Independent Analysis of Samsung Wi-Fi Product Performance

Samsung's Wireless Enterprise solution put through its paces in challenging environments

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Note
This report was commissioned by Samsung. However, the report has been prepared by Real Wireless *independently* of Samsung and represents our own views of the product and its features based on product testing and analysing test data in a real life environment.

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independent wireless experts

About Real Wireless

Real Wireless is a leading independent wireless consultancy, based in the UK and working internationally for enterprises, vendors, operators and regulators – indeed any organization which is serious about getting the best from wireless to the benefit of their business.

We seek to demystify wireless and help our customers get the best from it, by understanding their business needs and using our deep knowledge of wireless to create an effective wireless strategy, implementation plan and management process.

We are experts in radio propagation, international spectrum regulation, wireless infrastructures, and much more besides. We have experience working at senior levels in vendors, operators, regulators and academia.

We have specific experience in LTE, UMTS, HSPA, Wi-Fi, WiMAX, DAB, DTT, GSM, TETRA – and many more.

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Executive summary

Wi-Fi for Enterprise / Venues

With the increasing popularity of mobile devices in the enterprise and venues, such as smartphones and tablets, demands on the WLAN are growing fast. Such a growth is yielding more complex challenges due to the number of separate devices competing for different services at the same time using a shared resource, hence intelligent use of available bandwidth is essential. Business-critical requirements must be served by reliable enterprise-grade wireless solutions.

Challenges

Typical technical challenges associated with Wi-Fi deployment in busy/critical areas can be summarized as follows:

- Coverage
- Interference
- Contention
- Mobility
- Load Balancing
- Security

Independent testing:

Samsung appointed Real Wireless to carry out an independent assessment of a set of key features of the Samsung Enterprise Wi-Fi solution. A series of tests were carried out and supervised by Real Wireless to assess the product features in a challenging live environment, consisting of 54 access points in a busy educational establishment.

Outcomes:

When the listed features on the Samsung Wi-Fi solution were activated, significant performance improvements were observed, as follows:

- **AirEqualizer:**
  - Fair resource allocation between devices
  - Reducing contention risk
  - Up to 54% device throughput increase

- **IBSA** (Intelligent Beam Selectable Antennas):
  - Increases coverage and reduces interference
  - Up to 2.5 times stronger signal
  - Up to 210% more throughput

- **SON** (Self Optimising Network):
  - Optimises coverage and reduces interference

- Optimised network = higher speed = less contention
- Up to 160% more throughput (71% more on average)

- **WIPS** (Wireless Intrusion Protection System):
  - Intrusion detection (with separate chip; not in-band)
  - Intrusion detection successful when tested
  - WIPS chip feeds SON with information (out-of-band; no loss of RF airtime)

The features tested bring significant technical and commercial benefits to the installer, operator and end users of the system. In the RF domain, especially IBSA and SON complemented each other and impressed with the degree of performance and user experience improvement.

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1. Introduction

This document reports the findings from an independent, real-world assessment by Real Wireless of the capabilities of Samsung's Enterprise Wi-Fi Product range to cope with Wi-Fi challenges encountered in a busy environment.

The products tested consisted of the WEA 300 (802.11n) and 400 (802.11ac) series of Access Points, WEC 8050 and WEC 8500 Access Point Controllers and associated management software.

Whilst this report was commissioned by Samsung, the tests performed were defined by Real Wireless, and conducted under Real Wireless supervision. This report and its findings have been performed entirely by Real Wireless.

In order to perform this assessment, Real Wireless:

- Identified particular challenges that need to be addressed in high demand enterprise environments;
- Defined a test plan to assess the performance of Samsung's Wi-Fi products against these challenges;
- Supervised the testing for compliance with our test plan;
- Analysed the test results and determined the performance of the product features against the challenges.

This white paper explains the above process, assesses the performance of Samsung's Enterprise Wi-Fi Product range and summarises the main findings of this assessment.

2. Technical challenges of Wi-Fi in a busy environment

2.1 Overview

Unsophisticated Wi-Fi access points can provide adequate connectivity in many small static environments with a limited number of users. Deploying an access point at home is simple. However, the demands of multi-access point, busy environments with business critical requirements are quite different. Such environments include places such as offices, schools and colleges and other high user density areas such as shopping malls, airports, sports stadia etc. In such environments, good quality wireless connectivity is not a nice-to-have, but an essential business facility.

The key wireless challenges in these environments are:

- Coverage: Providing reliable connectivity over the area needed with no black spots;
- Interference: Ability to deal with multiple competing signals from other access points and other on-channel users;
- Air Interface Contention: Dealing with 'clashes' between transmissions from access points and client devices;
- Mobility: Maintaining connectivity as some users move throughout the coverage area whilst supporting all other users;
- Load Balancing: Ensuring that users are spread between access points to ensure that none suffer congestion;
- Security: Maintaining the security policies of the enterprise whilst users migrate across the enterprise, supporting authorised user access and barring unauthorised users from selected areas.

