

Defining Cross-Layer Design for Wireless Networking

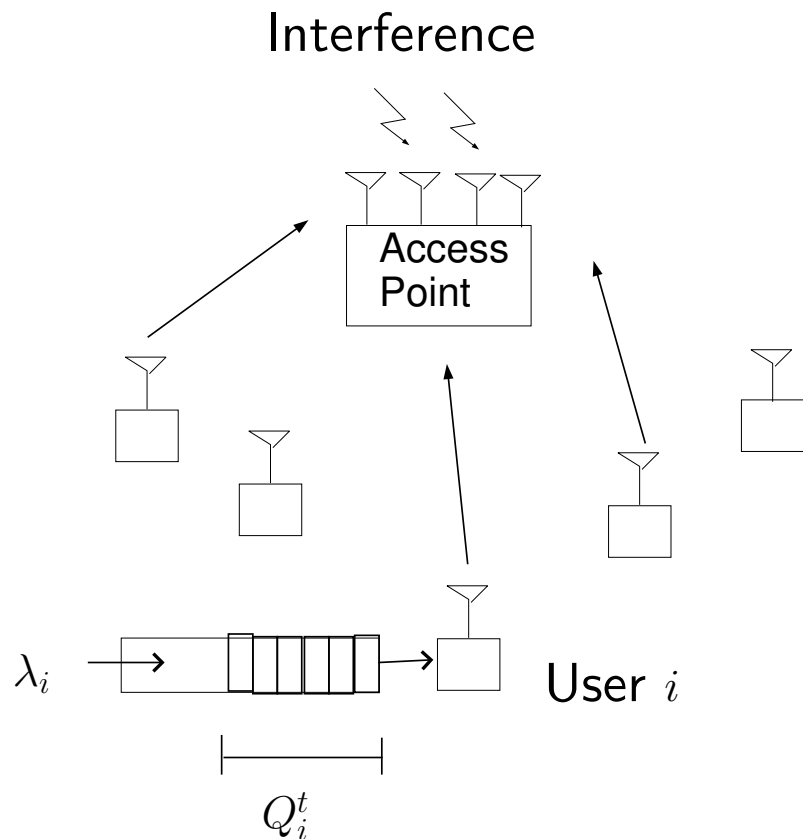
A Case Study on Random Access

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Random Multiple Access



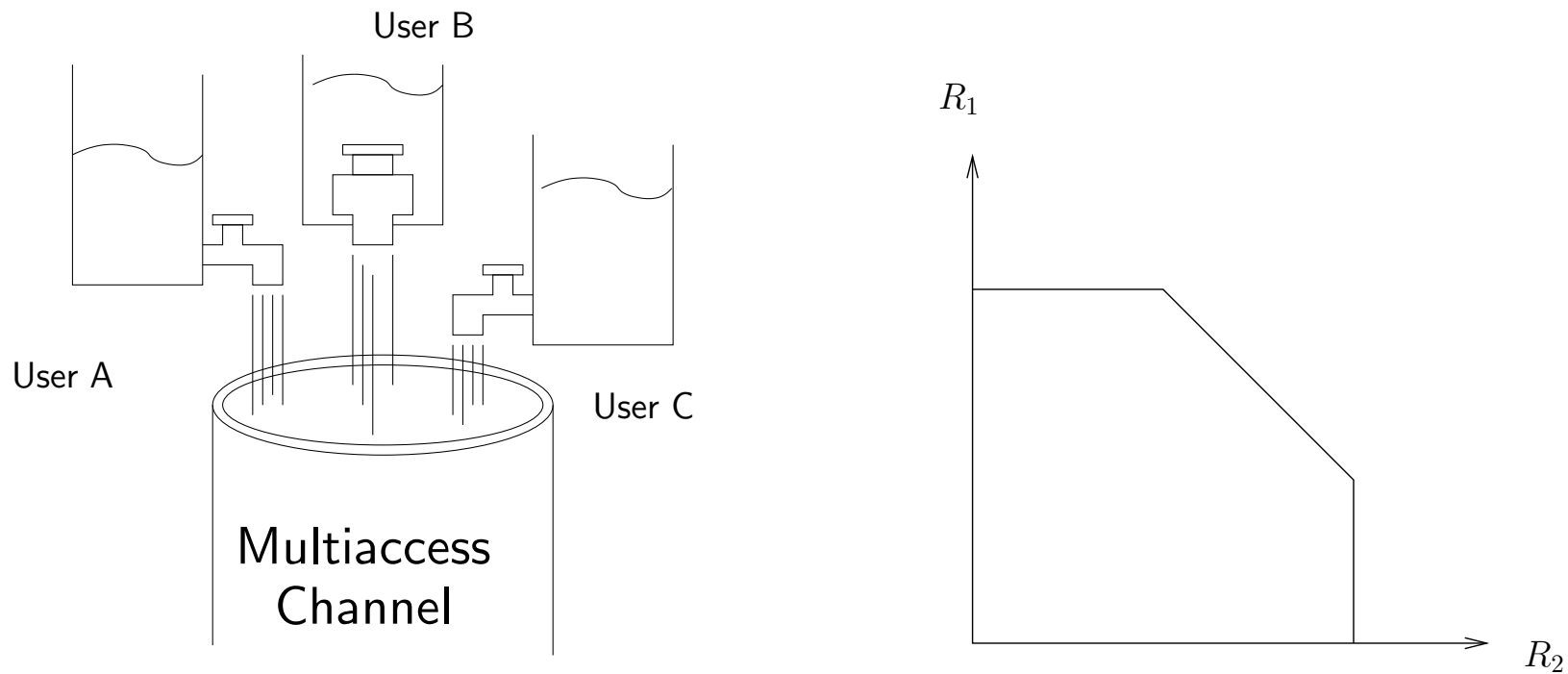
Characteristics

- packets arrive randomly.
- users contend.
- multiuser detection enables multipacket reception (MPR)

