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
A quantity associated with each packet signifying the “worth” of this packet for “overall performance”
Value (in)sensitivity

File transfer

Video streaming

MPEG-4 encoded video

I Frame -> 1 packet (for this talk)

I > P > B

All packets necessary

All packets equal

1 Frame -> 1 packet

File transfer

Video streaming
Value (in)sensitivity

File transfer

Video streaming

No deadlines

< 5 msec

< 105 msec

Nearer the deadline ... more important packet
<table>
<thead>
<tr>
<th><strong>File transfer</strong></th>
<th><strong>Video streaming</strong></th>
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<tbody>
<tr>
<td>All packets equal</td>
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Implications of value (in)sensitivity
Implications of value (in)sensitivity

File transfer
- All packets equal
- Error intolerant
- No deadlines
- Throughput matters

Video streaming
- Some more important
- Tolerates errors
- Deadlines
- Quality matters
Implications of value (in)sensitivity

File transfer
- All packets equal
- Error intolerant
- No deadlines
- Throughput matters

Video streaming
- Some more important
- Tolerates errors
- Deadlines
- Quality matters
Motivation

Protocols designed for throughput optimality
- Transport: TCP, UDP
- Network: BGP, OSPF, RED
- MAC: 802.11, 802.16
Protocols designed for throughput optimality
- Transport: TCP, UDP
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- MAC: 802.11, 802.16

Sub-optimal for media delivery
Problem Statement

How to make protocol decisions value aware?
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How to make protocol decisions value aware?

Only changing already present mechanisms
Problem Statement

How to make protocol decisions value aware?

- 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
Value Aware MAC: rate

How to make rate assignment value aware?
Traditional rate assignment

A  B  C  D  E

Lowest Value

Highest Value
Traditional rate assignment

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Max. Trpt.
Traditional rate assignment

All packets go out at 48 mbps

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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

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Send A, B @ 36 mbps to ensure delivery
Traditional rate assignment

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- **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

Order of transmitting packets

Lowest Value

Highest Value
Traditional ordering

A B C D E

External interference
Traditional ordering

A B C D E

External interference
Traditional ordering

A B C D E

MAC layer retransmit

External interference
Traditional ordering

A B C D E

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)
Value aware ordering

A B C D E

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?
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
Scaling user count

PSNR (in dB)

Number of Clients

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

PSNR (in dB)

Number of Clients

UCAST_INDIV
UCAST_SIMUL
BDCST

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

PSNR (in dB) vs. Number of clients

- UCAST_INDIV
- UCAST_SIMUL
- BDCST
- MEDUSA

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

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

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

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MEDUSA outperforms UCAST_INDIV !!

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Scaling video quality

MEDUSA outperforms UCAST_INDIV !!
Value aware retransmission helps

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