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T-DAB+ Coverage Planning – Models and Approach

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Contents of the Presentation

1. Requirements
2. Guidelines
3. Planning Software and Databases
4. Prediction Models
5. Key Aspects and Summary

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1. The importance of Planning and Requirements

- **Why plan?**
  - Analyse usability of existing infrastructure
  - Availability of frequencies
  - Coexistence with other services
  - How many services/programmes are needed?
  - Cost to of Network - Return on investments?
  - Roll out planning in different (realistic) phases

- **Clearly defined Planning Target** is important – Coverage, Area, Number of programmes, …

- Dialogue between Broadcasters - Network Providers – and Regulators

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1. Requirements – Iterations may improve quality!

- Planning is **an iterative process**

    - Refine requirements (Coverage, Capacity, Local/Regional subdivision..)

- Iterate plan a few times – improves quality

    - **Nominal plan 1** (including frequencies/allotments, general restrictions, ..)

    - **Intermediate plan 2** (Refined requirements, Detailed restrictions, Coordination with other countries, nominal site data)

    - **Detailed plan 3** (Implementation of plan, site data, equipment, usually **done by Broadcasters / Network Provider(s)**

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2. Planning Guidelines 1(2)

- **EBU Tech 3391**: Guidelines for DAB Network planning. A lot of useful information / parameters
  - DAB system
  - Single Frequency Networks (SFNs)
  - Receiver properties
  - Interference
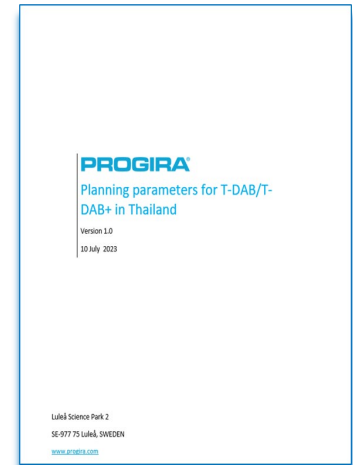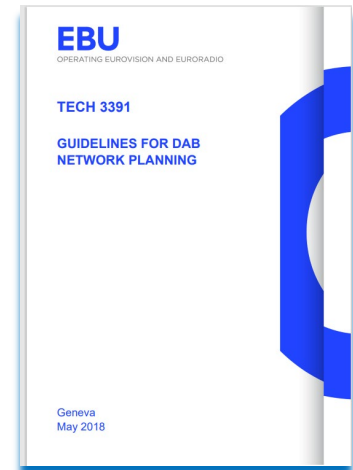 - …

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**GUIDELINES FOR DAB
NETWORK PLANNING**

Geneva
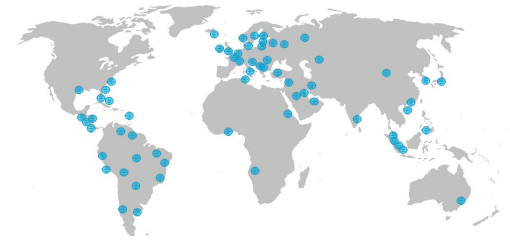May 2018

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2. Planning Guidelines 2 (2)

Development of "National" Guidelines often helps

- Requirements
  - Service type (mobile, indoor, …)
  - National, Regional, Local coverage
  - Planning targets
- Planning parameters
- Frequency availability
- Procedures – how is the planning done?
- Methods to calculate SFN coverage
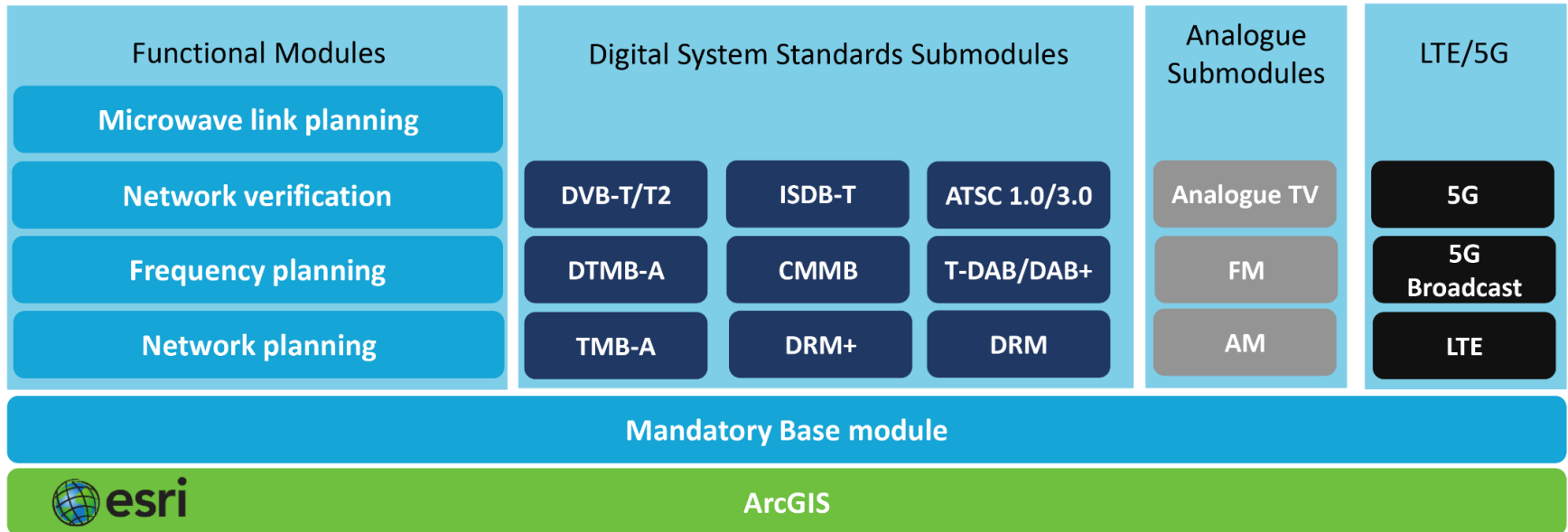- Software tools to use
- **Field strength Prediction model**
- …

A living document – Updates may be needed during process!

