Report on DVB-H Mobile TV Trial

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1 INTRODUCTION

DVB-H (Digital Video Broadcasting for Handheld) is one of the technology standards for the transmission of digital TV to handheld receivers such as mobile phones or PDAs. Published as an international open standard by ETSI, it is a physical layer specification designed to enable the efficient delivery of IP-encapsulated data over terrestrial networks. DVB-H is defined based on DVB-T standard with additional enhancements to improve performance of mobile reception and power consumption. The key technology enhancements are 4K mode and in-depth interleavers, time slicing and additional forward error correction (FEC).

In order to explore alternative technology to provide TV service to mobile customers in Hong Kong, PCCW teamed up with Motorola to set up an end-to-end trial DVB-H system network in Quarry Bay area of Hong Kong. The aim was to evaluate the performance of DVB-H service deployment in this highly dense urban city environment.

For terrestrial TV reception, high power hill top transmitter sites are usually deployed to provide wide area coverage. At the receiving end, high gain TV antennas are usually mounted on building rooftops, having direct line of sight path to the transmitting stations. Moreover, the received signal can be further amplified by wideband booster or channel amplifier if necessary.

In contrast, DVB-H needs to operate under a much harsher radio propagation condition than terrestrial TV. Users will treat it as part of the mobile services and expect to enjoy mobile TV in any location; typically in non line of sight and indoor environments. In addition, due to physical limitations, the antenna gain on DVB-H device is much lower than its terrestrial counterpart. In a dense urban city like Hong Kong packed with high-rise buildings, it is believed that the existing broadcasting infrastructure alone might not be able to provide the required coverage that is comparable to mobile phone services. For commercial deployment of DVB-H service, majority of transmitter stations are expected to be located on rooftop of buildings in urban area, and hence the configuration of rooftop sites was selected for this trial.

The trial was run from September 2006 to March 2007. Three DVB-H transmitter stations were setup in the Quarry Bay district. Tests and measurements were performed, which included reception in outdoor, indoor and vehicular environments, verification of system service, and assessment on interference to analogue TV. The results are summarized in this document.

2 TRIAL OBJECTIVES

The main objectives for this DVB-H mobile TV trial are:

(1) To understand the technology and system architecture;

(2) To assess radio coverage and performance of DVB-H in:
- Outdoor dense urban environment;
- Indoor environment, especially surrounded by high-rise buildings with reinforced concrete construction and metallized glass windows;
- Mobile environment where user uses the service in moving vehicle;

(3) To test and verify various functions provided by the system;

(4) To assess the risk of interference for DVB-H signal on the reception of analogue TV.

3 SYSTEM OVERVIEW / TRIAL CONFIGURATION

3.1 CELL SITE LOCATIONS

The field trial was conducted in Quarry Bay district along King's Road and Taikoo Place. The area resembles a typical Hong Kong urban environment and has a mix of commercial and residential areas.

DVB-H transmitters were installed at three locations – Somerset House (T1), Wing Wah Industrial Building (T2) and North Point Industrial Building (T3), and they operated in single frequency network (SFN) mode.

Each trial site had one to four antennas to provide radio coverage within the trial area. The head-end equipment was installed at Chai Wan and the content was delivered to the sites through a fibre distribution network.

3.2 SYSTEM COMPONENTS

The trial system was consisted of Headend System, Fibre Distribution Network and Radio Sites and DVB-H handsets.

The Headend System was composed of:

- H.264 video encoders
- Ethernet switches
- ASI converters
- IP encapsulator and manager
- MIP inserter
- Encryption and Conditional Access server (M-Secure)
- Electronic Service Guide (ESG) server

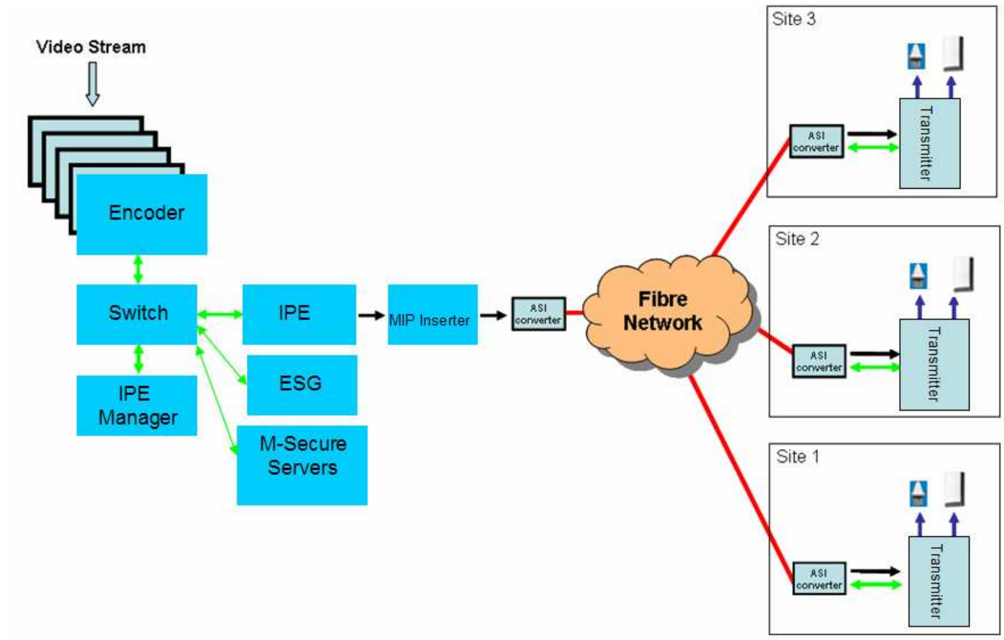
The Fibre Distribution Network was composed of:

- ASI converters
- Ethernet switches
- Fiber network

Each Radio Site was composed of:

- ASI converter
- DVB-H transmitter
- GPS antenna
- Vertically polarized UHF broadcast antenna(s)
- Splitters and surge arresters
- Cable and feeders

A number of DVB-H GSM handsets were used as receiving terminals.



