

Executive Summary of the DTT Frequency Planning Study

The Office of the Telecommunications Authority (OFTA) has appointed the PA Consulting Group (PA) to conduct a study on the digital terrestrial television (DTT) frequency plan for Hong Kong. The study was completed in May 2000 and this paper gives a brief summary of the findings and recommendations by the PA on the DTT frequency plan for Hong Kong.

1. EXECUTIVE SUMMARY

Digital terrestrial television (DTT) is an emerging technology which will finally replace the current analogue broadcast transmission. Managing of the frequency spectrum for the introduction of DTT, for the dual transmission transitional period and eventually the switch-over from analogue to digital is a complex and critical process which must be well planned to ensure minimum disruption of service. The plan should also allow a range of new services to be introduced. On request from OFTA, the PA Consulting Group (PA) has conducted a study to analyse and make recommendations on the options for the introduction of DTT in Hong Kong.

2. STUDY METHODOLOGY

The study involved analysing the current analogue frequency plans in Hong Kong and neighbouring Guangdong and Macao and finding gaps where DTT channels could be accommodated. The study assessed the 3 different DTT standards which have been proposed, analysing the frequency plans possible with each and other issues which have an impact on which is most appropriate for implementation in Hong Kong.

At the centre of the study was a field strength prediction and interference analysis model. The model incorporates internationally recognised propagation models and analysis methods. The field strength prediction model used digital map height data both of the Hong Kong territory and neighbouring mainland China. The field strength prediction model was validated by comparing predicted coverages with OFTA plots of measured coverages from existing analogue stations.

The outputs from this part of the study were the channels, power levels and antenna patterns required at each transmitting station in order to provide DTT coverage. Also assessed were which stations are required for DTT, including the possibility of adding new stations.

Having determined which channels could be used for DTT, strategies were determined for making the transition from the current analogue services to digital, including a period of parallel transmissions (or "simulcast") to ensure continuity of service.

Other issues specific to the Hong Kong environment were considered, such as tidal fading and the impact on common antenna and in-building distribution systems, which are the dominant method of reception in Hong Kong.

3. FREQUENCY PLAN CONCLUSIONS

Frequency plans have been found which can accommodate a wide range of policy options relating to new services, new broadcasters and HDTV. Worst case analysis has been used in order to ensure that the frequency plans are practically implementable.

The main factors determining whether DTT is possible are:

- DTT not causing interference to existing Chinese analogue coverage – this is the most common reason why channels are not possible
- Interference from existing analogue services both in Hong Kong and mainland China
- Minimum field strength for DTT reception. This is not the main factor because in all but a few cases there is some level of interference present.

The analysis indicates a maximum of 6 channels are available territory wide, with further analysis required to confirm 2 of the channels for Temple Hill and 1 for Golden Hill (where there are potential interference conditions to be coordinated with mainland China).

The 6 channels comprise 3 SFN (Single Frequency Network) channels (35, 37 and 62) and 3 others. SFN means all stations use the same frequency and stations, with the stations synchronised in order to avoid interference between signals received from more than one station. It is only supported by two of the DTT standards (DVB-T and ISDB-T). As a consequence, the ATSC standard is not capable of supporting 6 channels, but can only support a maximum of 3 channels as the MFN approach must be used.

The other 3 channels are based on the SFN approach (channels 41, 47 and 60), with other channels used in some areas (mainly the north-west of the territory where interference from China is highest) where these channels suffer interference. Some advantage may be found by adding new stations in the north-west of the territory, but issues of access and power to the proposed locations must first be verified.

A number of other channels are available or marginal (subject to more detailed planning to confirm) for DTT, but these do not provide territory-wide coverage.

The analysis determined 21 of the existing 39 analogue stations are required for DTT transmission. Fewer are required due to the lower power requirements and more robust multipath performance of the DTT signals. The coverage obtained using the 21 stations is shown in Figure 1.

