A Value Aware Approach for Wireless Media Delivery

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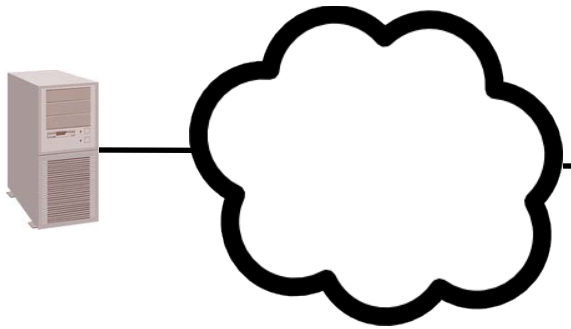
Outline

- Motivation
- Case Study: Value aware MAC
- Value aware MAC design and evaluation
- Conclusion
- Demo

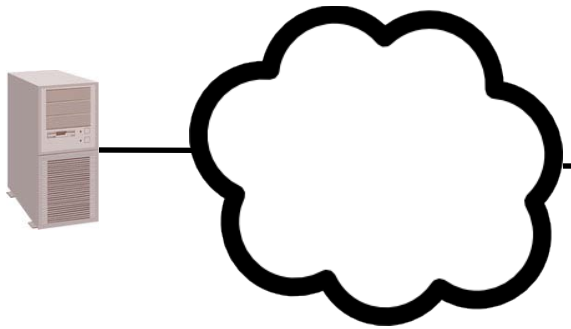
Settings

Settings



Data transfer → **Value insensitive**

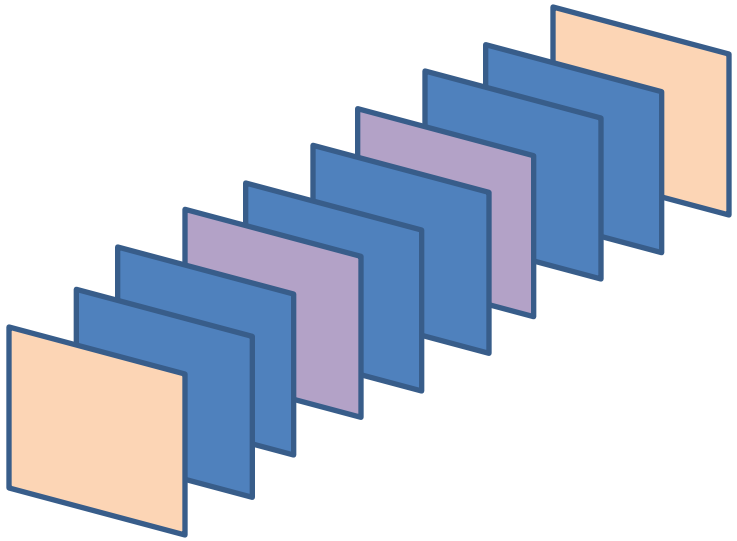
Applications



Value sensitive

Media delivery

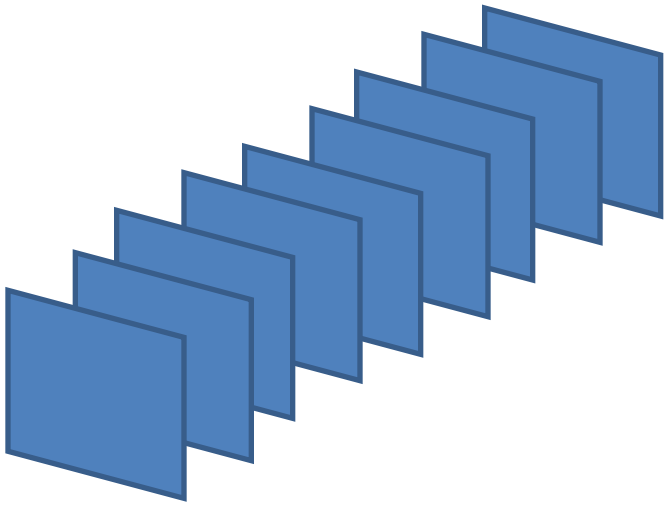
Value



A quantity associated with each packet signifying the "worth" of this packet for "overall performance"

Value (in)sensitivity

File transfer

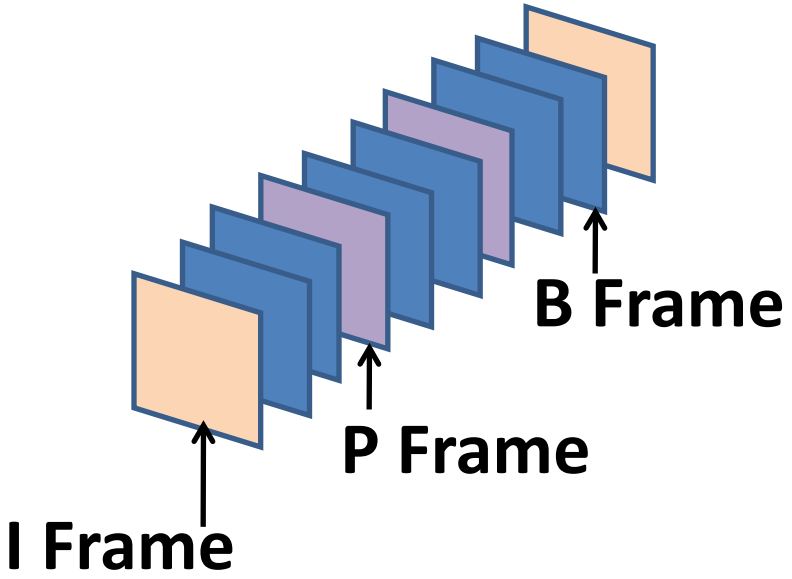


All packets necessary

All packets equal

Video streaming

MPEG-4 encoded video



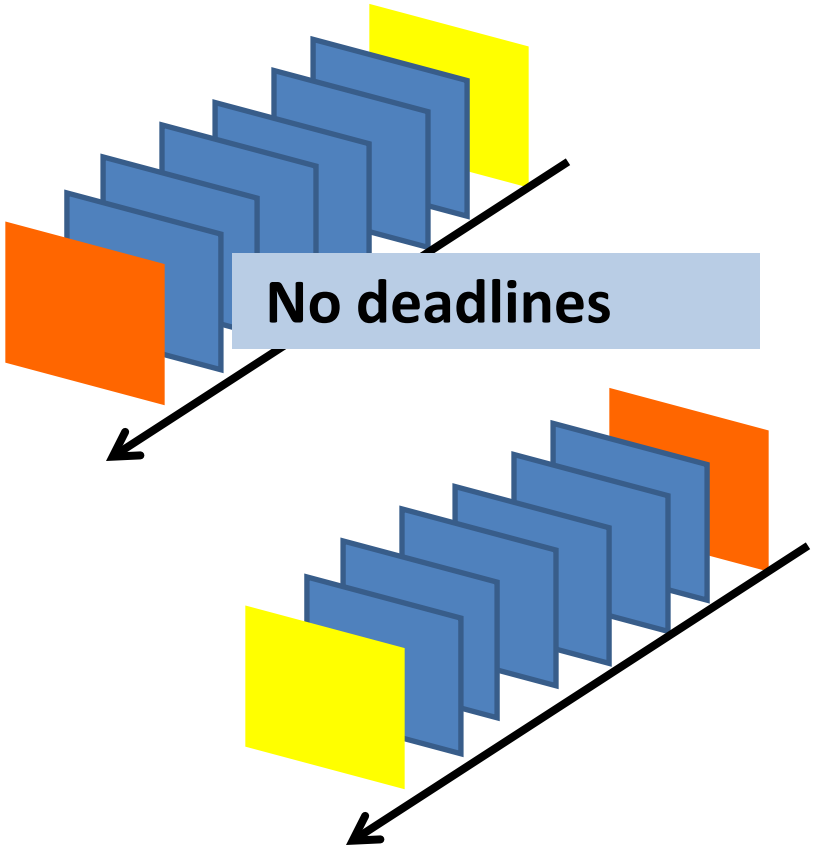
I > P > B

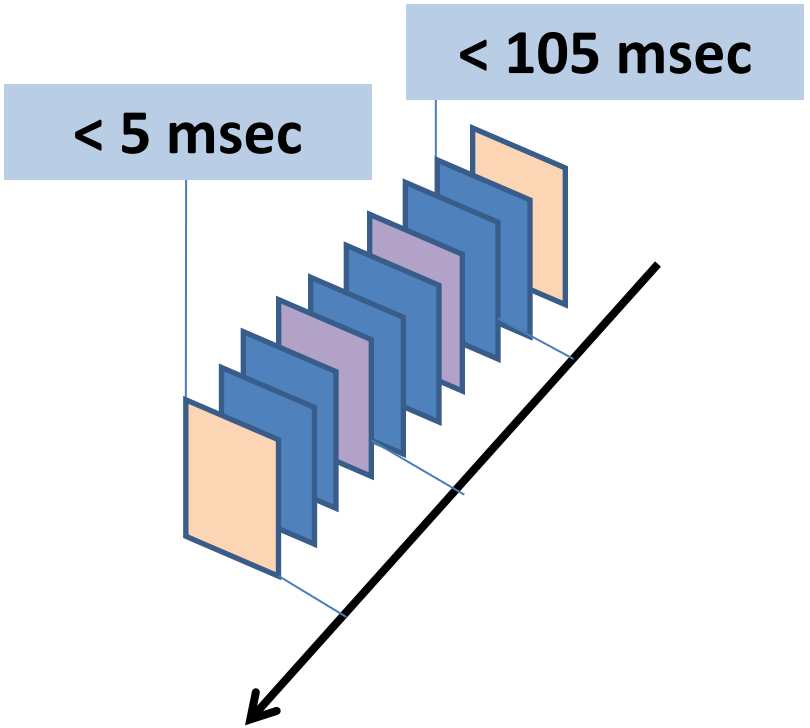
1 Frame -> 1 packet
(for this talk)