3.3 GENERAL TEST CONFIGURATION

Below is a summary of the major technical parameters of the trial:

Effective Radiated Power	100W ERP per antenna
Frequency	682MHz (UHF channel 47)
Bandwidth	8MHz non hierarchical modulation
DVB-H Network	Single frequency network (SFN)
Video & Audio Format	H.264 & AAC
DVB-H Parameters	Mode: 4K and 8K Modulation: QPSK and 16QAM Guard Interval: ¼ Code Rate: ½ and ¾ In-depth Interleaving
TV Channels	11 to 21 live streaming TV channels depending on the modulation scheme selected
Service Content	Linear channels of news, infotainment, sports, and general entertainment genres

4 TRIAL RESULTS

4.1 RADIO COVERAGE AND PERFORMANCE OF THE SYSTEM

4.1.1 Outdoor performance – stationary reception under different modulation schemes

The objective of the test was to evaluate the performance and coverage of different modulation schemes (as shown in the table). The test was conducted at outdoor environment in Quarry Bay area. Measurements were taken at 20 stationary test points and all test points had no direct line of sight to any transmitter antenna (i.e. NLOS condition).

Four different DVB-H modulation schemes were tested, with GI = ¼ and in-depth interleaving.

Mode	**1**	**2**	**3**	**4**
Modulation	QPSK	QPSK	QPSK	16QAM
Code Rate	½	⅔	¾	½

The Carrier to Noise ratio (C/N) measurement results, as logged on the DVB-H handsets, at the 20 stationary test points, are summarized below.

Stationary Test Location	**Mode 1 QPSK CR ½ C/N (dB)**	**Mode 2 QPSK CR ⅔ C/N (dB)**	**Mode 3 QPSK CR ¾ C/N (dB)**	**Mode 4 16QAM CR ½ C/N (dB)**
1	15.28	15.93	15.95	15.13
2	10.39	12.67	9.92	12.28
3	14.09	17.08	14.77	14.41
4	17.66	15.96	14.31	16.11
5	14.09	13.65	14.21	13.74
6	15.40	14.77	16.20	16.74
7	18.98	17.60	18.39	20.31
8	19.57	19.59	20.17	21.21
9	10.98	12.64	11.85	11.63
10	6.43	6.34	4.93	8.33
11	10.22	13.58	10.43	10.74
13	10.89	10.08	9.67	13.63
14	11.05	16.22	13.61	15.05
15	8.89	11.88	9.77	12.54
16	8.58	14.05	9.36	13.39
17	12.20	13.36	12.98	14.61
18	5.41	4.23	8.54	4.80
19	11.73	12.61	8.55	13.43
20	8.25	8.52	2.70	10.19

The MFER measurement results at the 20 stationary test points, as logged on the DVB-H handsets, are summarized in table below. MFER (Multi-protocol encapsulation Frame Error Rate) is the ratio of uncorrectable MPE-FEC frames over a period of time; and it is an indicator of the signal reception quality. A threshold value, typically MFER 5%, is considered to be the limit of acceptable signal reception quality for DVB-H service.

Stationary Test Location	**MFER%**			
	Mode 1 QPSK CR ½	**Mode 2 QPSK CR ⅔**	**Mode 3 QPSK CR ¾**	**Mode 4 16QAM CR ½**
1	0.00%	0.00%	0.00%	0.00%
2	0.00%	1.90%	28.68%	6.90%
3	0.00%	0.00%	0.00%	0.93%
4	0.00%	0.00%	4.35%	0.00%
5	0.00%	0.00%	0.56%	3.94%
6	0.00%	0.00%	0.79%	0.00%
7	0.00%	0.00%	0.00%	0.00%
8	0.00%	0.00%	0.00%	0.00%
9	0.00%	0.87%	19.64%	26.27%
10	6.34%	57.45%	NA	57.46%
11	9.00%	0.78%	21.84%	24.17%
13	0.86%	21.10%	42.34%	3.28%
14	0.00%	0.00%	2.63%	2.33%
15	3.33%	5.30%	59.42%	6.78%
16	3.42%	1.46%	44.02%	1.64%
17	0.79%	3.36%	5.88%	0.00%
18	0.00%	66.92%	26.18%	NA
19	0.00%	3.45%	64.90%	0.81%
20	1.72%	17.27%	NA	16.15%

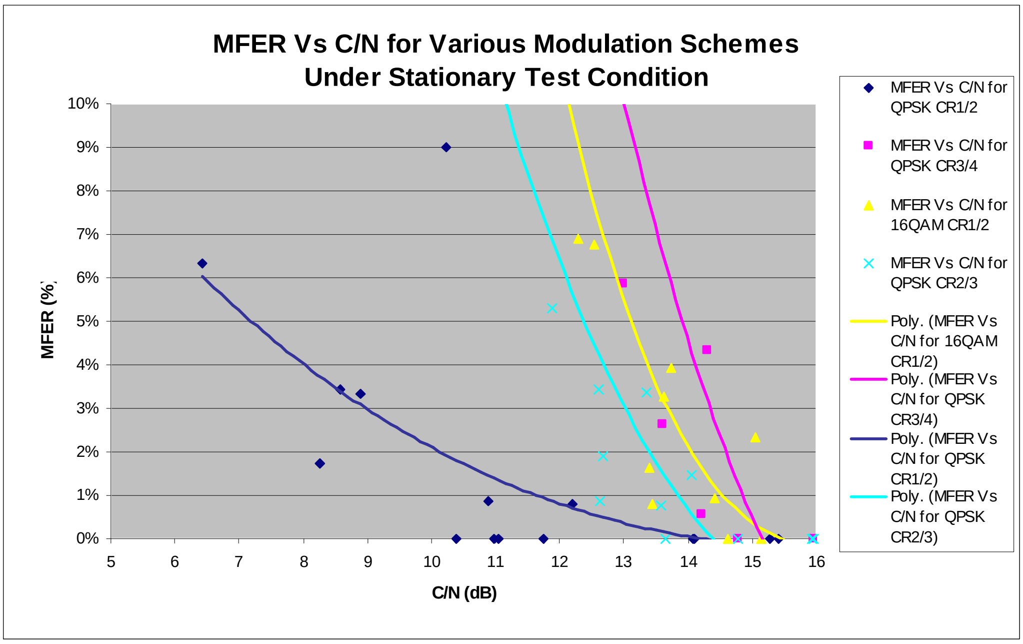
NA = Signal too weak for MFER computation.

