End-to-end Performance Diagnosis

[IEEE 802.16 Mentor Presentation Template (Rev. 0)]

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Re:
Solicitation of input contributions by IEEE 802.16's Metrology Study Group <http://ieee802.org/16/sg/met> for IEEE 802.16's Session #79 of 14-17 May 2012.

Base Contribution:
None

Purpose:
Consideration during discussions of Study Group activity and plans.

End-to-end Performance Diagnosis

Partha Kanuparthy
Georgia Institute of Technology

This Talk: Tools

* End-to-end userlevel diagnosis of wireless performance problems
* Detailed diagnosis of "speed"

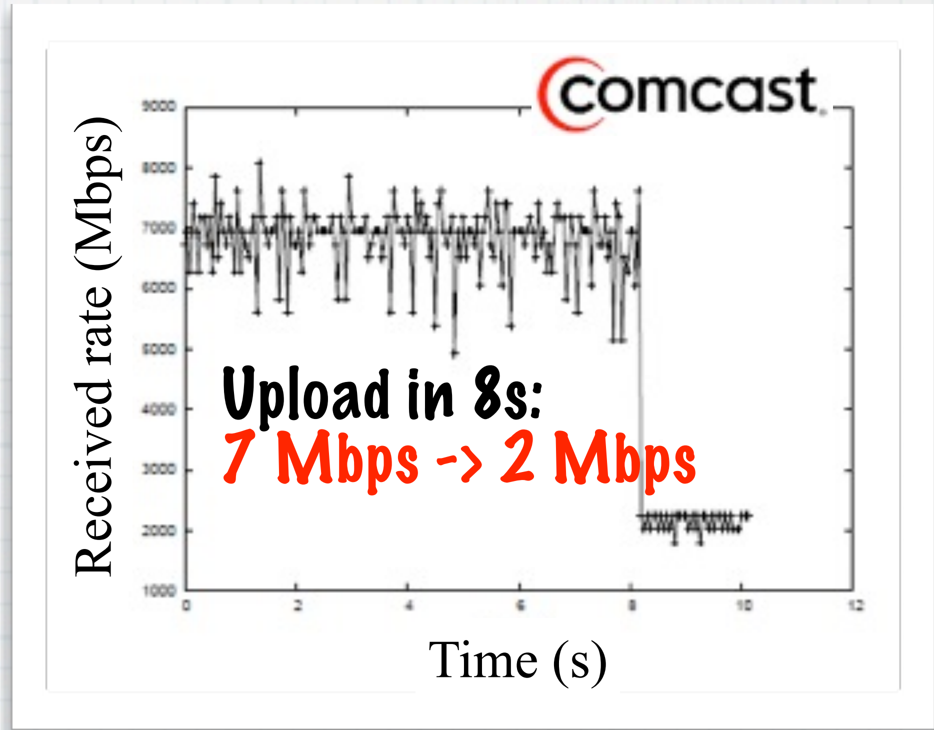
How is it relevant?

* Lesson 1: Measure the right metrics
  * TCP throughput can be sensitive to single loss, and is a complex function
  * delays, loss rate meaningful?
  * should allow user to troubleshoot perf.
* Lesson 2: Ensure Accuracy and Usability
  * measurement methods accurate under typical confounding factors: small form factors, busy OS, ...?
  * do the tools work without needing OS changes?
* Lesson 3: Diagnosis can be detailed
  * "5 Mbps throughput?" OR
    "10 Mbps throttled down to 2 Mbps after 7s"?

Detailed Diagnosis of "Speed"

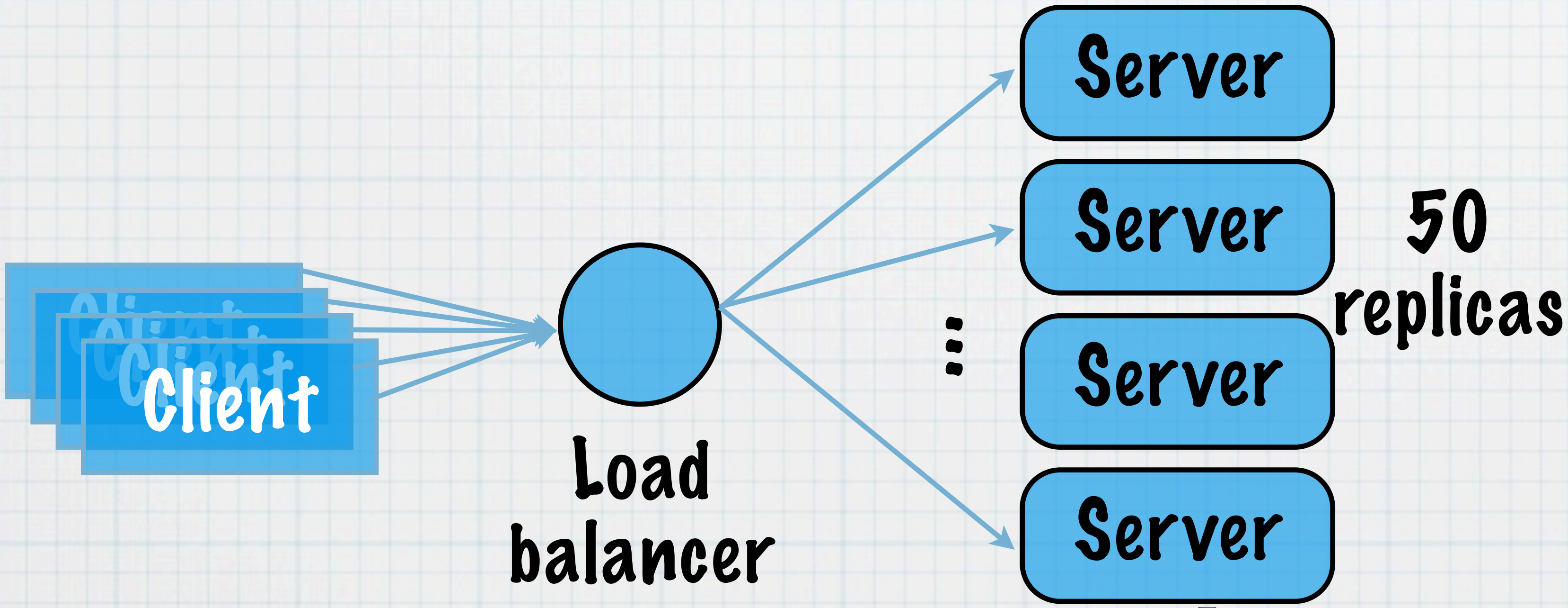
Traffic Shaping/Policing

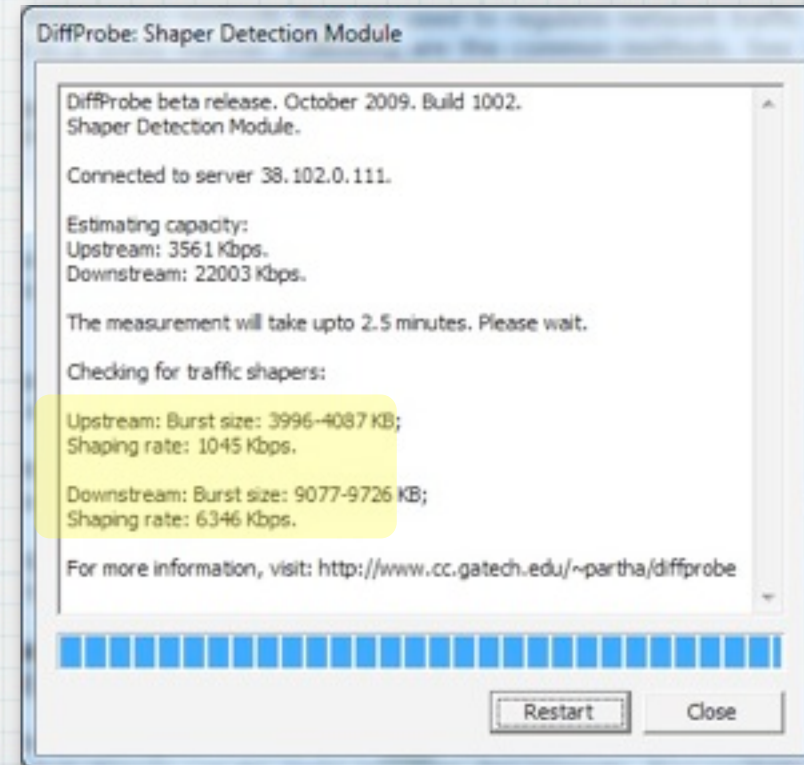
- Practice of dropping link capacity after some time
  - e.g., "PowerBoost" in cable ISPs
- What is a reasonable performance metric for "speed"?
  - throughput = 4 Mbps?
  - capacity = 7 Mbps; and sustained rate = 2 Mbps?



ShaperProbe Service

* Hosted on MeasurementLab.org
* Started mid-2009
* 1.5 million runs, 3k users/day; 5,700 ISPs





ShaperProbe Service

The measurement will take upto 2.5 minutes. Please wait.

Checking for traffic shapers:

Upstream: Burst size: 9548-9622 KB;
Shaping rate: 10714 Kbps.

Downstream: Burst size: 19371-19972 KB;
Shaping rate: 53274 Kbps.

