Distributed Systems
Non-Blocking Atomic Commit

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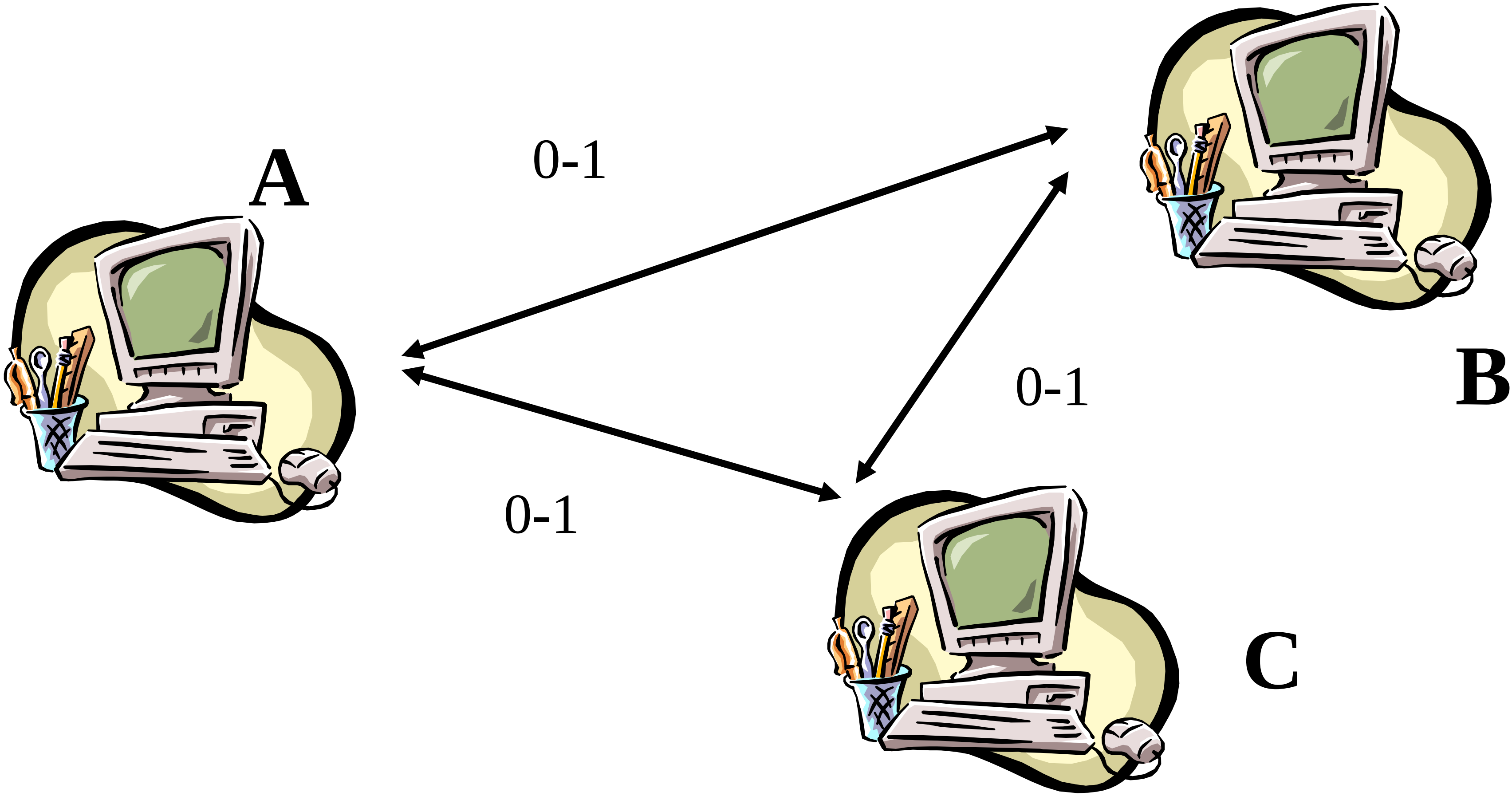
Non-Blocking Atomic Commit: An Agreement Problem



Transactions (Gray)

- A transaction is an atomic program describing a sequence of accesses to shared and distributed information

- A transaction can be terminated either by *committing* or *aborting*

Transactions

- beginTransaction
  - Pierre.credit(1.000.000)
  - Paul.debit(1.000.000)
- outcome := commitTransaction
- if (outcome = abort) then …

ACID properties

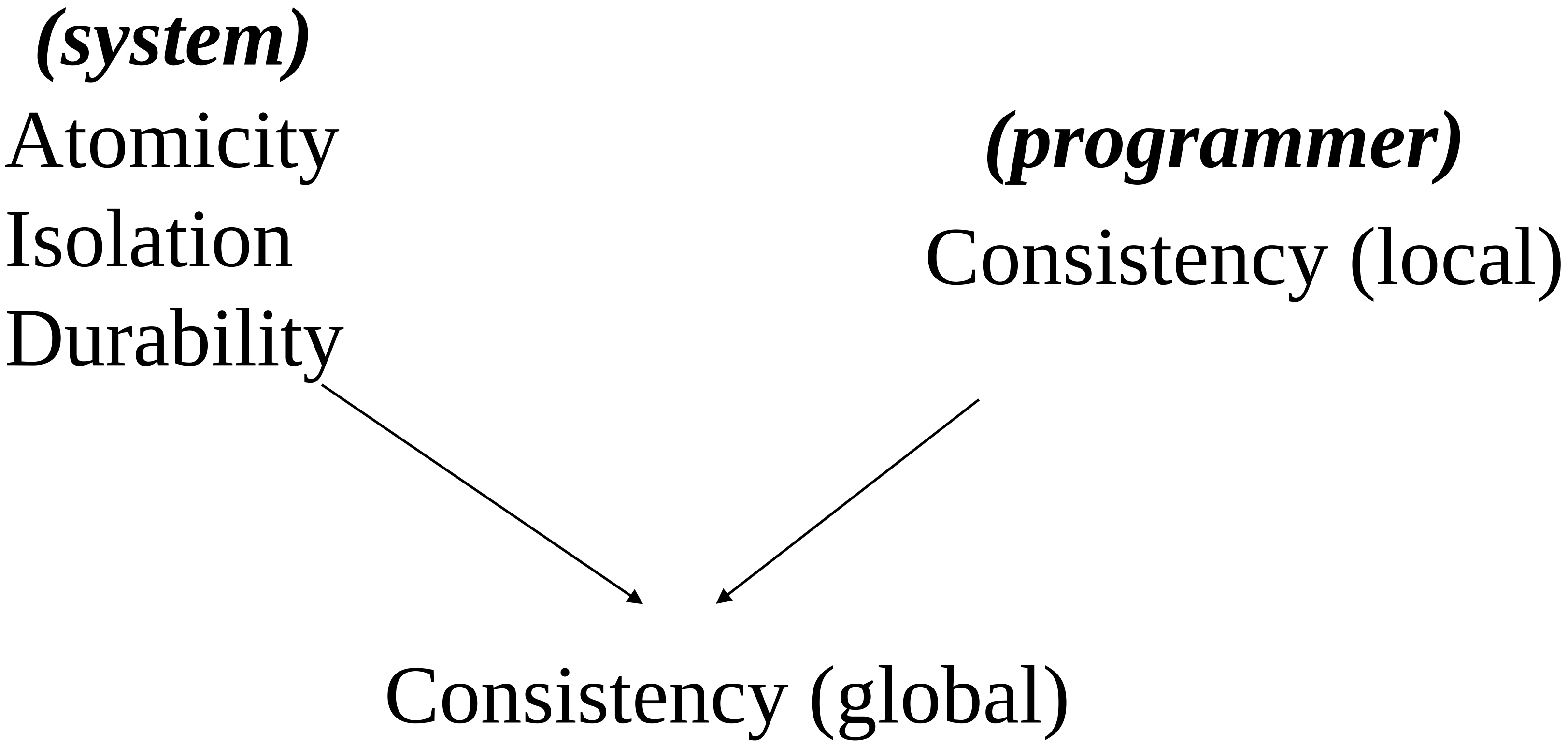
Atomicity: a transaction either performs entirely or none at all

