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Limitations of DAS and Wi-Fi Monitoring

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Introduction

Enterprise level DAS and Wi-Fi systems are an expensive proposition. The cost of an installation for a typical sports stadium runs into the millions of dollars. It definitely makes sense to add a monitoring layer so that the DAS and Wi-Fi equipment and functionality can be managed and maintained properly. DAS and Wi-Fi monitoring is a necessary component of the overall DAS/Wi-Fi system.

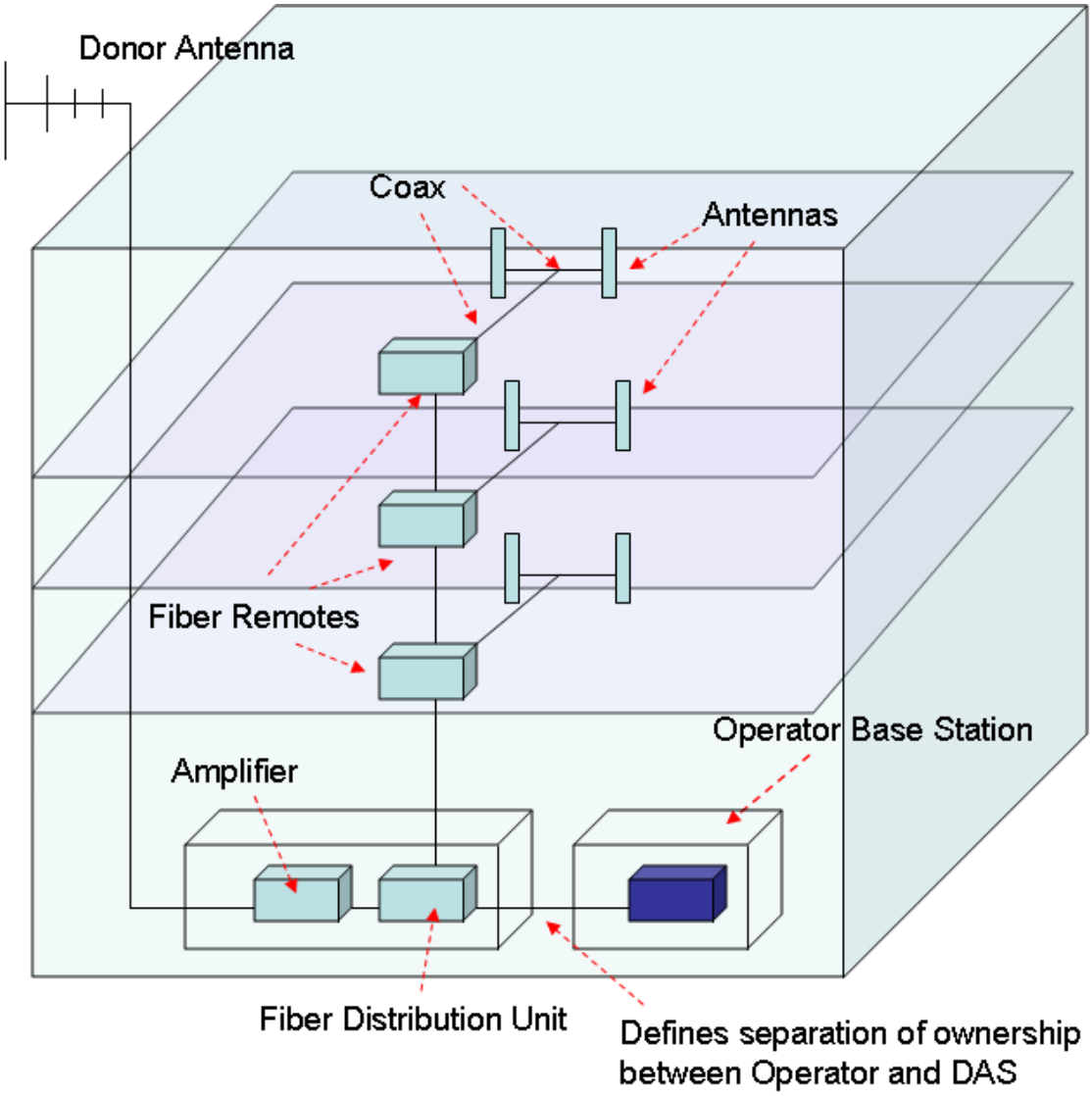
However, it is essential for the building owner or manager to understand that the DAS/Wi-Fi monitoring systems provide diagnostics and alarming information on the DAS/Wi-Fi system components and some quality information but from the viewpoint of the network elements, NOT from the viewpoint of the user. It DOES NOT provide all the information necessary to confirm a positive user experience. In other words, monitoring systems can indicate that all is well with the DAS/Wi-Fi network but the user can not make a call or the throughput is painfully slow.