Figure 2-1 summarises these challenges and they are described in more detail in the following section.

Figure 2-1: Summary of the key Wi-Fi challenges in a busy and dense environment

2.2 Coverage challenge

In typical enterprise environments with multiple users and multiple access points, coverage can be limited by obstructions which can attenuate the access point signal energy and cause poor performance and unreliable connectivity.

Figure 2-2 illustrates the wide variation in received signal levels in different parts of the area. Walls, furniture and even people obstruct and attenuate the signal, so even locations close to access points can suffer from weak signals. While the 2.4 GHz band available to Wi-Fi (802.11b/g/n) has somewhat lower attenuation than the 5 GHz band (802.11a/n/ac), its capacity is limited and it is increasingly crowded.

Although proper placement of the right number of APs can help to provide good coverage, the situation changes with time as people move, doors open and close and furniture is changed around.

Ideally, then, APs would dynamically adjust the direction and level of their transmitted power to beam the available power in the best possible direction to serve users at any given time.

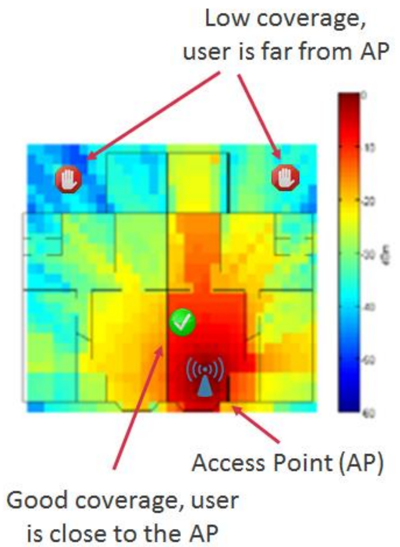

Figure 2-2: Typical propagation behaviour in indoor environment

2.3 Interference challenge

Wi-Fi spectrum used today is part of the 2.4 GHz and 5 GHz frequency bands and is often referred to as licence-exempt or unlicensed spectrum. This unlicensed spectrum is free to use, but comes with no protection or performance guarantees. The bands have to be shared with many other users, including neighbouring access points from other Wi-Fi systems, Bluetooth phones, microwave ovens, baby monitors and more, increasing in volume and density over time, as depicted in Figure 2-3.

Such interference from surrounding systems degrades performance, even when coverage is good. Interference can be avoided by spreading the users and access points across the available channels and by adjusting powers to the minimum necessary. The best channels change rapidly according to both the physical environment and the traffic demands of users on the systems, so a dynamic approach to choosing the best channels and powers is needed for best performance.

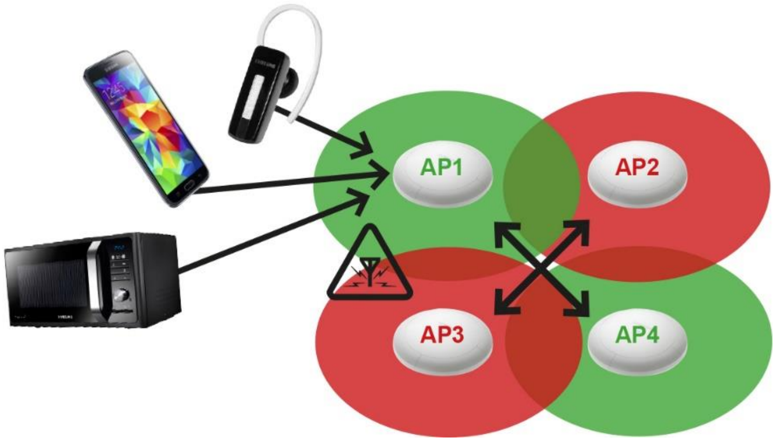

Figure 2-3: Interference risk from other APs and from external sources

2.4 Contention challenge

Wi-Fi networks attempt to be polite, by listening to the channel they are tuned to and only transmitting when it is clear. When an AP hears channel activity, it goes quiet and waits for a random time. Different access points wait for different random times. Although this gives all users *some* chance of accessing the channel, it leads to the potential for 'clashes' between retransmissions, as illustrated in Figure 2-4. The likelihood of clashes increases with the density and activity levels of all the access points and users. When a clash occurs, the data transmitted is usually lost and has to be retransmitted, reducing the data rate and further increasing the chance of subsequent clashes.

