RFI RESPONSE

Enterprise WLAN Infrastructure

Request for Information

1 April 2006

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Preface

Business' ever-increasing desire to "cut the cord" for voice, data, and video communications is fueling demand for large-scale wireless LAN deployments. To date, worldwide enterprise WLAN adoption rates have been low, and even those deployments have tended to be small-scale, tactical, and "hot-spot" like. This appears to be changing, as enterprises appear poised to start deploying WLAN more strategically and pervasively.

But this also raises the stakes. Aware of the implications of increased reliance on WLAN, enterprises are tempering their enthusiasm by re-examining long-held assumptions about WLAN benchmarks of performance, deployment, and utility.

This re-examination will lead to one inescapable conclusion: for pervasive, enterprise-wide WLAN deployments to succeed, a rethinking of the system topology is essential. What may have worked in the tactical, hot-spot model will not hold up when subjected to the ratcheting stress of large deployments running advanced applications that require seamless mobility and real-time, robust wireless connections.

Extricom's Interference-Free™ technology is ideal for high-performance delivery of converged data, voice (VoWLAN), video and other real-time mobile and mission-critical applications. This unique, patented architecture enables radically simplified deployment, dramatically lower total cost of ownership, and the co-existence of bandwidth-intensive voice and data services, all on the same WLAN system, while maximizing capacity, coverage, seamless mobility, and security. The result is the marketplace's only large-scale WLAN infrastructure that is as dependable as the wired network, supporting triple play services without performance compromises.

This document starts with an overview of the real-world challenges that face large-scale WLANs, followed by an overview of the Extricom architecture and its benefits. A number of documents are referenced throughout, which in aggregate will provide the reader with a thorough and fact-based exposition of the issues and opportunities of WLAN.

Pervasive Enterprise WLAN – Raising the Bar

Pervasive and strategic deployment means moving beyond the tactical, pilot, and/or "hot-spot"-like use of WLAN. This increases demands and expectations on two fronts.

1. Multi-use Infrastructure: meaning the push to concurrently support both voice and data.
2. Performance of Communications: as WLAN becomes the primary transport, users and administrators will increasingly expect it to perform like the wired counterpart. This means understanding performance in terms of those elements that affect the core communication function: coverage, capacity, mobility, and link resilience.

Given the above, the enterprise requirement can be summed up in the following statement:

"Cost effectively deliver multiple Wi-Fi services,
to many users, over a wide geographic area."

If we break down this seemingly simple statement, we find it to hold a number of important implications.

"Cost effectively…"

Relates to cost of ownership. The cost of deployment and maintenance is the single largest cost associated with owning a WLAN. The complexity of current architectural approaches raises questions of cost and risk when talking about larger scale, pervasive deployments.

"…deliver multiple Wi-Fi services…"

Points to the inevitable push to find multiple uses for the same WLAN infrastructure. The question then is how to ensure seamlessly mobile, secure, dependable, and high quality voice, data, and video on the same infrastructure.

"…to many users, over a wide geographic area."

The question of capacity and coverage is paramount. How will either be sufficient, especially in light of the limitations that are embedded in the very specification of 802.11?

With these objectives in mind, the WLAN topology alternatives can be assessed.

The Realities of 802.11 WLAN

Before going much further, we should be clear on certain facts of the 802.11 specification.

Frequencies Are Scarce

WLANs operate in two frequency bands: 2.4 GHz and 5 GHz. The 2.4 GHz band is where 802.11b and .11g modes operate, and such systems have only three non-overlapping channels available to the designer (the red channels shown in Figure 1).

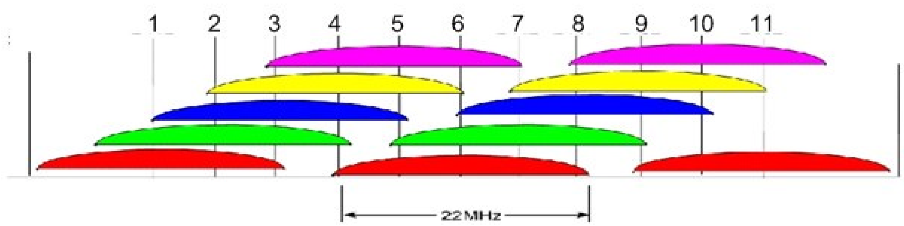

Figure 1 – 2.4 GHz Channelization Plan

The 5 GHz band, where the 802.11a mode operates, is a bit better, with more than eight non-overlapping channels available (subject to regulatory mandates). It is interesting to note that the vast majority of users and systems today are in the 2.4 GHz band.

