Reliable Data Transfer

Antonio Carzaniga

Faculty of Informatics
Università della Svizzera italiana

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Outline

- Finite-state machines
- Using FSMs to specify protocols
- Principles of reliable data transfer
- Reliability over noisy channels
- ACKs/NACKs

Finite-State Machines

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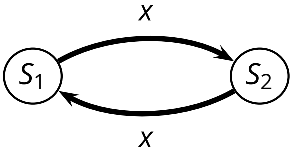
- Ubiquitous in computer science
  - theory of formal languages
  - compiler design
  - theory of computation
  - text processing
  - behavior specification
  - ...

Finite-State Machines



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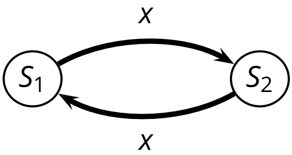

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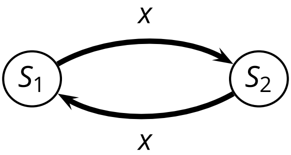

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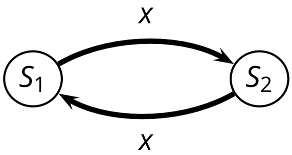

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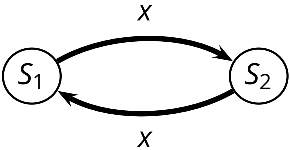

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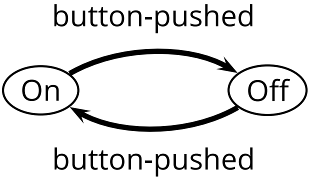

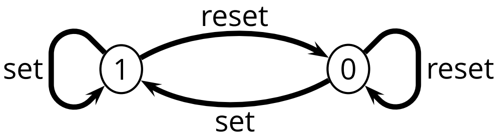
reset
set
1
0
reset
set

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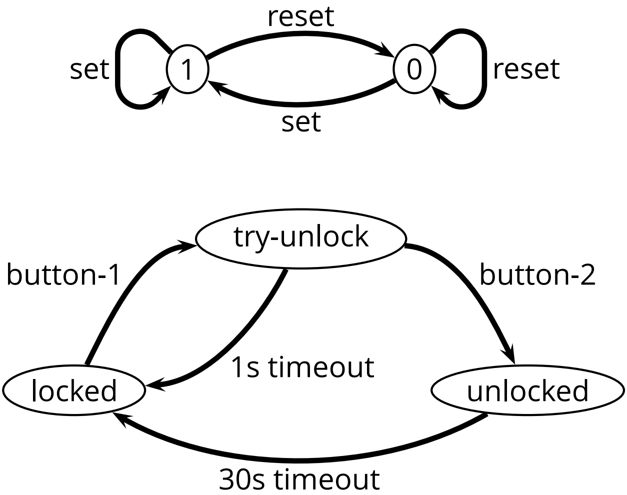