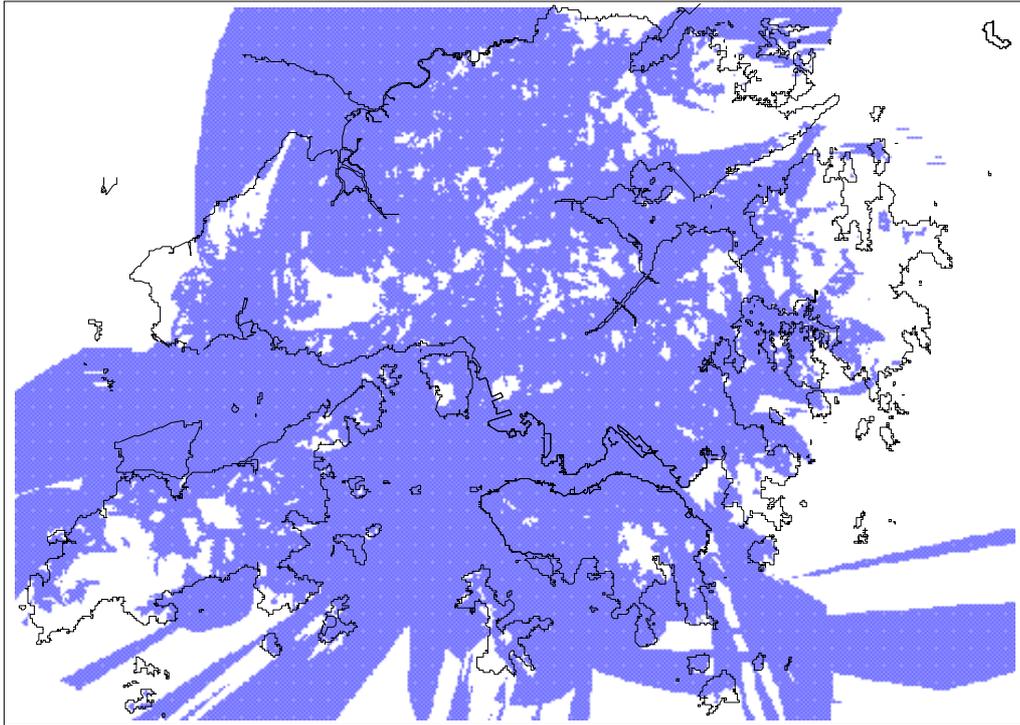


Figure 1 DTT Coverage Achieved with Recommended 21 Stations

Figure 2 summarises the frequency plan findings, including the ERP required at each station for implementing DTT. ERP is typically 10-20dB lower than current analogue levels, which is typical of the DTT planning parameters in other countries. Polarisation is taken to be the same as existing analogue channels in order to avoid the need for re-orientation of aerials. A number of changes are also required to existing analogue antenna patterns, mainly to minimise outgoing interference to mainland China.

Channel	Temple Hill	Castle Peak	Kowloon Peak	Golden Hill	Cloudy Hill	Lamma Island	Other Stations
21		10 W					
22							
23							
24							
25							
26							
27							
28							
29							
30			30 W		30 W		
31							
32					30 W		
33		10 W	10 W		30 W		
34							
35	100 W	100 W	100 W	100 W	100 W	150 W	-10 dB
36							
37	100 W	100 W	100 W	100 W	100 W	150 W	-10 dB
38							
39		10 W	10 W				
40							
41	100 W	10 W	10 W	30 W	30 W	150 W	-10 dB
42							
43							
44							
45			10 W		30 W		
46							
47	100 W		10 W	30 W	30 W	150 W	-10 dB
48							
49	100 W	10 W		100 W			
50							
51							
52							
53							
54							
55	100 W	10 W		100 W			
56							
57							
58							
59							
60	100 W		100 W	30 W	30 W	150 W	-10 dB
61							
62	100 W	100 W	100 W	100 W	100 W	150 W	-10 dB

✓
✓

 = Available for DTT

✓

 = Marginal for DTT - requires detailed coordination to confirm

Figure 2 Frequency Plan for DTT Stations and the Required ERP

5. TRANSITION PLANNING

Transition from the 4 existing analogue programmes to eventual switch-off of analogue is complex and must be carried out in several steps. The proposed transition plan is shown in Figure 4. The list of transposers to be switched off in steps 3, 5 and 7 is given in Figure 5.

	Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13
1	SFN on Channels 35, 37 and 62														
2	Migrate critical households to DTT														
3	Switch off 5 transposers from Ch 41/33														
4	Channel 41 SFN/33 MFN														
5	Switch off 3 transposers from Ch 47/30														
6	Channel 47 SFN/21/30 MFN														
7	Switch off 4 transposers from Ch 60/55														
8	Channel 60 SFN/55 MFN														
9	Switch off English channels - more MFNs														
10	Switch off all HK analogue - more SFNs														
11	Re-plan after analogue switch-off in China														

Figure 4 Proposed DTT Transition Plan

For Mux-D - MFN using Ch.41 (and Ch.33 at Castle Peak)	
41	Tsuen Wan, Ma Wan, Tuen Mun, Ying Pun, Sun Yuen Long Centre
33	Tuen Mun, Ying Pun, Sun Yuen Long Centre

For Mux-E - MFN using Ch.47 (and Ch. 30 at Kowloon Peak, Ch.21 at Castle Peak)	
47	Sham Tseng
30	Tseung Kwan O Village, Tui Min Hoi Sai Kung

For Mux-F - MFN using Ch.60 (and Ch.55 at Castle Peak)	
55	Wang Chau, Shek Kong
60	Ma Wan, Tsing Yi

Figure 5 Transposers to be switched off

One approach (dark shaded in the diagram) is to begin with a small number of channels to provide simulcast of existing analogue services. This allows viewers whose small transposers must be shutdown to free channels for more digital channels to switch over while maintaining continuity of service. While this number of stages is not ideal from an implementation view, it minimises the considerable expense of re-tuning or paying for DTT set-top boxes for large numbers of viewers whose analogue service must be switched off in order to make way for digital.

There is an economic and policy trade-off to be made between the speed of introducing DTT and the expense of converting viewers. Policy in the UK has been that it is the broadcasters who must pay for any action required to maintain analogue service.

