Unified Networks: Wire, Wireless, and the Best Tool for the Job

A Farpoint Group White Paper

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Despite our obvious (and, of course, well-deserved) reputation for the advocacy of all things wireless, Farpoint Group has in fact been guided since our founding 16 years ago by a simple mantra: *if you can use wire, you should use wire*. While this is seemingly in opposition to our primary mission, it is in reality the best advice we have ever offered. Any networking solution, no mater what its overall parameters and objectives, must employ the best set of tools for the job at hand. As we will explore below, wired networks are by no means made obsolete by wireless – and, indeed, the role of wire is in fact *enhanced* by the proliferation of wireless LANs now well underway. The core reasoning behind this statement is in the basic nature of wireless itself. Specific wireless applications are assigned, via regulation, to a portion of the electromagnetic spectrum - what is often described as "one big wire in the sky". Given, as we'll discuss in more detail below, the fundamental challenges inherent in applying the laws of physics that govern radio wave propagation, and their effect on range, coverage, throughput, and capacity, wire will remain the solution of choice for many. More importantly, though, wire and wireless are becoming more reliant upon one another, leading to a new era of *unified networks* − what we believe will be the most important networking strategy going forward, and the subject of this White Paper.

Core Wireless Scenarios

Realizing the core limitations of radio noted above, Farpoint Group generally recommends the use of wireless in three broad circumstances, as follows:

- *Where wire cannot be installed* − While most new buildings are wired during construction, it is usually not a huge challenge to install wire in existing structures. This is especially true in modern office buildings. But there are many facilities, particularly older buildings and residences, that can be very difficult, if not impossible, to wire, especially when cost is considered – and, of course, it always is. Wireless is the only option in this case, and, except in the face of pathological building construction that blocks radio waves, usually works quite well.

- *Where wireless is financially less costly* − Throughout most of its history, wireless was often deemed an expensive option. Indeed, as we saw dramatic price reductions during the 1990s in wired network adapters, and corresponding reductions in wired network equipment costs, most notably Ethernet switches, wireless remained a poor choice when financial elements were considered. WLAN adapters were often complex, two-piece affairs with performance of less than two Mbps and prices around US$600. In recent years, however, the cost of wireless adapters has fallen dramatically, benefiting from both the 802.11 standard and manufacturing economies of scale, to say nothing of fierce marketplace competition. Now *wire* is often the more expensive choice, not because of the cost of adapters, switches, or the cable itself (which is quite cheap), but rather due to the cost of the labor involved in the design and installation of a given solution.

- *Where mobility is a factor* − Finally, the killer app for wireless is truly in mobile applications, as wire simply cannot play when mobility is a requirement. This introduces, however, a critical point – as users begin to demand the same set of capabilities and services while mobile that they have when stationary, and as mobility becomes the *default* operating mode for an ever-increasing base of users, the requirements we place on wireless will be *identical* to what we ask of wire in terms of throughput, capacity, and reliability. Even with respect to time-bounded services, both wired and wireless need to deliver much the same set of capabilities. Today's .11g and .11a networks have performance that is imperceptibly different from that of 100BaseT Ethernet. And even higher wireless performance is about to be realized – see the Sidebar, *The Impact of 802.11n,* for more on this.

Bottom line - if at least one of these three criteria is not met in any given application, wire of some form is very likely the preferred solution. But the reality is a bit more complex, because, in fact, wireless cannot work in most cases without substantial support provided via wire.

Finding the Best Tool for the Job

A core objective for any IT department should be to assure that the available IT tools and resources are properly matched to the objectives of the organization IT serves. After all, it's not just about having the latest and greatest, but rather the most *cost-effective* and *appropriate* set of solutions meeting the needs of users.

The Impact of 802.11n

Wireless has traditionally been hampered in LAN applications by a number of restrictions on its deployment. The most important of these are regulatory constraints, specified by local authorities in each country. In the United States, for example, the Federal Communications Commission (FCC) specifies only a limited range of radio frequencies for use by WLANs, and, most importantly, places severe restrictions on the amount of transmit power that can be used. The latter is further restricted by the realities of battery life, and thus WLANs have often suffered from highly variable (and often poor) throughput, limited range, and user frustration.

The soon-to-be-complete IEEE 802.11n amendment to the 802.11 standard promises a dramatic leap forward in radio performance. Based on a very sophisticated technology known as MIMO/OFDM (Multiple Input/Multiple Output using Orthogonal Frequency-Division Multiplexing), products implementing 802.11n will have vastly improved throughput (to as much as 600 Mbps peak in very sophisticated and likely quite expensive implementations) with improved range and reliability as well. .11n is perhaps the most important development ever in the history of wireless LANs, and will over time replace all previous WLAN radio standards.

