



Trial Test Report  
on  
3.5GHz WiMAX Based  
Broadband Wireless Access Technology

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## **Objective**

1. Testify the performance of a trial broadband wireless access (BWA) network, working at 3.4 ~ 3.6 GHz frequency spectrum, covering long distance and under line-of-sight (LOS) and non-line-of-sight (NLOS) conditions.
2. Testify NGN applications on a trial broadband wireless access (BWA) network.
3. Testify Internet services on a trial broadband wireless access (BWA) network.

## **Introduction**

A trial implementation of the IEEE 802.16 standard, WiMAX (Worldwide Interoperability for Microwave Access) based wireless technology providing metropolitan area network connectivity in sub-urban areas of Hong Kong has been completed in September of year 2005. Two building rooftop sites at Tuen Mun and Tung Chung had been selected in this trial implementation.

This trial implementation aims to testify the throughput of the tested system in a point-to-multi-point network covering long distances and in LOS and NLOS conditions. Performance test of NGN and Internet applications and services had been carried out on this network. Results are summarized in coming sections.

## **Field Trial Locations**

Tuen Mun (Sam Shing) was selected as the base station location with the Access Unit installed. A 6Mbps broadband Internet access connectivity was subscribed for IP connectivity to the NGN platform.

Tung Chung (Hing Tung), SU Location 1, approximately 11 km, LOS, away from Tuen Mun (Sam Shing), was selected as a CPE location with the Subscriber Unit installed.

Tuen Mun (Pillar Point), SU Location 2, approximately 1.5 km, LOS, away from Tuen Mun (Sam Shing), was selected as a CPE location with the Subscriber Unit installed.

Tuen Mun (Pillar Point), SU Location 2, approximately 1.5 km, NLOS, away from Tuen Mun (Sam Shing), was selected as a CPE location again with the Subscriber Unit installed.

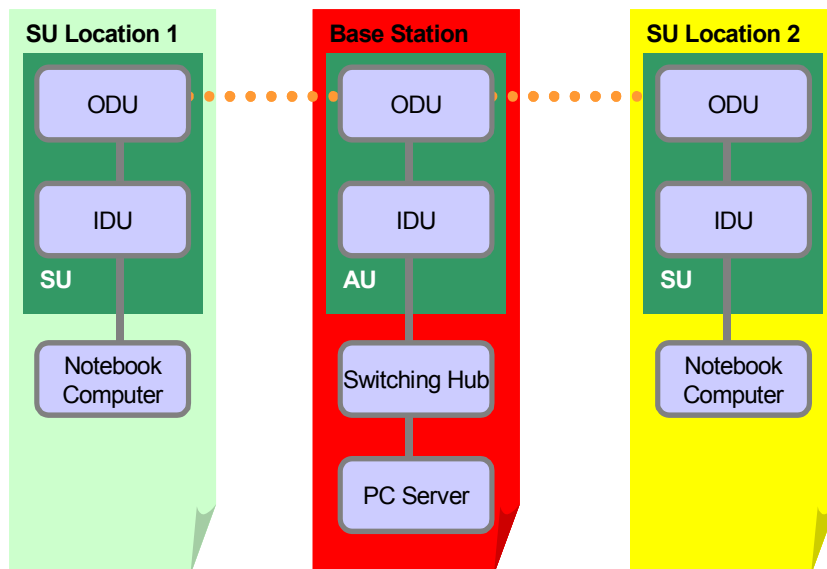


### Throughput, SNR and RSSI Test Setup

TCP and UDP throughput test had been carried out in the network at two CPE locations:

1. SU Location 1 : Tung Chung (Hing Tung)
2. SU Location 2 : Tuen Mun (Pillar Point).

With the aids of the built-in system tool and a 3<sup>rd</sup> party software tool, the throughput, SNR and RSSI figures are obtained and summarized below sections.