Consistency: a transaction transforms a consistent state into another consistent state

Isolation: a transaction appears to be executed in isolation

Durability: the effects of a transaction that commits are permanent

The Consistency Contract



(system)

Atomicity

Isolation

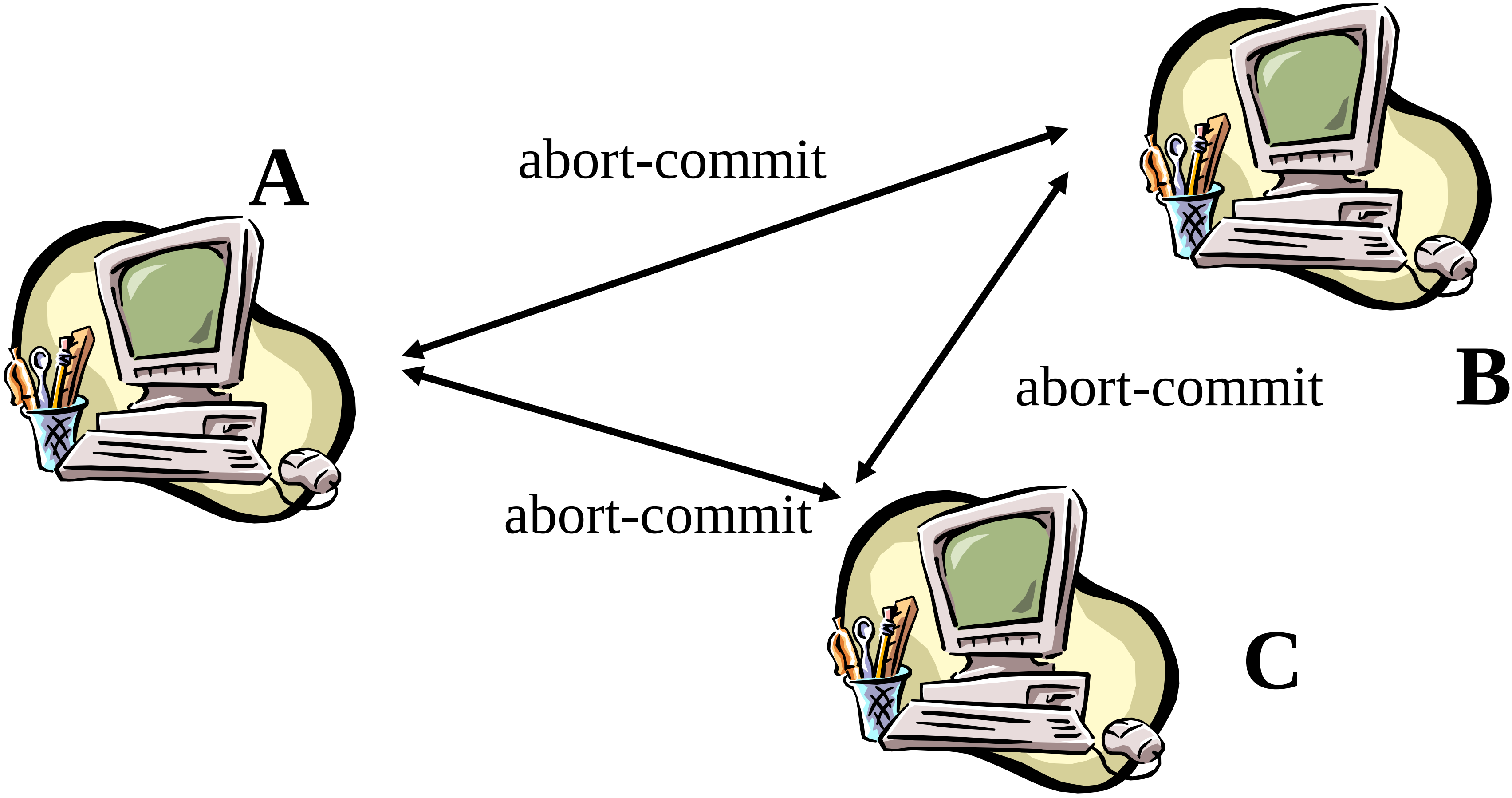
Durability

(programmer)

Consistency (local)

Consistency (global)

Distributed Transaction



A

abort-commit

B

abort-commit

abort-commit

C

Non-Blocking Atomic Commit

- As in consensus, every process has an initial value 0 (*no*) or 1 (*yes*) and must decide on a final value 0 (*abort*) or 1 (*commit*)
- The proposition means the ability to commit the transaction
- The decision reflects the contract with the user
- Unlike consensus, the processes here seek to decide 1 but every process has a veto right

Non-Blocking Atomic Commit

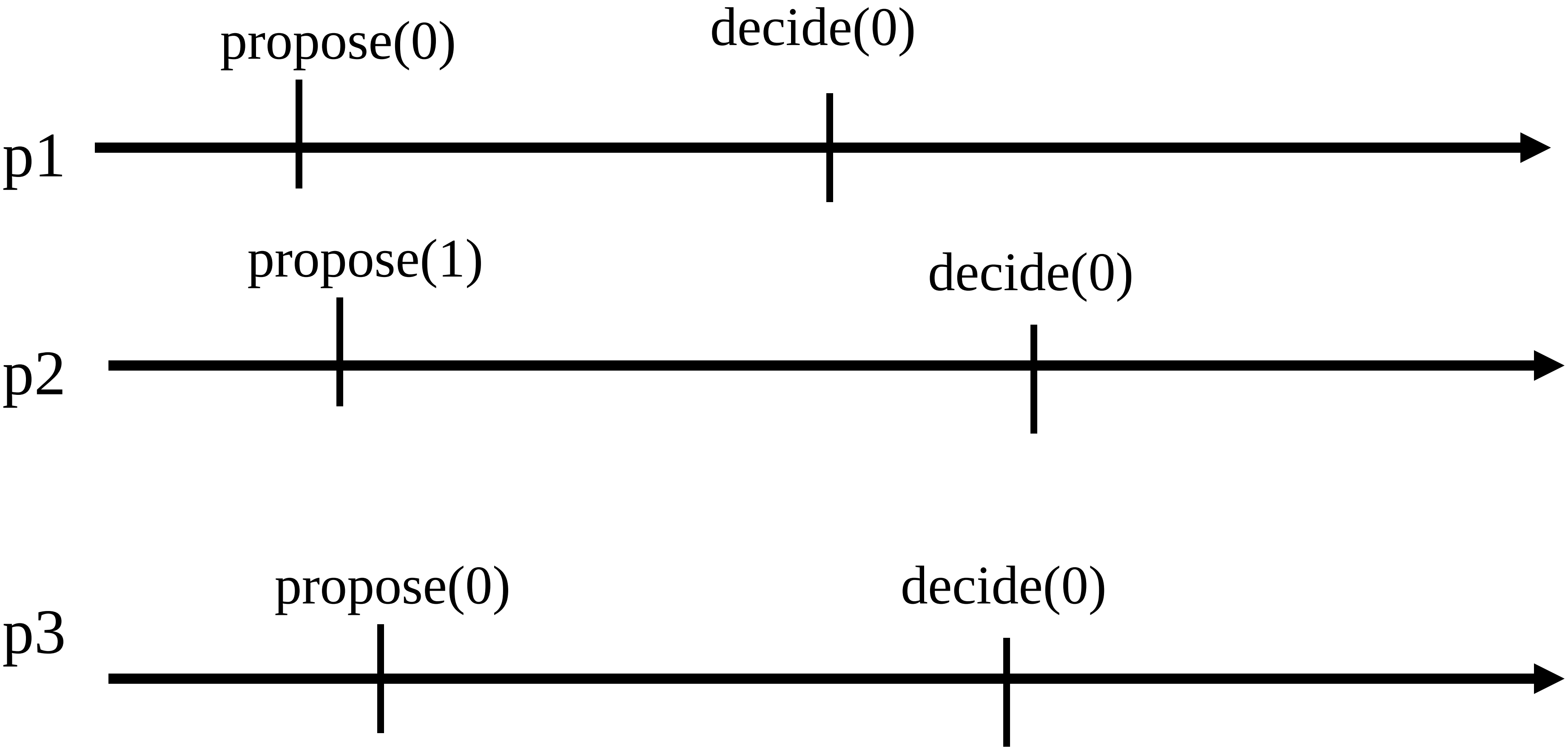
NBAC1. Agreement: No two processes decide differently

