Transport Layer

Transport Layer

- Big leap in the level of abstraction:
  - *Application Layer*: reliable, bidirectional stream-oriented service
  - *Network Layer*: unreliable Datagram service
- End-to-End Principle
  - as simple as possible network
  - all “smarts” are at the end nodes

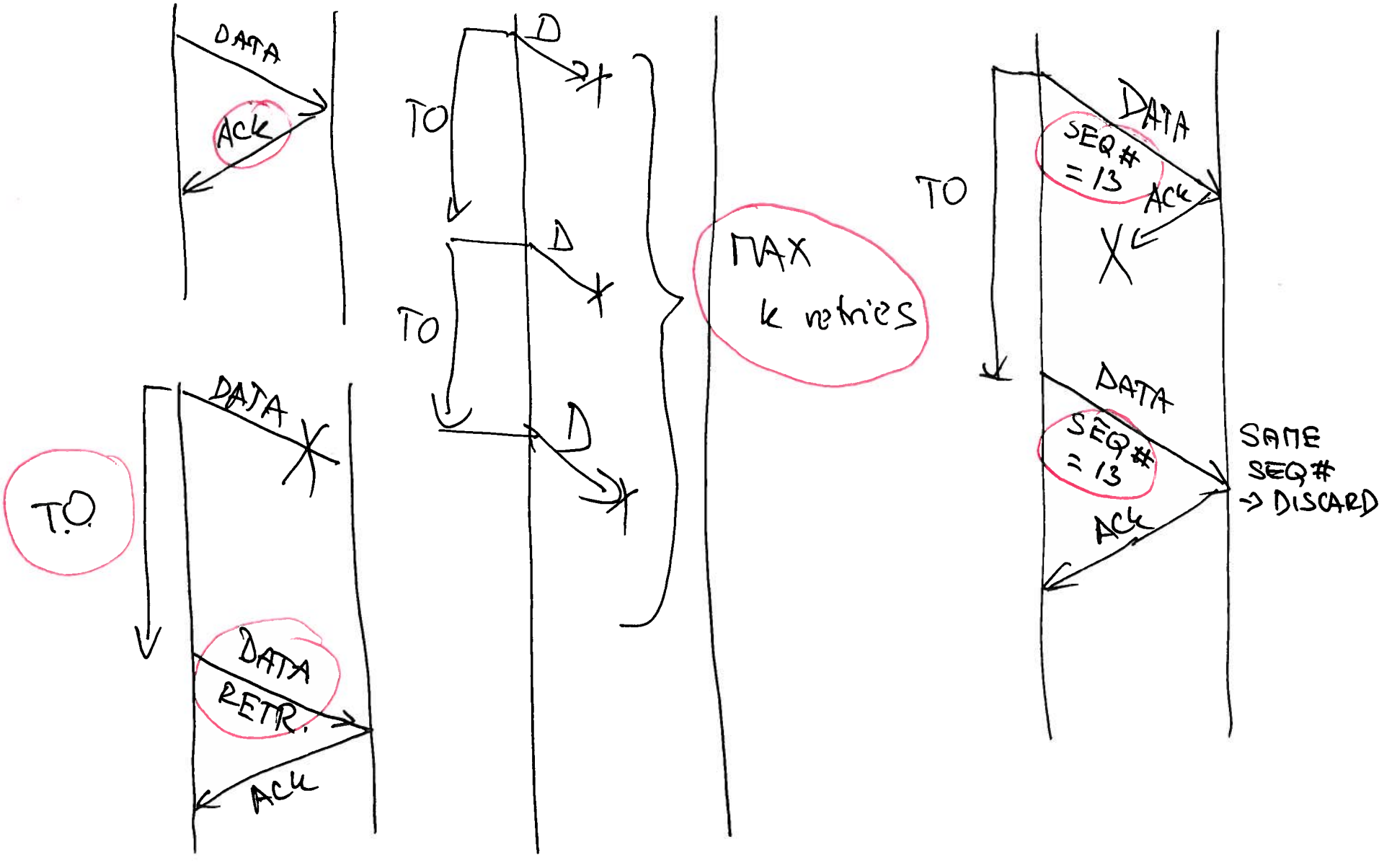
Functions of Transport

- Addressing
  - port numbers
- Error control
  - packet loss detection and retransmissions
- Flow and congestion control
  - controlling the transmission rate
- Session management