For more information, visit: http://www.cc.gatech.edu/~partha/diffprobe

You can run ShaperProbe to get a more accurate idea of your speeds.

ShaperProbe is actually meant to detect any shaping on your line, however because of that it runs tests for a longer time than any test site I know, resulting in a highly accurate reading.

I do know that I sustain ~2.8 MB/s via torrent or usenet when I've tried that to test. I haven't found reliable single-connection test as of yet (except for shaperprobe).

Some are more accurate than others. There's a tool called Shaperprobe that you can use, you can find a link to it from in here somewhere, that will give you the most accurate reading IMO.

to forum · permalink · 2010-06-05 13:08:02 · reply

5,700 ISPs

... in my zip code to both ... et at that moment, I was sustaining my 16mbps on an 8mbps plan. Chatted online and yes the 50/10 was available, ordered and ultimately got it.

Yes the best way is for a large download going past the boost so above is my example. I have also found that shaperprobe seems to do a good job estimating both the boost and sustained levels.

»www.cc.gatech.edu/~partha/diffpr···robe.exe

reak

& P2P TIPS, TRICKS AND INFO.

It's the most accurate thing that I've come across to date other than ... transfers...

to forum · permalink · 2010-03-24 18:57:00 · reply

reply to K2NNJ
Flash based speed tests really haven't kept up with technology. Try ShaperProbe
»www.measurementlab.net/measureme···iffprobe

It will give you a good idea of your provisioned speed and your speed with Power Boost.
--
[Insert Comcast employee disclaim...

Traffic Shaping with ShaperProbe

May 07, 09 by sharky 13,695 views

In my never so humble opinion it is almost a total waste of time going to speed testing sites such as those. As recommended "Shaper Probe" is the good stuff. Real life transfers are of course the most accurate.
I have to agree there. ShaperProbe has been spot on every time I've tried it.

Case-study: Comcast

* About 30k runs (Late 2009 - May'11)

C (Mbps)	ρ (Mbps)	σ (MB)	Burst duration (s)
3.5	1	5	16.7
4.8	2	5, 10	15.2, 30.5
8.8	5.5	10	25.8
14.5	10	10	18.8

(a) Upstream.

C (Mbps)	ρ (Mbps)	σ (MB)	Burst duration (s)
19.4	6.4	10	6.4
21.1	12.8	10	10.1
28.2	17	20	14.9
34.4	23.4	20	15.3

(b) Downstream.

Comcast Business Class Internet (May 12, 2010). http://business.comcast.com/internet/details.aspx.

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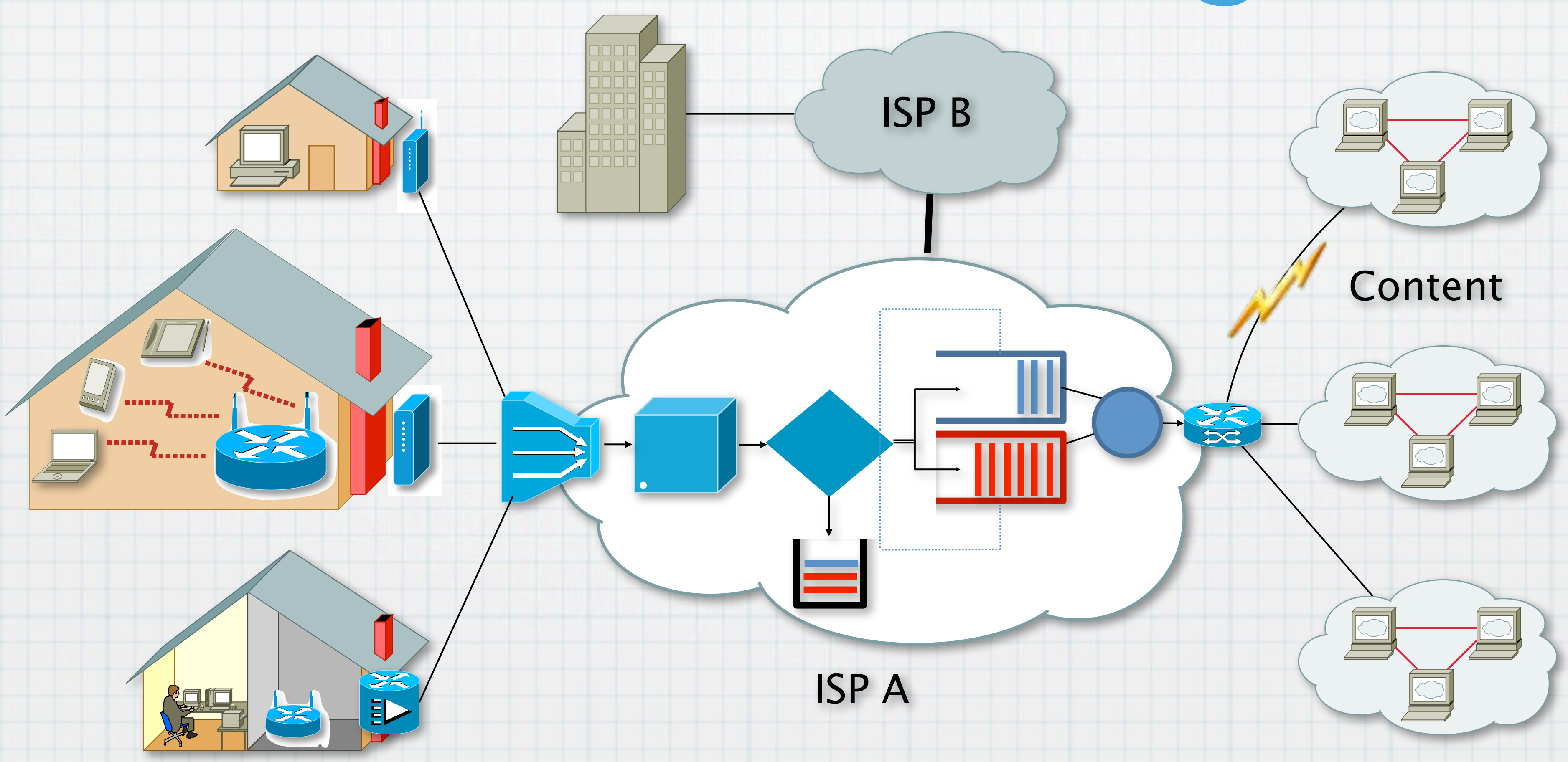
Home Wireless Userlevel Performance Diagnosis



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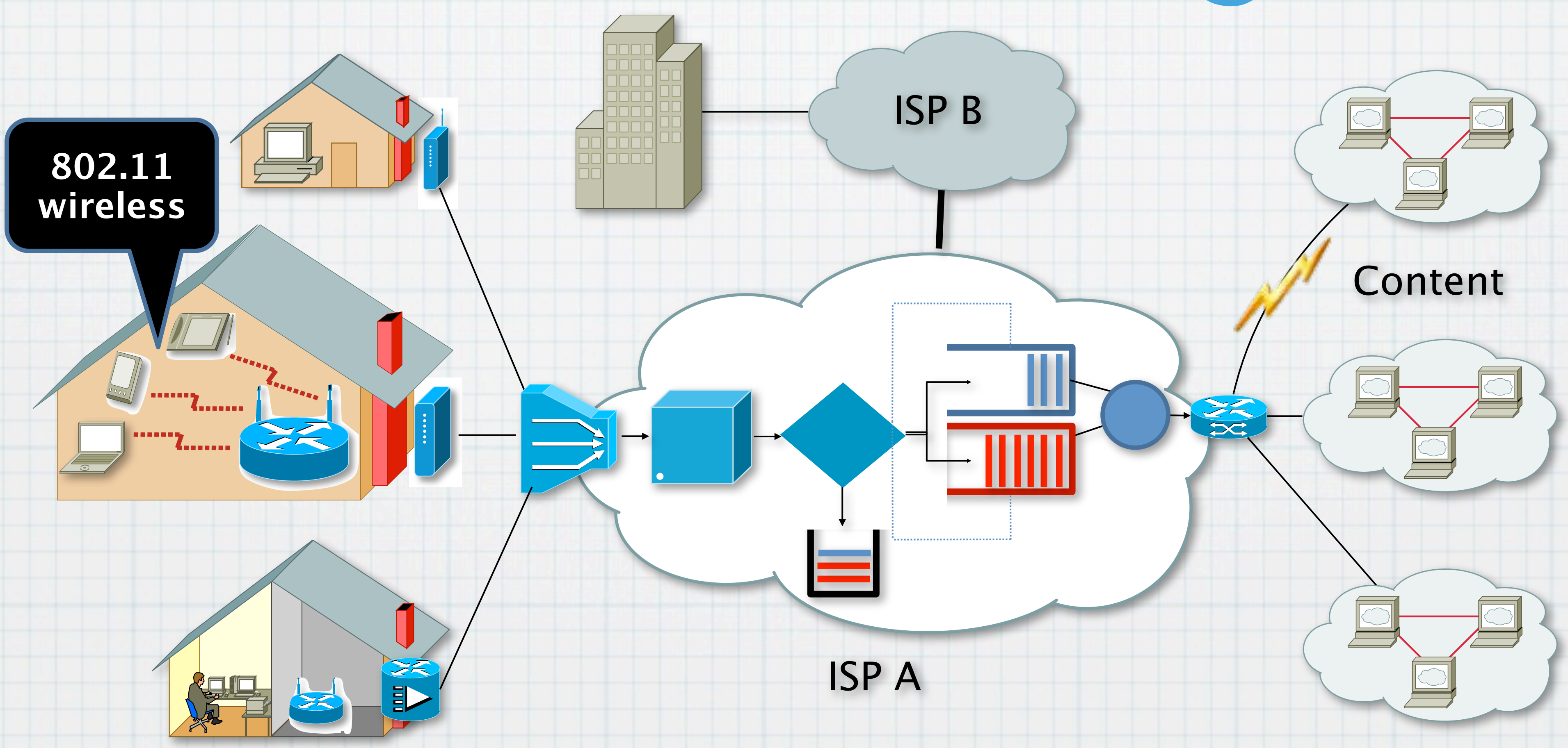
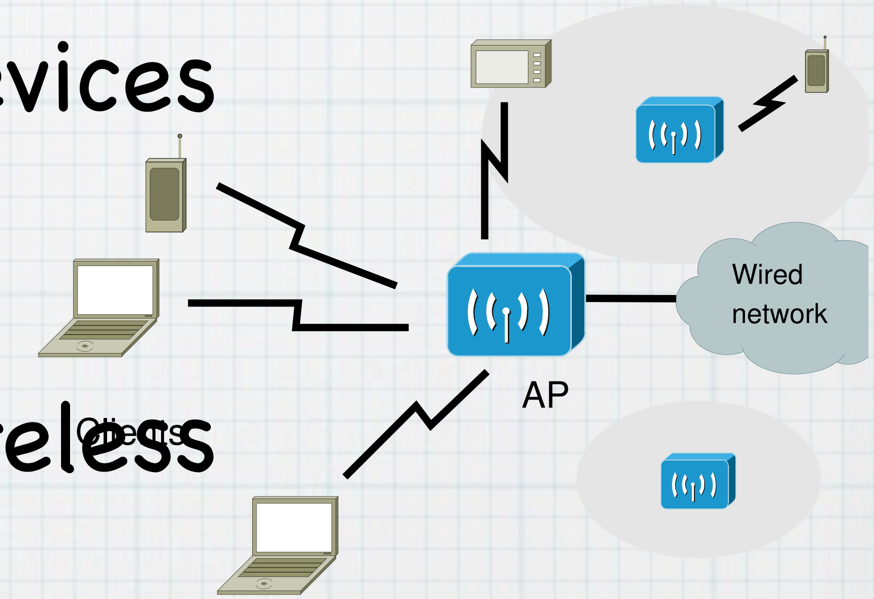


