Samsung
Wireless Enterprise
FMC
Product Overview

Companies are improving their infrastructures to enable the employees to use interphones and have the access to the company intranet in order to do their work, using their own smartphone instead of the wire telephone on the desk. The future office environment is becoming smart based on all the wireless infrastructure. Due to increase in wireless speed and development of related technologies, more and more companies are using HD sound quality level voice telephones through the design of cells optimized for voice. This trend leads the employees of those companies worry about protection of their personal information and privacy of the most. Those companies tend to increase investment in security of personal smartphones to keep pace with the BYOD (Bring Your Own Device) trend.

The FMC (Fixed Mobile Convergence) enables the employees to use wire telephone and mobile phone simultaneously. The employees can use interphones anywhere in the workplace while on the move with their mobile phone. To use the FMC, wireless infrastructure, not the existing Internet use oriented, but optimized for the environment for using voice should be designed. The roaming between APs, channel status, signal strength, data rate, etc. optimized for the voice environment should be designed. Also, before and after the wireless infrastructure is installed, survey and optimization of the actual installed location are necessary. The FMC network design capability such as each handset characteristics, frequency characteristics, signal decrease according to handset grip and handover optimization is the most important element for using the FMC. Samsung will suggest FMC establishment based on the experience of establishing large-scale site FMC.

Reason for Introducing FMC

- Employees can communicate anywhere in a variety of forms while moving around offices. Wireless communication centering on the smart office of all wireless environment.
- Mobile UC optimized for work can be used functions as an organization chart, work contacts, messenger, etc.
- Development of mobile device security technology • Introduction of WLAN security standards and wireless security equipment

- Reduction in communication costs due to use of interphone FMC between headquarter and branch, between offices by using interphones anywhere in the office.
- Supporting HD voice • Guarantees better voice quality than mobile communication

Considerations When Introducing FMC

- Jitter/latency
  When designing cells, the infrastructure is designed to secure enough bandwidth but a little delay can intermittently occur. This delay does not disable calls but it worsens voice quality and can be the cause of the jitter increase.

- Antennas of Client
  Although most smartphones are connected with 802.11n AP, only one stream can be supported. This should be considered to design cells. In addition, some UEs do not support dual band. Therefore, this should be also considered to design cells.

- Client security
  Some smartphones may not support the latest security related standard. In this case, there is a problem that voice calls can be hacked by malicious users.

- Capacity and transaction density
  The data rate decreases as distance from the AP increases. Minimum voice quality should be maintained by designing network to guarantee minimum bandwidth. The cells should be designed to be connected with adequate client per AP to be used by considering expected work location.

Samsung’s FMC Cell Design Know-how

In establishing wireless environment for smart office, wireless cell design is an element that can influence all network configurations including voice quality and AP quantity. The followings should be considered for careful design. The basic considerations below can be changed by consideration changes due to workplace environment, user distribution and work characteristics, and additional considerations.
Standard Considerations

**AP Tx Power**
- Usually, the Tx power of the AP can be set up to 18 to 20dBm.
- The Tx power of the handset is about 10 to 12dBm.
- If the Tx power of the AP is stronger than a handset, a service hole is generated since coverage between uplink and downlink varies.

**Minimum Data Rate Setting**
- Need to set the minimum data rate according to the number of concurrent voice calls per AP.
- Need to set the minimum data rate according to increase in the data access count per AP.
- 6Mbps for 8 to 10 calls / 24Mbps for 15 to 20 calls

**Maximum Access Count (Maximum number of concurrent users)**
- Consider maximum call capacity of the AP.
- Consider handover service capacity that considers mobile calls.
- Used as a standard for calculating the AP of the areas of dense users.

**Minimum Signal Strength Coverage**
- Predict signal strength of the FMC handset based on the actual inspection result through the cell survey. Check the cell according to the minimum data rate due to the number of users

**Channel Setup**
- The DFS channels (52, 56, 60, 64, 100, 104, 108, 112, 116, 120 and 124) are passive scan and they cannot be used more than 100ms per channel.
- 5GHz upper channels (149, 153, 157 and 161) are configured first and when the existing service provider network like KT uses the upper channels, 36, 40, 44 and 48 are used. (Domestic)
- 1, 5, 9 and 13 that the Korea Communications Commission recommends are used in 2.4GHz. (Domestic)

**Radio Wave Interference**
- Interfere in site radio waves using an measuring instrument (Existing wireless LAN radio wave) and select the location of the wireless LAN AP considering noise.