Value (in)sensitivity

File transfer

Video streaming



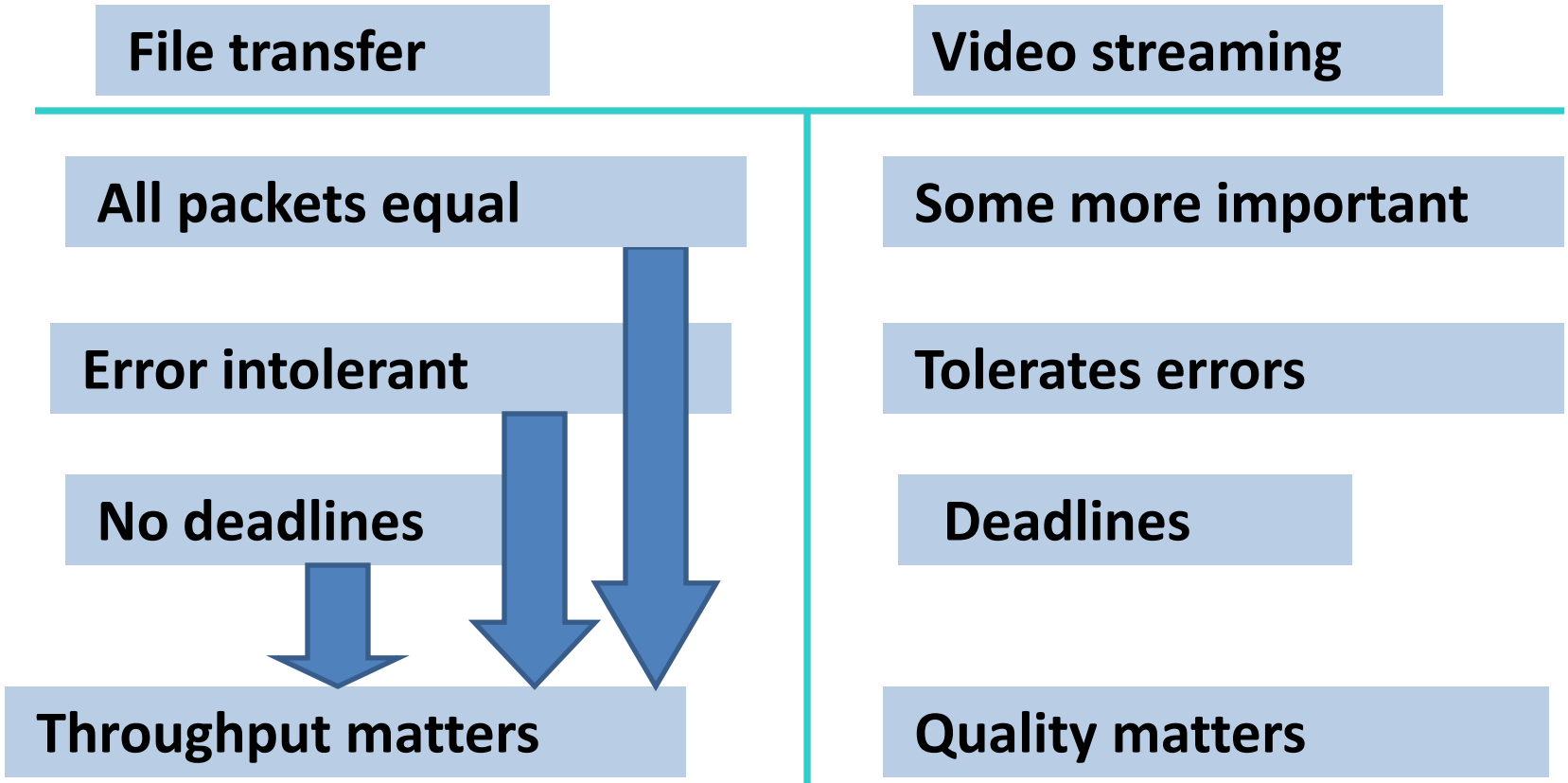


Nearer the deadline … more important packet

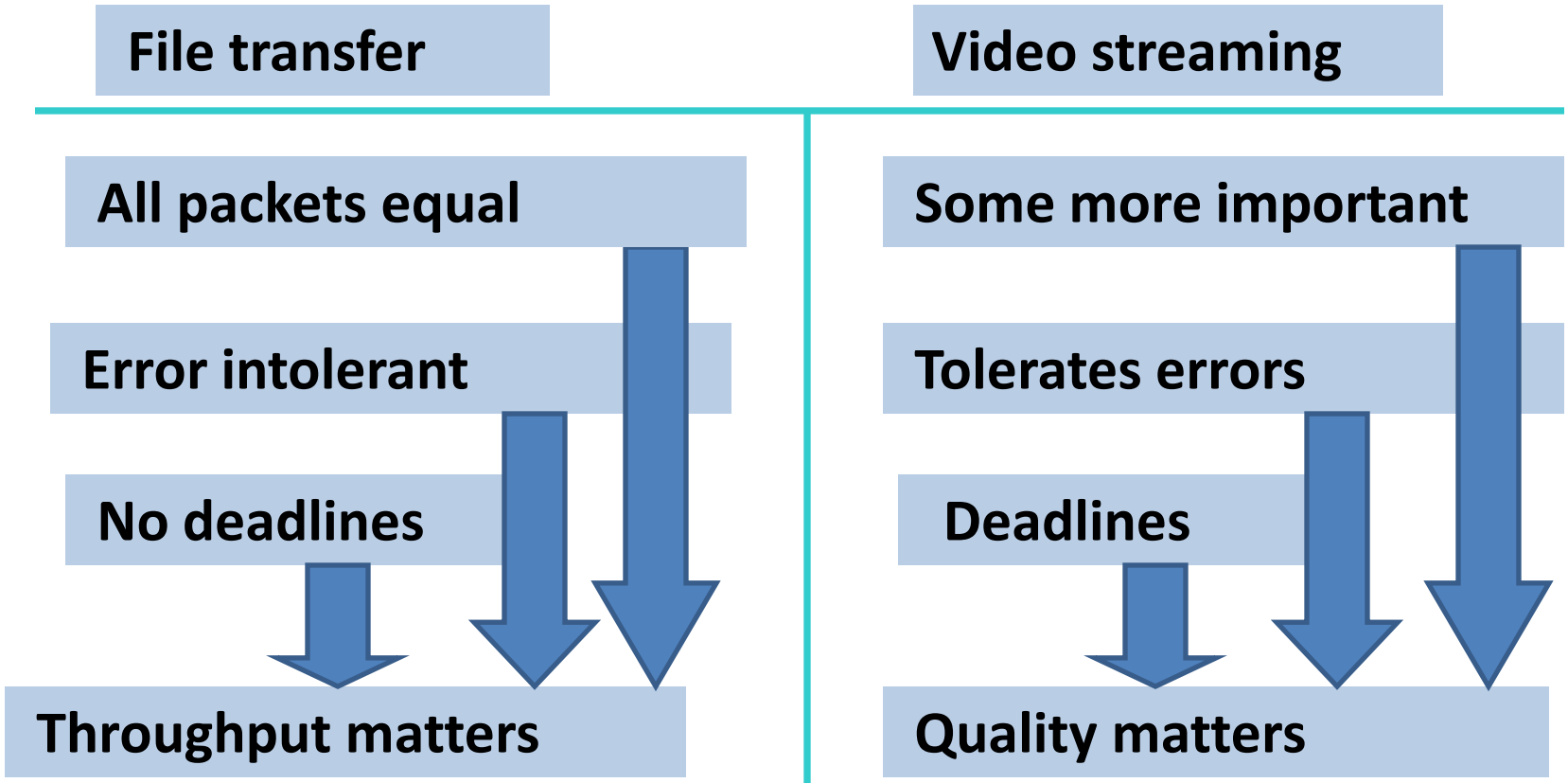
Implications of value (in)sensitivity

File transfer	Video streaming
All packets equal	Some more important
Error intolerant	Tolerates errors
No deadlines	Deadlines

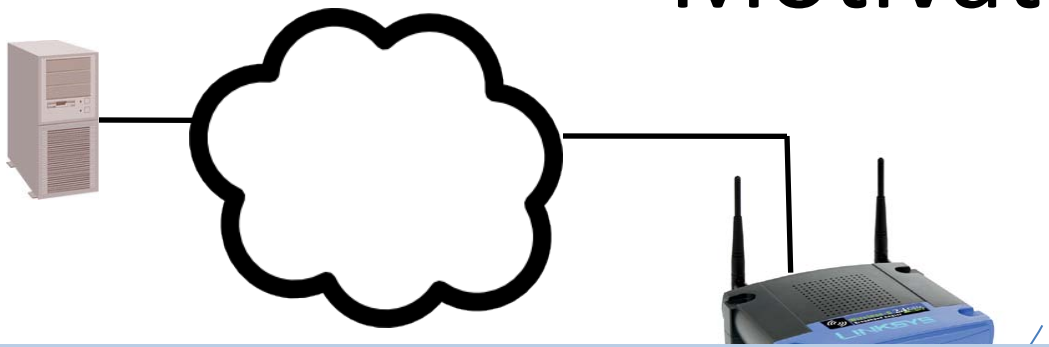
Implications of value (in)sensitivity



Implications of value (in)sensitivity

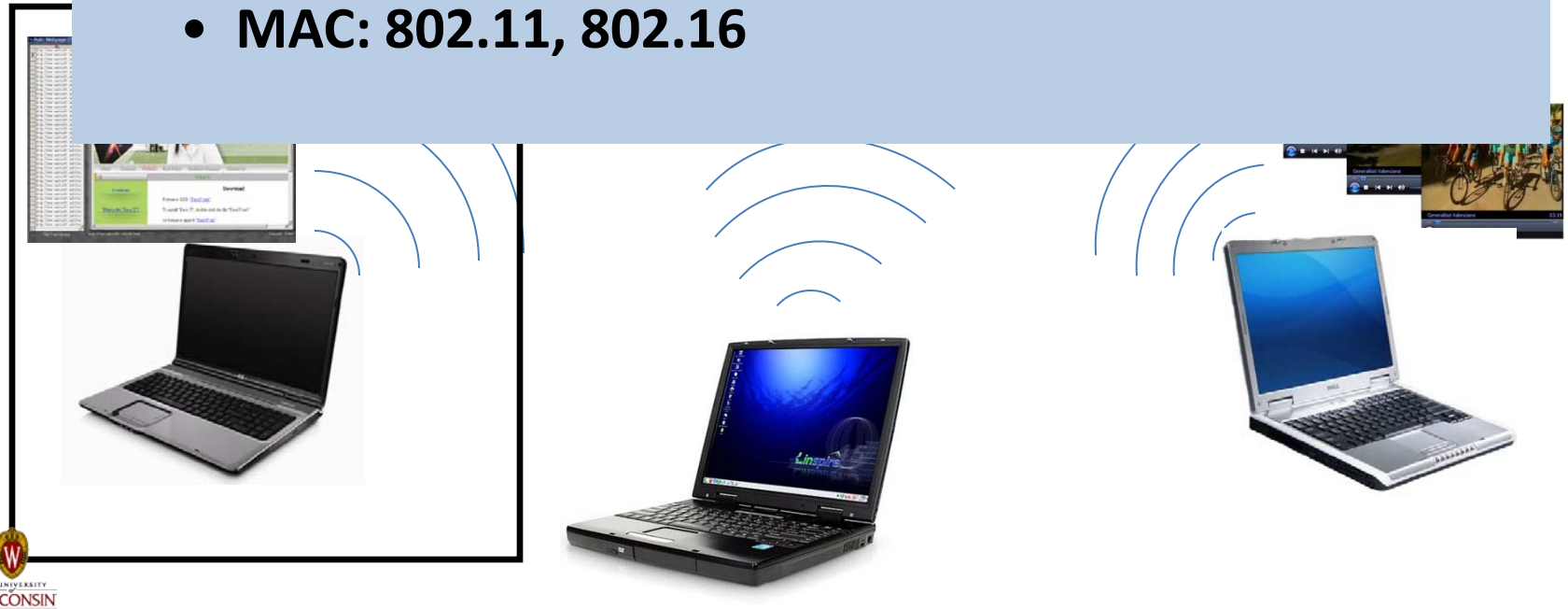


Motivation



Protocols designed for throughput optimality

- **Transport: TCP, UDP**
- **Network: BGP, OSPF, RED**
- **MAC: 802.11, 802.16**



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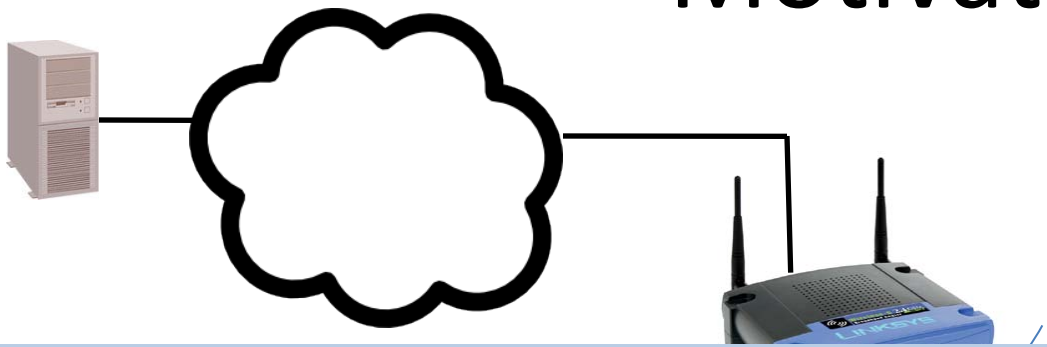
Motivation



Protocols designed for throughput optimality

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Sub-optimal for media delivery

Problem Statement

How to make protocol decisions value aware?

