DTTB Frequency Planning

Approach and choices made in developing the DTTB frequency plan in Thailand

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DTTB frequency planning

Topics

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

Thai DTTB Plan

Frequency assignment principles

Characteristic	A-priory plan	First come –first served	Non-protection basis
Known service areas	yes	yes	no
No unacceptable interference	yes	yes	no
Future requirements	yes	limited	yes
Flexibility regarding unforeseen developments	limited	limited	yes

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

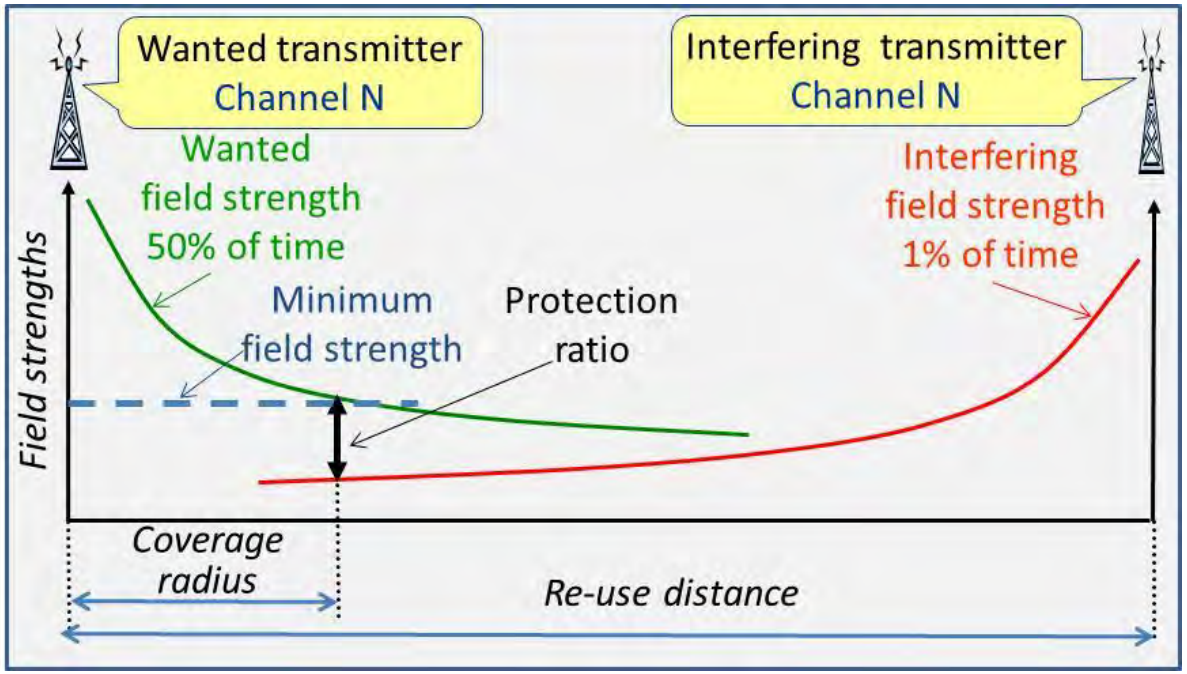
1. Frequency plan

1.2 Spectrum management principles

Frequency planning concept

- 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

Example Frequency re-use distance



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

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

Stages	VHF plan	UHF plan
Before DTTB launch	• ATV	• ATV • Mobile
During transition	• ATV	• ATV • DTTB • Mobile
After ATV switch-off	• DTAB	• DTTB • Mobile