Home 802.11 Networks

* Ubiquitous: most residential e2e paths start/end with 802.11 hop
* Use a shared channel across devices
  * infrastructure, half-duplex
* Co-exist with neighborhood wireless and non-802.11 devices (2.4GHz cordless, Microwave ovens, ...)



802.11 Performance Problems

* Wireless clients see problems:

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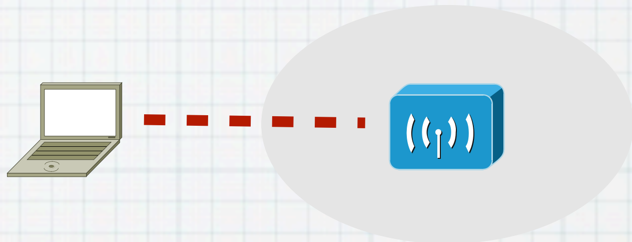
    * Low signal strength (due to distance, fading and multipath)



802.11 Performance Problems

* Wireless clients see problems:
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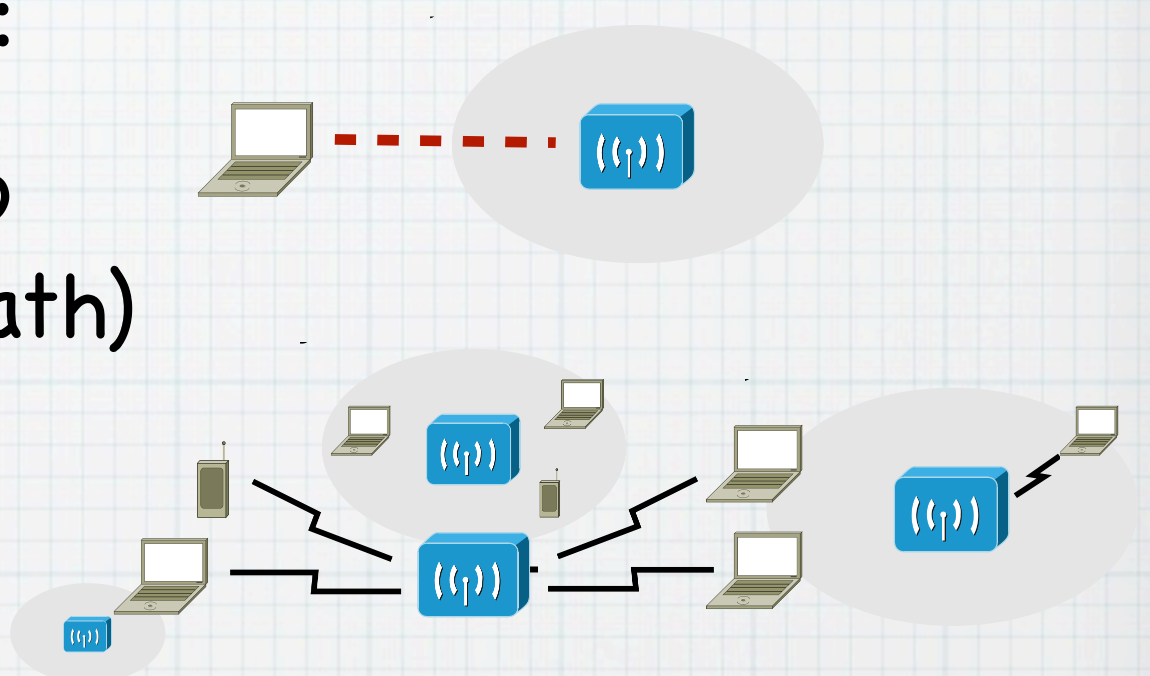
  * Congestion (due to shared channel)