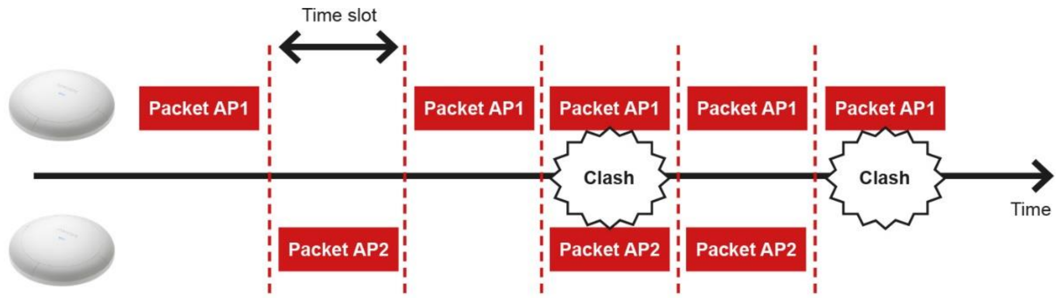

Figure 2-4: Simulation of interference and contention risk with multiple APs

So a traffic control mechanism is needed in busy environments to ensure fair distribution of the channel airtime amongst users.

2.5 Mobility challenge

Seamless Wi-Fi mobility is an increasing important requirement, especially in busy areas with many APs where people move around. Wireless offices become more common and therefore it is of upmost importance that employees (and guests) can move from room to room (between APs) maintaining connectivity and calls.

As shown in the figure below, a client served by AP1 moves to an area covered by AP2. A handover is needed to facilitate 'mobility' and provide a continuous service to the user. This is a critical requirement for real time traffic. In the absence of a mobility / handover feature, the client would experience a time-limited connectivity loss due to the need to re-authenticate.

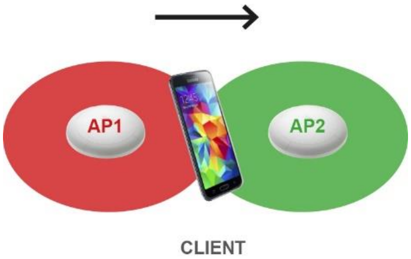

Figure 2-5: Illustration of a client moving between Wi-Fi APs (cells)

2.6 Load balancing challenge

APs may be located to provide good coverage but also need to evenly balance the number of users between them. When users congregate together, such as in meeting rooms or canteens, the nearby access points can become overloaded while others lie idle. This may result in high AP contention and subsequent performance degradation. In the worst case, it could render an AP useless for the connected users.

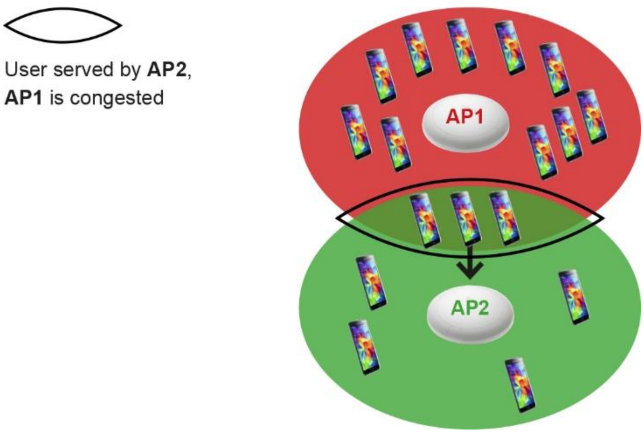

Figure 2-6: Illustration of busy APs and the advantage of load balancing

Ideally an automatic load balancing feature would spread users between access points, even when those are not the ones with the highest signal strength.

2.7 Security challenge

Another challenge of Wi-Fi deployment is security, since all data, including confidential and critical data, is transmitted 'over the air'. Even with typical access security measures (e.g. WPA2, radius servers and white listing), the air interface is open for anybody to transmit and receive data.

In case of a rogue user, rogue AP, not permitted user or an interferer, it is important that the network recognises it quickly to initiate counter measures.

Constant scanning of the Wi-Fi environment and analysing users and devices will allow immediate detection of potential security threats. Counter measures or alarms (for IT to intervene) can be configured to improve an enterprises network performance and security.

3. Introducing the Samsung Enterprise Wi-Fi Solution

3.1 System overview

The Samsung Enterprise Wireless Solution [1] is entirely designed and built by Samsung and consists of the following elements:

- **Access Points** (WEA 300 & WEA 400 series)
- **Access Point Controller** (WEC 8050 & WEC 8500)
- **Management Software** (WEM)

Figure 3-1: Samsung Wi-Fi Solution Elements

The **Access Points** [2] have the following top level specification:

- Dual Radio access point (2.4 GHz/5 GHz)
  - WEA 300 Series = 802.11n
  - WEA 400 Series = 802.11ac
- 2x2 & 3x3 MIMO
- Gigabit Ethernet / POE 802.3af
  (exception: PoE 802.3at for the 3x3 MIMO 802.11ac AP)
- Internal / External antenna
- Inbuilt WIPS/SON Module
- Ergonomic Design

