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Self-Organizing Networks

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I.   Introduction

This contribution proposes text for Section 18 of P802.16m SDD.

In a nut shell, the objective of Self-Organizing Networks (SON) is to provide a solution for organizing its own network resources in an automatic and optimal manner in order to increase overall network performance, quality, and reliability. SON is a process that involves Network Elements (NEs) in Radio Access Networks (RAN) and Core networks to enable automatic configuration, to measure / analyze KPI (Key Performance Indicator) data, and to fine tune network attributes in order to achieve optimal performance.

The major drivers for Self-Organizing Networks include the following:

- Increasing competition and investment of mobile Internet market has forced operators to reduce CAPEX and OPEX by minimizing human intervention in both deployment and operational phases.

- Increasing complexity in current mobile networks requires constant provisioning and tuning of huge amount of parameters in order to optimize network performance, coverage, and capacity.

- The huge amount of spatial-temporal data collected by multiple MS, FAP (Femto Access Point), and macro BS at any given time and location will be used not only to understand the wireless environment in providing mobile data services, but to assist trend analysis, network planning optimization, and automatic centralized management functions.

- Has the ability to detect, mitigate, and recover faults automatically in order to achieve five nines reliability and maintain customer satisfaction.

Figure 1 shows the Self-organizing Network Architecture that supports both macro BS and FAP (Femto Access Point). Broadband access technologies, such as DSL and cable, are used to backhaul FAP traffic through pubic Internet to WiMAX networks via WiMAX-GW. SON_Server is a server application in NMS (Network Management System) that interface with WiMAX_OAM&P (Operation, Administration, Maintenance, and Provisioning) to provide SON functions to SS, MS, FAP, and macro BS.
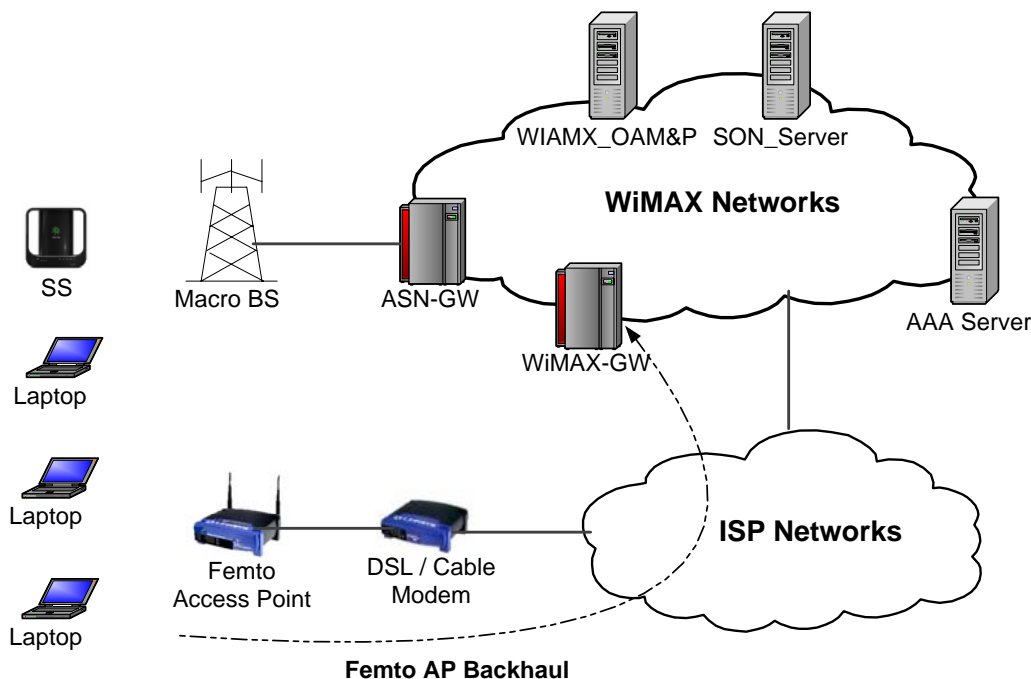

Figure 1: Self-organizing Network Architecture

Self-installation is mandatory for FAP, due to its volume and usage model. Here is an example for FAP to find the operating frequency and PHY parameters that are intended to cause minimal interference to neighboring macro BS or FAP.

1. When a FAP is powered up, it shall perform self-discovery to capture the PHY profiles of the surroundin macro BS and FAP, such as BS ID / FAP ID, RSSI.

2. FAP passes the PHY profiles to the SON-Server that stores all PHY profile of macro BS and FAP into a database.

3. SON_Server will select a PHY profile for FAP to use, based on the analysis of the PHY profiles being reported by FAP, and in the database.

