Frequency Planning for FM Broadcasting Service

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Basis of the VHF/FM transmission plan

- **High-quality FM stereo broadcasting service**
- **Territory-wide coverage**
- **Compatible with other services, particularly aeronautical service**
- **Frequency coordination with neighbouring territories**

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Frequency band & channel spacing

- **ITU Frequency Allocation: 87.0 – 108 MHz**
- **Most domestic FM receivers operate in the range 87.5 – 108 MHz**
- **In accordance with Rec. ITU-R BS.412-9**
  - A uniform spacing of 100kHz is adopted
  - Nominal carrier frequencies shall be integral multiples

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Propagation models for field strength prediction

- **Free-space propagation**
- **ITU-370 propagation curves (Rec. ITU-R P.370-7)**
- **General method for multiple obstacles (Rec. ITU-R P.526-8)**
  - Diffraction loss over irregular terrain
  - Suitable for terrestrial paths over land or sea and for both line-of-sight and trans-horizon

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Minimum usable field strength

- **Recommendation ITU-R BS.412-9**

Areas	Monophonic dB(μV/m)	Stereophonic dB(μV/m)
Rural	48	54
Large cities	70	74

- **In the absence of interference, 34dB(μV/m) is considered to give an acceptable monophonic service**

- **In practice, 60dB(μV/m) would give an acceptable stereophonic service**

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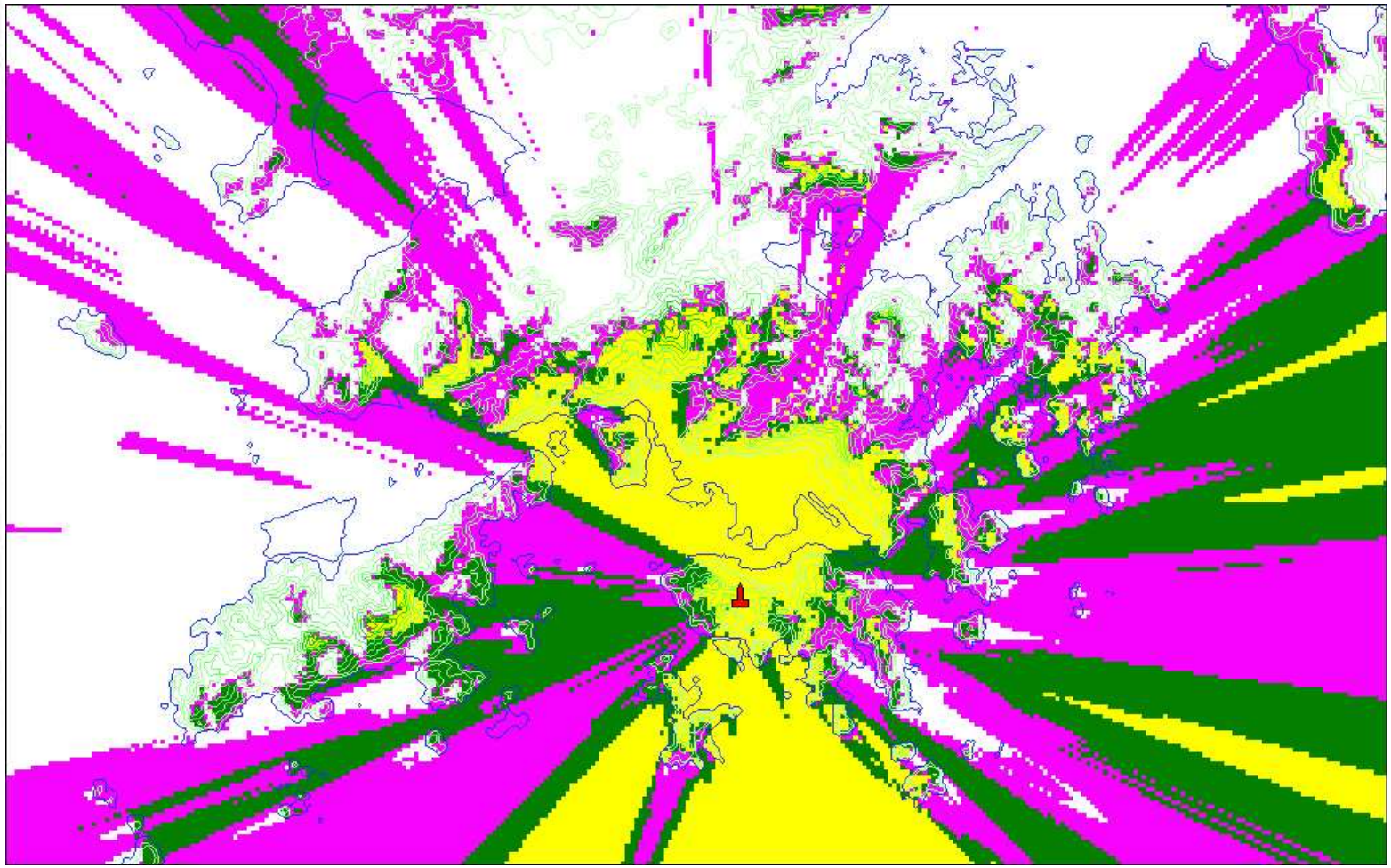
Coverage of Mt Gough (3kW erp)