## Equipment List

1. Access Unit with 90° Outdoor Unit (ODU) x 1
2. Subscriber Unit (SU) with 9° Outdoor Unit (ODU) x 2
3. Indoor Unit (IDU) x 2
4. 100BaseT Switching Hub x 1
5. Notebook computer (Windows 2000 Professional loaded) x 1
6. PC Server (Linux loaded) x 1

## Software Tools

1. i-Perf (version 1.7.0)
2. System Performance Monitoring Tools

## Throughput, SNR and RSSI Measurements with 1 connection

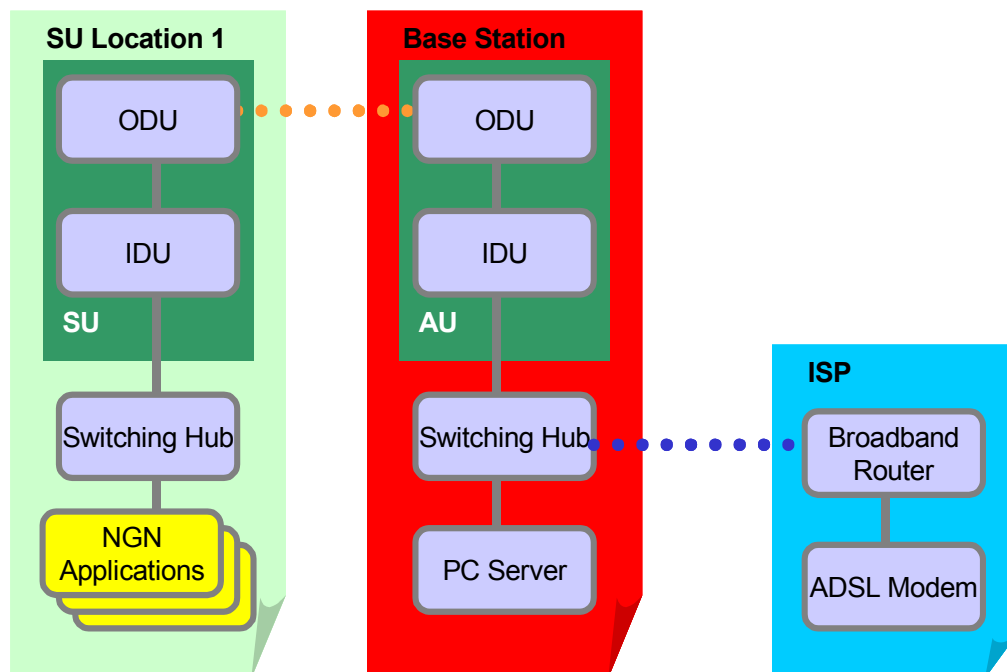
SU Location	1	2	2
Direction	LOS	LOS	NLOS
Weather Condition	Fine but Hazy	Fine but Hazy	Fine but Hazy
Estimated Distance	11 km	1.5 km	1.5 km
Round Trip Delay	26 ms ~ 33 ms	32 ms ~ 40 ms	32ms ~ 36ms
TCP window size	48 KByte	48 KByte	48 KByte
UDP buffer size	64 KByte	64 KByte	64 KByte
Number of Connection	1	1	1
TCP Throughput	Max. ~8.0 Mbit/s	Max. ~8.3 Mbit/s	Max. ~4.5 Mbit/s
UDP Throughput	Max. ~8.4 Mbit/s	Max. ~8.4 Mbit/s	Max. ~10.5 Mbit/s
Modulation Type	QAM 64	QAM 64	QAM 64
SNR	~ 34 dB	~ 32 dB	~ 32 dB
RSSI	~ -65 dBm	~ -66 dBm	~ -65 dBm

## Throughput, SNR and RSSI Measurements with 5 parallel connections

SU Location	1	2	2
Direction	LOS	LOS	NLOS
Weather Condition	Fine but Hazy	Fine but Hazy	Fine but Hazy
Estimated Distance	11 km	1.5 km	1.5 km
Round Trip Delay	26 ms ~ 33 ms	32 ms ~ 40 ms	32ms ~ 36ms
TCP window size	48 KByte	48 KByte	48 KByte
UDP buffer size	64 KByte	64 KByte	64 KByte
Number of Connection	5	5	5
TCP Throughput	Average ~1.21 Mbit/s per connection	Average ~1.16 Mbit/s per connection	Average ~1.23 Mbit/s per connection
UDP Throughput	Average ~1.71 Mbit/s per connection	Average ~1.61 Mbit/s per connection	Average ~1.72 Mbit/s per connection
Modulation Type	QAM 64	QAM 64	QAM 64
SNR	~ 34 dB	~ 32 dB	~ 32 dB
RSSI	~ -65 dBm	~ -66 dBm	~ -65 dBm