No Mobility

The 802.11 protocol was not designed for seamless mobility. It is better described as a protocol for portability. That's because the client, not the infrastructure, makes all the decisions regarding when and where to associate as it moves within range of different access points. A new standard that is being drafted, 802.11r, aims to introduce "fast roaming" by reducing the amount of time a client takes to make a transfer between two adjacent access points. This specification, as currently drafted, mitigates only a small portion of the total handoff time. In addition, it will likely require changes to be introduced on the client side.

Data Rate is a Function of Distance

A fact of radio propagation is the inverse relationship between distance and data rate. The farther the client moves from the access point, the lower the signal strength, and the lower the data rate that can be used. The drop-off is dramatic. Consider that, in the case of .11g, the nominal data rate of 54 Mbps can only be sustained within 25 feet of the access point[1]. The diagram below shows the coverage-capacity relationship for the .11b mode. It's important to remember that the actual throughput available to the users is approximately half of the data rate.

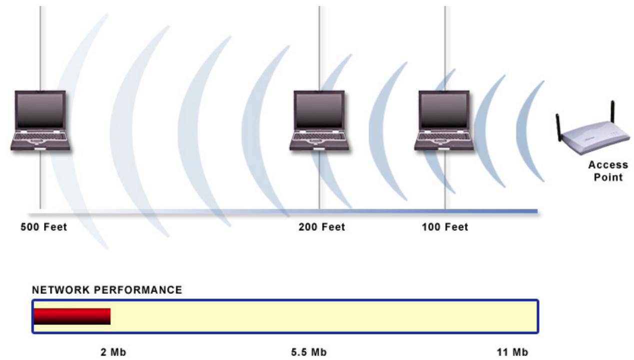

Figure 2 – Data Rate to Distance Relationship

A Polite Protocol for a Shared Medium

Since the channel is unmanaged and shared by all clients, the 802.11 specification introduced the Clear Channel Assessment (CCA) mechanism to minimize the possibility of multiple clients transmitting at the same time and thereby degrading each other's transmissions. While this makes for an egalitarian system of sharing common resources, it does create inefficiencies that translate into lower capacity – i.e. number of concurrent clients per channel. CCA is also notoriously unreliable, providing both false positives and negatives.

Mixed Mode Backward Compatibility Impacts Throughput

The co-existence of .11b and .11g on the same band (2.4 GHz) has allowed backward compatibility and advanced the adoption of the seemingly faster .11g standard. Unfortunately, the downside of this backward compatibility is that the presence of .11b client clients reduced the throughput experienced by all users. This effect can be severe, as shown in Table 1 below.[2]

#802.11b Clients	0	1	2	3	4	5	6	7	8	9	10
10	*7.9*	8.3	8.7	9.1	9.5	9.8	10.1	10.4	10.7	11.0	11.2
9	7.9	*8.4*	8.8	9.3	9.6	10.0	10.3	10.7	11.0	11.2	11.5
8	7.9	8.4	*8.9*	9.4	9.8	10.2	10.6	10.9	11.2	11.5	11.8
7	7.9	8.5	9.1	*9.6*	10.1	10.5	10.9	11.2	11.6	11.9	12.1
6	7.9	8.6	9.3	9.8	*10.3*	10.8	11.2	11.6	12.0	12.3	12.6
5	7.9	8.7	9.5	10.1	10.7	*11.2*	11.7	12.1	12.4	12.8	13.1
4	7.9	8.9	9.8	10.6	11.2	11.8	*12.3*	12.7	13.1	13.4	13.7
3	7.9	9.3	10.3	11.2	12.0	12.6	13.1	*13.5*	13.9	14.3	14.6
2	7.9	9.8	11.2	12.3	13.1	13.7	14.3	14.7	*15.1*	15.4	15.7
1	7.9	11.2	13.1	14.3	15.1	15.7	16.1	16.5	16.8	*17.0*	17.2
0	0.0	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	*30.5*
	Number of 802.11g Clients										

Table 1 – Channel Throughput of a Mixed Mode Channel

802.11e is a Statistical Answer to Quality of Service (QoS)

The 802.11e standard tries to establish a method for prioritizing voice traffic over data traffic, for systems in which these two different types of traffic contend for the same channels. The standard has two forms of implementation: one is statistical, and one is polling.

The statistical method gives a statistical advantage to the traffic type that has been defined as having a higher priority. It does so by exploiting the random “backoff” time mechanism of 802.11. The higher priority traffic will pick a random “backoff” time bound by a smaller range than lower priority traffic. As an example, voice will pick a number between 0-15, data between 0-31, and other traffic between 0-63. Thus, voice has a statistical advantage over data. But, it may very well be that a data client will pick a number between 0-15 and win over a voice client. The polling mechanism is very complicated, and allows the AP to poll the clients, but it then has to know exactly what type of traffic each client is running, and when it should be polled. At this time, it is unclear whether any system will actually support this.

The problem with a statistical solution is that it works well when the system is not loaded. When the system is heavily loaded, then more and more data clients will win over voice clients, and thus the hoped-for QoS will be lost. Also, this system is extremely inefficient. It means that data has to wait more, even if no voice calls are actually active.