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GUIDELINES FOR DAB NETWORK PLANNING

Geneva
May 2018

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Planning parameters for T-DAB/T-DAB+ in Thailand
Version 1.0
10 July 2023

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3. Planning Software – The ESRI ArcGIS Pro platform

- PROGIRA plan software
  - Used in about 50 countries
  - T-DAB model - System properties

Functional Modules	Digital System Standards Submodules			Analogue Submodules	LTE/5G
Microwave link planning					
Network verification	DVB-T/T2	ISDB-T	ATSC 1.0/3.0	Analogue TV	5G
Frequency planning	DTMB-A	CMMB	T-DAB/DAB+	FM	5G Broadcast
Network planning	TMB-A	DRM+	DRM	AM	LTE

Mandatory Base module

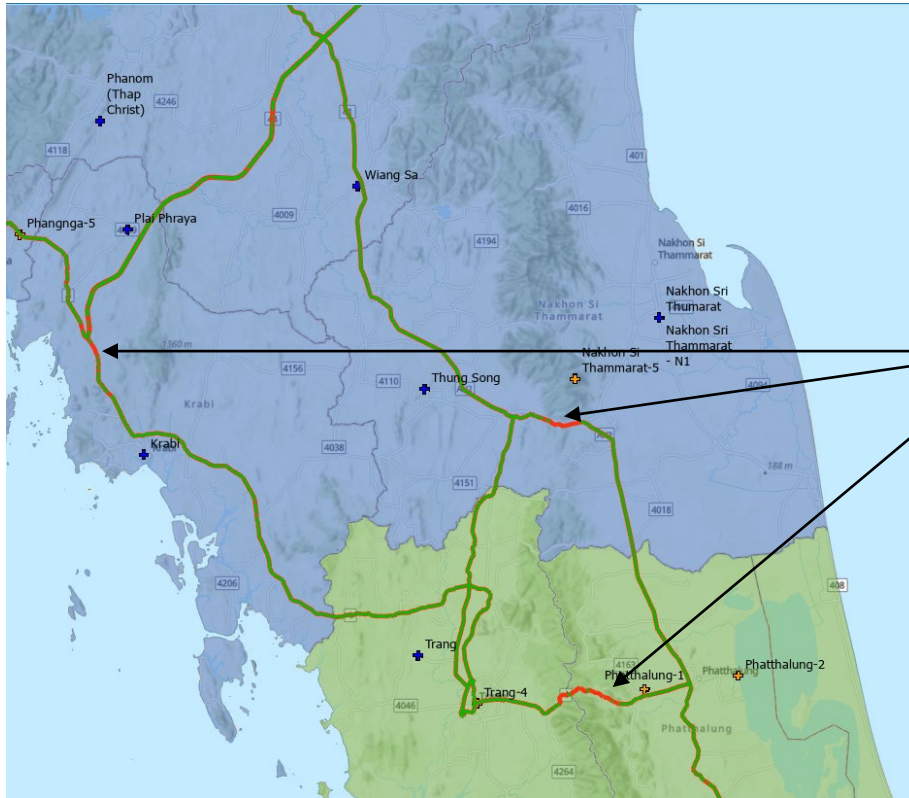**esri** — **ArcGIS**

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3. Planning Databases Example

Databases used in
Transmission planning

- **Elevation data**: Example
  50 x 50m raster data

- **Clutter data**: Example
  50 x 50m raster data

- **Population data:** used
  to verify if coverage
  target is met

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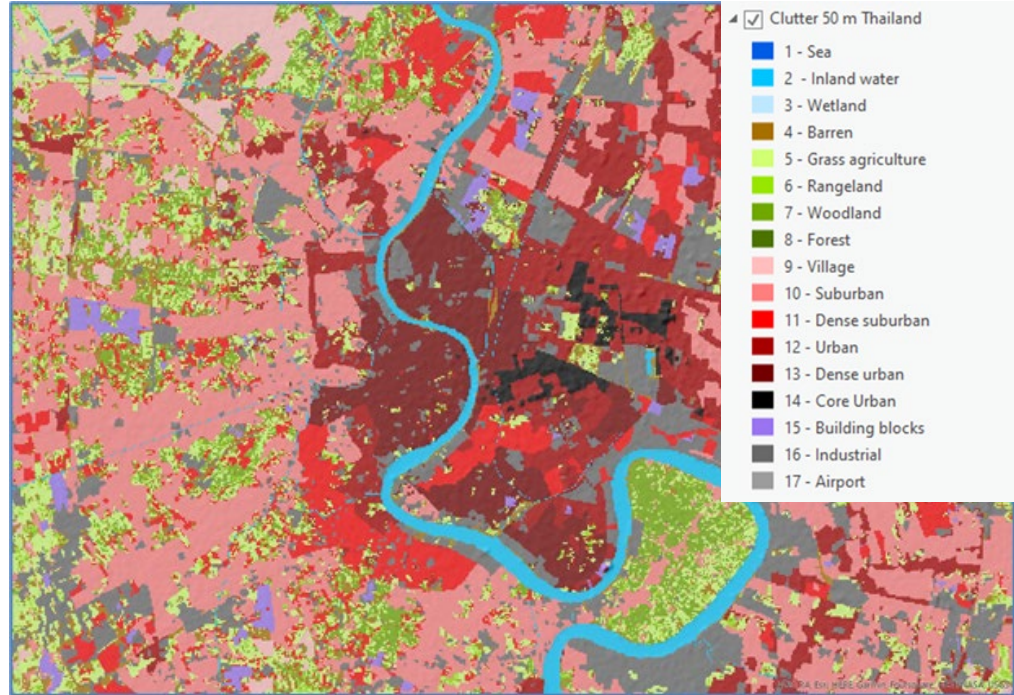
3. Road coverage – Road vector data