With service quality threshold of MFER=5%, the outdoor coverage percentages of different modulations are calculated and tabulated in below:

The calculation formula is: $\dfrac{\text{Number of locations with MFER} < 5\%}{\text{Total number of test locations}}$

Modulation Scheme	**Mode 1 QPSK CR ½**	**Mode 2 QPSK CR ⅔**	**Mode 3 QPSK CR ¾**	**Mode 4 16QAM CR ½**
Coverage Percentage	90%	75%	45%	65%

The following plot is based on above test data.



From the test results, the average C/N required to achieve MFER < 5% were about 7.1dB, 12.3dB, 14dB and 13.1dB for QPSK CR½, QPSK CR⅔, QPSK CR¾ and 16QAM CR½ respectively. QPSK CR½ modulation scheme achieved reasonable coverage, with 90% of all test points meeting 5% MFER criteria while QPSK CR ¾ modulation scheme yielded the worst coverage, with over half of the test points failed.

4.1.2 Indoor Coverage

The objective of the test was to evaluate the indoor reception performance and coverage of QPSK modulation. Measurements were taken at 14 stationary indoor locations at ground floor (except for 1 location which was at 2/F) within the coverage area.

At each location, measurements were taken by handset for both outside (1 meter away) and inside (1 meter away) the building.

The distance inside a building at which DVB-H reception failed, e.g. frequent video freeze, was also recorded. This distance was referred as “coverage edge” in the report.

The following DVB-H system parameters were selected for the indoor coverage test.

Modulation Scheme: QPSK
Code Rate ½
Guard Interval = ¼
In-depth Interleaving was on.

Location	Description	Field Strength (dBμV) Outside	Field Strength (dBμV) Inside	Coverage Edge (m)	Penetration Loss (dB)
1	Fast food restaurant (G/F)	68	50	7	18
2	Fast food restaurant (G/F)	65	42	5	23
3	Fast food restaurant (G/F)	68	45	5	23
4	Bank (G/F)	68	47	7	21
5	Chinese restaurant (G/F)	68	45	6	23
6	Market (G/F)	70	60	12	10
7	Clinic (G/F)	70	55	5	15
8	Fast food restaurant (G/F)	55	44	7	11
9	Fast food restaurant (G/F)	60	50	7	10
10	Video game centre (G/F)	43	20	1	23
11	Chinese restaurant (2/F)	60	52	4	8
12	Supermarket (G/F)	68	58	4	10
13	Supermarket (G/F)	42	27	1	15
14	Post office	42	23	1	19

The penetration loss for the 14 buildings was from 8dB to 23dB, and the average was 16dB. The service could be available indoor with distance ranging from 1m to 12m from the first wall of the building.

4.1.3 Mobile TV reception under vehicular speed

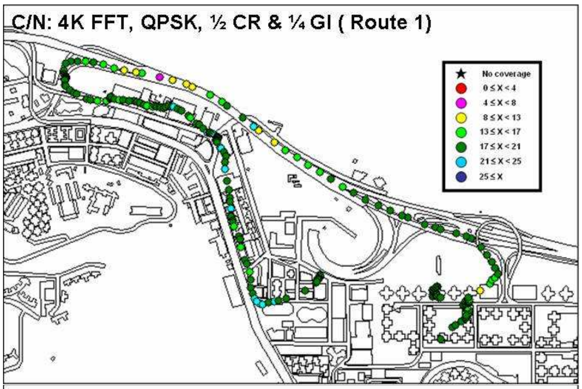
The objective of the test was to evaluate the mobile TV reception inside a moving vehicle traveling at up to 70km/hr in the trial area. During the test, the handset was located inside the test vehicle using the built-in antenna. Both 4K and 8K modes were tested to compare and evaluate possible Doppler Effect on mobile reception. In theory, 4k mode should have better tolerance to Doppler Effect compared to 8k mode.

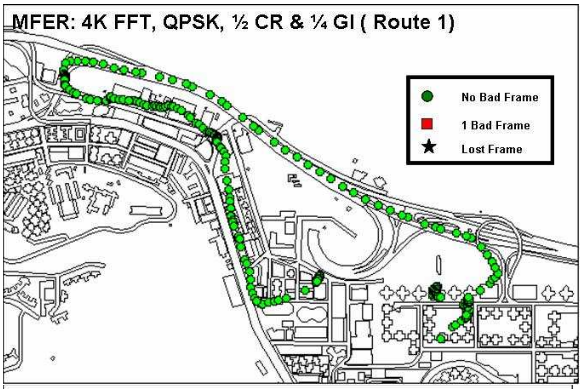
Drive Route 1

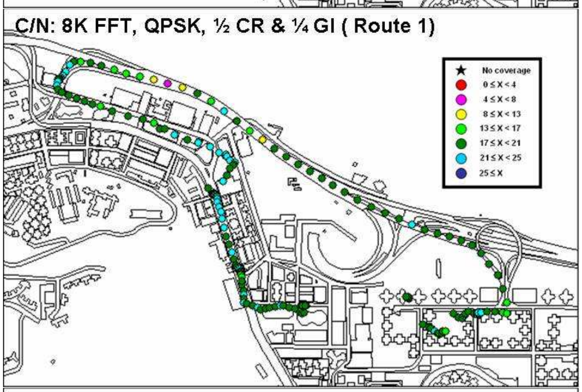
Drive Route 2

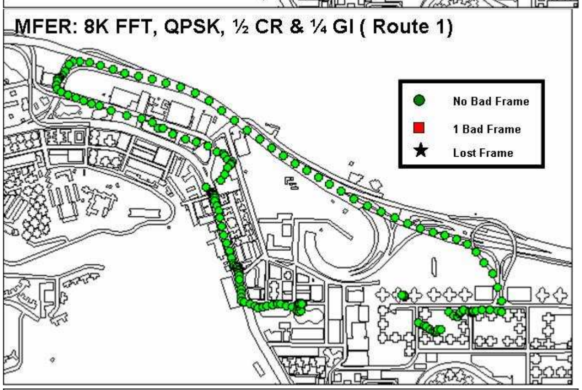
Description	Average Speed	Maximum Speed
4K Mode	50 km/hr	70 km/hr
8K Mode	50 km/hr	70 km/hr