Thai DTTB Plan

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

1. Frequency plan

1.4 Content of a plan

List of transmitting station characteristics

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

Example

Site 20.00

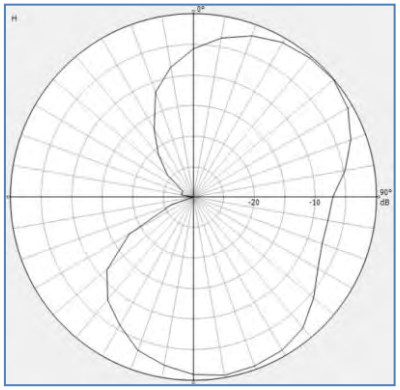
Chiang Mai

Long. 98.91502

Lat. 18.808140

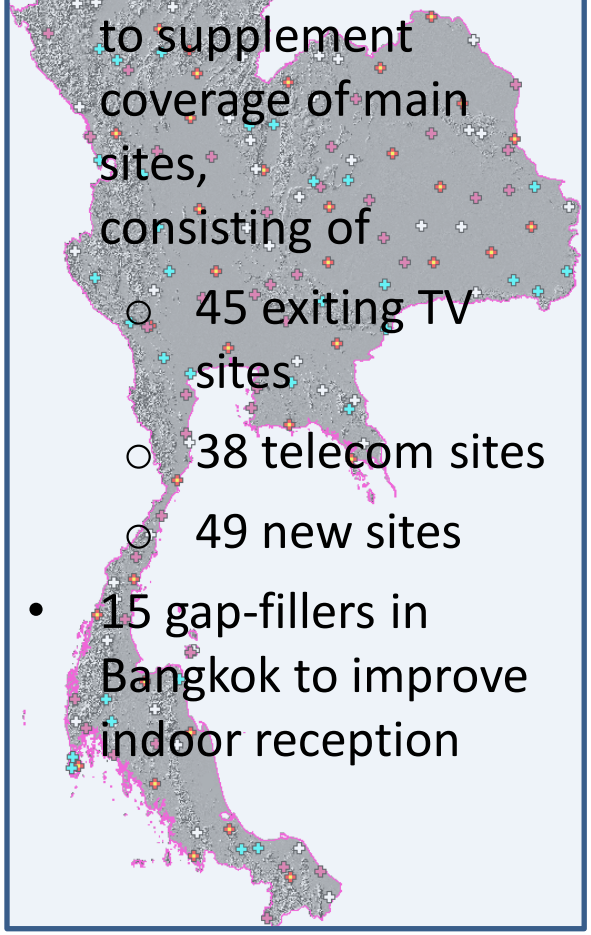
Network	Ch Sc C	Ch Sc B
NBT	46	60
Army TV-1	50	50
MCOT	54	54
TPBS	57	57
Army TV-2	38	38
Comm. TV	34	-

ERP 50 kW Directional antenna pattern



Thai DTTB Plan

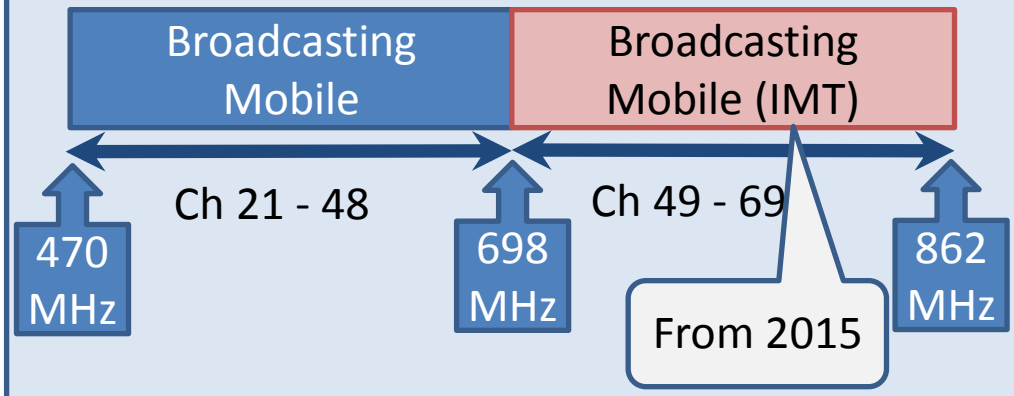
- 39 main sites
- 132 additional sites to supplement coverage of main sites, consisting of
  - 45 exiting TV sites
  - 38 telecom sites
  - 49 new sites
- 15 gap-fillers in Bangkok to improve indoor reception



2. Planning principles

2.1 Spectrum requirements

Thai DTTB Plan

International coordination	• Equitable access of the spectrum to all countries • Coordination agreements with neighboring countries	Within 100 km from Malaysian border use of even numbered channels
International and national spectrum regulations	• International frequency allocations in Asia-Pacific area in UHF band  • Each country should decide on the national applications	DTTB in UHF band Channels 26 to 60