This standard also requires changes to the client end.

With these fundamental realities of 802.11 as a backdrop, we can now assess how a given WLAN topology will respond to the challenges posed by the enterprise’s requirement.

The “Traditional” Architecture – Cell Planning Topology

In a cell planning topology, the available radio channels are distributed among the WLAN access points (APs), as shown in Figure 3 below. The diagram shows the 802.11b/g case, in which there are only three non-overlapping channels available. Each AP (represented by a hexagon) is assigned a specific radio channel, and then the APs are distributed to form a cellular coverage pattern. To do so, the designer must take care to provide sufficient physical separation between any two APs that use the same channel, so as to minimize the interference between them. This is the traditional topology that underpins traditional data-centric WLAN systems.

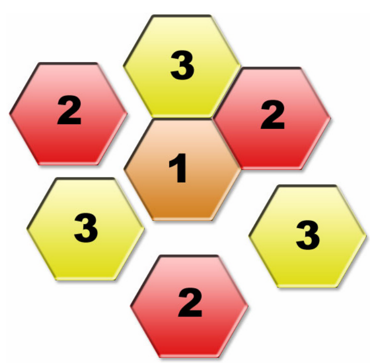

Figure 3 – Cell Planning Topology

Unfortunately, this topology is complex to deploy, optimize and maintain, and its real-world performance is inadequate to support pervasive WLAN deployments. At the heart of the problem is a fundamental inability of cell-planning topologies to cope with the severe scarcity of channels:

1. Insufficient capacity, resulting from co-channel interference and the very nature of CCA.
2. Latency-plagued mobility, as a result of frequent handoffs between APs on different channels.
3. Sub-optimal support of multiple services – In the cell planning topology, all users and all traffic types share (i.e. contend for) each channel. This presents QoS challenges that 802.11e cannot surmount.

References 3 and 4 provide the detailed analysis that lead to the above conclusions.

Extricom's View

Traditional WLAN architecture is like a car with no wheels. Ancillary but desirable elements such as security, device management, advanced services (RFID, location based services), wired-wireless convergence are like the seat belts, instrumentation, surround sound stereo, and trailer hitch. But without the proper tires, the car will ultimately drive poorly at best, or slide right off the road at worst. In this metaphor, the tires relate to the underlying wireless transport, whose quality is a function of capacity, mobility, link reliability, and ownership economics.

Extricom's patented Interference-Free™ WLAN architecture is founded on the following premise:

- Radio channels are scarce – user them wisely
- Use channels for capacity, rather than coverage
- Adhere to the 802.11 spec, without requiring customization in the clients
- Introduce true seamless mobility, not just portability, to WLAN
- Add centralized intelligence that overcomes 802.11's inherent scale limitations

The result is a unique architecture that enables the enterprise to build a large-scale WLAN infrastructure that is as dependable as the wired network, and supports triple play services without the aforementioned performance tradeoffs. What's more, WLAN deployment and maintenance is dramatically simplified, compared to the current generation of WLAN solutions.

Architecture Overview

Physical Topology

Extricom offers a switched WLAN architecture, comprised of a wireless switch governing an array of UltraThin™ Access Points. There are currently two switch models, EXSW-800 and EXSW-2400, each of which controls a dual-channel access point.

Figure 4 illustrates the main traits of the physical topology:

- The switch is located at the edge, with the access points connected to it via standard CAT-5 cable.
- The access points are powered through power over Ethernet (PoE); the PoE injector is built into the switch (i.e. it is not a price option).
- Each access point contains two (2) 802.11a/b/g radios.
- Clients utilize standard Wi-Fi NICs. The Extricom solution requires no modifications or custom components in the client.

