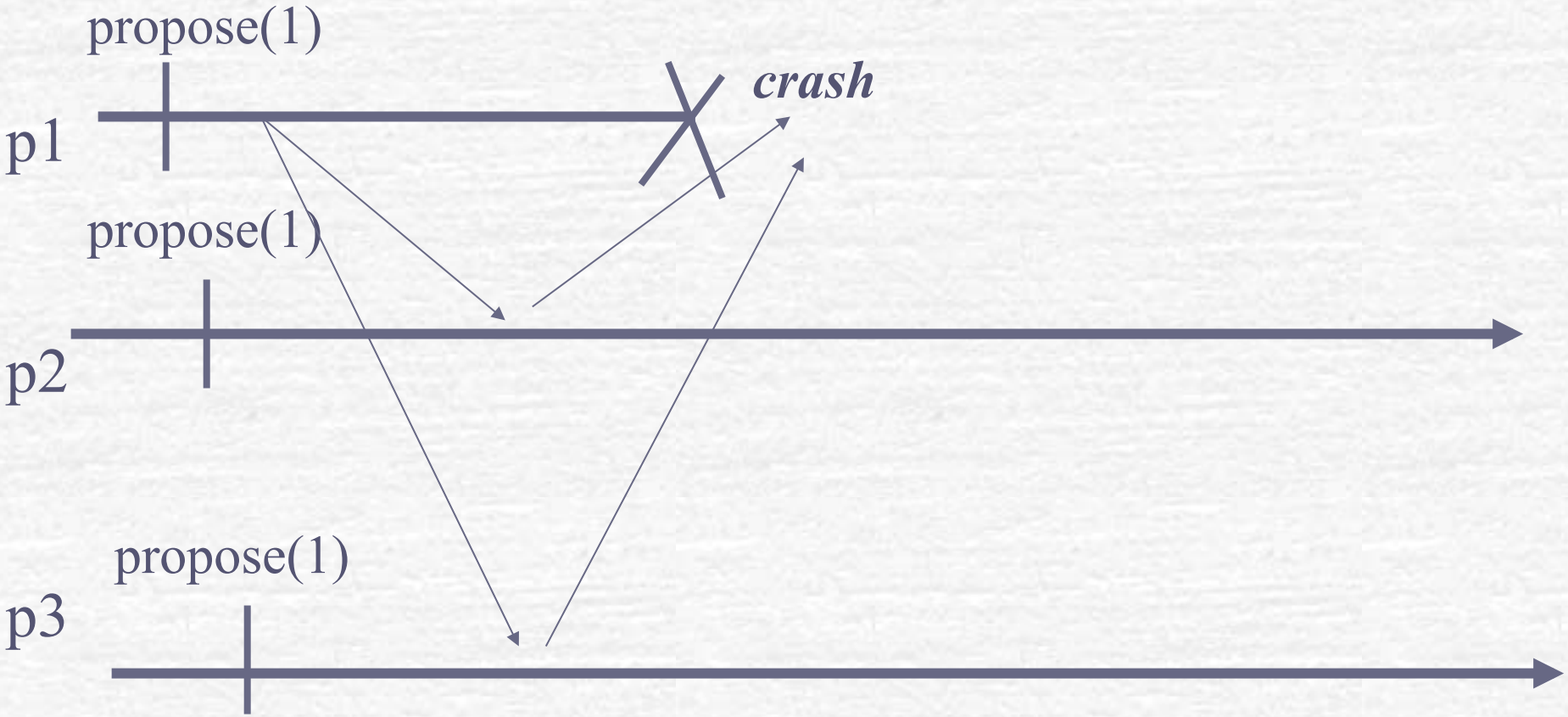
2-Phase Commit (2PC)



