WLAN DFA Technology White Paper

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Keywords

DFA, DCA, TPC, dual bands

Abstract

When APs are densely deployed, the 2.4 GHz band is prone to co-channel interference because there are a number of non-overlapping channels on this band. The Dynamic Frequency Assignment (DFA) algorithm is introduced to solve the co-channel interference problem. This algorithm enables an AC to automatically adjust the dual-band channel and power of APs on the entire network to avoid interference and improve performance.

Acronyms and Abbreviations

Acronym or Abbreviation	Full Name
AP	Access Point
AC	Access Controller
DFA	Dynamic Frequency Assignment
DCA	Dynamic Channel Assignment
TPC	Transmit Power Control

Contents

1 Background

In medium-density or high-density scenarios, APs are deployed at small intervals to meet customers' high requirements for the capacity. However, only three non-overlapping channels are available on the 2.4 GHz band. A large number of 2.4 GHz APs work on the same channel, causing co-channel interference.

The Dynamic Frequency Assignment (DFA) algorithm is developed to prevent co-channel interference in such a scenario. When there are sufficient 5 GHz channels, the 2.4 GHz radio of a dual-5G AP can be switched to 5 GHz so that the AP can work on dual 5 GHz bands. This approach avoids co-channel interference on the 2.4 GHz band and makes full use of radio hardware resources. When the AP is a common dual-band model or no more 5 GHz channel resources are available, the 2.4 GHz radio of some APs can be disabled or the 2.4 GHz radio switched to the monitor mode to eliminate co-channel interference.

The DFA algorithm is applied in medium- and high-density scenarios to automatically determine whether to disable or switch the 2.4 GHz radio and to automatically allocate optimal 2.4 GHz or 5 GHz channels for all APs.

2 Implementation

DFA needs to work with Transmit Power Control (TPC) and Dynamic Channel Assignment (DCA) to automatically adjust the frequency band, channel, and power of WLAN devices on the entire network to optimize the radio environment.

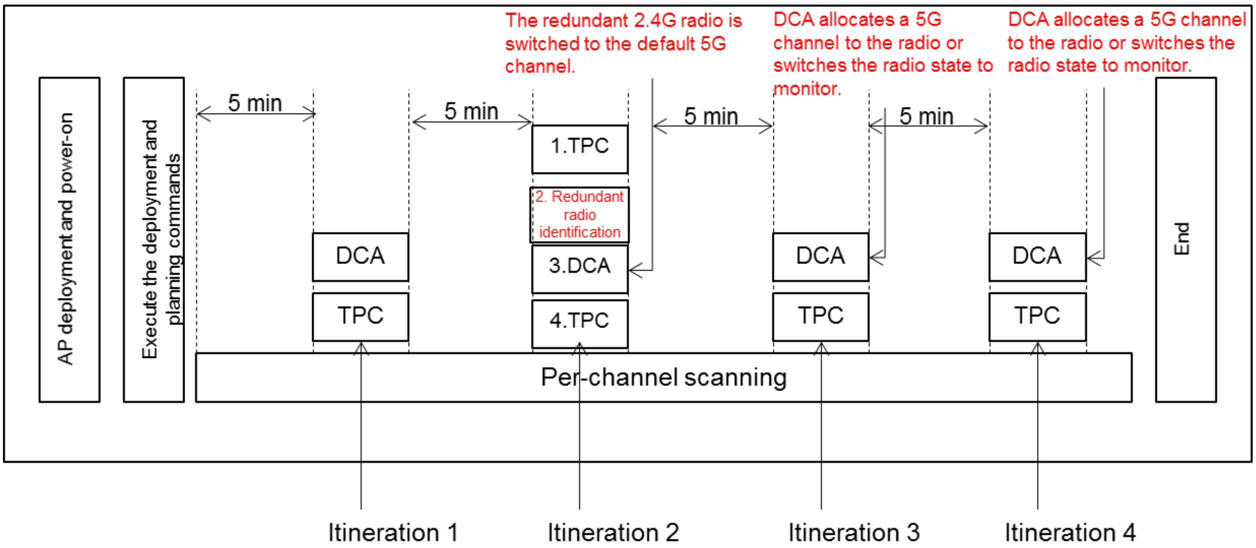
TPC helps dynamically allocate proper power to APs according to the real-time radio environment. The TPC algorithm aims to choose the proper transmit power for an AP to meet its coverage requirements, without causing large interference to neighboring APs.