Figure 3-2: Samsung WEA 302i AP

There are two **Access Point Controllers** (APC) [3] options with the following specification:

- WEC 8050:
  Can handle 75 APs, features 4x1G Base-T SFP based network connections and supports up to 1500 clients (clustering APCs to support up to 225 APs)

Figure 3-3: WEC 8050 Access Point Controller

- WEC 8500:
  Can handle 500 APs, features 2x10G Base-T & 8x1G Base-T SFP based network connections and supports up to 10,000 clients (clustering APCs to support up to 6000 APs)

Figure 3-4: WEC 8500 Access Point Controller

The typical system architecture with all its elements is the following:

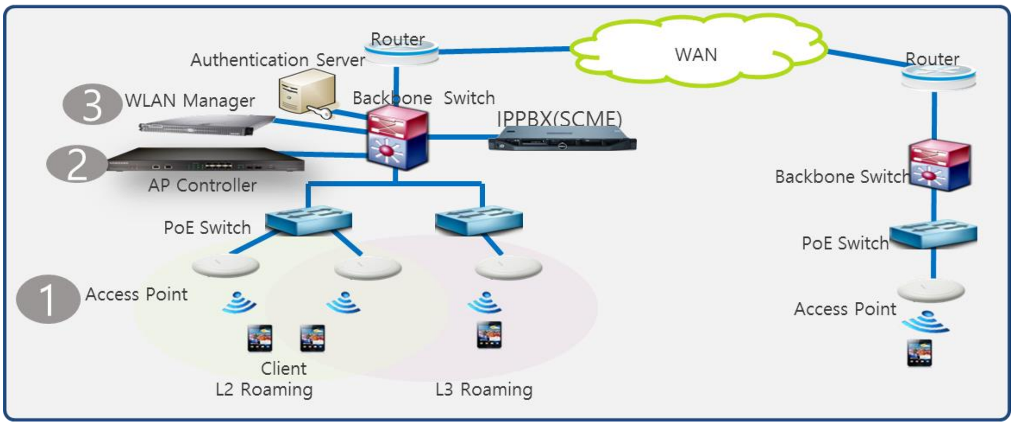

Figure 3-5: Typical Samsung Enterprise Wi-Fi Architecture [4]

3.2 System features

3.2.1 System features and how they address the Wi-Fi challenges

The Samsung product has several features targeted at addressing the Wi-Fi challenges in busy areas [4].

The features analysed in this report include:

- AirEqualizer
- IBSA (Intelligent Beam Selectable Antennas)
- SON (Self Optimising Network)
- WIPS (Wireless Intrusion Protection System)

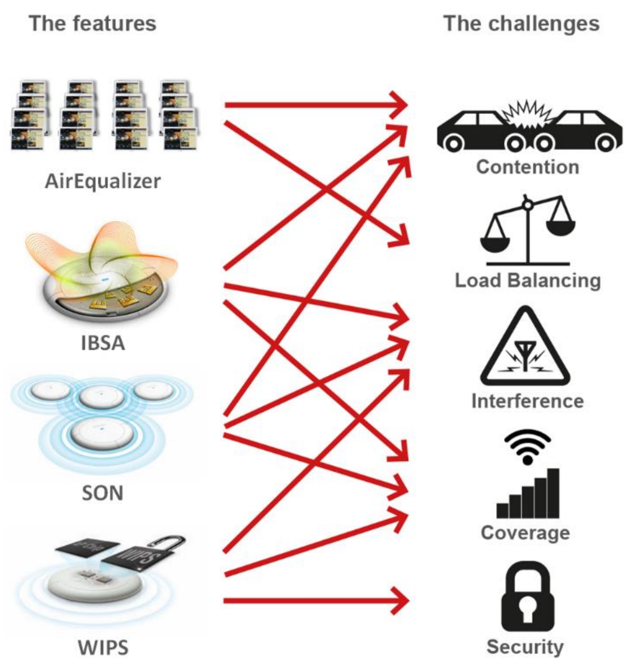

Figure 3-6: Samsung Wireless Enterprise Product Features tackling the Wi-Fi challenges

3.2.2 Feature 1: AirEqualizer

Samsung has implemented a traffic scheduling technology called 'AirEqualizer' [1] to ensure airtime fairness among multiple clients concurrently connected to an AP. Users near the edge of the coverage take longer to download a given amount of data, causing them to 'hog' the airtime. This algorithm helps to ensure that all clients get a fair amount of air time.

3.2.3 Feature 2: IBSA (Intelligent Beam Selectable Antennas)

Samsung implemented an intelligent fast beam-switching technique called IBSA [1]. This selects from amongst the beam patterns of multiple antennas on a packet-by packet basis, improving the coverage in low signal areas and reducing interference.