NBAC2. Termination: Every correct process eventually decides

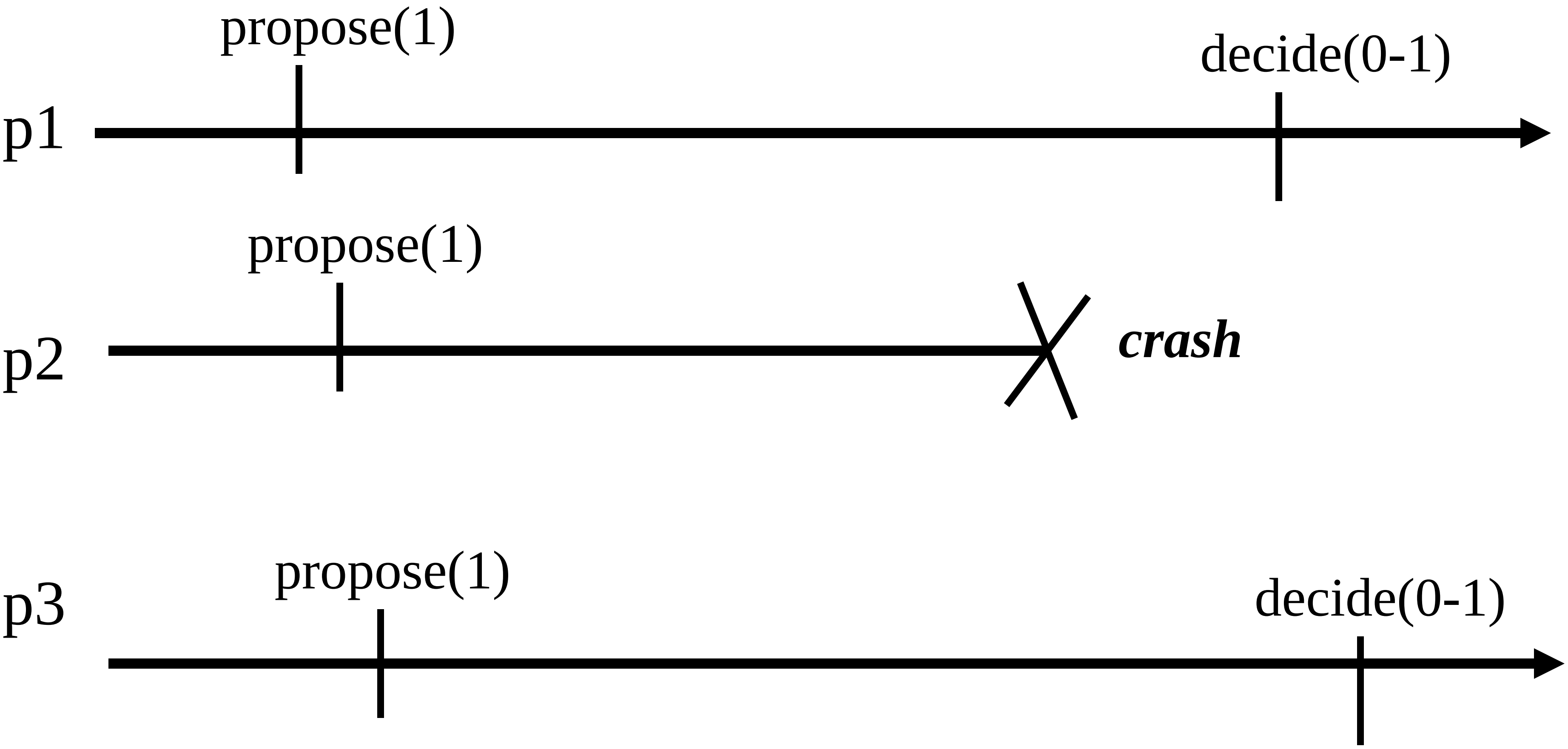
NBAC3. Commit-Validity: 1 can only be decided if all processes propose 1