Pink: 48 ~ 60dB(μV/m) Green: 60 ~74dB(μV/m) Yellow: >74dB(μV/m)



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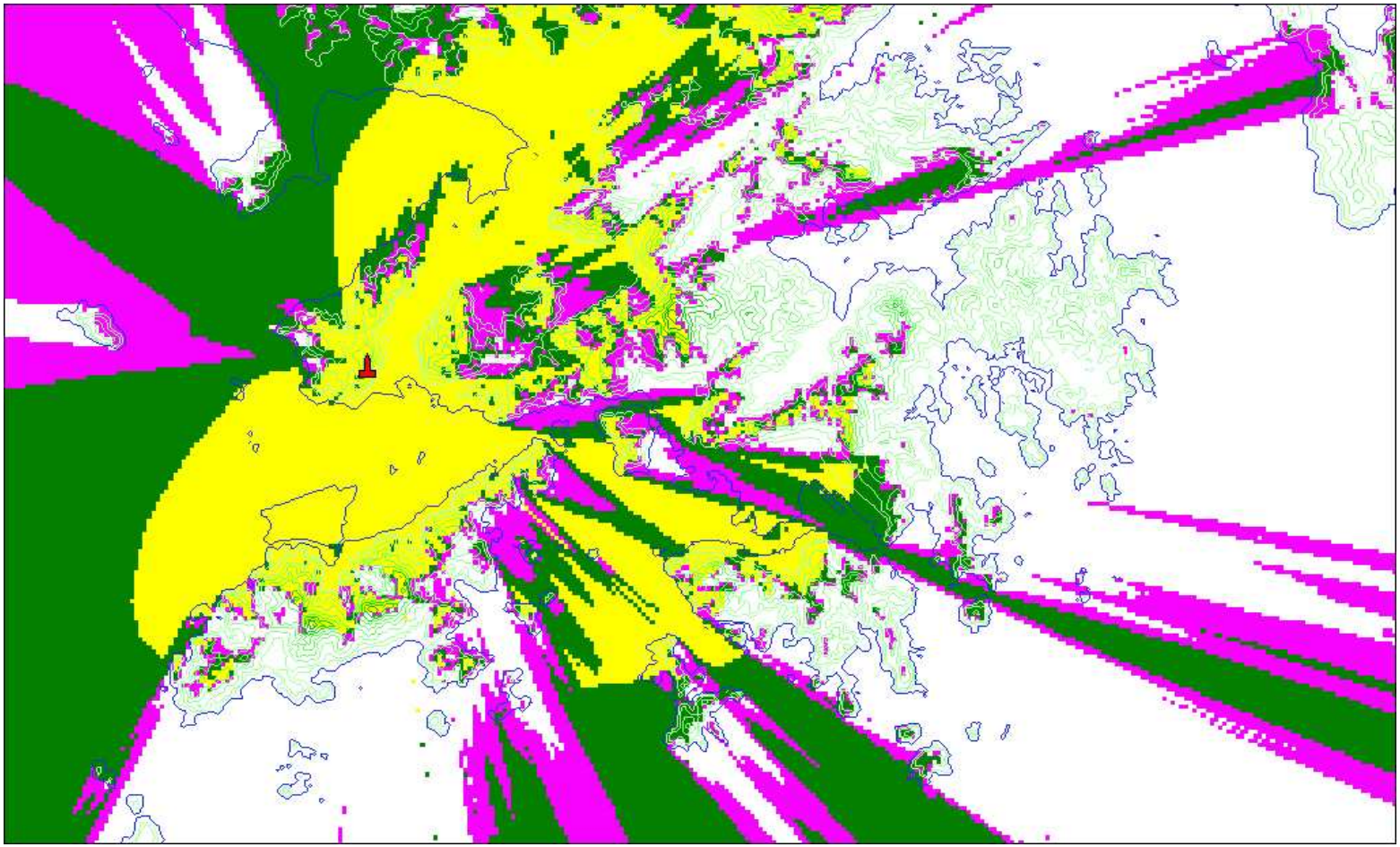
Coverage of Castle Peak (0.7kW erp)