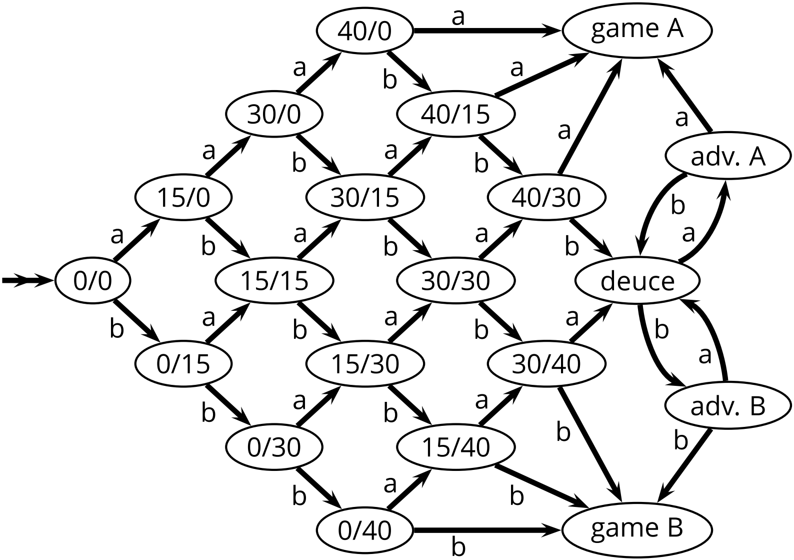

0/0
15/0
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15/40
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deuce
adv. A
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game A
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a
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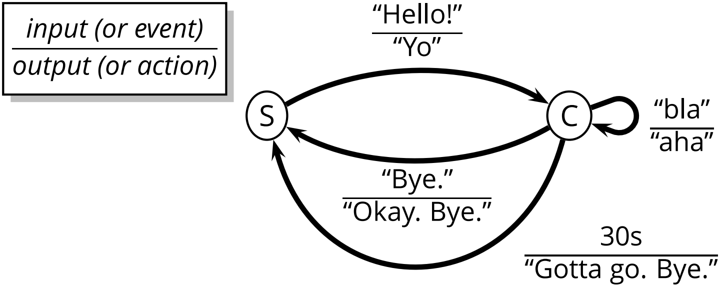
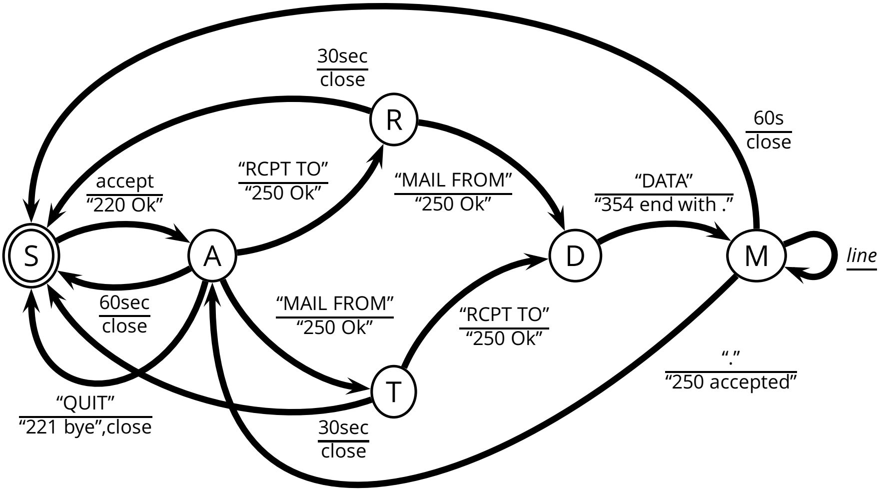
- E.g., here's a specification of a "simple conversation protocol"



Example

E.g., a subset of a server-side, SMTP-like protocol



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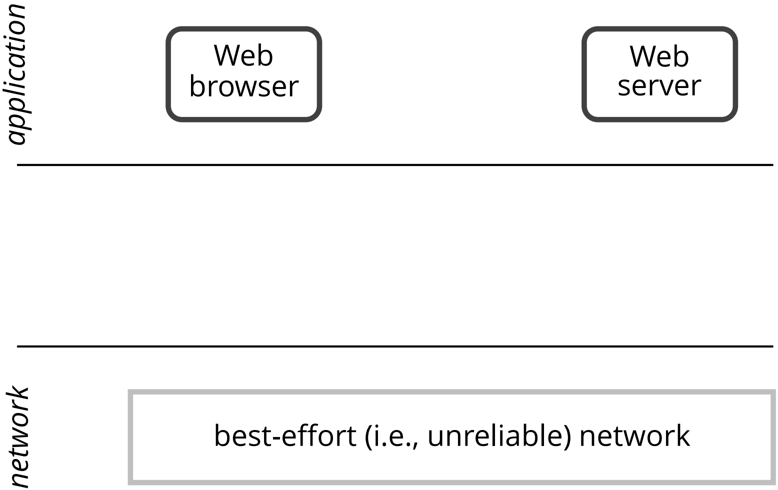

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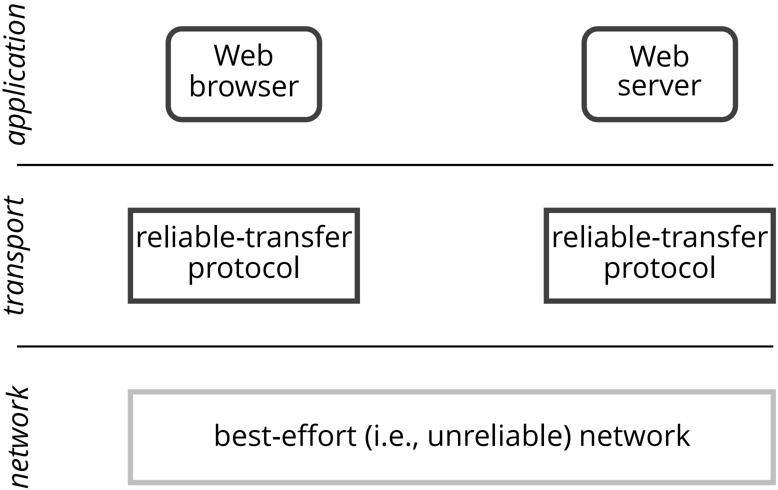

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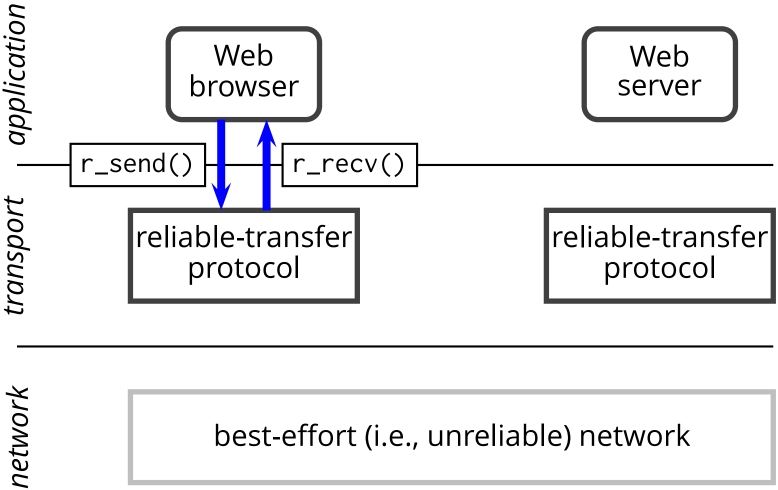