NBAC4. Abort-Validity: 0 can only be decided if some process crashes or votes 0

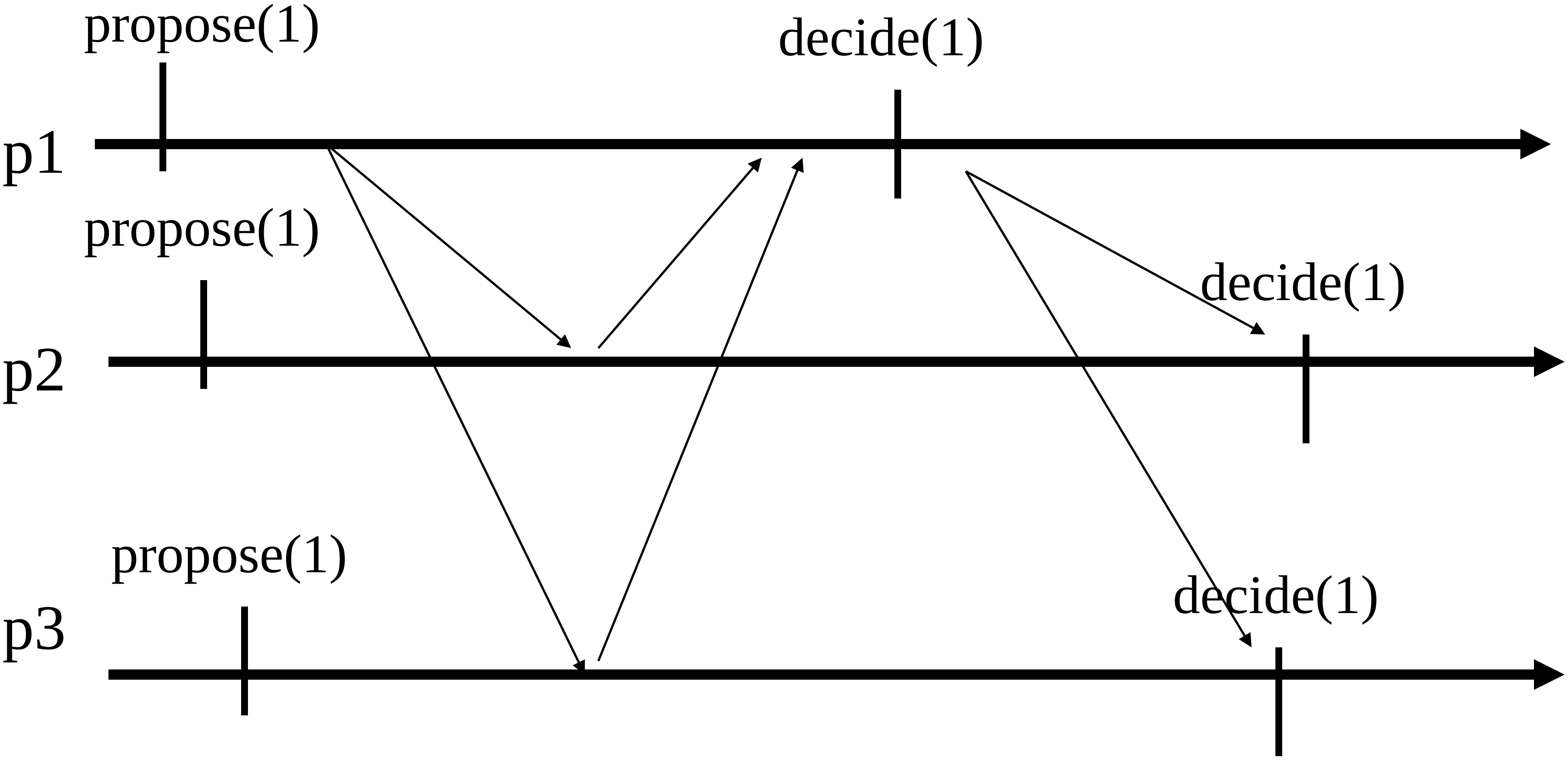
Non-Blocking Atomic Commit



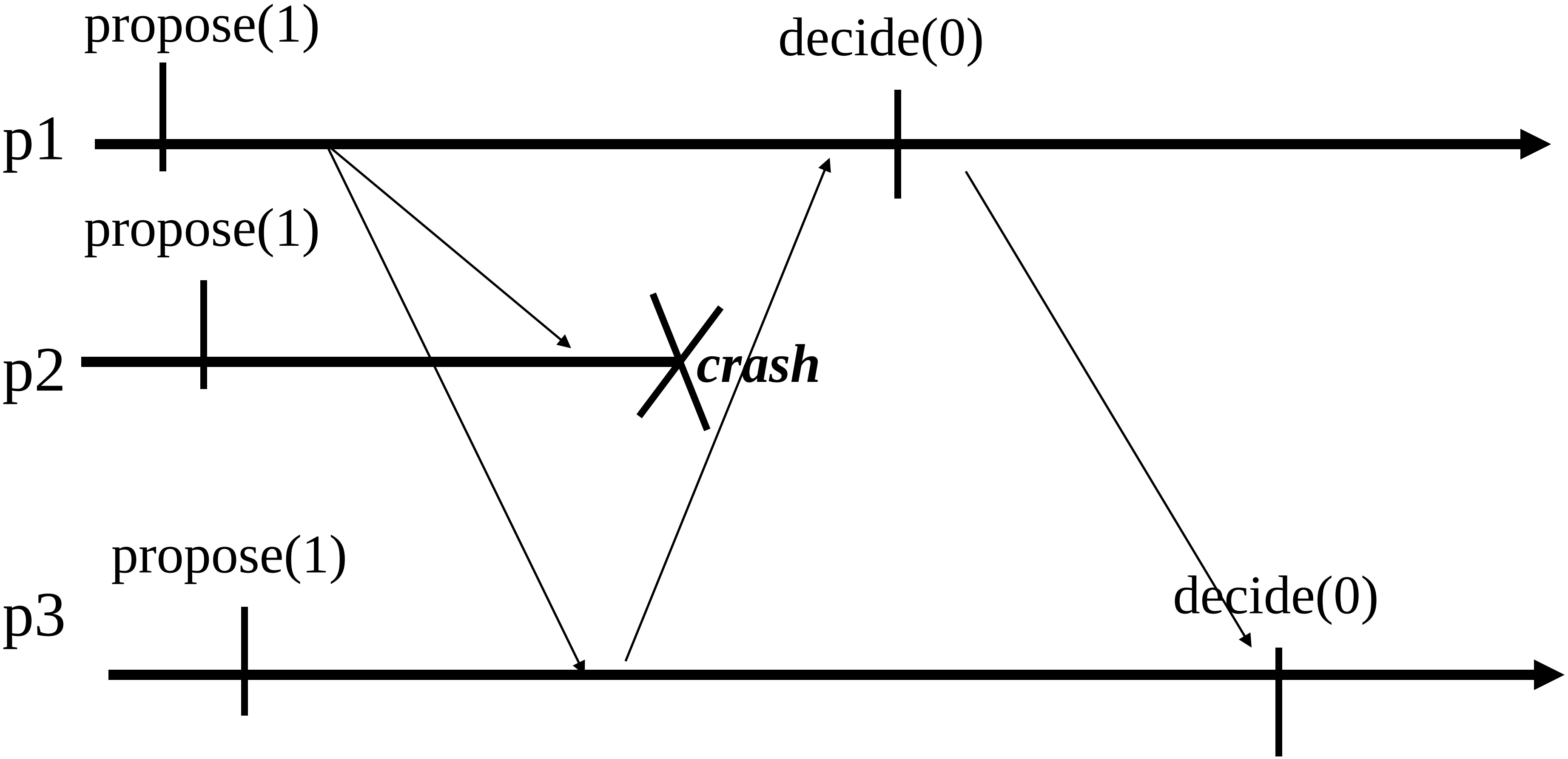
Non-Blocking Atomic Commit



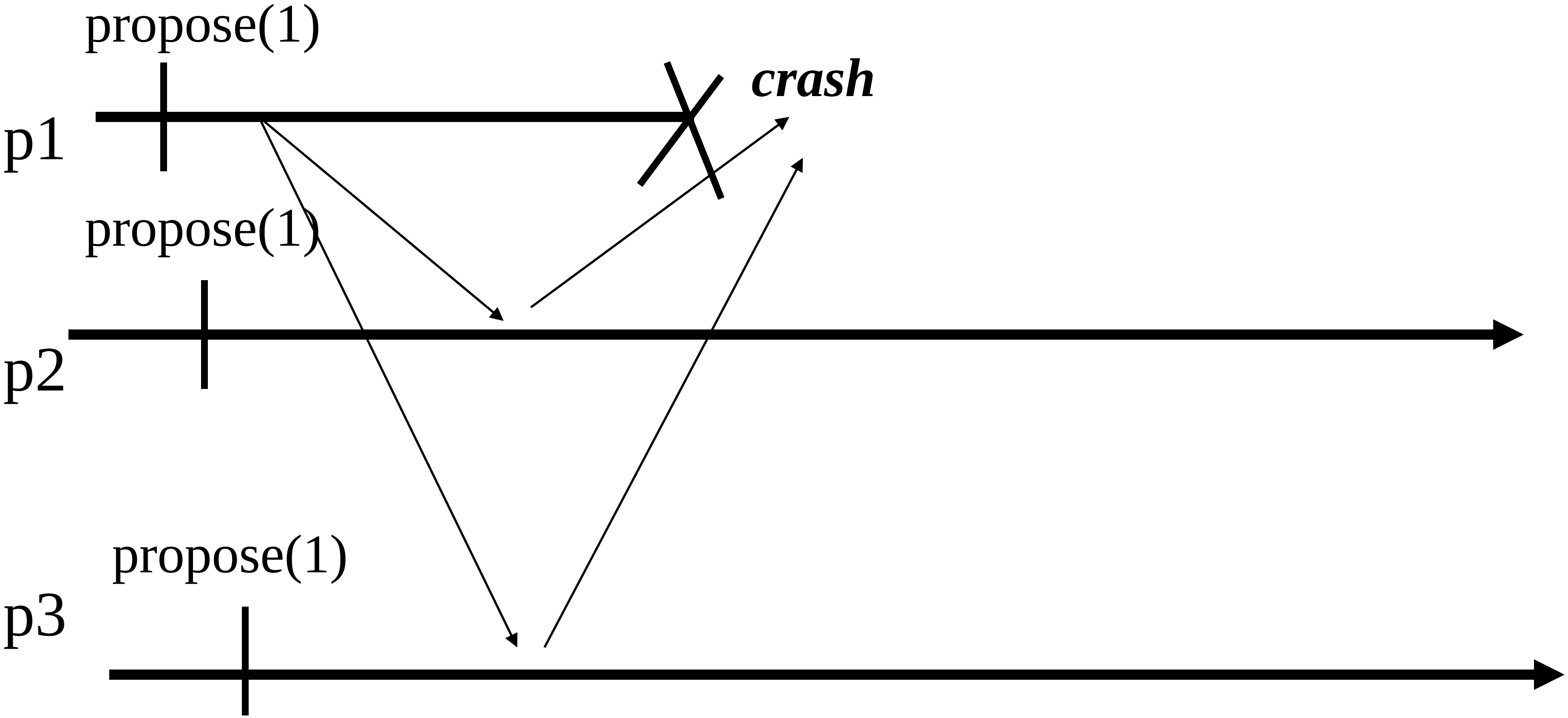
2-Phase Commit



2-Phase Commit



2-Phase Commit



Non-Blocking Atomic Commit

- ***Events***
  - Request: <Propose, v>
  - Indication: <Decide, v'>
- ***Properties:***
  - ***NBAC1, NBAC2, NBAC3, NBAC4***

Algorithm (nbac)

- **Implements:** nonBlockingAtomicCommit (nbac).
