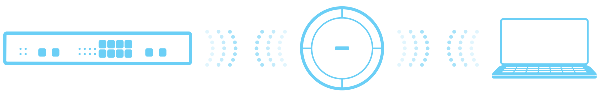
WireLESS, Communicate MORE

Samsung Wireless Enterprise

WLAN AP & Controller



WHITE PAPER

SAMSUNG

Introduction...Smart World

Enterprise wireless environments have typically been established to meet the needs of desktop computing. Other than accessing the network from meeting rooms, even laptops have tended to be largely static in operation. However, with the increasing popularity of mobile devices, such as smartphones and tablets, demands on the wireless network are growing more complex as more and more devices compete for service on the move.

The increasing use of mobile devices brings a range of new challenges to the wireless LAN.

- There are very many more devices competing for network resources. Each person entering the enterprise may bring with them anywhere between 2 and 6 devices.

- Mobile devices are often optimised to maximise battery life and have relatively weak transmit power; yet must co-exist in a wireless network with high end laptops supporting up to 3x3 MIMO technology.

- With increased use of portable devices, there's an expectation that wireless coverage extends to all parts of the building including staircases, corridors, restaurants etc.

- Applications such as VoIP and streaming video require there to be no interruption of service when roaming within the enterprise..

- The proliferation of wireless networks plus interference from other wireless devices (DECT, Bluetooth, RFID, microwave ovens etc.) demands sophisticated approaches to manage resources, minimise interference and optimise performance.

- Security is a constant concern. Wireless networks need to balance the requirement for simple and efficient authentication whilst protecting from unauthorised use and malicious attack.

It is clear that WLAN equipment must be designed and optimized to meet the needs of a new era of mobility. The expectation is of a service that replaces the speed and reliability of a wired network whilst delivering the convenience and ubiquity of a wireless always on service. A new solution is required that is built from the ground up around this new mobile paradigm.

Samsung has introduced a new set on innovative capabilities to the WLAN.

- **AirEqualizer**
  Guarantees that all devices, regardless of speed or capability have fair use of the shared wireless resource.

- **Self Organizing Network (SON)**
  A rich set of capabilities that simplify the design and management of the network. The network monitors its own operation and dynamically adjusts to optimise performance.

- **Voice Aware Traffic Scheduling (VaTs)**
  Recognises that voice traffic has different needs and optimises the network performance to provide best in class service, even when a large number of devices are simultaneously in use.

- **Intelligent Beam Selectable Antenna (IBSA)**
  Provides the optimal beam pattern using multiple internal antennae to adapt coverage according to the location and capability of client devices.

- **AirMove**
  Provides seamless services as a client moves within the enter prise by enabling the network to determine which access point to connect to and the optimum time to roam.

AirEqualizer

A wireless LAN is designed to allow devices to share wireless resources in a distributed method by setting all devices to have the same chance to transmit data.

A typical WLAN access point processes packets in a consecutive order according to a first-in-first-out (FIFO) method. This allows devices that access the AP and receive data services to each transmit and receive the same number of packets.

Different WLAN devices may use very different transmit and receive speed depending on the wireless standard supported (802.11a/b/g/n), strength of the wireless signal and distance from an access point. For example, some devices send and receive data at 6 Mbps while others may support 450Mbps. To send and receive the same amount of data, the slower devices need to send and receive data for a longer time than the faster devices.

Hence, if the sending and receiving counts are same, the slow devices use the wireless resource for a longer time. The wireless resource cannot be effectively used and the faster devices will approach the speed of the slower devices.