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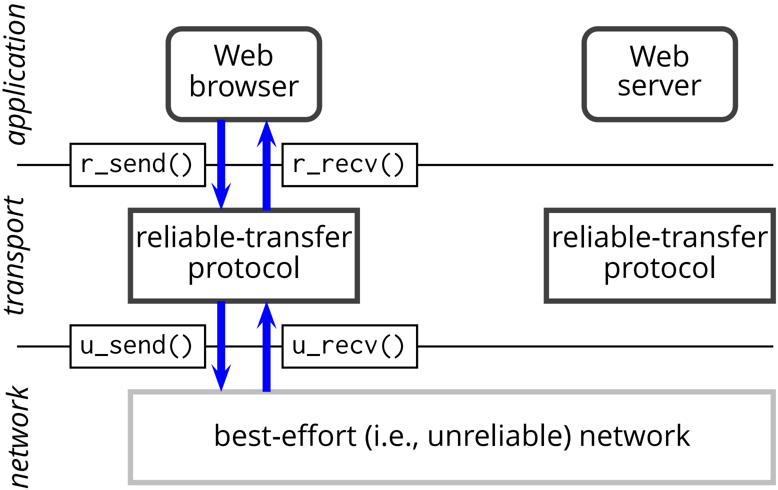

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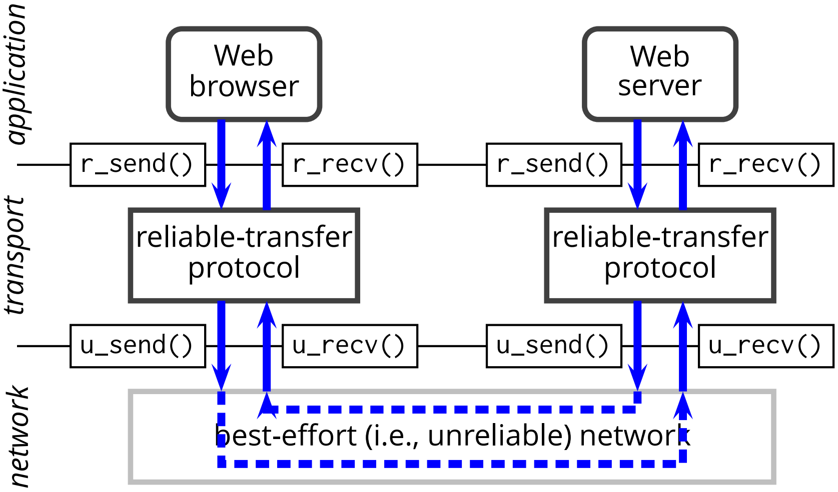

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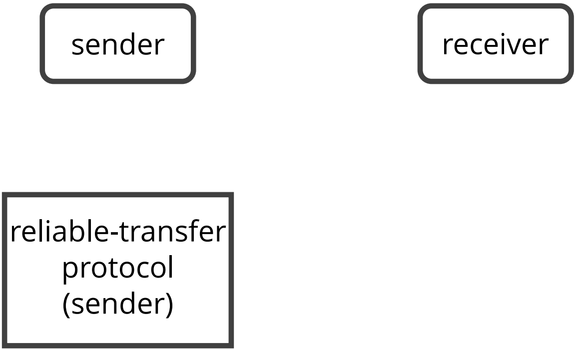

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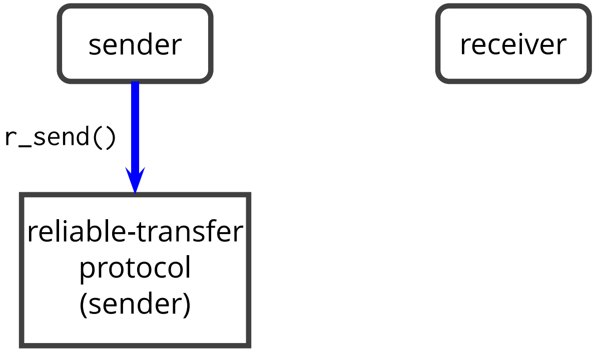

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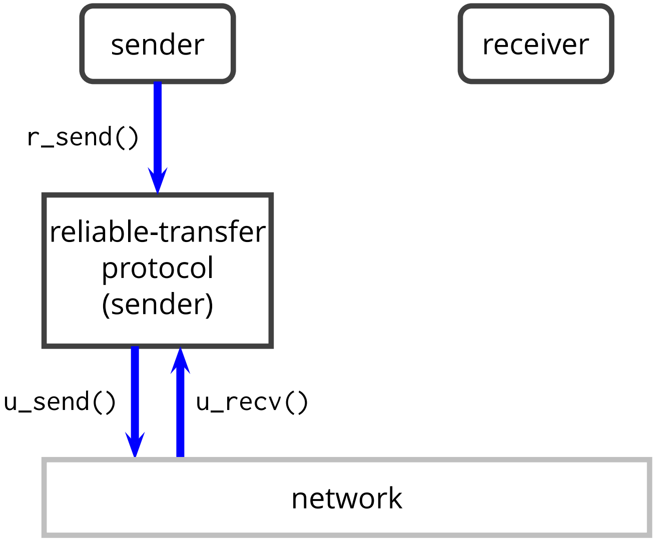

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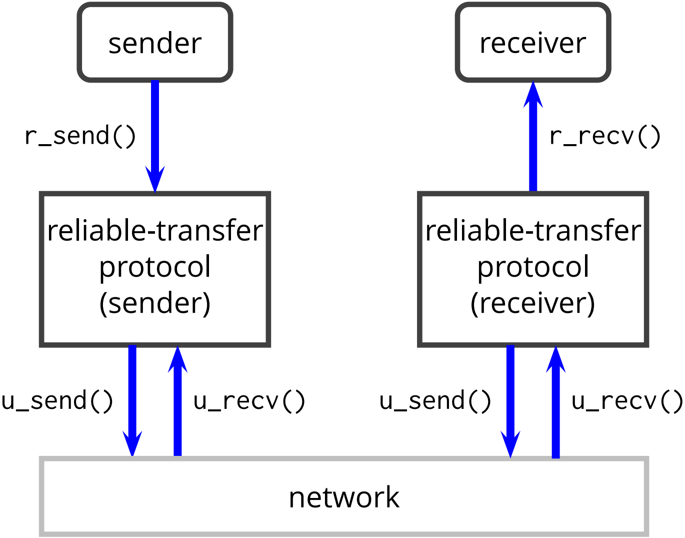

