# MeshDriver - Performance Test Results


## Abstract

Test results of various performance tests done using MeshDriver-enabled access points.




MeshDriver is available for downloading at EmbedOne website http://embedone.com

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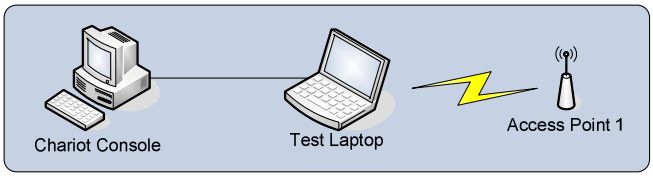
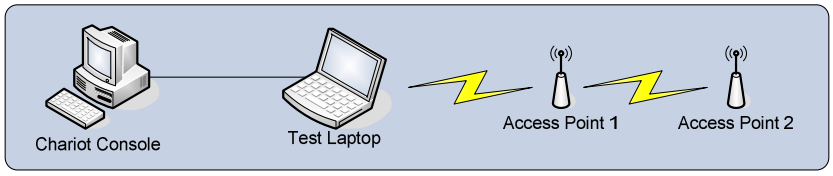
# 1. Test Overview

These tests were performed using a network consisting of one to four Linksys WRT54GL access points ("nodes") with MeshDriver installed and one laptop. IxChariot software was used for the performance evaluation. The access points are equipped with only one radio, which greatly limits the performance of the network.

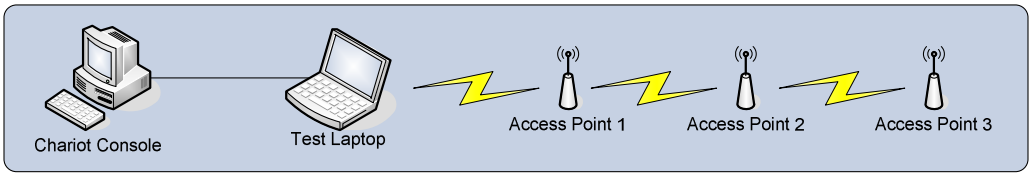
The nodes were configured to function in ad hoc mode, where all of them are in the same frequency. They were physically located near each other, and whitelist configuration was used to set them up in a chain (see below). Test laptop and the nodes were arranged in four different setups with different number of nodes in them. The access points are equipped with relatively low-power Broadcom BCM5352EKPBG chipset.



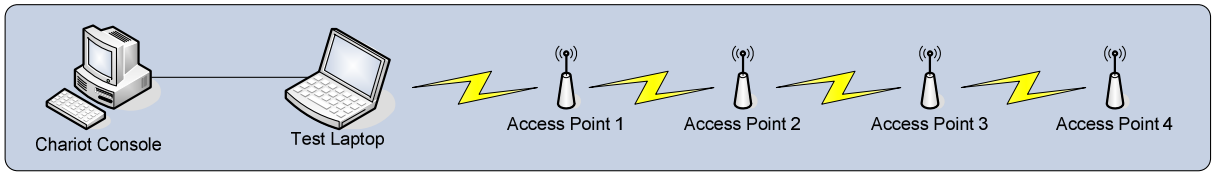

Setup 1




Setup 2




Setup 3




Setup 4

The test laptop was running Windows XP with IxChariot Console version 6.40. The access points were running IxChariot Endpoint 6.40. The tests were performed in uncontrolled radio environment.

# 2. Maximum throughput test

The maximum throughput from test laptop to the highest numbered access point (Access Point 1 in Setup 1, … Access Point 4 in Setup 4) was measured. In addition to the throughput, CPU load was measured.

| | Setup 1 (1 hops) | Setup 2 (2 hops) | Setup 3 (3 hops) | Setup 4 (4 hops) |
|---|---|---|---|---|
| **Throughput** | 13.2 | 7.4 | 4.2 | 3.5 |
| **CPU load** | 83 | 70 | 54 | 45 |

Table 1. Maximum throughput without encryption

| | Setup 1 (1 hops) | Setup 2 (2 hops) | Setup 3 (3 hops) | Setup 4 (4 hops) |
|---|---|---|---|---|
| **Throughput** | 4.1 | 2.5 | 2.2 | 2 |
| **CPU load** | 90 | 70 | 60 | 65 |

Table 2. Maximum throughput with software CCMP encryption

As can be seen from the tables, software encryption performed on processor with inadequate performance decreases the maximum bandwidth. If performed on high-power processor, the throughput values are similar to unencrypted maximum.