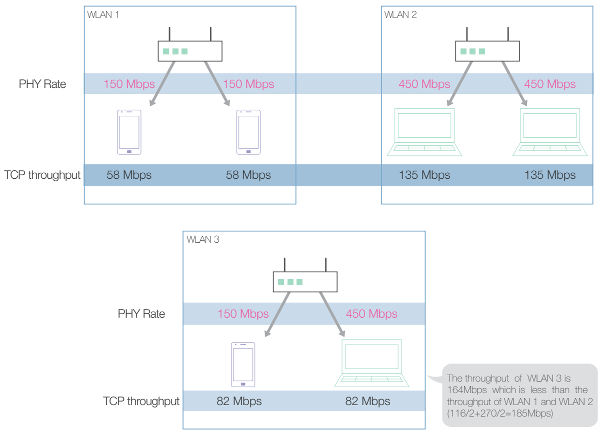


Figure 1. Operation of a normal WLAN AP

For instance, a smart phone with only one antenna can send and receive data at a maximum speed of 150 Mbps. As shown in Figure 1, if only two smart phones connect to an AP and use data services, the total data throughput of the WLAN reaches approximately 116 Mbps. This is a theoretical throughput taking into account protocol overhead and retransmission on the shared wireless media.

A laptop may have several antennas to take advantage of the higher speeds offered by MIMO. For example, a laptop with three antennas can send and receive data at a maximum speed of 450 Mbps. Similar to the first example, if only two laptops connect to the AP and use data services, the total data throughput of the WLAN reaches approximately 270 Mbps.

The final example in Figure 1 shows what happens when one smart phone and one laptop connect to the WLAN and use data services. Whilst you might expect to achieve the mean data throughput of the first two examples, the total throughput is in fact only 164 Mbps.

This is because the slow smart phone sends and receives data for a longer time than the laptop and consumes more time on the shared wireless resource. The faster laptop is assigned less resource and operates at the speed of the slower device.

Samsung's AirEqualizer makes a fundamental change to the way resource is allocated to devices in a WLAN. Rather than giving each device the same number of transmissions, AirEqualizer allocates the same amount of time to each device. Therefore devices capable of transmitting and receiving at a faster speed can achieve a higher data throughput than slower devices in the same time allocation.

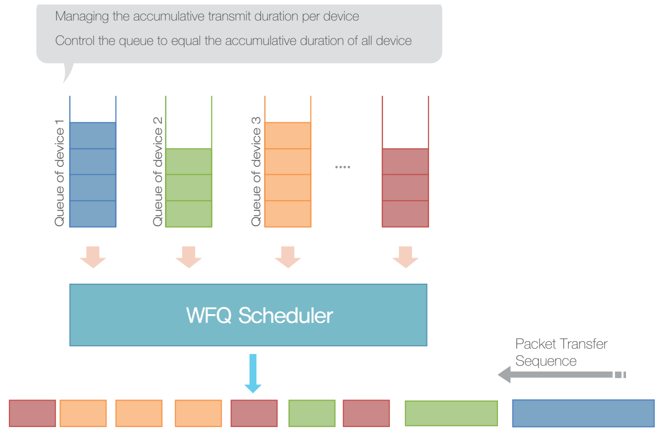


Figure 2. Operation of AirEqualizer

AirEqualizer achieves this by maintaining a separate queue for each device and processing the queue in accordance with a weighted fair queuing (WFQ) method. By tracking the accumulated time used by each device for packet transmission and preferentially processing packets for devices with the shortest accumulative time, all devices are given the same total transmission time.

Figure 3 returns to the earlier scenario where a slow smart phone and fast laptop compete for network resources. With AirEqualizer, the total data throughput is increased from 164 Mbps to 193 Mbps. Just as importantly, the relative speeds of the two devices are in line with their individual performance.