DCA adjusts channels for one radio so that each AP obtains the optimal channel, minimizing adjacent-channel and co-channel interference to ensure reliable transmission on the network.

DFA adjusts radios by disabling the redundant 2.4 GHz radio or switching this radio to monitor or 5 GHz.

The following describes the functions of DFA in different phases, involving the use of TPC and DCA.

2.1 Automatic Air Interface Resource Planning for Radios upon Deployment



1. Complete neighbor information within 10 minutes before redundant radio identification.

   On the live network, an AP collects the beacon and probe frames sent from its neighboring APs to fill its neighbor information table. This table records the interference of neighboring APs to the radios of the AP. If the radio interference of a neighboring AP exceeds the threshold, the radio of this neighboring AP is marked.

2. Perform TPC twice to adjust the power before redundant radio identification.

   Before the deployment command is executed, the minimum transmit power of each AP radio is provided according to the network planning result. This minimum power ensures the optimal STA performance. The TPC algorithm records information about neighboring APs and decreases the power of neighboring APs that cause high interference. Note that the power cannot be lower than the minimum threshold. Power adjustment performed using TPC is a gradual process and is determined based on neighboring AP information. After the TPC power adjustment is performed twice, the optimal power in the channel planning can be achieved.

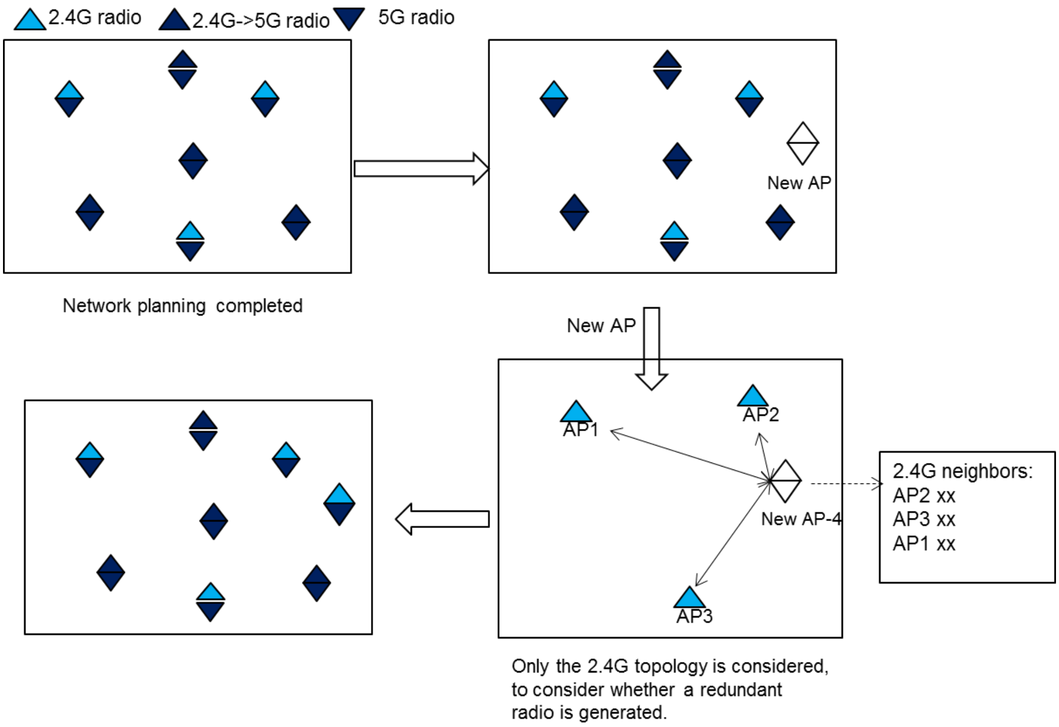
3. In iteration 2, redundant radio identification, dynamic channel allocation (DCA), and TPC are performed. The redundant radio is shut down or switched.