802.11 Performance Problems

* Wireless clients see problems:
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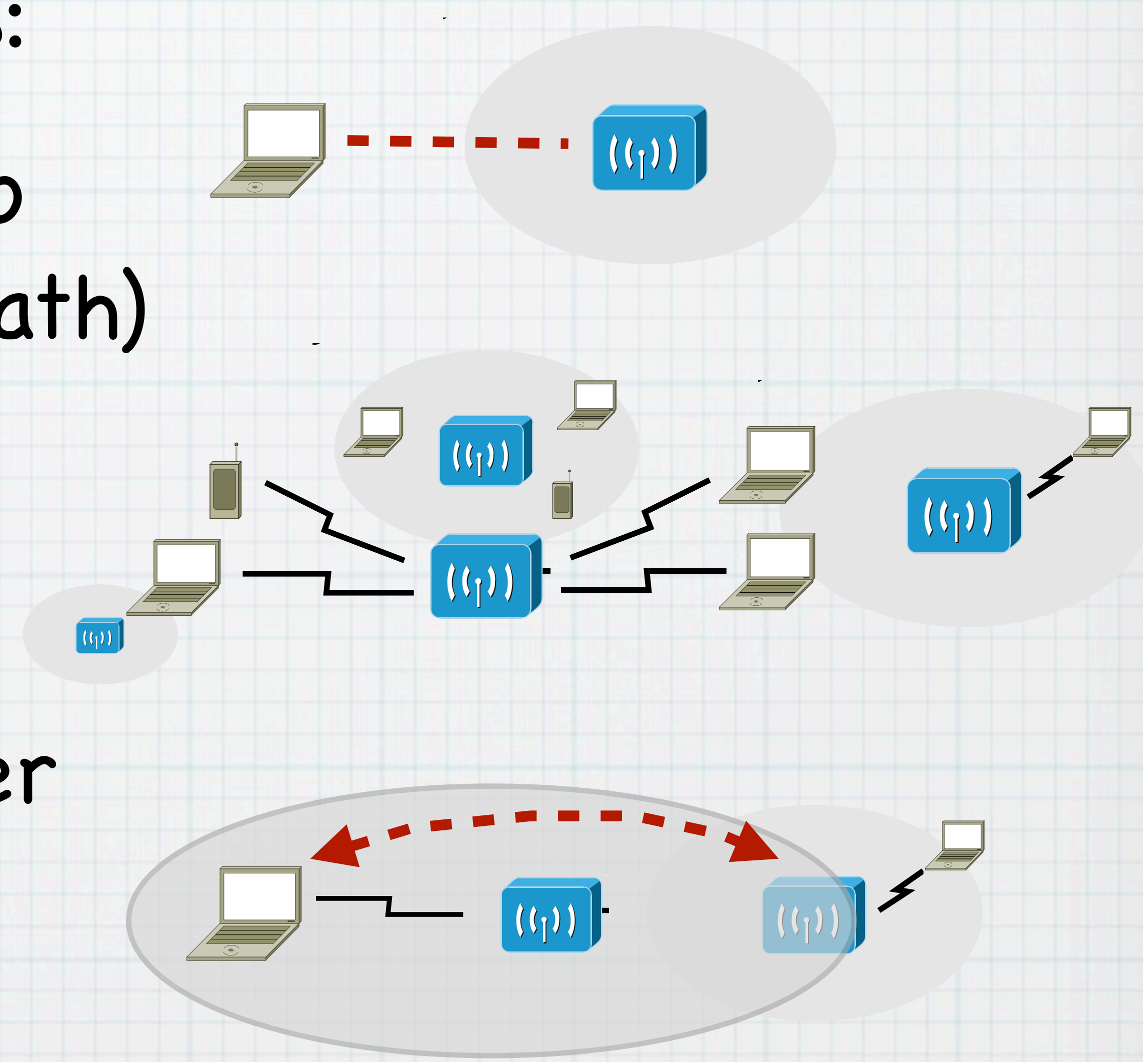
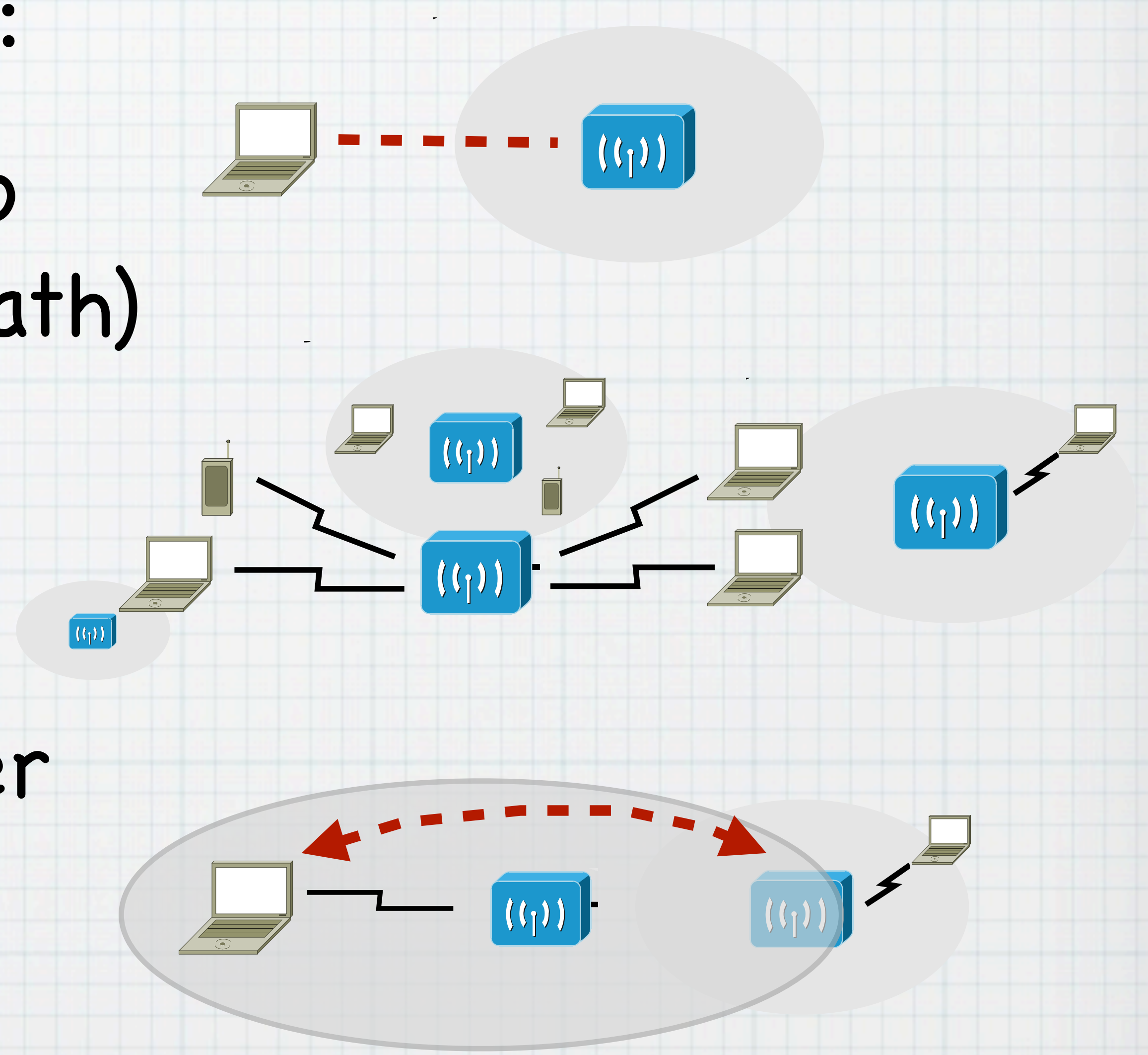
    * Hidden terminals (no carrier sense)



802.11 Performance Problems

* Wireless clients see problems:
  * Low signal strength (due to distance, fading and multipath)
  * Congestion (due to shared channel)
  * Hidden terminals (no carrier sense)
  * Non-802.11 interference (microwave, cordless, ...)



Why not measure throughput?

* Why not "upload speed = 5 Mbps" and "download speed = 7 Mbps"?
  * congestion: 7 Mbps
    hidden terminal: 0.3 Mbps!
  * allows user to better understand & troubleshoot connection

WLAN-Probe

* We diagnose 3 performance pathologies:
  * congestion, low signal strength, hidden terminals
* Tool: WLAN-Probe
  * single 802.11 prober
  * user-level: works with commodity NICs
  * no special hardware or administrator requirements

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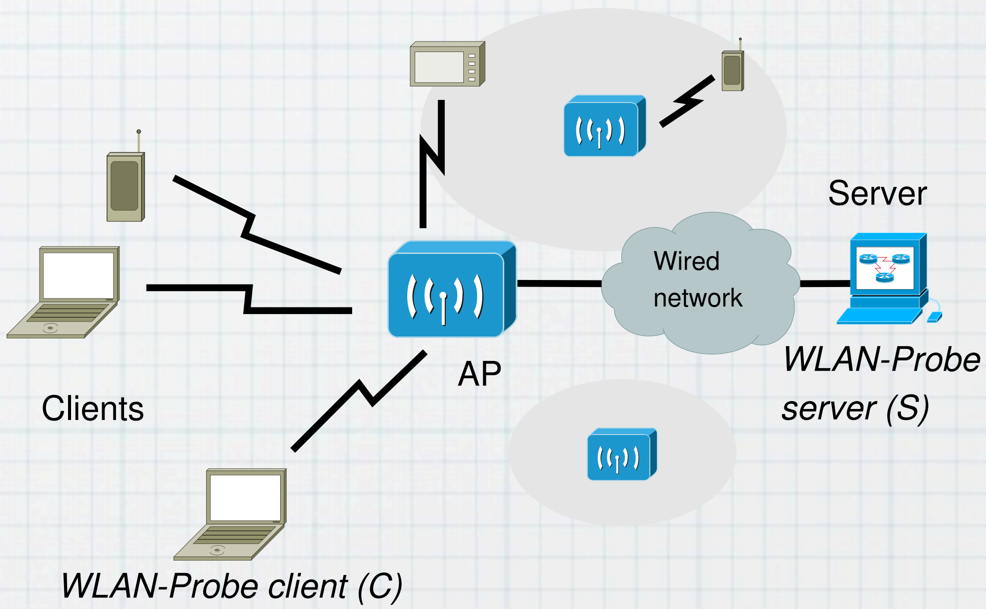

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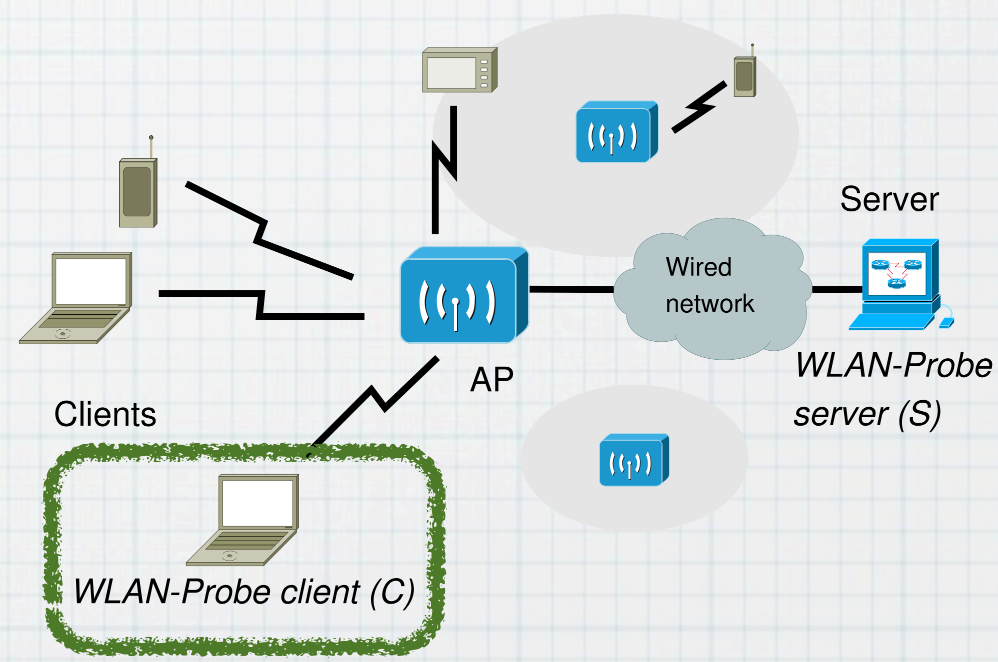