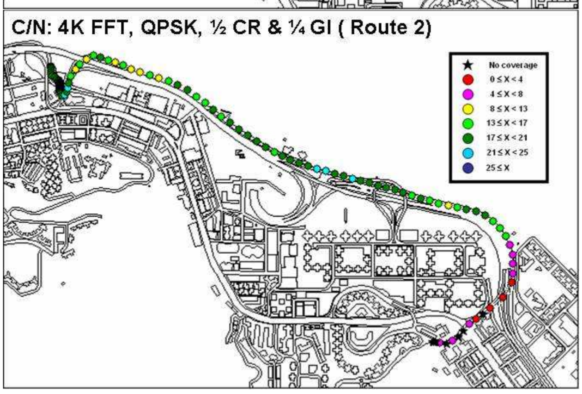
With maximum speed 70Km/hr, the average C/N and MFER values did not show any degradation on 8K mode in comparing to 4K mode. The C/N and MFER plots for 4K and 8K modes on both Route 1 and Route 2 are shown below.

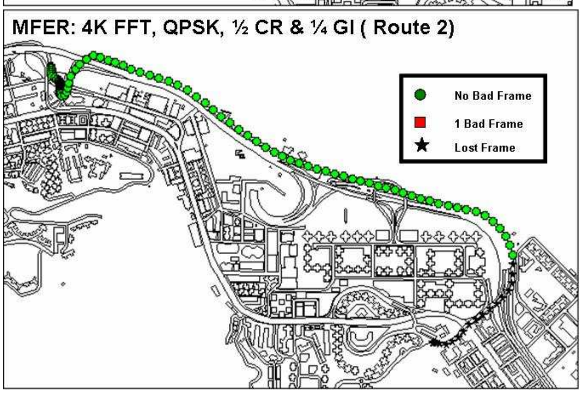


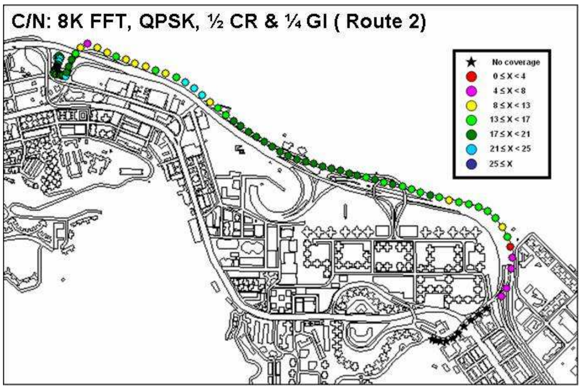




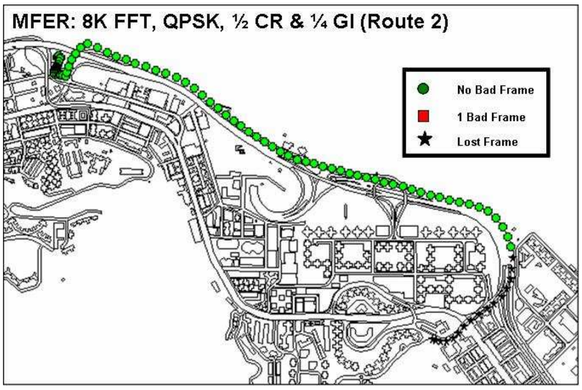








C/N: 8K FFT, QPSK, ½ CR & ¼ GI (Route 2)



MFER: 8K FFT, QPSK, ½ CR & ¼ GI (Route 2)

The tables below show the average C/N and the corresponding MFER for Route 1 and Route 2.

Route 1 FFT Mode	Average C/N (dB)	MFER
4K Mode	18.68	0.00%
8K Mode	18.68	0.00%

Route 2 FFT Mode	Average C/N (dB)	MFER
4K Mode	15.95	0.00%
8K Mode	16.50	0.00%

It was found that the average C/Ns were 17.41dB and 17.73dB for 4K mode and 8K mode, respectively. The results did not show significant performance degradation on 8K mode. In addition, there was no observable degrade in video quality for handover between the three transmitting stations along the drive route.

4.2 SYSTEM FUNCTIONAL TEST

The system functional test focused on the following areas:

- Testing Electronic Service Guide (ESG)
- Testing Conditional Access (CA) & Encryption
- Multi-channel operation on a single RF carrier
- Channel switching time measurement
- Testing of interactive services

4.2.1 Electronic Service Guide (ESG)

In addition to A/V streaming services, Electronic Service Guide (ESG) service, by means of IP Datacasting over DVB-H broadcast (ESTI TS 102 471), was also verified during the trial. Essential ESG functions such as data conversion & preparation, ESG loading, ESG updating, program selection, program schedule & information display, etc were tested with satisfactory results. A screen capture of an ESG page as displayed on the receiver is illustrated below for reference.

4.2.2 Conditional Access (CA) & Encryption

Test was conducted satisfactorily on verifying contents delivered over the DVB-H trial was properly protected and restricted for authorized users only. Trial contents were encrypted in the link layer and only those receivers (users) with proper subscription credentials would be able to decrypt the broadcast contents. The corresponding content encryption and conditional access (CA) arrangement implemented in the trial was based on 18Crypt standard (DVB-CBMS 18Crypt) as specified in IP Datacast over DVB-H: Service Purchase and Protection (ESTI TS 102 474).

4.2.3 Multi-channel operation on a single carrier

The objective was to verify operation and performance of a multi-channel system using a single RF carrier. The test was done to show the system was capable of multiplexing multiple TV channels (11 with QPSK modulation to 21 with 16QAM modulation) on a single RF carrier and the end user was able to view all channels under an adequate signal strength environment.