Baseline Protocol

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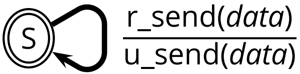
sender



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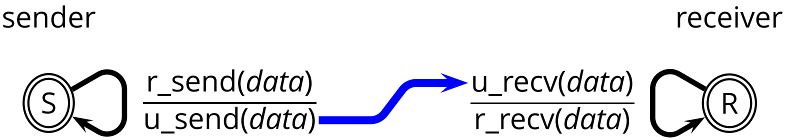

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  - ***retransmission:*** the sender retransmits corrupted packets

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  message is 1001011011101000 ⇒ send 1001011011101000<u>0</u>

  Receiver:
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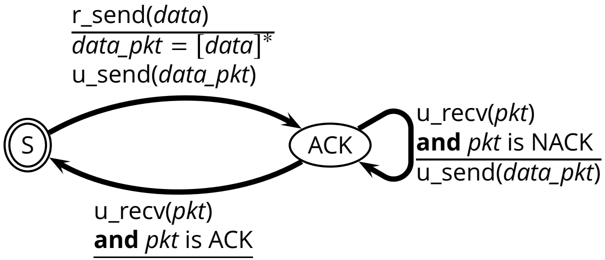

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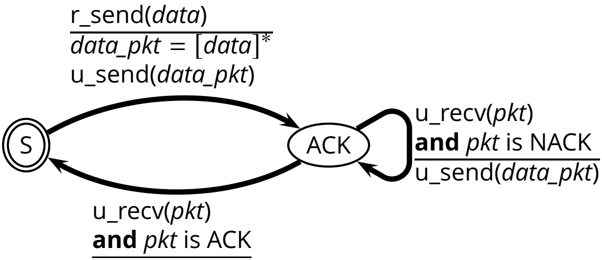

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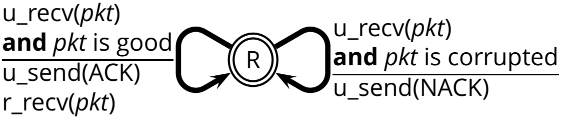

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- Does the protocol really work?
- What happens if an error occurs within an ACK/NACK packet?

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  - good idea, but it introduces *duplicate packets* (why?)

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- How many bits do we need for the sequence number?

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  7. receiver hears: "7: let's go see Taxi Driver"
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- How many bits do we need for the sequence number?
  - this is a "stop-and-wait" protocol for each packet, so the receiver needs to distinguish between (1) the next packet and (2) the retransmission of the current packet

Dealing With Duplicate Packets

- The sender adds a *sequence number* to each packet so that the receiver can determine whether a packet is a retransmission

  1. sender says: “7: let’s go see Taxi Driver”
  2. receiver hears: “7: let’s go see Taxi Driver”
  3. receiver passes “let’s go see Taxi Driver” to application layer
  4. receiver says: “Got it!” (i.e., ACK)
  5. sender hears: “. . . *noise* . . . ”
  6. sender (assuming a NACK) says: “7: let’s go see Taxi Driver”
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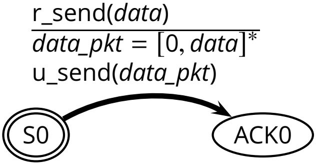

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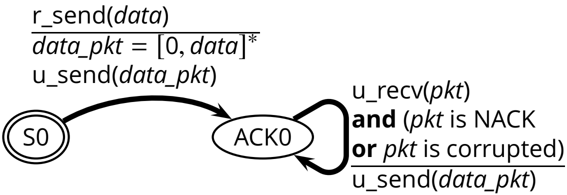

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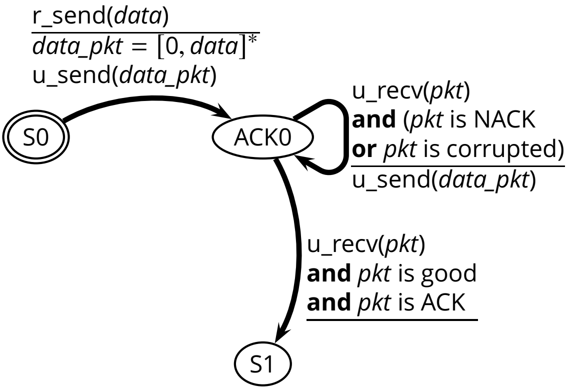

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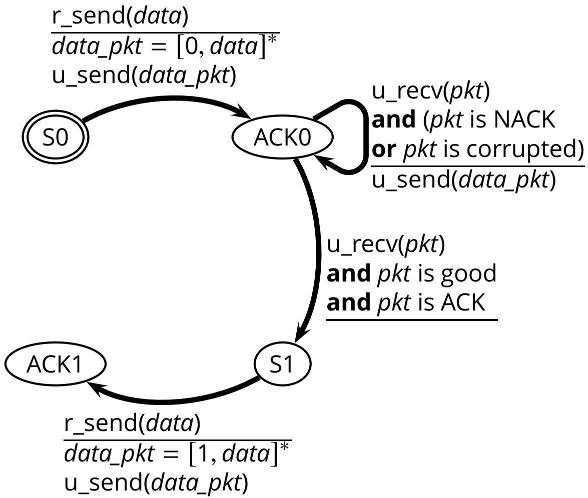