Cross Layer Issues

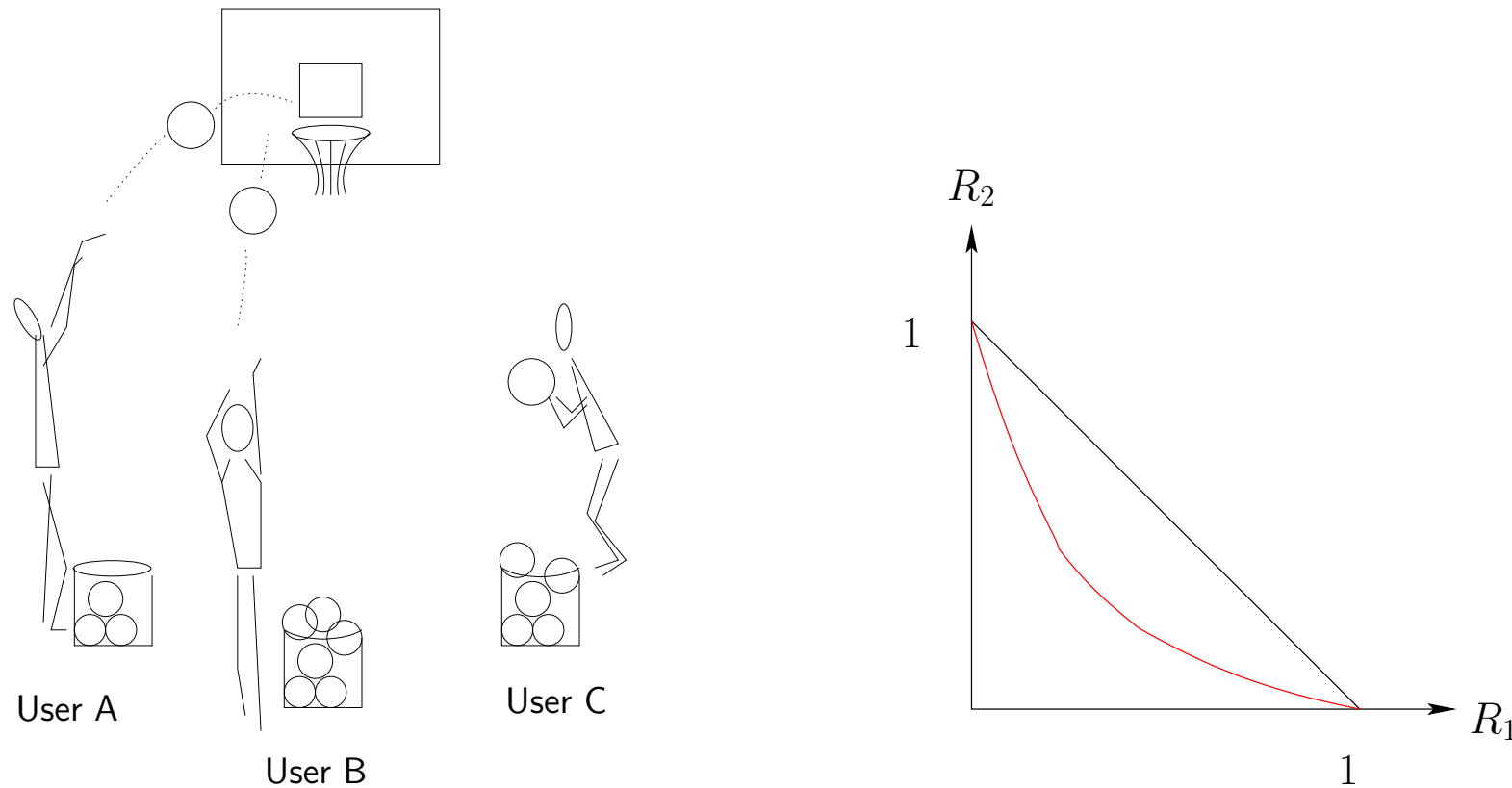
- Should the MAC layer assume a multiuser physical layer?
- Does it make sense to design PHY and MAC layers jointly.
- How should we allocate resources between PHY and MAC layers?