The result was successful; end user could select and view any one of the broadcasted TV channels using a DVB-H handset under an adequate signal strength environment.

4.2.4 Channel Switching Time

The objective was to measure the channel switching time of DVB-H service on a handset. The channel switching time was measured on two cases:

1. Switch to adjacent channel and then record the switching time for ten times.
2. Switch from first channel to last channel and the record the switching time for ten times.

The counting was started when channel switching button was pressed on the handset and ended when the both video and audio were observed.

The result showed the average switching time was about 4 seconds for both test cases.

4.2.5 Interactive Services

The DVB-H receivers used in the trial were also mobile handsets with GPRS & SMS capabilities, a back channel was therefore available for conveying information in the reverse direction (from users to network) in addition to the forward direction for normal broadcast TV service. This capability enabled the possibility in offering various interactive services supplementing the basic A/V streaming services. A few interactive service examples, namely polling, lucky draw, and ticketing, were evaluated during the trial in order to assess the technical capabilities & user experience. These service examples were triggered by tapping a soft-button on the TV display, and subsequently made use of the WAP browser & SMS editor available on the handset to enable users to interact with the corresponding applications through the mobile network. Such interactive capability was proved to be technically viable and well received by users in the trial. However, user interface (UI) design and application responsiveness were identified as future improvement areas.

4.3 ASSESSMENT OF INTERFERENCE ON ANALOGUE TV SYSTEMS BY DVB-H

There was concern that the DVB-H transmitter on rooftop would generate strong signal in the TV band which might cause signal blockage or interference to TV boosters and CABD system, affecting normal TV reception for households in vicinity. Following test items were performed to investigate this issue.

- Free Space Loss vs. Field Measured Loss
- Wideband TV Booster Desensitization
- CABD Channel TV Amplifier Desensitization

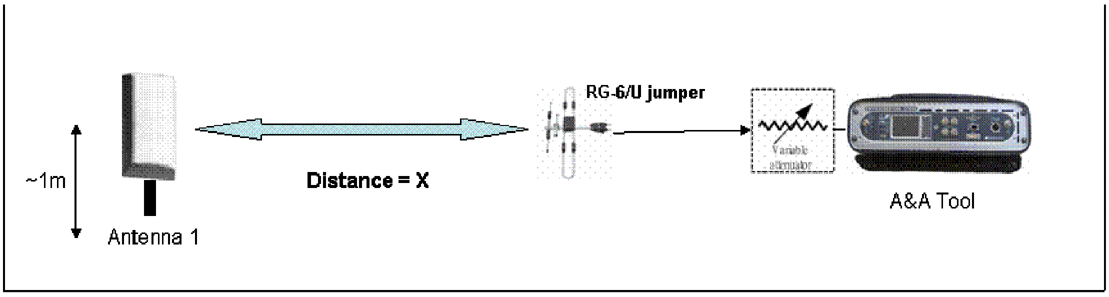
4.3.1 Propagation Loss of DVB-H Signal

The test was to measure the attenuation of DVB-H signal (dBμV) against distance and free space loss was used as the reference. Moreover polarization loss was also assessed in this test. When analogue TV and DVB-H signals employing different polarization (i.e. horizontal vs. vertical); cross polarization loss between the two systems helps to reduce interference on analogue TV system. The results obtained would be used to analyze the impact of DVB-H signal to the reception of analogue TV in subsequent test cases in this section.

The equipment setup for signal strength measurement at one of the cell sites is shown below.

A TV antenna with 2dB gain was used for this test and the cable loss of the 4 meters RG-6/U jumper cable between the antenna and the field strength meter (A&A Tool) was 0.84dB.

Rooftop Level Measurement



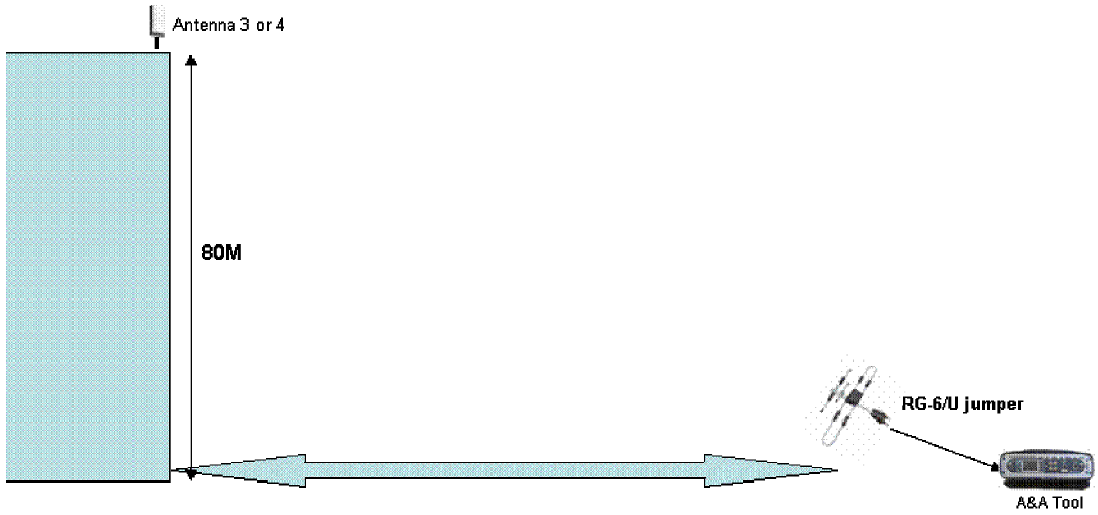
The measurement data are shown at the following table.