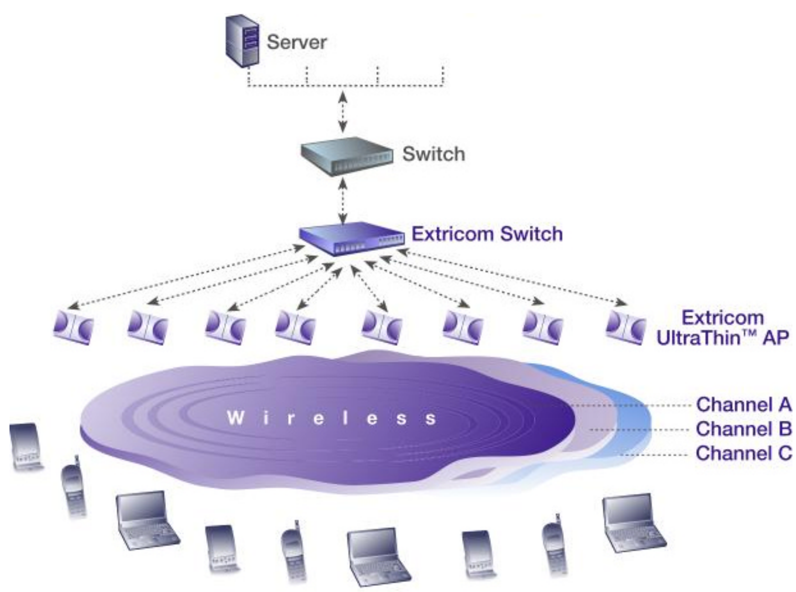

Figure 4 – Extricom WLAN Physical Topology

Note that, although Extricom uses the same component terminology adopted by the "switched WLAN" industry, this is as far as the comparison goes. The key to understanding Extricom's unique differentiation is to look at the function of the switch and access points.

The Concept

The Extricom Interference-Free architecture is a unique technology that overcomes the intrinsic limitations of traditional wireless LANs. At the heart of the solution: eliminating the traditional concept of cell-planning to achieve radio coverage. Instead, the Extricom solution provides continuous "blankets" of coverage by using each WLAN channel everywhere, while preventing any co-channel interference through tight control of the distributed access points.

Extricom uses a centralized WLAN architecture, in which the central switch makes all of the decisions for packet delivery on the wireless network. The switch directs all of the traffic because the access points have no capabilities of their own… no software, no storage, no smarts, just radios. The clients don't even associate with the access point. Instead, the access point rapidly funnels the traffic back to the switch for processing. As a result, a given 802.11a/b/g channel can be deployed at *every* access point, to deliver complete coverage, consistent capacity, and zero-latency roaming, without co-channel interference.

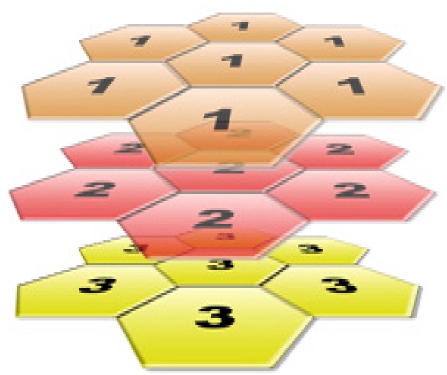

Figure 5 – "Channel Blanket" Topology

Conceptually, the switch can be thought of as a "Mega" access point, connected to a diversified antenna with up to twenty-four "drops" (the UltraThin Access Point). This unique channel blanket WLAN topology enables a combination of highest performance and easiest deployment and maintenance.

Performance

- Concurrent support of voice over Wi-Fi and data traffic, with inherent QoS through traffic segregation by channel.
- Complete and ubiquitous wireless coverage without the co-channel interference that plagues all of today's systems.
- Seamless mobility with zero-latency roaming, eliminating one of cell-planning's key obstacles to toll-quality Voice over WLAN.
- Increased capacity from overlapping channel "blankets", which provide "stacked" capacity at high-traffic locations such as conference rooms.

- TrueReuse™ channel processing that further boosts aggregate channel capacity by enabling multiple simultaneous links within the same blanket, while overcoming the limitations of CCA.
- The elimination of mixed-mode inefficiencies which degrade channel capacity, by segregating different .11b and .11g modes on different channel blankets.
- Thanks to uplink diversity and optimized downlink selection, the system delivers wire-like connection dependability, eliminating the frustration of dropped calls or interrupted communications.

Simplicity

- Convenient Deployment without RF Engineering – AP placement is determined based only on where capacity is required and wherever is convenient, and is not limited by the dictates of co-channel interference.
- True plug-and-play maintenance of WLAN – Any changes to system topology are made simply by moving, adding, or deleting access points connected the switch, without needing to re-do a channel plan or reconfigure anything.

Performance and Scalability

As mentioned in the Architecture overview, the Extricom system is specifically designed with the performance, scale and reliability needs of large-scale enterprise deployments. Under the category of performance and scalability, Extricom focuses on four fundamental dimensions:

- Coverage
- Capacity
- Seamless Mobility
- Quality of Service

Coverage

Today's switch family consists of an 8-port and a 24-port model, enabling the creation of channel blankets whose ubiquitous coverage extends between 1 and 24 access points. How much physical geography this covers is a function of the desired throughput performance. Clearly, if an organization sets its user service level at lower throughput, then the needed data rate is lower, and APs can be spaced farther apart. Conversely, APs will be deployed more densely as the data rate requirement increases. The key point, however, is that APs can be placed wherever required, free of the limitations imposed by co-channel interference. This essentially means that, from a coverage perspective, the Extricom system can scale as large as required by the organization, simply by deploying multiple switches to cover their geographic needs, both at headquarters and in satellite offices.