Pink: 48 ~ 60dB μV/m Green: 60 ~ 74dB μV/m Yellow: >74dB μV/m



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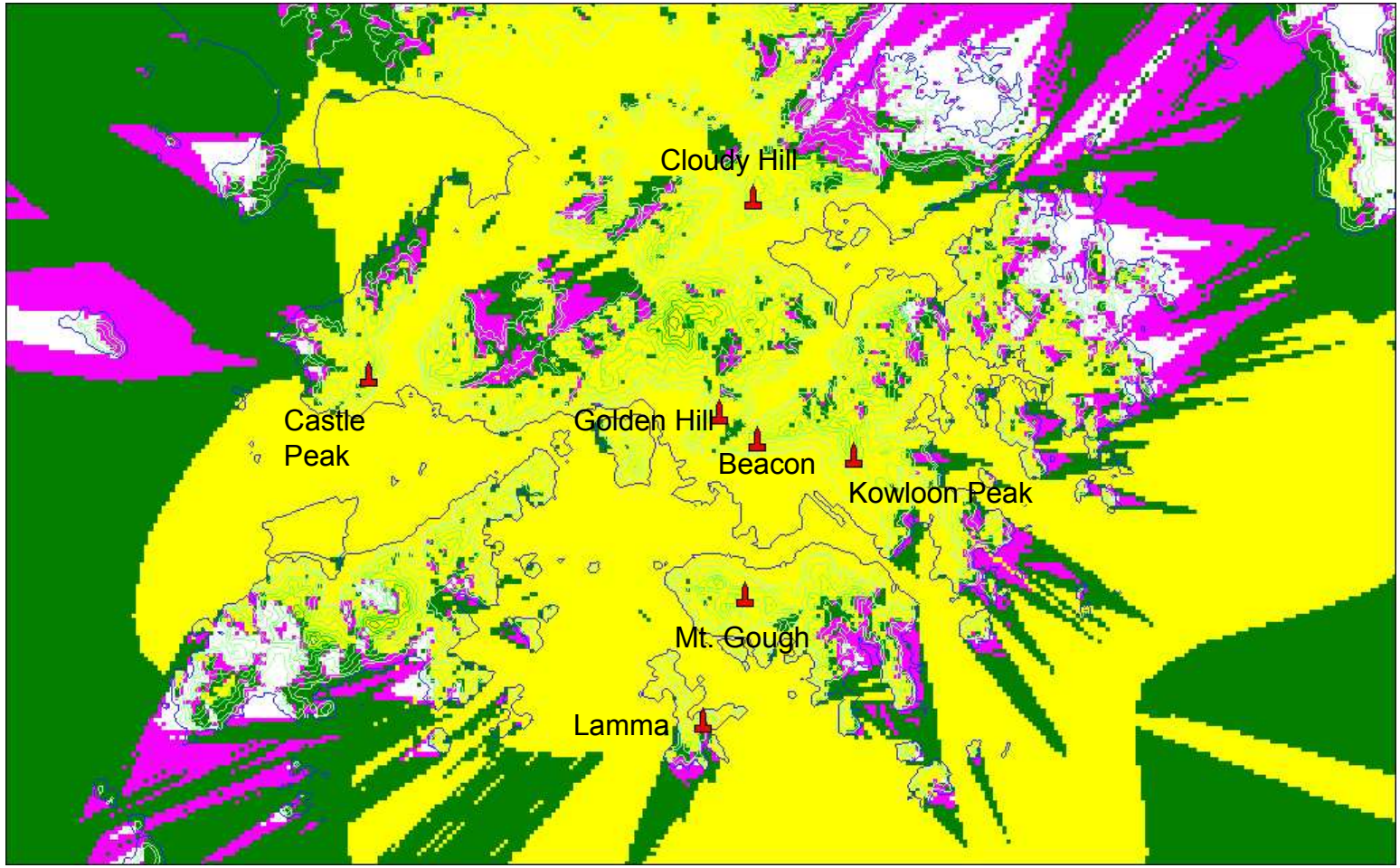
Territory-wide coverage

Pink: 48 ~ 60dB μV/m Green: 60 ~ 74dB μV/m Yellow: >74dB μV/m



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Radio-frequency protection ratio

Carrier frequency spacing (kHz)	Protection ratio (dB) using a maximum frequency deviation of ±75 kHz
0	45
100	33
200	7
300	-7
400	-20

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Permissible value of interference

Margin = Wanted signal – Interference signal – Protection Ratio

Carrier frequency spacing (kHz)	Permissible value of interference dB(μV/m)
0	29
100	41
200	67
300	81
400	94