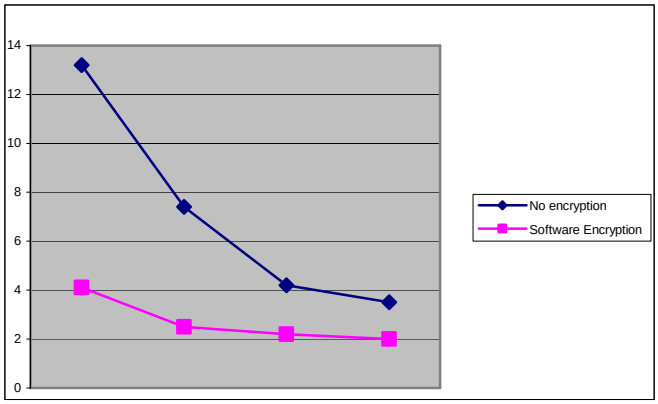



Chart 1. Throughput (Mb/s) with 1 to 4 hops.

In the following two charts, throughput over 10 minutes is presented with three hops.

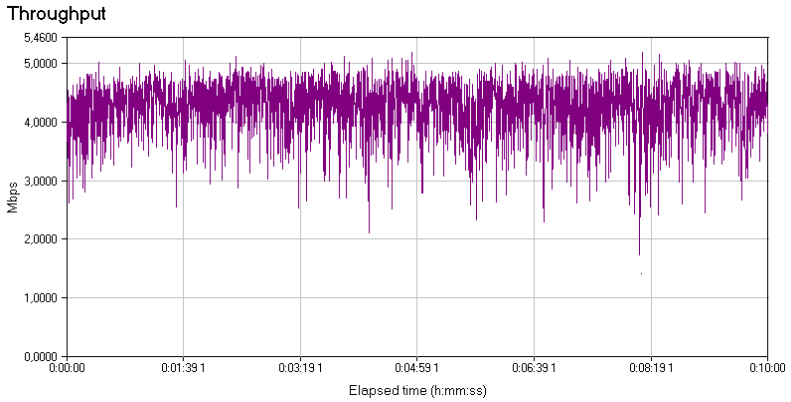



Chart 2. Throughput with 3 hops and no encryption

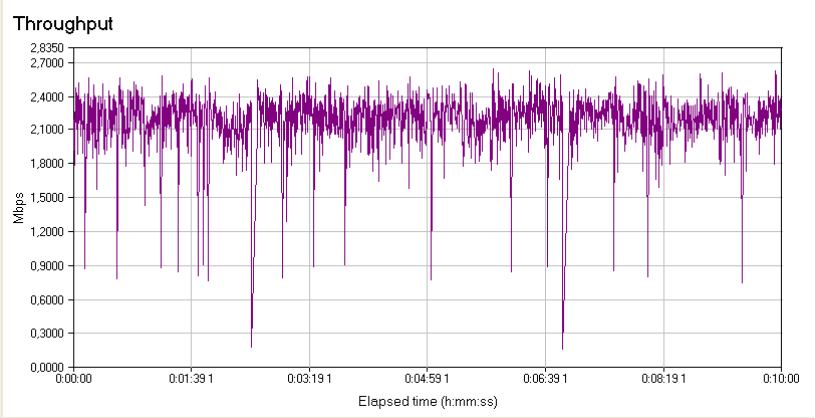



Chart 3. Throughput with 3 hops and software encryption enabled

## 3. Response time test

Response times from laptop to the node most far away was also measured under no load in the network. Response time was measured 4 times and the minimum was recorded, because the test was performed in uncontrolled radio environment and other wireless devices interfering with the test network cause retransmissions.

| | Setup 1 (1 hops) | Setup 2 (2 hops) | Setup 3 (3 hops) | Setup 4 (4 hops) |
|---|---|---|---|---|
| **No encryption** | 5 | 9 | 13 | 19 |
| **Software CCMP** | 17 | 27 | 30 | 33 |

Table 3. Response times

Response times were measured with software encryption disabled and enabled. As can be seen from the table, encryption adds some latency (<20 ms with 1 to 4 hops).