2PC



2PC is blocking



3PC

- Skeen 81
- Mohan – Strong – Finkelstein 83

- Guerraoui – Larrea - Schiper 96
- Keidar – Dolev 98
- Gray – Lamport 2004

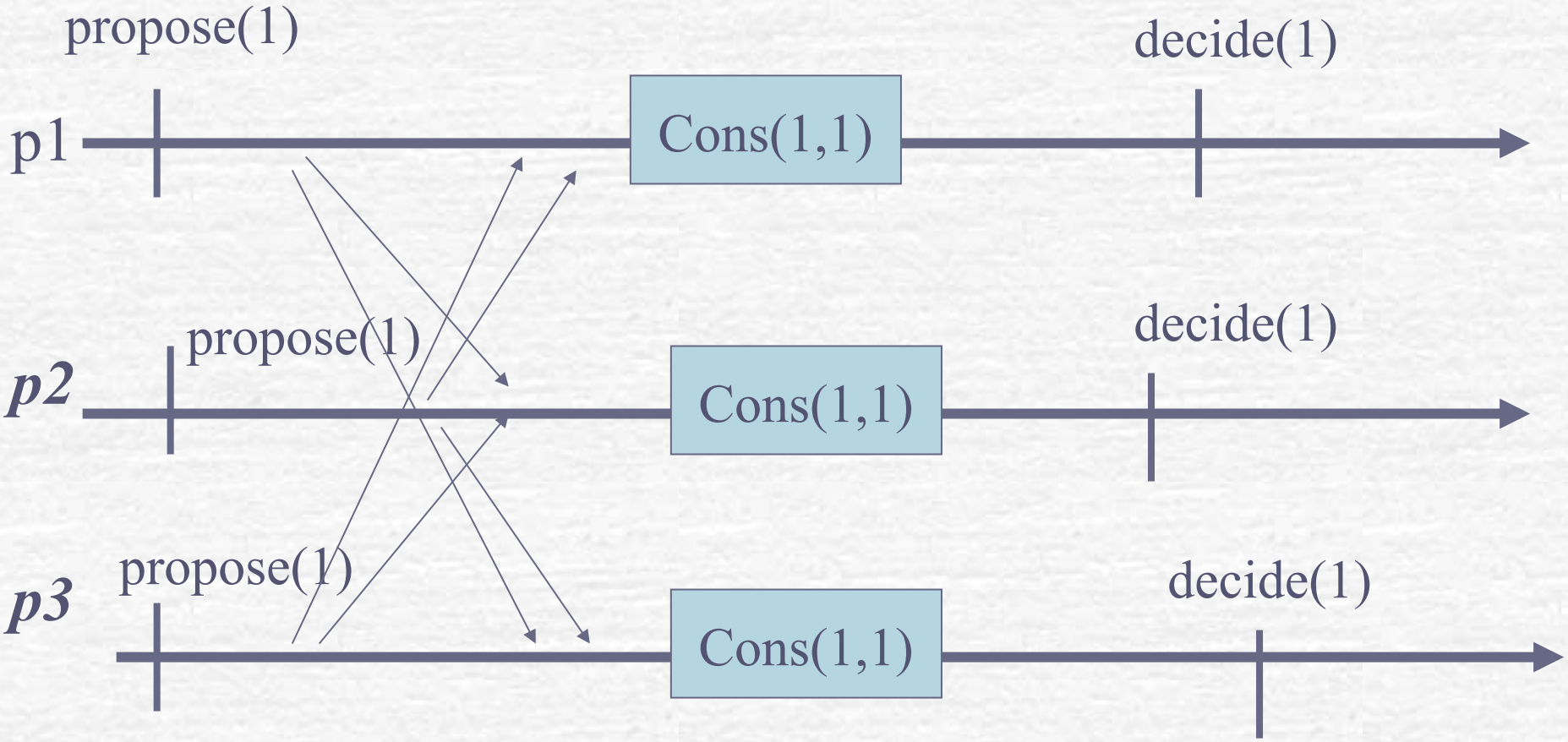
