

**INTERDIGITAL**<sup>®</sup>

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White Paper



**Cellular & Wi-Fi Networks Convergence:  
Policy-Driven Intelligent Network Selection  
& Traffic Management**

Published Third Quarter 2015

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# 1 The Need for Smart Connection Management

Smartphones, tablets, and other devices people use in their daily life have the capability to connect to multiple networks and to support multiple applications. These include: voice and video services, web browsing, gaming, social media, TV, messaging, health, and other enterprise-specific applications—the list is endless. Accessible networks might include 3G and 4G networks, carrier-grade Wi-Fi, connected vehicles, home and enterprise networks, free and premium Wi-Fi networks at a particular venue.

Subscribers seek the highest quality of experience with the least cost. They want their applications to work anywhere, at any time, with no hassles. And sometimes, having an application that works well is worth the extra cost for a user—an opportunity for monetization.

Mobile network operators (MNOs), Mobile Virtual Network Operators (MVNOs), and Multiple System Operators (MSOs) seek to provide services with the highest quality of experience to their subscribers that can be delivered profitably, to create new revenue streams leveraging the vast capabilities supported by mobile devices and their networks, and to differentiate their offerings from competitors, especially from the Over-the-Top (OTT) service providers.

Moving forward, we see a vast selection of 3G, 4G, and Wi-Fi based networks. Sometimes these networks are uniquely qualified to support a service, but more often these networks provide similar yet differentiated capabilities which enable choices. Each has its advantages in terms of quality of experience, cost, capability, average load, battery consumption, or overall impact on adjacent services. And based upon changing conditions, such as time of day, instantaneous load, and changing location the capabilities of a particular network may vary. This could make another network the best choice 'now' to support a specific application.

How do we do this? How do we enable the smart devices to make the best decisions concerning network technologies and connections? How do we make roaming between the various networks and technologies seamless, automatic, and intelligent?

This is the role of the InterDigital® Smart Access Manager (SAM), working in cooperation with industry standard technologies such as ANDSF, Hotspot 2.0 etc.

SAM is a smart client that leverages policy information provided by the MNO to make the best choice 'now.'

In summary, SAM provides the ability to interpret changing conditions, to intelligently control network connections, and to create opportunities for new Service Provider (SP) monetization strategies.

SAM provides the ability for a SP to meet the needs of its subscribers with the best solutions for the SP – through a policy mechanism that the SP controls— with the potential for subscriber- and SP-partner managed parameters.



Many Apps, Many Locations, Many Choices

Note: Icons used in the above graphic are intended as examples of available smart device applications. The logos are the property of their respective companies.

## 2 An Example – Smart Connections from a Subscriber Perspective

The following scenarios show the benefits of a policy driven intelligent connection management solution like InterDigital's SAM. Consider how these capabilities can enhance the SP's network offerings, increase customer loyalty, and create new revenue streams.

**AT YOUR OFFICE** – You (the subscriber) are in your office, in your corporate complex, where you are connected to your corporate Wi-Fi network. The local VoWiFi network compensates for weak signal strength within parts of the corporate complex. A colleague calls your smartphone and suggests lunch at the local mall to discuss some business matters. He shares the link to a file that you review via your smartphone.

*Automatic Use Of Enterprise Networks Controlled by Enterprise IT Org*

**LEAVING FOR LUNCH** - Around noon, you walk out to your car in the parking lot to drive to the restaurant where you will meet your colleague. The corporate VoWiFi network signal level is weak and your phone automatically switches to the 4G mobile network. As you approach your car, your colleague calls to verify that you are coming and starts a conversation.

*Automatic Switch Between Cellular 4G and VoWi-Fi Networks*

**YOUR CONNECTED VEHICLE** – Once started, your car's internal Wi-Fi network becomes available. Because you have previously authorized it, your phone automatically switches both voice and data to take advantage of the vehicle's internal network, preserving battery and leveraging the car's stronger transceiver. This is an example of seamless Automatic Network Switching based upon Policy. The conversation with your colleague completes and you select a music app from the car's display while driving.

*Network Selected Based Upon Availability and Subscriber Parameters*

**AT THE RESTAURANT** – You are now in the middle of a busy mall, seated with your colleague at a restaurant. Because your SP has a partnership with the mall, your phone automatically switches to the mall's free Wi-Fi data network. You order lunch and begin your business conversation.