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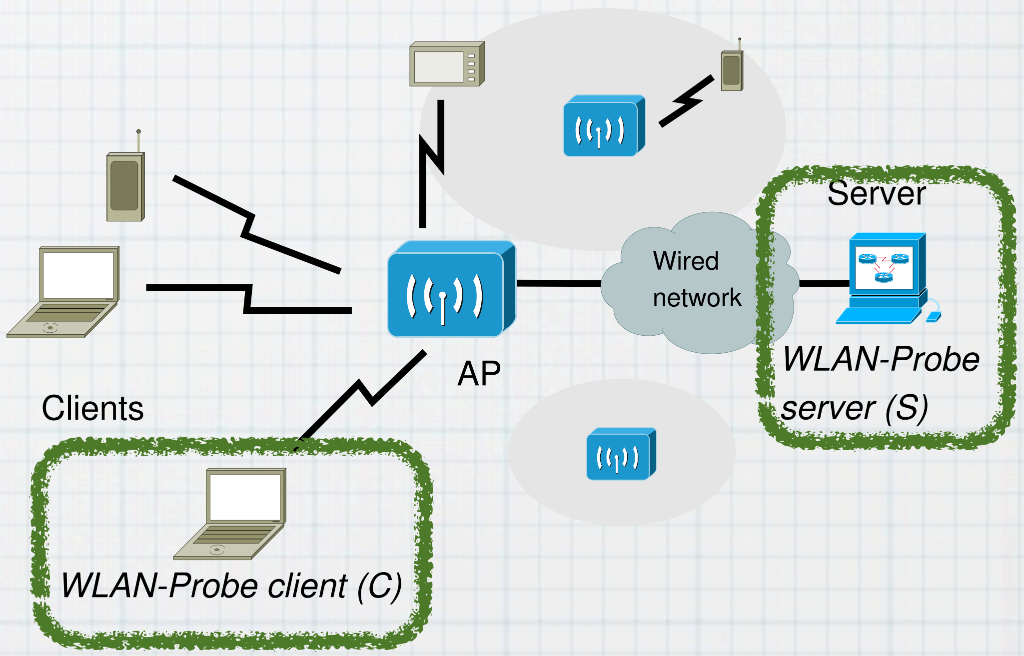
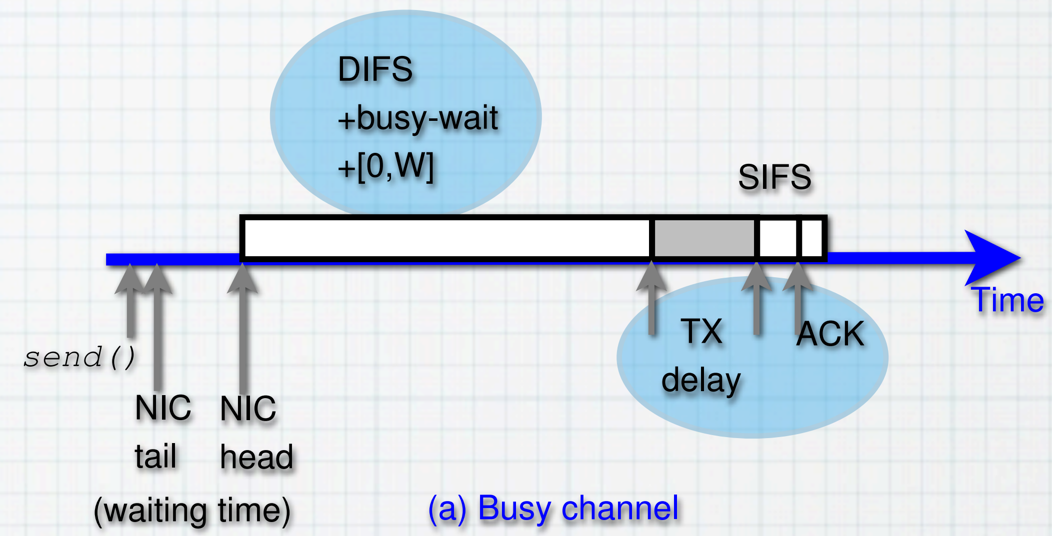
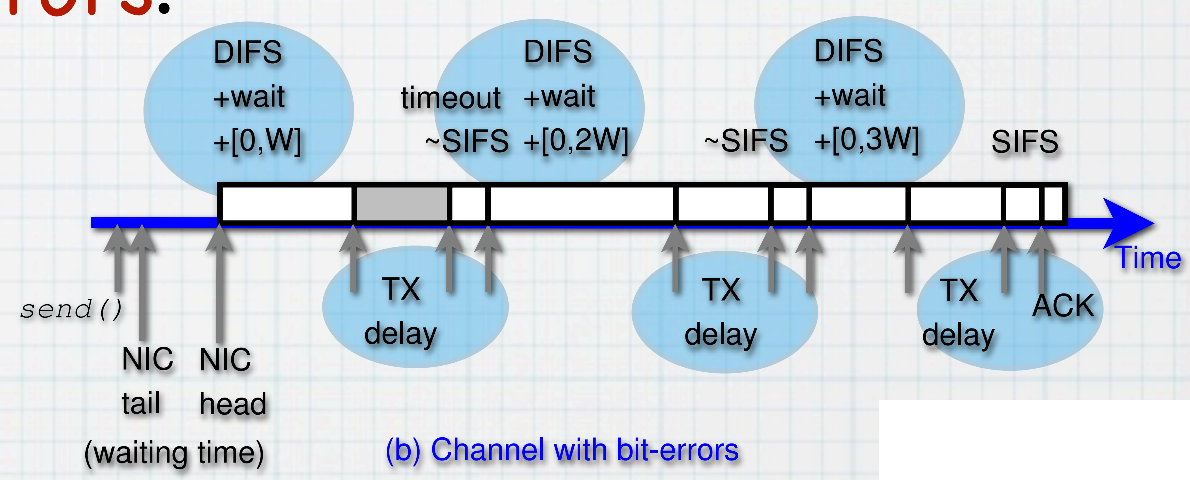


Life of 802.11 Packet

* Delays in a busy channel:
  * channel busy-wait delay
* Delays in presence of bit errors:
  * L2 retransmissions
  * random backoffs
* Unavoidable variable delays:
  * TX-delay(s) (based on L2 TX-rate)
  * 802.11 ACK receipt delay



(a) Busy channel



(b) Channel with bit-errors

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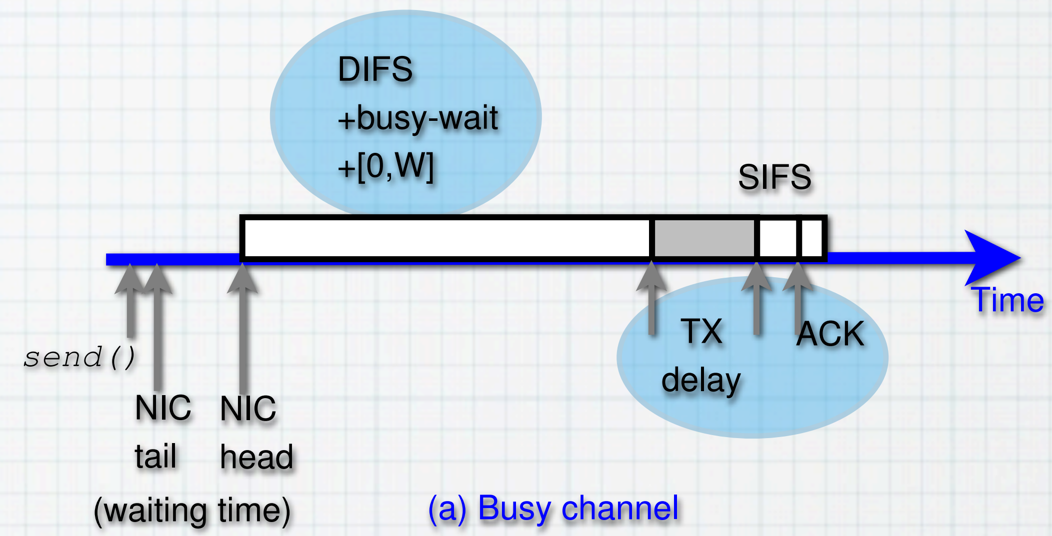