Example

- Highway – 99.9%
- Main Road (1 digit) – 93.4 %
- Regional Roads (2 digits) – 89.2%

Uncovered parts

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# 4. A few Propagation models

	IRT-3D	CRC-Predict	ITU-R P.1812	ITU-R P.526	Deygout Assis	Longley Rice	ITU-R P.1546	ITU-R P.370	Okumura Hata	Free space
Freq. range	50 – 2000 MHz	50 –2500 MHz	30 – 3000 MHz	100 – 10000 MHz	100 – 10000 MHz	20 – 20000 MHz	50 –3000 MHz	50 – 3000 MHz	150 –2000 MHz	No freq. limitation
Free-space	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Reflection	Yes	Yes, ground	No	No	No	No	No	No	No	No
Refraction	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Troposperic Scatter	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Diffraction	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Terrain based	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Clutter database	Yes	Yes	Yes	No	No	No	No	No	No	No
Static clutter att.	No	No	No	No	No	No	Yes	Yes	Yes	No
Tabulated FS values	No	No	No	No	No	No	Yes	Yes	No	No
Tuning of model to fit measurements	Yes	Yes	Yes	No	No	No	No	No	No	No

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4. Field strength Propagation models

- Many field strength prediction models to choose from

- ITU-R Models

  - **ITU-R 1546** – Area general model
    - ✓ Field strength curves
    - ✓ Effective Antenna height (heff)
    - ✓ Mainly for coordination purposes
    - ✓ Useful to be able to provide same result between countries
    - ✓ Clearance angle - involving terrain data

  - **ITU- 1812** – Terrain based
    - ✓ Clutter + elevation data

Rec. ITU-R P.1546-6   15

FIGURE 9
600 MHz, land path, 50% time

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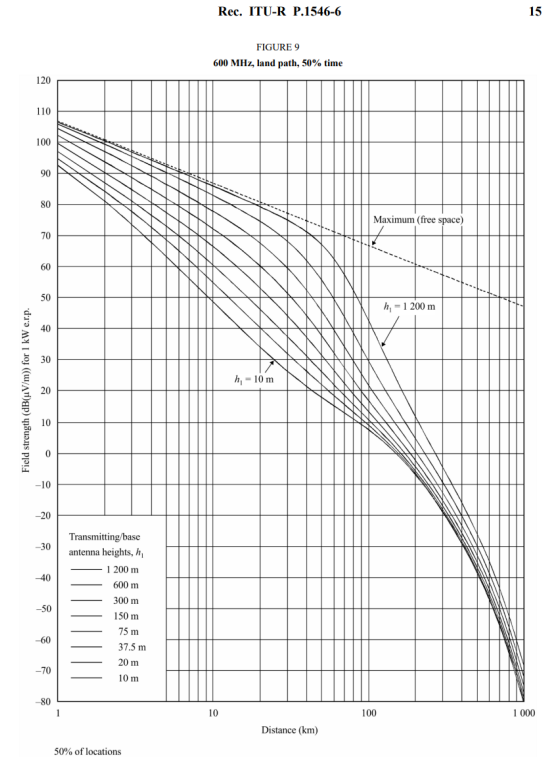
4. Field strength prediction models – Comparison
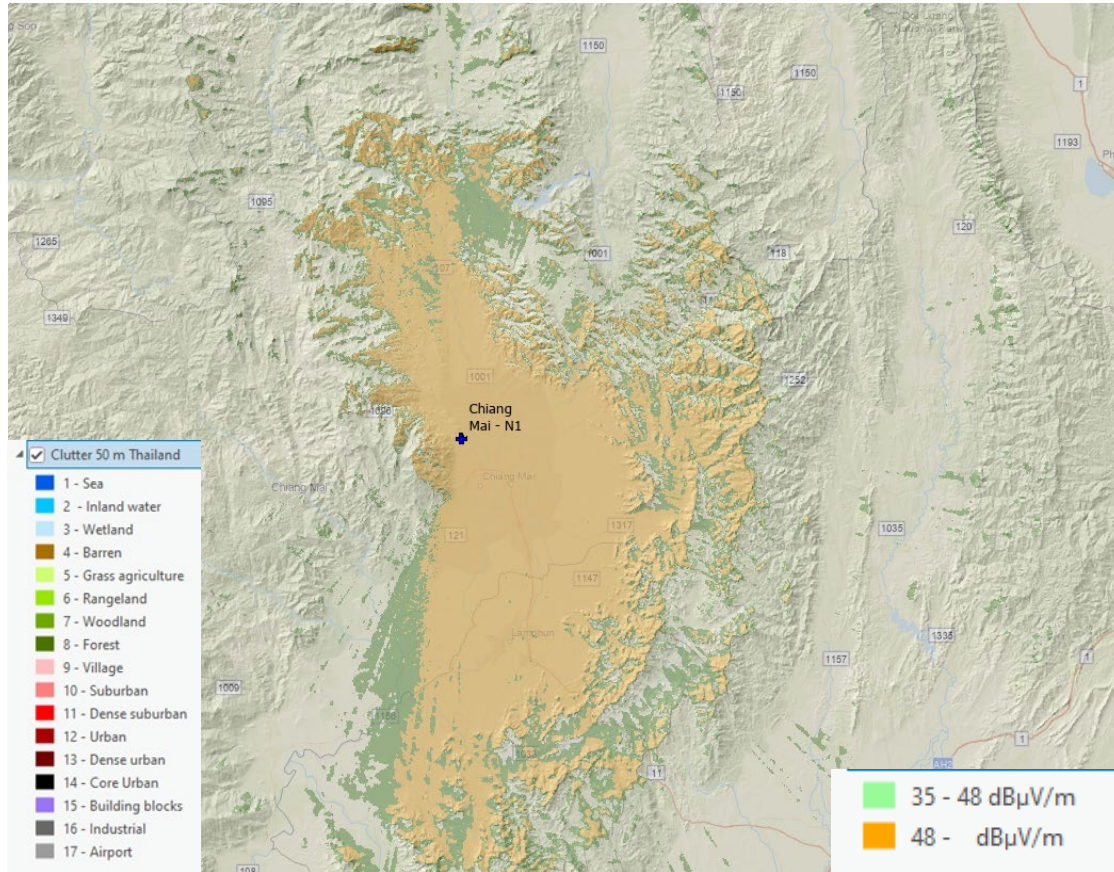
Example In Thailand