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Only changing already present mechanisms

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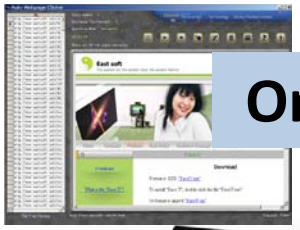
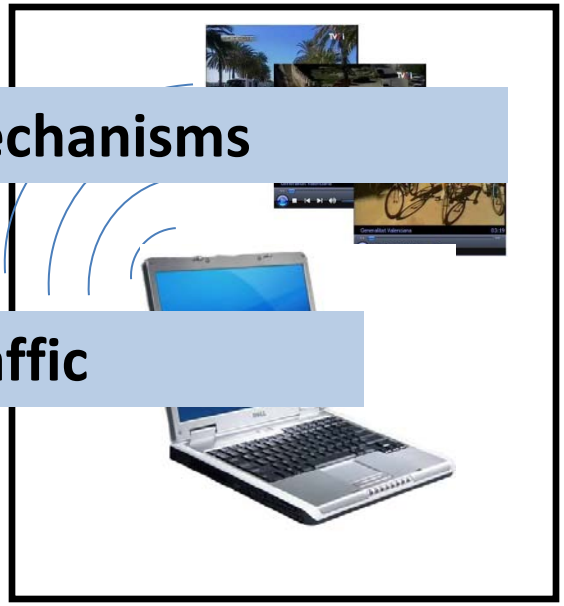


Only changing already present mechanisms

Without introducing any extra traffic



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Value Aware MAC

How to make MAC decisions value aware ?

- **Rate assignment**
- **Packet ordering**
- **Retransmission**

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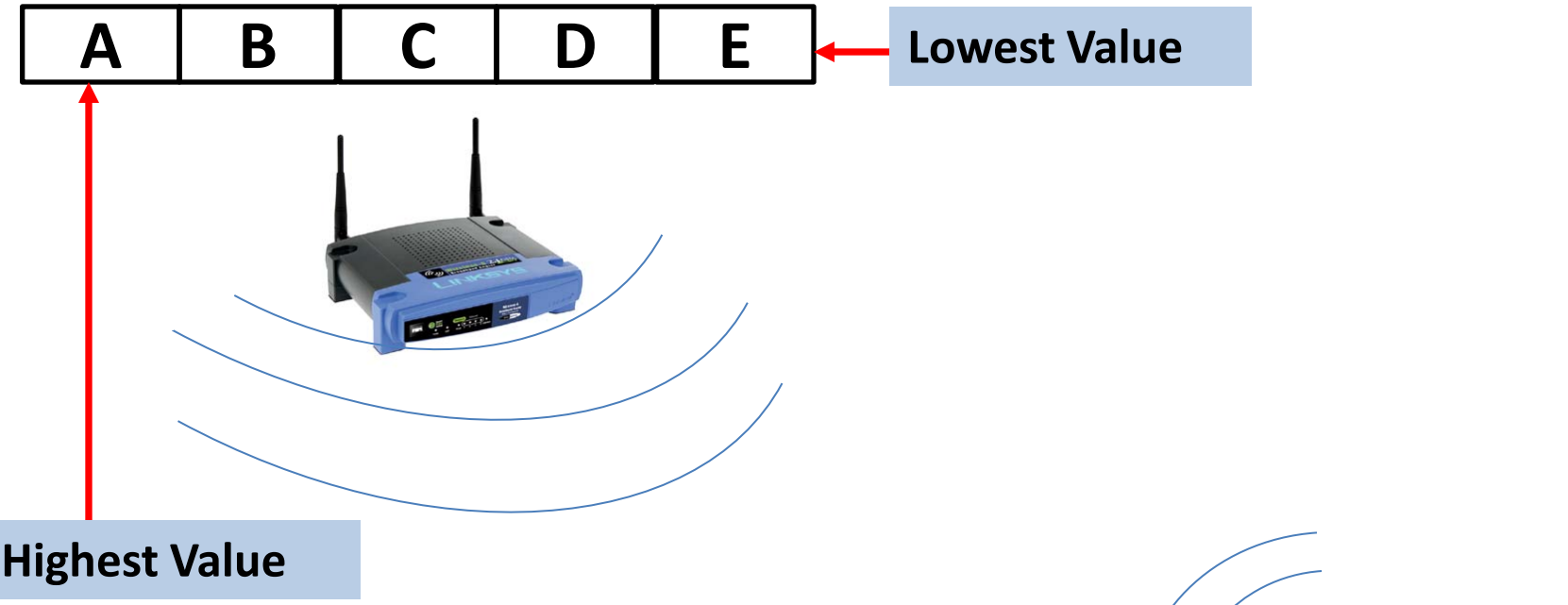
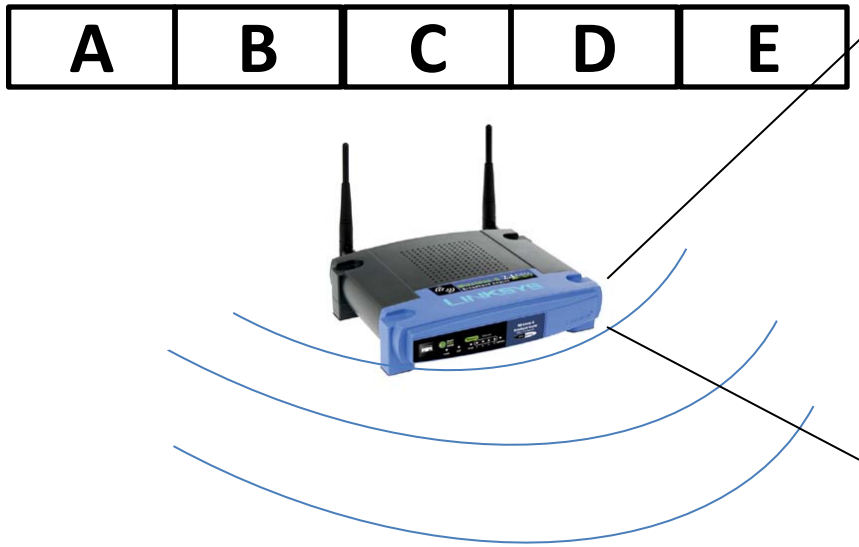
Value Aware MAC: rate

How to make rate assignment value aware?

Traditional rate assignment

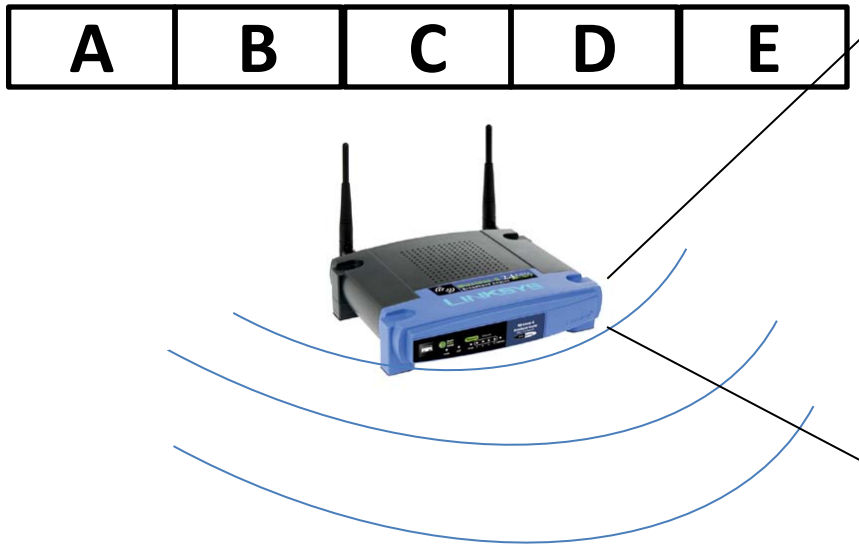


Traditional rate assignment



Rate	Trpt.	Er. Prb.
6	4.5	0
….	….	….
36	28	1%
48	32	15.1%
54	31	19.2%

Traditional rate assignment



Rate	Trpt.	Er. Prb.
6	4.5	0
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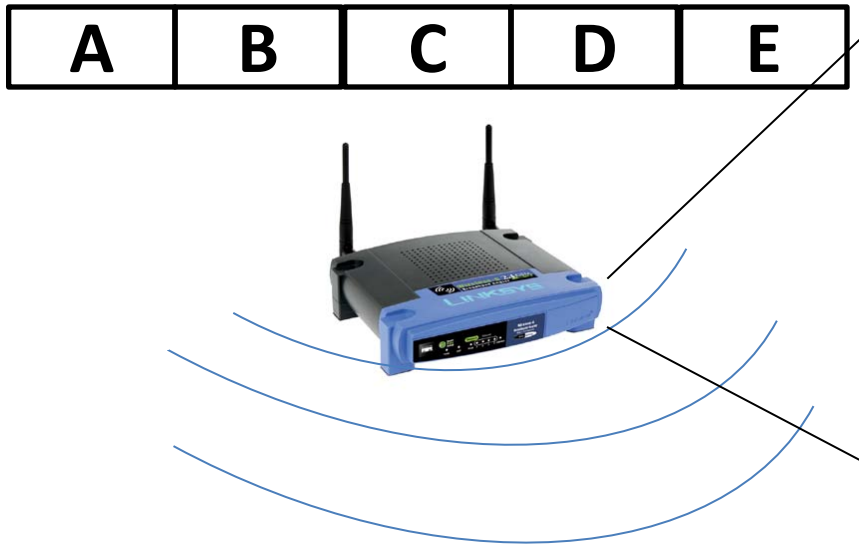
Max. Trpt.