Capacity

The Architecture overview already mentioned that, by deploying overlapping channel blankets, the local capacity of Extricom's WLAN system is effectively "stacked". This gives organizations the ability to provide capacity to high-density user locations such as meeting rooms, conference theaters, and cafeterias. Furthermore, the blanket approach is the only real solution for supporting .11b and .11g devices on the same network – by separating each to a different channel, capacity is not bogged down.

Extricom's centralized, packet-by-packet architecture enables an additional and inimitable capability: TrueReuse capacity.

TrueReuse

The idea behind TrueReuse is to take each channel blanket and multiply its aggregate capacity. While the blanket provides the coverage, mobility, and link resilience benefits already described, TrueReuse introduces a way to boost the aggregate capacity of that blanket.

TrueReuse essentially takes the concept of frequency reuse and actually delivers the benefit that had long been hoped-for in cell planning topologies. To increase the capacity of the channel, the Extricom switch uses its real-time knowledge of the entire system to decide when to permit multiple access points to simultaneously transmit on the same channel, to different clients, without causing co-channel interference. In essence, TrueReuse takes a single collision domain and dynamically splits it into sub-collision domains, thereby multiplying aggregate capacity.

How? The system dynamically measures the RF reception quality from each client on a packet-by-packet basis. These measurements are used to create a high granularity, real-time map of co-channel interference throughout the deployment. This map is then used to determine when simultaneous transmissions on the same channel will not cause co-channel interference. The switch uses its real-time information to overcome the limitations imposed by the CCA mechanism, and to provide efficient frequency reuse.

The net result is a multiplication of the aggregate capacity of the channel blanket. The Extricom system will deliver three to ten times more system capacity than comparable cell-planning systems. This capacity multiplication is beyond that which is achieved through the “stacking” effect of overlapping channel blanket.

Extricom formally announced TrueReuse at the DEMO 2006 Conference, and demonstrated a three-fold increase in channel capacity, serving off-the-shelf clients operating on a system that is deployed entirely within the confines of the conference ballroom. This level of channel reuse, capacity increase, and blanket coverage, in such a constrained space, has never before been possible.

Seamless Mobility

Seamless mobility is at heart of the value of wireless. It is however something that cannot be taken for granted. In a cell-based topology, the client roams repeatedly performs a “hands-off” operation as it moves from access point to access point. This process is very inefficient in the Wi-Fi world, since the 802.11 specification gives the client the responsibility of deciding when to hand-off, leading to a number of undesirable effects. The bottom line is that roaming causes delays (latency), dropped calls, and dropped security sessions.

The Extricom system inherently eliminates the concept of roaming. Once the client associates with the switch, it simply moves anywhere within the channel blanket, without ever experiencing a “hand-off”. The result is zero-latency mobility. This has significant benefits for voice over Wi-Fi and real-time data applications, as well as ensuring that the client’s security session always stays connected.

Quality of Service

The channel blanket approach establishes a “built-in” method for QoS, since it permits different traffic types to be dedicated to separate channels, without the need for any unique capabilities on the client side. The goal is to eliminate contention, not just mitigate it.

Extricom adopts a broader definition of Quality of Service than typical in the industry – focusing on the overall question of multi-service support. As enterprise systems scale to encompass more and more users, with differing requirements, the issue of multi-service expands beyond the voice versus data discussion. It includes:

- Concurrent support for .11b and .11g clients. Recall that older computing platforms use .11b, all new computers include .11g, most PDAs are made only for .11b, and Wi-Fi handsets are predominantly .11b. This makes for quite a mix of device types which, if placed on a mixed-mode channel, will cause overall performance to degrade. And since all channels are shared by all users in a cell planning topology, segregation of .11b and .11g users is not possible. The channel blanket topology in fact permits this. Furthermore, Extricom's new Any Band, Any Mode dual-channel operation permits a dual-radio AP to concurrently carry two channels in the same band, configured for any use or mode. This is an industry first.

- Voice versus data. Separating these two types of traffic on different resources (channels) is a deterministic and reliable way to ensure that these competing users can co-exist.
- Role-based segregation, which separates users on different physical channels based on role (e.g. guest / employee, student / professor) to ensure that a known amount of bandwidth is dedicated to particular constituents.
- Security-based segregation, which separates different security on physically different channels, in addition to the VLAN separation that is possible through different SSID within a blanket.

System Availability and Management

The use of WLAN systems as a primary network access method and for mission-critical purposes requires high availability and manageability. In the Extricom WLAN system, availability and manageability have four aspects.

Consistent capacity and coverage

This is achieved through the channel blanket architecture. This permits coverage to be created at will, with anyplace-placement of APs. The blanket approach also delivers consistent WLAN data-rate throughout the deployment, thanks to the ability to deploy AP in any needed density. The result is that Extricom's channel blanket approach ensures consistency and predictability of service throughout the deployment.