ITU-R 1546-6 No Clearance Angle

ITU-R 1546-6 Clearance Angle

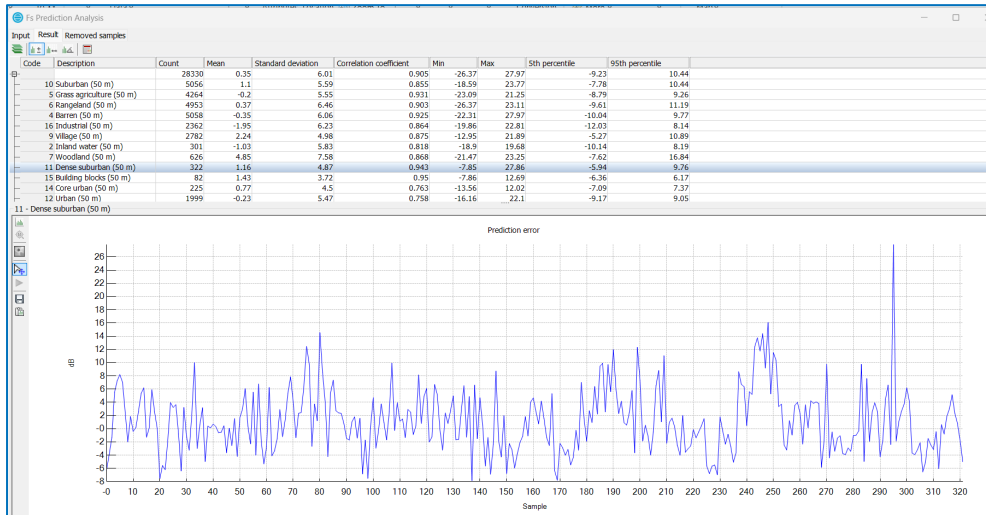ITU-R 1812 – Terrain No Clutter

ITU-R 1812 – Terrain With Clutter

CRC Predict – Terrain and Clutter (Adj)
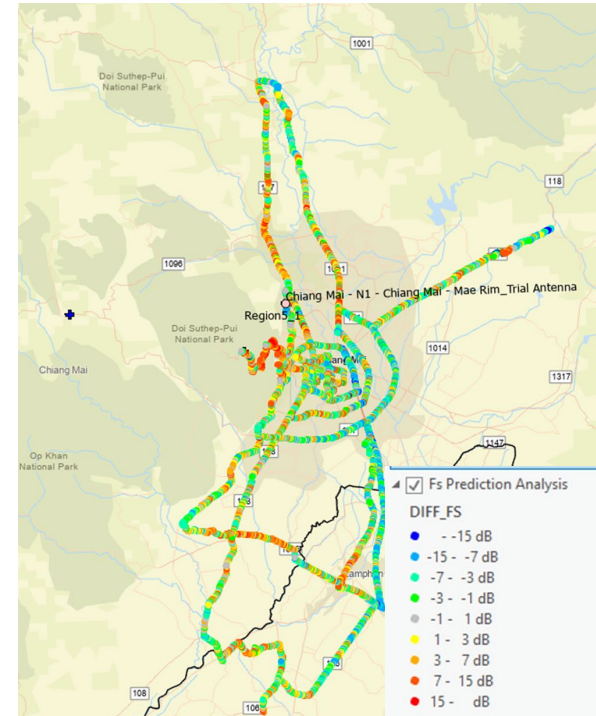
Mobile antenna @1.5 m
Resolution 50 x 50 m