*Automatic Network Selection Based Upon Previous Authorization*

**BUSY DAY AT THE MALL** - You and your colleague are working over lunch, using your smart devices. The restaurant gets busy and the mall's free Wi-Fi data network starts getting congested. The network's response time is poor and getting worse. A pop-up from the SAM client gives you the choice of selecting a premium data service for today for a modest fee or free after watching a video advertisement sponsored today by a big box store at the mall. You accept to pay the small fee even though you are somewhat intrigued by the teaser of the big box store's advertisement. Your phone switches over to the premium data network. Data access is markedly improved. You and your colleague are able to finish your working session before the end of lunch.

*Quality of Experience Monetization Options*

**AT HOME** – After a busy day, you arrive home. As you enter your home, your phone automatically switches over to your home Wi-Fi network.

*Congestion Recognition with Automatic Resolution*

**WATCHING TV** - Sometime later, sitting on your patio with a cold drink and a snack, you start the TV app on your phone to watch the news. You are able to watch the news without interruption while your children in another room flood your home Wi-Fi network with the traffic from gaming devices. Your phone has automatically recognized the congestion and switched to the 4G-LTE signal that is available.

### 3 The InterDigital Solution

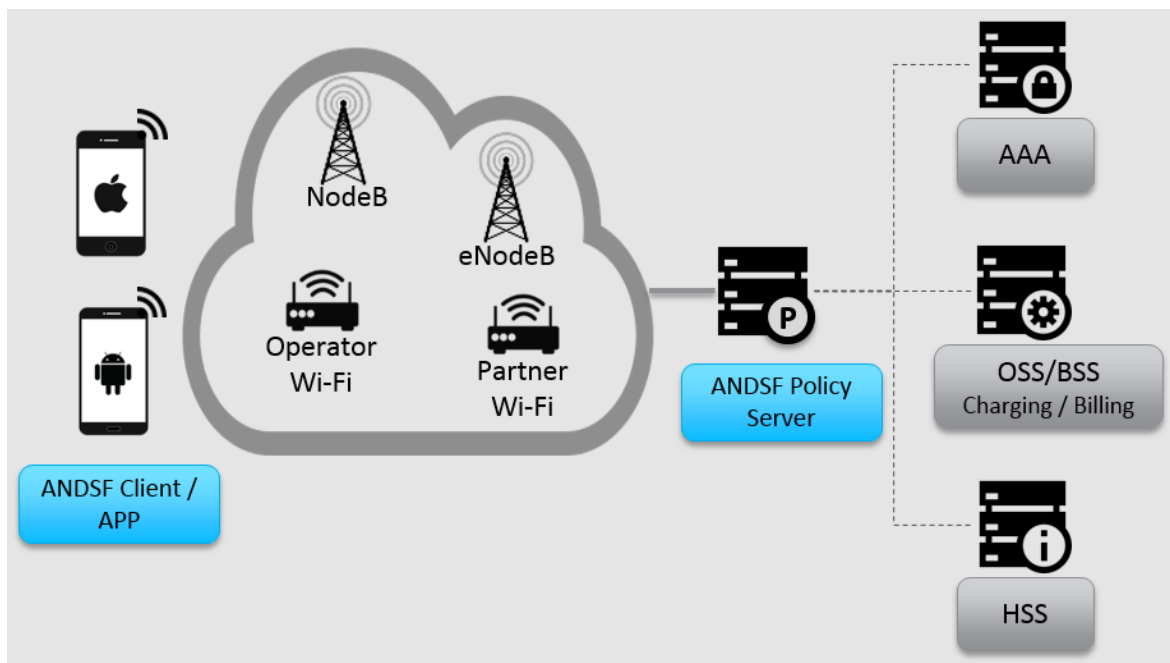
We expect our devices and mobile services to work anywhere, anytime. We don't want to be bothered with connection details. We want a high quality of experience for our apps and content. But we also want a low price.