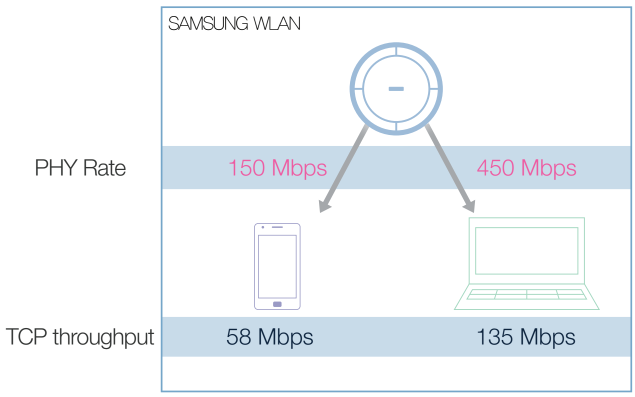


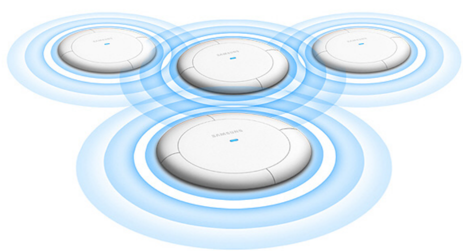
Figure 3. Operation of Samsung WLAN AP

In any environment where a variety of WLAN devices are used, effective implementation of airtime fairness is critical to prevent the performance of the overall WLAN from being degraded when few employees use very slow WLAN devices. With the increased adoption of BYOD, it is often impossible to restrict the type of devices gaining access to the network.

In very dense environments such as classrooms where a large number of devices compete for network resources, airtime fairness prevents the network from grinding to a halt.

Tests have shown that in typical mixed environments with multiple clients, AirEqualizer improves overall throughput by over 60%, provides optimum wireless service and ensures that no clients are starved of service.

Self Organizing Network (SON)



In a conventional enterprise WLAN with many access points, the design of the network can be very complex. The skill and experience of the engineer is critical to the success of a project. Even an excellent design can be subsequently undermined by changes to the RF and or physical environment.

Self Organising Network technology simplifies the engineering of a WLAN by automating cell design. Using a combination of conventional wireless resource management and new techniques adopted from LTE network design, attributes such as transmission power and channel selection are adjusted automatically. In a voice environment, this can include automatically optimising cell configuration and coverage to consider the needs of smart phones.

Once the WLAN is in service, SON continues to work, largely unseen in the background, to ensure that the network adapts to changing circumstances. Built in monitoring modules in every access point ensure this is achieved with zero impact on performance.

Dynamic RF Configuration & Optimization

In order to ensure that an access point is always using the optimum channel and transmit power to deliver the best performance possible, it is necessary to constantly monitor the wireless environment. To be effective, all available channels on both 2.4Ghz and 5Ghz bands need to be monitored.

In a conventional WLAN there are two alternative methods of monitoring performance.

1. Deploying additional access points in dedicated monitoring mode throughout the environment - clearly this approach adds cost to the solution.

2. Using the main access points to also monitor performance by briefly interrupting service at regular intervals - the disadvantage of this approach is that it impacts the performance of the wireless ser vice and cannot respond to changes as quickly as when dedicated monitoring is deployed.

Samsung's WLAN takes a different approach by including a separate monitoring module in every access point to continuously collect Wi-Fi data (RSSI, channel, utilization, etc.). The data is then used to optimise channel selection and transmit power to minimise channel interference and maximise performance.

All achieved at no additional cost and with zero impact on access point service delivery.

Coverage Hole Detection & Correction

Both during the initial network set-up or subsequently in normal service due to changes in the RF environment, the system is able to automatically detect coverage problems.

1. By collecting and analyzing the statistical information on uplink and downlink service quality obtained from connected wireless devices, the system is able to detect whether there are gaps in service coverage
2. If a coverage hole is detected, an alarm is raised and the system automatically attempts to improve downlink quality by adjusting transmission power
3. If the alarm cannot be cleared by automatic adjustment, the system provides detailed analysis allowing an operator to consider modifying the physical design of the network.

