Module 5: Measuring networks

1. Recap from last week

2. Measuring and monitoring

3. Streaming and monitoring

4. Profiling users

5. Wrap-up & homework

Recap from last week

First Week

We formed a wireless mesh network using Raspberry Pis

Second week

We configured a wired network using Raspberry Pis

Third Week

We configured a wireless mesh network using Raspberry Pis

Fourth Week

We planned out a wireless mesh network in our community

This Week

We will *measure* our network

Measuring & Monitoring

Net neutrality

According to Wikipedia

> Net neutrality is the principle that Internet service providers treat all data on the Internet the same, and not discriminate or charge differently by user, content, website, platform, application, type of attached equipment, or method of communication.

Measuring Networks

Measuring a network provides a single point-in-time calculation of an attribute of a network.

Why do we measure networks?

- What is expected of our network and what is the reality?

- How can we improve the network?

- Is the user experience acceptable?

Monitoring as long-term measuring

- Monitoring networks provides a constant measurement

- Most monitoring suites provide:

  - Means of collecting measurement results, *push* or *poll*

  - Means of storing this data for a long period of time

  - Means of querying or viewing the data collected

Push vs. poll

Push

- Provides event-driven information
- Requires nodes to be operational
- Usually only one node provides access to the information

Poll

- Monitoring node requests information from each reporting device
- Monitoring node knows when a node is non-responsive
- Allows possibility for any node to be monitor
- Provides more consistent information but uses more bandwidth

Bits & bytes

Bit

- A bit holds only 1 or 0 (*on* or *off*)
- Denoted by a **lower case b** (e.g. b, b/s, bps)

Unit	Definition
b	bit
b/s or bps	bit per second
kb/s or kbps	kilobit per second
Mb/s or Mbps	megabit per second
Gb/s or Gbps	gigabit per second

Byte

- Contains 8 bits
- Denoted by an **upper case B** (e.g. B, B/s, Bps)

Unit	Definition
B	byte
B/s or Bps	byte per second
kB/s or kBps	kilobyte per second
MB/s or MBps	megabyte per second
GB/s or GBps	gigabyte per second

Prefixes

Prefix	Name	Multiplier
k	kilo	1000^1
M	mega	1000^2
G	giga	1000^3
Ki	kibi	1024^1
Mi	mebi	1024^2
Gi	gibi	1024^3

Network metrics

Volume *(bits or bytes)*

- Collected over time

- Sum of all bits/bytes sent and received

- Common tool to keep track of this is `MRTG` (Multi Router Traffic Grapher)

Speed *(bps or Bps)*

- Also called "bandwidth" sometimes

- How much data over a period of time

- Common to test between two points using `iperf3`

Round trip time *(seconds)*

- Commonly called "RTT"
- Time for a packet to reach the destination and back
- Common tool to test this is `ping` or `noping`

Jitter *(seconds)*

- Difference between time packets take to reach the destination

- Usually measured with UDP packets

- Common tool to test this is `iperf3` using UDP packets

Packet loss

- The number of packets that do not reach the destination

- Packets are sometimes re-transmitted, other times ignored

- Common tool to test this is `ping` and `noping`

Speed test

Using speedtest.net, run a speed test with available public WiFi:

- Run speed test from a single device
- Run speed test from two devices simultaneously
- Run speed test from several devices simultaneously

If the speed test is using the full internet connection, each additional user running a speed test should cut the speed for everyone. If it does not, it could indicate:

- Wireless bottleneck
- Server bottleneck
- Per device bandwidth limit

Streaming and monitoring

Cellphone usage

- Identify your apps' data usage
- Record a few of the top apps that used up the most data
    - Was this data transmitted over WiFi or cellular network?

Discuss

- Is cell data worth "more" than WiFi? Why?
- Were you surprised about some of your apps' data usage?

Streaming over WiFi

We will monitor a video stream using `bwm-ng` (Bandwidth Monitor - Next Generation).

After that, we will use `tc` (Traffic Control) to limit the bandwidth available to the stream and observe the effects.

Profiling users

User profiles

In a group, discuss one of the following user profiles:

- Gamer

- Streamer (YouTube, Netflix, etc.)

- Web user with occasional video conferencing calls (web, email, instant messaging, Skype, Hangout, etc.)

User profile considerations

Consider the following in your discussion:

- What are the most used services by the user?

- How would the user be affected if internet access becomes unavailable?

    - What would the user consider as "internet went down"?

    - What is the threshold for the user?

    - Packet loss / poor link quality

    - Latency / ping

    - Bandwidth speed

    - Bandwidth allotment

- Does network traffic trend change throughout the day for the user's connection?

- Look at your local internet provider (Bell, Rogers, etc.), which plan would you suggest for them and why?

- Does wired vs. wireless affect the experience?

Next week

Long-range low-power radio networks using **LoRa technology**