2. Planning principles

2.2 Reception mode

Thai DTTB Plan

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

- 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

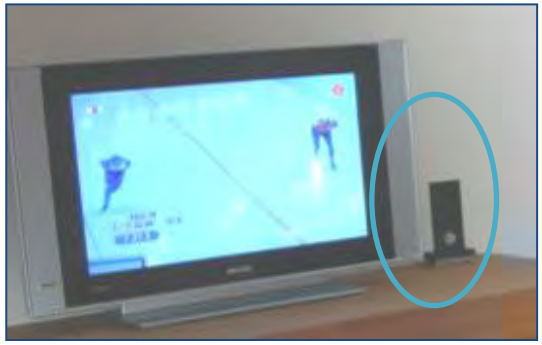
2. Planning principles

2.3 Reception mode

Thai DTTB Plan

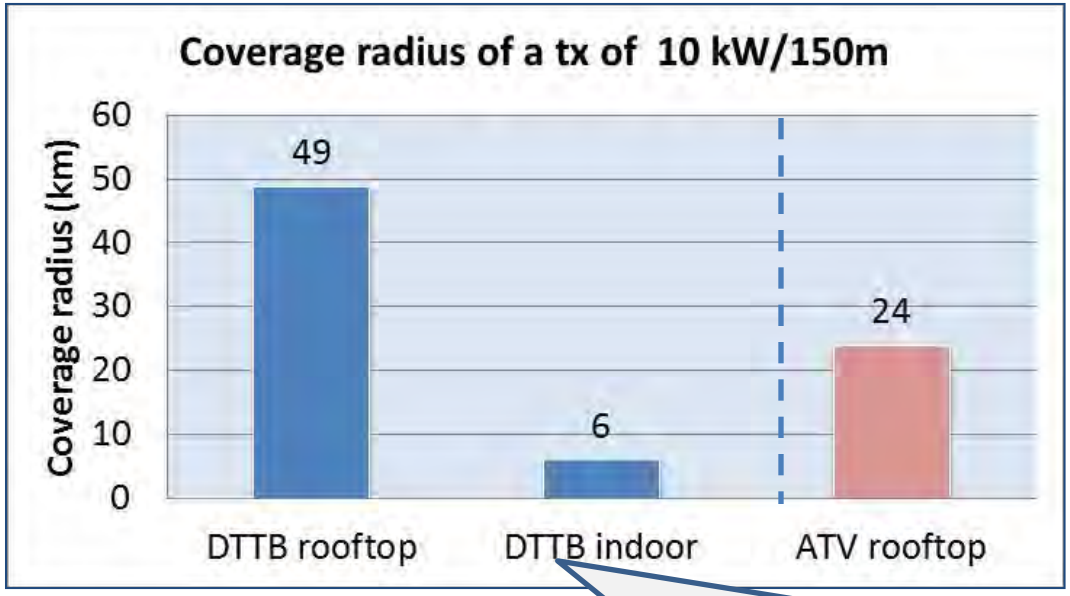
Indoor reception

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



- 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

Indoor reception requires much higher signal strength than rooftop reception



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

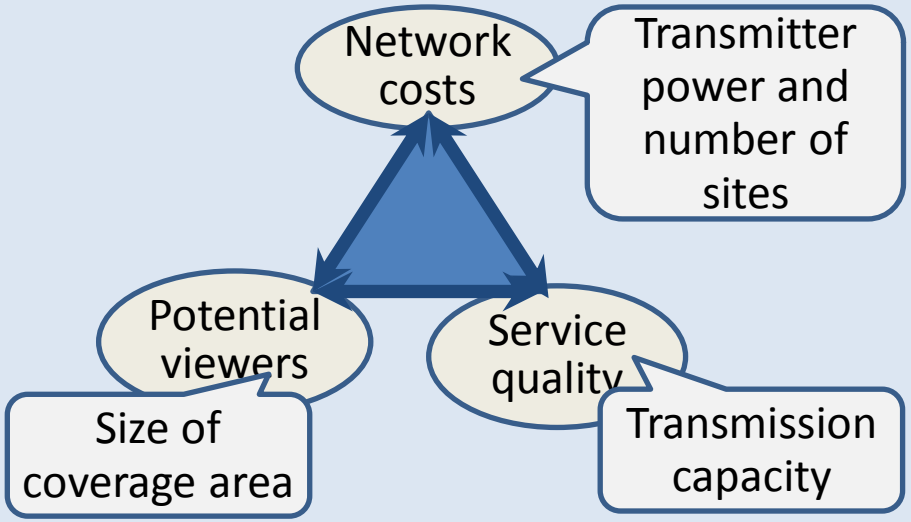
2. Planning principles

2.4 Service trade-off

Capacity, coverage and transmitted power are interrelated

- DVB-T2 system variant
  - More capacity → more power needed or smaller coverage area
  - More suitable for indoor and mobile reception → less capacity
- Site characteristics
  - More power and higher antenna → larger coverage