## 4. VoIP test

Voice over IP traffic was simulated using the IxChariot software. Voice over IP G.711u call success was measured with 1 to 6 simultaneous calls. MOS average and minimum values were recorded.

MOS measures the perceived call quality on the scale of 1 to 5, where 1 is the lowest perceived quality and 5 is the highest possible quality. The codec selection affects the quality as well and the MOS for selected G.711 codec is 4.1 – therefore under no circumstances the quality can be better than 4.1 regardless of the network being used.

Once again it should be noted that the tests were done in uncontrolled radio environment and therefore the minimum values can be caused by external radio interference and do not represent typical operation.

| | Setup 1 (1 hops) | Setup 4 (4 hops) |
|---|---|---|
| **1 call** | 4.18 (3.21) | 3.98 (2.81) |
| **2 calls** | 4.13 (2.38) | 4.06 (2.53) |
| **3 calls** | 4.15 (3.21) | 4.04 (1.72) |
| **4 calls** | 4.07 (2.81) | 3.97 (2.34) |
| **5 calls** | 4.10 (3.23) | 4.07 (2.80) |
| **6 calls** | 4.11 (3.70) | 4.00 (2.80) |

Table 4. VoIP MOS average (minimum), unencrypted traffic

As can be seen from the table, with up to 6 calls, the MOS average is equally good with even 4 hops.

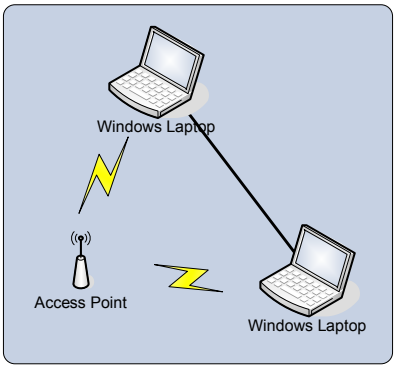
| | Setup 1 (1 hops) | Setup 2 (2 hops) | Setup 3 (3 hops) | Setup 4 (4 hops) |
|---|---|---|---|---|
| **1 call** | 4.14 (3.21) | 4.03 (1.00) | 3.87 (1.00) | 3.99 (2.53) |
| **2 calls** | 4.09 (2.82) | 4.05 (2.43) | 4.10 (2.82) | 4.00 (2.80) |
| **3 calls** | 4.06 (2.42) | 3.91 (1.00) | 4.03 (1.00) | 3.65 (2.09) |
| **4 calls** | 4.02 (2.61) | 4.11 (2.83) | 4.04 (2.22) | 3.80 (1.00) |
| **5 calls** | 3.86 (2.34) | 3.99 (1.00) | 3.93 (1.00) | 3.76 (2.66) |
| **6 calls** | 3.90 (2.36) | 3.80 (1.00) | 3.73 (1.00) | 3.69 (1.00) |

Table 5. VoIP MOS average (minimum), encrypted traffic

With encryption enabled, some performance degradation can be seen with large number of simultaneous calls.

## 5. Handover test

Handover delay was measured using three nodes: Windows laptop, Linux laptop and a Linksys WRT54GL access point. The nodes were connected in a triangle manner. Windows and Linux laptops were connected with Ethernet cable and both were connected wirelessly to the access point.




File transfer IxChariot test was run between Windows and Linksys. During the test the radio on Windows laptop was turned off (and on again later). When the radio was turned off there was a gap in transfer rate for maximum of 5 seconds. When the radio was turned back again, there was no visible change in transfer rate.