The preferred approach is to introduce 3 SFN channels and the 3 MFN channels at launch (light shading in the diagram). This reduces number of roll-out stages and allows more DTT channels (and hence new services) to be introduced earlier, although this would require the migration of more users to digital to be funded.

Optionally, steps 9 and 10 could be made coincident, reducing the number of times equipment (including common antenna system headends) would require modifications. Cost trade-offs need to be performed to determine which approach is optimum.

6. SELECTION OF DTT STANDARD

The study has investigated all 3 DTT standards which have been proposed (DVB-T, ATSC and ISDB-T). Differences in planning parameters between the standards are not sufficiently significant to make major differences in the frequency plan options, with the exception of ATSC not supporting SFN operation. However, planning for co-existence with the existing 8MHz PAL analogue services means that DVB-T or ISDB-T are best suited because those standards require slightly less interference protection.

Considering other issues, DVB-T is most appropriate for use in Hong Kong for the following reasons. It supports SFN operation which is essential given the congested spectrum situation. For future service applications it is flexible enough to offer HDTV and mobile reception. It is most well advanced in terms of deployments and equipment availability.

DVB-T has a number of data rate and modulation options. Analysis for the Hong Kong geography shows "8k mode" must be used (as selected in most European countries). A "guard interval" of no less than 1/8 must be used to avoid unacceptable interference and to make SFN operation feasible. This enables a data rate of 22.1Mbps per multiplex which is definitely sufficient for 4 programme services and possibly for 5.

7. COMMON ANTENNA AND IN-BUILDING DISTRIBUTION SYSTEMS

Trials have shown that DTT (ISDB-T, DVB-T and ATSC standards) can be received through existing in-building distribution networks, with suitable changes to the headend. There are many building specific aspects which means specific design work is required to accommodate the existing analogue set-up and new DTT channels.

Adding new DTT channels to the frequency plan requires changes to the headend equipment such that each new channel requires extra hardware. Therefore, to avoid repeated visits to each building, equipment should be installed at the outset for future phases of the DTT roll-out, even if it is only partially activated at each phase.

8. NEXT STEPS

This study is part of an overall programme being conducted by OFTA for the introduction of DTT to Hong Kong. The following issues which should be fed from this frequency planning study into the overall programme.

8.1 FREQUENCY PLAN OPTIONS

Detailed plans for implementing DTT have been presented. OFTA should review these findings. In particular:

- The broadcasters should be consulted to determine the practicality of the proposed antenna pattern changes for DTT. Equipment suppliers should be approached to determine availability of equipment for the recommended ERP and antenna patterns.

- The locations of the proposed new stations in the north-west of the territory should be assessed to determine if it is practical to implement transposers there.
- Trade-off analysis must be performed to develop an optimum design for distributing the digital signals to the transposers.

The key area requiring further validation is SFN operation over the whole territory, as limited trials have been performed of a DVB-T SFN over a wide area. Also, the cost and practicality of synchronising an SFN network over the full area of the territory should be confirmed.

8.2 TRANSITION STRATEGY

An initial transition strategy is proposed, and this should be reviewed in conjunction with other work linked to the introduction of DTT. In particular, policy objectives should be refined based on the findings of the study in areas such as:

- introduction of new services (mobile reception, HDTV)
- new operators and allocation of programmes to multiplexes
- restrictions on phasing out analogue services (eg. % population covered by digital before switch-off can occur).

An assessment should be made of the number of viewers who will be affected by the switch-off of the small transposers on the channels proposed for DTT. Cost trade-offs should then be performed including aspects such as re-tuning of these transposers (or viewers) to other stations or channels, funding and installing DTT STBs, cost of information campaigns and revenue from new services or operators. The exact ordering of the proposed transition plan can therefore be optimised according to policy objectives.

8.3 CHOICE OF DTT STANDARD

The ongoing ATSC trial should be completed and reported, using the same parameters as used in the previous ISDB-T and DVB-T trials.

Where possible, OFTA should review the frequency planning findings and the conclusions of this study with each of the standards suppliers.

8.4 COORDINATION WITH MAINLAND CHINA

Through the coordination process, OFTA should obtain an understanding of the Chinese plans for DTT. This will impact the long term possibilities for DTT in Hong Kong. Of importance are their preference for standard, the number of channels they expect to deploy, whether an SFN approach will be used and the timing of these plans.

The specific issues relating to Temple Hill and Golden Hill interference towards the existing analogue TV channels of the neighbouring areas must be resolved in order to confirm 6 DTT channels are available territory-wide before switch-off of any main analogue stations.

One deficiency of the frequency planning process was the lack of information on antenna patterns of the mainland Chinese stations. Obtaining information on these could allow better prediction of the interference into Hong Kong in future frequency planning analysis.

9. CONCLUSION

Although the existing analogue frequency plan in Hong Kong and neighbouring mainland China is congested, the study has determined a set of frequency plans and implementation strategies which can accommodate a wide range of policy objectives. These findings should now be included within the overall programme for the introduction of DTT into Hong Kong as described above.

30 May 2000