- **Uses:**
  - BestEffortBroadcast (beb).
  - PerfectFailureDetector (P).
  - UniformConsensus (uniCons).
- **upon event** < Init > **do**
  - prop := 1;
  - delivered := $\emptyset$; correct := Π;

Algorithm (nbac – cont’d)

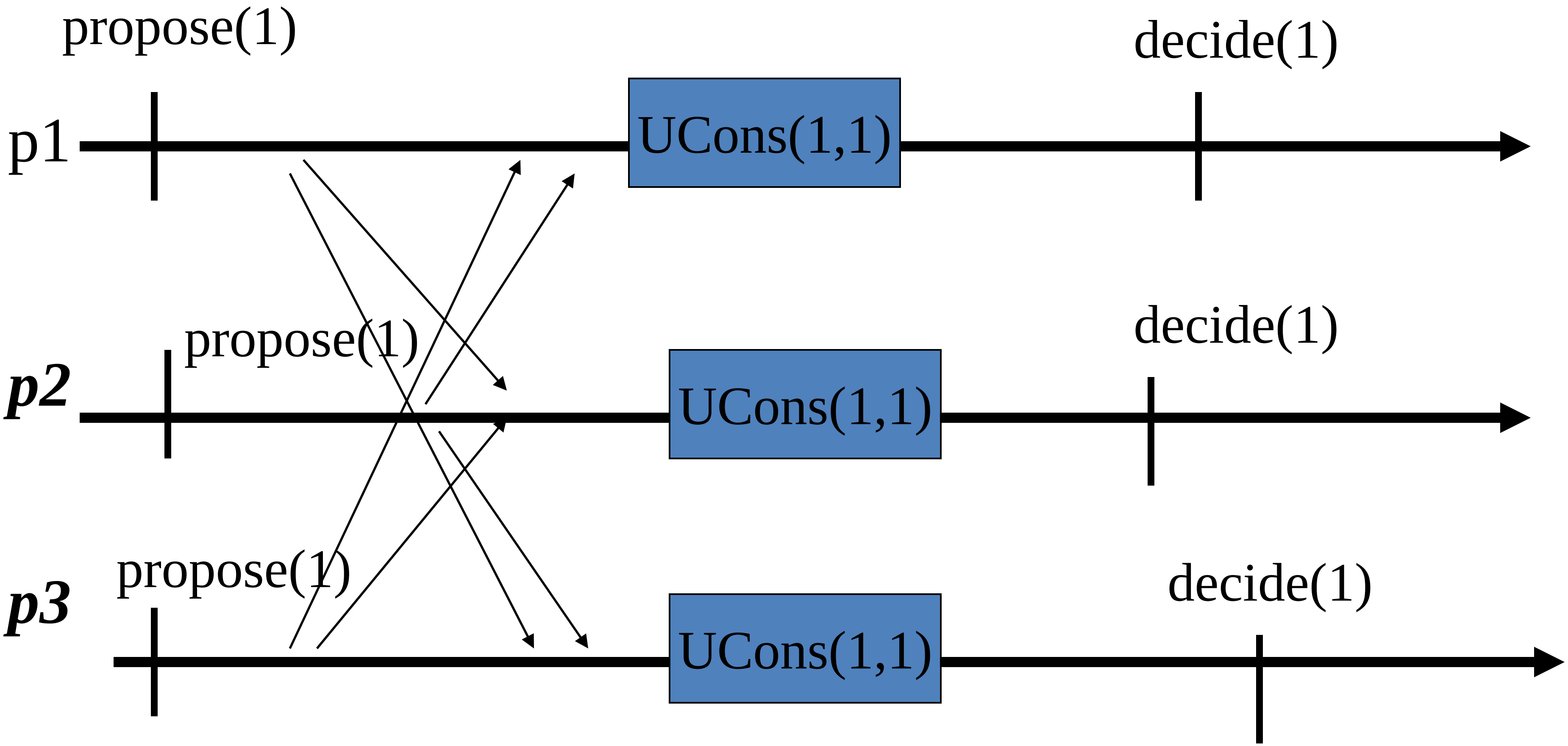
```
upon event < crash, pi > do
    correct := correct \  {pi}
upon event < Propose, v > do
    trigger < bebBroadcast, v>;
upon event <bebDeliver, pi, v> do
    delivered := delivered U {pi};
    prop := prop * v;
```

Algorithm (nbac – cont’d)