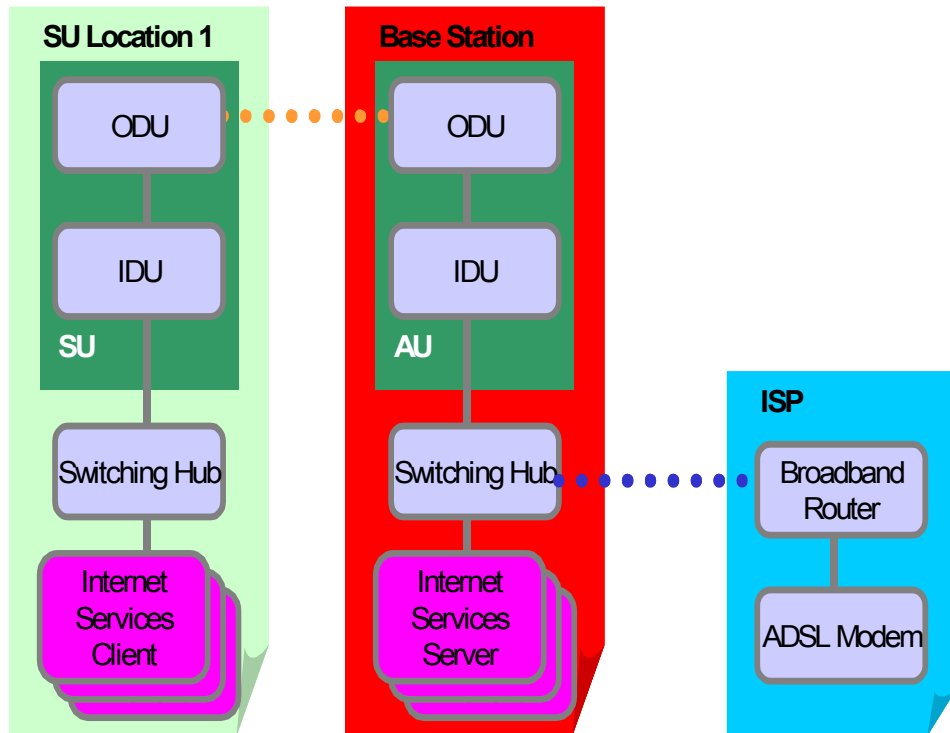
## NGN Application Test

Several NGN CPEs were installed in Tung Chung (Hing Tung). The CPEs connected to NGN platform through the WiMAX network and the ISP. Perceptual call-through test were carried out. Results are generally acceptable that all tested IP phone CPEs function properly.



## Internet Service Test

Server-client network structure had been setup in Tuen Mun (Sam Shing) and Tung Chung (Hing Tung) with a LINUX server loaded with HTTP, FTP, DNS, DHCP, POP3 and SMTP services. It simulated a small-scale ISP operation on the WiMAX network. All services on HTTP, FTP, DNS, DHCP, POP3, SMTP are tested with positive results.



## **Conclusion**

Installation procedure of the trial system is not labor-intensive and simple. SNR, RSSI and transmission power can be monitored through its built-in maintenance console interface in real-time manner.

Theoretically, WiMAX technology can provide coverage in both LOS and NLOS conditions. NLOS has many implementation advantages that enable operators to deliver broadband data to a wide range of customers. In this trial, throughput performance with one connection in short-haul (1.5 km) and long-haul conditions (11 km) showed no significant difference. A maximum of 8.4 Mbit/s data rate can be achieved. However, in NLOS condition, even it was in short-haul condition, TCP throughput performance degraded by half. With the simulation of 5 connections, results showed no significant difference on the average throughput rate in both LOS and NLOS conditions. Throughout all the tests, modulation type maintained as QAM64, no adaptive modulation had been observed.

As WiMAX is a broadband wireless access technology providing metropolitan area network connectivity, all NGN and Internet applications and services should work on this network. The technology has the potential to provide high speed Internet access services without traditional wire-lined plant and can deploy services fast to market.