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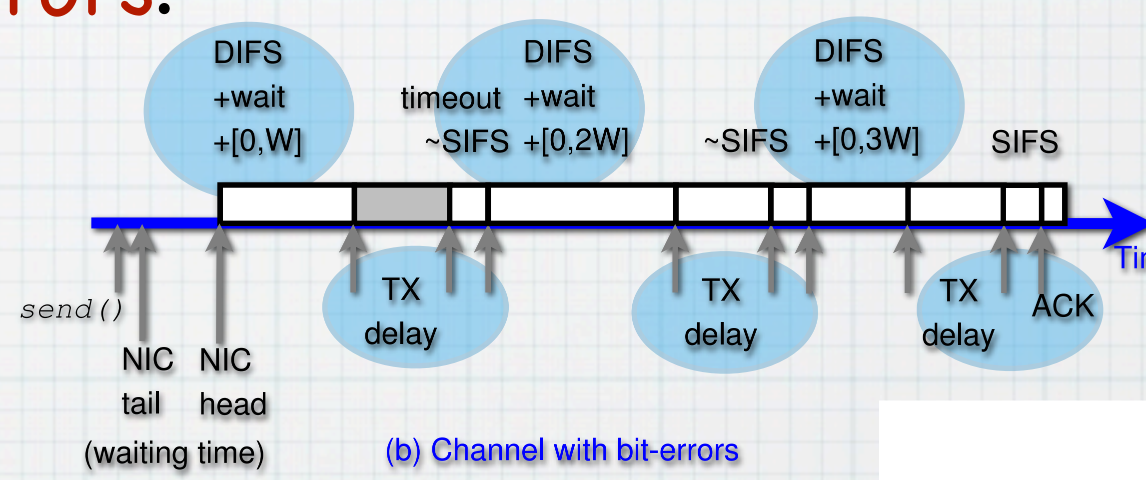

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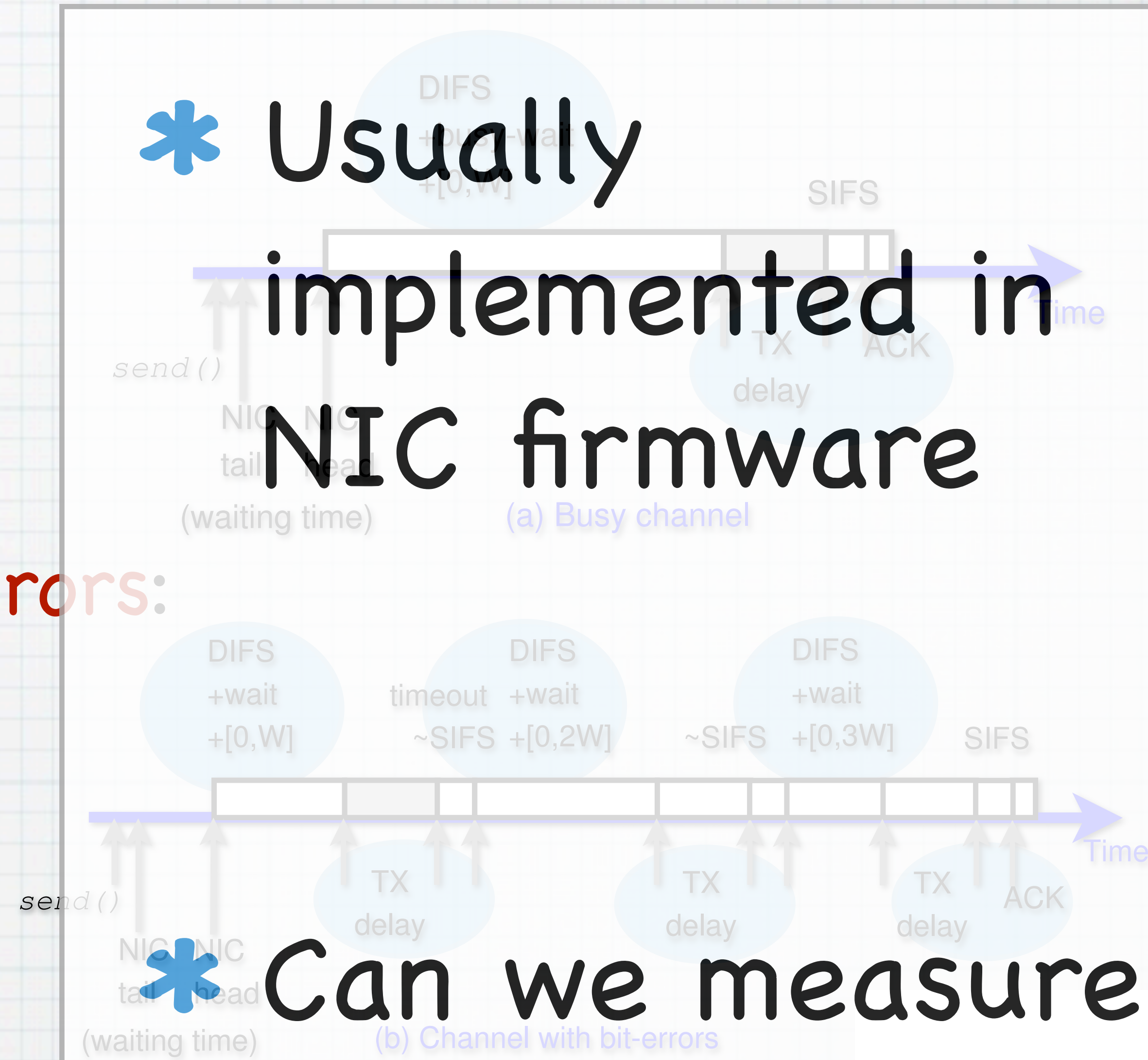

* Usually implemented in NIC firmware
* Can we measure these delays?
  * Yes!

Access Delay

busy-wait | re-TXs | backoffs | TX-delay | ACKs

Access Delay

busy-wait

re-TXs

backoffs

~~TX-delay~~

ACKs

rate adaptation!

Access Delay

busy-wait | re-TXs | backoffs | ~~TX-delay~~ | ACKs

rate adaptation!

- Captures channel "busy-ness" and channel bit errors
  - excludes 802.11 rate modulation effects
- d = OWD - (TX delay)

first L2 transmission

Access Delay

busy-wait | re-TXs | backoffs | ~~TX-delay~~ | ACKs

rate adaptation!

* Captures channel "busy-ness" and channel bit errors
  * excludes 802.11 rate modulation effects
* d = OWD - $\boxed{\text{(TX delay)}}$

first L2 transmission

??

Access Delay: TX delay

* d = OWD - (TX delay)
* TX-rate?
  * send 50-packet train with few tiny packets
  * use packet pair dispersion to get TX-rate:

$$r_{i,1} = \frac{s_i}{\Delta_i - \Delta_{\text{tiny}}}$$

current busy-wait delays

  * Estimate a single rate for the train: rates remain same across train!

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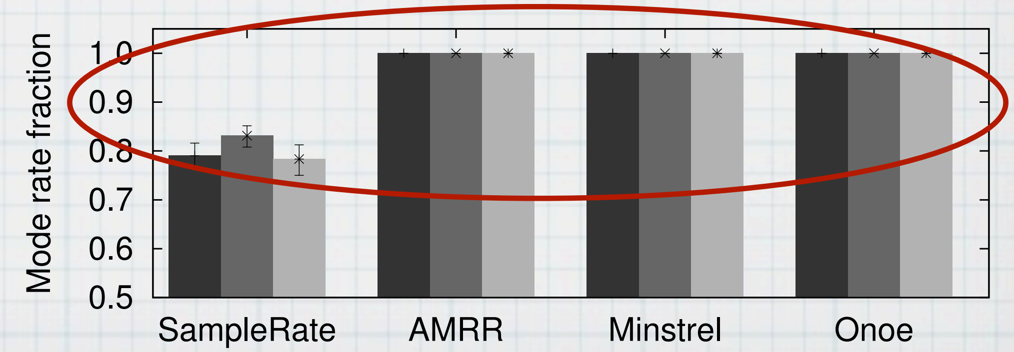
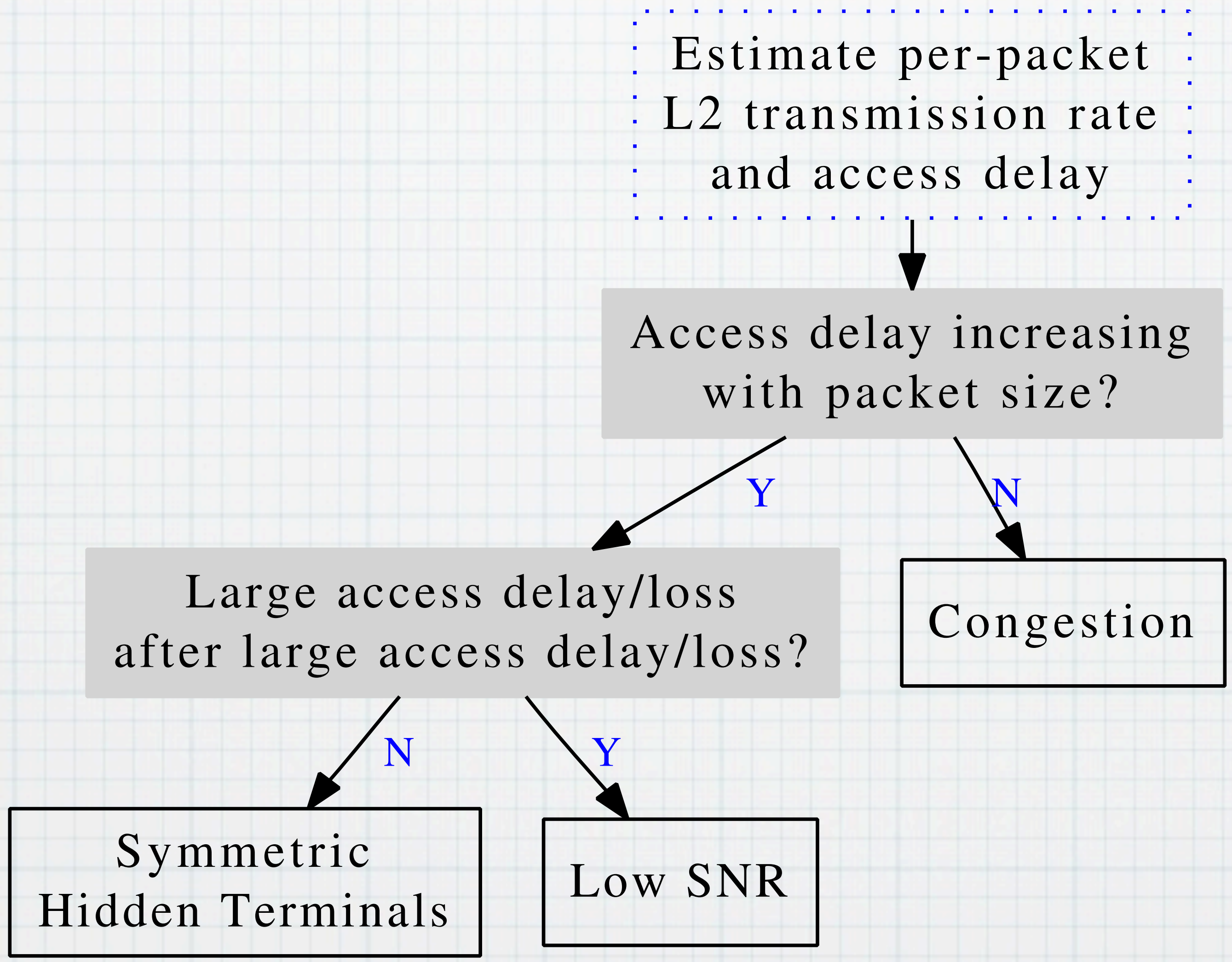