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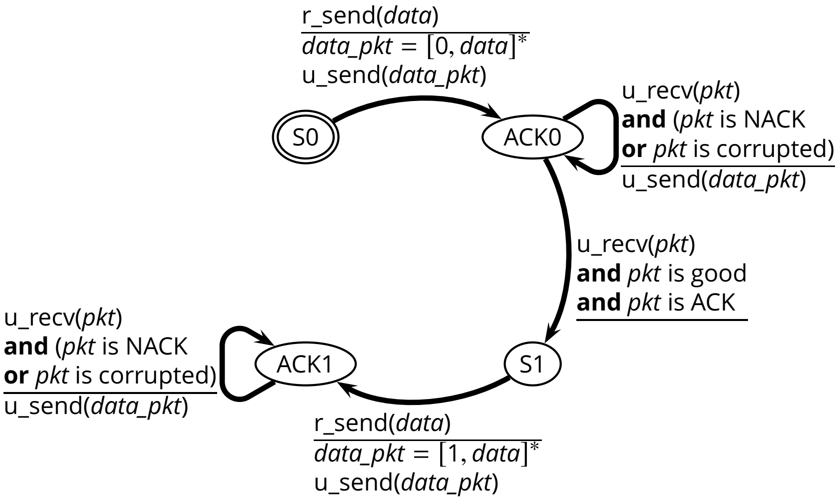

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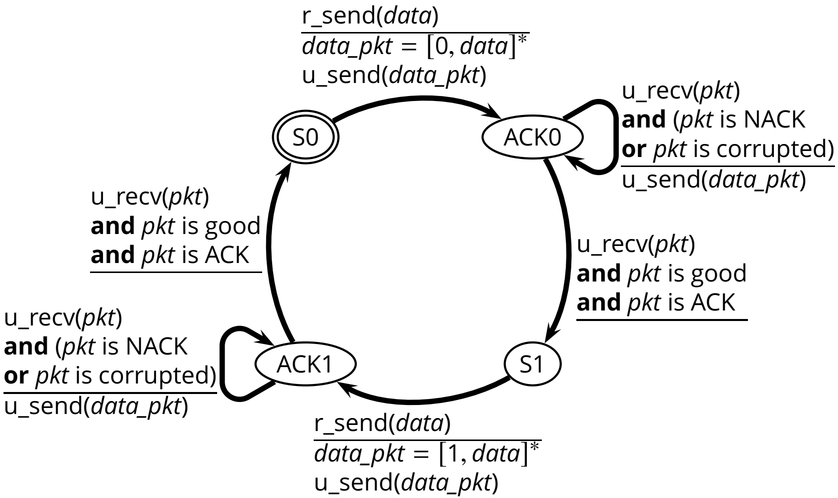

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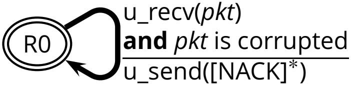

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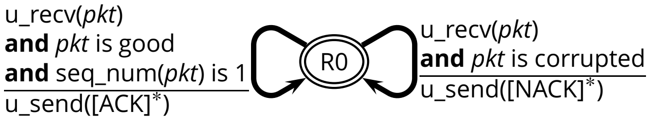

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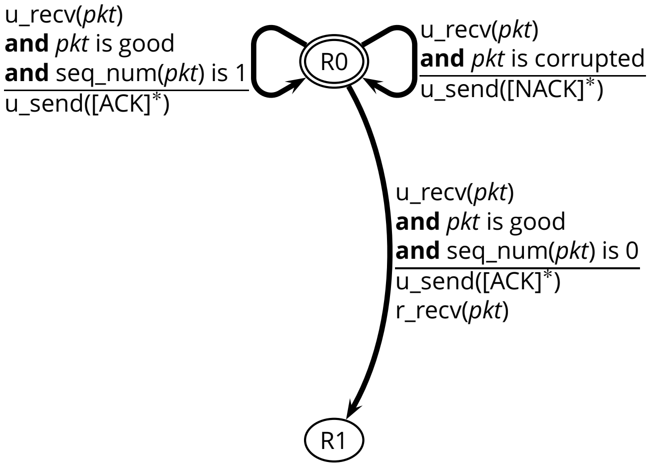

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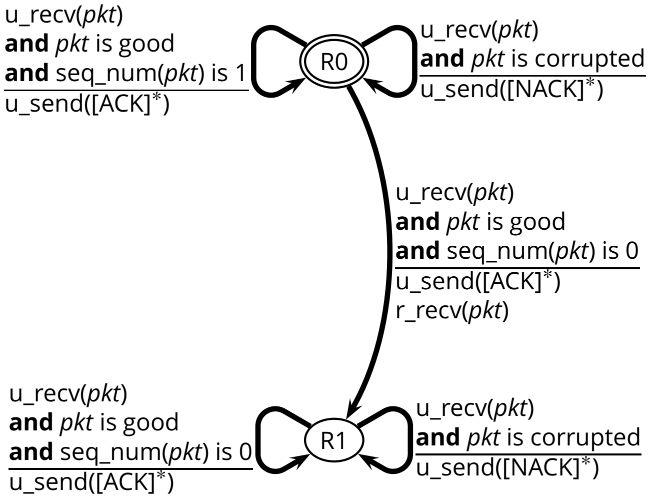

