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# Performance Measurement of Wireless LAN Using Open Source



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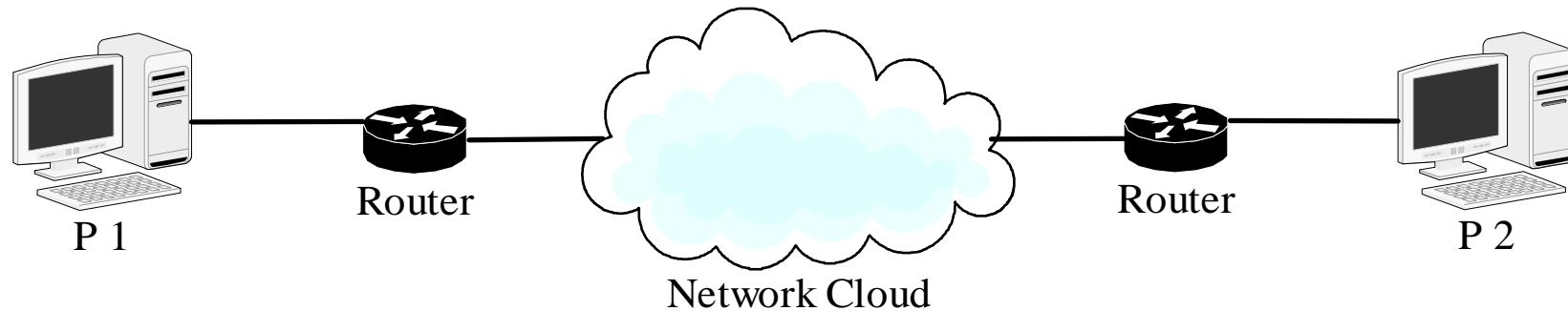
AU – KBC Research Centre

<http://comm.au-kbc.org/>

# 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 ?

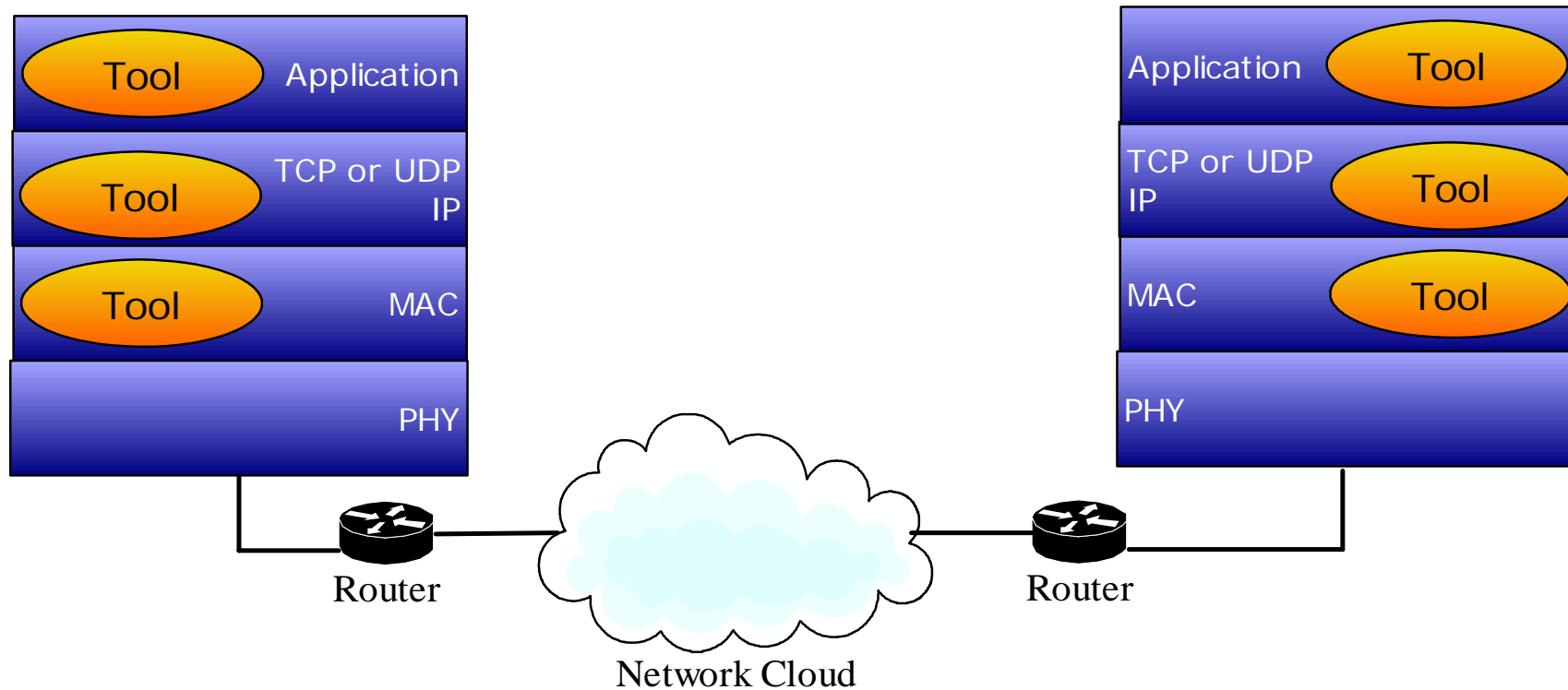
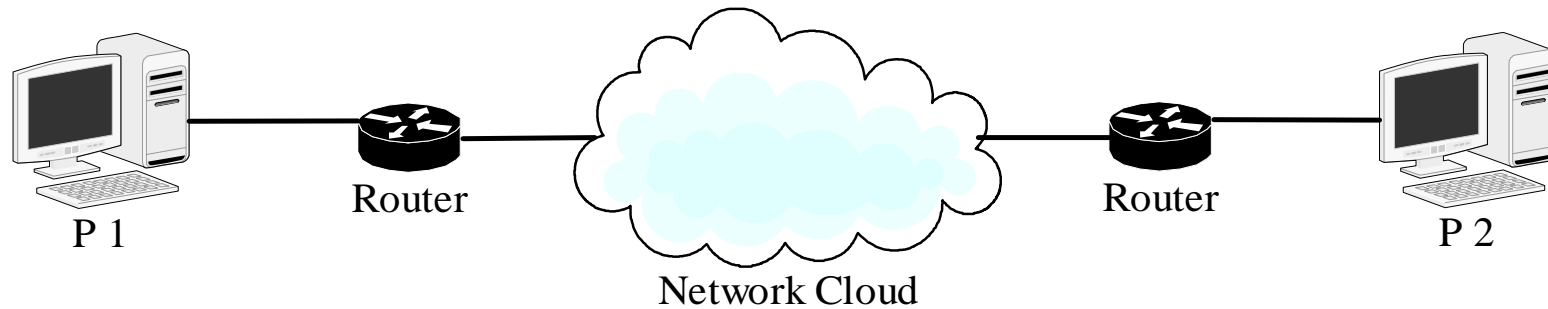


- What are the factors affecting network Performance ?
- How this factors affecting Performance ?
- Impacts made to the user because of these ?