Robustness and adaptability RF changes

The second requirement is achieved through *packet-by-packet* processing, which ensures maximum robustness of both the uplink and the downlink. Extricom's access points provide the switch with up-to-date over-the-air information. Since all APs carry the same channel, the uplink transmission benefits from diversity reception by the switch. That is, the switch can select the best AP to serve a particular client for *any* particular packet. It will also use that uplink information to make the best selection for a downlink AP. The result is that instabilities in the RF can easily be overcome through a dynamic selection of a different AP.

Redundancy to component failure

The third requirement deals with component failure. Modern WLAN systems have two major components: APs and controllers/switches. Extricom's blanket approach seamlessly handles AP failure. Since all APs operate on the same channel, redundant APs can be placed throughout the deployment. These APs are in fact *active* at all times, and therefore not only provide redundancy, but also extend the coverage and capacity of the network. When one AP fails, the packet-by-packet decision mechanism will immediately and automatically stop using that AP, and select a different AP. Since this process is done on a packet-by-packet basis, the client will not notice any "blackout" period and will not lose a single packet. To provide switch redundancy, Extricom allows a "slave" switch to be added to the system. This "slave" will be *inactive* until the "master" switch fails. At that point, the "slave" system will be activated.

In conclusion, Extricom's blanket approach, coupled with packet-by-packet processing, enables high availability required by mission-critical WLAN deployments.

Management and Monitoring

With the enterprise in mind, Extricom's WLAN architecture was designed with fully centralized management. Extricom's UltraThin APs require absolutely no configuration and are completely plug-and-play.

The system can be configured via SNMP MIBs, a Web configuration facility or a command line interface (CLI).

For monitoring, the system sends SNMP traps about events that require corrective or preventive action, such as AP failure or high network load. Statistics are also provided by the switch, to enable IT managers to make informed decisions regarding network performance and the end user experience.

VoIP Over WLAN

The Extricom system is ideal for voice over WLAN (VoWLAN)[4]. It is in this area where Extricom's performance in coverage, capacity, zero-latency mobility, link reliability, and QoS through traffic segregation really shines. Table 2 below provides a direct comparison of the Extricom solution to the traditional cell planning architecture.

	Cell Planning Approach	Extricom Channel Blanket Approach
Coverage	Coverage and capacity are constrained by the level of co-channel interference.	AP placement is not constrained by co-channel interference. Coverage and capacity are both maximized.
Capacity	Aggregate capacity is affected by co-channel interference, which is a function of AP overlap. Localized capacity is bogged down by mixed-mode operation.	Aggregate capacity is a function of AP density, without co-channel interference implications. Localized capacity is maximized through "stacking" channel blankets and eliminating mixed-mode degradation.
Mobility	Roaming between APs introduces latency and jitter. More efficient handoff mechanism requires enhanced capabilities in the client (802.11r).	There is no roaming within the channel blanket, resulting in zero-latency mobility and seamless persistence of communications and security. This is achieved without requiring enhancements in existing client capabilities.
Quality of Service	QoS is affected by contention between voice and data users on the same channel/AP. 802.11e is proposed solution for prioritizing traffic type. This too requires enhanced capabilities in the client.	By separating different traffic types onto separate channel blankets, contention is inherently avoided. This applies to voice and data, as well as other contention cases such as .11b vs. .11g users, user roles, and security levels. Once again, this is achieved without requiring enhancements in existing client capabilities.
Handset Battery Life	The denser the coverage, the higher the client transmit data rate. The higher the data rate, the shorter the phone transmit time, inherently lengthening battery life.	

Table 2 – Comparison of Topology versus VoWLAN Support

To highlight the value of Extricom's link reliability, consider the case of Wi-Fi to cellular convergence. This convergence proposes to use dual-mode (Wi-Fi / cellular) handsets that will operate on the company's private WLAN whenever possible, instead of the cellular system, thereby reducing cellular airtime charges. In an ironic twist, early deployments of dual-mode handsets (Wi-Fi / cellular) have actually resulted in an increase in cellular airtime, in large part because the WLAN system's connection was not robust enough to hold on to the phone and keep it from bouncing to the cellular network as the phone went in and out of WLAN reception.

Another hot topic often debated is the capacity for VoWLAN – i.e. how many concurrent calls can the system support. In both internal and external independent testing, Extricom has shown the ability to carry 15 simultaneous voice calls per channel, with complete, zero-latency mobility throughout the channel blanket. Furthermore, utilizing a 2-radio access point, an aggregate of 30 simultaneous voice calls has been demonstrated, concentrated at a given location. TrueReuse technology will boost this number to approximately 20 calls per channel, and 60 calls using all three 2.4 GHz channels in overlapping blankets, while maintaining complete mobility.

Security

The question of security is one that must be addressed holistically. Figure 6 below shows the security "chain".