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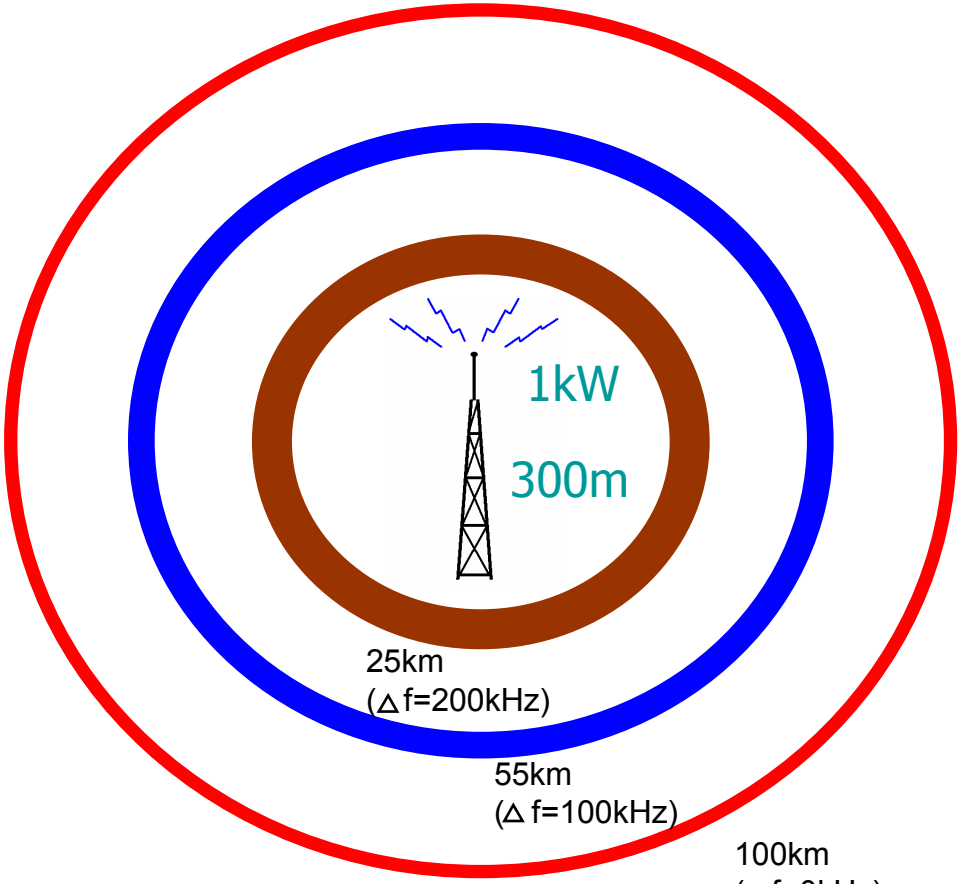
Interference zone