Service trade-off



Thai DTTB Plan

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

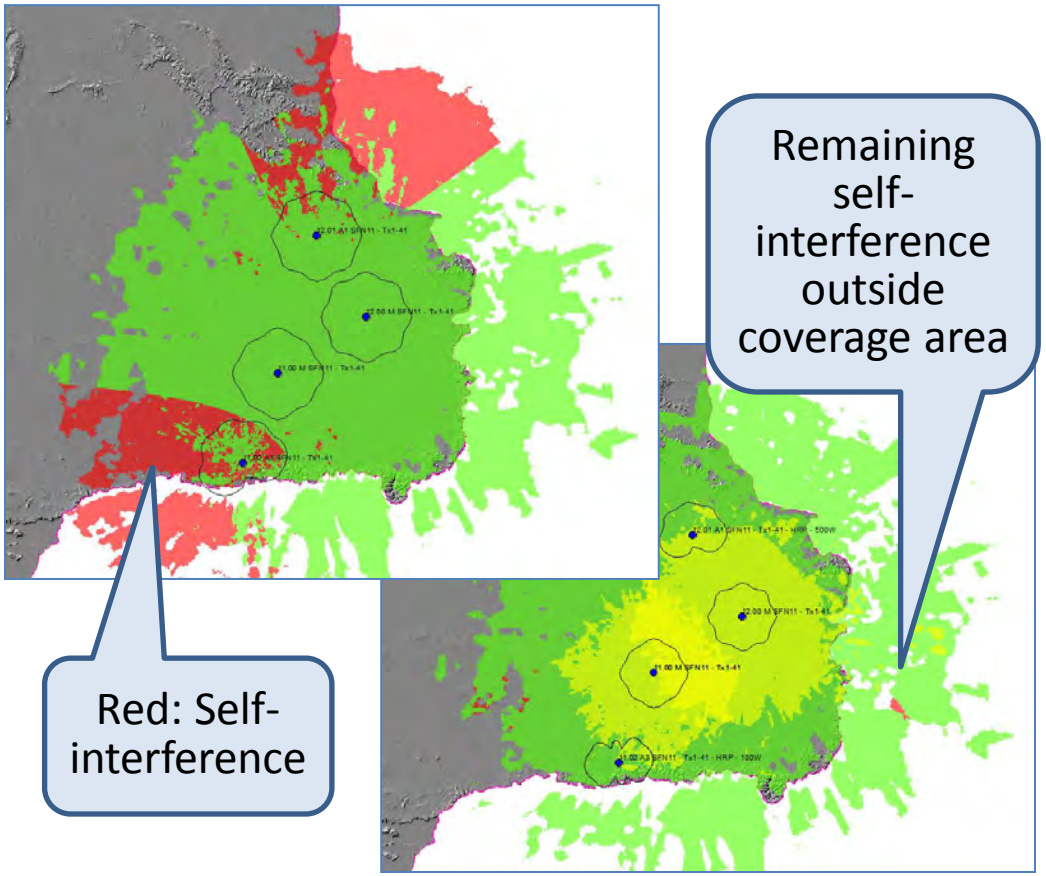
2. Planning principles

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-inter-ference resolved by means of artificial delay and modified antenna patterns



Thai DTTB Plan

- 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

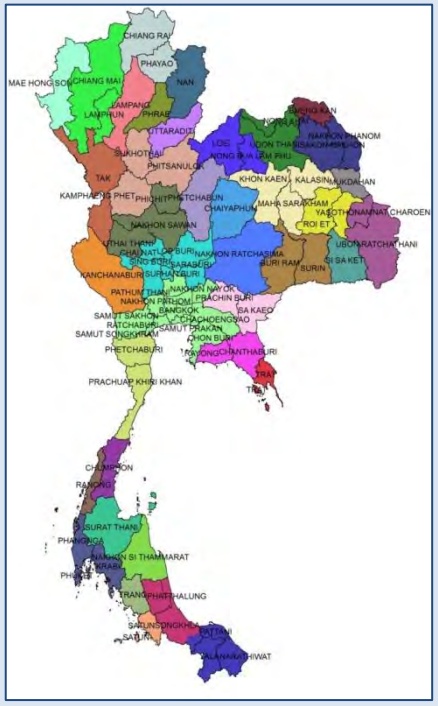
2.6 Regional coverage

Thai DTTB Plan

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)