Traditional rate assignment



Rate	Trpt.	Er. Prb.
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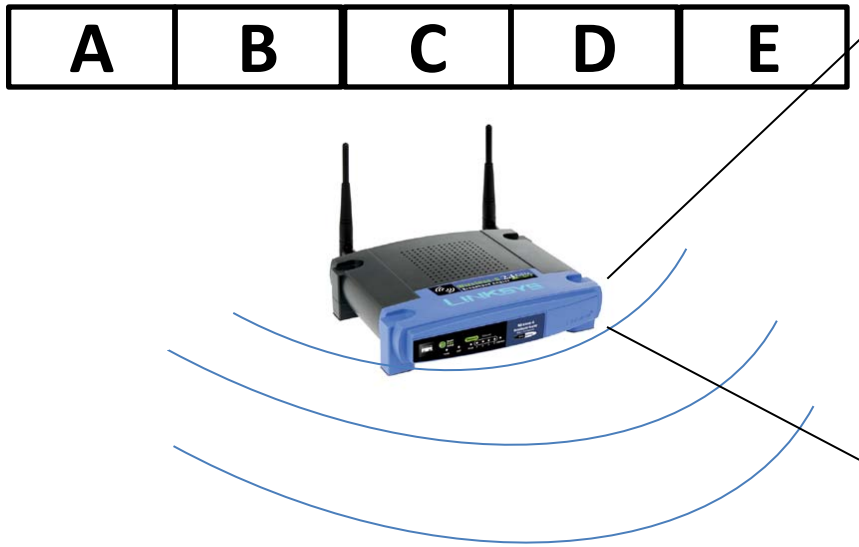
All packets go out at 48 mbps

Traditional rate assignment



Rate	Trpt.	Er. Prb.
6	4.5	0
….	….	….
36	28	1%
48	32	15.1%
54	31	19.2%

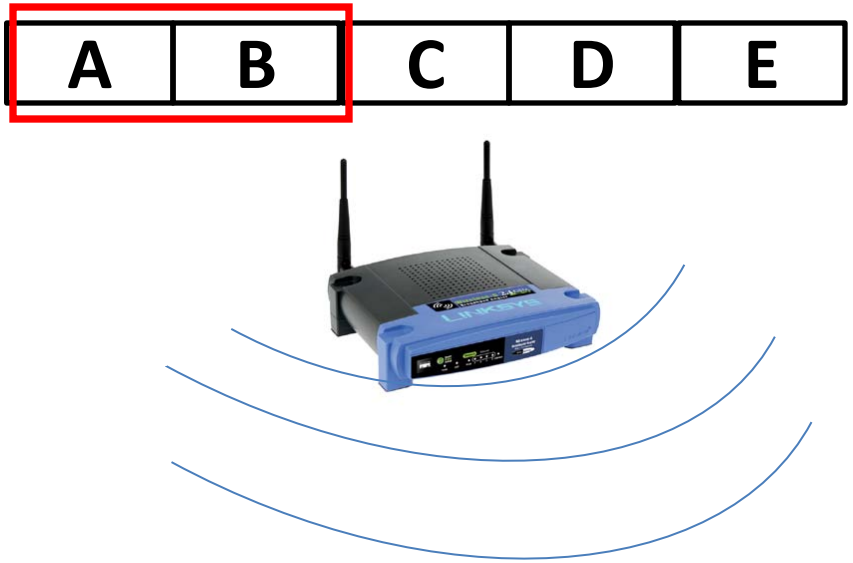
All packets have equal probability of errors

Value Aware MAC: rate

How to make rate assignment value aware?

Assign rate to maximize quality (not throughput)

Traditional rate assignment



Rate	Trpt.	Er. Prb.
6	4.5	0
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36	28	1%
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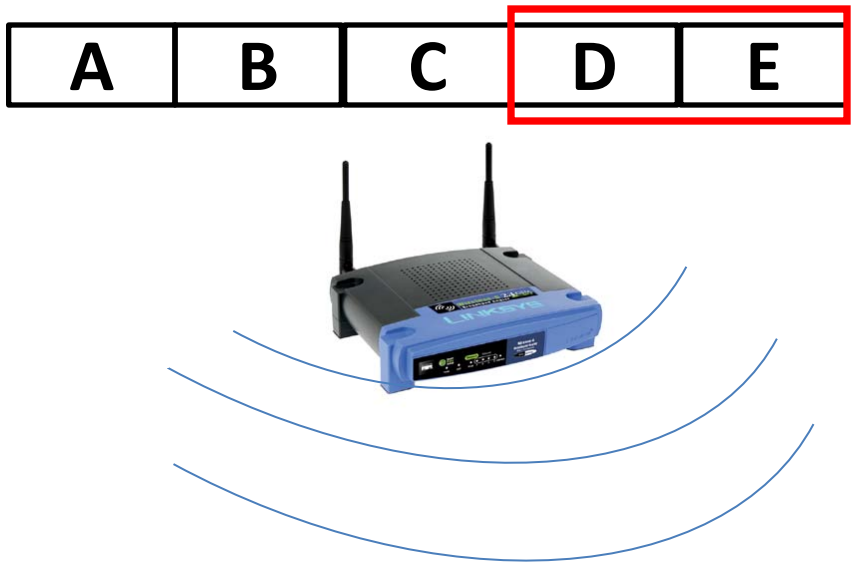
Send A, B @ 36 mbps to ensure delivery

Traditional rate assignment

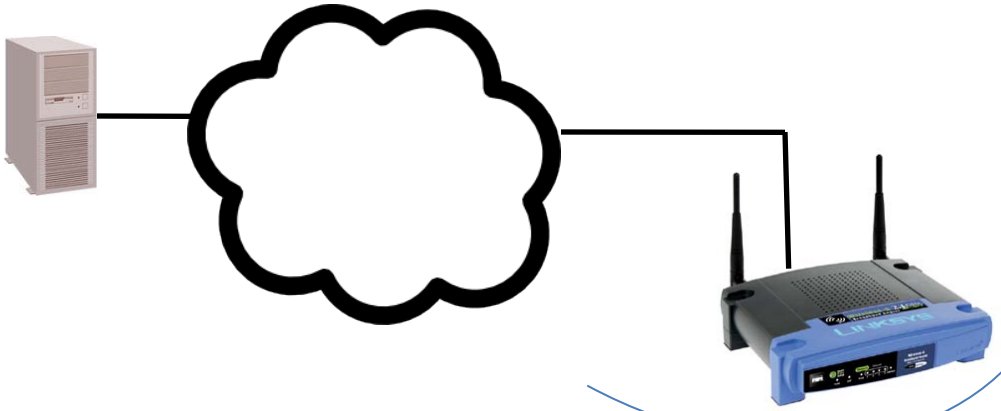


Rate	Trpt.	Er. Prb.
6	4.5	0
….	….	….
36	28	1%
48	32	15.1%
54	31	19.2%

Send A, B @ 36 mbps to ensure delivery

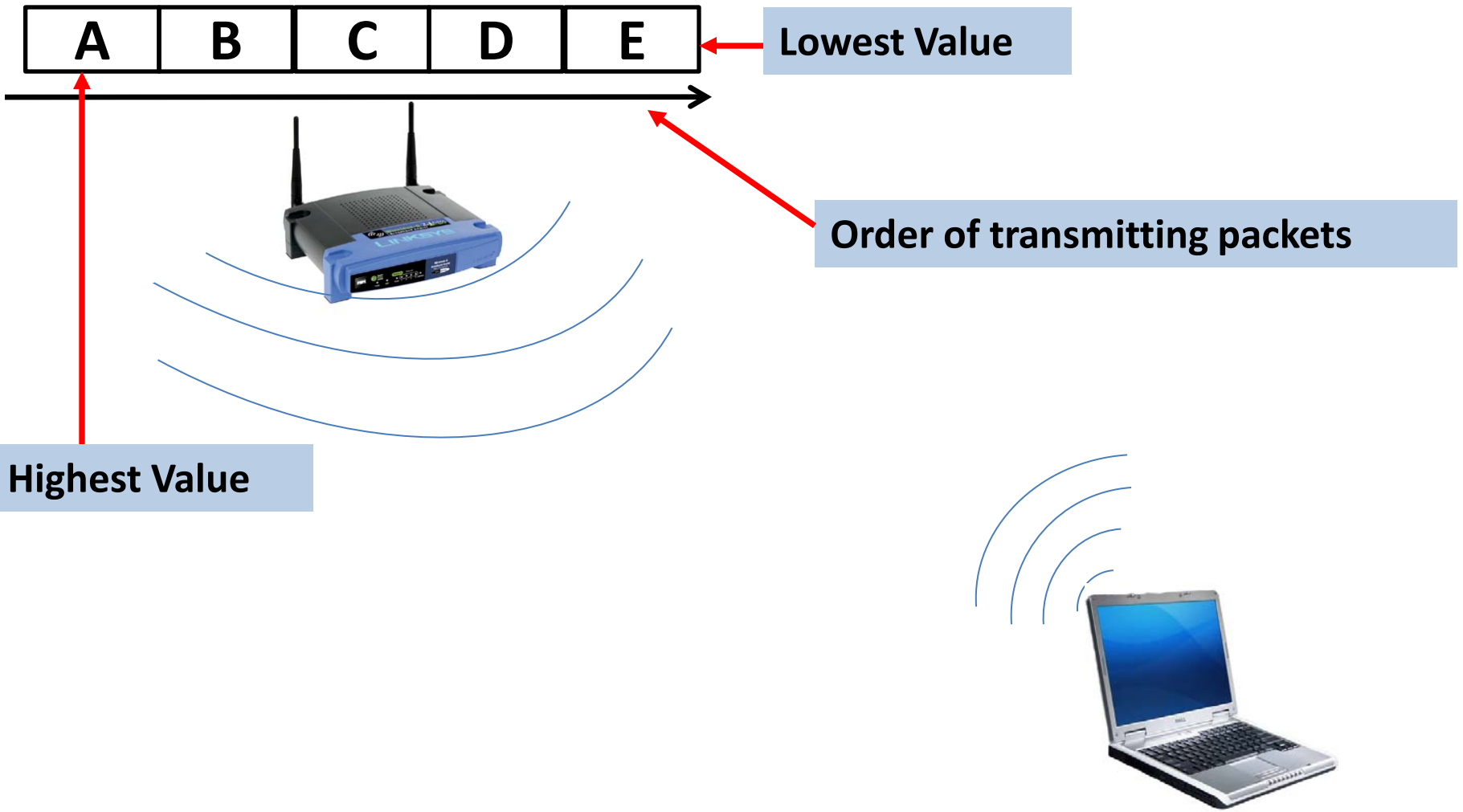
Send D, E @ 54 mbps to compensate

Value Aware MAC: ordering

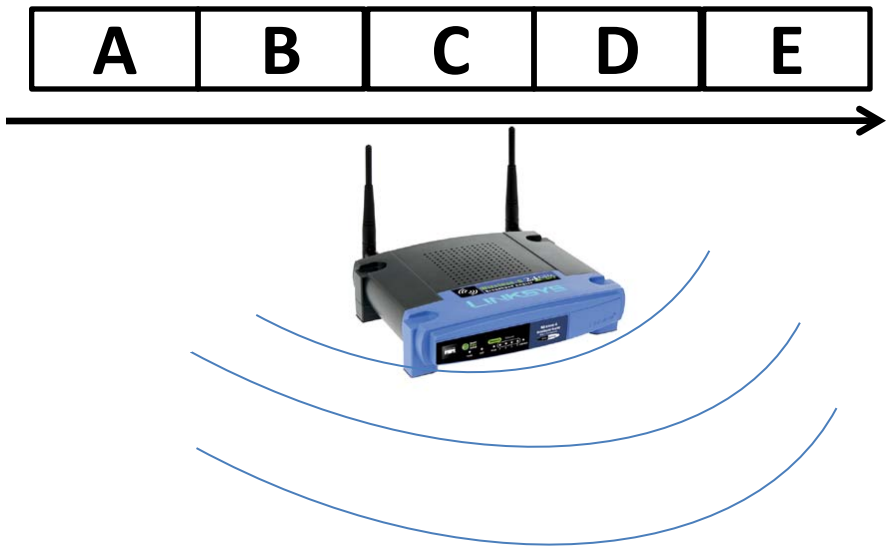


How to make packet ordering value aware?