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4. Field strength Prediction program

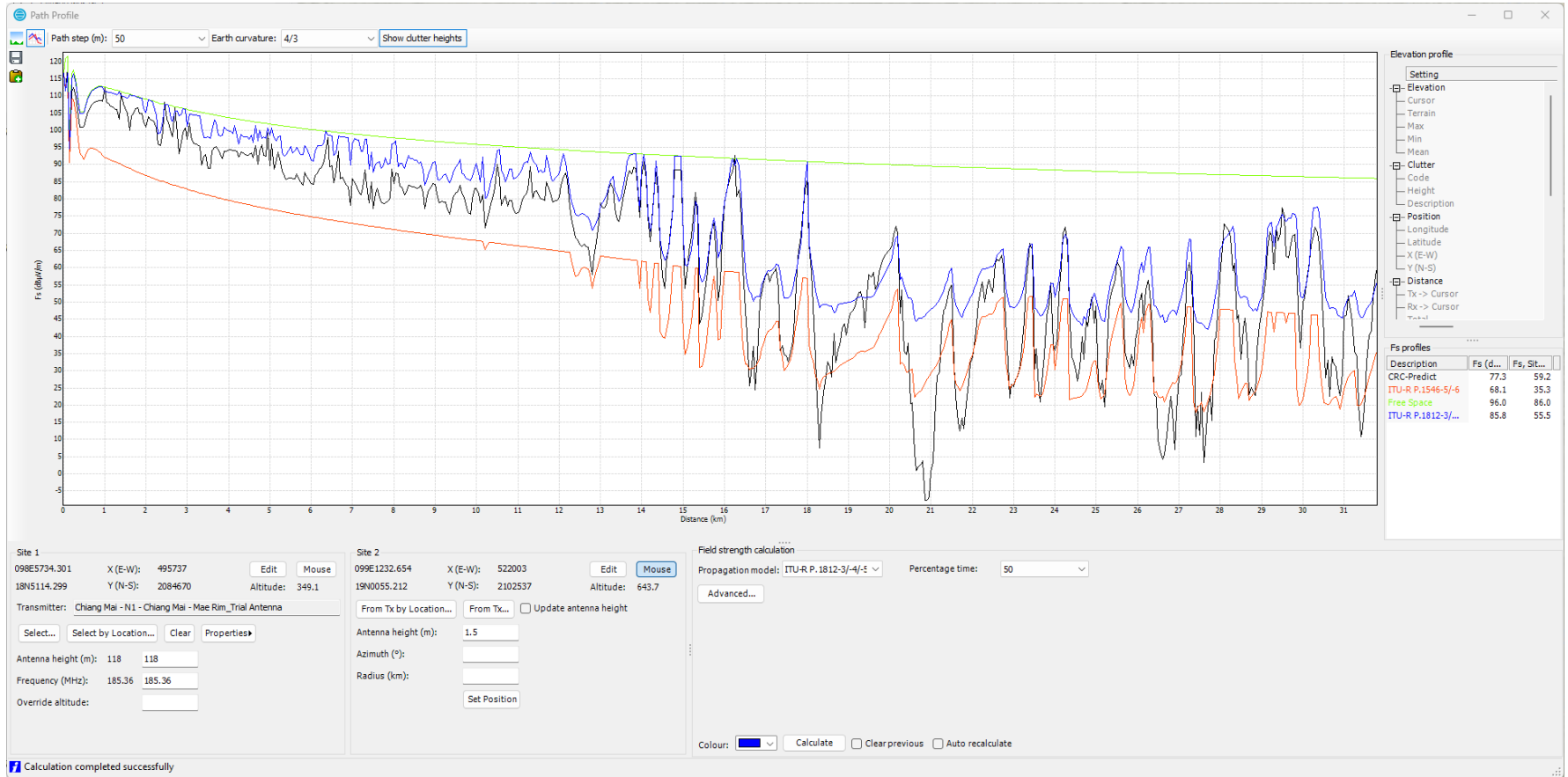**Prediction Accuracy for CRC-Predict**
- Measurement from DAB Trial in Chiang Mai

- Mean error 0.3 dB, Spread 6 dB, correlation about 90%
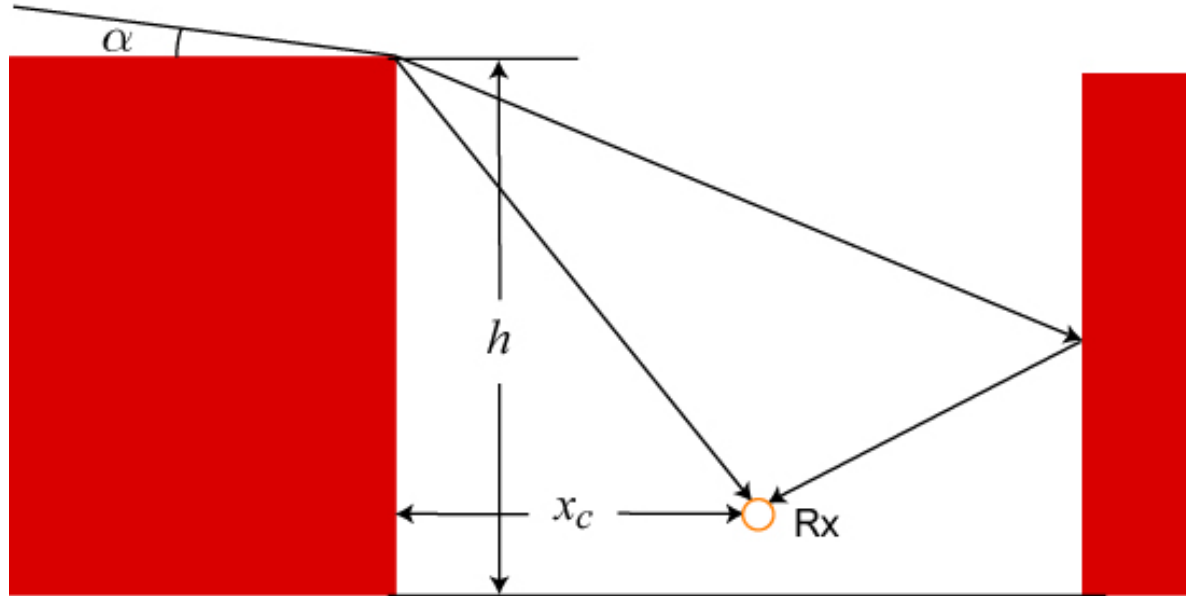- Potential for adjustment of clutter parameters