Even with this amazing improvement in radio performance, however, WLANs are still far short of the capabilities of wire – which, thanks to gigabit Ethernet, are today 1 Gbps peak, or more than three times the 300 Mbps peak performance that we're likely to see in most .11n implementations. Gig-E is certainly under no threat from wireless of any form today. Moreover, we expect that the proliferation of .11n will itself spur much additional demand for Gig-E, since the performance of today's 100 Mbps Ethernet is clearly inadequate for both the interconnection of .11n APs as well as for backhaul and bridging to wire. We'd conclude, then, that .11n isn't going to replace wire, but, rather surprisingly, will in fact spur it on.

Wireless LANs, for much of their history, were not viewed as a good choice for the enterprise. Among the core reasons cited by IT management for not adopting wireless LANs were the lack of a standard, insufficient throughput (especially at longer range), security issues (these being almost legendary today), high prices and other challenges relating to total cost of ownership (TCO) and return on investment (ROI), and the operational challenges surrounding the management of wireless networks. All of these, have, of course been addressed, through the ever-vibrant 802.11 family of standards, innovations from the Wi-Fi Alliance (most notably the WPA and WPA2 security specifications, along with WMM spec addressing time-bounded performance and the just-announced Draft 802.11n spec), and falling prices accompanied by ever-improving price/performance. We'll return to the management issue below.

Wired networks, primarily in the form of 10/100 (and increasingly gigabit) Ethernet, have formed the backbone of enterprise solutions for more than 25 years. While wire most certainly has a significant cost associated with it, primarily in terms of the labor involved in planning, design, and installation, wire also has one undeniable benefit: *the ability to multiply bandwidth*. This property derives from the fact that each individual circuit of wire, cable, or fiber represents its own bandwidth domain. Whereas wireless involves the use of radio, and thus the sharing of small portions of the electromagnetic spectrum along with a broad range of the inherent technical challenges, every wired circuit is unique unto itself. Adding more capacity to a wired network is thus quite easy – *just add more wire*. Again, the installation expense involved needs to be considered, often carefully, but this multiplicative benefit of wire gives it a key advantage over wireless.

The fact that the electromagnetic spectrum is a shared medium introduces an additional range (please pardon the pun) of concerns, especially with respect to the frequencies used by WLANs. These are known as the *unlicensed bands*, meaning that end-users are free to operate any equipment which has been approved as a class by the local regulatory authority, the Federal Communications Commission (FCC) in the case of the United States. This is why the unlicensed bands have become known over the years as the "kitchen sink" or even "garbage" bands – there is no coordination among users of this spectrum, and indeed, under most regulations there *cannot* be so as to avoid the situation whereby any given entity is monopolizing a given band and thus undermining the uncoordinated sharing that is critical to making this spectrum useful in the first place.

Even with regulation, however, wireless LANs always face the possibility of radio-frequency interference (RFI) from a potentially large number of sources, including many beyond the wireless LAN itself. We discussed the interference issue in detail in our recent series of White Papers and Tech Notes on this subject, and we discovered that interference – from WLAN and non-WLAN sources alike – can in fact have a seriously detrimental impact on the performance of WLANs in general, as well as the time-bounded services required for voice (VoFi) and video (VidFi) applications. While we detailed a number of methodologies for dealing with the potential for interference, most notably Spectrum Assurance (SA) tools and adjustments to AP location, channel assignments, and transmit power levels, it is safe to say that wire will always have an advantage in this area. Electromagnetic interference is almost never an issue in wired networks, especially when shielded cable or (particularly) fiber is used.

Finally, wired networks will always have an advantage in their fundamentally deterministic nature. It is fairly easy to use network management systems to evaluate the performance of any part of any wired LAN, thus pinpointing the areas that need improvement via upgrades to network infrastructure. Wireless networks, on the other hand, typically see intermittent degradation due to interference, varying range between endpoints, user mobility, and antenna orientation. This makes the management of wireless networks much more challenging, but a variety of approaches is available to deal with these issues, depending upon the capabilities of the WLAN management platform used. Finally, note that both wired and wireless networks can suffer from congestion due to simply exceeding the capacity provisioned in any given case. The addition of more wire, and more access points, is a fact of life in any large-scale network installation, wired or wireless, throughout the life-cycle of a given installation.