3.2.4 Feature 3: SON (Self Optimising Network)

One way to optimise coverage and mitigate interference is the successful planning of the network and dynamic spectrum allocation.

Samsung has implemented a self-organising network (SON) [1] feature where the access point controller (APC) is able to constantly optimise the APs configuration (channel frequency and channel power) to improve the RF environment.

This feature uses a built-in dedicated RF chipset in the APs for constant RF monitoring without sacrificing time for serving users.

3.2.5 Feature 4: WIPS (Wireless Intrusion Protection System)

Samsung has created an efficient module to detect unauthorized access points using the Wireless Intrusion Detection System (WIDS)/WIPS function [1]. The WIPS module is independent of the Wi-Fi module and therefore does not consume any Wi-Fi resource (timeslots for scanning) which would impact the capacity available to the users. WIPS is able to detect and raise alarms about any AP that is illegally installed without an administrator's approval and also any wireless terminals connected to the AP.

3.2.6 Other features

There are other features available which were not tested as part of this analysis that also provide further performance enhancements:

VaTS: Samsung also implemented a feature called 'VaTS' (Voice Aware Traffic Scheduling) [1] which serves the Samsung voice application. It reduces voice capacity and hence reduces also the contention, enabling more simultaneous calls on the same channel.

Load Balancing: The aim of this feature is to limit the clients connected to an AP (or a band) by moving them to another band or AP, hence balancing the load over APs and bands. This feature also reduces the risk of contention [1].

Air Move: Seamless Wi-Fi mobility is an increasingly important requirement, especially in busy enterprise areas with many APs where people move around. Mobility and handovers are handled by the Air Move feature [1], where the APC decides the optimal time and the target AP for handover by applying handover technology derived from Samsung's LTE carrier solutions.

4. Test setup

4.1 Test site

The test site, Harborne Academy [5], is part of the Birmingham Metropolitan College Group with 600 students and typically 250 - 300 wireless smart devices connected simultaneously.

The Samsung installation over 3 floors includes 54 Access Points (WEA 302) and 1 Access Point Controller (WEC 8500) and was deployed in summer of 2013 [6].

The tests were conducted on the first floor with 23 APs but focused mainly around the atrium with the highest AP density and due to the open space, the highest risk area for interference.

Figure 4-1: The test site: Harborne Academy

4.2 Test infrastructure and architecture

The tested Samsung products were the 802.11n based WEA 302i APs with 2x2 MIMO running the latest firmware (V2.11.1).

Each AP was connected with a 1 Gig Ethernet link to the WEC 8500 Wireless Enterprise Access Point Controller (APC) running the latest version (V2.11.1).

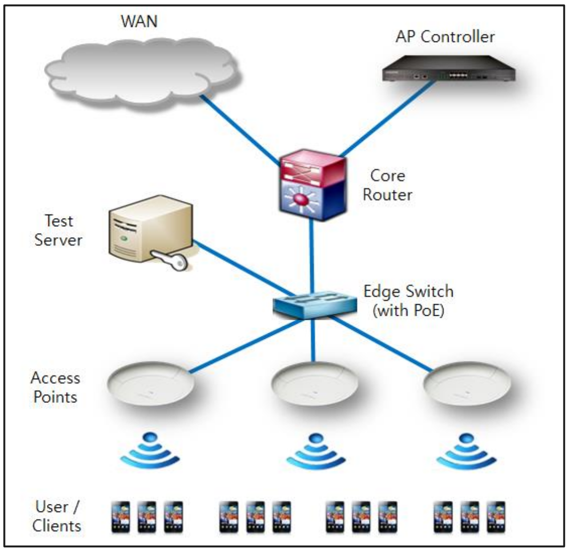

Figure 4-3: Test site architecture

Figure 4-2: Test floor overview

4.3 Test devices and tools

The testing was conducted using some of the following client devices:

- 30 x Ergo 1115 netbooks running Windows 7 Professional 9SP1) with Atheros AR938x dual-band single stream 802.11n Wi-Fi chipsets
- 1 x Samsung S5 running Android version 4.4.2 with dual stream, dual-band 802.11ac Wi-Fi chipset
- 1 x Samsung S4 running Android version 4.3 with single stream dual-band 802.11ac Wi-Fi chipset

A test server was connected to the APC on the WAN port to run the test applications.

IPerf (version 2) was used for uni-directional and bi-directional bandwidth testing to create Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) data streams to measure the throughput per client (Wi-Fi user). For latency measurements, the HRping programme was used.

5. Test results

Our testing, specified that features should be enabled and disabled to enable direct 'A/B' assessment of performance impacts. The results are shown in terms of throughput or percentage of throughput improvements, throughput being the actual data rate experienced by a user, rather than potential misleading 'headline' data rates.