   A redundant radio still interferes with surrounding APs after power adjustment. In this case, adjust the radio using DFA based on the AP capability. The adjustment result is to shut down the 2.4 GHz radio or switch it to the 5 GHz band or monitor mode. If an AP supports 2.4G-to-5G switchover, switch the 2.4 GHz radio to the 5 GHz band. If an AP does not support this capability, switch the 2.4 GHz radio to the monitor mode or shut down the radio.

4. After DFA is performed on the 2.4 GHz redundant radio, channels are optimized on the radio across the network through iteration 3 and iteration 4.

   Similarly, APs collect neighbor information and adjust radios and power using the DFA and TPC algorithms. The DCA algorithm is added in this phase to adjust the channels of the 5G radio on the entire network.

2.2 Redundant Radio Switching Automatically Performed for New APs



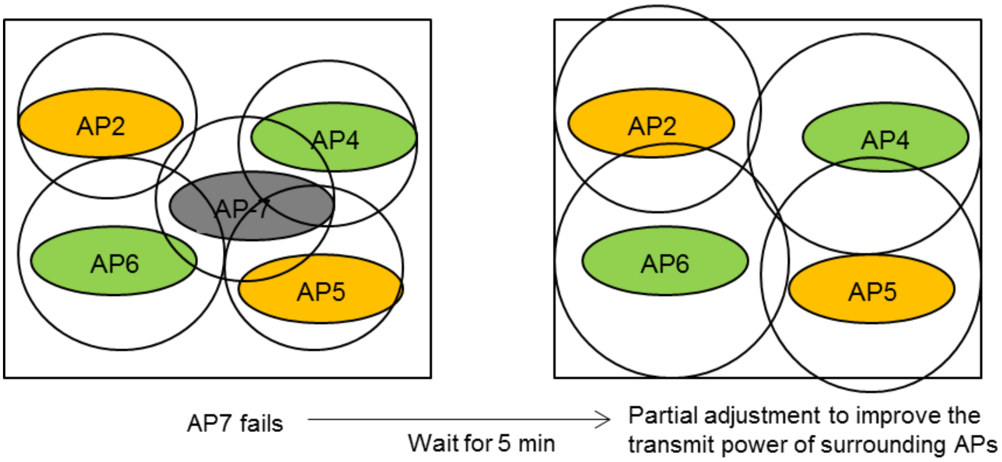
1. Scan and add APs to construct a 2.4 GHz topology.