Diagnosis Tree



Size-dependent Pathologies

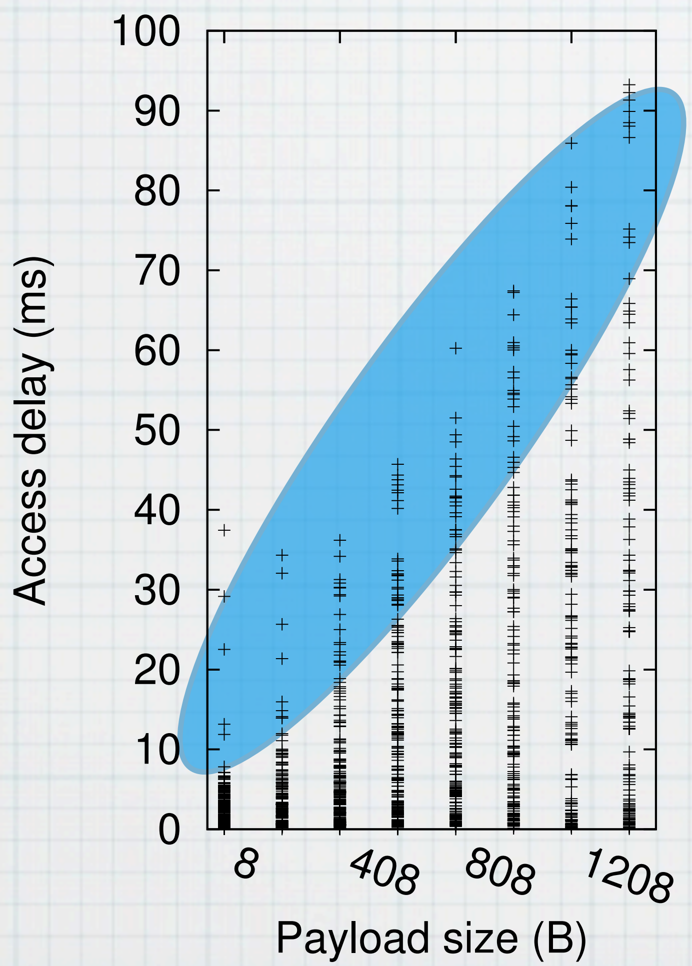
Bit errors increase with packet size:

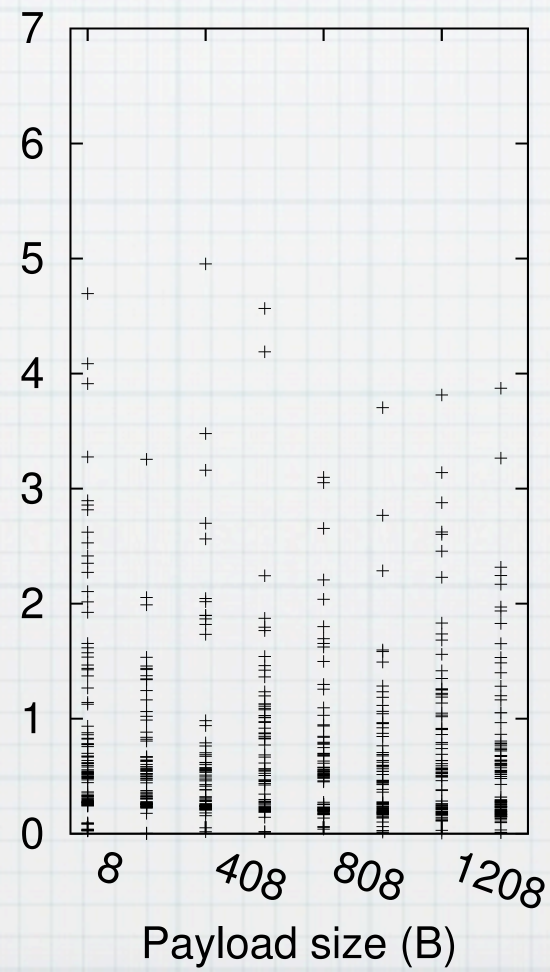
Higher percentile access delays show trends.