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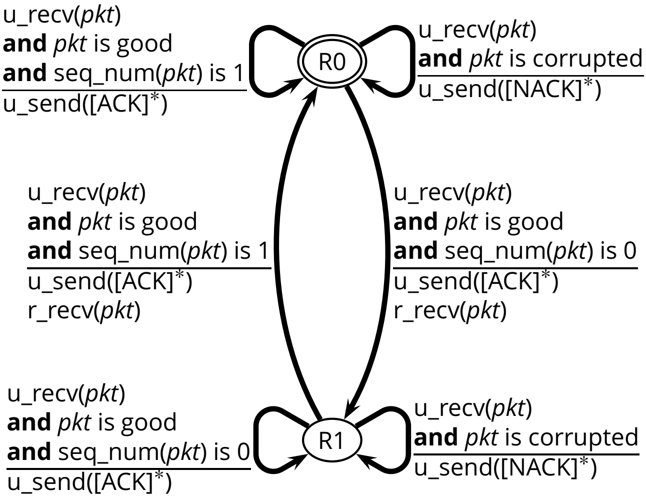

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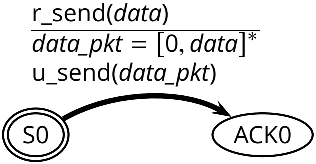

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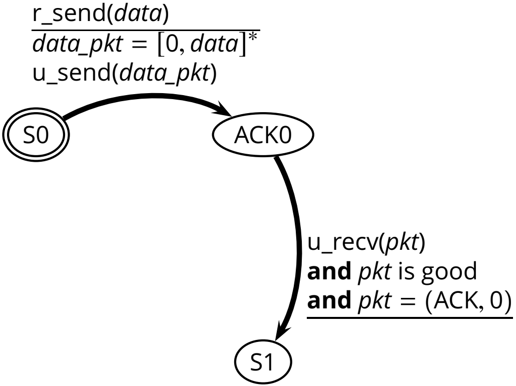

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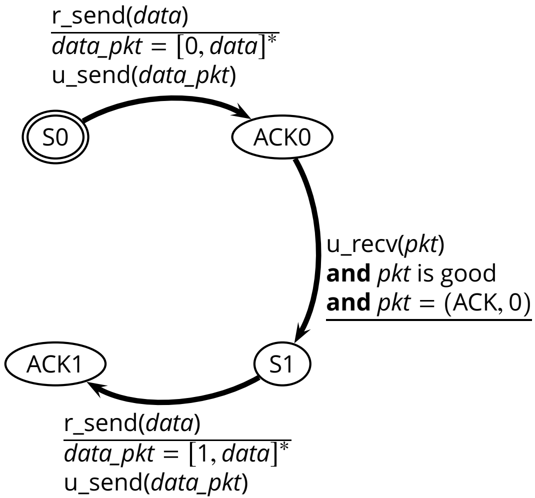

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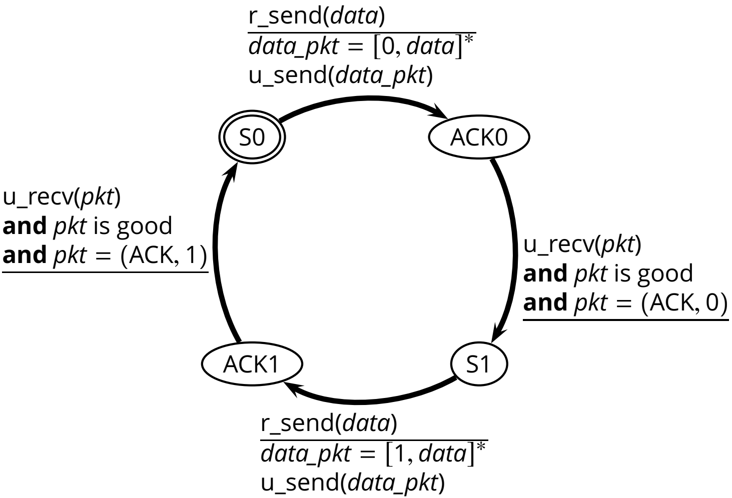

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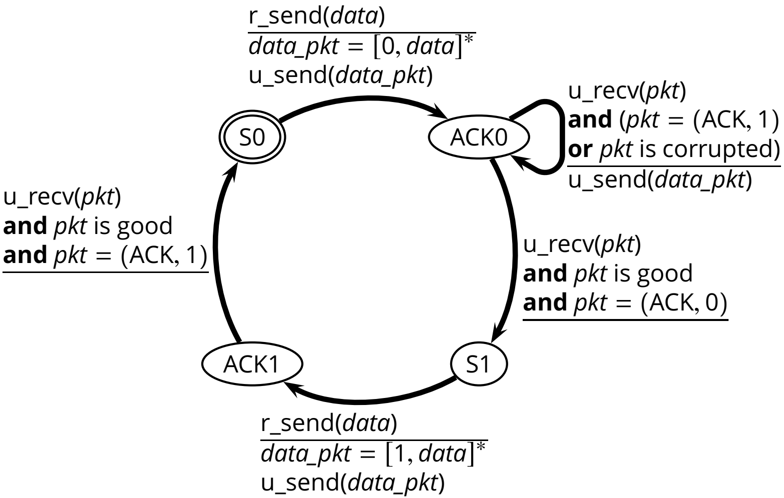

