Defining Cross-Layer Design for Wireless Networking

A Case Study on Random Access

Lang Tong

School of Electrical and Computer Engineering
Cornell University, Ithaca, NY 14853

2003 IEEE Conference on Communications
May 14, 2003
Random Multiple Access

Characteristics

- packets arrive randomly.
- users content.
- 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 fundamental unit is packet. Packets arrive randomly.

Users content (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

- No MPR
- Weak MPR
- Critical MPR
- Strong MPR

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