# 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

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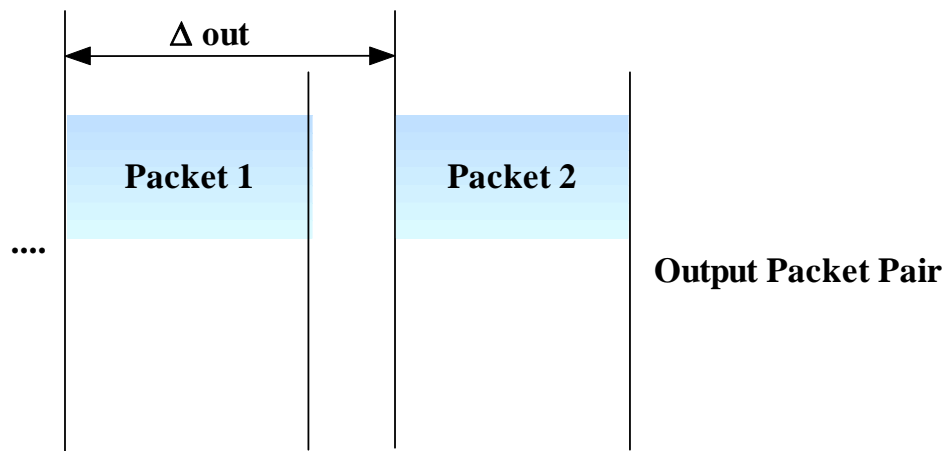
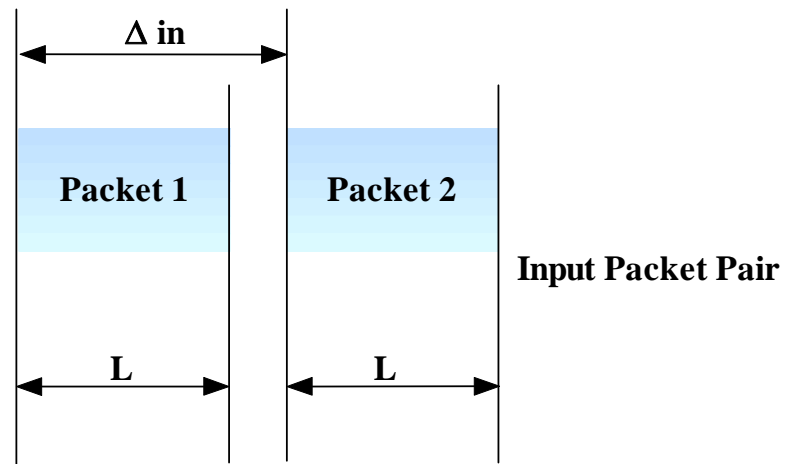
## Metric

- 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 packet of size  $L$  send back to back
- Packets receive with  $\partial$  time space dispersion

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

$$C = L / T$$

$$\Delta_{out} = L / C_0$$

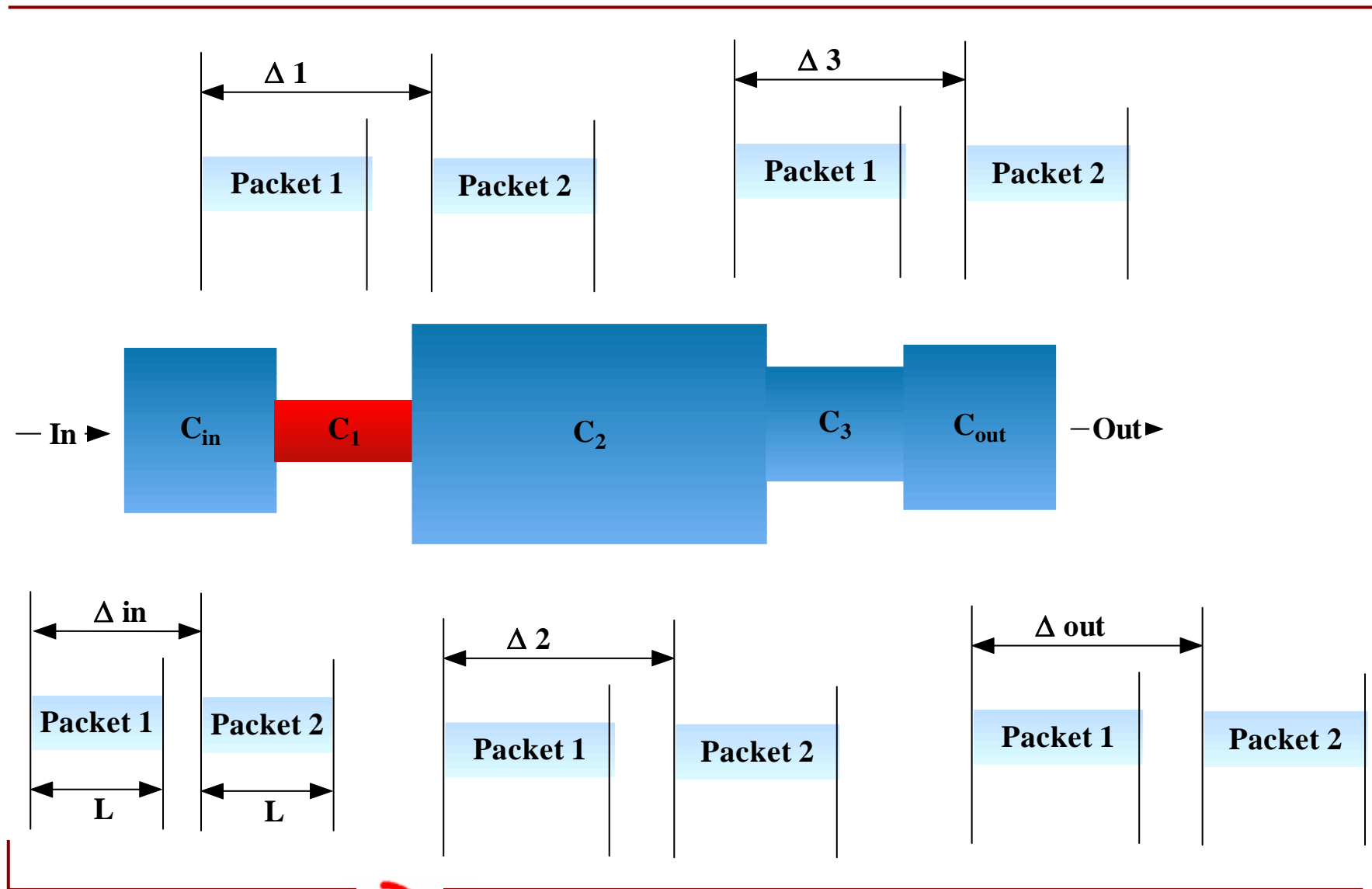
$$\Delta_{out} = \text{Max}(\Delta_{in}, L/C_i)$$

