ALTAI
Super WiFi

GUIDELINES ON MINIMIZING INTERFERENCE BETWEEN DIFFERENT ISP'S WIFI NETWORK IN A CITY

WHITE PAPER

The use of WiFi network is becoming a trend and more people are using WiFi to access to internet. Although using WiFi is convenient, without proper coordination between service operators, it is possible that leading to the mutual interference between service operators. Therefore, minimizing interference is necessary in order to ensure the stability of WiFi service. In this paper, Altai will propose a number of guidelines that can minimize the interference between multiple WiFi networks that are deployed in the same place.

1. Overview

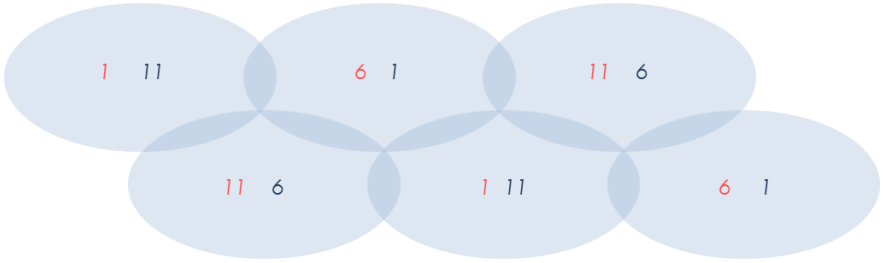
With the growth of smartphones, tablets and thousands of Apps which utilize the WiFi as a communication platform, the demand for WiFi networks is ever increasing, and now to such an extent that nearly all types of service operators including mobile operators, ISPs and tier-1 operators are deploying or thinking of deploying their own WiFi network. The ISM 2.4 GHz WiFi spectrum contains a maximum of only three non-overlapping frequency channels, namely 1, 6 and 11 channels for minimum interference. If the deployment of several WiFi networks in one city are not planned or coordinated properly, the effective throughput capacity that can be used as a whole will be cut substantially due to mutual interference between the networks. How to avoid this conflict and hence the waste of a natural resource becomes an important topic.

We propose a number of guidelines that can minimize the interference between multiple WiFi networks that are deployed in the same place, from different technical, commercial and regulatory approaches as summarized in below:

- Minimize the number of city-wide WiFi ISP licenses to two
- The first and second ISP to wholesale the network by regulation to the latter players
- Using channels 1, 6, 11 at start up to maximize the spectrum utilization with minimum adjacent channel interference
- Use a WiFi product with strong interference mitigation
- Use a WiFi product with low spurious emissions
- Use a WiFi product with features that can optimize the network in noisy environment
- Use 5GHz spectrum for access

2. Regulatory Approach to Minimize the Number of Players

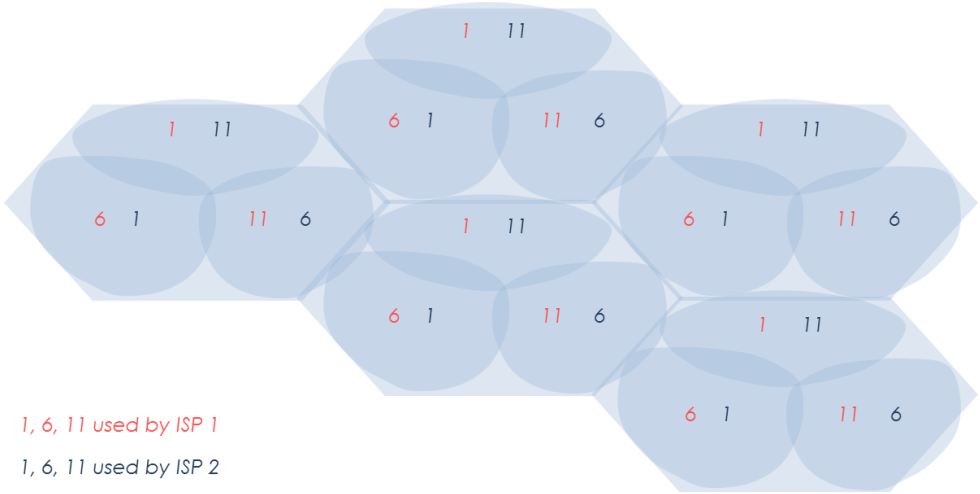
The local radio committee can limit the ISP license for public city-scale WiFi service to only two ISPs. This is the most direct method in lowering the total number of competing WiFi networks. Each ISP can use the three non-overlapping frequency channels throughout the city, but use different non-overlapping frequencies in the same area. For omni coverage type of AP, the frequency planning for two networks with minimum interference can be illustrated as below:



1, 6, 11 used by ISP 1

1, 6, 11 used by ISP 2

For sector coverage type of AP or base station, the frequency planning for two networks with minimum interference can be shown below:



1, 6, 11 used by ISP 1

1, 6, 11 used by ISP 2

The above illustration can also be looked as a mixed type of sector and omni coverage AP. For example, each hexagon is a large cell site covered by three sector APs by ISP 1. Each hexagon also represents three small cell sites each covered by one omni AP by ISP 2.