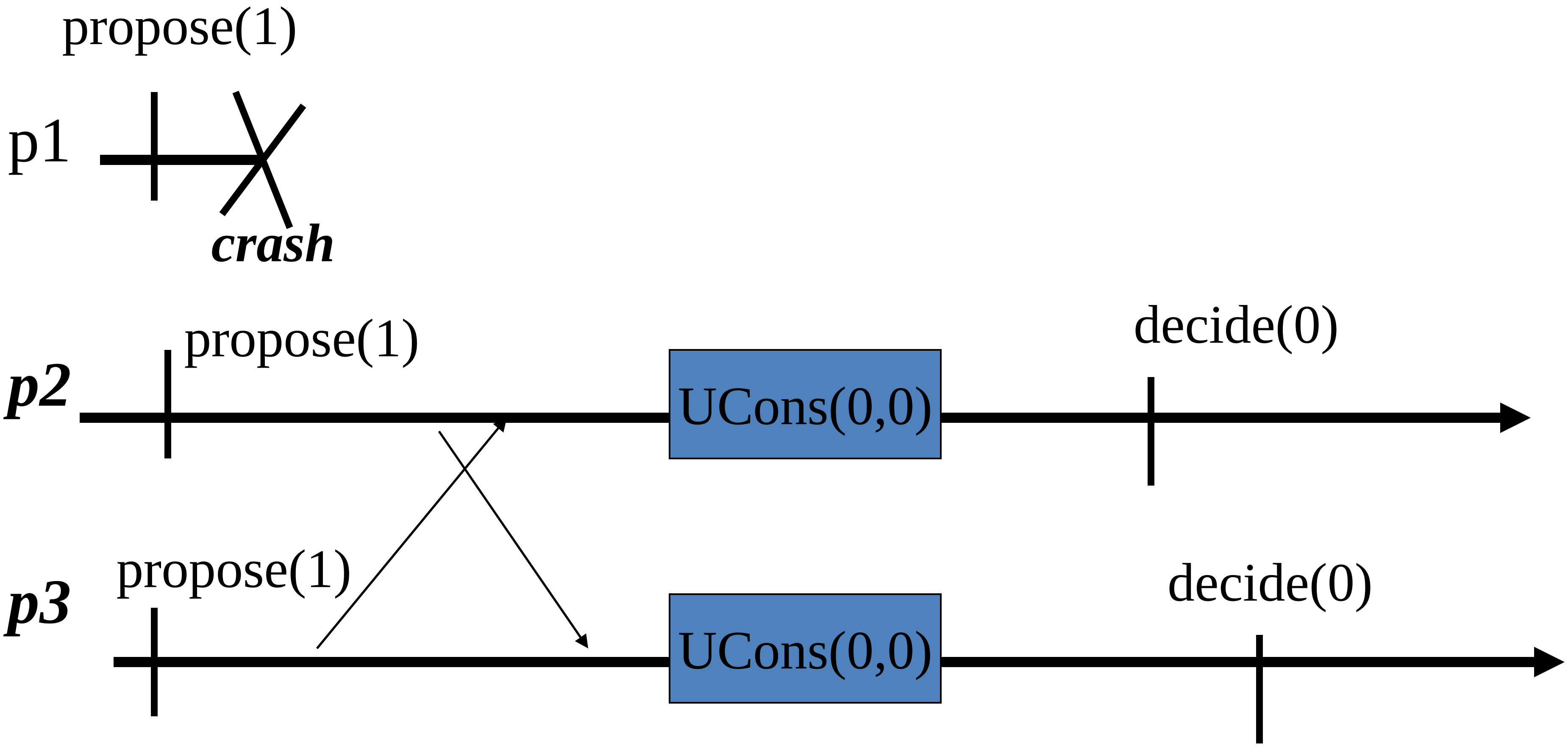
```
upon event correct \ delivered = empty do
    if correct $\neq \Pi$
        prop := 0;
    trigger <  uncPropose, prop>;

upon event < uncDecide, decision> do
    trigger < Decide, decision>;
```

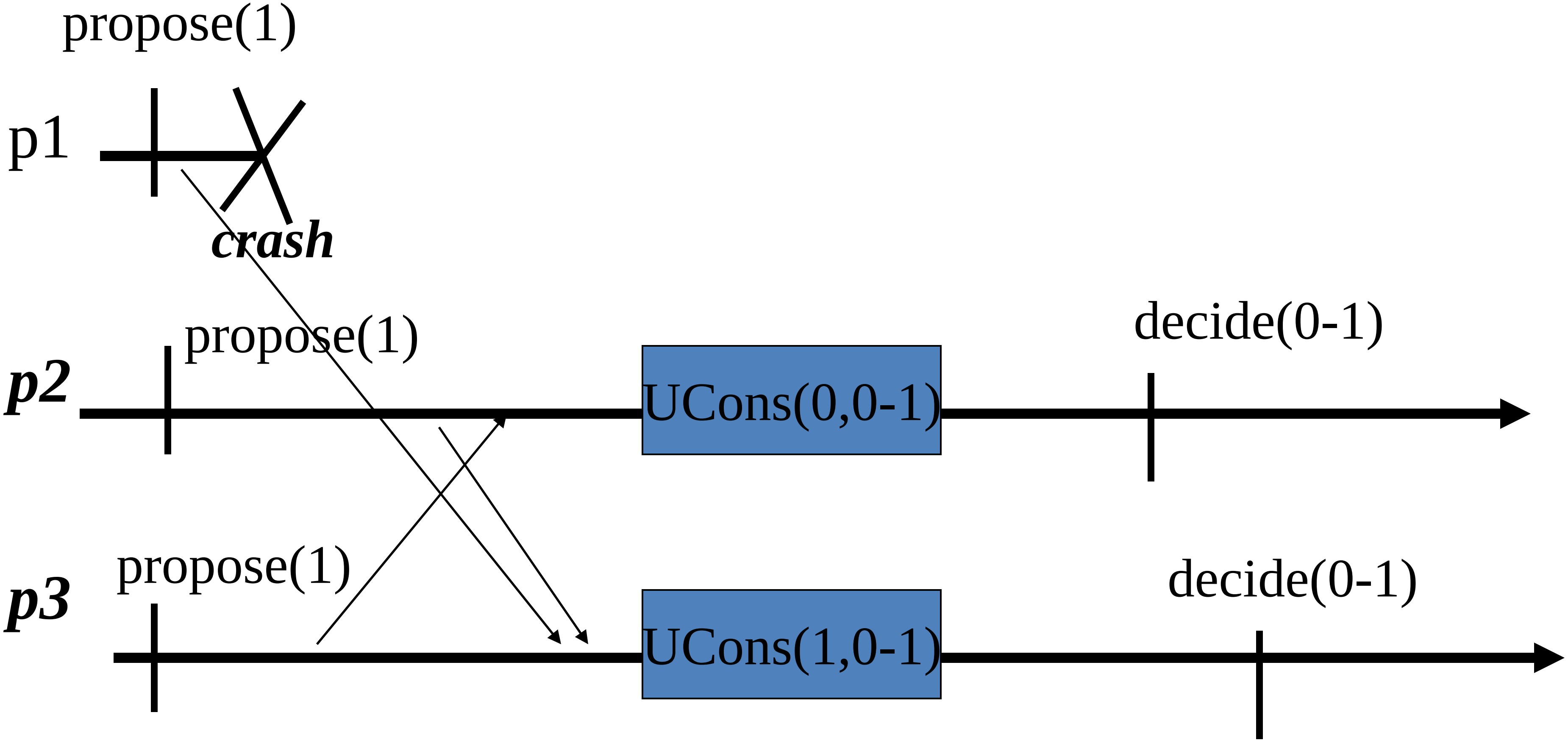
nbac with ucons



nbac with ucons



nbac with ucons



Non-Blocking Atomic Commit

- Do we need the perfect failure detector P?

  - 1. We show that <>P is not enough
  - 2. We show that P is needed if one process can crash

  - NB. Read DFGHTK04 for the general case

Non-Blocking Atomic Commit

- Do we need the perfect failure detector P?