$$\text{Dispersion } \partial = \Delta_{out} - \Delta_{in}$$

$$\text{Dispersion } \partial = \text{Max}(L/C_i)$$

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

$$\text{Capacity } C = L / \partial$$

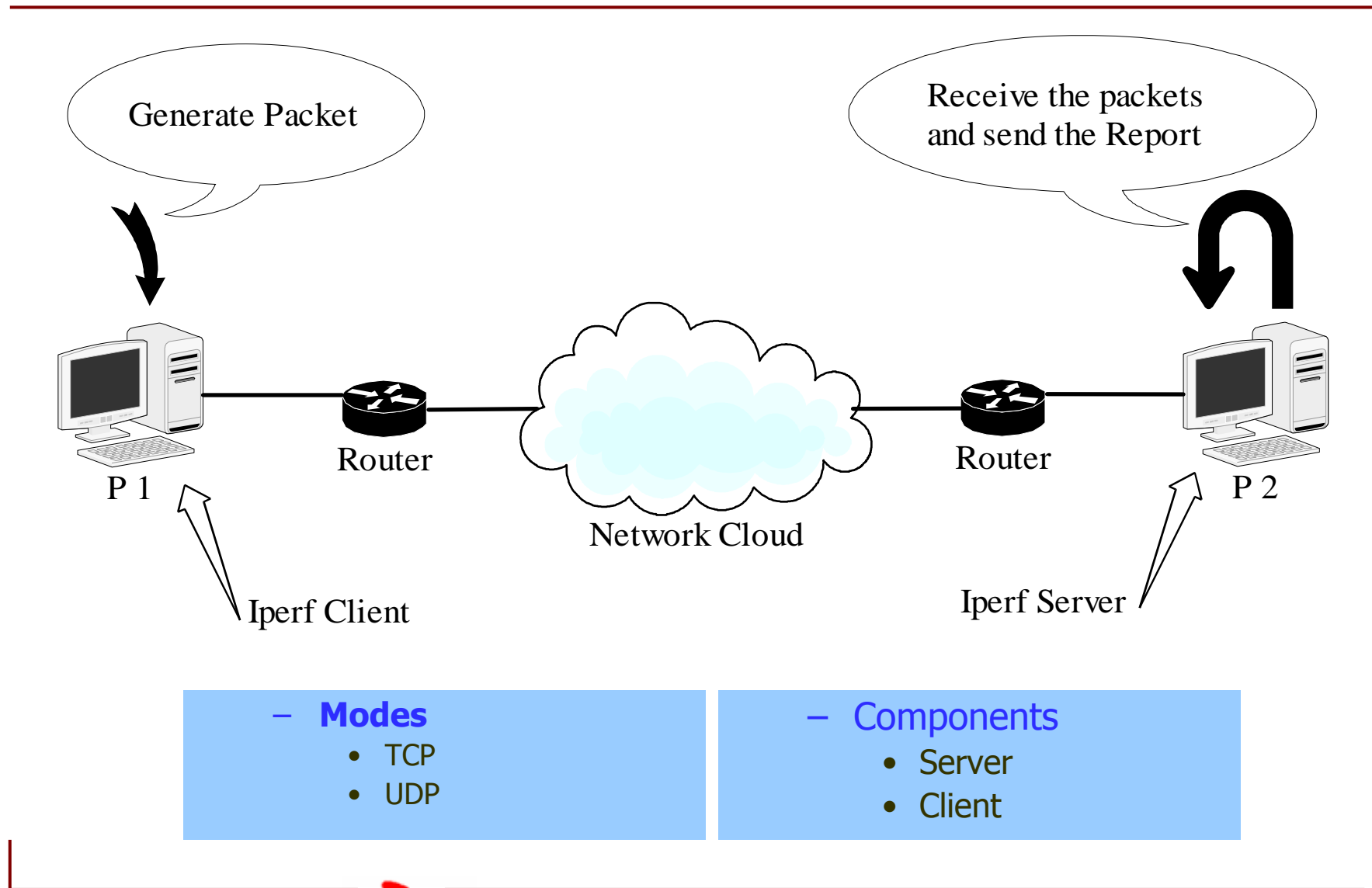


# Active Probing Tools

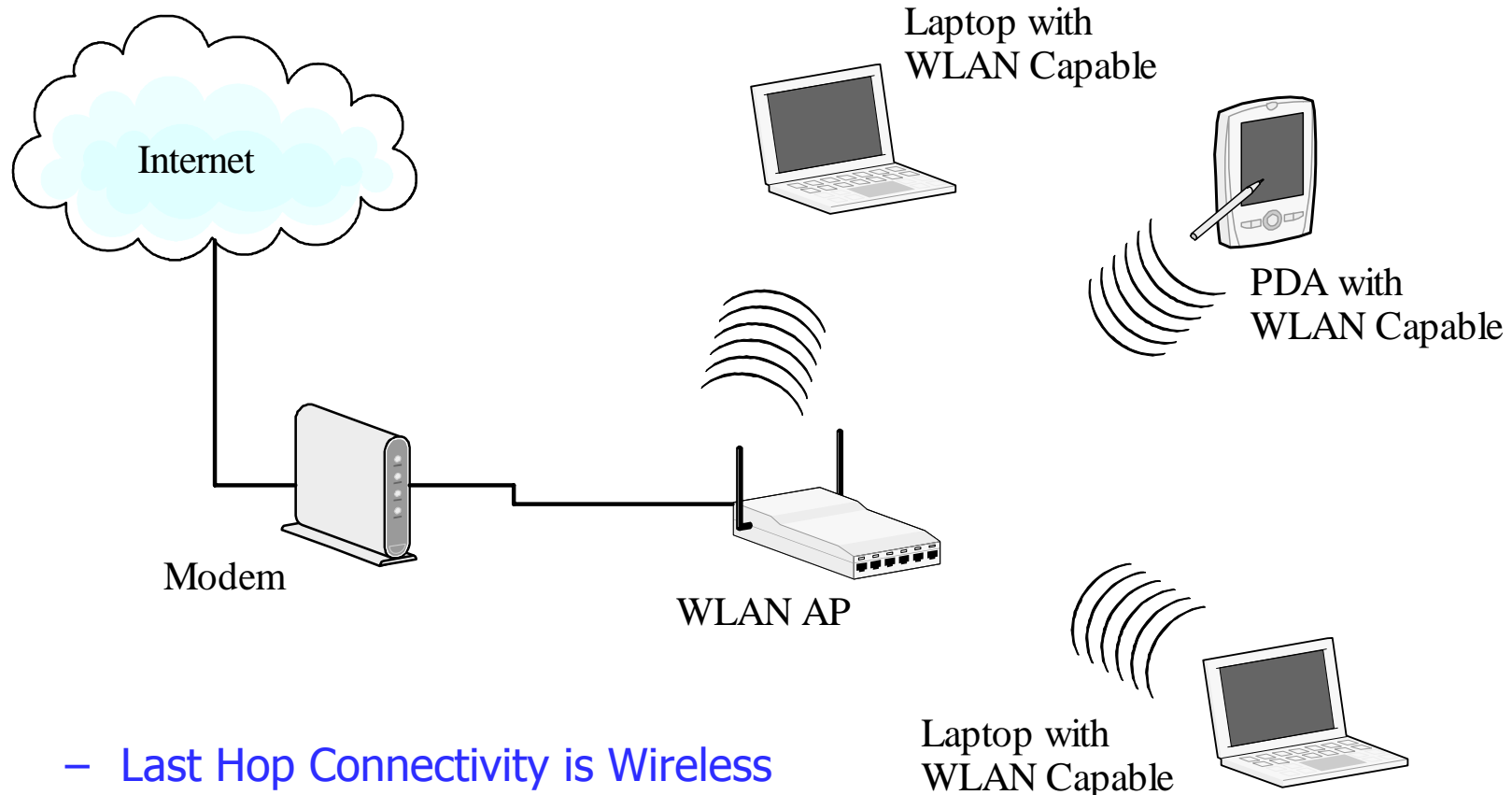
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- Throughput & Delay Measurement Tools