TV antenna placement - distance away from Transmitter antenna	Measured Signal Level (dBµV)
Horizontal (5m away)	99.6
Horizontal (10m away)	95.8
Horizontal (15m away)	98.6
Horizontal (20m away)	82.5
Horizontal (25m away)	83.4
Horizontal (40m away)	63.2
Vertical (5m away)	121.7
Vertical (10m away)	116
Vertical (15m away)	113.2
Vertical (20m away)	110.8
Vertical (25m away)	106.2
Vertical (40m away)	97.83

Remark: The Transmitter antenna output power (vertical polarization) was 49.99dBm (99.81W)

Street Level Measurement

Due to the limitation on rooftop, street level measurements were taken for measurement points where the distance was greater than 100m from the transmitter. The equipment setup for signal strength measurement at street level measurement is shown below.



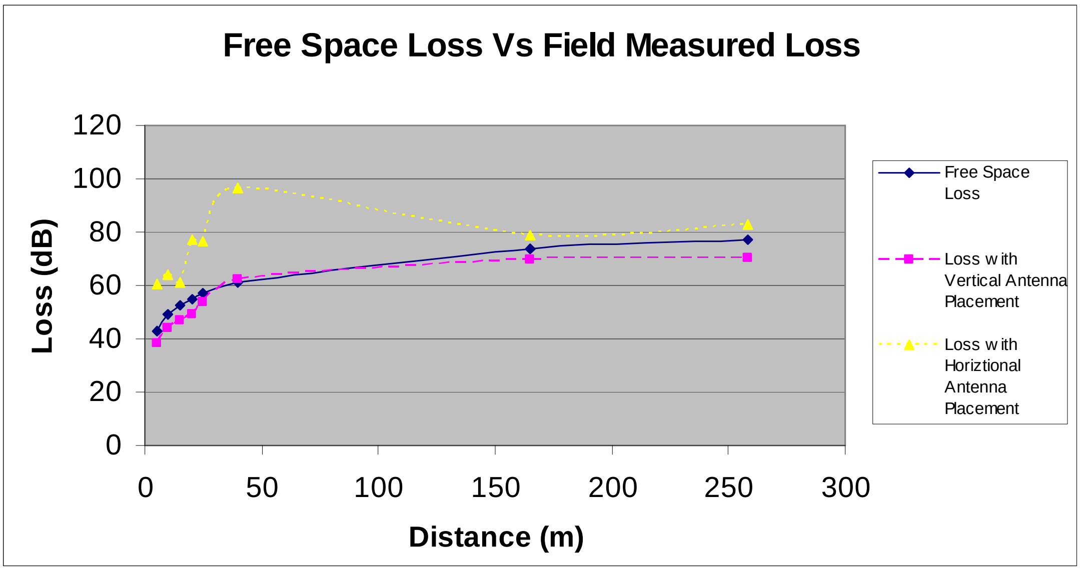
TV antenna placement - distance away from DVB-H Transmitter antenna	Measured Signal Level (dBμV)
Horizontal for antenna 3 (258m away)	76.71
Vertical for antenna 3 (258m away)	89.50
Horizontal for antenna 4 (165m)	80.40
Vertical for antenna 4 (165m)	89.75

Remark: The Transmitter antenna output power (vertical polarization) was 49.66dBm (92.75W) for Antenna 3 and 49.54dBm (90W) for Antenna 4.

For the street level measurement, the DVB-H Transmitter antenna was located at ~80m height. With 18^{o} down tilt (antenna 3) / 27^{o} down tilt (antenna 4) and 28^{o} vertical beam-width, the 3dB beam hit the ground at 246m (antenna 3) and 157m (antenna 4) away from the Transmitter antenna. The actual received signal level was higher than the one calculated from free space calculation and it might be due to the reflection from the surrounding buildings.

Since most of the analogue TV antennas in that area were placed horizontally, therefore loss with horizontal antenna placement was also measured for reference. It was shown that there were 14 to 34dB difference between the horizontal and vertical antenna placement at receiving end, i.e. an average of ~24dB cross polarization isolation between DVB-H transmitting antenna and analogue TV antenna.

The free space loss verse field measured loss is shown in the following plot:



Due to stronger scattering of signal at street level, the cross polarization effect was reduced as compared with rooftop measurement.

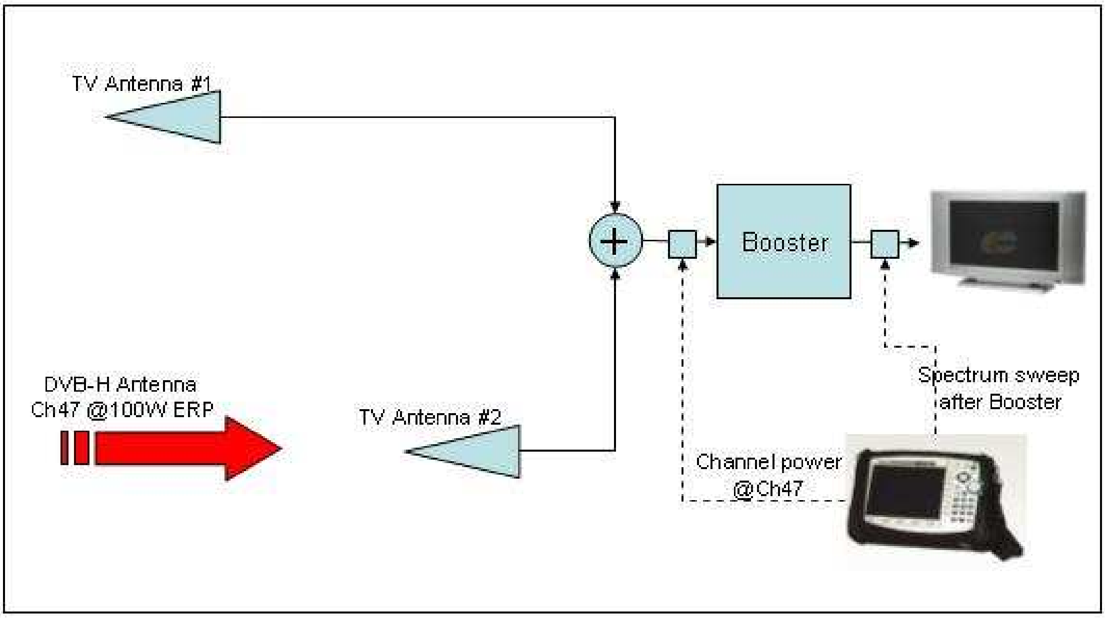
In subsequent analyses in this section, we would adopt free space path loss plus cross polarization isolation as the propagation model for DVB-H signal.

