Distributed Systems

Terminating Reliable Broadcast

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Terminating Reliable Broadcast
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• Like reliable broadcast, terminating reliable broadcast (TRB) is a communication primitive used to disseminate a message among a set of processes in a reliable way

• TRB is however strictly stronger than (uniform) reliable broadcast
(Uniform) Reliable Broadcast

p1

broadcast(m)

p2

\(crash\)

p3

deliver(m)

deliver(m)
(Uniform) Reliable Broadcast

broadcast(m)

p1

p2

crash

p3
Terminating Reliable Broadcast

p1

broadcast(m)

p2

crash

deliver(m)

p3

deliver(m)
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\[
\text{broadcast}(m) \\
\text{crash} \\
\text{deliver}(\varphi)
\]
Terminating Reliable Broadcast

- **Like** with reliable broadcast, correct processes in TRB agree on the set of messages they deliver

- **Like** with (uniform) reliable broadcast, every correct process in TRB delivers every message delivered by any process

- **Unlike** with reliable broadcast, every correct process delivers a message, even if the broadcaster crashes
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- The problem is defined for a specific broadcaster process $pi = src$ (known by all processes)
- Process $src$ is supposed to broadcast a message $m$ (distinct from $\varphi$)
- The other processes need to deliver $m$ if $src$ is correct but may deliver $\varphi$ if $src$ crashes
Terminating Reliable Broadcast (pi)

**TRB1. Integrity:** If a process delivers a message m, then either m is $\varphi$ or m was broadcast by src

**TRB2. Validity:** If the sender src is correct and broadcasts a message m, then src eventually delivers m

**TRB3. (Uniform) Agreement:** For any message m, if a correct (any) process delivers m, then every correct process delivers m

**TRB4. Termination:** Every correct process eventually delivers exactly one message
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Events

- Request: <trbBroadcast, m>

- Indication: <trbDeliver, p, m>

Properties:

- TRB1, TRB2, TRB3, TRB4
Algorithm (trb)

**Implements:** trbBroadcast (trb).

**Uses:**
- BestEffortBroadcast (beb).
- PerfectFailureDetector (P).
- Consensus(cons).

**upon event** < Init > **do**
- prop := ⊥;
- correct := S;
Algorithm (trb – cont’d)

upon event < trbBroadcast, m> do
  trigger < bebBroadcast, m>;

• upon event < crash, src > and (prop = ⊥) do
  • prop := ϕ;
Algorithm (trb – cont’d)

upon event <bebDeliver, src, m> and (prop = ⊥) do

  prop := m;

• upon event (prop ≠ ⊥) do
  • trigger < Propose, prop >;

• upon event < Decide, decision> do
  • trigger < trbDeliver, src, decision>;
Algorithm (trb); src = p2

p1

broadcast(m)

p2

crash

p3

UCons(φ, φ-m) deliver(φ -m)

UCons(m, φ-m) deliver(φ -m)
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• The TRB algorithm uses the perfect failure detector P (i.e., P is sufficient)

• Is P also necessary?
  • Is there an algorithm that implements TRB with a failure detector that is strictly weaker than P? (this would mean that P is not necessary)
  • Is there an algorithm that uses TRB to implement P (this would mean that P is necessary)
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- We give an algorithm that implements $P$ using $\text{TRB}$; more precisely, we assume that every process $p_i$ can use an infinite number of instances of $\text{TRB}$ where $p_i$ is the sender src.

  - 1. Every process $p_i$ keeps on $\text{trbBroadcasting}$ messages $m_{i1}, m_{i2},$ etc.
  - 2. If a process $p_k$ delivers $\varphi_i$, $p_k$ suspects $p_i$.

- NB. The algorithm uses (non-uniform) $\text{TRB}$.