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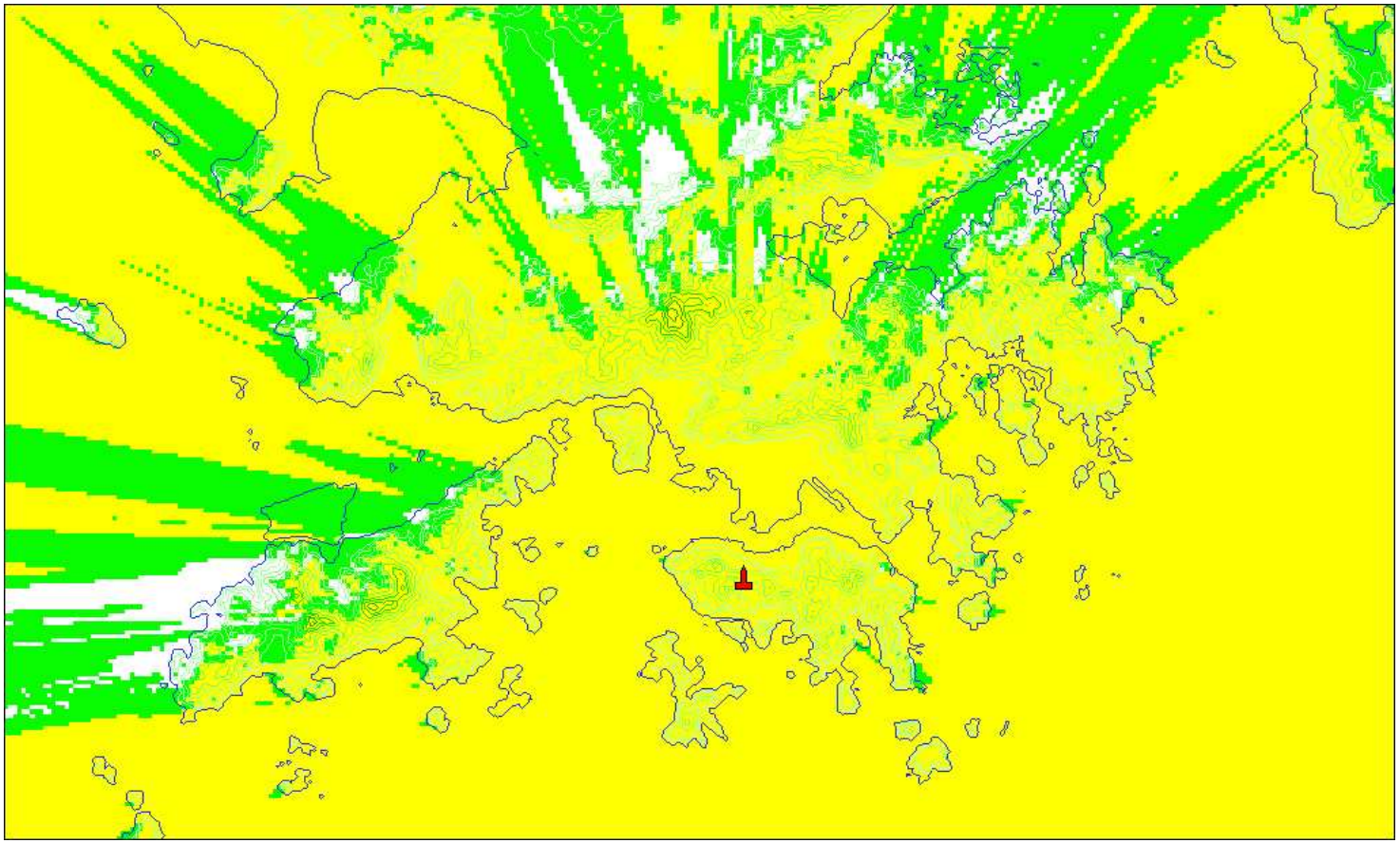
Interference field strength prediction

Mount Gough (erp 3kW Height: 400m)
White: <29dB(μV/m) Green: 29 ~ 41dB(μV/m) Yellow: >41dB(μV/m)



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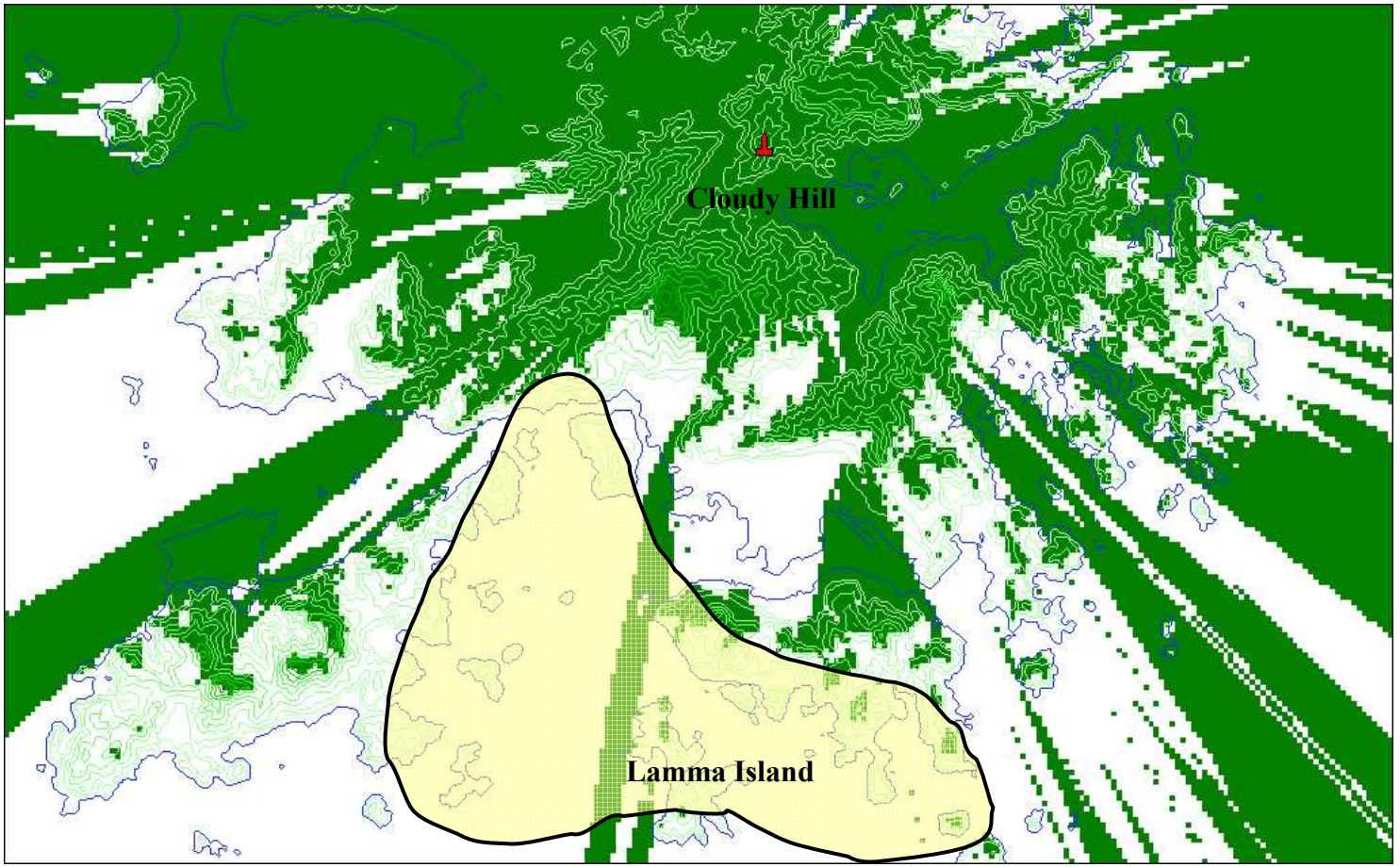
100kHz separation between Cloudy Hill and Lamma