So what we really want is for our mobile devices to automatically anticipate our needs and to behave accordingly. **SPs who provide this capability will create loyal customers.**

*Please consider, for a moment, how you as a Service Provider can leverage the InterDigital® Smart Access Manager (SAM) and network-based policy management functions to keep your subscribers happy, retain control in the face of competition by Over-the-Top (OTT) providers, and generate new revenues from opportunities created by the Smart Access Manager.*

#### 3.1 How the InterDigital Solution Fits into your Network

There are two main components of the InterDigital SAM solution. The smartphone-based **SAM Client**, which is deployed on the smartphone, senses changes in the network environment and reacts to services and applications running on the phone. A mobile-network-based **ANDSF server** provides the policy rules and logic necessary for decision making, costs/revenue, etc. This 3GPP-specified component naturally integrates with your existing EPC network, or may be deployed already.





### 3.2 The Smartphone-Based Client – The SAM

The smartphone-based component, or client, is the SAM. The SAM Client is supplied by InterDigital and may be combined with a SP's infrastructure in a variety of ways to achieve different results. The SAM itself has a foreground part and a background part.

The SAM middleware is the background part of the SAM client. This is the part that monitors the ongoing conditions, consults the ANDSF server, and sets up the secure tunnels and connections necessary for operation of the various voice, video, and data services.

Operating in the foreground are the portions of SAM that are visible to the subscriber. These SAM Apps enable subscriber-controlled parameterization. They can be supplied as a white-labeled product of the SP or they can be supplied in a form that is embedded within other apps, such as a TV or video app, or a private enterprise app.

SAM Apps are responsible for reporting and modifying parameters that control the connection management behaviors and dialogue with the subscriber to select options. For example, SAM will provide a choice to watch an advertisement in return for access to a higher quality network.



### 3.3 The Network-Based Policy Server – The ANDSF Server

The SAM Client communicates with the network-based **ANDSF server** for connection management decisions and to report analytical information concerning network and connection status. Communication between the SAM Client and the ANDSF Server is via the 3GPP-specified S14 interface.

### 3.4 The Network-Based Wi-Fi Access Component – The ePDG

The SAM Client interworks with the network-based **ePDG** to setup and manage a secure connection that supports VoWiFi. Functionality includes establishment and management of secured tunnel communications.

### 3.5 The Network-Based Access Points – The AP

The SAM Client works with access points, including Hotspot 2.0 Access Points, for Wi-Fi connection management.

### 3.6 How It Works – Connection-Management Decision Criteria

Connection-management decisions are enforced by the SAM Client and interfaces with the ANDSF server. The ANDSF server is a policy server that hosts connection management rules and various decision-making parameters. It also

tracks network and device status. This tracking may include information related to the subscriber's device, various apps, or other interested parties (e.g. an enterprise), in addition to the requirements of the SP.

The following is a partial list of criteria that can be used for decision making for connection management:

- Date and Time
- Current Location
- Application ID, Network ID, Realms, Wildcards, etc.
- Subscriber, Application, and Network Operator-provided preferences, rules, and parameter values
- Current connection attributes, analytics, and thresholds, including how they are changing
- New network availability, attributes, analytics, and thresholds

### 3.7 Maintaining Connection Control and Quality of Experience (QoE)

By hosting the ANDSF server, the SP controls the behavior of the various apps, services, content providers, and other parties that interact during connection management and service delivery.

Network selection is based upon ANDSF policy and subscriber-supplied preferences including:

1. ANDSF Inter-System Mobility Policy (ISMP) rules, which provide Wi-Fi networks preference rankings
2. ANDSF Discovery Information, which provides credentials for seamless Wi-Fi authentication without user intervention
3. ANDSF Inter-System Routing Policy (ISRP), which provides application traffic steering rules
4. SAM-provided analytics, which provide qualitative information about networks and connections
5. Subscriber-provided parameters, which may influence network or option selections
6. Enterprise-partner-provided information, which may influence or control some aspects of connection management for the partner's own Wi-Fi networks

## 4 Example Revisited – This Time from the SP's Perspective

Let's go back to the scenarios from Chapter 2 and this time, take a look at what is going on behind the curtain—that is, from the perspective of the SP.

### 4.1 At the Office

**WHAT HAPPENED:** The subscriber's phone automatically switched to corporate Wi-Fi networks for voice and data. The data network connection was directed to a specific enterprise SSID for corporate data access.

