opinion piece

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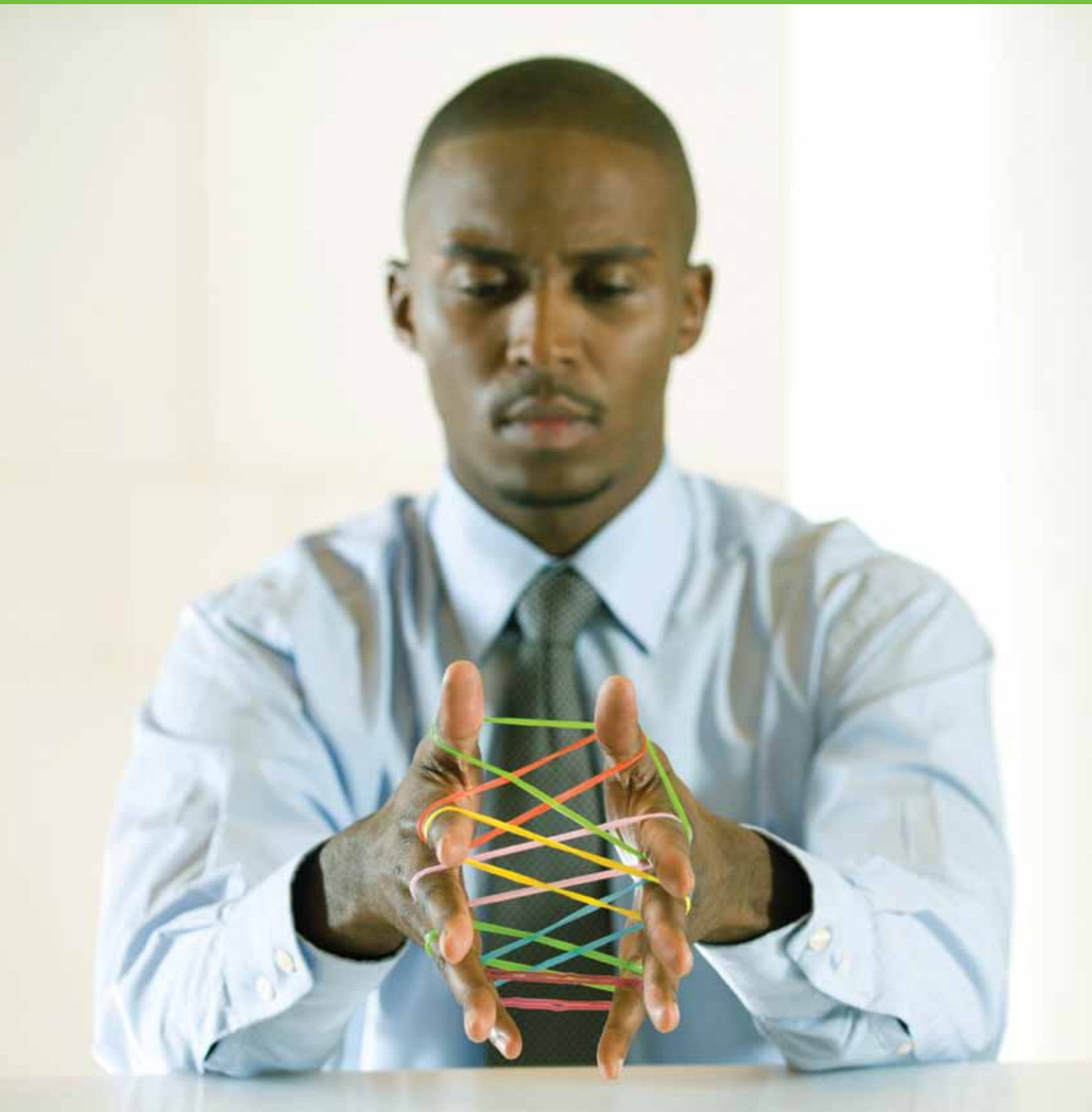
Does Wireless Mesh with your Organisation?



As mobility enabling technologies like wireless LANs become more prevalent within enterprise offices, and pervasive mobility is becoming an increasingly critical requirement for the workforce, organisations are now facing a new challenge. The demand for outdoor wireless coverage has been increasing as enterprises discover the extent to which providing connectivity throughout a campus can increase users' productivity and mobility. However, companies are faced with tight budgets and reduced resources, so the solution that they implement must take advantage of existing tools, knowledge and resources to maintain cost effectiveness. Furthermore, they need an outdoor wireless LAN solution that effectively supports today's networking requirements, and lays the foundation for the integration of business applications and processes.