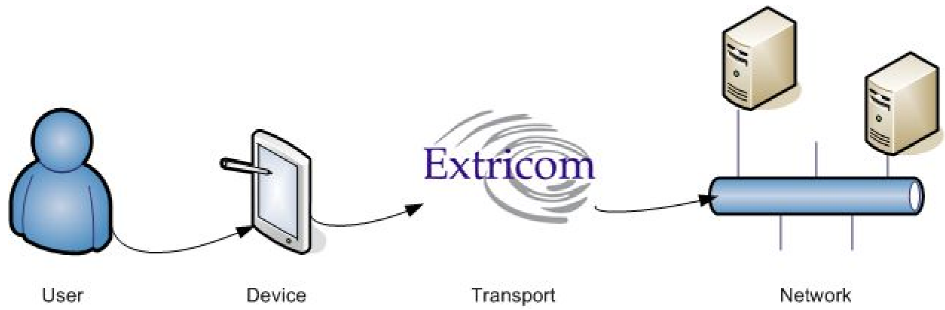

Figure 6 – The Security Chain

Extricom's focus is on ensuring the internal integrity of the wireless transport. Security in this domain takes two forms: physical and logical. Physical security is achieved by centralizing all security functions in hardware in the switch, with no security functions performed in access points. Logical security is enabled by supporting the full 802.11i standard. AES and RC4 cryptographic engines are implemented in hardware to ensure wireless-speed processing, yet maintaining firmware upgradeability. The authentication needs of User and Network are supported through the standard's requirement for support of external authentication servers such as RADIUS. Additionally, it is important to note that each transmission remains fully encrypted end-to-end, from Device to Network, since the encryption points are the Device and the Extricom Switch. Finally, if desired, the enterprise can superimpose any client VPN technology as it sees fit, confident in the knowledge that such VPN clients do not lose their session connection as the device moves anywhere within the channel blanket.

Security measures pertaining to User (e.g. authentication, identity management) and Device (e.g. securing stored data from physical theft) are generally outside of Extricom's domain.

Design and Deployment

The complexity of the design and deployment challenge is a function of the architecture. The complexities of cell planning make deployment extremely time consuming and iterative. The existence of increasingly sophisticated planning tools is certainly evidence of that. And even then, these planning tools can only provide a snapshot of the RF environment – one which is obsolete almost from the moment that the plan is done, considering that the 802.11 propagation characteristics are highly sensitive to changes in the office environment.

Extricom's approach results in unmatched ease of deployment and maintenance. By avoiding cell planning, co-channel interference, and the host of give-and-takes that must be iteratively balanced and re-tuned, the need for extensive planning is radically diminished. The bottom line is to free IT from having to acquire RF engineering expertise in order to deploy a sound WLAN infrastructure.

Design

In the design phase, the goal is to answer the basic question: "How many access points are needed, and where, to achieve the desired level of service?"

Answering this question for cell-based WLAN topologies is a multi-variable problem, requiring the designer to find the right mix of channel assignment, transmit power, antenna type and location of each AP, further correlated against number, type, and distribution of users. And even after a theoretical combination of all these factors is reached with the aid of planning tools, there will still be the real-world problem of CCA false positives, unpredictable collision domain sharing effects, time-based variability in RF link strength, and random contention of differing traffic types on the same channels, which add up to unpredictable WLAN performance.

Contrast this with Extricom's channel blanket approach. To answer the question of quantity and placement of APs, the only parameters needed are (i) the target data rate for the desired throughput level, and (ii) the forecasted number, type, and distribution of users.

The target data rate translates into a signal strength value. Any rudimentary coverage prediction tool can be used to map, on a floor plan, the number and placement of APs as a function of the desired signal strength, such that, within the combined coverage of all APs, the client is guaranteed to receive the target signal strength or better. Varying the transmit power, antenna type, and channel assignment, on an AP-by-AP basis, are *not* variables that the Extricom system needs to revert to in order to deliver a high-performance design!

Next, the number, type, and distribution of users are used to simply determine how many channel blankets are needed, and which blankets require TrueReuse capacity processing to attain the target aggregate throughput.

In addition, the resulting Extricom system will not suffer from CCA false positives, unpredictable collision domain sharing effects, time-based variability in RF link strength, and random contention of differing using traffic types on the same channels, thereby yielding steady and predictable performance.

Validation

A plan is essentially an estimate. After deployment, what happens when an in-field validation reveals that the estimation was wrong? In a cell-based system, a variation between planned and actual will require a full re-analysis of the system, since access points will need to be moved, added, and/or deleted to resolve the deviation. With that, the process of balancing of all the aforementioned variables starts again. In the case of Extricom, however, making a change to the starting deployment is simply a matter of moving and/or plugging in additional access points, without requiring any re-planning or device re-configuration.