**BEHIND THE CURTAIN:** The subscriber's employer has an enterprise agreement with the SP. The SP provides on premise Wi-Fi Hotspots that enable VoWiFi. This solution enables mobile phone access anywhere within the company's labyrinth of buildings without signal problems. This is a good deal for the enterprise. It is a cost-effective way to ensure the employees can wander the halls of this company without loss of network access. It also means that no additional investment in the 4G infrastructure in and around the enterprise is required by the SP.

As part of this agreement, the SP supplies a new revenue generating service to the enterprise that enables additional connection management capabilities that are controlled (parameterized) by the enterprise IT department. This service might be provided in conjunction with a customer loyalty agreement to supply cell phones and other smart devices for enterprise/private use by employees of the company, or as an add-on service that generates revenue. The enterprise IT department uses this to manage individual employee access via a set of SSIDs that have varying access capabilities. For example, HR employees access the network via an SSID that gives access to HR servers, employees in the accounting department see the financial systems, and software developers access the development servers and a test bed.

As the subscriber arrived at work in the morning, the SAM on his phone recognized the presence of a new set of Wi-Fi networks and noted the subscriber's location as being within the boundaries of the enterprise. It consulted with the ANDSF server. The rules specified that based on the time of day, location, and subscriber identification, the phone should use the enterprise VoWiFi network for calling and should connect to a specified SSID for data access. An enterprise single-sign-on procedure was also performed upon initial connection.

## 4.2 Leaving For Lunch

**WHAT HAPPENED:** Around noon, the subscriber walked to his car for his offsite lunch meeting. On the way to the car, a call comes in. During the call the subscriber enters his car, places the phone in a cradle, and drives away. The call ends sometime later.

**BEHIND THE CURTAIN:** Upon leaving the office, the location change registers with the SAM client. The presence of a strong 4G signal and the reduced quality of the enterprise's hotspot-signal strength triggers evaluation of the rules and the phone is switched from the enterprise Wi-Fi for both voice and data to the default 4G cellular network. The call is processed as a normal cellular call as the subscriber walks to his car and continues in that mode after entry into his vehicle.

## 4.3 Drive in a Connected Vehicle

**WHAT HAPPENED:** Upon starting the car, the SAM sees the emerging presence of the vehicle Wi-Fi network with a strong signal. The SAM then switches both voice and data network access to leverage the strong transceiver built into the car.

**BEHIND THE CURTAIN:** When the subscriber started his connected vehicle, the SAM sees the vehicle's Wi-Fi hotspot become available. The subscriber has previously configured his preferences for his smartphone to use the vehicle network for voice and data when it is available. An exchange between the SAM Client and the ANDSF server confirms how the connections should be handled in this environment. The SAM transitions the network connections automatically.

## 4.4 At the Restaurant

**WHAT HAPPENED:** Upon arrival at the mall restaurant, the phone automatically switches data access to the mall's Wi-Fi network.

**BEHIND THE CURTAIN:** Like a football stadium or an airport, the mall can be a very busy place with a high volume of subscribers compressed into a small geographic space. Working with the SP, the mall operator has deployed a Wi-Fi



network within the mall for customer convenience. The Wi-Fi network enables offloading of data traffic from the mobile network. From the SP's perspective, this frees up the available mobile bandwidth for voice services and gives better service overall.

When our subscriber arrives at the mall, the SP's policy, encoded in the ANDSF server, automatically switches the phone's data path to use the Wi-Fi network at the mall.

## 4.5 Busy Day at the Mall

**WHAT HAPPENED:** The mall's free data network is very busy today and response time is poor. This poor response time is detected by the SAM Client on the smartphone. A pop-up gives our subscriber the choice of selecting a premium data service for today for a modest fee or free after watching a video advertisement sponsored today by a big box store at the mall. The subscriber accepts the proposal to pay the fee even though somewhat intrigued by the teaser for the big box store's advertisement. The phone switches over to the premium data network and data access is markedly improved.

**BEHIND THE CURTAIN:** During data access, the SAM notes that the response times are growing longer. The SAM Client consults with the ANDSF server for options. The ANDSF server provides information that describes how the smartphone may prompt the subscriber for access to a premium network data service provided by the mall. This option is made possible by an agreement between the SP and the mall operator.