5.1 AirEqualizer

With the help of the AirEqualizer feature, the 'faster clients' obtain the same time allocation as the 'slow clients'. This prevents 'hogging' of resources by faster clients, balancing performance more fairly across users.

For the purpose of this test, 10 clients were connected to a single AP at various distances; Clt 1-4 were in the same room, Clt 5-10 further away in other rooms. The throughput per client increased by up to 54% when the AirEqualizer feature was enabled, as Figure 5-1 shows.

Overall, the AirEqualizer feature provides enhanced user experience and allows more users per access point.

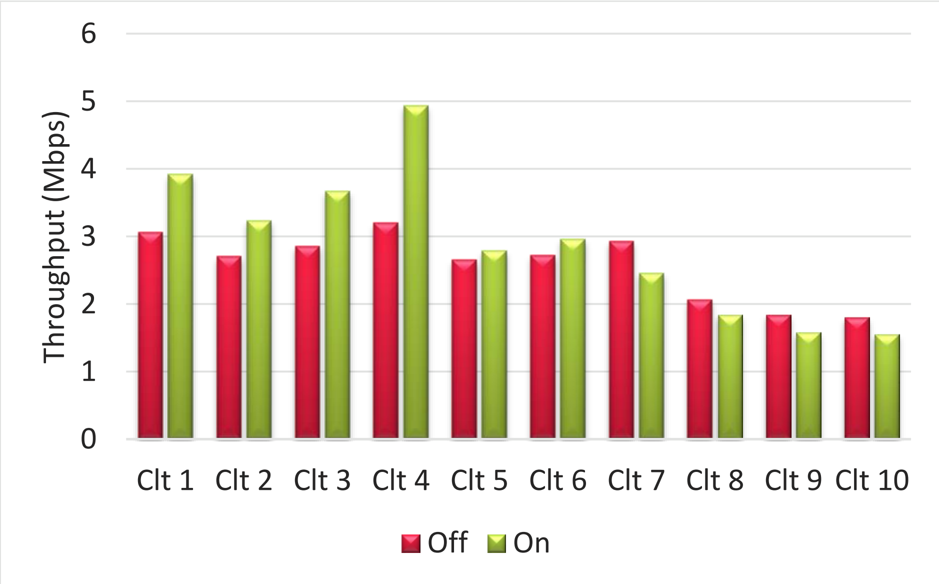

Figure 5-1: AirEqualizer effect on throughput/client

5.2 IBSA (Intelligent Beam Selectable Antennas)

IBSA optimises the antenna beam to suit current device locations and provide better signal levels, continuous coverage, less 'black spots' and less interference.

In this test, 4 clients were connected to a single AP. When IBSA was turned on, the received power increased by up to 2.5 times, and the average throughput increased by 14% as Figure 5-2 shows.

The clients furthest away from the AP have seen the highest improvement. An additional lab measurement with a client at the edge of coverage gave a throughput gain of up to 210%.

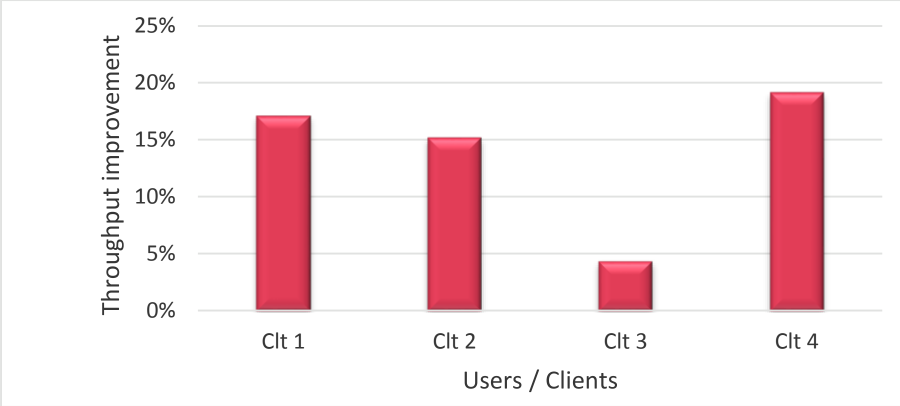

Figure 5-2: Throughput improvement due to IBSA

5.3 SON (Self-Organising Network)

The SON feature automatically optimises the AP channel allocations and powers. As a result, the interference between clients reduced causing an increase in the throughput.

For this test, we had clients at different random locations connected to the APs available. The APs were in default configuration before the SON feature was turned on. The throughput per client increased by up to 160% due to the SON feature activation as shown in Figure 5-3. Overall, an average of 71% throughput improvement was recorded in a 'live' environment due to the SON feature.