So far, though, selecting the best tool for the job appears more complex than ever. But as we noted above, the fundamentally complementary nature of wired and wireless networks, as well as the need for a common management architecture to minimize cost and improve efficiency, is motivating an important next step in the evolution of enterprise LANs – *unified networks*.

The Rise of the Unified Network

We have often remarked that the amount of wire required by wireless is often quite amazing. While it is, for example, possible to interconnect access points wirelessly via the use of the Wireless Distribution System (WDS) defined in the IEEE 802.11 standard, as well as via wireless-mesh techniques as are embodied in a number of products aimed at indoor (although primarily at outdoor and metro-scale) applications, most APs are connected to a wired Ethernet switch over standard Cat5 (or better) cabling. Again, the multiplicative effect of wire and its resistance to interference are essential in high-performance applications; access points are essentially bridges that get user traffic onto the wired network at its edge and are thus essentially dependent upon wire.

We thus conclude that wired and wireless networks are not just complementary, but in fact *cooperative* and *interdependent*. This thinking on the part of vendors has led to the most important innovation in networking since the rise of the wireless LAN itself, *unified networks*. Unified in this case means conceptualizing, designing, building, and operating networks that have both wired and wireless components sharing a number of common components and services. Wireless networks today consist of access points (APs), controllers, and location and management appliances. Wired networks consist of switches, routers, and management consoles (see Figure 1). Noting that APs need to be connected to controllers via wired switches, and the need for both operational and financial efficiencies, the unified network is born. The key is in leveraging wire to interconnect wireless elements, and in using wireless to provide the mobility and convenience lacking in purely wired networks.

While we can today design and implement networks that are unified to a great degree, all enterprise networks will eventually include unified network management. Network management has historically, and unfortunately, been viewed as an unglamorous element relegated to techies.

And yet the literally hundreds of services inherent in a comprehensive network management solution largely determine the success of failure of the network, providing configuration, administration, monitoring, control, operational analysis, security, and integrity functions, just to name a few. Unified networks are motivated by the large degree of commonality that exists between wired and wireless nets. It makes little sense, for example, to have two entirely different directories or security databases in a single enterprise network, just because some users are wired and some wireless. Indeed, the fact that a given user can easily and regularly move between these domains is another key driver of the unified approach. And again, users demand the same set of services and performance no matter what their mode of connectivity.

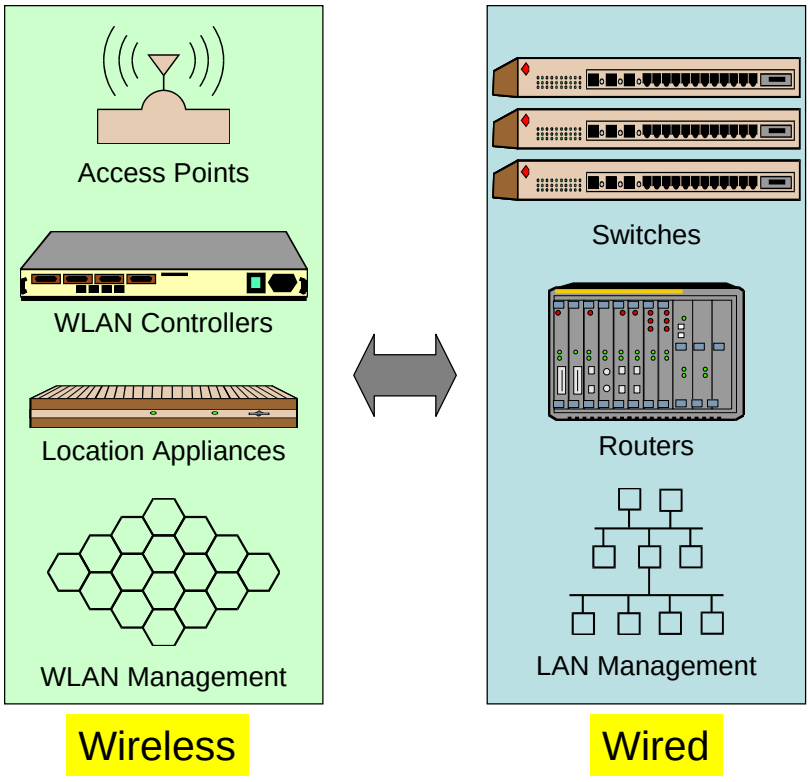

Figure 1 - Commonality and interdependence in network equipment provide the initial motivation for unified networks. APs, controllers, and location appliances require the services of wired switches and routers. The final step in LAN unification will be the development of management platforms to serve both wire and wireless; the complexity of the software task involved in producing a unified platform keeps these separate today. *Source:* Farpoint Group.

