Rapid PHY Selection (RPS): Emulation and Experiments using PAUSE

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Acknowledgments

- **Most of this work was done by Francisco Blanquicet (graduate student at USF)**

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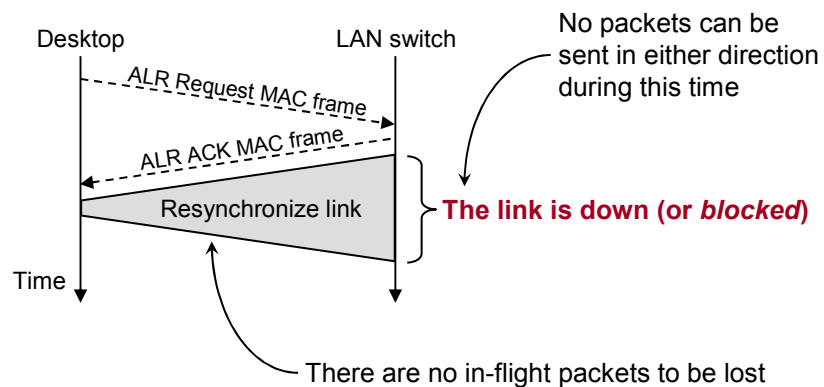# Motivation

- **Question…**

  What are the effects of a link disruption as may be caused by RPS on higher-layer protocols and applications?
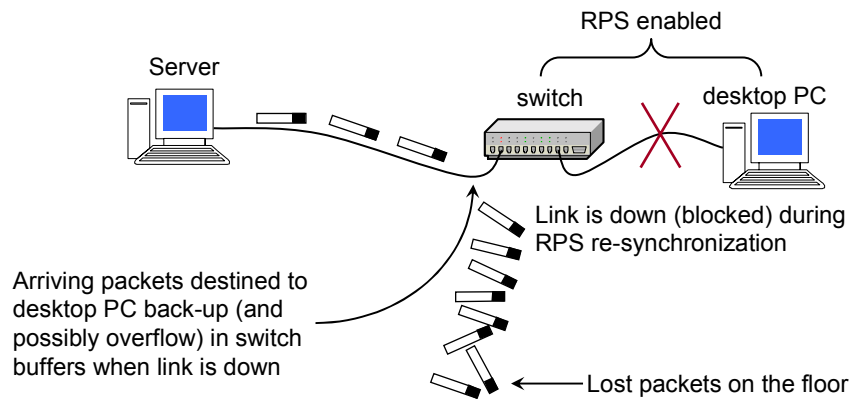
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Link disruption by RPS

- **RPS mechanism could be a MAC frame handshake**

Desktop   LAN switch

ALR Request MAC frame

ALR ACK MAC frame

Resynchronize link

Time

No packets can be sent in either direction during this time

The link is down (or *blocked*)

There are no in-flight packets to be lost

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Link disruption by RPS continued

- **Link disruption may cause packet loss**
  - Packets lost due to buffer overflow in switch

RPS enabled

Server

switch   desktop PC

Link is down (blocked) during
RPS re-synchronization

Arriving packets destined to
desktop PC back-up (and
possibly overflow) in switch
buffers when link is down

Lost packets on the floor

Worst case packet loss

- **Worst case is a burst of packets at *full data rate***
  - And, an RPS rate switch during the burst

1 millisecond of 1 Gb/s = 122 KBytes
1 millisecond of 10 Gb/s = 1.2 MBytes

➡ What is the probability of this occurring?

➡ What is impact of this if/when it occurs?

Packet loss from RPS

- **Calculating packet loss**
  - Assume RPS occurs during a burst

- **Inputs are**
  - *R* = Burst rate (bits/sec)
  - *B* = Burst size (bits)
  - *S* = Switch buffer size (bits)
  - *T* = RPS switching time (sec)

$$Loss = R \cdot \min\left(\frac{B}{R}, T\right) - S$$

- If negative result, no loss

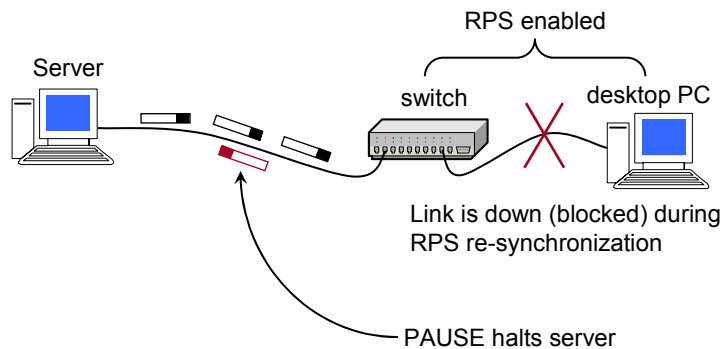- Divide by mean packet length to get (roughly) number of packets lost