  - ***1. We show that <>P is not enough***
  - 2. We show that P is needed if one process can crash

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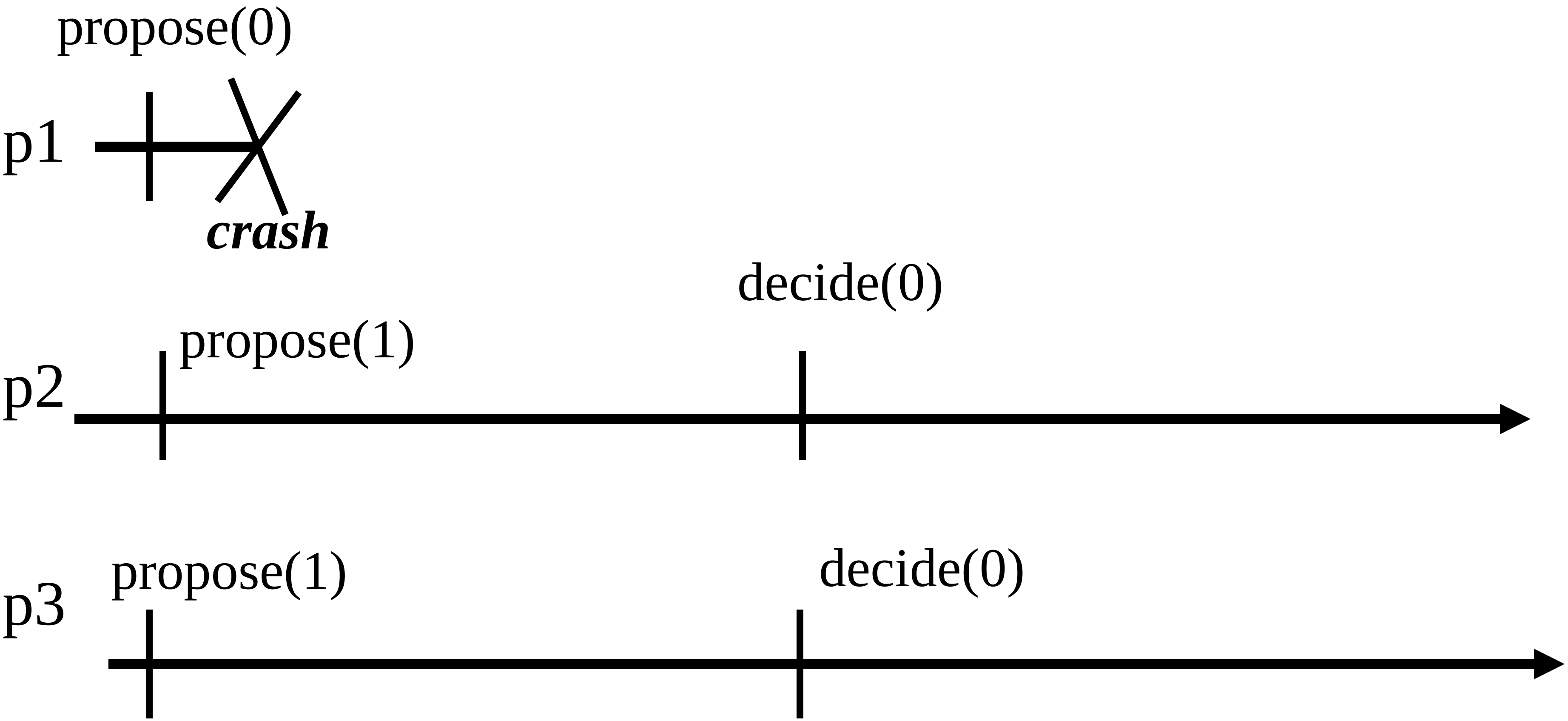
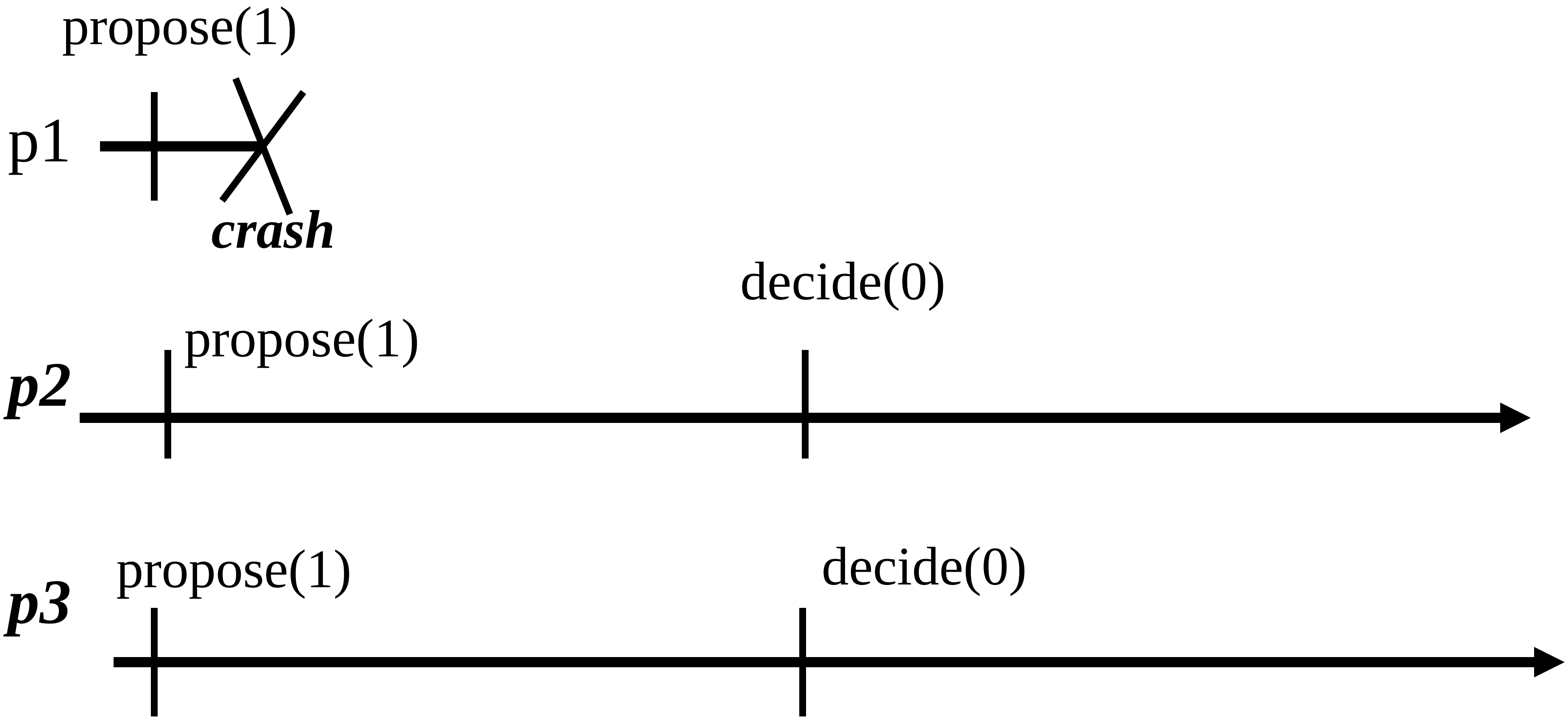
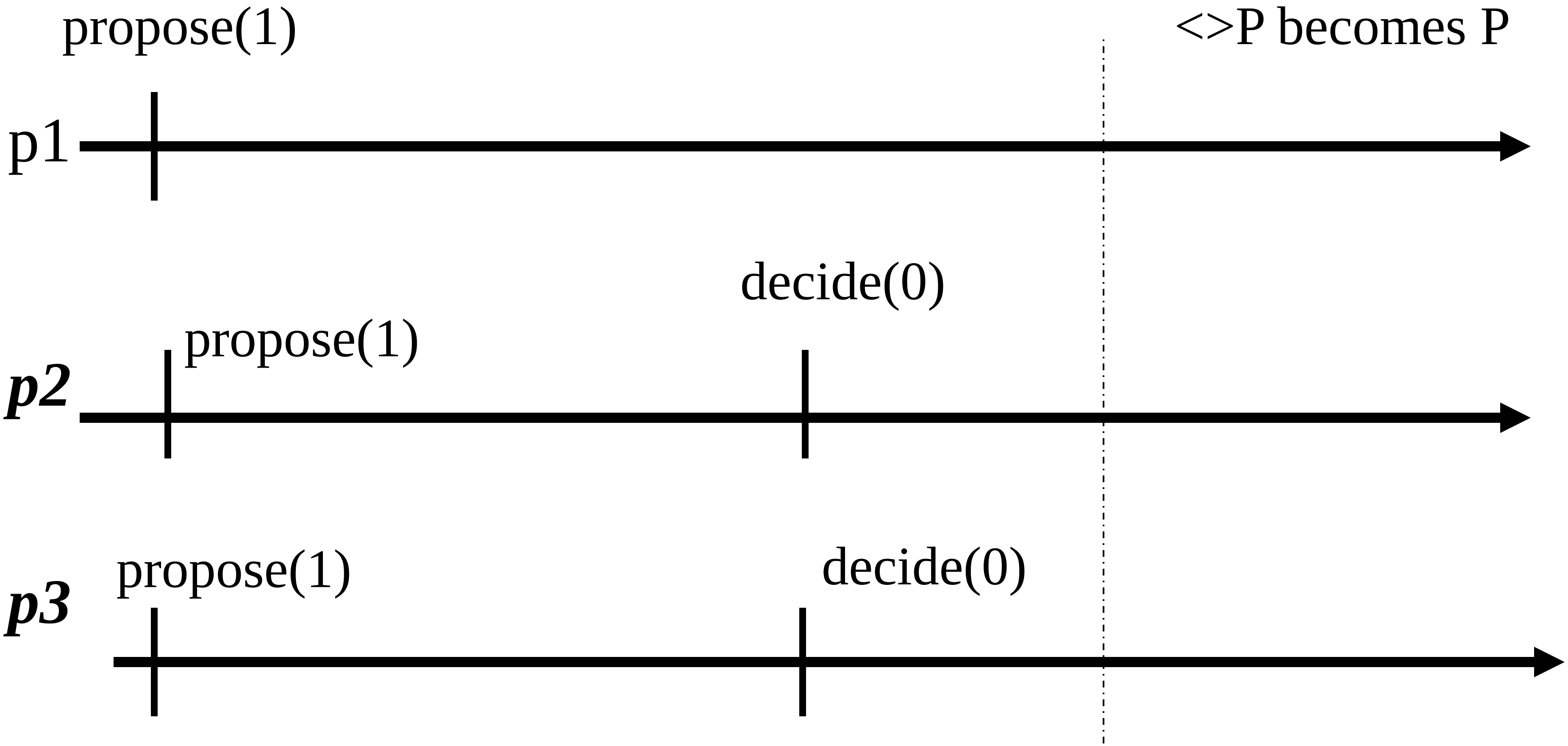
1. Run 1