**Channel Bonding**
- Speed can increase twice by connecting two 20MHz bandwidths but the number of available channels decreases.
- The use is prohibited in 2.4GHz. (No available channels), The use is not recommended in 5GHz (Available channel decrease)

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### Samsung Wireless Enterprise Solution

Samsung provides the wireless enterprise solution components for using the FMC service as follows.

**<Samsung’s Wireless Enterprise Components>**

**Differentiation of Samsung Wireless Enterprise Solution**

Specialized, differentiated technologies of Samsung’s wireless enterprise solution enable users to experience much improved voice quality and seamless service compared to the existing wireless environment. The system, handset and applications of Samsung are all developed and differentiated to be optimized for the FMC. With this, specialized interoperation technology between Wi-Fi and 3G/LTE as well as differentiated technologies such as voice quality helps in increasing voice quality and reducing communication costs within the company. Samsung provides the know-how of one and only 5G bandwidth FMC service in Korea.
Seamless Calls and Voice Quality Improvement - AirMove

The existing Wi-Fi handover uses handover mechanism led by the handset but the AirMove, the Samsung’s unique handover mechanism is led by the LTE handset and controller to determine the handover time. The function is supported only when Samsung FMC Client is installed.

- During minimized handover time, packets are also transmitted after buffing so that handover is performed without packet loss. With this, service without interruption can be also supported during wireless LAN handover and seamless calls can be provided by reducing voice disconnection time.
- In case of usual handset-leading handover, since scan for all channels (Service interruption during scanning) should be performed, wireless LAN service interruption time increases. However, in case of Samsung, the controller determines the optimized handover time period considering the network status, RF resource and many more.
- Since packet drop is minimized, high throughput is guaranteed.

The below table shows handover performance comparison when using Samsung’s AirMove technology. Users can check that there is no voice cut-off when using the Samsung AP compared to other companies. Also, users can check that the throughput is 1.7 times higher. It is because the AirMove minimizes handover time and maximizes service time.

50% Increase in Concurrent Voice Call - VaTS (Voice Aware Traffic Scheduler)

This technology decreases overhead of the voice frame to maximize capacity of the system and effectively increase the use of network resources.

Silence packets during chatting are detected and transmitted by multi framing, which is a method of grouping many packets at the same time and sending, to optimize air resource. In addition, voice data is multiplexed to the VaTS super-packet and the converted multicast packet is transmitted to each handset so that the air resource achieves the maximum efficiency. Concurrent voice call can increase up to 50% using this function.

Conditions for Measurement: 5 times of measurement for one AP using the DSLA (Digital Speech Level Analyzer). As shown in the test result above, constant PESQ measurement of the Samsung AP is maintained even in case of maximum 36 concurrent calls. But, the PESQ value of the APs of competitors decreases as concurrent calls increase.

The test result of when voice and data are used simultaneously is shown as below. It shows the comparison of when using voice calls of 3 laptops and 20 smartphones. When using voice/data simultaneously, Samsung’s throughput and PESQ figures are also relatively higher than competitors. When performing the throughput test simultaneously using 8 laptops and 16 smartphones, variation between UEs of Samsung is narrow compared to competitors.

\[<\text{PESQ Measurement Test of Concurrent Voice Call}>\]
LTE based Smart Handover - Smart Handover

If handset is out of the Wi-Fi zones while voice call is being used or RF signal is not good, the voice call is automatically switched to 3G/LTE. For this, interoperation between the AP controller and communication manager is essential. This technology applied the optimized handover method used in the LTE to Wi-Fi.

- If handset is out of the Wi-Fi zones, the AP controller requests call transfer to the communication manager.
- The communication manager requests a 3G/LTE call to the smartphone so that the existing voice call is maintained.

Automatic Switchover to Interphone - Smart Routing

While making a call to the mobile phone number of an extension subscriber by using a smartphone in the Wi-Fi zone, the smart routing function automatically switches the mobile phone number to the extension number. Since calls between mobile phones in the company are switched to interoffice calls, the enterprise communication costs are reduced. Samsung Communication Manager and FMC Client are necessary for this.