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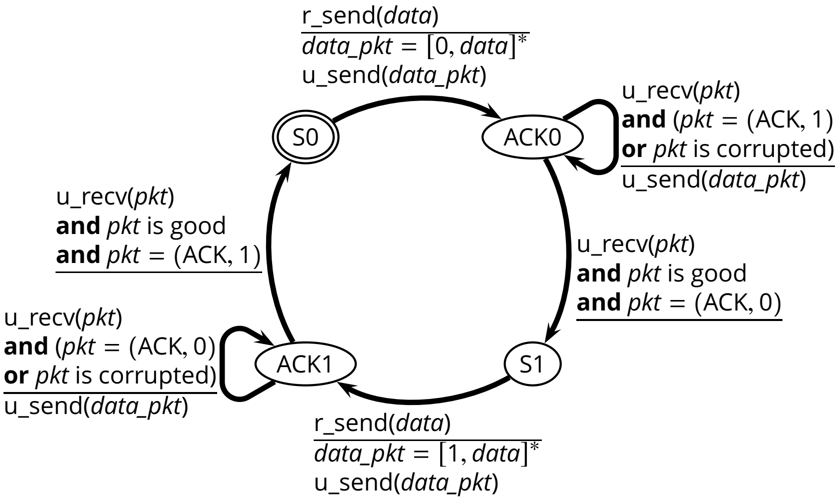

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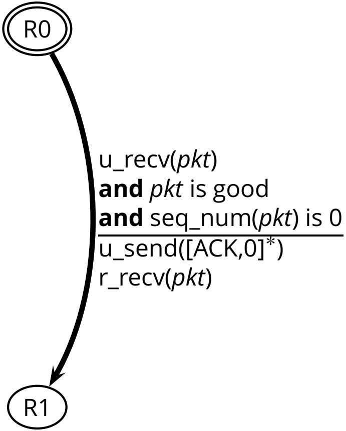

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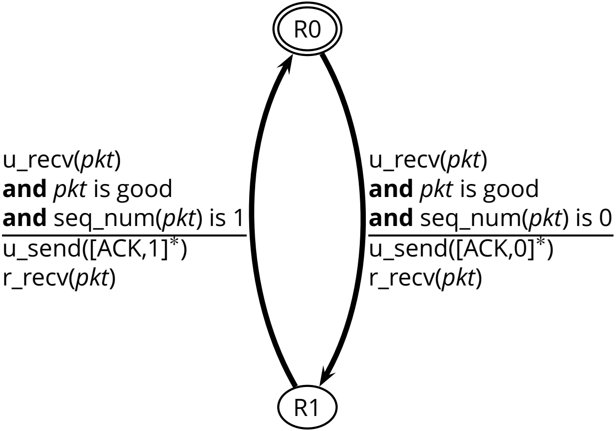

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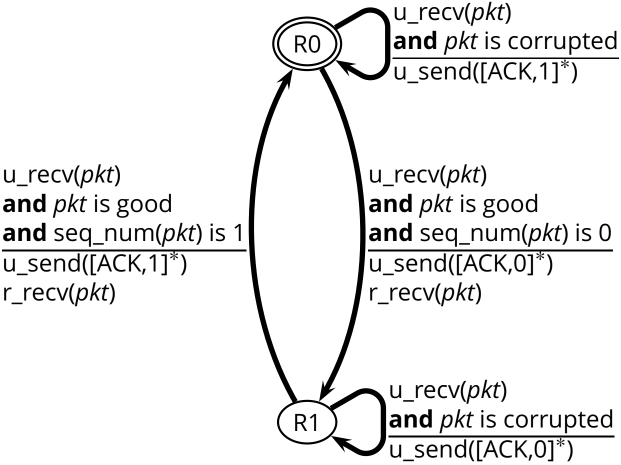

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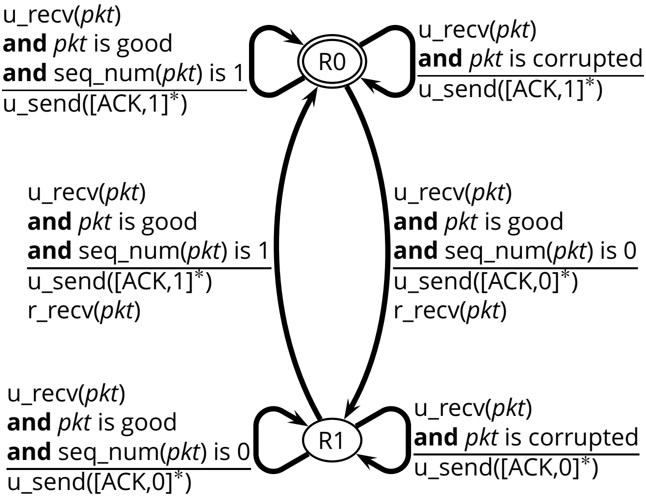

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- *ACKs, retransmission, and sequence numbers:* lost packets can be easily treated as corrupted packets

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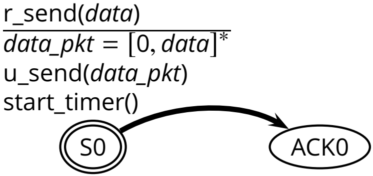