DAS monitoring systems DO NOT measure the user perceived experience. They only measure the lower layers of the transport system such as connections between antennas, cabling, controllers, multiplexers, etc. It does not measure the higher layers of call mobility communication such as signal to noise, interference, signal quality, connections, data throughput, layer 3 messaging, etc. between the mobile user and the Operator's (Verizon, AT&T, etc.) switching/call processing equipment.

Wi-Fi monitoring systems provide information from the Access Point level. While it provides overall throughput through the Access Point as well as number of connections it does not provide areas of interference, user measured throughput and signal level coverage.

DAS System Architecture

The DAS system for a typical indoor installation consists of the Operator's Base Station equipment interfacing to the DAS at the Fiber Distribution Unit. See the following diagram. The point of ownership separation is shown.



The DAS accepts the signaling from the Operator Base Station equipment and the donor RF from an external antenna via an amplifier and through a Fiber Distribution Unit. The signaling is carried over the desired frequencies via fiber to Fiber Remote units installed throughout the venue. From the Fiber Remotes, coax is run to the individual antennas. Typically 4 antennas per Fiber Remote are provided. Additional antennas can be added via splitters.

DAS Manufacturers vary in their product offerings but the basic architecture is the same. The key point here is that the DAS has no knowledge of the cellular phone signaling. It is a simple albeit highly intelligent transport system for RF. Further, while some Fiber Remotes have the ability to measure signal strengths at the antenna point. It does not have the ability to measure signal levels at the location of the cellular phone or device. It has the ability to know if the transport system has failed (i.e. antenna is broken, connector is loose, cable has been damaged, control unit software has failed, power is out, etc.) but it does not have any knowledge of the signaling failing or if the system RF design is not functioning optimally.

What DAS Monitors

Below is a chart from a paper that analyzed 3,000 DAS nodes for failures. These failures came from the DAS monitoring system. Note that all of these failures except for RF Power level adjustments are hardware failures, power failures or unknown failure requiring rebooting the device. RF power adjustment is based on a comparison from the original walk test and the current RF measurement as measured at the antenna location. Hardly a measure of user located signal levels and certainly not a measurement of signal to noise at the user location.

Resolution to Outage	% Of Occurances
Power Cycle Required on Remote Hardware	23.9%
Local Electrical Power Outage	19.8%
Commication Router Required Reset	9.8%
Fiber Optics Damaged Or Broken	9.5%
Remote Hardware required replacing	6.9%
Reset Circuit Breaker	4.8%
Replaced Node Component	4.7%
RF Powerlevels adjustements	4.4%
Replaced or Repaired Electrical Components	4.3%
Fiber Option Connections Required Cleaning	3.7%
Replaced Hardware on HUB	3.4%
Remote Reset	2.4%
hub power cycled	2.4%

Source: Monitoring DAS Networks by Padraig Tobin, Errigal Telecommunications CEO

What DAS does NOT monitor

DAS systems do not monitor the signaling level of the network. They do not measure the capacity or quality of the user experience from the user's perspective. While the DAS may work perfectly fine in its function of carrying the signals over its transport layer it has no knowledge of the quality of that signal.

In addition, the Operator's may optimize their portion of the DAS when the system is installed. Many things can change over time.

Wireless networks are constantly changing due to the requirements of the Operators to meet the growing demand of increased usage of the networks. To adapt to these requirements Operators are constantly changing parameters, adding new cell sites, upgrading technology, adding additional spectrum. The network outside the DAS venue can have a huge impact on the DAS performance.

If the cell sites outside are transmitting too strong it can cause interference on the DAS and greatly reduce the capacity. If the donor cell signal gets disrupted this can have a huge impact on the DAS.

In order to meet outdoor capacity requirements Operators are adding additional cells. If this is done near the indoor venue this can have a dramatic affect on the DAS.

Additional spectrum and improved technologies, such as 4G and Voice over LTE are being added to the networks.

DAS antennas, cabling and connectors can loosen or move or deteriorate over time. These soft failures may not be noticed by the DAS management system and can have dramatic effects on users.

Operators can change parameters on the base station equipment that may affect user quality. Internet connections coming into the Operator's base station equipment may become compromised and can affect data throughput.

Changes in the environment of the building (temperature, new signs, differing seating arrangements, new construction) can affect the user experience.

Over time the usage patterns change. More people will be using their mobile devices as time goes on. As usage increases the capacity and quality will degrade.

The Problem with WiFi

WiFi is typically installed along side a DAS. The same wiring runs and antenna locations are typically used although this can vary. Many think that WiFi is the answer because we all have WiFi in our homes and offices and its fast and works great.

However, when putting WiFi into a stadium, hospital, resort or any environment where you have many users in a condensed area or interfering signals this technology begins to break down or at a minimum becomes very difficult to engineer and optimize properly.

Here is a post explaining the technical issues of WiFi in terms of radio frequency sharing and connections.