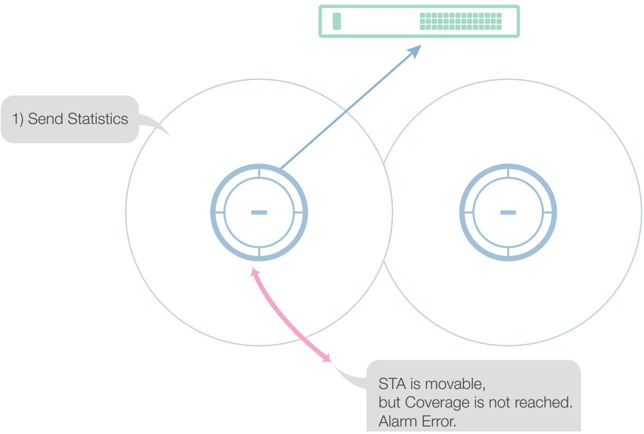


Figure 4. Coverage Hole Detection

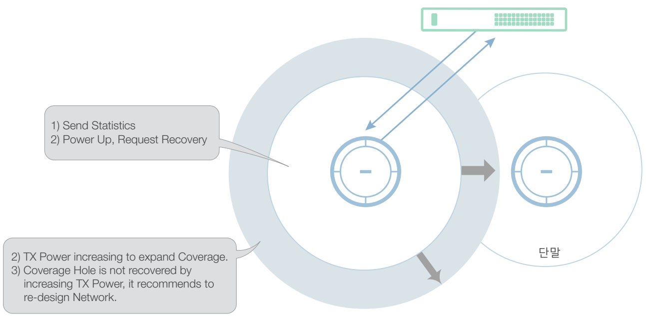


Figure 5. Coverage Hole Correction

Self Healing - Outage Detection & Mitigation

Using the built-in monitoring module, an access point constantly monitors the status of surrounding access points. If a problem with the RF of a neighbouring access point is detected, an alarm is raised at the controller. The controller will automatically attempt to mitigate against the coverage hole by adjusting transmit power from surrounding APs as well as rebooting the AP found to be out.

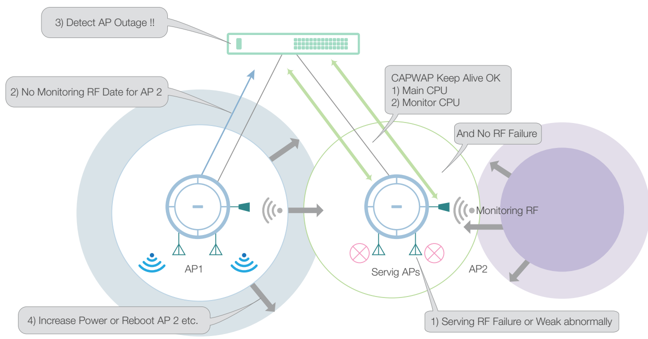


Figure 6. AP Outage Detection

Self Healing - Sleeping Cell Detection & Mitigation

A “Sleeping Cell” is an AP that is not providing any access services even though the RF looks normal. In a typical WLAN, APs are deployed close enough together that a client device can access another AP near the sleeping cell. Hence the sleeping cell may not be obvious even though it is degrading the overall performance of the network.

Samsung SON takes a systematic approach to dealing with sleeping cells.

1. Identifies the status of a “sleeping cell” by collecting various service related statistical data about the AP from the APC.
2. When a "sleeping cell," is detected, automatically adjusts transmit power from surrounding APs to mitigate against the coverage hole.
3. Then performs a diagnostic test on the access point (checking L2 and L3 connectivity). If the diagnosis test fails, reboots the AP.