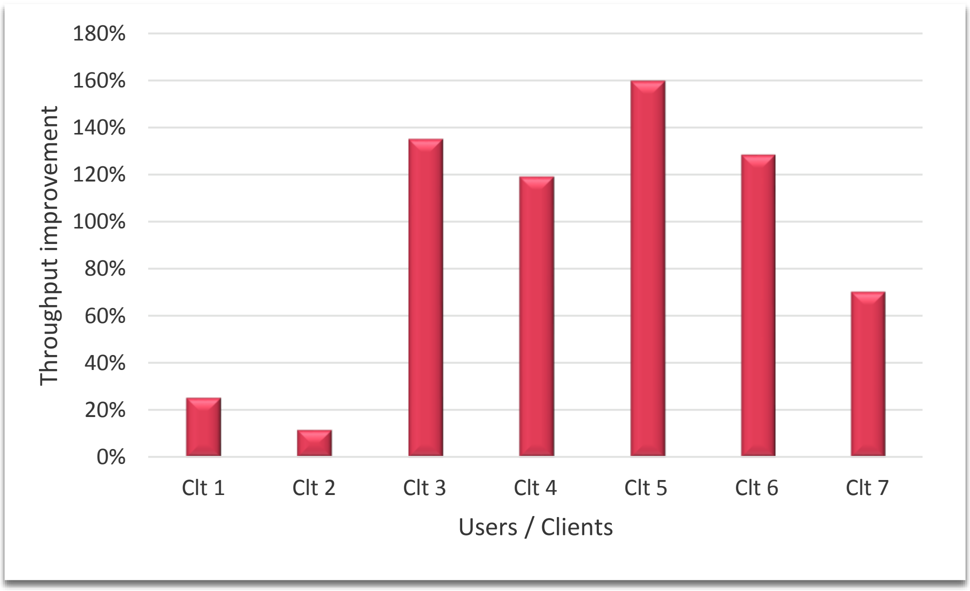

Figure 5-3: Throughput improvement when SON feature is enabled

5.4 WIPS (Wireless Intrusion Protection System) and Load Balancing

In the **WIPS** (Wireless Intrusion Protection System) test, a rogue AP was introduced into the system. This rogue unit was detected and reported by the AP to the controller (APC) in 1min 32s. No further action was taken as the scope was only to ensure rogue devices are detected and recorded by the APC.

In the **Load Balancing** test, the goal was to let the APC recognise units and interrogate if they are 2.4 & 5 GHz capable. We wanted to test if the 5 GHz capable units would re-associate at 5 GHz when the Load Balancing feature was enabled as indicated in Figure 5-4.

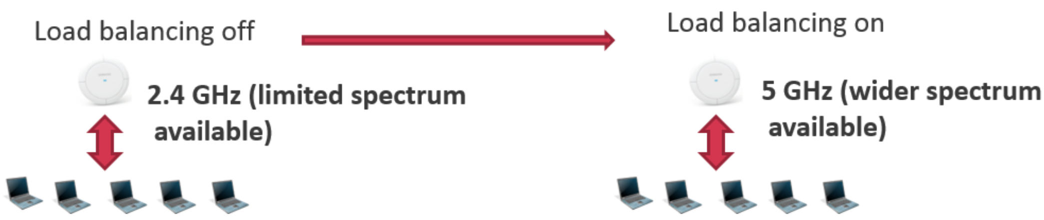

Figure 5-4: Load Balancing feature

We connected four clients supporting 2.4 & 5 GHz and one client supporting 2.4 GHz only, to an AP when load balancing was disabled. As can be seen in Figure 5-5, all the clients associated on 2.4 GHz.

2.4 GHz association and feature off.txt - Notepad

MAC Address	IP Address	AP	BSS	WLAN	Auth	Protocol	AirMove	SSID
30:14:4A:4B:34:09	192.168.111.43	1	F4:D9:FB:3A:A9:30	2	Yes	802.11n(2.4GHz)	No	mtds
30:14:4A:4B:34:04	192.168.111.42	1	F4:D9:FB:3A:A9:30	2	Yes	802.11n(2.4GHz)	No	mtds
30:14:4A:4B:36:4D	192.168.111.41	1	F4:D9:FB:3A:A9:30	2	Yes	802.11n(2.4GHz)	No	mtds
30:14:4A:4B:34:06	192.168.111.37	1	F4:D9:FB:3A:A9:30	2	Yes	802.11n(2.4GHz)	No	mtds
30:14:4A:4B:35:28	192.168.111.39	1	F4:D9:FB:3A:A9:30	2	Yes	802.11n(2.4GHz)	No	mtds
C8:AA:21:15:D7:81	192.168.111.11	1	F4:D9:FB:3A:A9:30	2	Yes	802.11n(2.4GHz)	No	mtds

Figure 5-5: APC first association report when load balancing was disabled

When load balancing was enabled and the units re-associated, the APC recognised the units and interrogated its records to see which units support 5 GHz. The dual band units were connected automatically to the 5 GHz channel where more bandwidth is available to free up the more likely to be congested 2.4 GHz band. As can be seen in Figure 5-6, all clients other than the one that supported only 2.4 GHz connected on 5 GHz.