Consensus

Agreement: No two processes decide differently

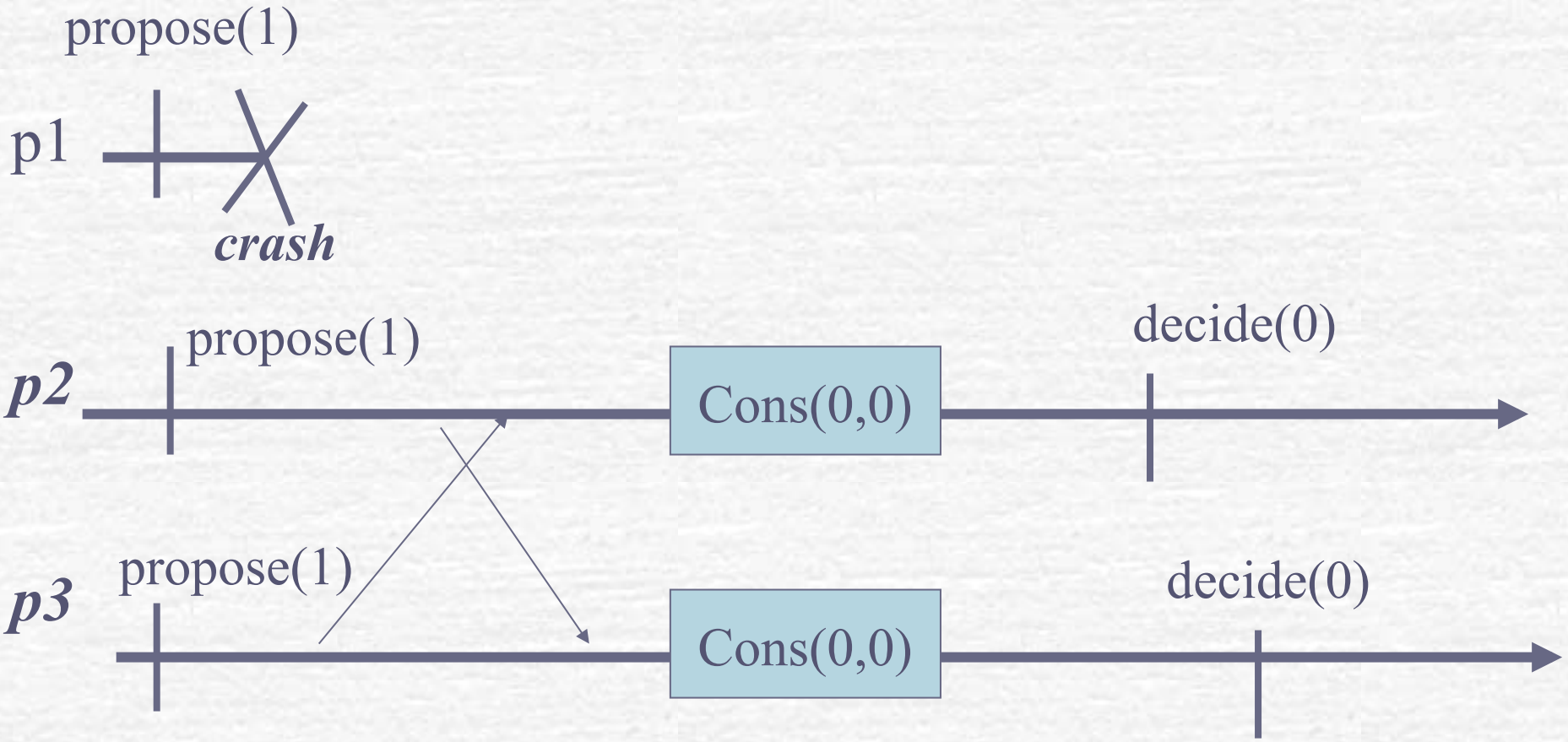
Termination: Every correct process eventually decides