The Physical Layer Perspective



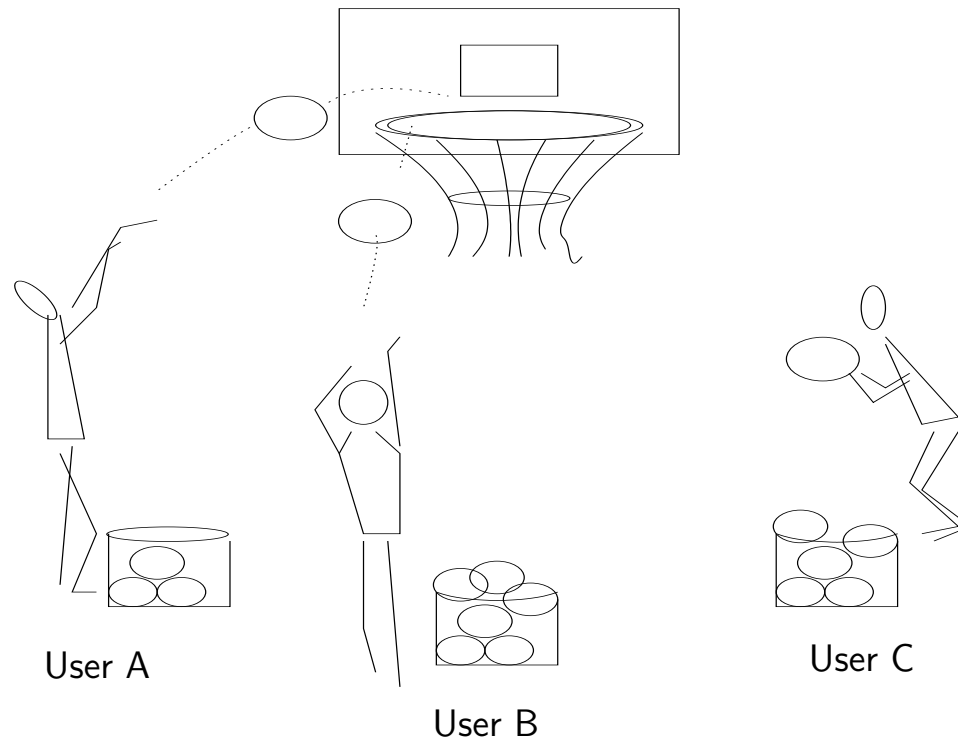
- The fundamental unit is **bit**. Endless bits from each user.
- Users share the channel via resource allocation.
- Capacity achieving signaling.