Due to Tx power limitation, the size of a FAP tends to be small that provides necessary separation for FAP to co-locate with macro BS. Figure 2 is an example of frequency reuse = 3, where

The number of frequency = 3 (i.e. F1, F2, F3)

Sectors = 3 (i.e. F1a, F1b, F1c, F1a + F1b + F1c = F1)

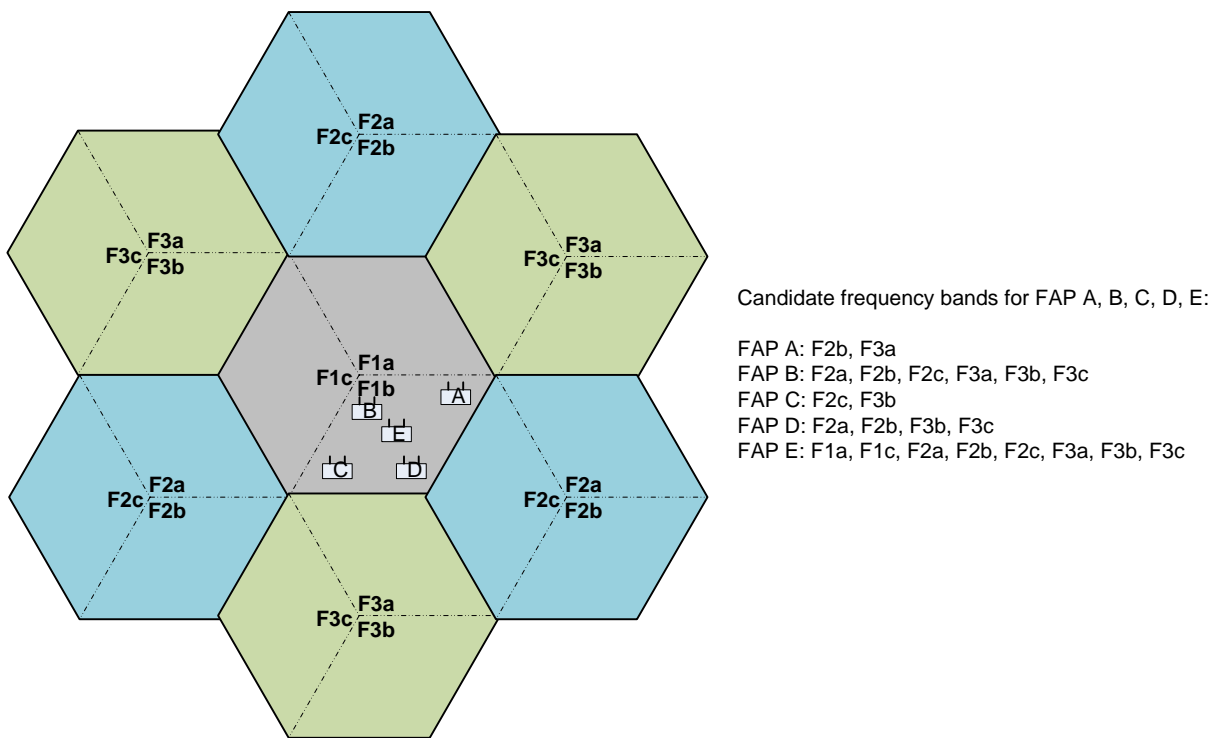It shows the correlation between FAP's location and the list of candidate PHY profiles.

Candidate frequency bands for FAP A, B, C, D, E:

FAP A: F2b, F3a
FAP B: F2a, F2b, F2c, F3a, F3b, F3c
FAP C: F2c, F3b
FAP D: F2a, F2b, F3b, F3c
FAP E: F1a, F1c, F2a, F2b, F2c, F3a, F3b, F3c

Figure 2: Frequency Reuse Pattern = 3

II.   Proposed text

18.   Support for Self-organization

Self-Organizing Networks (SON) is composed of Self-configuration, Self-optimization, Self-planning, and Self-healing.

18.1   Self-configuration

Self-configuration is the process of bringing up network elements with minimum craftsperson intervention. Cellular networks today still require a lot of manual configuration and optimization to bring up macro BSs that can work with neighboring BSs harmoniously. Self-configuration or self-discovery shall enable a macro BS to interact with neighbor macro BSs and SON server automatically to configure radio, PHY, and MAC parameters, with minimum human intervention. Self-installation is mandatory for FAP (Femto Access Point), due to its volume and usage model. Self-configuration shall enable a FAP to discover the environment and communicate with SON server automatically to configure radio, PHY, and MAC parameters without any human intervention.

18.2   Self-Optimization

Self-optimization is the process of utilizing measurement data to optimize network performance, coverage, and capacity. The environment of mobile Internet is constantly changing as subscribers are moving continuously; therefore, the networks need to be tuned constantly in order to achieve optimal performance, such as the dynamic allocation of subcarriers to each sector in order to support fractional frequency reuse. Here is the list of metrics that should be reported to SON Server for analysis and control.

- Measurement unit: MS, SS, FAP, macro BS
- Serving BS ID
- GPS location: MS, SS, FAP
- Time stamp
- UL/DL performance metrics: RSSI, SINR, CINR

18.3   Self-planning

Self-planning is the process of collecting and analyzing network parameters to assist network or service planning. Operator can leverage MS to provide huge amount of spatial-temporal data at any given time and location, without the need sending the trucks. These data will be used to assist trend analysis, and network planning optimization. The spatial-temporal data include the following:

- Serving BS ID
- MS GPS location
- Time stamp
- UL/DL performance metrics: RSSI, SINR, CINR
- Sustain / peak data throughput

18.4   Self-healing

Self-healing is the process of restoring system operation in the case of faults with minimum impacts to users.