Validity: The value decided is a value proposed

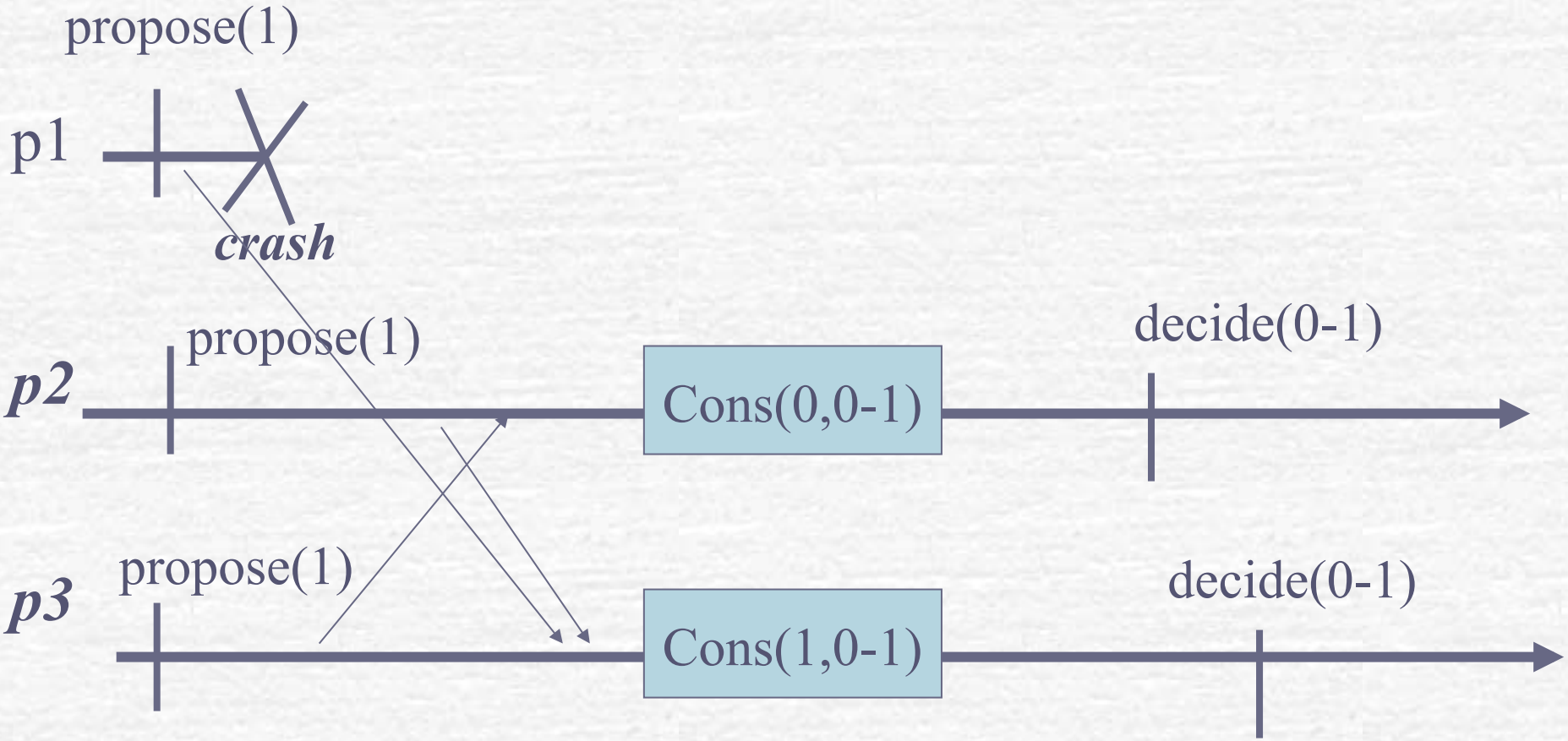
Commit with Consensus



Commit with Consensus



Commit with Consensus



Weak Consensus

Agreement: No two processes decide differently

Termination: Every correct process eventually decides