3. Commercial Approach to Provide Wholesale Model by the First ISP

In order to allow several ISPs to provide WiFi service using only one or two networks, the radio committee can raise regulations or add ISP license conditions that the first and the second ISP have to deploy their WiFi networks so that they can support a wholesale model to subsequent players and to set upper limits on wholesaling profit. The wholesale model means that different ISPs can share the same WiFi network but to the end users they appear as different networks including different SSIDs, service plans, billing method and marketing promotion.

This approach is analogous to allowing a second service provider in sharing the building block wiring laid by the first service provider through regulation in Hong Kong.

The limited space in a buildings vertical ducting can usually support only two operators to lay their own telecom cables, this regulation can allow competition between several operators and avoid a monopoly under limited resources environment.

By this approach, the second, third and subsequent ISP players can choose from building its own network or wholesaling from the preceding network operator. They will compare investing a new network on its own with large lump sum of money and long investment return but with better ownership and control, or wholesaling from existing operator which requires no hardware investment and a quicker return but with less control in ownership in long run.

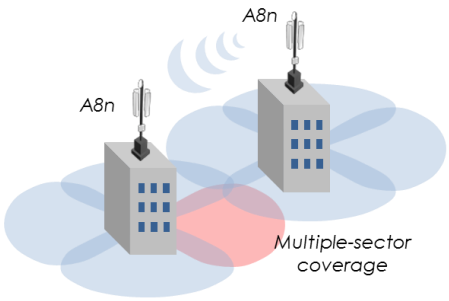
From a resources point of view, the wholesaling model can better utilize the frequency spectrum and avoid the reduction in capacity due to network interference, which can be as high as 25% for two networks and even more for three networks. It can also trade-off a very low profit margin for the wholesaler to make this wholesale business model practical.

In some countries, a neutral service provider will be appointed to build, wholesale and maintain the WiFi network, and this approach will lower the confidentiality issue directly between the competing ISPs. Alternatively, all ISPs can be the stakeholder of this neutral service provider.

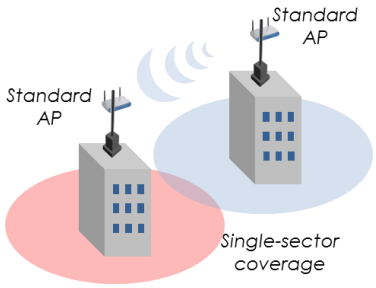
4. Technical Approach in Choosing Products with Strong Interference Mitigation

Some WiFi products are better designed in mitigating the effects of interference in the network. We use the Altai A8 Super WiFi Base Station as an example to illustrate how inter-site interference can be mitigated. The A8n is designed with multiple radios and smart antennas, which when subject to interference will have only one out of its multiple sectors affected and this design is definitely more robust in an interference environment.

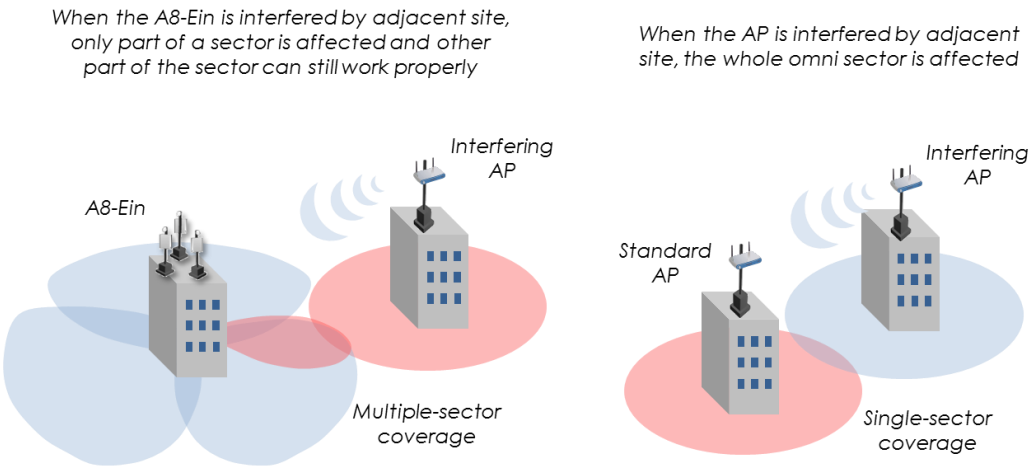
When the base station is interfered by adjacent site, only one sector affected and other sectors can still work properly



When the AP is interfered by adjacent site, the whole omni sector is affected



If the omni coverage design of the multiple radios AP is changed to sector coverage design, the interfering direction can be narrowed down more precisely and the affected area can be reduced. This can be illustrated in below by using the Altai A8-Ein Super WiFi base station as an example.