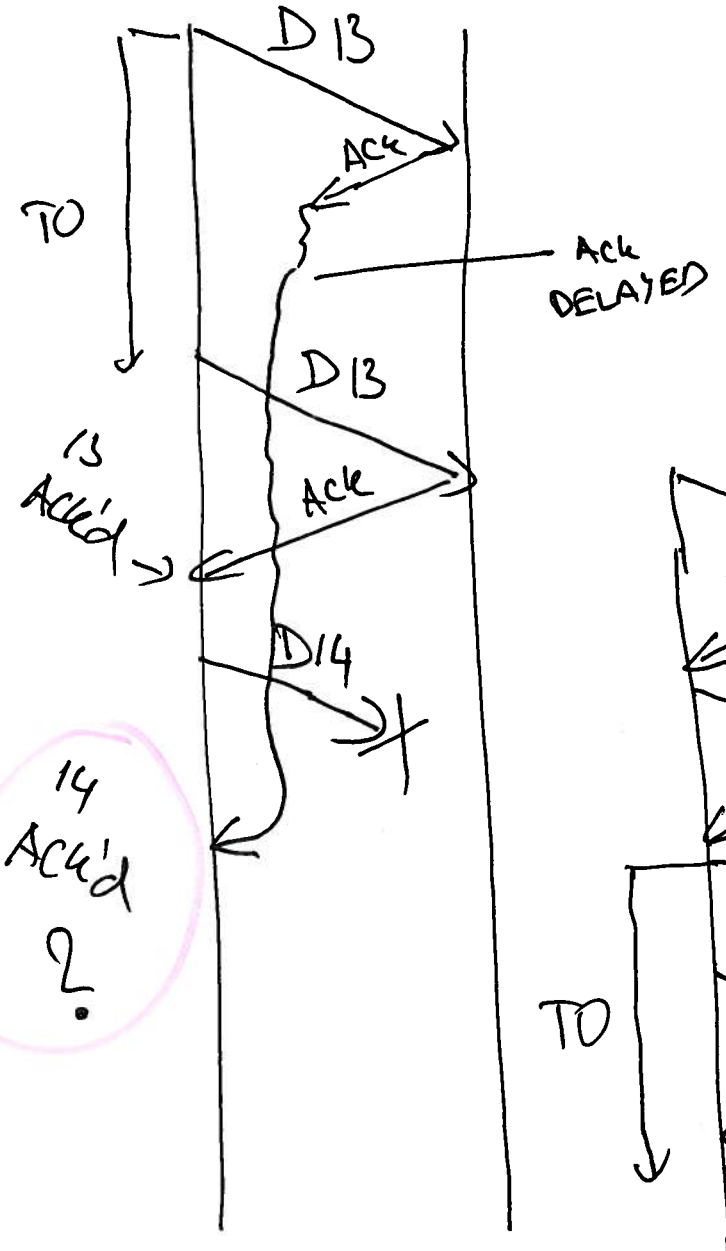
Principles of Reliable

- **Goal:** deliver despite unreliability of network layer or detect that delivery is not possible
- Automatic Repeat reQuest (**ARQ**):
  - acknowledgment
  - timeout
  - retransmission
  - give up after k retransmissions
  - sequence numbers on data packets
  - cumulative acknowledgment numbers