5 GHz association and feature on.txt - Notepad

MAC Address	IP Address	AP	BSS	WLAN	Auth	Protocol	AirMove	SSID
30:14:4A:4B:36:4D	192.168.111.41	1	F4:D9:FB:3A:A9:23	2	Yes	802.11n(5GHz)	No	mtds
30:14:4A:4B:34:06	192.168.111.37	1	F4:D9:FB:3A:A9:23	2	Yes	802.11n(5GHz)	No	mtds
30:14:4A:4B:34:09	192.168.111.43	1	F4:D9:FB:3A:A9:23	2	Yes	802.11n(5GHz)	No	mtds
30:14:4A:4B:34:04	192.168.111.42	1	F4:D9:FB:3A:A9:23	2	Yes	802.11n(5GHz)	No	mtds
30:14:4A:4B:35:28	192.168.111.39	1	F4:D9:FB:3A:A9:23	2	Yes	802.11n(5GHz)	No	mtds
C8:AA:21:15:D7:81	192.168.111.11	1	F4:D9:FB:3A:A9:30	2	Yes	802.11n(2.4GHz)	No	mtds

Figure 5-6: APC association report when load balancing was enabled

6. Summary

The Samsung Enterprise Wi-Fi solution, its features and performances were independently validated by Real Wireless in an established live installation. In particular, the following features were tested:

- AirEqualizer
- IBSA (Intelligent Beam Selectable Antennas)
- SON
- WIPS
- Load balancing

When the above features on the Samsung Wi-Fi solution were activated, significant performance improvements were observed, as follows:

- **AirEqualizer**
  - Fair resource allocation between devices
  - Reducing contention risk
  - Up to 54% device throughput increase

- **IBSA** (Intelligent Beam Selectable Antennas)
  - Increases coverage and reduces interference
  - Up to 2.5 times stronger signal
  - Up to 210% more throughput

- **SON** (Self Optimising Network)
  - Optimises coverage and reduces interference
  - Optimised network = higher speed = less contention
  - Up to 160% more throughput (71% average)

- **WIPS** (Wireless Intrusion Protection System)
  - Intrusion detection (with separate chip; not in-band)
  - Intrusion detection successful when tested
  - WIPS chip feeds SON with information (out-of-band; no loss of RF airtime)

The features tested – especially IBSA and SON – bring significant technical and commercial benefits to the installer, operator and end users of the system.

- Less detailed RF planning needed; the system self-optimises itself to suit other APs, users and the environment
- Large throughput increase; resulting in higher efficiencies and better user experience
- Better continuous coverage; less 'black spots' but also less interference

- More users; due to increase coverage and reduced interference, the efficiency increases, which as a result means that more users can be supported at good throughput levels

In the deployment phase, the benefits are potentially fewer APs needed and less time spent designing and optimising the network.

From an operational point of view, the benefits result in higher uptime, less time for network analysing and reconfiguration, greater potential revenues, always-on (connected) and higher efficiencies (e.g. less employee downtime).

Overall, the benefits of Samsung's advanced features deal effectively with the challenges of Wi-Fi deployment in busy enterprise environments.

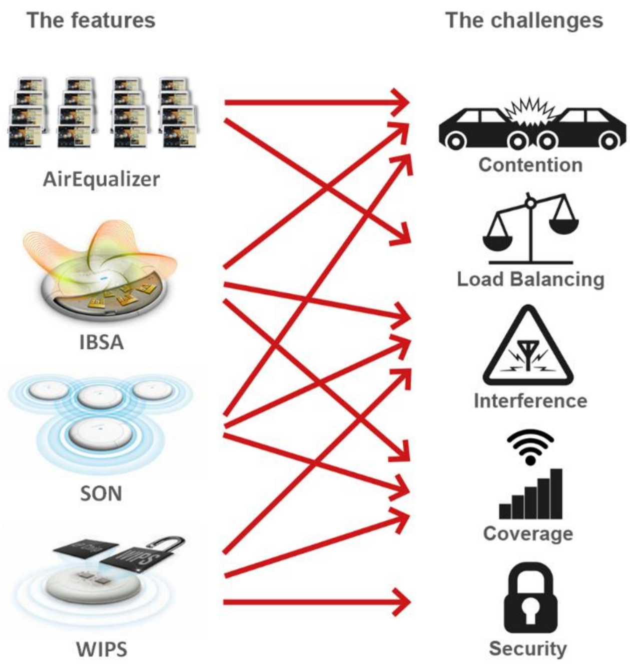

Figure 6-1: Samsung's advanced features tackling the WiFi challenges

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