Has 5GHz Bandwidth FMC Cell Design Experience

Most of the currently released UEs support 2.4GHz/5GHz dual band. Samsung has the know-how for the FMC service in 5GHz bandwidth as well as in 2.4GHz bandwidth which is mostly used. Since there is less interference in 5GHz bandwidth than in 2.4GHz bandwidth, 5GHz is effective for voice quality improvement. Due to the nature of frequency, the cell design in 5GHz bandwidth should be different from the cell design in the existing 2.4GHz bandwidth for the FMC service. Various handset models have different characteristics such as Rx sensibility, etc. When each UE’s characteristics are considered and specialized cells are designed in 5GHz bandwidth, voice quality and service quality during handover can be guaranteed. Samsung can provide the service optimized for voice based on differentiated know-how such as FMC cell design experience in 5GHz bandwidth in a large building that accommodates 10,000 people.

- Only 4 channels can be used in 2.4GHz, Since 8 channels are used in 5GHz, it is easy to design cells in 5GHz. (Domestic 36, 40, 44, 48, 149, 153, 157 and 161 (8 channels in total))
- The technology avoiding 5GHz radar frequency has been applied.
· H/O algorithm of 5GHz wireless environment has been optimized. Since Samsung FMC client does not scan radar operation frequency channels, the handover time is 80% faster or more than competitors’ 5GHz scan.

Since users can use the dialer of the smartphone instead of a separate FMC dialer, they can directly use the FMC. It is different from the existing other VoIP apps.

· Integrated 3G/LTE Dialer: Since users use the integrated 3G/LTE dialer instead of a separate FMC dialer, they do not need to run a separate FMC app to make a call.

· Optional Calling of Personal Telephone and Company Telephone: When dialing with an external telephone, the user can select whether to make a call using 3G/LTE environment for a personal purpose or a call using wireless LAN environment for a business purpose.

· When the recipient answers a call using the integrated business CID dialer, the caller’s information such as the name, photo, title, etc. is transmitted from the server and displayed even though the information is not saved in the recipient’s mobile phone. In case of a business call in the office, this function can increase work convenience.

· Best Voice Quality - HD Voice Provision

Samsung provides the best voice quality optimized for Samsung smartphones by applying HD voice. We are continuously improving voice quality by minimizing voice delay through cooperation with the smartphone development team as an handset manufacturer.

· Voice Delay Minimization: Minimized voice delay through development cooperation with the smartphone development team. Voice delay has been improved more than 60% compared to the competitors.

· Voice Tone and Articulation Improvement: Used smartphone voice quality technology. Applied voice tuning HD voice technology. Wideband Codec (AMR-WB) and Super Wideband Codec (SILK).

· Voice Quality Tuning Optimization: Pre-tuning of voice quality in detail so that it suits each Samsung smartphone environment. Maintain output for guaranteeing voice quality.

· Easy-to-Use Telephone UI from a User Viewpoint

The UI optimized for the Samsung smartphones from user’s viewpoint enables the latter to use the FMC more conveniently.
Case of Samsung Wireless Enterprise Solution Establishment

Samsung wireless enterprise solution was established in the mobile laboratory of Samsung Electronics Suwon Complex where 11,000 employees work.

- **Standard for Applying Wireless LAN Quality Optimization**
  - Definition of wireless LAN cell edge standard and overlapping execution considering 5G frequency characteristics
  - Calculate the AP quantity considering users who access concurrently in crowded areas such as offices, restaurants, etc. Areas for office work: Install one AP per 30 seats considering 2/3 used concurrently for full-time employees’ work Commonly used areas (restaurants, etc.): Install one AP per 50 seats since frequency of the usage of wireless LAN use in those areas is lower than in the areas for office work.
  - **Applying Optimization for Commonly Used Area**
    - Calculate the standard cell edge of AP signal strength considering wide spaces
    - During handover, LoS (Line of Sight) is secured to maintain call quality.
  - **Applying Optimization for Typical Floor**
    - Calculate the AP quantity based on seats considering full-time employees in crowded spaces of the areas for office work.
    - Apply the threshold of higher signal strength than commonly used areas considering FMC call frequency.