  - Ping
  - Traceroute
  - **Iperf**
  - Thrulay
- Path Characterization & Bandwidth Estimation
  - pathChirp
  - Pathload
  - ABwE
  - Netperf
  - Nettek

# Iperf



# 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

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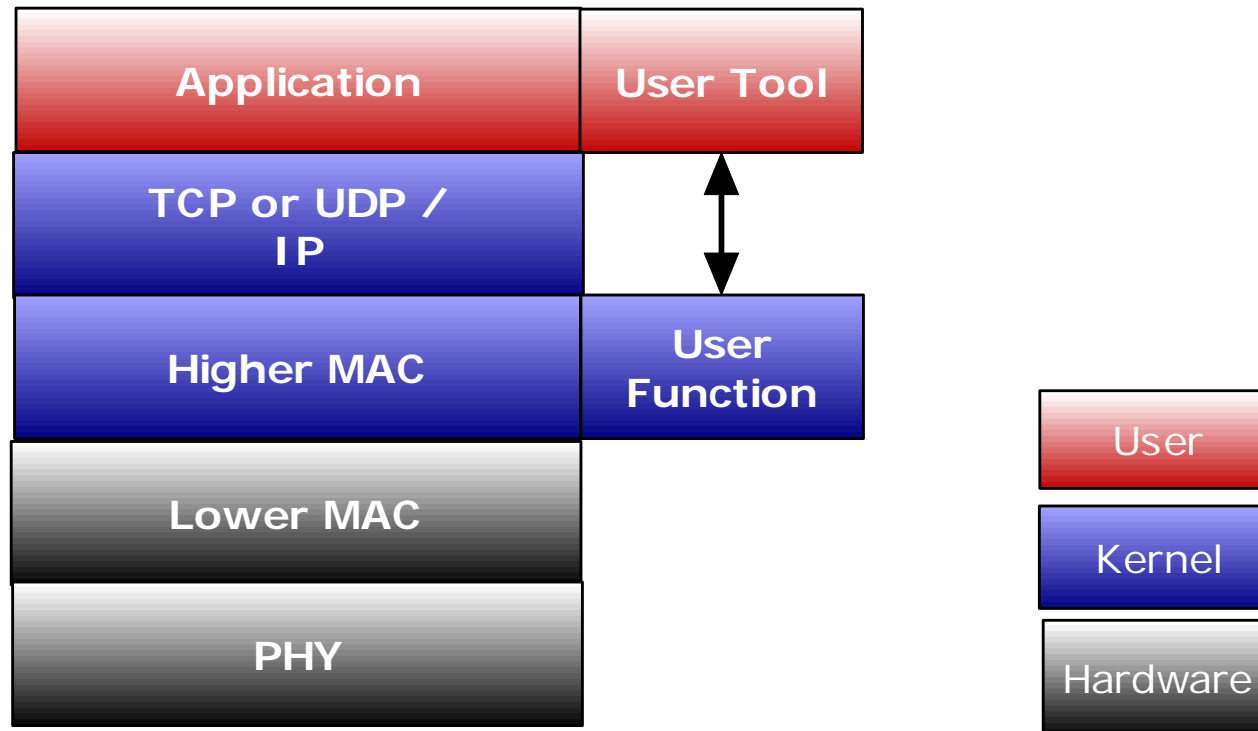
## PHY Layer