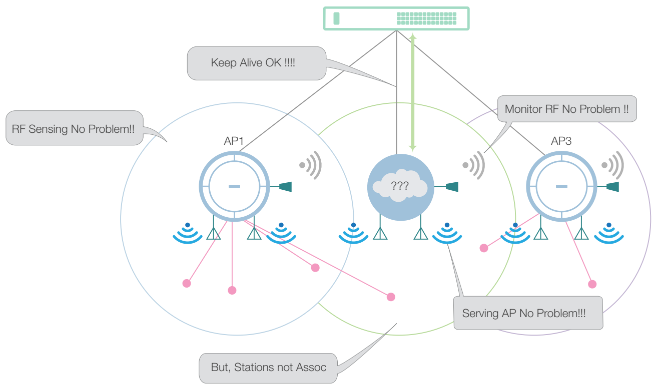


Figure 7. Sleeping Cell Fail Detection

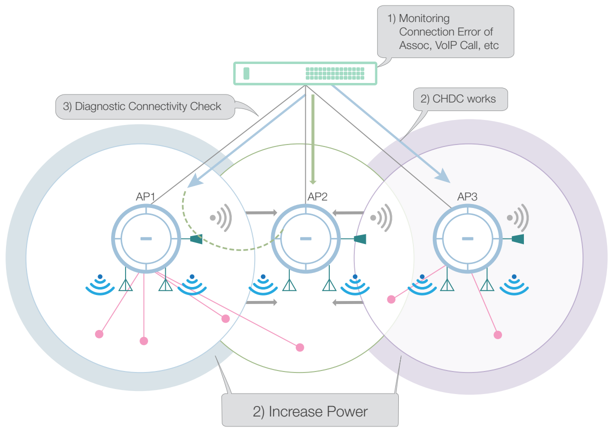


Figure 8. Sleeping Cell Mitigation & Diagnostics

- VaTS reduces positive ack and inter-frame spacing that add overhead in a stable channel environment. Degradation of voice quality is avaoided by re-transmitting a voice packet using the negative ACK method.

- For typical small voice packets, large packet overhead relative to payload results in inefficient use of valuable wireless resources. Rather than individually transmitting packets to multiple devices, VaTS goes through common multiplexing stage before transmission and sends one large packet to multiple terminals.

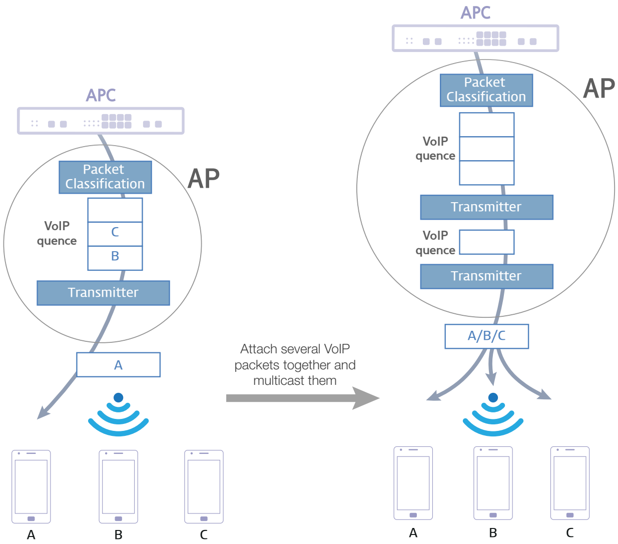
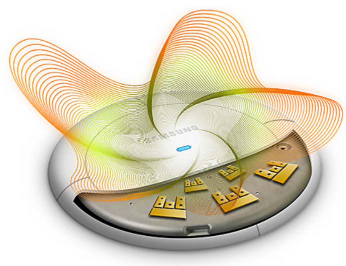


Figure 9. Voice Aware Traffic Scheduling(VaTs)

Voice Aware Traffic Scheduling (VaTs)

With increased adoption of BYOD and the use of Smart Phones in the enterprise, many organisations are looking to deploy VoIP to mobile devices in the WLAN. Voice needs are quite different to data. Whilst bandwidth requirements are low, it is very sensitive to delay. VaTS is a Samsung patented technology designed to increase concurrent call capacity by 50% or more compared to conventional approaches and can deliver substantial cost savings in dense user environments. VaTS is supported for a range of Android devices.