Users can use the FMC in any section without service interruption due to cell optimization based on 5G as follows. We performed optimization considering office spaces, used handset, employees, pattern of use, etc.

The below shows the services used in the smart office environment using the Samsung wireless enterprise solution.

<table>
<thead>
<tr>
<th>Service</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMC 2.0</td>
<td>Call routing, voice calls, smart routing, HD voice, smart handover and wireless desk phone functions</td>
</tr>
<tr>
<td>Wireless LAN (Data Service)</td>
<td>Mobile devices like 2.4G/5G laptop, etc.</td>
</tr>
<tr>
<td>mVoIP</td>
<td>Free voice calls through LTE/3G data network (No area limit)</td>
</tr>
<tr>
<td>e-Meeting</td>
<td>Meeting room reservation/data sharing/meeting participants check, etc.</td>
</tr>
<tr>
<td>Wireless Desk Phone</td>
<td>Interoperation with smartphone (AOM, Call Move, Contacts, Click to Dial, Hot Desking, etc.)</td>
</tr>
<tr>
<td>VoIP call service</td>
<td>Free calls between domestic/overseas workplaces</td>
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<tr>
<td>Reinforcement of Security System</td>
<td>Protect information and IT infrastructure by block-</td>
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<td>ing spread of DDoS, virus, etc.</td>
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<tr>
<td>Videoconferencing</td>
<td>Wire/Wireless(Mobile) Videoconferencing Service</td>
</tr>
</tbody>
</table>

**Samsung Wireless Enterprise Solution Benefit**

Users can use more specialized service than typical FMC when using Samsung wireless enterprise solution.

- **Smart Routing:** If the user calls to the other party’s mobile phone number even though the latter answers a call at his interoffice phone number, smart routing is automatically performed to the interoffice phone number so that the communication cost is reduced.
- **Can concurrently receive a call by wire and wireless phone using the Multi-Ring function.** The extension number is provided to the desk phone and smartphone.
- **Smart Handover:** If a busy VoIP call is out of Wi-Fi zones, it is switched to 3G/LTE.
• Combined FMC/LTE Service: When calling, the caller can select the caller’s phone number and method of call charge generation through the optional LTE and VoIP calling.

• Context CID: The information such as the caller’s name, title, department, etc. is displayed by the CID.

• Messenger for Business Use: Employees can communicate with the group members added to the work contacts using the messenger.

• Employees can make/receive calls using their smartphone like the interoffice phone outside the office. Business calls outside the office are not also charged.

Competitiveness of Samsung

• Samsung has globally competitive smartphone line-up. Samsung provides stable and developed wireless enterprise solution using its integrated original wire/wireless technology/know-how.

• Samsung supports specialized service for establishing FMC environment from cell design to optimization. The voice quality of the FMC is highly dependable on cell design optimized for various smartphones and each site. Samsung establishes the optimal FMC environment based on its various experiences and know-how for each site/smartphone model.

• To provide the best voice quality among the enterprise products, Samsung continuously perform optimization based on smartphones. Samsung executed the best FMC voice quality by cooperating with the smartphone development team and using smartphone voice quality technology. It is a firm competitiveness that only smartphone manufacturers can secure.

• Has the FMC service know-how in the 5G bandwidth. Since there is less frequency interference in 5GHz bandwidth than in 2.4GHz bandwidth, 5GHz is effective for voice quality improvement. Samsung executed less voice cut-off than competitors by applying 5G bandwidth handover algorithm.

• Recommendations for WLAN security operation of the National Intelligence Service are satisfied. TLS/sRTP is supported. The WLAN authentication server supports PEAP authentication and WPA2 encryption of wireless sections.

Conclusion

If a company uses the Samsung Wireless Enterprise Solution, you do not have to think about the problems such as poor voice quality, etc. usually concerned when using the FMC within the company, its employees can be provided with the optimized work environment through the Smart Office establishment. Companies should use the optimal enterprise FMC solution executed through Samsung’s various specialized technologies. The FMC voice optimization experience for each device and infrastructure is one of the most important elements for establishing the FMC. Samsung that has relevant technologies, specialized equipment, experiences, opportunities of cooperation as a device manufacturer and integrated wire/wireless infrastructure is the only best solution.