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

## MAC Layer

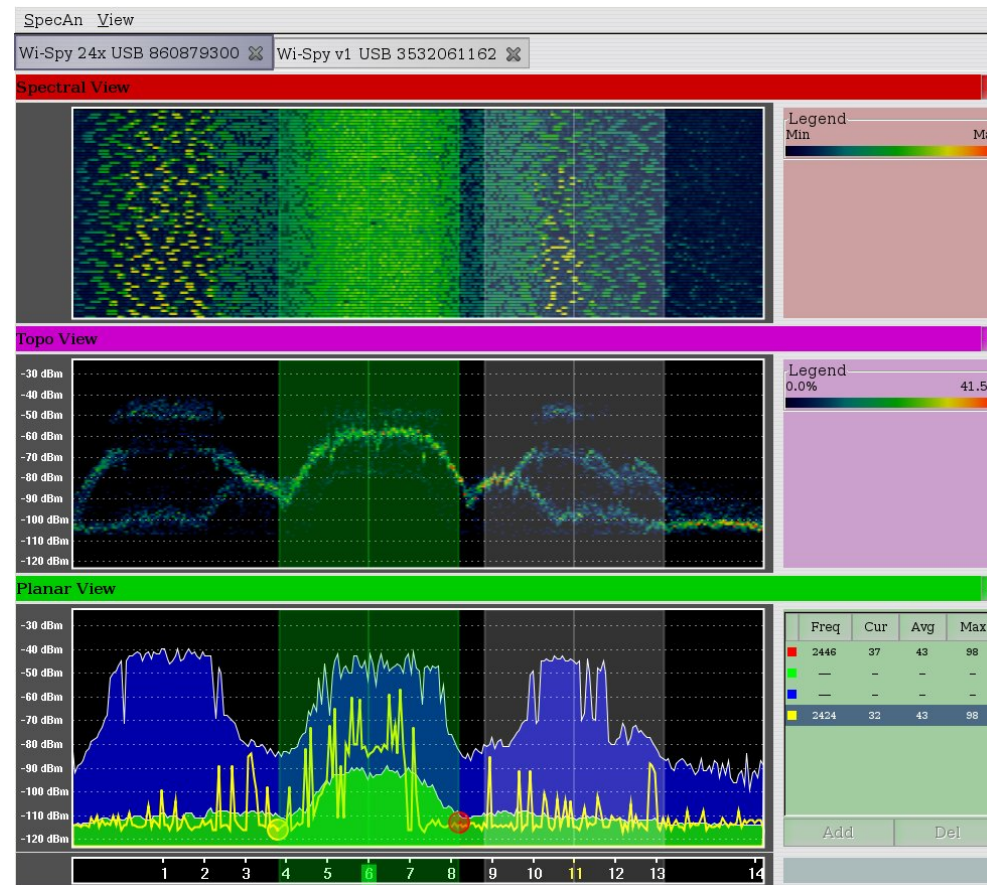
- Throughput
- Retries
- Received Data Rate
- Queuing Delay
- Packet Error Rate
- Power Consumption

# 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



Courtesy : Kismet

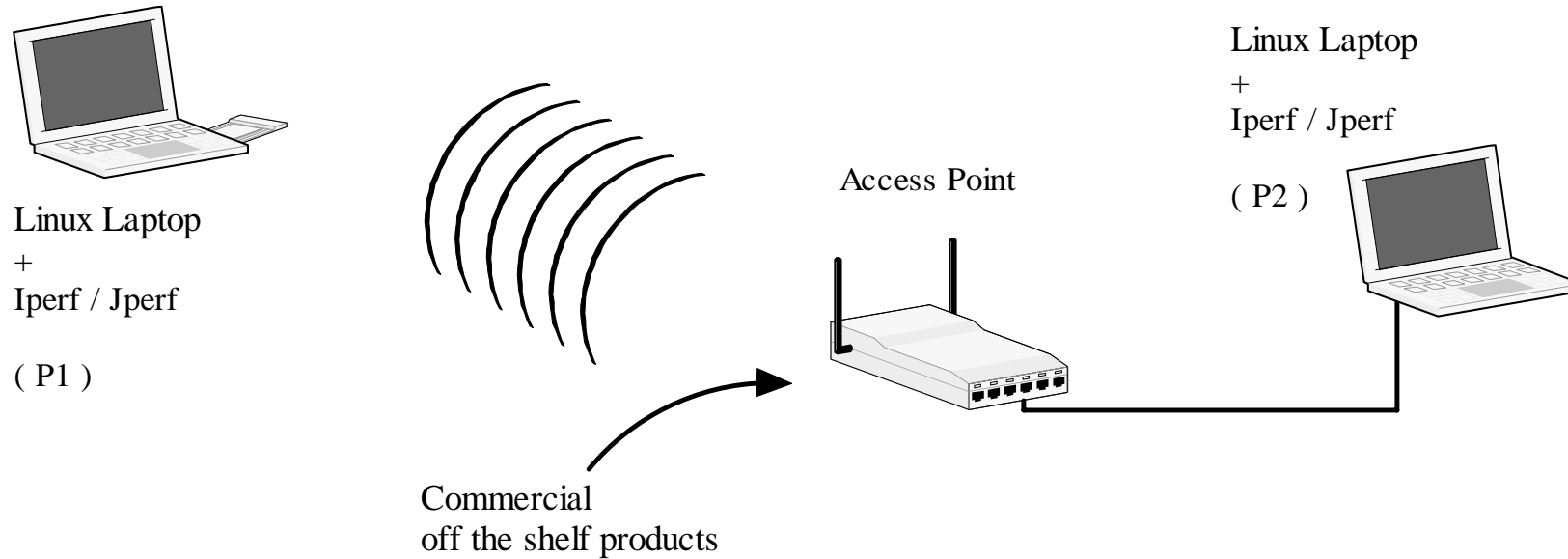
- Wispy + Spectool-GTK (Kismet)
- Information from lower layer (Modified driver)

# WLAN Higher Layer Measurement

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- This is as similar as the normal wired network
- Then what is the difference ?
- Parameters
  - Jitter
  - Throughput