For many companies, challenging environments in the outdoor space create technology hurdles that must be overcome by any proposed solution. The outdoor wireless solution clearly needs to operate without the need of a wired infrastructure. In many cases, there may not be the opportunity to design or pre-install the solution, so it must adapt around network failures and interference without extensively compromising service, almost in a self-healing manner. Finally, traditional indoor power options may not be available, so the solution may need to support alternate sources of power to maintain operation.

Wireless mesh is a technology solution that can address these business and technology challenges and provide a robust and dynamic solution to meet their varied and unique requirements.

What is wireless mesh?

Mesh is a network topology where devices are connected with many redundant connections between nodes. This concept is not actually new – the Internet is an example of Mesh network and has been in place for many years, providing connectivity for users worldwide. The success of the internet has proven that meshed networking is the best way to build broadband networks. Mesh, combined with new IEEE standards and Wireless technology, creates a new game-changing technology in the market.

A Wireless Mesh Network (WMN) provides communication between nodes over multiple wireless hops on a full or partial mesh topology. The interconnected wireless routing nodes use a wireless mesh routing protocol to establish frame-forwarding paths through the mesh. Unlike traditional WLANs, a WMN is usually self-forming and has distributed network control.

What's driving adoption?

A brief review of the market shows that wireless mesh is gaining favour as a robust and scalable solution.

Pervasive connectivity: Employees – part of the ever growing mobility generation – now expect pervasive coverage in all areas at work and enterprises are adding wireless mesh to their existing wireless LAN infrastructures as a way to provide further wireless coverage throughout buildings and campuses.

Outdoor coverage: Corporate wireless connectivity is spreading outdoors resulting in larger coverage areas; sports stadiums and oil rigs are just a couple of examples.

Support for voice communications: The growth of voice over wireless LAN adoption drives the need for pervasive coverage and wireless mesh.

What can mesh do?

There are several operating characteristics which are fuelling a growing movement towards using wireless mesh technology throughout a campus or even a metropolitan area.

These characteristics include (and allow mesh to):

- Operate without a wired infrastructure
- Create a self-forming fixed or mobile network without any pre-design or pre-installation
- Automatically route around network failures and adapt to Radio Frequency (RF) interference
- Be utilised indoors with a network diameter of a few hundred yards/meters
- Be deployed outdoors with a network diameter of tens of miles/kilometres
- Be used within licensed or unlicensed spectrum
- Operate on battery and solar power

These capabilities allow for the deployment of a dynamic, flexible and adaptive solution across a range of vertical industries and applications.

Another key characteristic of wireless mesh is its ability to significantly enhance network performance via:

- Fault tolerance
- Load balancing
- Increased throughput
- Protocol efficiency

Combined with dramatically reducing management overhead and associated cost, most of today's existing standard wireless networks cannot claim to have these compelling capabilities. As the demand for outdoor WLANs and indoor extension of LANs increases, Wireless Mesh can enable cost effective, secure deployments of enterprise campus to metropolitan-scale outdoor Wi-Fi networks.

The value derived from **"always on"** internet access is exponentially **increasing** as is **cost efficient links** to remote buildings and temporary classrooms.

The ideal profile for wireless mesh?

Does your organisation fit the profile for wireless mesh?

- Is there a requirement for improved "day to day" communication and collaboration out in the field?
- Is there a need for creative and innovative new services and process optimisations to be supported?
- Is the movement of wireless benefits of "internal workspace" to outdoor metro-wide environments an appealing proposal?

If you've answered "Yes" to one of more of those questions, wireless mesh could be an option for you and your organisation.

The following, more specific, questions should generate further discussion:

- Could the reliable extension of wireless data and voice services across your city result in a more coordinated emergency response from public safety personnel?
- Do you need to improve building and surrounding outdoor security by monitoring areas via video surveillance or providing live video feeds to security personnel?
- Can your student body benefit from value-added services like virtual libraries, eBook rentals and Internet access across the large breadth of your campus?
- Is your environment too challenging for conventional wireless networks with point-to-point due to intermittent obstructions or increasing network noise, resulting in service disruption?

Where mesh works

Getting a sense of where wireless mesh is being used may help you further in determining if this technology is relevant for you and your organisation.

We're finding wireless mesh being used by companies across a variety of industry segments:

Education or campus environment

Moving indoor wireless outside is a common theme among enterprises with large corporate campuses looking to provide "blanket" coverage for connectivity and asset tracking. Universities and healthcare institutions have a similar requirement to extend wireless coverage throughout their entire campuses.