In addition to the free data network, the mall also offers a premium Wi-Fi data service. The premium service may be sponsored by stores within the mall or sold as an extra cost offering. This is an example of a new, multi-layered revenue opportunity for the SP and the mall.

As noted above, SAM's user-interface layer provides a prompt to the subscriber, which is appropriately customized with the mall's and the sponsoring big-box store's logos. The subscriber can then either choose to pay a fee to access the premium network, or to watch a commercial message. In our example, the subscriber selects to purchase access directly (instead of choosing to watch the video advertisement).

This selection is passed back to the ANDSF server which generates a billing record for the subscriber and a credit for the mall's SP. The smartphone, meanwhile, now accesses data via the premium network. Had the subscriber selected the commercial message, the SAM App would have played the video clip, and upon completion would have reported the viewing and provided access to the premium network. In turn, the ANDSF server would have provided a billing record for the big box operator and credit to the mall's SP.

## 4.6 At Home

**WHAT HAPPENED:** As the subscriber arrived at his home, his smart phone automatically switched data to use the home Wi-Fi network.

**BEHIND THE CURTAIN:** Our subscriber has a home Wi-Fi network that is supplied by an Internet Service Provider (ISP). The network is supported by a generic access point or perhaps a Hotspot 2.0 capable access point. Upon arrival, the phone simply connects to the home data network.

## 4.7 Watching TV

**WHAT HAPPENED:** Sometime later, sitting on his patio with a cold drink and a snack, the subscriber starts the TV app on his phone to watch the news. It just works—automatically. He watches the news without interruption while his children in the other room flood the home Wi-Fi network with traffic from their gaming system.

**BEHIND THE CURTAIN:** As the smartphone starts using the TV app, the SAM Client recognizes that the home data network is congested and consults with the ANDSF server for an alternative. The ANDSF server indicates that the phone may switch to the 4G mobile network for the TV app as long as the network is accessible. The phone, upon determining that the 4G signal is strong, routes the data path for the TV app via the 4G network, delivering the news to the subscriber who is unaware that this has all taken place.

## 5 Summary of Benefits

The InterDigital SAM with information provided by enterprise customers, content providers and subscribers, and using policies controlled by the SP can achieve the following:

**MOBILE SUBSCRIBER SATISFACTION** – the automatic connection management provided by the SAM is a major part of having the smartphone perform automatically as the subscriber expects. Much of this is going on behind the curtain, invisible to the subscriber, as it should be. The SAM contributes to a higher quality of experience (QoE), reduces subscriber and carrier burden for device management, and keeps the device optimally connected.

**SERVICE PROVIDER CONTROL** – the use of SAM technology allows the SP to retain control of the subscriber's use of the network and to give the best service possible at specified price points. The SAM allows the SP to control resource allocations, provide premium services, create new revenue streams, and compete effectively against OTT-service providers.

**SUBSCRIBER PREFERENCES, ENTERPRISE CONTROLS** – the SAM Client working with the ANDSF server enables the SP to provide services to Wi-Fi network partners and customers. This enables them to control portions of connection-management functions that are appropriate to their interaction with the subscriber. The SAM also allows the subscriber to store preferences and/or permissions for automatic management of connections and services. All of these capabilities work towards making the subscriber happier with his services and allowing the SP and its clients and partners to control appropriate portions of the total capability.

**REDUCED COSTS, NEW REVENUE GENERATION** – the SAM enables the network operator to balance optimal resource usage with optimal subscriber services. New services for content providers, enterprise customers, and individual subscribers can all result from using the SAM solution.

## About InterDigital

InterDigital, Inc., designs and develops advanced technologies that enable and enhance mobile communications and capabilities. Founded in 1972, our engineers have designed and developed a wide range of innovations that are used in mobile technology products and networks that include 2G, 3G, 4G and IEEE 802-related products and networks.

For more than four decades, InterDigital has been a pioneer in mobile technology and a key contributor to global wireless standards. Our team of more than 150 engineers – nearly 75 percent of whom hold advanced degrees, including nearly 50 PhDs – has unparalleled expertise in major mobile connectivity and content delivery technologies. Since 2000, InterDigital has spent close to \$900 million on technology research and development.

The company's activities are organized around the concept of the Living Network: a future where intelligent networks self-optimize to deliver service that is tailored to the content, context and connectivity of the user, device or need.

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