4. Field strength Prediction models – "Flat terrain"

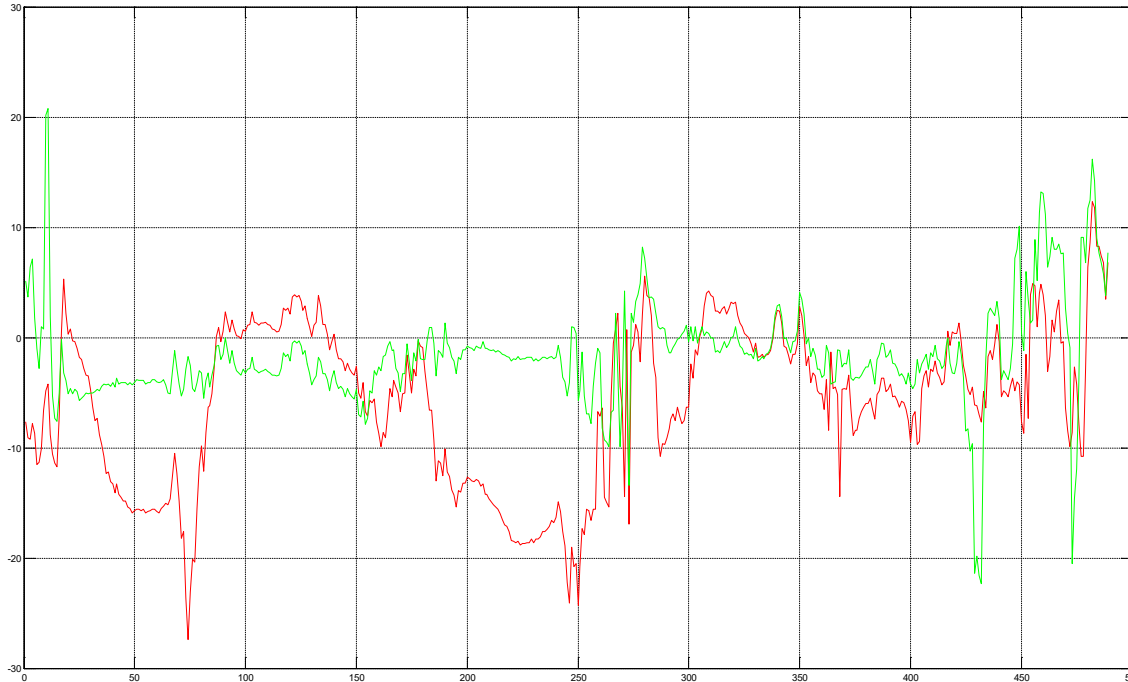# 4. Field strength Prediction models – Hilly terrain

4. Field strength at street level (use of clutter data)

4. Comparison between 2D and 3D model

- Mobile Measurements in Hong Kong, dense urban area - 480 MHz
- Standard deviation Error - reduced from 7.2 dB (CRC) → 4.6 dB (IRT3D)
- Mean error improved -5.8 dB (CRC) to -1.5 dB (IRT3D)

- IRT3D (Predicted-measured)