To this point, most enterprises have conceived and implemented wireless LANs as *overlay* networks, bridging to wire at key points in terms of data flow but not in terms of management. Unified networks change this world view dramatically – it is time to think *network*, not simply wired or wireless networks in isolation, and the realization of this vision is already starting to happen in some leading product lines today. Software complexity will delay the unification of management for a period, but such will happen over the next few years.

Finally, in addition to the technical and operational benefits we noted above, unified networks in addition are a powerful strategy for lowering and optimizing the total cost of ownership of an enterprise network infrastructure. Capital expenditures (CapEx) are favorably impacted by a greater use of fewer common elements, existing infrastructure can be leveraged, and the need for additional third-party components can be minimized. Note that these in turn can yield an-

other important benefit, a reduced need for wiring closets, rack space, and (increasingly expensive) electrical power and HVAC. Standardized design can result in lower ongoing operational (OpEx) expenses, including lower maintenance and life-cycle cost, reduced training and support expense, and lower network management costs, with the added benefits of greater efficiency and possibly even less downtime that can result from both common operational issues and less inherent complexity. It's also easier to add new services with the unified approach.

Conclusions and Recommendations – Looking Ahead

Networks have often been described by analogy as the circulatory systems of modern enterprises. As most firms live and die based on their ability to obtain, move, store, analyze, and act on information, access to the network is as mission critical an activity as exists in *any* business anywhere in the world today. Wired *and* wireless, the LAN is the core of any IT solution.

While we again believe that wireless LANs will become the default access mechanism for many if not most enterprise users over the next five years, we would never imply that this evolution necessarily means that wired networks will no longer be important. Indeed, as we have discussed herein, the opposite is true, and we continue to recommend the following:

- *Always run wire* − and lots of it, during the construction of a new building, and when remodeling, retrofitting, or simply building out the interior of any enterprise structure. Drops should still be included in all offices, conference rooms, and cubicles. While some of these will be unused, others will be occupied by printers, WLAN access points, and, well, the essential long-term unpredictability of network use and evolution simply demands such an approach. And, again, the cost to install cabling during buildout and finishing is far lower than that required once the structure is complete and occupied.

- *Design wireless into the solution from the start* − Wireless will become the real edge of most enterprise networks, and it is important to consider the capacity needs of wireless users when designing the wired components of any network. While it is easy to add more capacity to modern enterprise-class wireless LANs, it is best to assume that wireless service will see high demand once in operation as as WLAN technology continues to evolve.

- *Use the wired network to leverage wireless* − As we have discussed in our White Papers on dense deployments, using the existing wired network as a core implementation strategy for the WLAN is a key to minimize costs and maximizing ROI. The days of running special wiring for APs have long passed. The additional traffic and overall capacity demands of wireless users need to be carefully considered when specifying the wired elements of any enterprise network. This is especially true when we add time-bounded services – most notably voice in the form of VoFi – to the network. The convergence of cellular and Wi-Fi via handsets incorporating both technologies and both enterprise- and carrier based convergence solutions is a powerful motivator here.

- *Think unified* - Unified networks are more than just APs, wire, and switches; they represent a core IT strategy that must be considered as a totality. While perhaps only 15-20% of enterprises have installed WLANs with facility-wide coverage to date, we believe that essentially *all* of them will over the next few years. The time to implement a unified solution, then, is *now*. As we noted above, we also believe that unified networks will offer superior total cost of ownership characteristics, as they minimize the number of elements required and introduce operational efficiencies that are otherwise unavailable. Note also that we'll be seeing a lot more hardware unification as well, with WLAN controllers already available as plug-in options in many switches and routers

In general, we recommend the use of wireless LANs for access by most users (especially for mobile users, or wherever mobility is a factor), and for convenience, cost-effectiveness, guest access, mobile voice services and where dynamic location and tracking is required. Note that many wireless devices will not be associated with users, but will rather be location/tracking tags and other specialized units for an increasingly broad range of security, facilities, manufacturing, and other uses. We certainly have no problem in recommending the use of a fundamentally wireless solution in smaller venues, including branch offices, but obviously disagree that the office of the future will be completely wireless. We therefore continue to recommend wire as the primary vehicle for stationary users, interconnect, backhaul, servers, and for the highest possible performance.

And to finally answer the question we posed earlier, and for all of the reasons noted above, we believe that the best tool for the job – essentially any enterprise networking job - is in fact a unified network. Unified networks are poised to become *the* key strategy for LAN deployments from this point forward.

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