Green: > 41dB(μ V/m)



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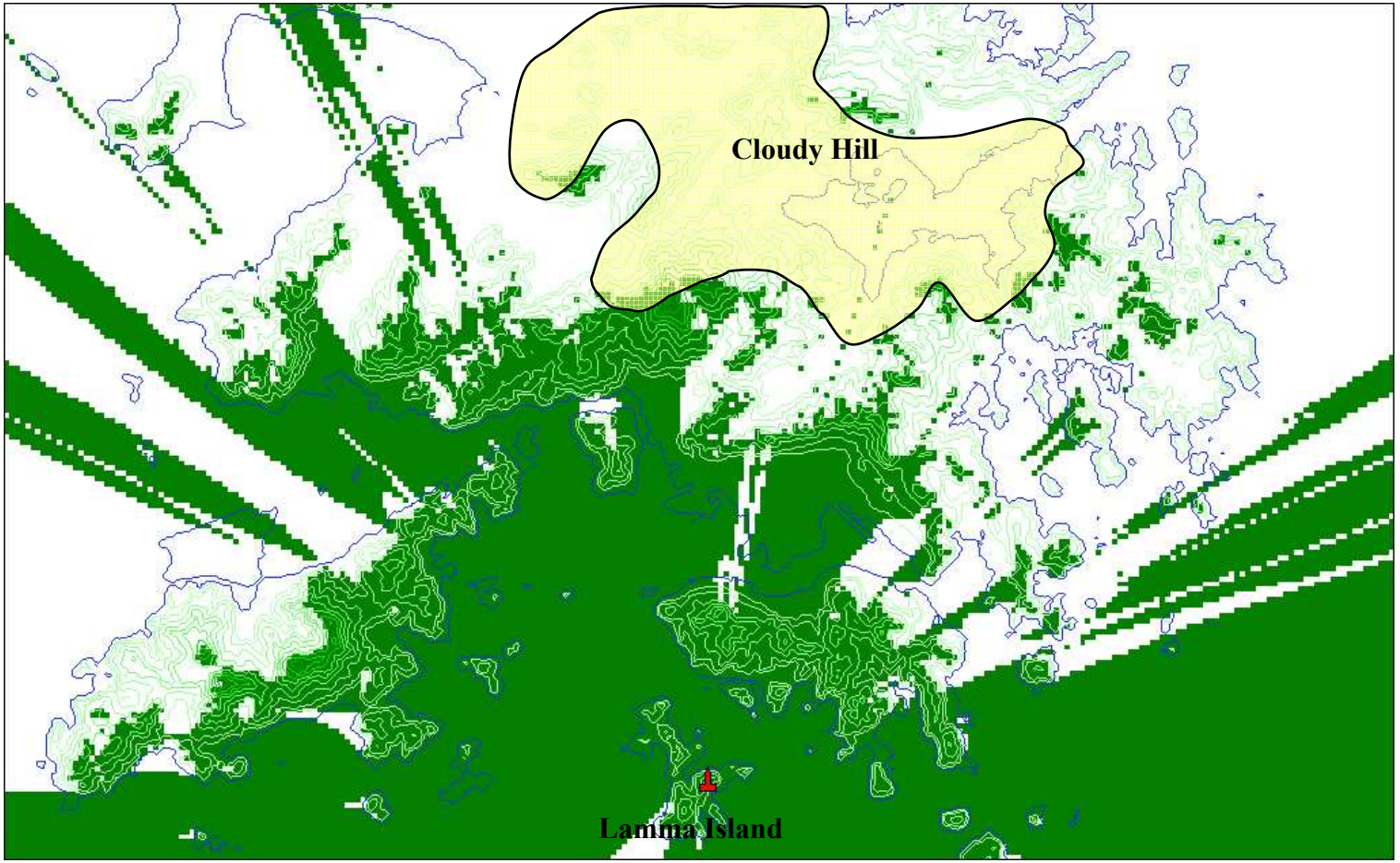
100kHz separation between Cloudy Hill and Lamma