4.3.2 Wideband TV Booster Desensitization

Desensitization refers to the reduction in receiver sensitivity due to the presence of a high-level off-channel signal overloading the radio-frequency amplifier or mixer stages, or causing automatic gain control action.

The objective of this test was to assess the risk of desensitization due to a DVB-H system operating at channel 47 to a near-by analogue TV booster. Desensitization for the lower three adjacent channels (CH44, 45, 46) and upper three adjacent channels (CH 48, 49, 50) was assessed. The brand and model of the TV booster used in this test was [XXXXXX] TV Booster, with a design to amplify all TV signals received in the UHF band.

The equipment setup for wideband TV booster desensitization:



"TV Antenna #1" was used to receive local UHF TV channels and its position was fixed during the test. "TV Antenna #2" faced directly to the DVB-H transmitting antenna which represented the worst case scenario producing the strongest interference.

Measurement were taken at the input port and output port of the booster, as shown in the above diagram. A TV set was used for monitoring picture quality and was tuned to a local UHF TV channel.

With DVB-H system switched off, the mean channel power (over 8MHz) measured at the output port of the booster on different UHF channel [dBµV] were:

UHF Channel	CH 44	CH 45	CH 46	CH 47	CH 48	CH 49	CH 50
Mean Channel Power [dBµV]	64.3	64.6	64.4	64.5	64.6	64.4	64.3

The above figures were used as the base line for analyzing desensitization due to DVB-H signal interference.

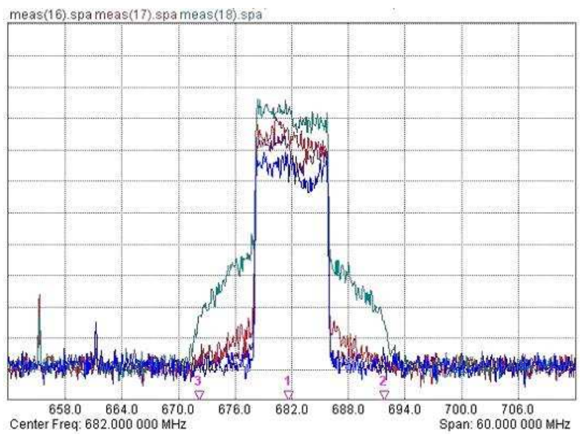
With DVB-H transmitter switched on, "TV Antenna #2" was placed from various distances to the DVB-H transmitting antenna, and measurements were taken at seven positions. The result is as follows:

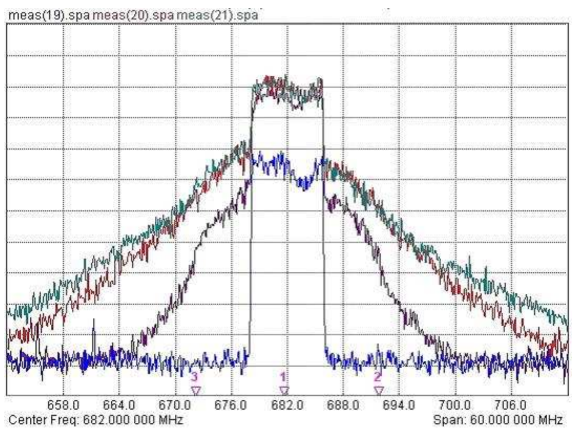
"TV Antenna #2" Location	Mean Channel Power (over 8MHz) at TV booster output port [dBμV]						
	CH 44	CH 45	CH 46	CH 47	CH 48	CH 49	CH 50
1	64.7	64.5	64.4	94.9	64.6	64.2	64.4
2	64.5	64.2	65.4	97.9	64.9	64.4	64.2
3	64.9	64.3	66.9	99.8	66.6	64.3	64.5
4	64.7	64.4	74.9	103.4	74.0	64.3	64.3
5	64.9	68.1	85.1	106.4	84.4	67.7	64.3
6	72.8	81.8	93.5	108.1	91.6	79.4	70.7
7	76.5	84.2	94.5	108.1	91.4	81.4	75.0

The rise in mean channel power was due to DVB-H interference (desensitization) and the increase in output level is shown in below:

"TV Antenna #2" Location	Rise in Mean Channel Power (due to interference) [dB]							Picture quality of local TV channel 21 (Jade) as observed on the TV set
	CH 44	CH 45	CH 46	CH 47	CH 48	CH 49	CH 50	
1	0.4	-0.1	0.0	30.4	0.0	-0.2	0.1	Good
2	0.2	-0.4	1.0	33.4	0.3	0.0	-0.1	Good
3	0.6	-0.3	2.5	35.3	2.0	-0.1	0.2	Slightly snowy pictures
4	0.4	-0.2	10.5	38.9	9.4	-0.1	0.0	Snowy pictures
5	0.6	3.5	20.7	41.9	19.8	3.3	0.0	Heavily snowy pictures
6	8.5	17.2	29.1	43.6	27.0	15.0	6.4	Heavily snowy pictures
7	12.2	19.6	30.1	43.6	26.8	17.0	10.7	No image on TV screen

The spectrum sweeps at the output port of booster for each "TV Antenna #2" measurement location are shown in the pictures below. The left picture shows the sweeps for "TV Antenna #2" location 2 to 4 and the right picture shows the sweeps for "TV Antenna #2" location 5 to 7. In both pictures, the deep blue colour line is the sweep for location 1 (farthest away from DVB-H antenna).





“TV Antenna #2” Location	Corresponding labels / line colour
1 (farthest away)	Line in deep blue colour
2	Label “meas16.spa”
3	Label “meas17.spa”
4	Label “meas18.spa”
5	Label “meas19.spa”
6	Label “meas20.spa”
7 (closest)	Label “meas21.spa”

The result could be used to estimate the required separation distance between DVB-H antenna and wideband TV booster by appropriate radio propagation formula. An example is illustrated.