In the highly competitive arena of collegiate candidate recruitment, the ability of a university to provide pervasive wireless connectivity over the breadth of their campus is an increasingly important factor that today's younger mobility generation evaluates when selecting an institution to continue their advanced education. Users are not only students; administration staff and other facilities staff also need such levels of coverage to accomplish their tasks with more responsiveness and increased productivity. These benefits can be realised via applications such as video surveillance by campus security staff, as well as alarms or alerts during emergency situations on campus. The value derived from "always on" Internet access is exponentially increasing as is cost efficient links to remote buildings and temporary classrooms. The increased coverage alone raises the value of the network.

Public safety and municipality

The public sector is leading the way in terms of adoption of the technology as state, county and city governments have increasing public safety requirements and applications used by police, fire and other emergency or 1st responders in disaster situations. Many cities have begun to implement public broadband services for city workers, utilities and inspectors. Other municipal wireless mesh projects are increasingly appearing as local governments try to boost economic development by making high-speed Internet access available to all.

According to industry analysts, mesh networking in various applications is becoming a low-cost alternative for municipalities to enhance data communications and improve public safety interoperability. The ability for public safety officials to upload arrest reports, download fugitive watch reports and receive "amber alerts" with pictures, whilst in their vehicles, can lead to countless improvements in responsiveness of police officers in the field. Equally critical is the ability for municipal workers to enforce building codes around fire and safety; the value derived from e-Permitting and e-Inspection can be directly measured in time – what used to take days can now take hours.

Service provider

Service providers are using wireless mesh for higher capacity backhaul of mobile cellular and fixed wireless traffic. This is in direct response to the requirement of evolving services to support higher data speed networks (e.g. UMTS, HSPDA). As the service provider market deals with an increasing number of bandwidth and coverage hungry consumers and small-medium businesses, they require increased cost efficiency and management capabilities. For the general public, service providers can realise the true value of a wireless mesh network as it can implement fee-based services, perhaps even extra fee services, high bandwidth plans or city-wide roaming.

Wireless mesh technology is a high performance, scalable wireless network solution that has been deployed extensively throughout the world as a "last mile" solution for Internet service providers. "Last mile" access is a solution whereby service providers deploy and extend wireless connectivity to areas without traditional wired backhaul network access and capability.

Making the case for wireless mesh

Wireless mesh deployments can lower operational costs. The Mesh network's ability to self-form and self-heal afford significant reductions in administration, maintenance and support costs. In addition, the skill sets required for network administration already exist within the IT department and therefore the learning curve is typically lower than for cellular and other centralised wireless networks.

Wireless mesh provides intelligent wireless routing via an adaptive protocol which creates and maintains the mesh, providing resiliency to interference and network outages which reduces management costs. The technology's ability to automatically detect access points and add them to the network significantly reduces deployment costs.

WMNs are integrated solutions which allow for easy management and design. A dual-radio option enables the mesh network to maximise all available channels, minimise the occurrence of interference from unlicensed devices, minimise latency and configure routes dynamically. This decreases the need for internet gateways.

Finally, as a critical component of any wireless network, wireless mesh provides reliably secure outdoor access. Support for 802.11i security with various EAP types, as well as support for open authentication with web authentication, ensures that users are authorised to join the network, while hardware-based AES encryption ensures network privacy without compromising performance.

Going forward

Wireless mesh technology enables deployment of wireless connectivity across large coverage areas as well as in areas that lack access to a wired backhaul network. Wireless Mesh provides for resilient, self-forming, scalable networks making it an important and versatile technology in today's markets. There are several recommendations to be aware of when considering deploying Wireless Mesh.

In terms of environments where wireless mesh provides the most benefit, we have recommended considering a WMN for outdoor venues. It is an ideal solution for outdoor environments that lack a wired ethernet distribution system (e.g., sports stadiums, mining facilities, parking facilities, cargo storage, college campuses, and municipalities). Such venues can take advantage of mesh routing protocols to forward traffic without a wired network. Wireless mesh is also a good solution to extend WLAN in areas that lack a wired infrastructure (e.g., stairwells, restrooms, courtyards, and decks).

It's important to set realistic performance and coverage expectations. Many wireless mesh design considerations should be evaluated in order to deploy a WMN that satisfies the desired performance, reliability, and manageability goals. The choice of network architecture, network design, spectrum, number of radios per AP, and product configuration can significantly impact the user experience.