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Packet loss graph (theory)

- **For a 10 Gb/s link**
  - Assume T = 1 millisec and B = 10 Mbytes
  - Assume R = 2000, 4000, and 8000 Mb/s

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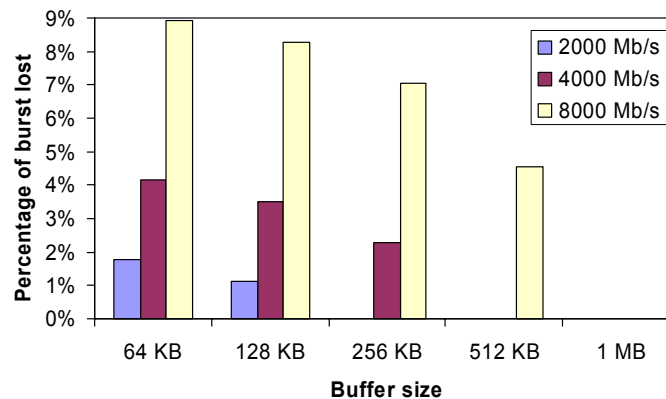
Preventing packet loss with PAUSE

- **Loss can be prevented/minimized with PAUSE**
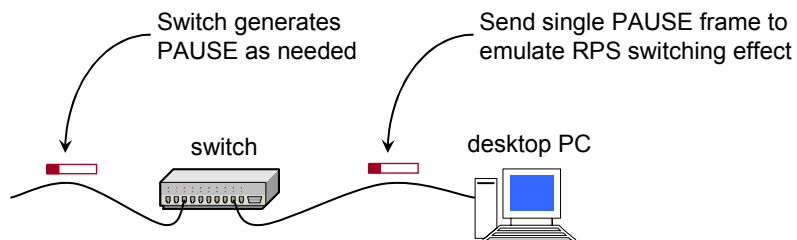 - Switch PAUSEs server during RPS switching time

RPS enabled

Server

switch   desktop PC

Link is down (blocked) during
RPS re-synchronization

PAUSE halts server

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Did some experiments at 1 Gb/s

- **Idea: Use PAUSE to *emulate* RPS switching time**

- **PAUSE can emulate RPS to some extent**
  - Blocks traffic in one direction
  - Can select duration of blocking (to emulate RPS switching time)
  - Note that link returns to same data rate as before

Switch generates
PAUSE as needed

Send single PAUSE frame to
emulate RPS switching effect

switch   desktop PC

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Experiment set-up

- **To study packet loss and effects on applications**
  - Used a rawsend program to send PAUSE frames to emulate RPS
  - TCP and UDP server throughput is about 350 Mb/s
  - UDP streamer sends packets at 144 kb/s (emulates Skype)

Commodity 5-port 1 Gb/s switch
· **Note:** Sends PAUSE frames

TCP and UDP server

Emulated RPS link

switch   desktop PC

1 Gb/s

UDP streamer   1 Gb/s

1 Gb/s
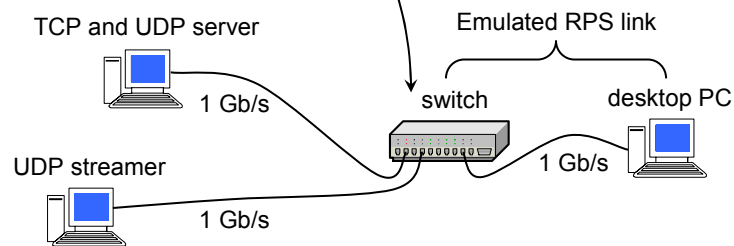
Experiments

- **Experiment #1 – TCP file downloads**
  - Download files while RPSing

- **Experiment #2 – UDP bulk data transfer**
  - Download while RPSing

- **Experiment #3 – TCP download + UDP stream**
  - Download + streaming while RPSing

Emulated RPS once per second

Emulated RPS switch times were 1, 10, and 20 milliseconds

Experiment observations

- **TCP downloads are always successful**
  - Download time increase is 2x to 5x total RPS switching time

- **UDP bulk data packet loss is as expected**
  - Packet loss proportional to total RPS switching time per second

- **UDP streaming packet loss**
  - No packet loss detected
    - Due to low bit rate resulting in very low probability of packet loss

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Experiment observations continued

- **For all of the experiments…**

> **If switch sends PAUSE to server then no packet loss occurs**

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Conclusions

- **Do not want to introduce something into network that causes packet loss**

- **PAUSE flow control can automatically prevent (or at least reduce) packet loss**

- **Not clear that packet loss will be "bad" for low utilization links**

- **Can think of packet loss as a trade-off**
  - Energy saved versus packets lost

- **In any case, RPS is not intended for all links**

Questions?

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