DTTDB Frequency Planning
Approach and choices made in developing the DTTDB frequency plan in Thailand

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DTTB frequency planning

1. Frequency plan
   - Spectrum management principles
   - Different scenarios
   - Content of a plan

2. Planning principles
   - Spectrum requirements
   - Reception mode
   - Service trade-off
   - Single Frequency Networks
   - Regional coverage
   - Presentation of results

3. Data and tools
   - Databases and planning software

4. Planning process
   - Planning sequence
   - Planning steps
1. Frequency plan
1.1 Spectrum management principles

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>A-priory plan</th>
<th>First come–first served</th>
<th>Non-protection basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Known service areas</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>No unacceptable interference</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Future requirements</td>
<td>yes</td>
<td>limited</td>
<td>yes</td>
</tr>
<tr>
<td>Flexibility regarding unforeseen developments</td>
<td>limited</td>
<td>limited</td>
<td>yes</td>
</tr>
</tbody>
</table>

A-priory plan giving broadcasters and NOs certainty for a long period:
- maintaining high quality reception levels
- in coverage areas described at moment of licensing

Thai DTTB Plan
1. Frequency plan

1.2 Spectrum management principles

- Specifying transmitting stations (frequency, power, antenna height) in such a way that
  - The required coverage is achieved
  - While interference is kept to an acceptable level
- In DTTB: interference means no picture

Thai DTTB Plan

Interference taken into account if sites are separated:
- < 400 km across land
- < 650 km across sea
1. Frequency plan

1.3 Different scenarios

<table>
<thead>
<tr>
<th>Stages</th>
<th>VHF plan</th>
<th>UHF plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before DTTB launch</td>
<td>ATV</td>
<td>ATV, Mobile</td>
</tr>
<tr>
<td>During transition</td>
<td>ATV</td>
<td>ATV, DTTB, Mobile</td>
</tr>
<tr>
<td>After ATV switch-off</td>
<td>DTAB</td>
<td>DTTB, Mobile</td>
</tr>
</tbody>
</table>

Scenario A
- 5 transmitters per site
- First deployment phase with 11 sites

Scenario B
- 5 transmitters per site
- During transition
- Temporarily channels to avoid interference with ATV

Scenario C
- 6 transmitters (multiplexes) per site
- After ATV switch-off

A frequency plan related to the transition from analogue TV (ATV) to digital television (DTTB) consists of three stages.
1. Frequency plan

1.4 Content of a plan

- Site name and coordinates
- Site and antenna height
- Effective radiated power (ERP)
- Antenna pattern
- Channel or frequency
- Network

### Example

**Site 20.00**
Chiang Mai  
Long. 98.91502  
Lat. 18.808140

<table>
<thead>
<tr>
<th>Network</th>
<th>Ch Sc C</th>
<th>Ch Sc B</th>
</tr>
</thead>
<tbody>
<tr>
<td>NBT</td>
<td>46</td>
<td>60</td>
</tr>
<tr>
<td>Army TV-1</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>MCOT</td>
<td>54</td>
<td>54</td>
</tr>
<tr>
<td>TPBS</td>
<td>57</td>
<td>57</td>
</tr>
<tr>
<td>Army TV-2</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>Comm. TV</td>
<td>34</td>
<td>-</td>
</tr>
</tbody>
</table>

**Thai DTTB Plan**

- 39 main sites
- 132 additional sites to supplement coverage of main sites, consisting of:
  - 45 exiting TV sites
  - 38 telecom sites
  - 49 new sites
- 15 gap-fillers in Bangkok to improve indoor reception
2. Planning principles

2.1 Spectrum requirements

### International coordination
- Equitable access of the spectrum to all countries
- Coordination agreements with neighboring countries

### International and national spectrum regulations
- International frequency allocations in Asia-Pacific area in UHF band
  - Broadcasting Mobile
    - Channels 21 to 48
    - 470 MHz
  - Broadcasting Mobile (IMT)
    - Channels 49 to 69
    - 698 MHz
  - From 2015
  - 862 MHz
- Each country should decide on the national applications

Thai DTTB Plan
- Within 100 km from Malaysian border
- Use of even numbered channels
- DTTB in UHF band
  - Channels 26 to 60
  - From 2015
2. Planning principles

2.2 Reception mode

- **Rooftop reception**
  - Directional antenna on the roof
  - Reception height in planning: 10 m
  - Antenna bearing and channel range could be different compared to analogue TV
  - Antenna replacement may be needed for good DTTB reception

- **Thai DTTB Plan**
  - Requirement to cover 95% of the households with rooftop reception
  - Assuming well located receiving antenna of good quality
  - Use of antenna amplifier were needed
  - Planning results indicate for each receiving location the best DTTB transmitter
  - Antenna replacement may be needed for good DTTB reception
2. Planning principles

2.3 Reception mode

Indoor reception

- Small antenna in the room
- Reception height in planning: 1.5 m

Indoor reception requires much higher signal strength than rooftop reception

For same coverage as rooftop reception
16,000 x more transmitted power needed

Thai DTTB Plan

- Indoor reception in many towns due to close location of sites
- About 40% households with good indoor reception
- 15 gap-filler in Bangkok to improve indoor reception