The MAC Layer Perspective



- The fundamental unit is **packet**. Packets arrive randomly.
- Users contend (Channel Seizure Multiple Access).
- Settle conflict via scheduling.

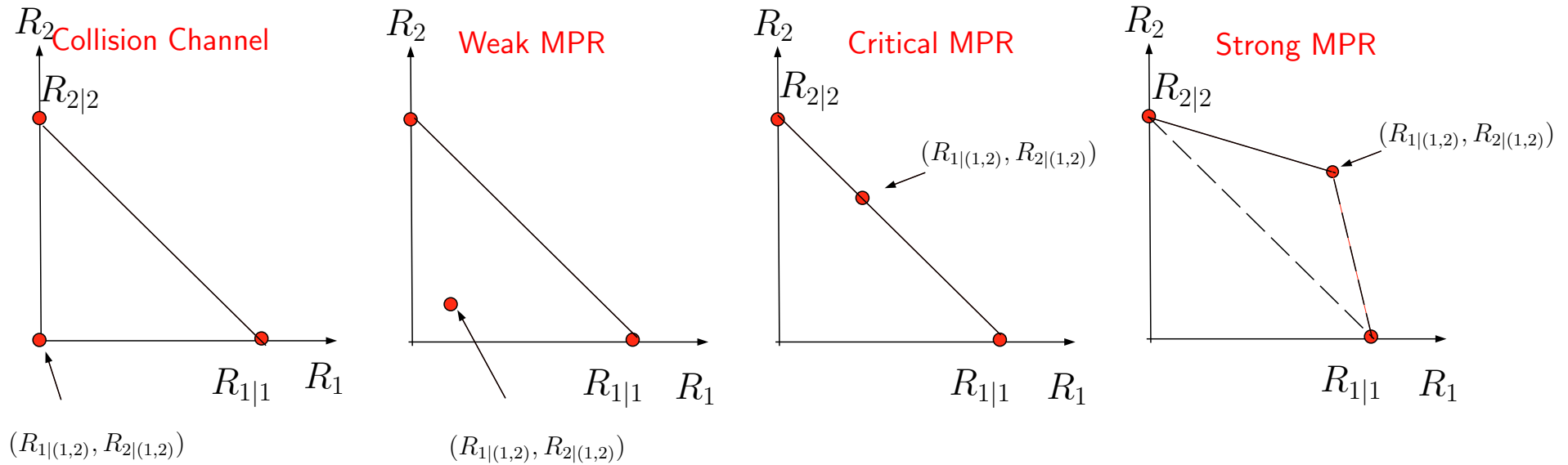
Impact of PHY Layer Advances