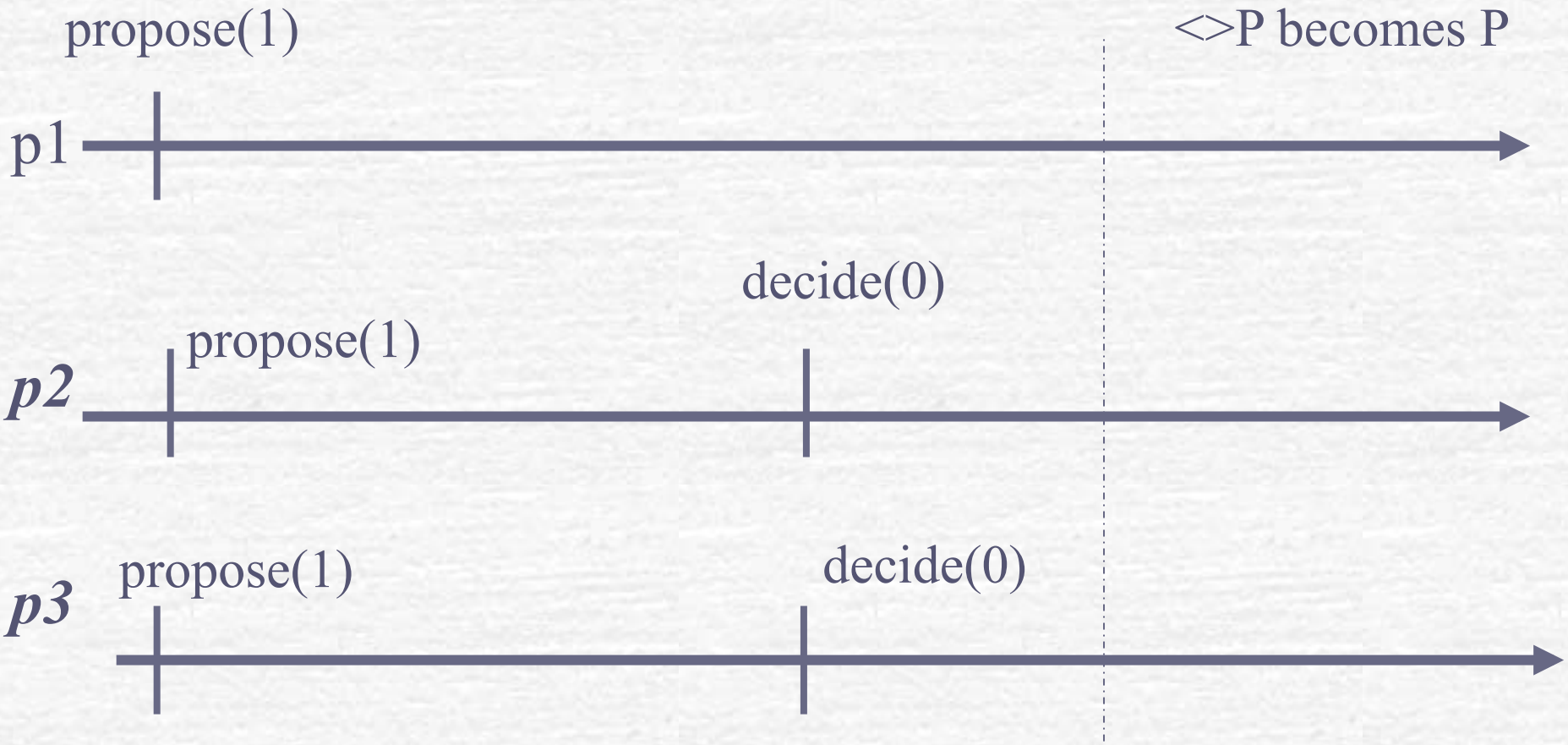
Weak consensus: 0 and 1 are both possible values

- *70's : Lampson/Gray (1st protocol)*
- *80's : Skeen/Dwork (1st result)*
- *90's: Hadzilacos/Guerraoui (problem)*
- *2000's: Kuznetsov (computability)*
- *2017: Wang (complexity)*