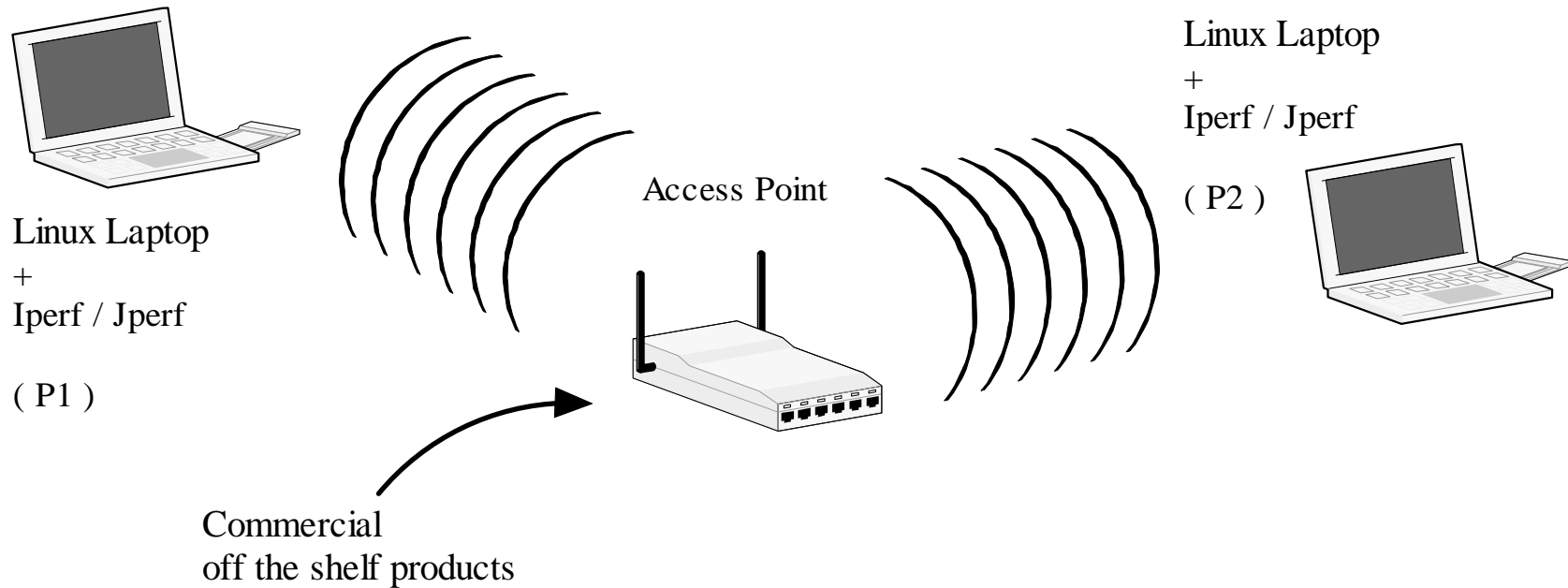
# Performance Measurement in WLAN



## – Performance Measurement

- P1 in Wireless and P2 in Wired Network

# Performance Measurement in WLAN



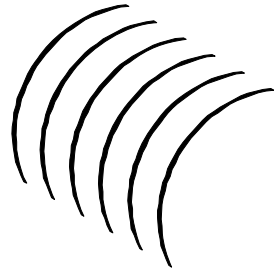
## – Performance Measurement

- P1 in Wireless and P2 in Wired Network
- Both P1 and P2 in Wireless

# Test Setup



Linux Laptop  
+  
Iperf / Jperf  
( P1 )



Access Point



Linux Laptop  
+  
Iperf / Jperf  
( P2 )



Commercial  
off the shelf products

**“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



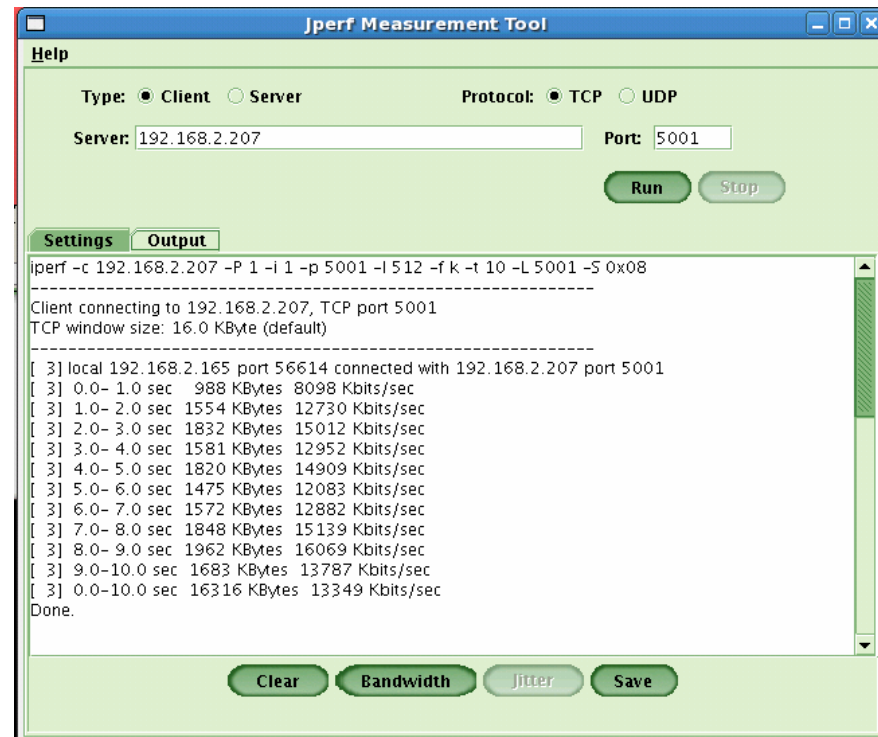
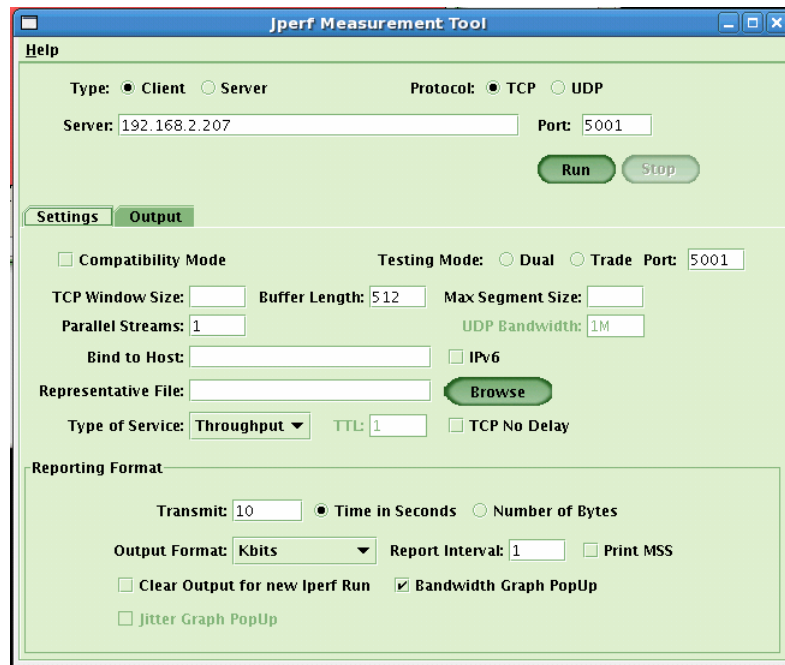
Server

```
designe@server-y:~  
File Edit View Terminal Tabs Help  
[designe@server-y designe]$ iperf -s  
-----  
Server listening on TCP port 5001  
TCP window size: 85.3 KByte (default)  
-----  
[ 4] local 192.168.2.207 port 5001 connected with 192.168.2.165 port 56614  
[ 4] 0.0-10.1 sec 15.9 MBytes 13.3 Mbits/sec
```