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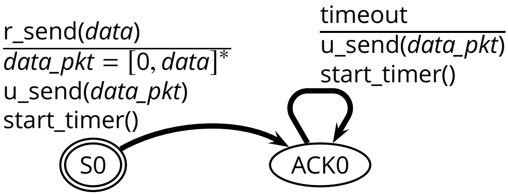

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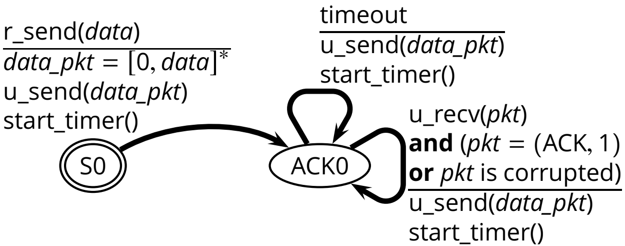

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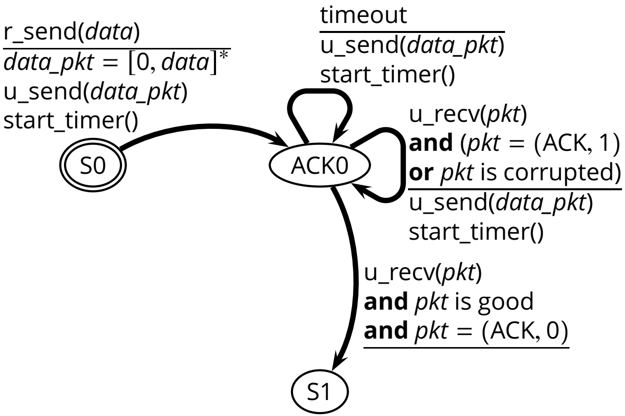

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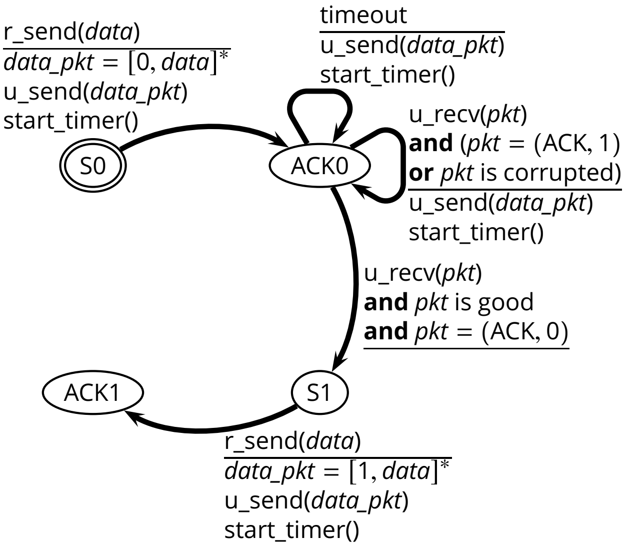

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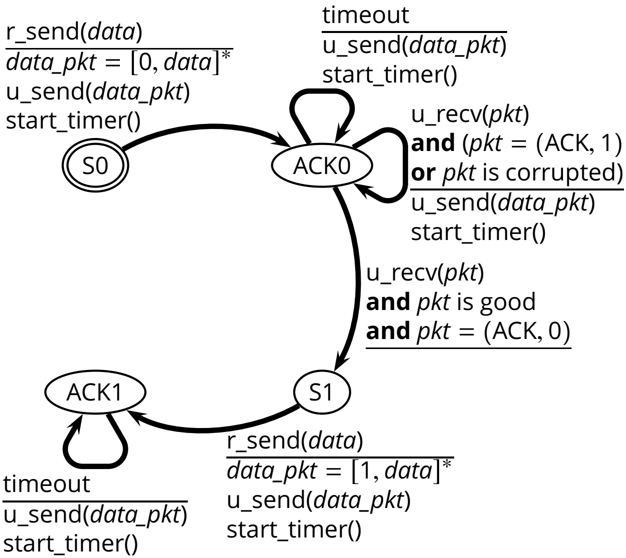

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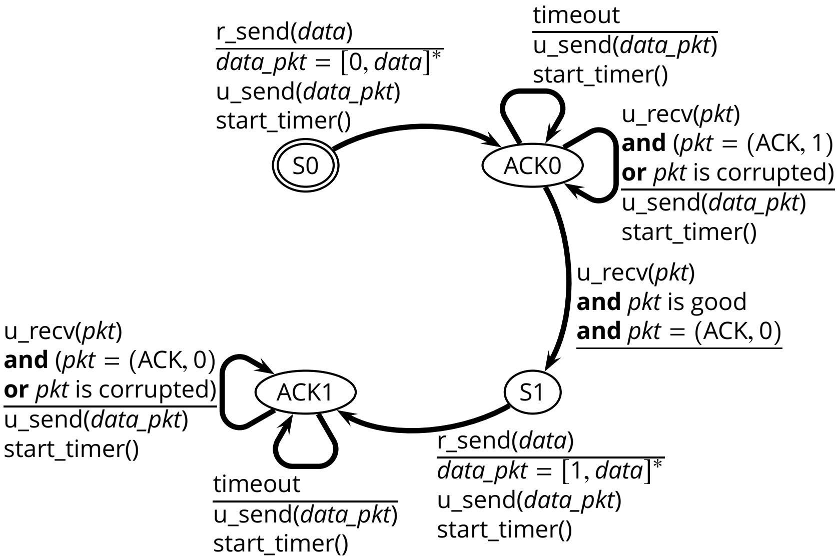

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