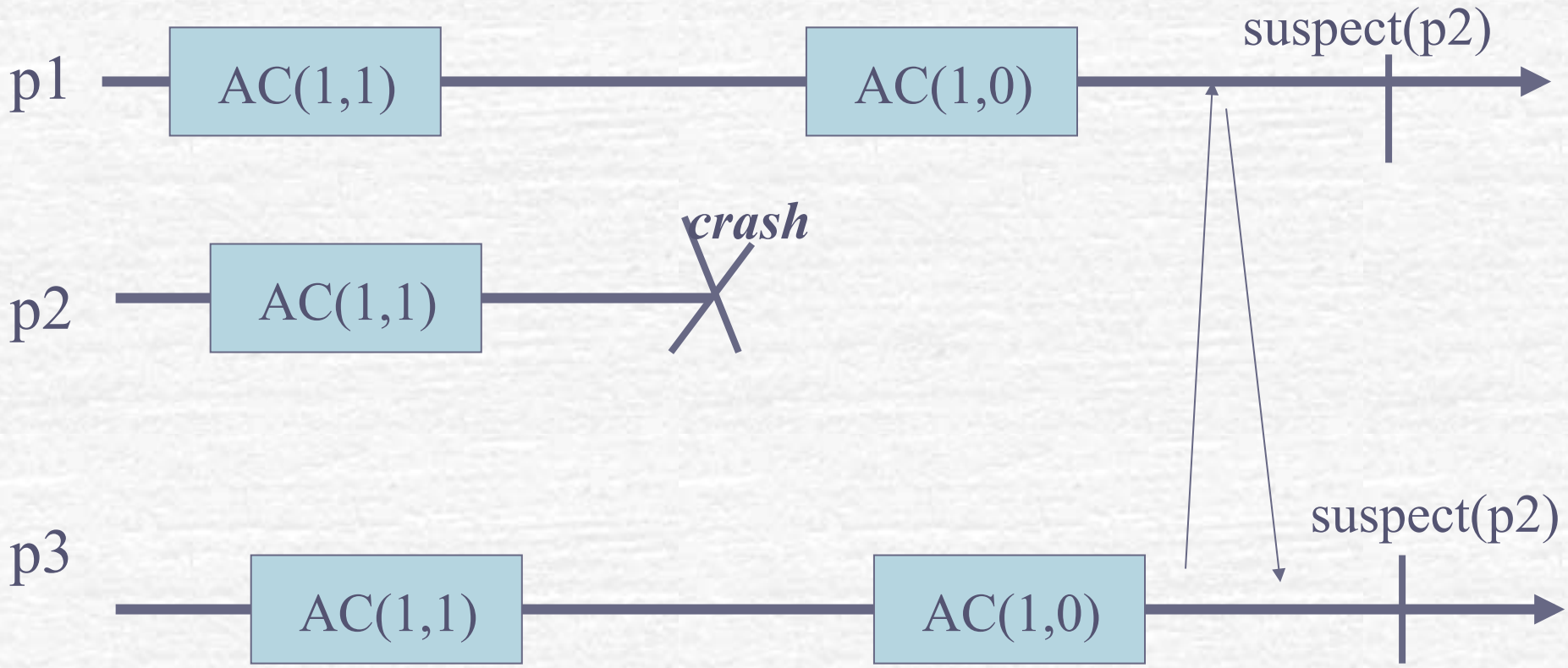
Computability (Weakest FD)

- 1. <>P is not enough
- 2. P is needed if one process can crash
- 3. The weakest FD is (FS, FS or (Ω and ξ))

1. <>P is not enough (Gue'95)



2. P is needed with one crash (FRT'99)



3. The WFD for Atomic Commit

- GK 02: (FS, Ω)

- DFGHTK 04: (FS ∧ (◇ FS ∨ (Ω ∧ ξ)))

Consensus

Agreement: No two processes decide differently

Termination: Every correct process eventually decides

Validity: The value decided is a value proposed

Quittable consensus: Q can be decided if there is a failure

- *70's : Lampson/Gray (1st protocol)*
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How fast can a transaction commit in a nice run?

Skeen/Dwork 83: 2n-2 messages assuming n-1 failures in a synchronous system

Complexity (Delays)

- 1 if synchrony
- 2 if asynchronous agreement (indulgent)

Complexity (Messages)

- $n - 1 + f$ if f failures and synchrony
- 0 if validity only in nice executions
- $2n - 2$ if validity despite asynchrony
- $2n - 2 + f$ if agreement despite asynchrony

Today

- Sinfonia, Percolator, Clock-SI, Yesquel use 2PC
  - 2 message delays / 2n-2 messages
  - No termination + synchrony assumption
- INBAC
  - 2 message delays / 2n messages
  - Termination + agreement in asynchrony
- 0NBAC
  - 1 message delay / 0 messages
  - Validity only in nice executions

Netys 2017

- Abstract Dec 2 / Paper Dec 9
- Conference May 17/19