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http://arstechnica.com/features/2012/08/why-your-smart-device-cant-get-wifi-in-the-home-teams-stadium/?comments=1&post=23209164#comment-23209164

“The root of the problem is that it's shared spectrum. 2.4GHz WiFi (not all devices support 5Ghz, so you can't rely on that to solve the problem) is only 60MHz wide. That's 3 non-overlapping 20 MHz channels and 11 total channels with 5MHz center offsets.

When a device (client or access point) wants to transmit, it listens on the 20MHz of frequency it wants to transmit. If it hears something, it doesn't transmit (this is Carrier Sense Multiple Access Collision Avoidance, or CSMA/CA).

Fundamentally, when you have hundreds of devices within "earshot" it can be very, very hard to find a slice of time to transmit in.

In the context of a stadium, basically everybody is within range of everybody (especially if they're using 802.11n with MIMO), making it fundamentally VERY difficult to find time slots to communicate within.

In addition, nearly all access points (even very high end ones) have a lot of difficulty communicating with more than 30 clients at the same time. This is why you see references to deploying 200 to 400, even 500 access points in such a physically small facility.

It really comes down to a matter of multiplexing shared access over the time on a (contextually) very limited channel space. Similar to how you can't hold a conversation with somebody five rows down in the stadium, your hand held devices have trouble having a conversation with their access point.

The very real protocol limitations of CSMA/CA cause it simply and fundamentally breaks down to the point of not functioning in the presence of this many devices.”

In addition to the sharing and connection problem the 2.4GHz spectrum is shared with other devices such as microwave ovens, garage door openers and such. There is a lot of noise in this spectrum and the more noise the lower the signal to noise ratio which lowers the capacity of the channel which lowers the throughput availability.

Monitoring WiFi

There are monitoring solutions for enterprise WiFi systems that provide a host of information about the connections and signal levels but they are limited to the Access Point location. They do not provide end to end quality information all the way to the end user without performing specific tests on a mobile device. This monitoring software can detect the number of connections at the Access Point level as well as the combined throughput but it doesn't provide the view as seen from the user.

In order to determine the user experience it is necessary to walk the venue and log the signal quality and throughput information along with the location of the user. From this data the interference, coverage and throughput information as measured from the user perspective is obtained and can be used to identify problem areas and to log information that can be used to modify the WiFi network to improve the quality.

This becomes very challenging particularly during an event with a large number of people in a small area such as a stadium or convention hall or where there are many obstacles and interferers such as in a hospital, resort or office building.

Solution

Building owners and managers can choose to rely on the DAS or Wi-Fi vendors or the Wireless Operators to maintain the capacity and quality of the DAS and Wi-Fi user experience. This is certainly an option but the priorities of these companies might not be aligned with the Building Owner/Manager.

The DAS/Wi-Fi vendors and Wireless Operators each have a responsibility of providing a quality user experience and they are inherently part of the install, design, optimization and maintenance of the system itself. It seems wise to have a third party perform the user experience measurements so as to eliminate any suspicion of biased results. We do not infer that bias in the results would occur by using the DAS/Wi-Fi vendor or Operator but it is the mere usage of them that raises questions as to how the data was collected, test methods, etc.

A complete third party opinion is the best approach to measure the capacity and quality of the DAS in an ongoing way so that the DAS Owner/Manager has the confidence that their needs are 100% aligned with the goals of the company providing the test results. In addition, the test results can be used as a positive tool to discuss ways of improving the DAS user experience. The DAS system needs constant attention as it is a dynamic network that needs to be tested and modified. If left alone it will slowly degrade due to the changes in the network, environment and user usage patterns

Conclusion

DAS monitoring systems do just that, monitor the DAS. They do not measure the user experience. They can not tell if the user in Section C Row11 Seat 6 is getting 30mbps or 100kbps of throughput. They do not know what the percentage of dropped calls or blocked calls. They do not know the WiFi throughput or connection access or drop rate.

DAS monitoring does not monitor the signaling level of the cellular network. Wi-Fi monitoring does not measure the quality and throughput from the user perspective. This needs to be done by test methods that simulate the user experience. In other words, the proper way to monitor the user experience in an ongoing basis is through a combination of walk tests (4 times a year on average) and fixed devices scattered throughout the stadium. Measurements from fixed devices are calibrated from the walk tests and provide continuous monitoring of the DAS and Wi-Fi networks automatically.

DAS/Wi-Fi vendors and Wireless Operators can perform walk studies and quality comparison reports but they are part of the system. Their responsibility lies in the functionality of *their* equipment. A third party company that has no bias is needed to properly and fairly measure the user experience.

Finally, wireless networks including DAS and Wi-Fi require constant testing and modification due to changes in the outdoor network, wireless technologies, available wireless spectrum, building modifications and user usage patterns. A Greek philosopher one said, “The only thing constant is change”. The DAS/Wi-Fi may or may not work great when it is new. It is surely guaranteed that it will not get better over time unless it is measured properly.