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

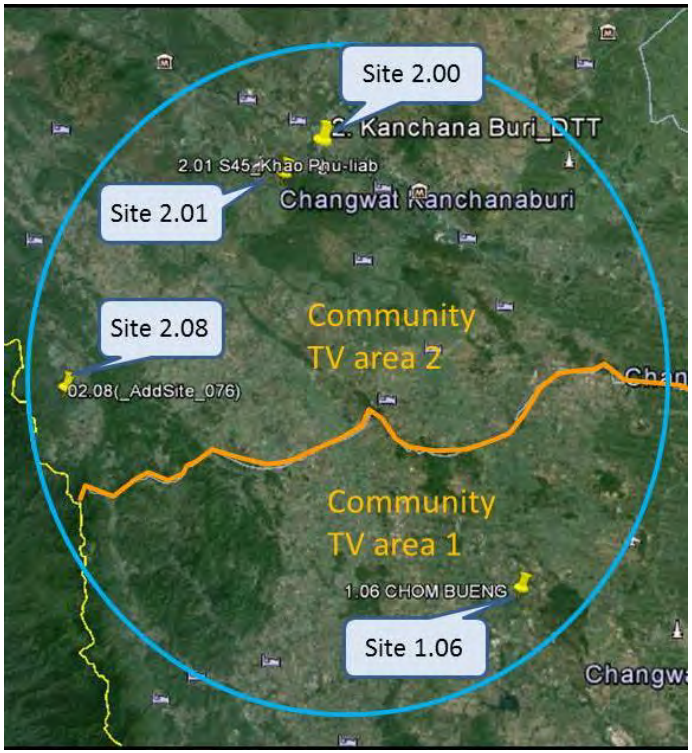


Example

SFN with 3 sites in community TV area 2 and 1 site in community TV area 1

Site	NBT	CTV
2.00	49	33
2.01	49	33
2.08	49	33
1.06	49	52

Decoupled from SFN to enable transmission of different services



2. Planning principles

2.7 Presentation of results

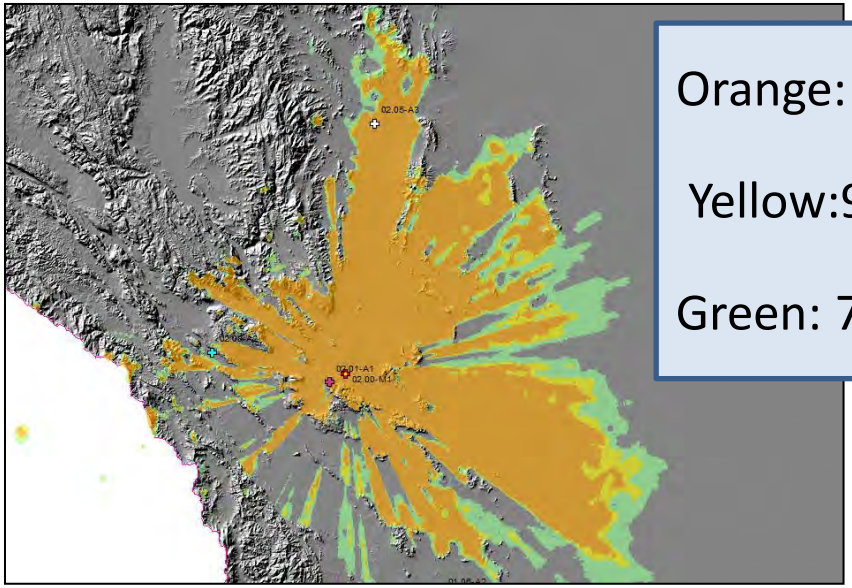
Thai DTTB Plan

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

Example

Coverage presentation



Orange: ≥ 95%

Yellow:90-95%

Green: 70-90%

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

3. Data and tools

3.1 Databases and planning software

Thai DTTB Plan

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

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

Thai DTTB Plan

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

4. Planning process

4.2 Planning steps

1	Network topology	• Specification of location and initial ERP and antenna of sites
2	Initial channel assignments	• According to best practices
3	Compatibility analysis	• One channel per site (mid channel)
4	Detailed SFN/MFN planning	• Resolving interference
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

Thai DTTB Plan

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