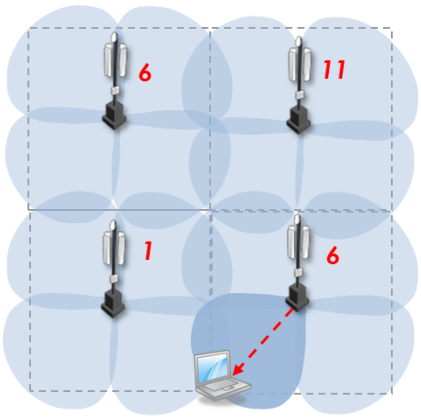
Further, the A8n/A8-Ein has multiple high quality RF filters on each receive and transmit path. These RF filters can improve the network performance in high interference urban areas substantially, and is suitable for co-location deployment with 3G cellular systems.

In some case where the interfering source is predictable, the down-tilt angle of each A8n antenna or the whole A8-Ein unit under interference can be adjusted to reduce the cell size to reduce or avoid the interference.

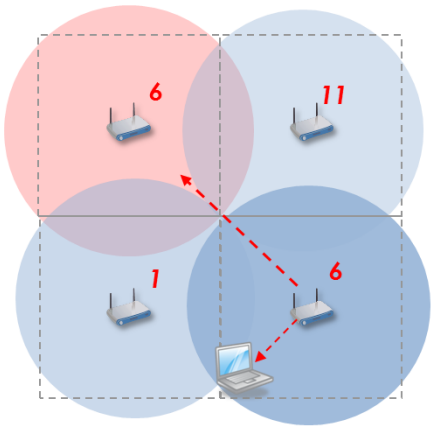
5. Choosing Products with Generating Less Interfering and Spurious Emissions

WiFi products that are equipped with multiple radios and antennas can cause less interference to other sites and also to its own network. This can be illustrated by the following example using the A8 as an example. The sectored coverage design of the A8 causes interference to one direction during a transmission rather than to all directions as is the case for single radio AP products.

Transmission at one direction causes no interference to other directions



Transmission to a client at one direction will cause interference to all directions due to omni-directional broadcasting



Spurious emission is another factor to be considered if the APs are to be deployed in city areas and especially where 3G co-location will be employed. The spurious emission levels that meet and exceed 3GPP's requirements of-100 dBm/100 KHz in GSM, TD-SCDMA (F, A) and TD-LTE (D) spectrums and -90 dBm100 KHz in TD-SCDMA (E) spectrum are desired. The interference mitigation level is to be greater than +10 dBm CW for most frequency bands.

Using A8n as an example, it meets the above specifications which mean it can be co-located with a GSM or 3G base station at a minimum antenna separation of only 0.2 or 0.5 m respectively! For most other APs they normally require 15 to 60 m antenna separation.

6. Using Products with Network Optimizing Features for Adapting to Interfering Environments

Given that interference is unavoidable in urban areas, WiFi equipment vendors have been developing features that can enhance the network throughput performance under interference conditions using different methodologies. For example the Altai A8n has developed its *AirFi*™ throughput optimization feature which works extremely well in noisy environment by automatically calculating the bandwidth assigned for each and all users such that the throughput for high speed users can be improved substantially. Those highly interfered users whom are operating at very low speed can be maintained and controlled in a manner so that they will not lead to significant degradation to the system throughput. The system throughput can be doubled by enabling this feature.

Another feature as developed by Altai is called *Data Rate Selection*. This feature allows the administrator to set the minimum data rate that a client is required to associate to the AP. This is equivalent to shrinking the cell size to reduce the total interference the AP exposes to.

Use of 5 GHz Spectrum

With more and more client terminals supporting in the 5 GHz WiFi spectrum, the construction of 5 GHz AP network can offload part of the traffic from the original 2.4 GHz network and hence can reduce the interference. Further, the 5 GHz spectrum contains more non-overlapping bands enables more flexibility in radio planning with less interference.

The Altai A8n, A2 and A2-Ei series support WiFi clients operating at 2.4 GHz and 5 GHz concurrently, and are preferred for new deployment for dual-band. This can reduce the cost and time of installing 2.4 GHz and 5 GHz AP separately.

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Jun 1, 2012
Revised on Jul 17, 2013