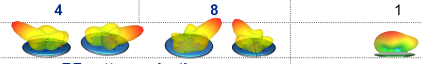
Intelligent Beam Selectable Antenna (IBSA)



Samsung access points consist of up to 12 internal antennas providing an optimal RF pattern through beam shaping according to the needs of the environment. . In doing so, coverage holes are mi-nimised, overall coverage improved and receive sensitivity increased by 2 dB or more compared to other implementations. This allows the signal sent by a mobile device with weak transmit power to be accurately received even over a long distance.

Also provides optimal coverage through dynamic adjustment according to the location of devices. Furthermore, it provides performance equal to or better than that of an external dipole antenna.

- Provides multiple antenna patterns to optimise coverage
- Includes two antennas for each physical antenna port.
- At the point of transmission, the antenna pattern is dynamically selected to maximize coverage
- Coverage may be additionally boosted by minimizing the wireless resource used in unnecessary areas

	Samsung		Competitor	
Antenna Type	2×2 MIMO	3×3 MIMO	2×2 MIMO	3×3 MIMO
# of Antennas	8	12	4	6
# of Antennas Pattern	4	8	1	
				
Feature	RF pattern selection based on WiFi & user status		Fixed pattern	

AirMove

AirMove is a technology supported for Android clients that provides seamless services when a user roams within the WLAN. In a conventional WLAN, roaming is controlled by the client. When the receive signal received by a client falls below a specific threshold, it scans for another access point with better service. Even when new standards (802.11r) are applied to reduce access and certification time, it is impossible to reduce to zero and achieve a seamless transfer. Samsung's AirMove applies LTE technology so that it is the WLAN Controller that makes the decision on the optimal time and target access point for handover. This provides seamless roaming for voice calls and video streaming and guarantees throughput during handover two or more times higher than that of a conventional WLAN.

The operation principles of AirMove are as follows:

① Setup Request: Sends network entries to the device

② Setup Response: APC transmits the parameters (scan time, threshold value, etc.) relating to the list of APs around handover

③ Scanning: The terminal sends a probe request (broadcast).

④ HO decision: Based on the information on the strength of the terminal signals secured from APs, the APC selects the handover time and a target AP to be newly connected among neighboring APs.

⑤ HO command: APC orders to move from the conventionally serviced AP to a new AP.

⑥ HO execution: The terminal completes the handover.

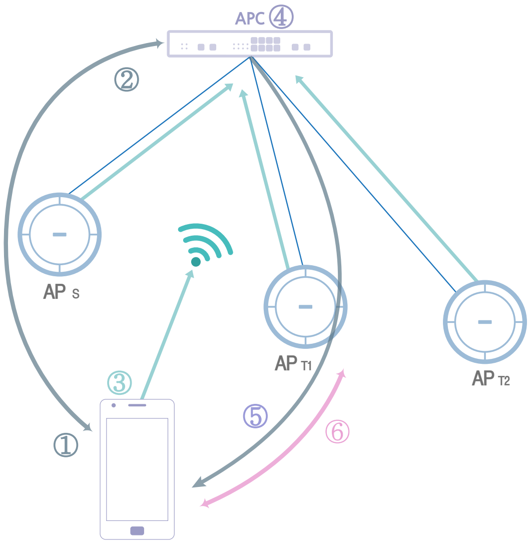


Figure 10. AirMove operation process

Summary

The Samsung WLAN solution is designed from the ground up to provide the best possible service for the wide variety of mobile devices used in a typical environment today.

Using multi-antenna technology, the typical range is increased by 14% whilst coverage, speech quality and data errors are improved by 30%.

In addition, the superior power of the AP affects the devices connected to it, minimising their power consumption for longer battery life, and increases the number of concurrent users per AP by up to 50%.

Truly a state of the art solution for an increasingly mobile world.

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