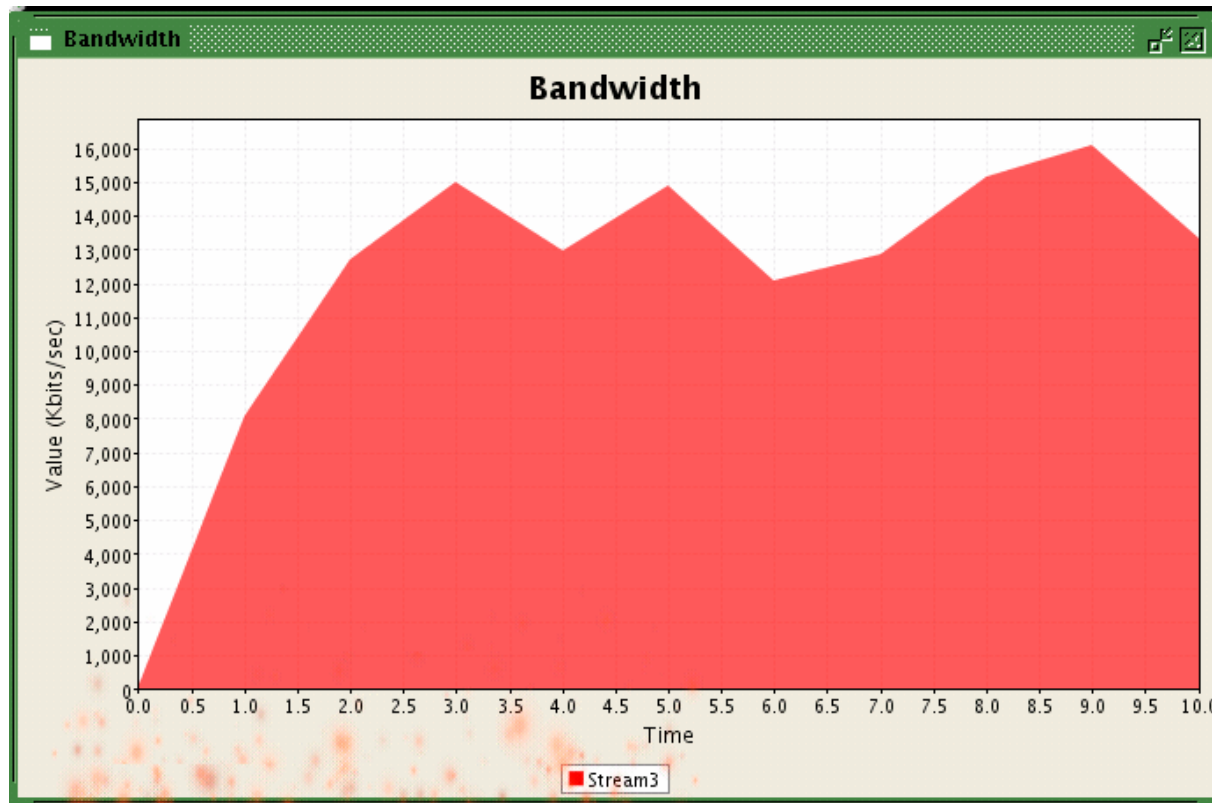
Client

```
root@Cl100:~  
File Edit View Terminal Tabs Help  
[root@Cl100 ~]# iperf -c 192.168.2.207 -P 1 -i 1 -l 512 -t 10 -S 0x08  
-----  
Client connecting to 192.168.2.207, TCP port 5001  
TCP window size: 16.0 KByte (default)  
-----  
[ 3] local 192.168.2.165 port 43675 connected with 192.168.2.207 port 5001  
[ 3] 0.0- 1.0 sec 1.48 MBytes 12.4 Mbits/sec  
[ 3] 1.0- 2.0 sec 1.32 MBytes 11.1 Mbits/sec  
[ 3] 2.0- 3.0 sec 1.38 MBytes 11.6 Mbits/sec  
[ 3] 3.0- 4.0 sec 1.22 MBytes 10.3 Mbits/sec  
[ 3] 4.0- 5.0 sec 1.28 MBytes 10.8 Mbits/sec  
[ 3] 5.0- 6.0 sec 1.46 MBytes 12.3 Mbits/sec  
[ 3] 6.0- 7.0 sec 1.52 MBytes 12.7 Mbits/sec  
[ 3] 7.0- 8.0 sec 1.55 MBytes 13.0 Mbits/sec  
[ 3] 8.0- 9.0 sec 1.28 MBytes 10.8 Mbits/sec  
[ 3] 9.0-10.0 sec 1.42 MBytes 11.9 Mbits/sec  
[ 3] 0.0-10.0 sec 13.9 MBytes 11.7 Mbits/sec  
[root@Cl100 ~]#
```