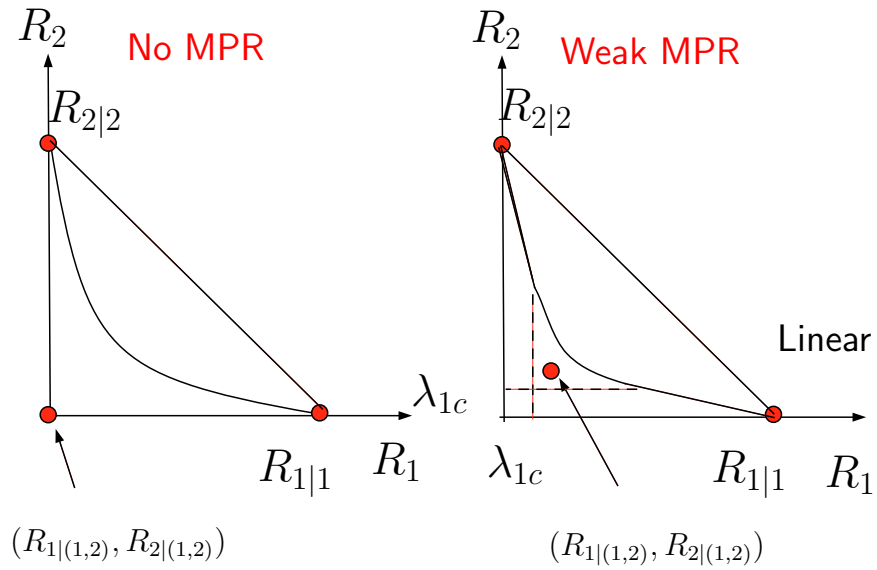
Make the basket larger, shooters more accurate, scores higher but only if...

The Best We Can Hope

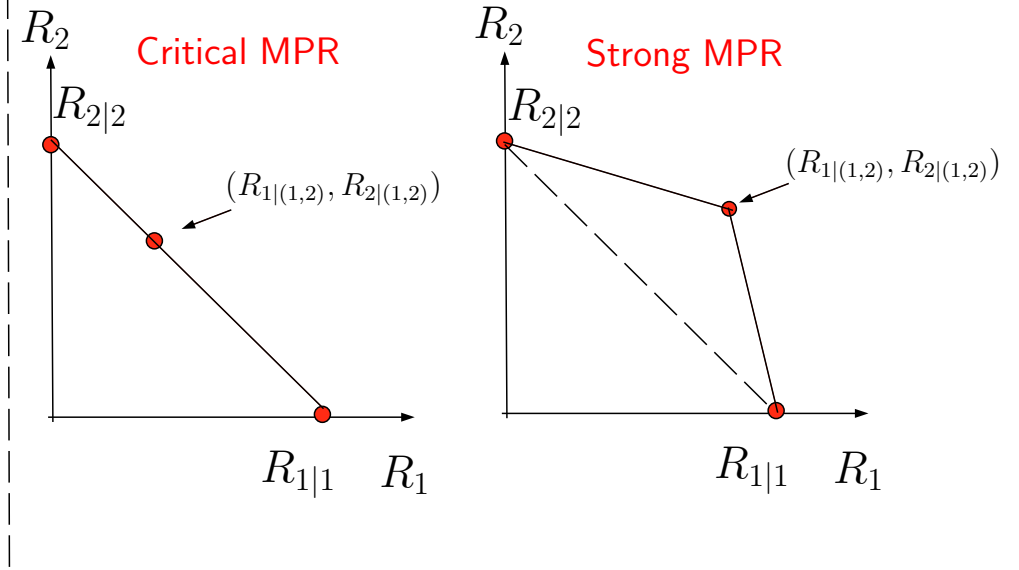
Optimal Scheduling with Multipacket Reception (MPR)