Green: > 41dB(μ V/m)



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Frequency separation at the same site

- **Normally 1.8 MHz separation at the same site is required**
- **0.8 MHz separation is minimum for low power transmitters or where separate antenna is used**
- **In the case of Hong Kong, 1.7 MHz separation is used**

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Frequency separation between transmitters at the various sites

	Mount Gough	Cloudy Hill	Castle Peak	Golden Hill	Lamma	Beacon Hill	Kowloon Peak
Mount Gough	17	2	4	3	4	3	4
Cloudy Hill	2	17	2	1	1	3	3
Castle Peak	4	2	17	3	2	1	2
Golden Hill	3	2	3	17	2	2	2
Lamma	4	1	2	2	17	1	2
Beacon Hill	3	3	1	2	1	17	3
Kowloon Peak	4	3	2	2	2	3	17

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Carrier frequency differences greater than 400 kHz

- **For carrier frequency differences greater than 400 kHz, the protection ratio values should be substantially lower than -20dB**

- **The protection ratio value for the particular carrier frequency difference of 10.7 MHz (intermediate frequency of the domestic receivers) is -20 dB**

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Compatibility with aeronautical services in the band 108-137 MHz

- **FM broadcast interference to instrument landing system (ILS) localizer, omnidirectional radio range (VOR), and aeronautical communications (COM) equipment has been a widely recognized problem**

- **The interference may cause serious problem (disruption of air/ground communication, errors in course deviation etc.)**

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Interference assessment criteria

- **Rec. ITU-R SM. 1009-1 stipulates the criteria for compatibility calculations**

- **Characteristics of aeronautical systems such as Designated Operational Coverage (DOC), interference threshold, protection ratios etc. are taken into account**

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Types of interference mechanisms

- **Type A1 interference**
  - Inter-modulation generated from several broadcasting transmitters
- **Type A2 interference**
  - Spurious radiation from broadcasting transmitters
- **Type B1 interference**
  - Inter-modulation products due to broadcast transmissions which are produced in the aeronautical receiver
- **Type B2 interference**
  - Desensitization in the RF section of an aeronautical receiver

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Multiple interference

- Multiple inter-modulation products should be taken into account for each interference mode
- The total interference margin is calculated by using the power sum of the individual interference margins

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Type A1 interference

- **Due to**
  - signals from one or more transmitters leaking into another transmitter
  - corrosion effects in the antenna and feeder systems
- **Only third order inter-modulation is considered**
- **The number of inter-modulation products (ips) falling on the aeronautical frequencies should be avoided or minimized**

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Example of Type A1 interference

Station A
107.6 MHz
102.5 MHz
88.6 MHz

121.5 MHz is the aeronautical emergency frequency

Station B
105.9 MHz
90.3 MHz

Three-signal case	$f_1 + f_2 - f_3 = f_{intermod}$
Station A	107.6 + 102.5 – 88.6 = 121.5 MHz
Two-signal case	$2f_1 - f_2 = f_{intermod}$
Station B	2 x 105.9 – 90.3 = 121.5 MHz

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Type A2 interference

- **Relates to the unwanted sidebands from a transmitter operating at the upper end of the broadcasting band**
- **Need not be considered for frequency differences > 300kHz**
- **Can be completely avoided by making all assignments below 107.7 MHz**

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Type B1 interference

- The aeronautical receiver are being driven into regions of non-linearity
- Only third order inter-modulation products are considered
- The number of ips falling on the aeronautical frequencies should be minimized