1. Run 2



1. Run 3


propose(1)
<>P becomes P
p1
decide(0)
propose(1)
p2
p3
propose(1)
decide(0)

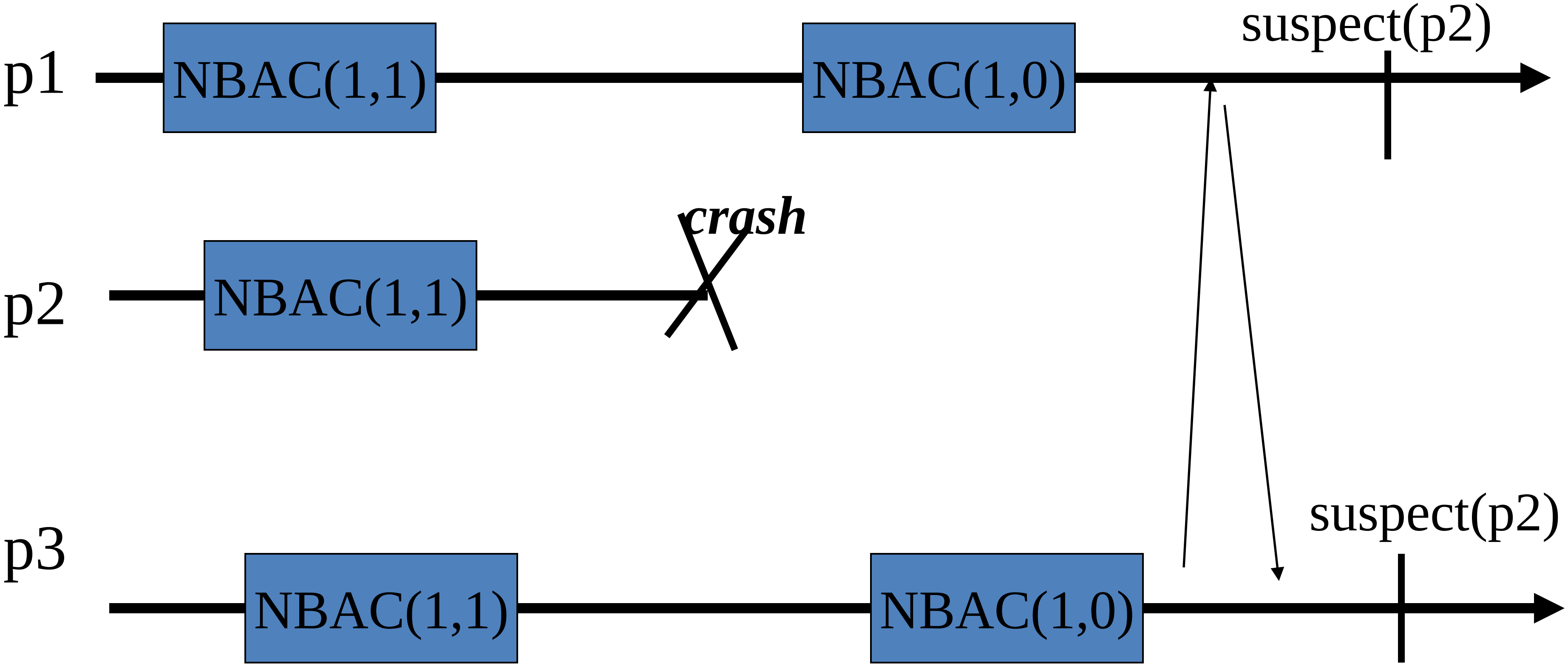
Non-Blocking Atomic Commit

- Do we need the perfect failure detector P?

  - 1. We show that <>P is not enough
  - ***2. We show that P is needed if one process can crash***

  - NB. Read DFGHTK04 for the general case

2. P is needed with one crash


p1
NBAC(1,1)
NBAC(1,0)
suspect(p2)
p2
NBAC(1,1)
crash
p3
NBAC(1,1)
NBAC(1,0)
suspect(p2)