Coverage radius of a tx of 10 kW/150m

<table>
<thead>
<tr>
<th>Reception type</th>
<th>Coverage radius (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTTB rooftop</td>
<td>49</td>
</tr>
<tr>
<td>DTTB indoor</td>
<td>6</td>
</tr>
<tr>
<td>ATV rooftop</td>
<td>24</td>
</tr>
</tbody>
</table>

For same coverage as rooftop reception
After extensive studies and field tests by NOs, DVB-T2 system variant selected (16k, 64QAM, 3/5, PP2) providing:

- Mid range capacity of about 22 Mbit/s per transmitter
- Fairly robust indoor reception possibilities
2. Planning principles
2.5 Single Frequency Networks (SFN)

Use of SFN where possible

- The content of the transmission must be the same at all sites in a SFN
- Use of SFN is limited by “self-interference”

Example
Self-interference resolved by means of artificial delay and modified antenna patterns

- Guard-interval of selected DVB-T2 variant is 266 µs
- If transmitter distance in SFN is > 79.8 km self-interference may occur, depending on C/I ratio
- 127 of the 132 additional sites are part of a SFN
- All 15 gap-fillers in Bangkok in SFN
- In total 48 SFNs
2. Planning principles

2.6 Regional coverage

Some SFNs cover more than one regional area

- Site in a different regional area than the other sites in the SFN should transmit different services
  - Different channel needed (excluding it from the SFN)

Example

<table>
<thead>
<tr>
<th>Site</th>
<th>NBT</th>
<th>CTV</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00</td>
<td>49</td>
<td>33</td>
</tr>
<tr>
<td>2.01</td>
<td>49</td>
<td>33</td>
</tr>
<tr>
<td>2.08</td>
<td>49</td>
<td>33</td>
</tr>
<tr>
<td>1.06</td>
<td>49</td>
<td>52</td>
</tr>
</tbody>
</table>

Thai DTTB Plan

- 5 networks with national services
- 1 network with services for each of 39 community TV areas

Decoupled from SFN to enable transmission of different services
2. Planning principles
2.7 Presentation of results

Reception probability in a small area (100 by 100 m)

- Reception probability in %, taking into account:
  - Field strength of wanted signal
  - Field strength of interfering signals
  - Minimum median field strength (Emed) and protection ratio according to ITU-R recommendations

Thai DTTB Plan

Reception probability
- ≥ 95%: good reception
- 90 - 95%: good reception with well located antenna of good quality
- 70 – 90%: for information
- Wanted signals 50% of time
- Interference 1% of time

Coverage presentation

Example

Orange: ≥ 95%
Yellow: 90-95%
Green: 70-90%
3. Data and tools
3.1 Databases and planning software

Accurate coverage predictions require detailed data and advanced planning software.

- Digital terrain databases
  - Terrain height
  - Land use (clutter) type and height
- Population database
  - People or households per small area unit
- Site data
  - Accurate coordinates, antenna heights and antenna data (if appropriate) of existing sites
- Backgrounds maps
  - Detailed information on terrain and urban areas

Terrain height and clutter data resolution
- 100 by 100 m in whole country
- 20 by 20 m in Bangkok

Population database
- Population and households per tambon

Background maps
- Bing maps and Google Earth

Planning tool
- Progira plan

Thai DTTB Plan
4. Planning process

4.1. Planning sequence

**Original DTTB plan**
- Analysis of original plan
- To be reviewed due to new requirements and choice of DVB-T2 system variant

**39 main sites after ASO**
- Planning of 39 main sites optimized for the situation after analogue TV switch-off
  - Scenario C

**39 main sites during transition**
- Planning of 39 main sites before analogue TV switch-off, based on scenario C
  - Scenario B and A

**15 gap-fillers Bangkok**
- Verification of planning of 15 gap-fillers in Bangkok
  - Scenario C and B

**Additional sites**
- Planning of additional sites to reach coverage target of 95% households
  - Scenario C

**Planning main sites before additional sites:**
- “First come-first served” principle
- Planning of additional sites in such a way that main sites are not unacceptably interfered

Thai DTTB Plan
## 4. Planning process

### 4.2 Planning steps

<table>
<thead>
<tr>
<th>Step</th>
<th>Task Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Network topology</td>
<td>• Specification of location and initial ERP and antenna of sites</td>
</tr>
<tr>
<td>2</td>
<td>Initial channel assignments</td>
<td>• According to best practices</td>
</tr>
<tr>
<td>3</td>
<td>Compatibility analysis</td>
<td>• One channel per site (mid channel)</td>
</tr>
<tr>
<td>4</td>
<td>Detailed SFN/MFN planning</td>
<td>• Resolving interference</td>
</tr>
</tbody>
</table>
| 5    | Compatibility and coverage check | • All channels per sites  
• Checking on errors or omissions  
• Review of ERP to optimise coverage  
• Coverage calculations and presentation of results |

Main challenge was to reach the coverage target of 95% household coverage per network.

Thai DTTB Plan