- Propagation model – free space loss shown to be reasonable model in previous section 4.3.1
- TV aerial – 10dB
- Cross polarization loss – 24dB

“TV Antenna #2” Location	Power level of CH47 at the input of the TV booster [dBμV]	Required separation distance by calculation [m]
1	81.5	50.9
2	83.3	41.2
3	88.3	23.3
4	91.2	16.7
5	96.2	9.4
6	106.3	2.9
7	113.3	1.3

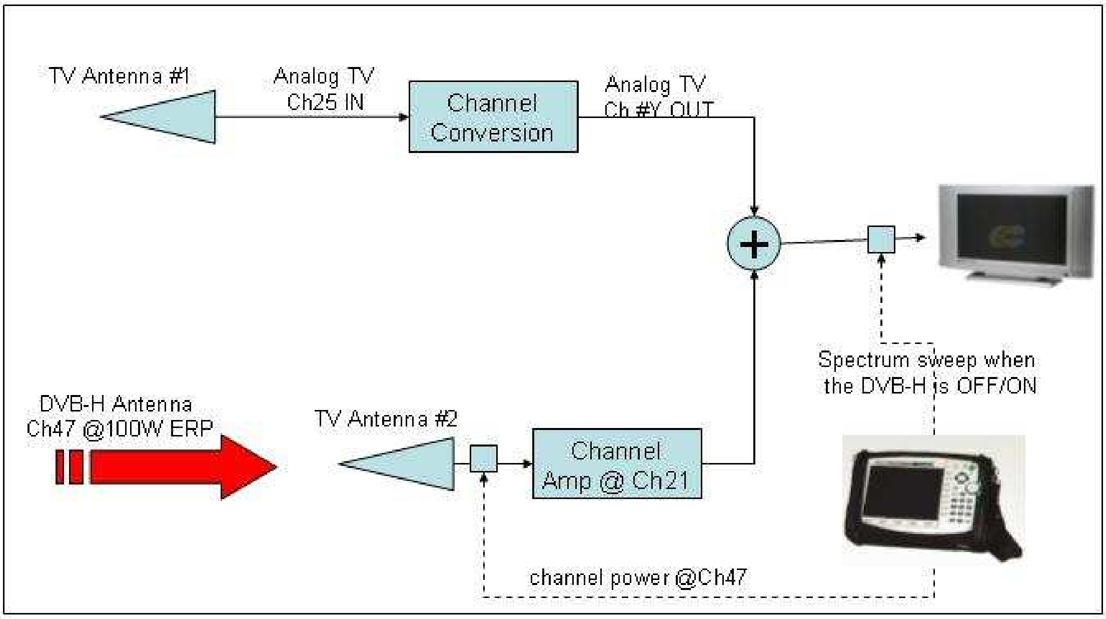
From the test we know user began to notice impairment on TV picture at “TV Antenna #2” location 3 and therefore the required separation distance is >23.3m.

4.3.3 Interference to CABD Channel Amplifier

The objective was to investigate interference caused by a DVB-H system operating at channel 47 to a near-by CABD system.

The CABD equipment used in this test was [YYYYYY] Headend Base Unit with two Single Channel Amplifiers. The channel amplifier was designed to amplify a pre-configured UHF channel signal.

Below diagram shows the equipment setup of this test which was designed to simulate a typical CABD TV system.



The "Channel Conversion" was to simulate a digital satellite receiver with output tuned to "CH#Y" in CABD system, where Y = 46 or 48.

The "Channel Amp" and "TV Antenna #2" setup was to simulate the UHF antenna reception and amplification in a CABD system. In the test; the setup was tuned to a local UHF TV broadcasting channel CH21 (i.e. receiving TVB Jade signal from Temple Hill transmitter).

The TV set was used for monitoring picture quality of the digital satellite receiver output and local UHF TV channel in all scenarios.

The result:

Test No.	Digital Satellite Receiver channel no.	Picture quality of satellite channel as observed on the TV set	Picture quality of CH21as observed on the TV set
1	CH46	No observable difference	No observable difference
2	CH47	No observable difference	No observable difference
3	CH48	No observable difference	No observable difference

5 CONCLUSION

The radio coverage and performance of DVB-H system in outdoor, indoor and vehicular conditions were evaluated. QPSK and ½ code rate achieved the best performance in terms of radio coverage among all modes tested. On channel capacity, 16QAM modulation offered roughly twice the amount of TV channels in the same spectrum compared with QPSK modulation but at a cost of inferior indoor coverage performance. It was also found that high speed mobility up to 70km/hr did not affect the reception of the service and service handover between transmitters was possible as well. However, at a few locations in the Indoor Coverage test cases, DVB-H reception was not as good as mobile phone services.

System functions such as ESG, CA & Encryption, multi-channel operation, interactive services and channel switching time were tested with positive results as well.

The issue on potential interference to analogue TV systems (both wideband booster & channel amplifier configurations) was also assessed in the trial. From the measurements, when DVB-H transmitter antenna and TV aerial were separated by reasonable distance, which was in general practically achievable and manageable in Hong Kong environment, DVB-H signal from transmitter located at rooftop would not cause excessive interference to analogue TV systems.

In summary, DVB-H technology demonstrated its capability to provide mobile TV service in Hong Kong environment employing a configuration with rooftop transmitters. However, it is expected that both hill top and rooftop sites will be crucial for territory-wide deployment. To achieve good coverage with adequate indoor reception, complementing hill top transmitters sites with low power transmitters or gap fillers on building rooftops is inevitable. Potential interference of rooftop transmitter to the nearby analogue TV systems is considered manageable by proper planning to achieve the required separation distance.

The results and data collected in this trial are valuable and will definitely helpful in planning for future deployment of mobile TV service in Hong Kong.

This trial has been conducted successfully to cover mobile TV reception in outdoor, indoor and vehicular environments; one important area that has not been assessed in this trial is the underground train environment. With millions of commuters traveling everyday, mobile TV performance in underground train environment is worth to explore further.

- END -