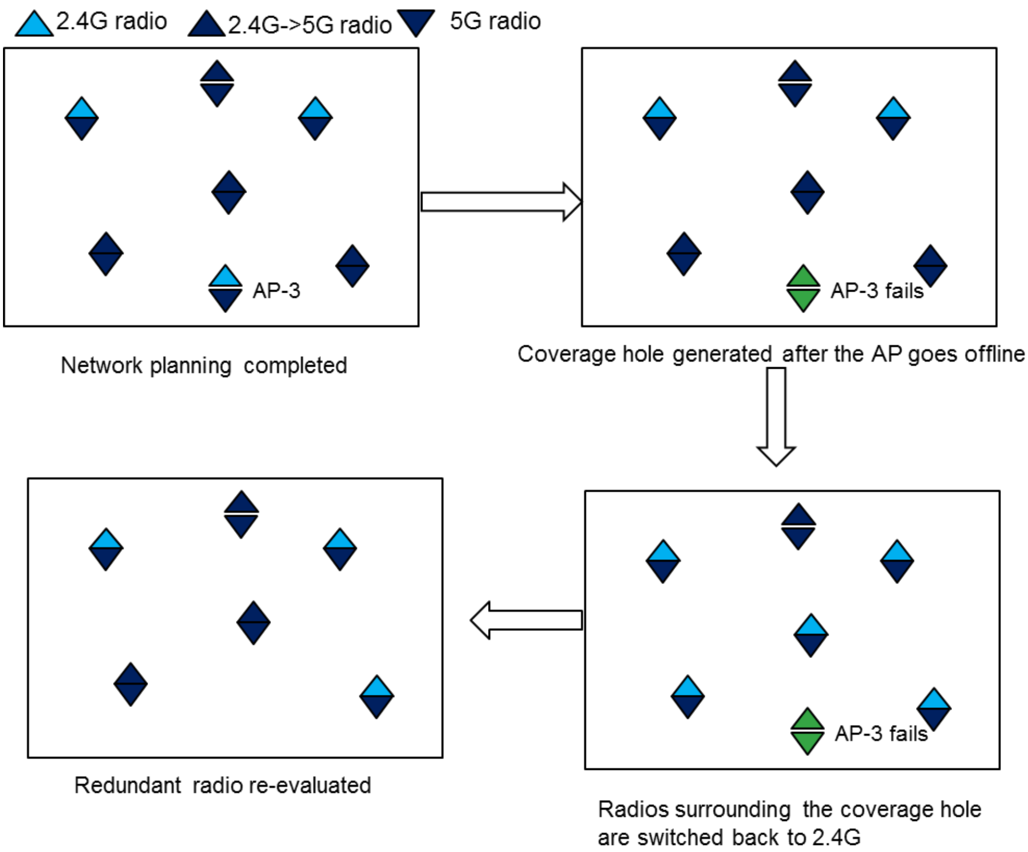
   If APs working on the 2.4 GHz and 5 GHz bands are deployed, determine whether a redundant radio exists. Skip this step if dual-5G APs are deployed. In the 2.4 GHz topology, you do not need to pay attention to the completed network planning. APs are switched to the 5 GHz radio.

2. Adjust the 5G radio of the entire network.

   After the redundant radio is handled, optimize the channels and power of the 5 GHz radio.

2.3 Automatic Compensation for Detected Coverages





As shown in the preceding figure, AP3 becomes faulty, and Wi-Fi signals disappear. The system performs the following operations to address this issue:

1. Switch the top four neighbors in the coverage hole back to the 2.4 GHz band.
   - Preferentially select radios in monitor or shutdown mode.
   - Preferentially select radios with no STA or a small number of STAs associated.

2. Scan and reconstruct the 2.4 GHz topology.
3. Adjust 5G radios on the entire network.

3 Customer Benefits

The DFA feature helps customers reduce O&M costs. On a WLAN, a large number of APs are deployed, especially in high-density scenarios. This requires a large amount of manpower for network planning. Additionally, if more APs are needed or some APs cannot work properly (for example, due to a power failure), more network planning personnel are required.

The DFA algorithm can greatly simplify network planning. The calculation result of the algorithm helps reduce co-channel interference and improve the overall network performance and user experience.

4 Typical Application

Deploying Wi-Fi networks has become a trend for large stadiums. In Europe, Huawei has successfully deployed high-density Wi-Fi networks for soccer stadiums such as Signal Iduna Park of Dortmund and Amsterdam Arena of Ajax. These Wi-Fi networks provide convenient network access services for fans in terms of event sharing, live broadcast, media broadcast, and online gaming. In high-density stadiums, to provide access from tens of thousands of users, all APs work in dual-band mode to leverage 5 GHz resources. Additionally, APs are deployed at a minimum interval of around 7 m to offer Wi-Fi coverage for high-density users. In this scenario, DFA can be used to properly allocate 2.4 GHz radios, which greatly reduces air interface interference as well as improves the access bandwidth and user experience of each access user.