Optimal Schedule vs ALOHA



Simple PHY, Strong MAC



Strong PHY, Simple MAC

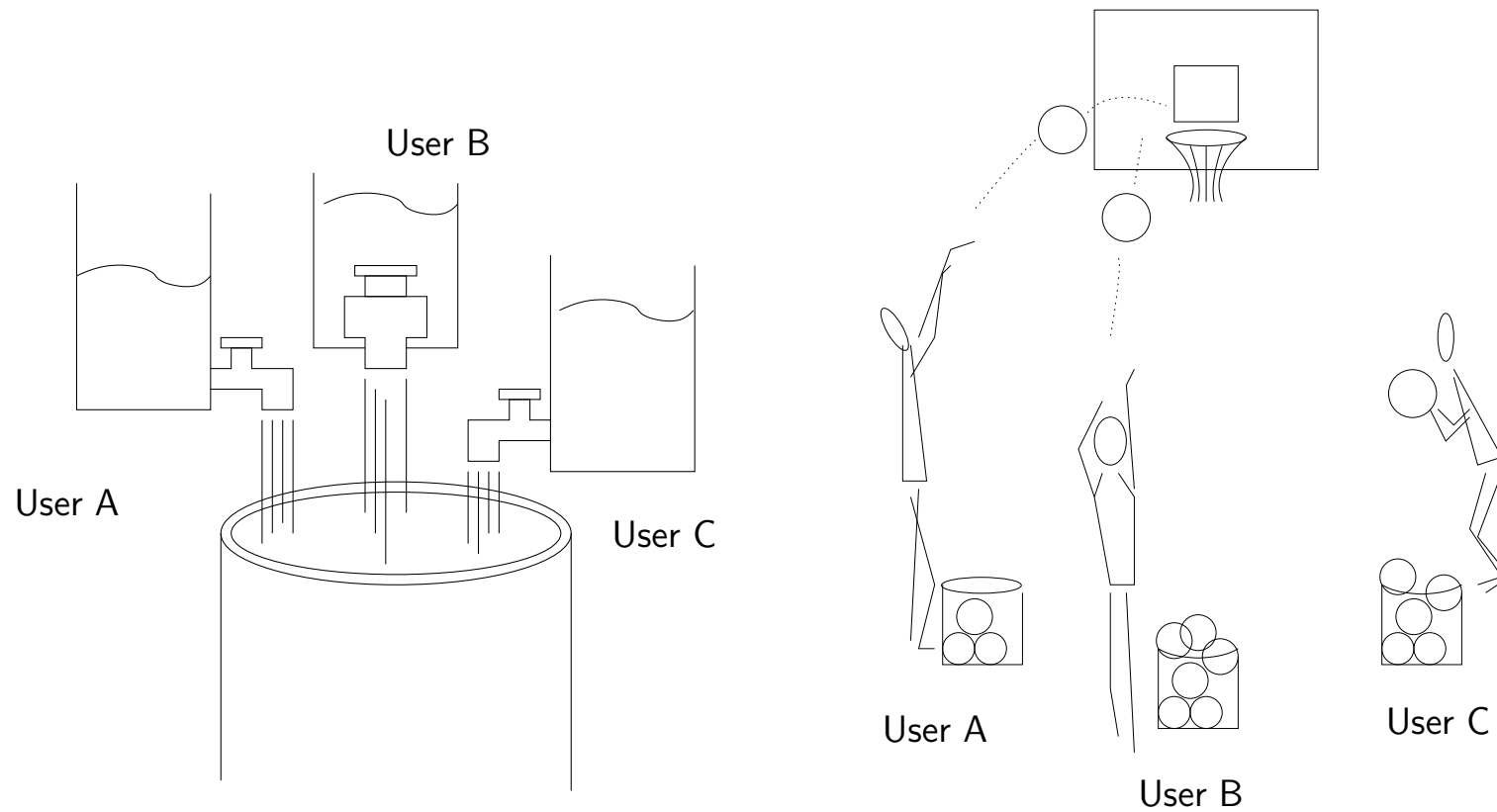
Back To Junshen's Questions

- Do we need unified or different methodologies?
- Would cross layer design lead to new architectures?

Think about sensor networks!

Has there been a convincing case made for cross layer design?

Gallager on Multiaccess Channels (1985)



“A better set of models and approaches are needed for multiaccess communication than collision resolution or information theory alone.”