- CRC (Predicted-measured)
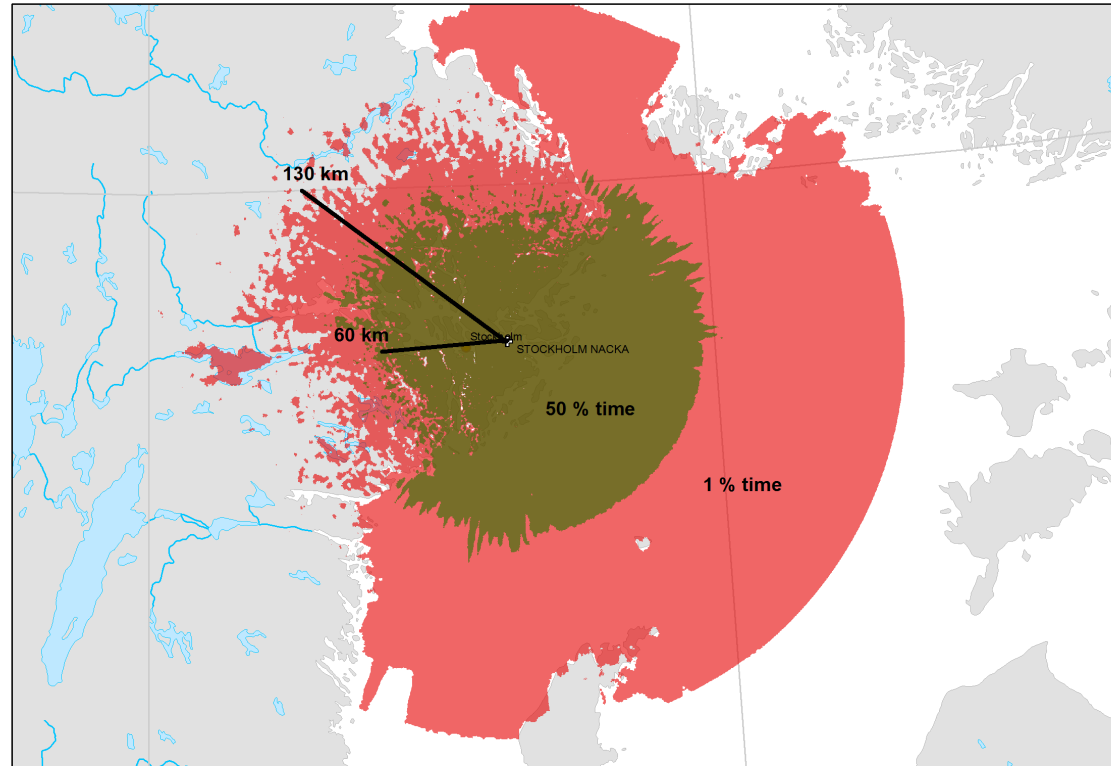
Resolution:5 meters Building data

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4. Spherical Earth (Tropospheric propagation)