Case examples that demonstrate Extricom's ease of deployment include:

- A 10 story hotel in California, deployed with one switch every two floors and four access points per floor, deployed and placed into operation in one day, without any pre-installation planning (e.g. mapping, coverage analysis, etc…)
- A university in Georgia, who originally asked us to provide a system for their lab, and on the day of delivery, changed their mind and asked Extricom to deploy it in a live environment in the student cafeteria instead. The system was installed and placed into operation that same day.

A final note about Extricom's deployment: APs have no configuration. This means that configuring an Extricom system means configuring only the switch. The switch is where the frequency, mode, network (e.g. SSID, VLAN), and security parameters for each channel blanket are defined. Furthermore, since all APs use the same channel, the configuration of a multi-AP deployment is as simple as a single AP deployment. In systems with multiple switches, Extricom provides a central configuration facility that enables a master switch to be used to establish a template, which is then propagated to all slave switches. This leaves only switch-specific parameters to be further edited.

All of the above demonstrate the Extricom system's dramatically reduced effort and risk in planning and deployment, compared to anything ever before seen by the industry.

Guest Access

Extricom's architecture includes a number of traits that facilitate guest access services.

- Guest "channel blanket": one possibility is for the IT manager to designate an entire channel blanket for guest use only, physically separating guests from the other users of the network. By physically separating guests to a different channel, the IT manager will also ensure that guests will not share the bandwidth of mission-critical users.
- Multiple SSID support: Extricom's system supports up to 16 SSIDs per channel blanket. The IT manager can designate one or more of these for guest access. The "guest SSID" can be configured with any 802.11i authentication and encryption method and tied to a guest VLAN ID on the wired network. The mapping would be set up in such a way that sensitive internal information is inaccessible.

Advanced Services

Extricom has to-date focused its efforts on developing a performance breakthrough for WLAN, so as to truly enable enterprises to confidently make the shift to a more pervasive wireless system. Extricom has always believed that, without these significant advancements in the foundation of WLAN, advanced services would ultimately be handicapped from achieving their full utility.

Advanced services such as location based services (LBS) and RFID are examples of such higher level applications that can be overlaid onto the Extricom solution.

Wired-Wireless Integration

Extricom's focus is to create the optimal wireless network for the enterprise. The enterprise's desire for efficiencies from common frameworks for wired and wireless networks is only natural. But it is separate from the issue of building the most dependable, high-performance, and flexible wireless network segments. In addition, wired-wireless integration goes well beyond the physical network transport issue. It pertains to building a common construct for security (including authentication, authorization, and administration), device management, cross-domain mobility, and identity management. These and other areas span the complete enterprise architecture. Extricom believes that the best way to deliver the highest value is to focus first on the caliber of the wireless segment, and contribute to the "wired-wireless project" by including the appropriate standard interfaces within the wireless system (e.g. authentication and encryption standards, SNMP management).

Cost

The Total Cost of Ownership of an Extricom WLAN solution is generally significantly lower than comparable solutions in the marketplace, while delivering superior performance and business flexibility. The costs that go into the WLAN business case include equipment, design and deploy, and maintenance.

Equipment

A bundle of the 8-port Switch with 8 Dual-Radio UltraThin Access Points starts at approximately $10,000. This represents a full-featured switch, including:

- TrueReuse channel processing
- Any band / any mode dual-channel operation (switch and access points operating dual-radios)
- PoE powering of access points
- 802.11i security
- On-board management, including centralized configuration and monitoring
- 1-year warranty on all parts and labor

Firmware upgrades are currently included in the price of the equipment. A support services contract is available for approximately 15% of the original purchase price.

Design, Deploy, and Maintain

Extricom estimates that the time to design and deploy the Interference-Free WLAN solution is 40 to 70% less than that required for comparable competing offerings. In addition, the cost of deployment risk is an element that each enterprise needs to quantify, relating to the risks of design re-work that arise with cell-based topologies, as well as the potential of finding that, after all is said and done, the cell-based system can never be configured to overcome the intrinsic interference, capacity, and mobility hurdles it finds in its environment.

From a maintenance standpoint, Extricom estimates that the cost of “moves, adds, deletes” (i.e. modifying the WLAN to keep in step with changes in the business) is 50 to 75% lower than that required for comparable competing offerings.

About Extricom

Founded	June 2002
Headquarters	New York and Tel Aviv
Investors	Motorola Magnum Communications Fund Vertex Venture Capital Nikko Antfactory
Other Offices	London (UK), Paris, Milan, Tokyo
Customer Base	Includes customers in the university, healthcare, municipalities and hospitality verticals.
Distribution	100% through distributors and value-added resellers
Technology	Seventeen (17) patents filed, four (4) already accepted

Document References

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3. **802.11 WLAN Coverage and Capacity White Paper**. Extricom, 2003
4. **Voice over WLAN**, Extricom 2004