Traditional ordering

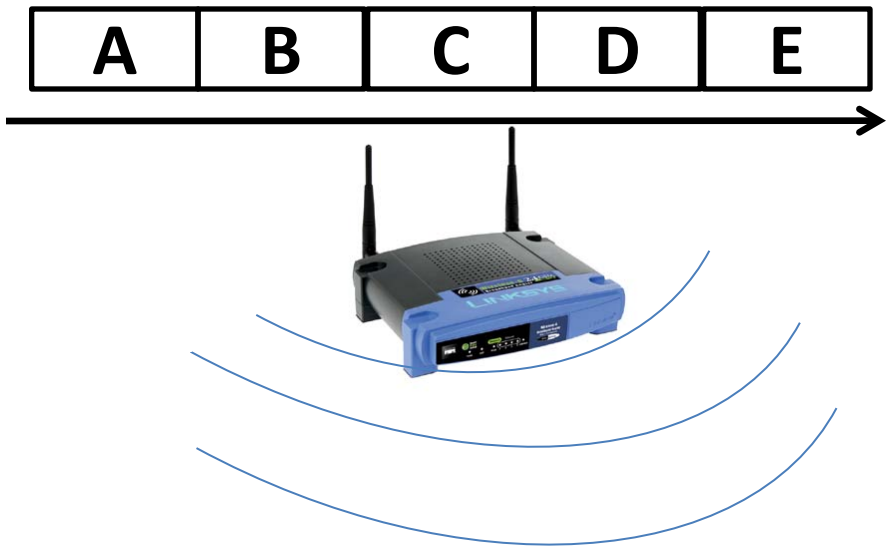


Traditional ordering



External interference

Traditional ordering



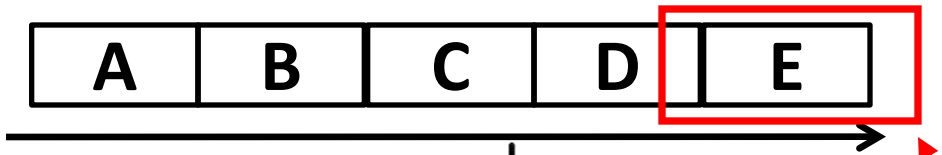
External interference

Traditional ordering

MAC layer retransmit

External interference

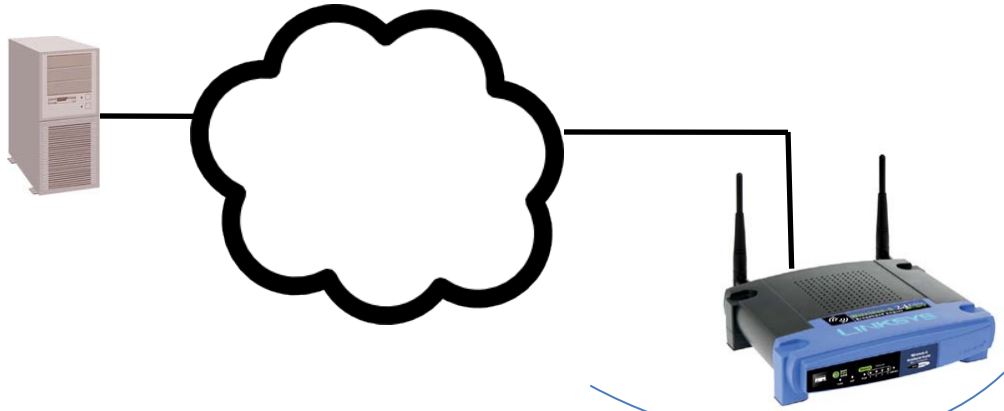
Traditional ordering



Head of line blocking

External interference

Value Aware MAC: ordering



How to make packet ordering value aware?

Transmit valuable packets earlier to maximize quality (not in FIFO order)

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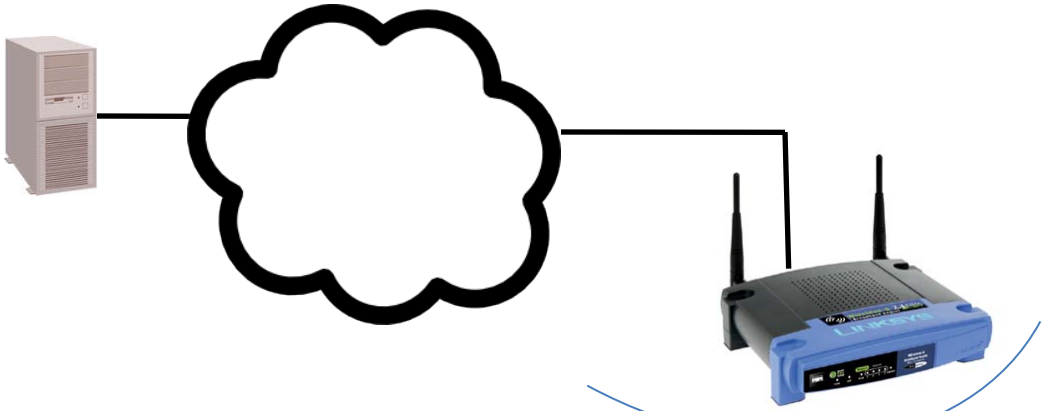
Value aware ordering

External interference

Value Aware MAC: retransmissions



How to make retransmission strategy value aware?

Value Aware MAC: retransmissions

How to make retransmission strategy value aware?

Retransmit valuable packets more to maximize quality (not fixed for all packets)

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Example

How to multicast HD video to clients connected to an AP ?

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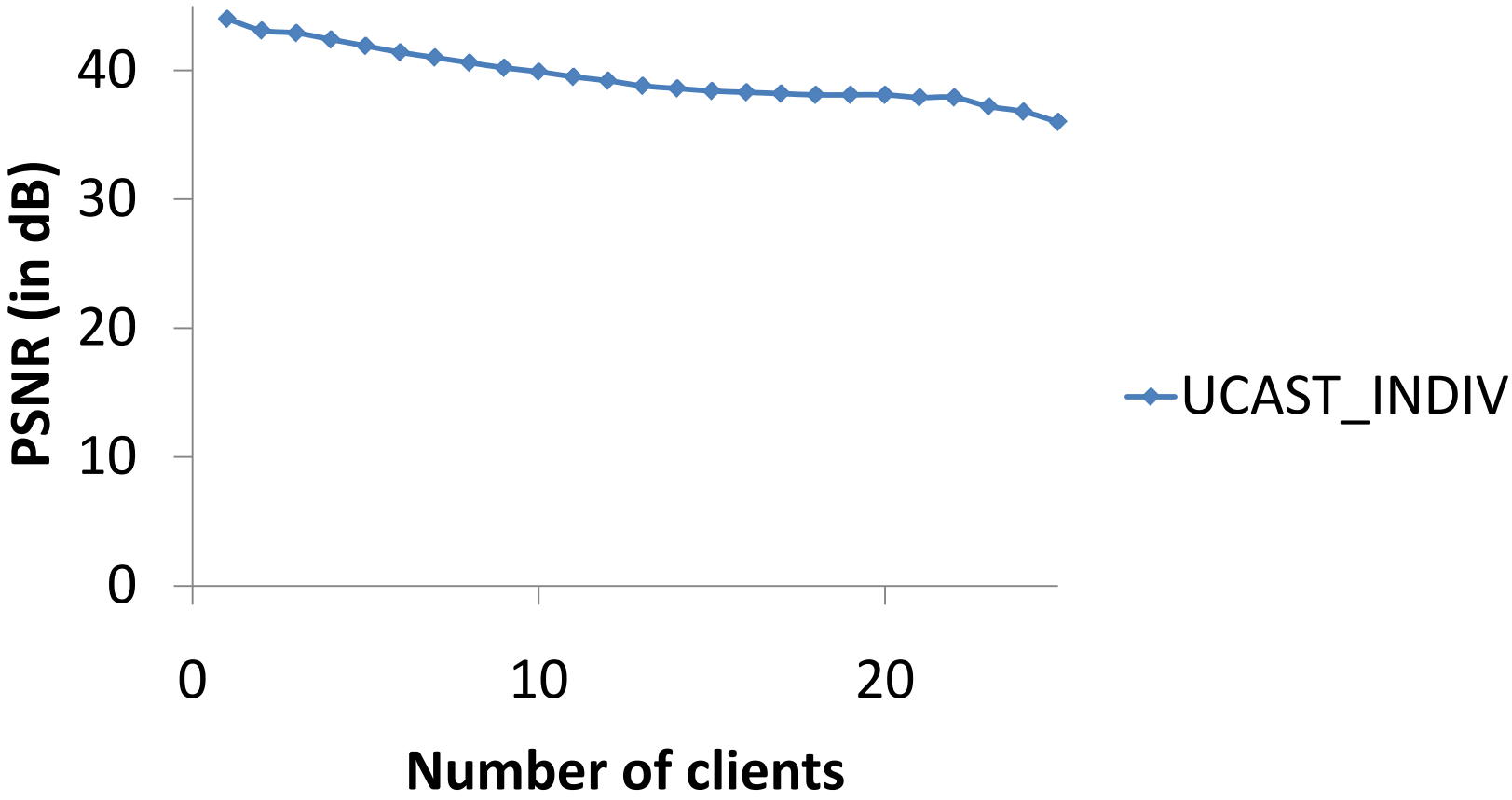
MEDUSA

Media delivery using adaptive (pseudo)broadcast

- Value estimation (normalized weight heuristic)
- Rate adaptation (Inflate-Deflate algorithm)
- Packet ordering (Inflate-Deflate algorithm)
- Retransmission planning (Network coded)
- Application level asynchronous feedback

Details in “Scalable WiFi based Media Delivery using Adaptive Broadcasts”, NSDI’10