ARQ COMPONENTS

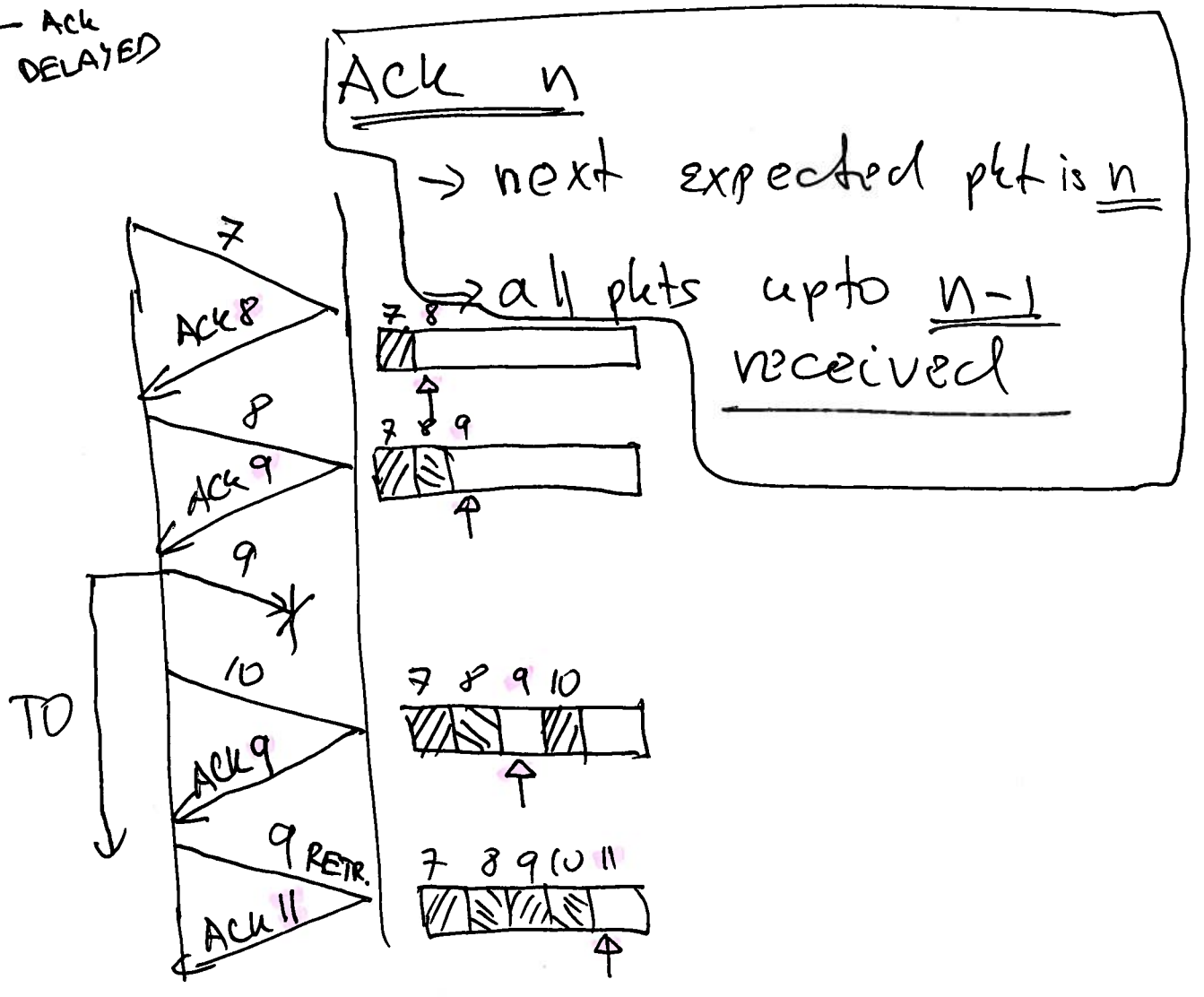


PROBLEM:



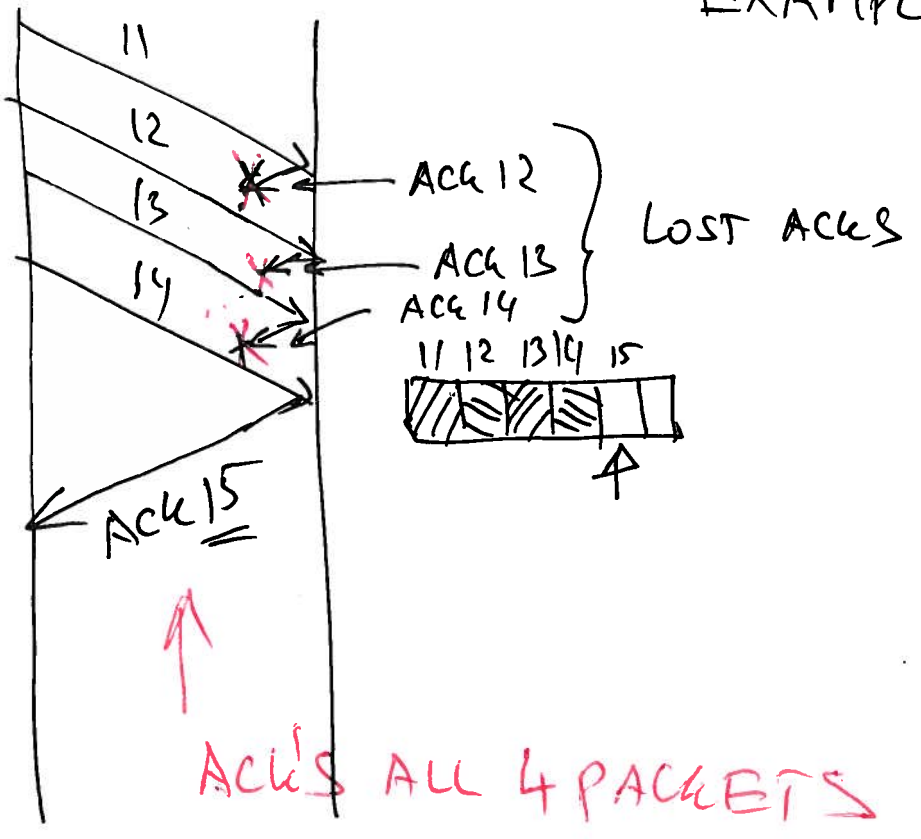
SOLUTION:

CUM. Ack #s



CUMULATIVE ACKNOWLEDGMENT

EXAMPLE

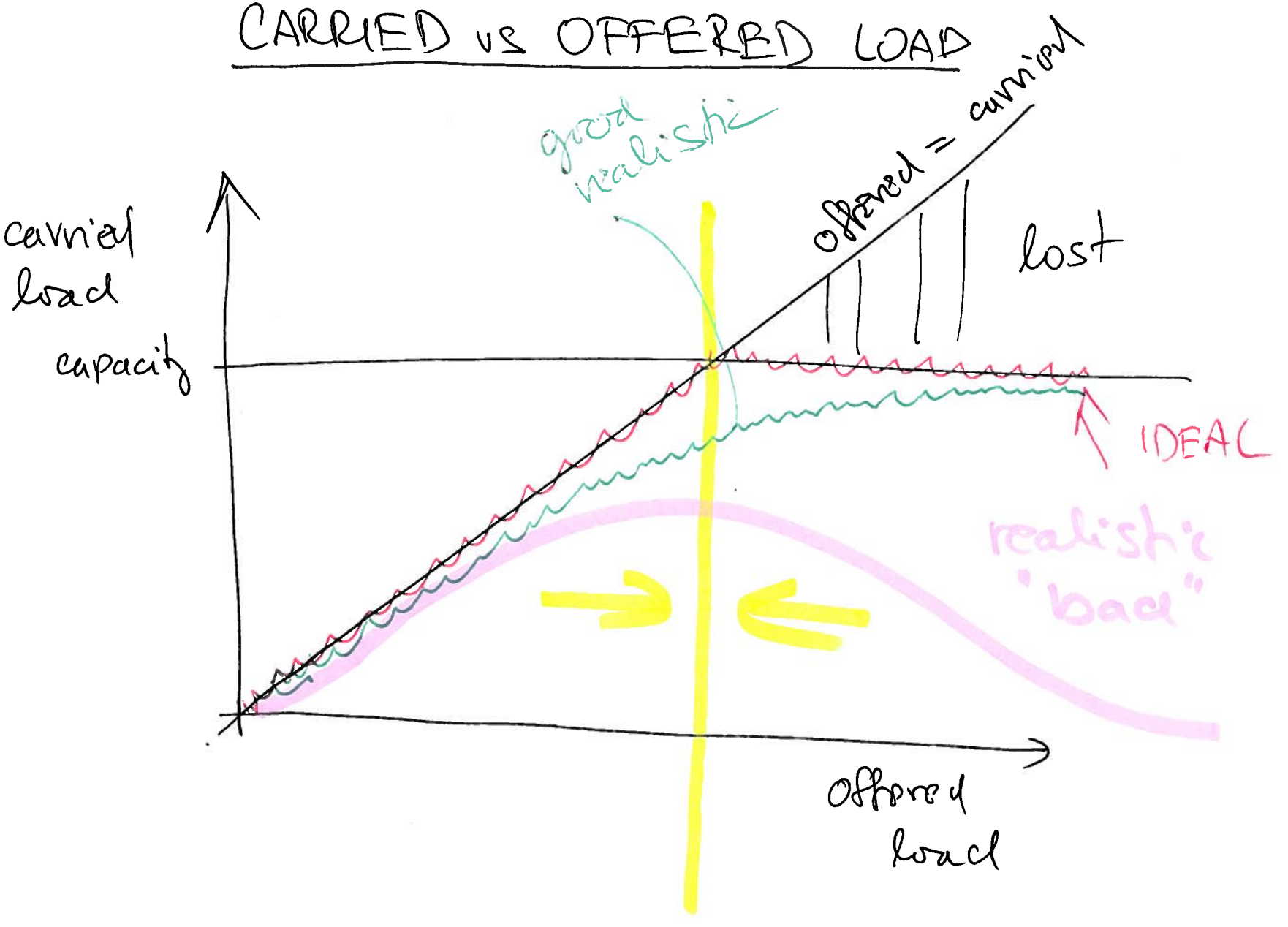


Flow control

- Flow control, congestion control, traffic management, etc. (same fundamental issue)

- **Goal**: Make the most effective use of the network capacity
  - avoid congestion
  - maximize utilization
  - maintain fairness (or deliver promised service level)

CARRIED vs OFFERED LOAD



LOAD VS LATENCY DIAGRAM