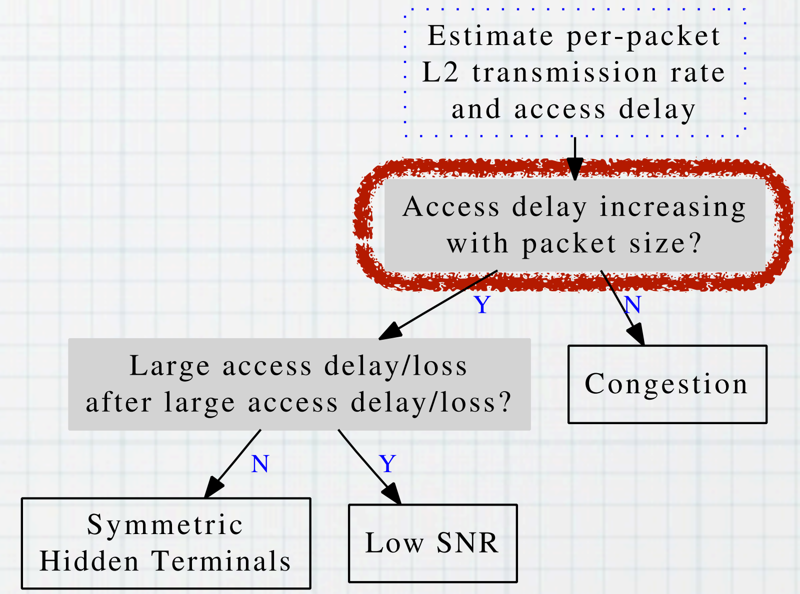
Low signal strength

Hidden terminals

Congestion

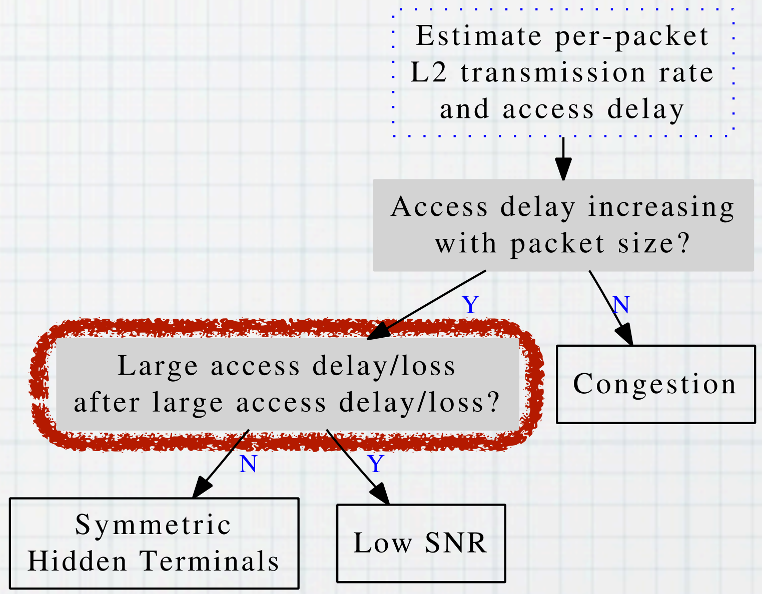






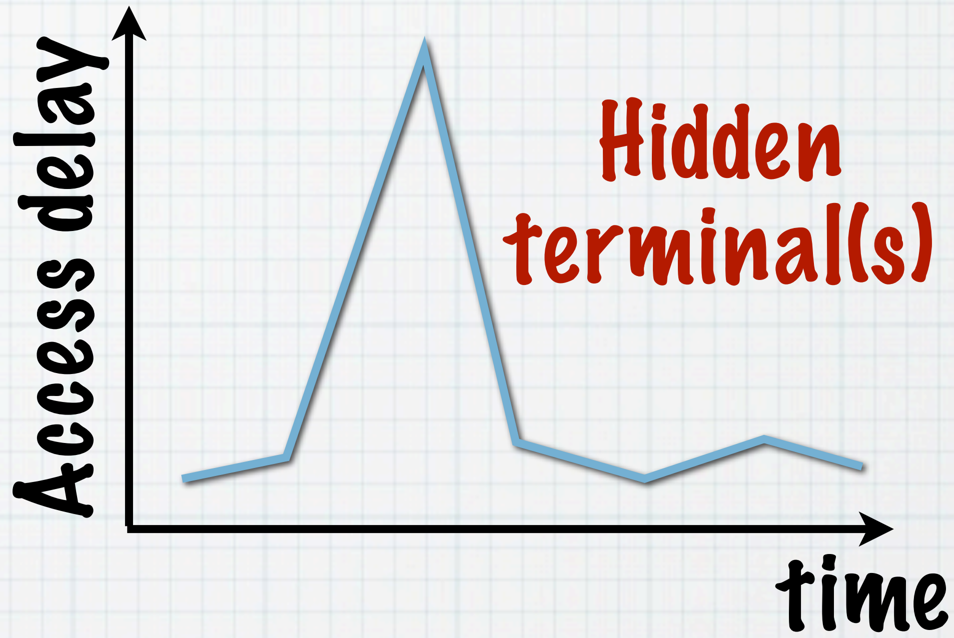
Hidden Terminals

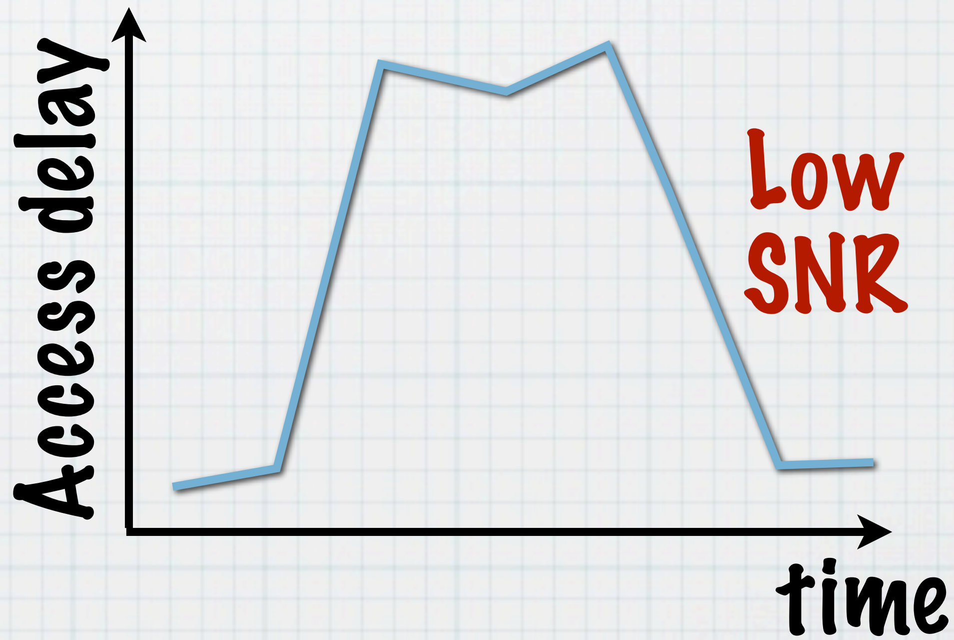
* Hidden terminals respond to frame corruption
  * by random backoffs
* Look at immediate neighbors of large delay or lost (L3) packets
  * hidden terminal: neighbor delays are small
  * low SNR: neighbors are similar



Hidden Terminals

* Define two measures:
    * p_u = P [high delay or L3 loss]
    * p_c = P [neighbor is high delay or L3 loss | high delay or L3 loss]
* Hidden terminal:
    * $p_c \approx p_u$





Hidden Terminals

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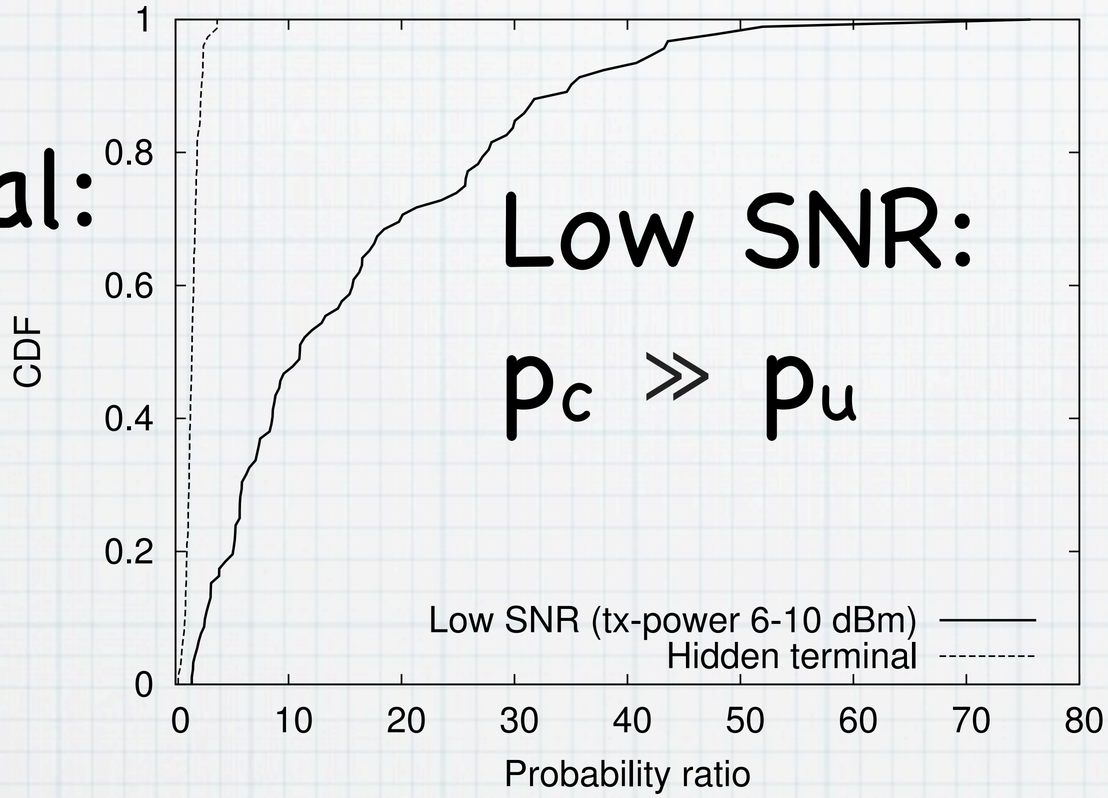
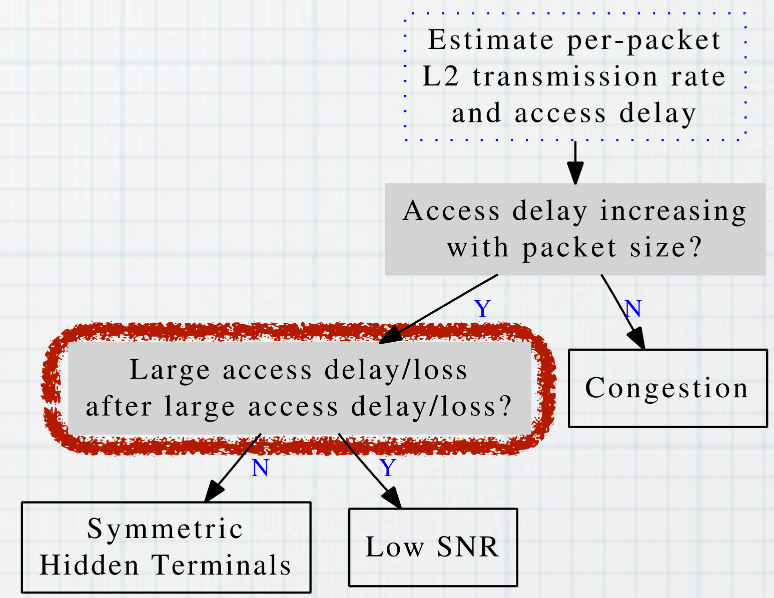


Low SNR:

$p_c \gg p_u$



Ratio: p_c / p_u sufficient to diagnose hidden terminals.

Thank You!

partha AT cc.gatech.edu

* Lesson 1: Measure the right metrics

* Lesson 2: Ensure Accuracy and Usability

* Lesson 3: Diagnosis can be detailed