Scaling user count



(5-15% error rates), mobile calendar, 2 min, 5 Mbps, 20 runs

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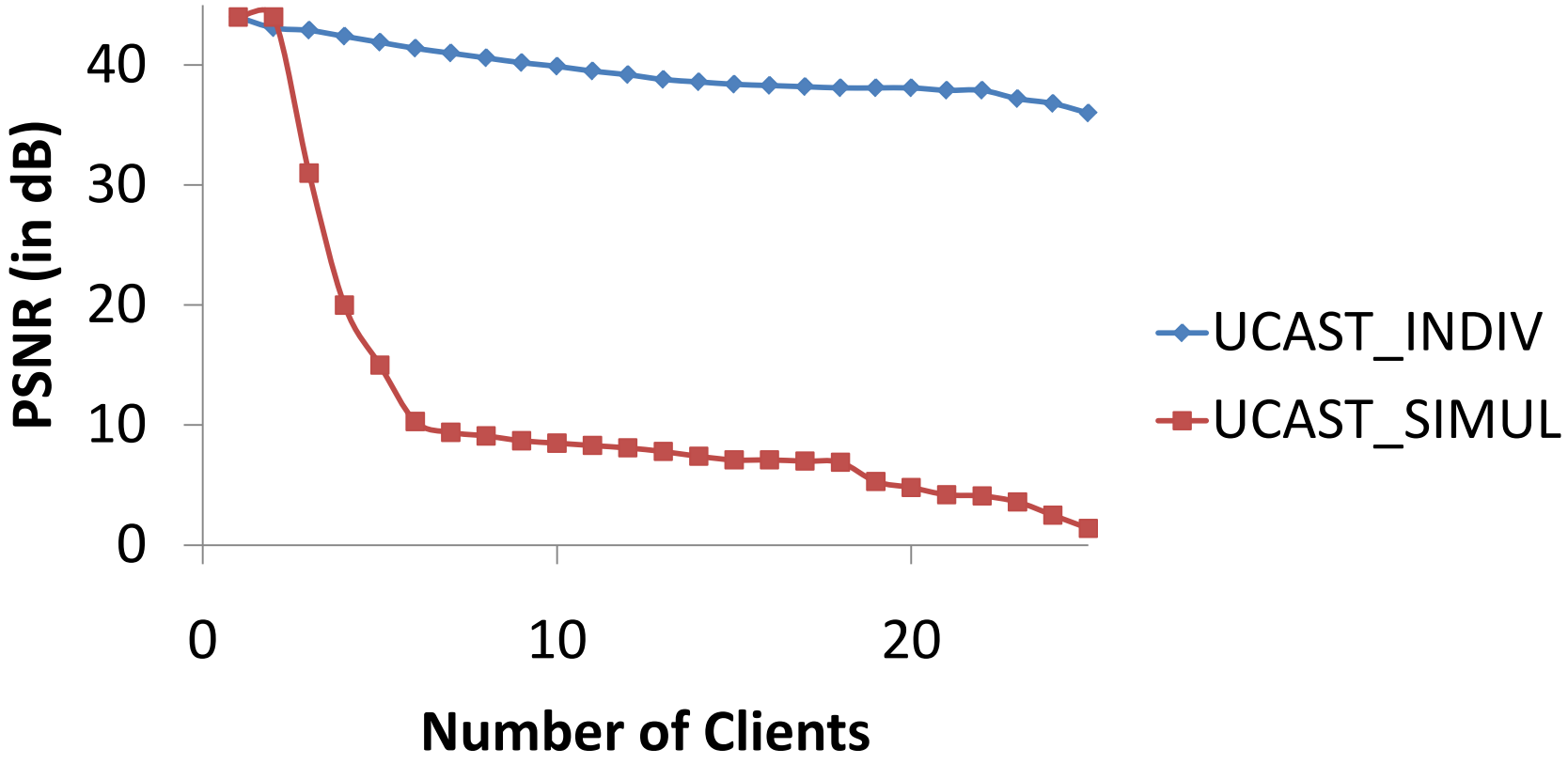
Scaling user count



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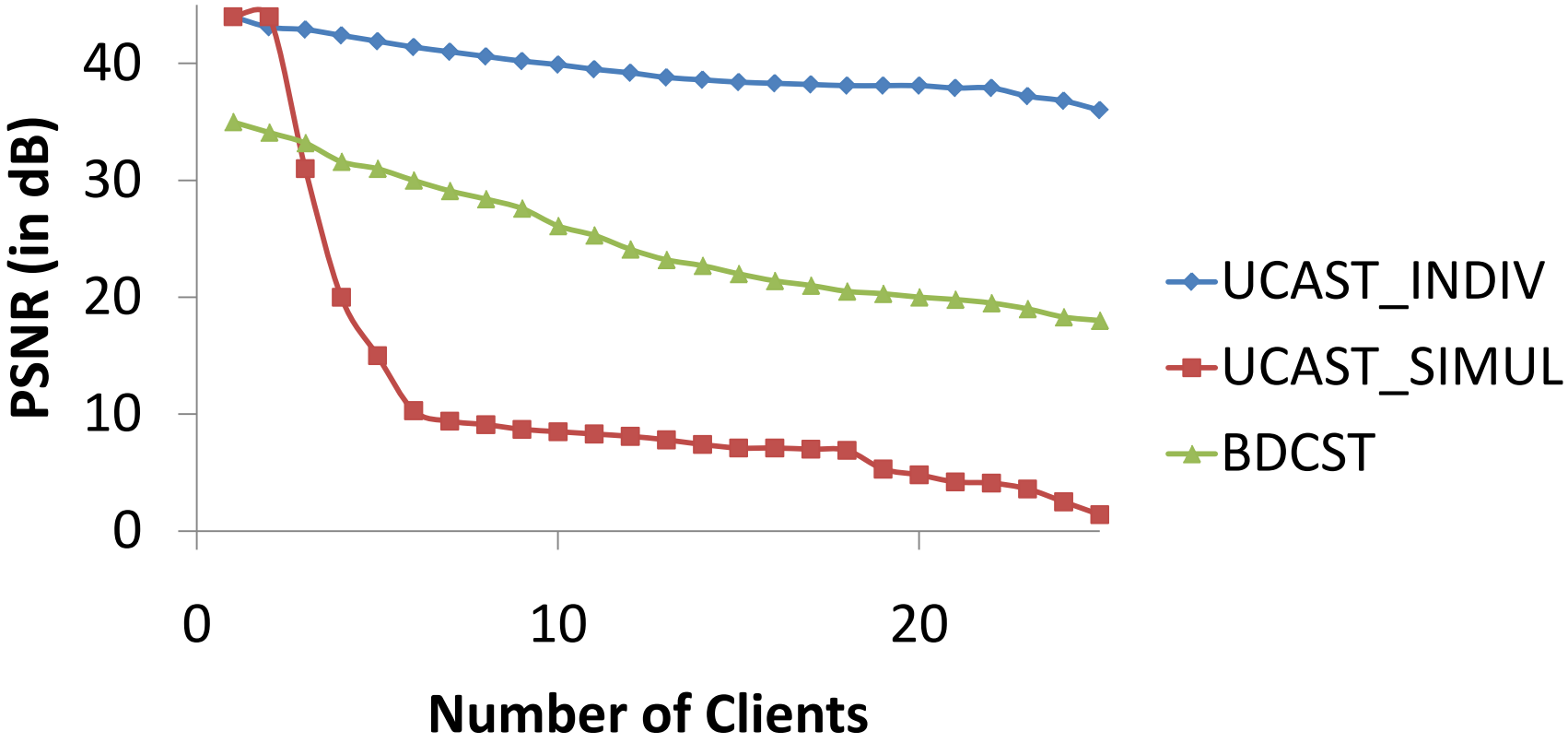

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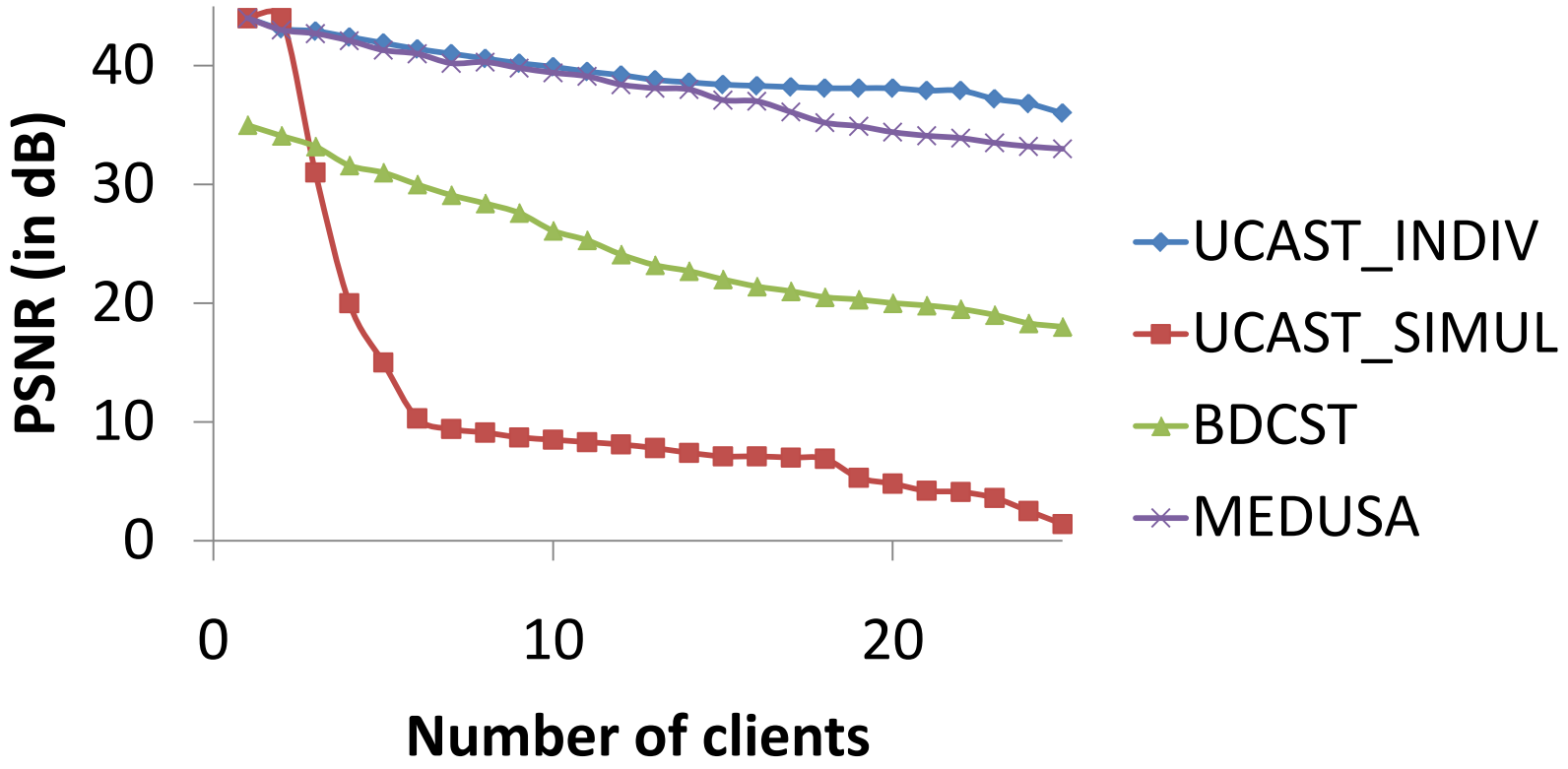

