Performance Measurement of Wireless LAN Using Open Source

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Overview

• General Network
  – Why Network Performance Measurement?
  – Network Performance Metrics
  – How Network Performance is Measured?
  – Measurement Methods
    • Ex: Pair Packet
  – Active Probing Tools
    • Ex: Iperf

• Wireless Network
  – Performance Measurement In Wireless LAN
  – PHY / MAC / Higher layer Measurement
  – Measuring Methods and setups

• Effect in Wireless
  – Effect of these Metrics
  – Some Results
Why Network Performance Measurement?

- What are the factors affecting network Performance?
- How this factors affecting Performance?
- Impacts made to the user because of these?
Network performance metrics

- One-Way Delay (OWD)
  - Serialization Delay
  - Propagation Delay
  - Queuing Delay
  - Forwarding Delay
- Round-Trip Time (RTT)
- Delay Variation (Jitter)
- Packet Loss
  - Congestion
  - Errors
- Packet Reordering
- Maximum Transmission Unit (MTU)
- Available Bandwidth (Throughput)
- Link Capacity
- Bandwidth Delay Product (BDP)
How Network Performance is Measured
Measurement Methods

Metric
- Distance
  - Per-hop
  - End-to-End
- Values
  - Bulk Transfer
  - Achievable
  - Bottleneck / Minimum

Methods (Ex: for IP layer)
- Variable Packet Size
- Packet Pairs / Trains
- Self – Loading Periodic Streams
- Parallel Connection
Ex: Pair Packet technique for Capacity

- Two packets of size \( L \) send back to back
- Packets receive with \( \vartheta \) time space dispersion

\[
\text{Time} = \frac{\text{Size} (L)}{\text{Capacity} (C)}
\]

\[
C = \frac{L}{T}
\]

\[
\Delta_{\text{out}} = \frac{L}{C_0}
\]

\[
\Delta_{\text{out}} = \text{Max}(\Delta_{\text{in}}, \frac{L}{C_i})
\]

\[
\text{Dispersion} \ \vartheta = \Delta_{\text{out}} - \Delta_{\text{in}}
\]

\[
\text{Dispersion} \ \vartheta = \text{Max} \left( \frac{L}{C_i} \right)
\]

\[
\text{Min}(C_i) \rightarrow \text{end-to-end Capacity}
\]

\[
\text{Capacity} \ C = \frac{L}{\vartheta}
\]
Active Probing Tools

- Throughput & Delay Measurement Tools
  - Ping
  - Traceroute
  - **Iperf**
  - ThruLay

- Path Characterization & Bandwidth Estimation
  - pathChirp
  - Pathload
  - ABwE
  - Netperf
  - Netttest
Iperf

- **Modes**
  - TCP
  - UDP

- **Components**
  - Server
  - Client

Generate Packet

Receive the packets and send the Report

Network Cloud

P 1

Router

Iperf Client

P 2

Router

Iperf Server
Wireless LAN

- Last Hop Connectivity is Wireless
- Bottleneck will be always at wireless

- What are the Network Parameters that make major effects?
- How it is effecting?
Performance Measurement in WLAN

**PHY Layer**
- Received Signal Power
- Signal To Noise Ratio
- Bit Error Rate
- Throughput
- Interference

**MAC Layer**
- Throughput
- Retries
- Received Data Rate
- Queuing Delay
- Packet Error Rate
- Power Consumption
WLAN PHY / MAC Measurement

Using MAC Packet injecting / and process Tools
- Approximate PHY and MAC Parameters can be Measured
- This depend on the implementation of hardware
- Tools like libmac, netlib-80211b etc
WLAN Phy Signal Measurement

- Wispy + Spectool-GTK (Kismet)
- Information from lower layer (Modified driver)

Courtesy: Kismet
WLAN Higher Layer Measurement

- This is as similar as the normal wired network

- Then what is the difference?

- Parameters
  - Jitter
  - Throughput
Performance Measurement in WLAN

- Performance Measurement
  - P1 in Wireless and P2 in Wired Network
Performance Measurement in WLAN

- Performance Measurement
  - P1 in Wireless and P2 in Wired Network
  - Both P1 and P2 in Wireless
Test Setup

Test Setup diagram showing a Linux laptop connected to an access point. The access point is connected to a commercial off-the-shelf product. The diagram includes the following steps:

1. **Linux Laptop + Iperf / Jperf (P1)**
2. **Access Point**
3. **Commercial off the shelf products**
4. **Linux Laptop + Iperf / Jperf (P2)**

Command details:

- **"Iperf -c <host>"**
  - Iperf -c 192.168.2.73
  - \(-p <num_streams>\) test with parallel TCP streams
  - \(-w <buffer_size>\) set socket buffer size

- **"Iperf -s -D > iperfLog "**
  - Iperf -s -D /var/log/iperfLog
  - Iperf can run as a daemon
Server

Client

Wireless Communication Research Group @ AU - KBC
Jperf (GUI for Iperf)
Bandwidth Graph
Effect of these Metrics

• Major parameters effecting the WLAN
  – PHY
    • Interference
    • RSSI
    • SNR
    • Data Rate
  – MAC
    • Queuing Delay
    • Packet Loss / Errors
    • Available Bandwidth (Throughput)
  – IP
    • Delay Variation (Jitter)
    • Available Bandwidth (Throughput)
Channel Interference

![Graph showing channel interference and throughput as a function of distance between AP 1 and AP 2.](image)

*Courtesy: [3]*
Signal Strength vs. Received Rate

 Courtesy: [2]
Distance Vs Throughput

Throughput Comparison

Throughput (Mbps)

Range (ft)

802.11a

802.11b

Courtesy: Atheros
Thank You

Questions?

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