# Jperf (GUI for Iperf)



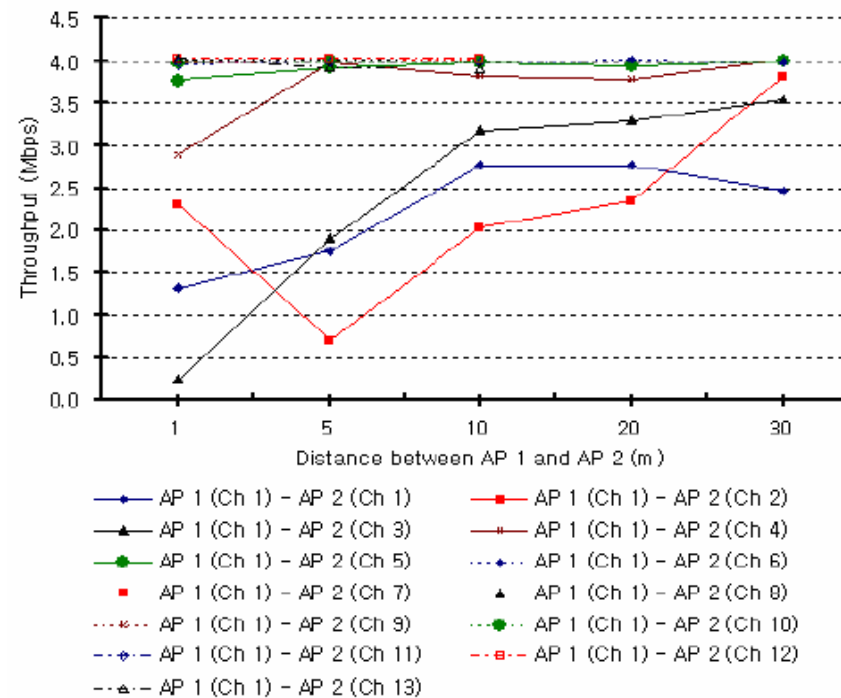
# Bandwidth Graph



# Effect of these Metrics

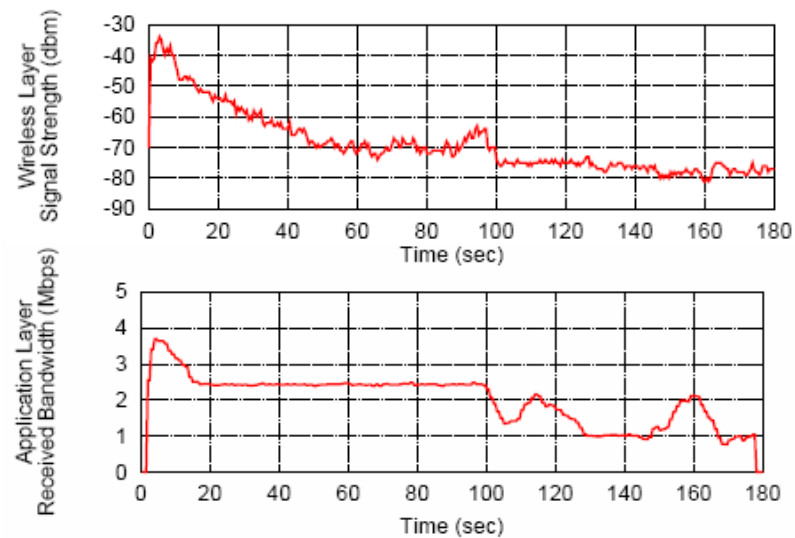
- Major parameters effecting the WLAN
  - PHY
    - Interference
    - RSSI
    - SNR
    - Data Rate
  - MAC
    - Queuing Delay
    - Packet Loss / Errors
    - Available Bandwidth ( Throughput )
  - IP
    - Delay Variation (Jitter)
    - Available Bandwidth ( Throughput )

# Channel Interference



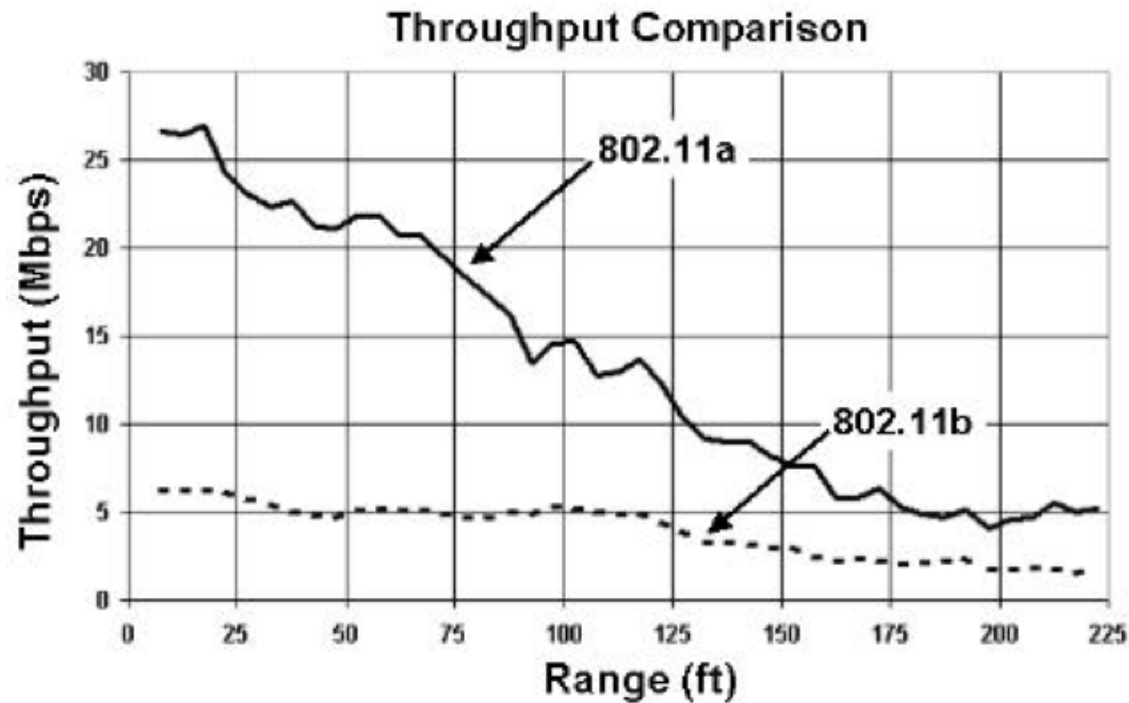
Courtesy : [3]

# Signal Strength vs. Received Rate



Courtesy : [2]

# Distance Vs Throughput



Courtesy : Atheros

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# Thank You

Questions ?

Contact : [vipintm@au-kbc.org](mailto:vipintm@au-kbc.org)

# Reference

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