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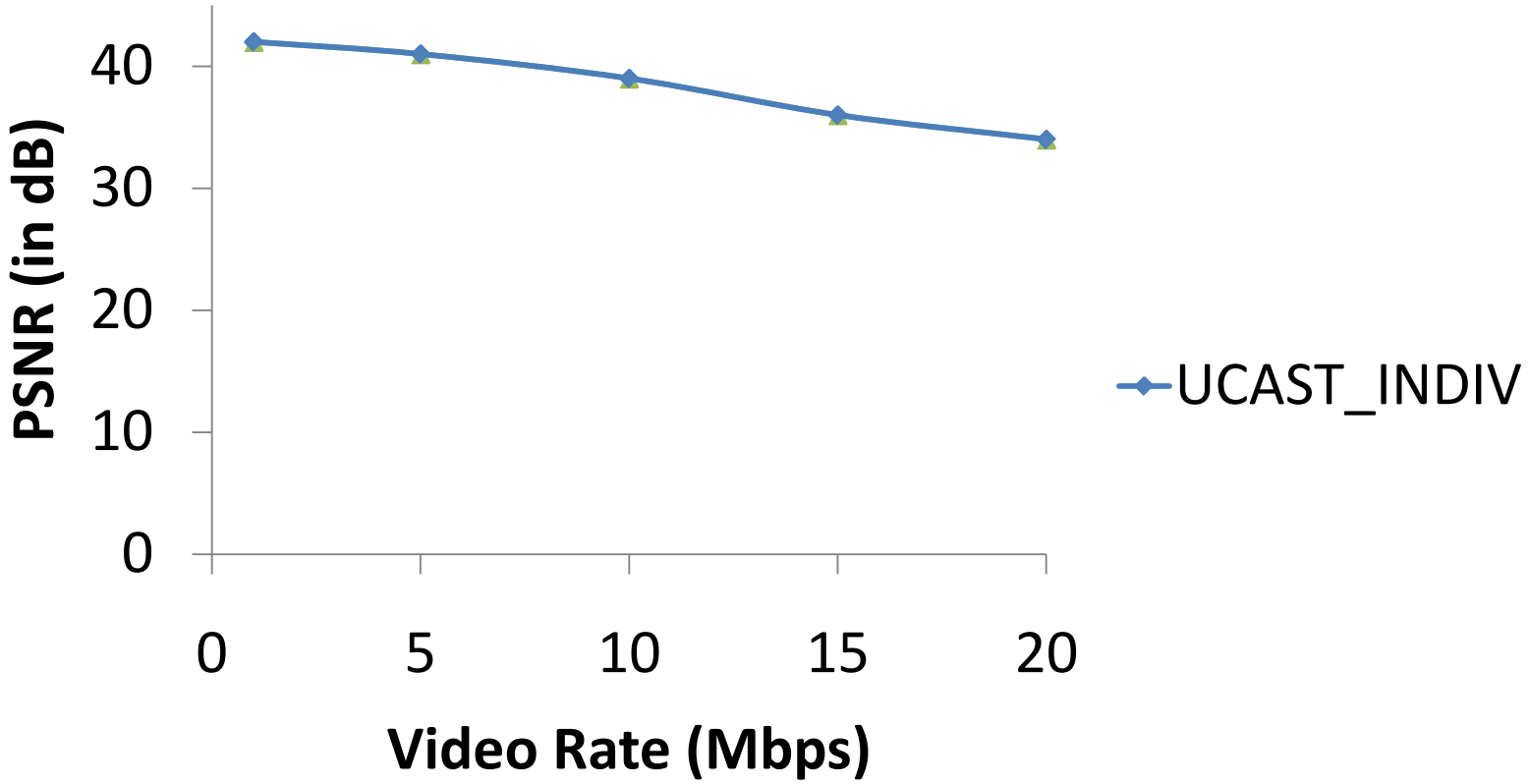
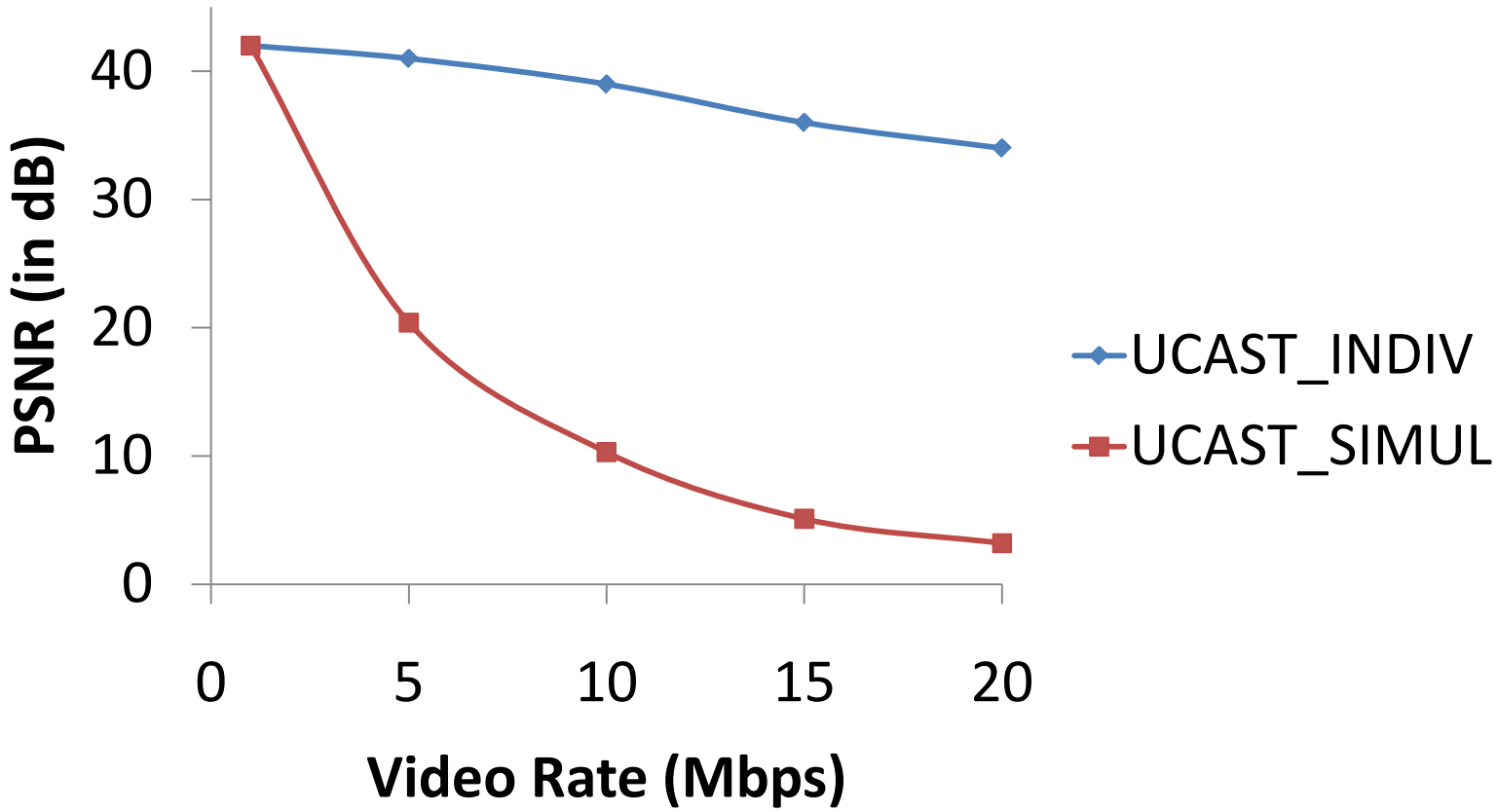
Scaling video quality



(5-15% error rates), mobile calendar, 2 min, 10 clients, 20 runs

Scaling video quality



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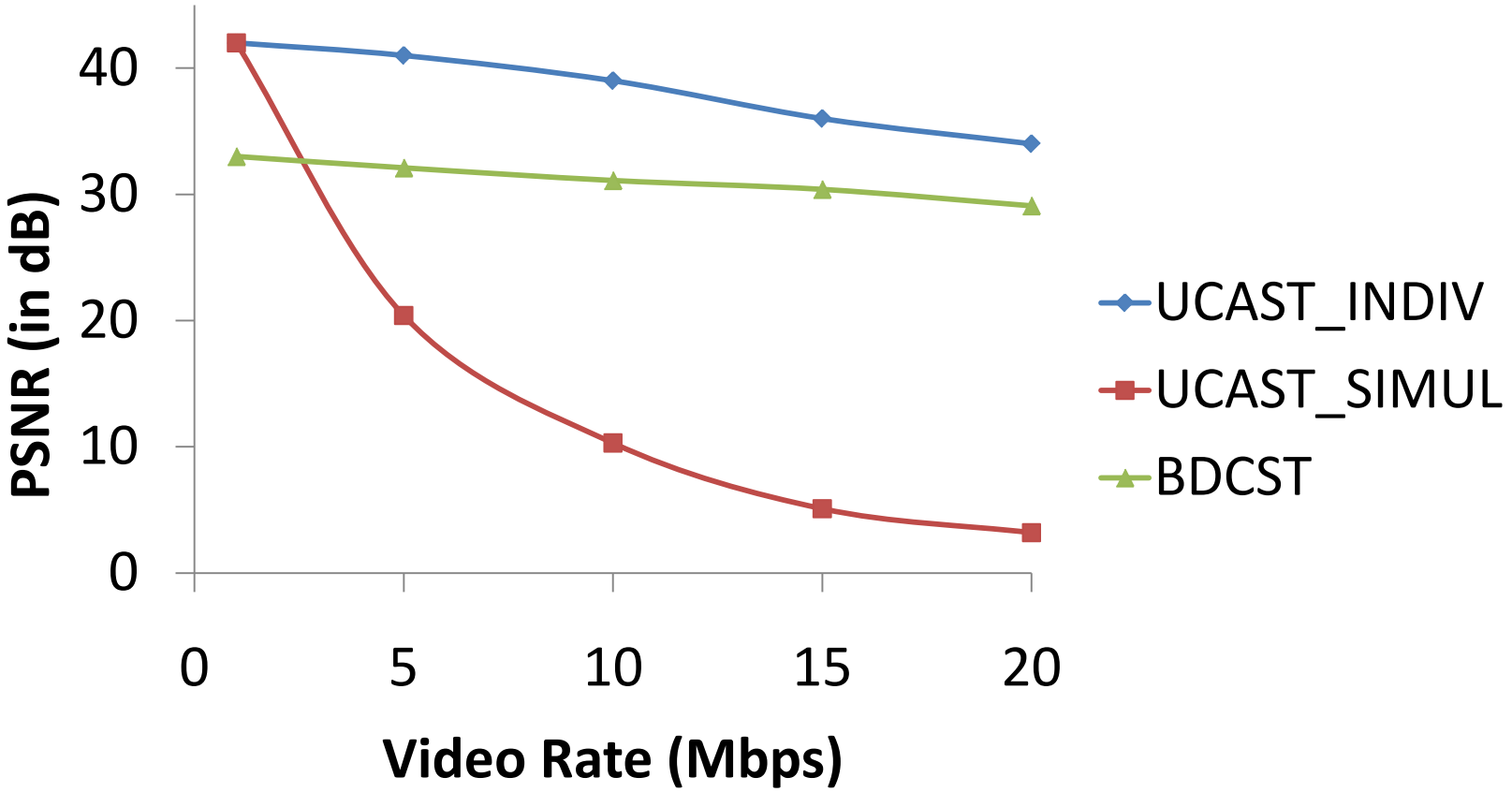