Each node frequently **recalculates the best path**, based on the **received signal strength**, **throughput**, **error rate** and **latency**.

Conclusion

It is clear that wireless mesh networks can address the demand for outdoor wireless coverage and increase users' productivity and mobility. The lower operational costs of a self-forming and self-healing network, coupled with leveraging existing wireless technology and knowledge, make it an ideal candidate to address critical business challenges for organisations. Without the need for wired infrastructure or time consuming network design, a Wireless Mesh Network can adapt to many issues that arise on the network and issues with interference, re-routing transmissions using optimal paths and keeping communications and responsiveness to critical situations at adequate levels. Outdoor wireless mesh products are 'ruggedised' in order to operate in the more extreme and challenging outside environments. Mesh access points are designed to mount to existing lampposts and use the same power source as the lamps themselves. Wireless mesh is a disruptive technology solution that can address the business and technology challenges companies face when searching for an ideal outdoor wireless solution to meet the growing demands of an increasingly mobile workforce.

Appendix: How does wireless mesh work?

In a mesh network topology, smart, self-aware nodes (i.e. wireless devices) automatically self-organise. A new node joins the wireless mesh network using a simple, discovery protocol to multicast its presence to listeners on the network. Existing nodes recognise the new node and reconfigure and retune the network transparently to incorporate it. Each node frequently recalculates the best path, based on the received signal strength, throughput, error rate and latency. Unlike most WLANs, a WMN usually has a distributed network control.

It's important to understand there are actually two types of wireless mesh networks – an infrastructure mesh network and an ad-hoc mesh network.

Infrastructure mesh network overview

An infrastructure wireless mesh network uses RF links to provide a data path from unwired APs back to an AP that does have a connection to the wired network or Internet. There may be multiple hops between an AP without a wired connection and the base station that provides the wired connection. This specification simply allows an AP to communicate directly with another AP wirelessly (this is sometimes referred to as an AP "operating as a repeater"). The design specification does not define routing algorithms to determine the best route (when multiple routes exist) or resolve routing conflicts in the case of loops in the configuration.

Infrastructure wireless mesh provides a means of extending a wireless network into areas where it is not feasible to run wired networking because of cost considerations or physical constraints. These wireless meshes can be configured to operate both indoors and outdoors (e.g., for sports venues, oil or gas operations, outdoor sensors).

Ad-hoc mesh network overview

The ad-hoc mesh architecture is basically a peer to peer (P2P) network where end stations function as routing nodes and are often mobile. Such networks are created where and when they are needed, without prior network design. As ad-hoc mesh devices come within range of each other, they identify themselves and set up links to the new devices. Each client may be in communication with many different devices and can route traffic between any of the devices on the network. As clients move around and enter or leave the network, links between devices are constantly updated, and the routing tables are modified, allowing any-to-any communications between the devices connected to the mesh.

Ad-hoc networks are particularly useful for short-term networks as they provide a good means of creating a high-speed wireless connectivity for users in highly fluid situations, such as first responders reacting to a regional disaster. The proprietary routing protocols that maintain the mesh are highly optimised for these specific types of operations, resulting in minimal usage of the available bandwidth for overhead. The multiple paths created by the ad-hoc mesh can ensure that there is at least one operational path between any two clients in the vast majority of situations, even as the clients move from place to place.

Infrastructure mesh vs. ad-hoc mesh

Which implementation should be used? The answer depends on the purpose of the network and the applications to be used on the WMN. Relatively static, more permanent, networks where mobility of users is pretty low are best deployed using infrastructure mesh design. If you're looking to deploy a highly dynamic, yet temporary, network that has less of dependence on infrastructure thereby allowing for more mobility of users, an ad-hoc mesh network is the way forward.

Complementary technologies

The growing interest and market acceptance of wireless mesh has spawned additional work that will add to the standardisation, reliability and performance of these networks.

IEEE 802.11s

Proposed Mesh standard for mesh discovery, configuration, security, and routing protocols. This will allow for interoperability of competing devices and enhance the spread of metro-area Wi-Fi mesh networks.

IEEE 802.11n

New wireless standard that significantly improves throughput (>100 MBps) and doubles the range. While IEEE final ratification will be in early 2009, the Wi-Fi alliance is already certifying products based on draft standard.

IETF standards

RFC 4728 defines dynamic source routing (DSR) protocol for mobile ad-hoc networks which provides an interoperable method to establish and maintain an ad-hoc mesh network.

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