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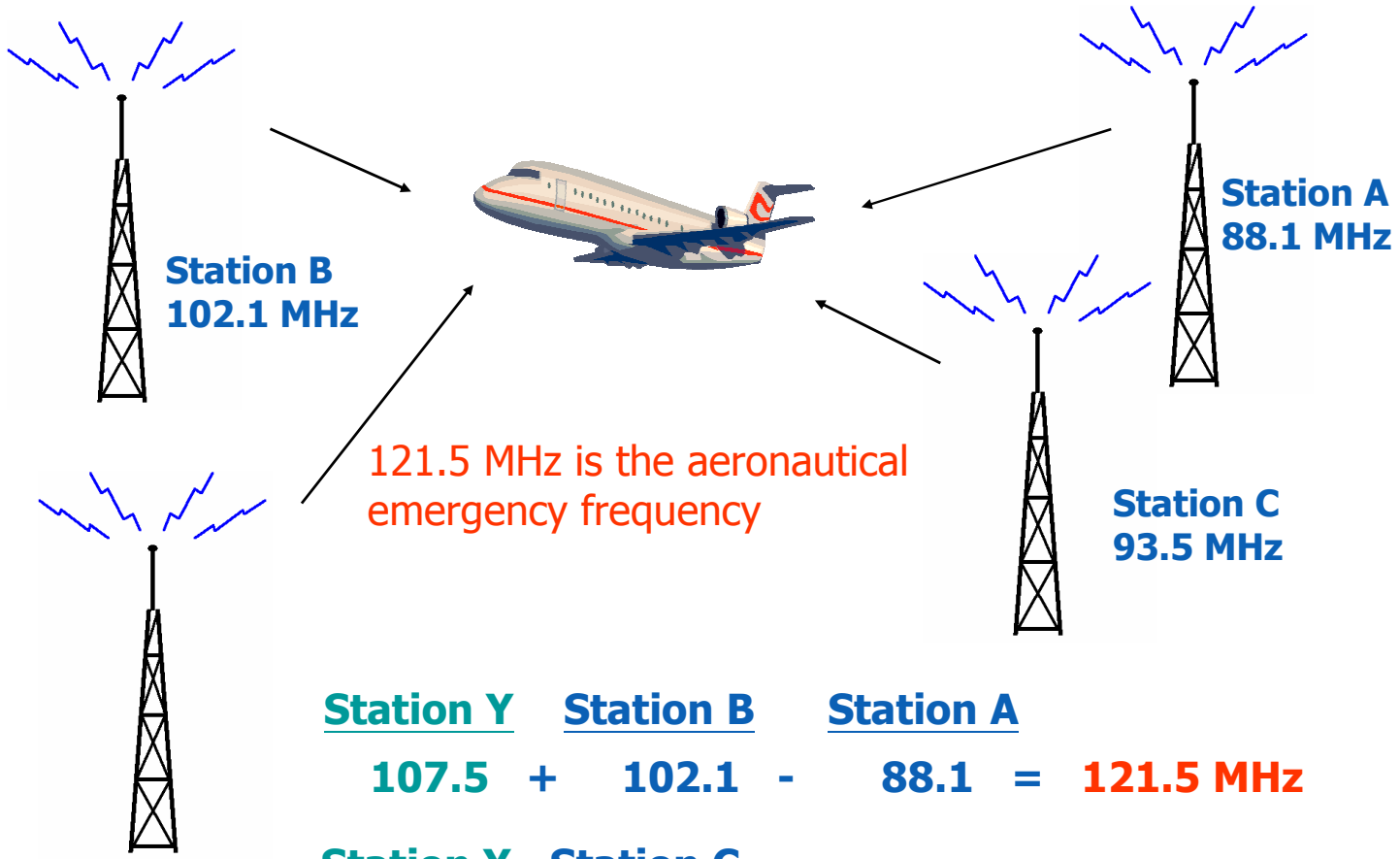
Example of Type B1 interference



Station Y Station B Station A

107.5 + 102.1 - 88.1 = 121.5 MHz

Station Y Station C

2 x 107.5 – 93.5 = 121.5 MHz

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Type B2 interference

- **Due to the presence of strong broadcasting signals**
- **B2 interference can be minimized by using minimum radiated power**

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VHF/FM Transmission Plan

VHF/FM Frequency (MHz)						
Mount Gough (3 kW)	Cloudy Hill (0.5 kW)	Castle Peak (0.7 kW)	Golden Hill (0.1 kW)	Lamma Island (0.5 kW)	Beacon Hill (0.15 kW)	Kowloon Peak (1 kW)
88.1	88.3	88.6	88.9	89.1	89.2	89.5
90.3	90.7	91.2	90.9	91.6	91.1	92.1
92.6	93.2	93.4	92.9	93.6	93.5	94.4
94.8	95.3	96.4	95.6	96.0	96.3	96.9
97.6	97.8	98.7	98.4	98.2	98.1	98.9
99.7	100.0	100.4	101.6	102.1	100.5	101.8
104.0	104.7	102.5	105.5	104.5	102.4	106.3

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