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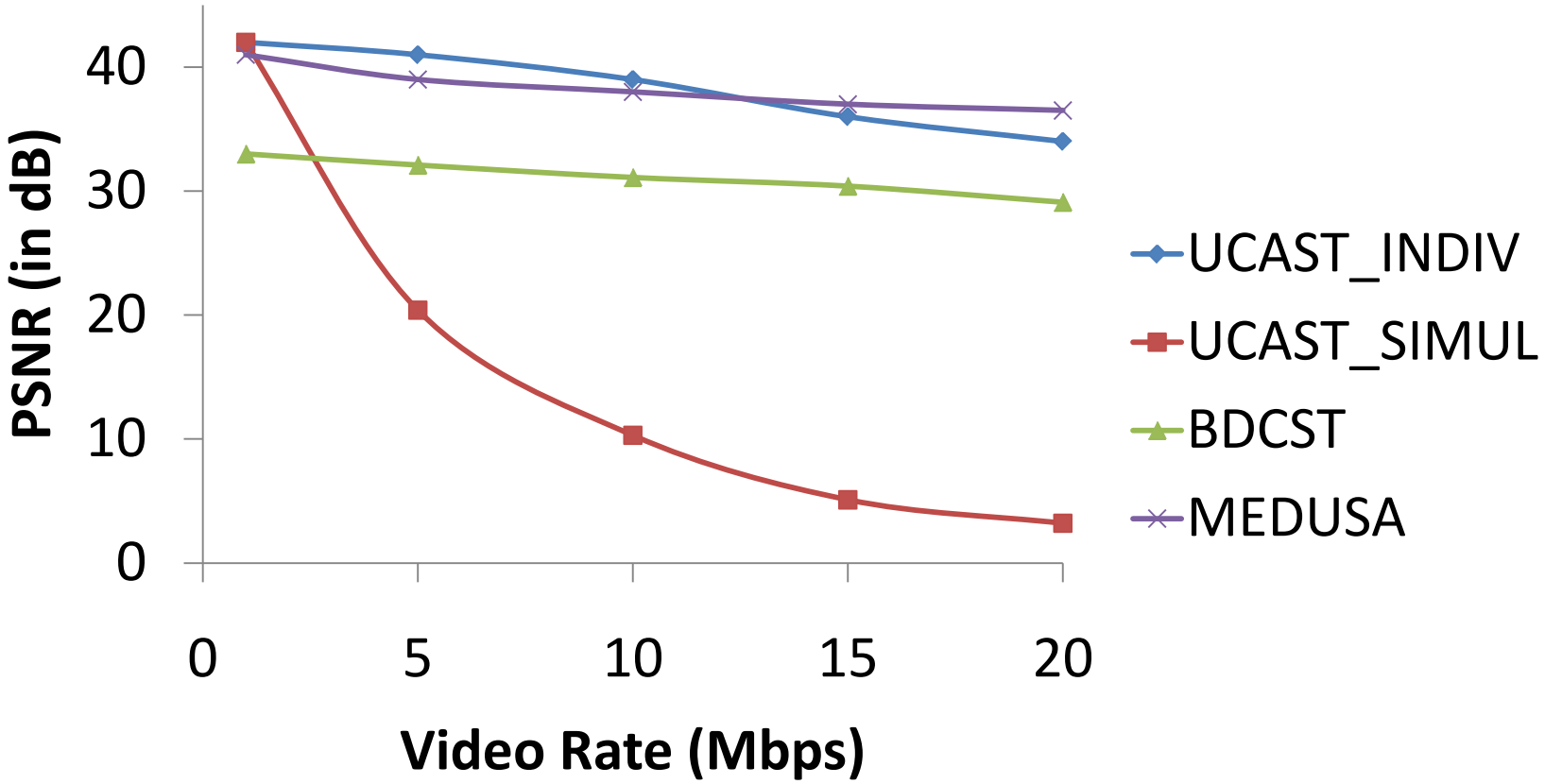

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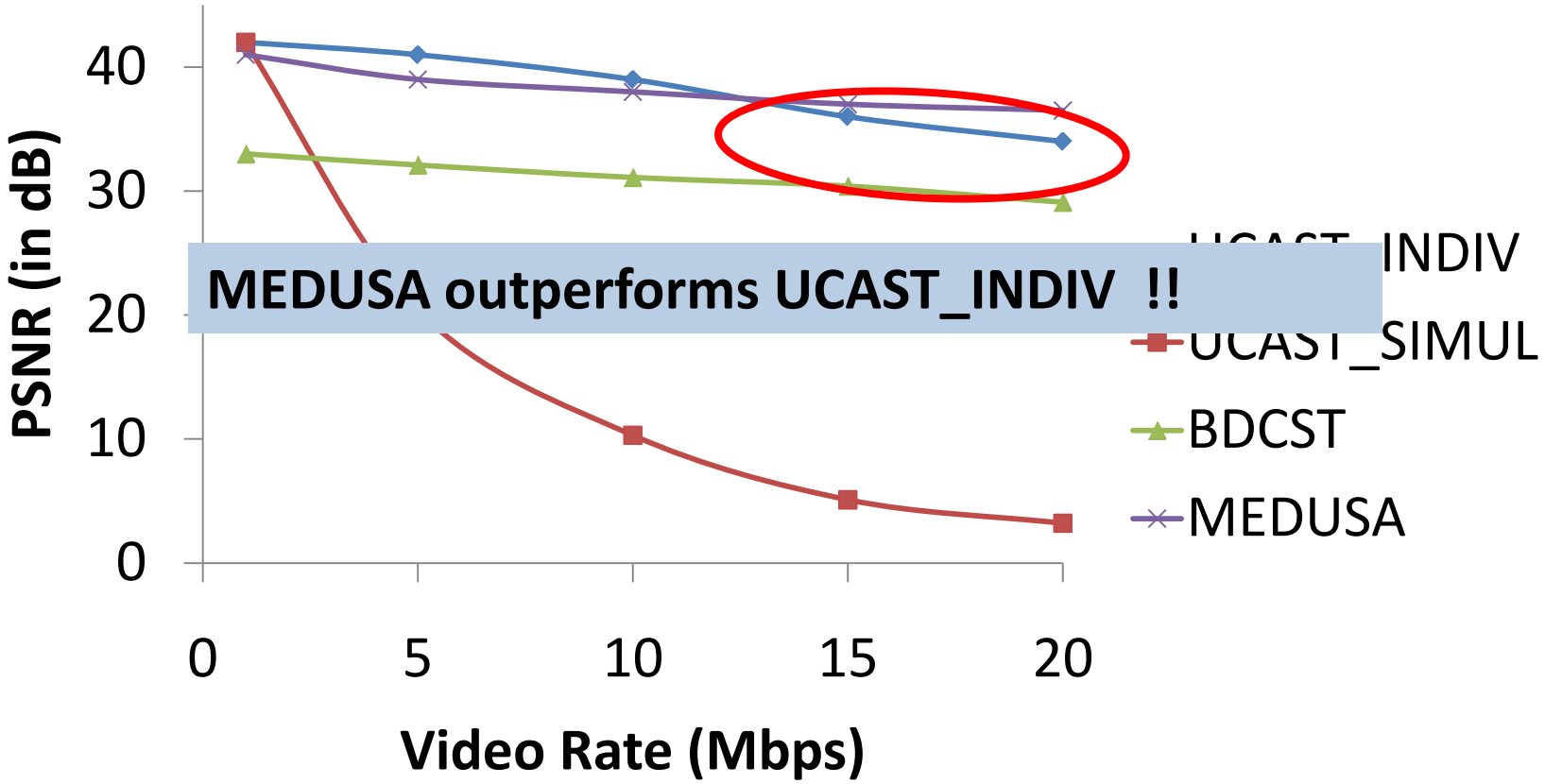

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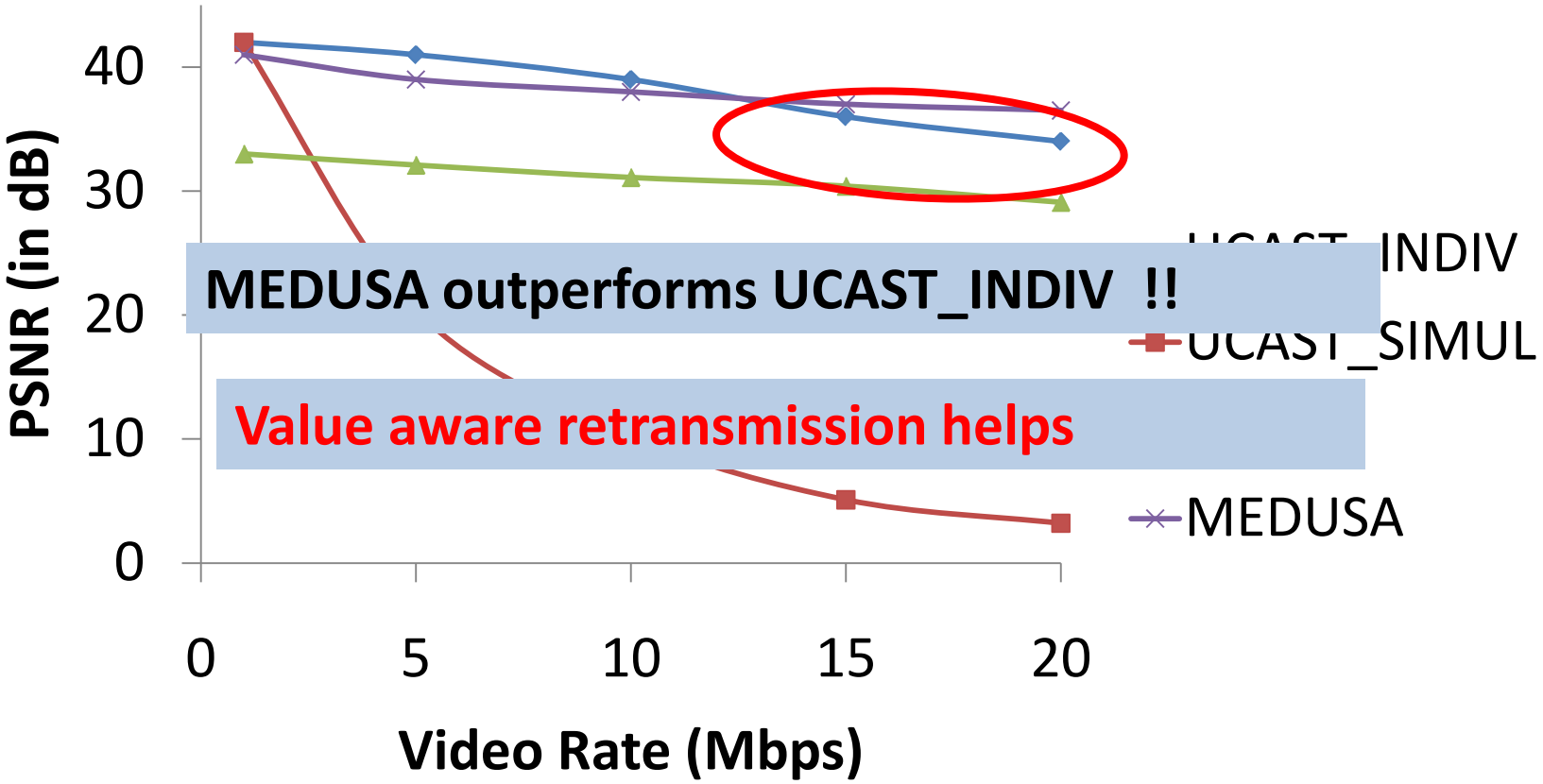

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Conclusion

- Motivate the necessity of value aware protocol design
- Show how MAC layer decisions can be taken based on value of packets
- Present a value aware adaptive multicast media delivery scheme: Medusa
- Evaluate performance of Medusa and find its performance to be satisfactory

Demo

- 5 mbps, @30 fps, MPEG4
- Evalvid sender, Quicktime player
- 15-25% MAC error rate
- Screen capture @15 fps (Camtasia)
- Show the worst client:
  - WiFi Broadcast
  - Medusa