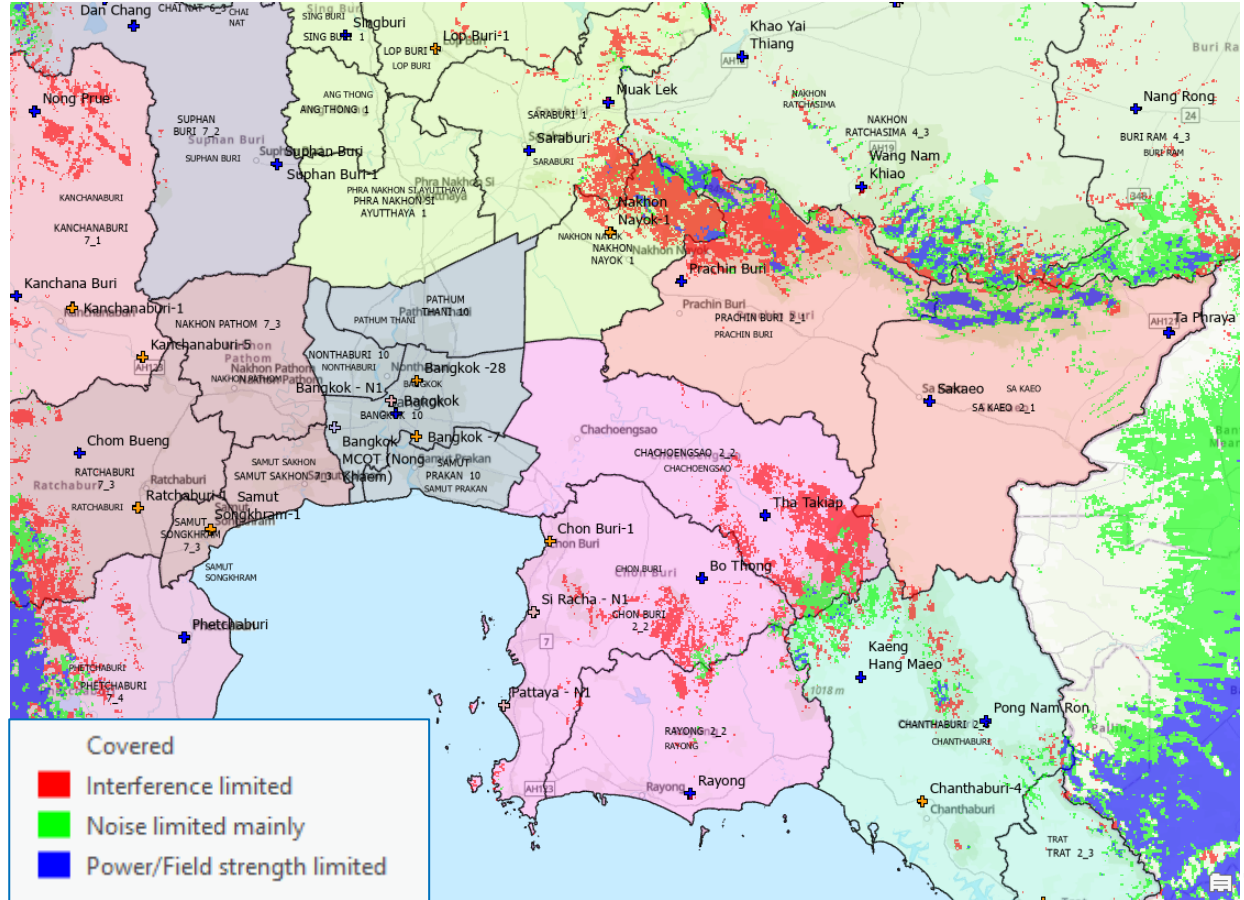Large difference between

- 1 % of time

And

- 50% of time propagation

- Change of Earth curvature OR
- Measurement based

- Needed in SFNs

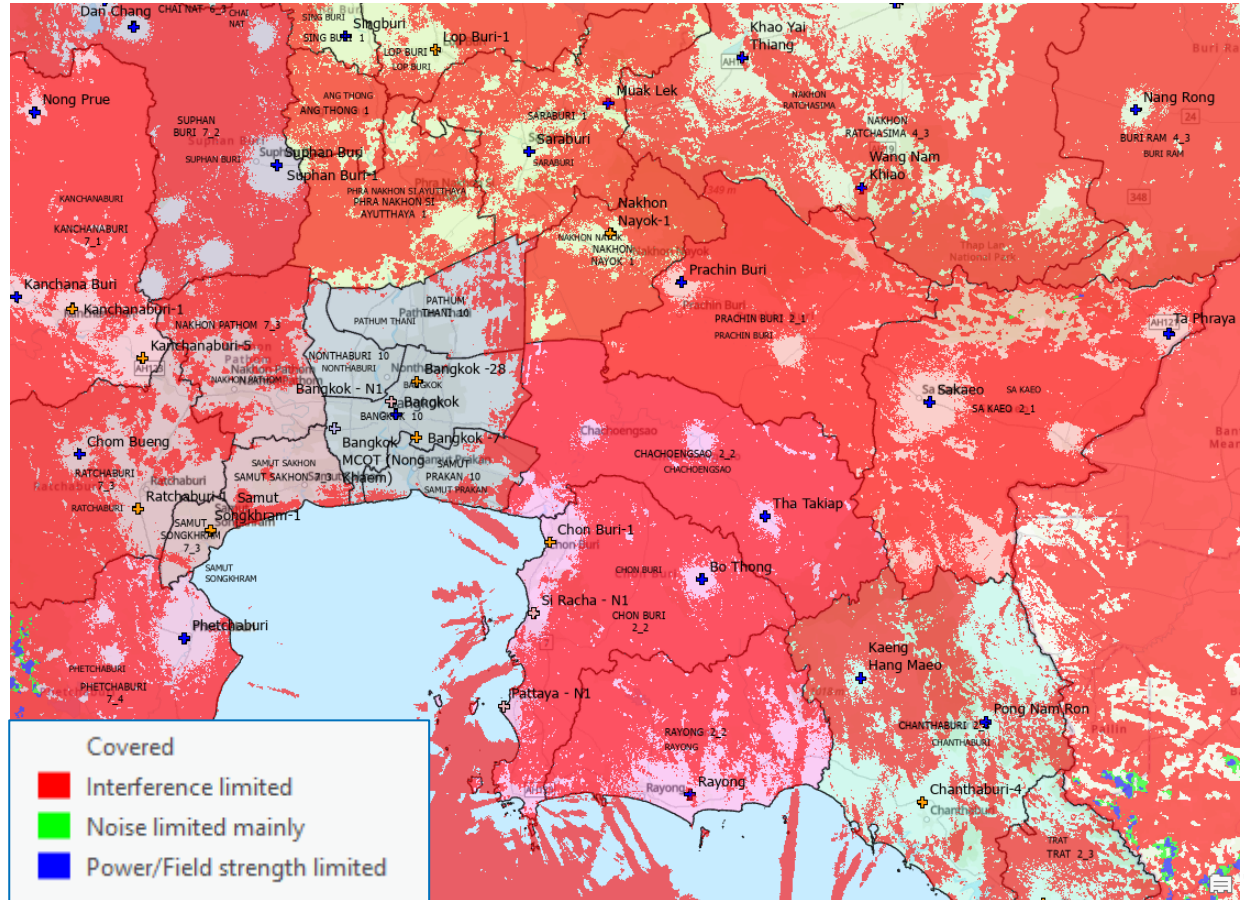# 4. T-DAB SFN 50% vs 1% of time

T-DAB
SFN Self
Interference

50% of time

4. T-DAB SFN 50% vs 1% of time

T-DAB
SFN Self
Interference

1 % of time

Covered

- 🟥 Interference limited
- 🟩 Noise limited mainly
- 🟦 Power/Field strength limited

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4. Properties of Prediction Model for T-DAB @ Band III

Prediction model "Requirements":

- Calculate at 1.5 m receiving antenna height
- Mechanism for different time percentages (e.g. 50%, 10, 5 and 1%) to access Interference and SFN self-interference
- Use of clutter data (Urban and Suburban areas important)
- Use Model which can be adjusted/tuned using measurement data
- Database Resolution 100m, 50m, 20m @VHF frequencies
- T-DAB SFN model: Coverage Probability – SFN Delay optimization

But

- Choice of the field strength prediction model may be "national" decision!
- Any model will allow evaluation of difference between network options
- 3D prediction is often an "overkill" at VHF (cost of 3D building data may be high)

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5. Coverage Planning summary

- Clearly defined targets is essential - Coverage, Area, Number of programmes…

- Involvement from Broadcasters and Network providers - important

- Iterative planning process – Nominal → Detailed planning – a few iterations

- SFN size vs. Effective frequency reuse + DAB Self-interference and program flexibility

AND

- Plan before buying equipment! One "unnecessary" site will save the cost of the planning!

Define <u>Requirements</u> as detailed as possible <u>and</u> be prepared to reconsider…
If you know what you want, you have a chance to getting it…

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Thank you for listening!

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