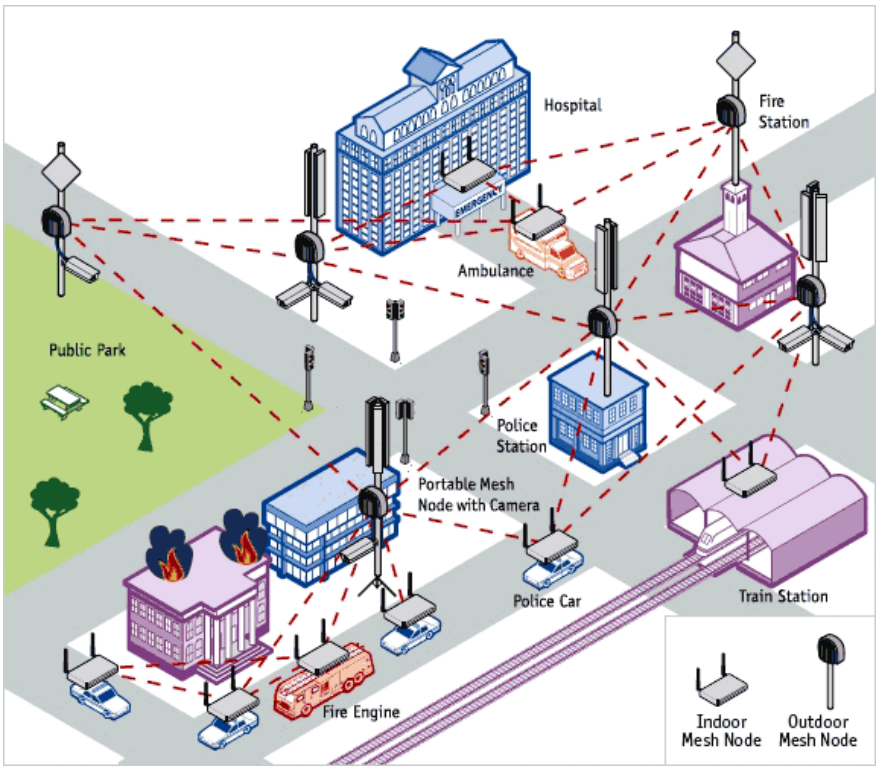
Technology trends in Security VI

Wireless Mesh Networks



Wireless mesh networks are WiFi radio networks with fixed nodes. Each node acts as a router so if one fails or is damaged by a perpetrator, wireless packets can be re-routed through other nodes. **Wireless mesh networks allow wireless video surveillance coverage over wide areas, with two-way audio as well.** Besides, they eliminate wiring costs that might be prohibitive for wide-area applications.
The self-healing capability of mesh networks enables the network to operate even when one node breaks down or a connection goes bad. As a result, the network is typically quite reliable, as there is often more than one path between a source and a destination in the network.

A **wireless mesh network** (**WMN**) is a communications network made up of radio nodes organized in a mesh topology. Wireless mesh networks often consist of mesh clients, mesh routers and gateways. The mesh clients are often laptops, cell phones and other wireless devices while the mesh routers forward traffic to and from the gateways which may, but need not, connect to the Internet. The coverage area of the radio nodes working as a single network is sometimes called a mesh cloud. Access to this mesh cloud is dependent on the radio nodes working in harmony with each other to create a radio network. A mesh network is reliable and offers redundancy. When one node can no longer operate, the rest of the nodes can still communicate with each other, directly or through one or more intermediate nodes. The integration of WMNs with other networks such as the Internet, cellular, IEEE 802.11, IEEE 802.15, IEEE 802.16, sensor networks, etc., can be accomplished through the gateway and bridging functions in the mesh routers. Mesh clients can be either stationary or mobile, and can form a client mesh network among themselves and with mesh routers. **WMNs are expected to resolve the limitations and to significantly improve the performance of ad hoc**

networks, wireless local area networks (WLANs), wireless personal area networks (WPANs), and wireless metropolitan area networks (WMANs).

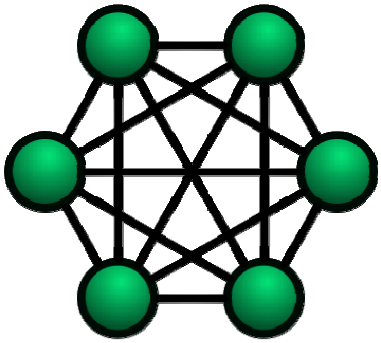
Architecture

Wireless mesh architecture provides a cost effective and dynamic high-bandwidth network over a specific coverage area. **Wireless mesh architecture infrastructure is, in effect, a router network minus the cabling between nodes.** It comprises of peer radio devices that don't have to be cabled to a wired port like traditional WLAN access points (AP) do. Mesh architecture sustains signal strength by breaking long distances into a series of shorter hops. Intermediate nodes not only boost the signal, but cooperatively make forwarding decisions based on their knowledge of the network, i.e. perform routing. Such architecture, may, with careful design provide high bandwidth, spectral efficiency, and economic advantage over the coverage area.

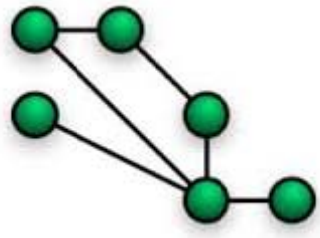
Wireless mesh networks have a relatively stable topology except for the occasional failure of nodes or addition of new nodes. The path of traffic, being aggregated from a large number of end users, changes infrequently. Practically all the traffic in an infrastructure mesh network is either forwarded to or from a gateway, while in ad hoc networks or client mesh networks the traffic flows between arbitrary pairs of nodes.

This type of infrastructure can be decentralized (with no central server) or centrally managed (with a central server), both are relatively inexpensive, and very reliable and resilient, as each node needs only transmit as far as the next node. Nodes act as routers to transmit data from nearby nodes to peers that are too far away to reach in a single hop, resulting in a network that can span larger distances. The topology of a mesh network is also reliable, as each node is connected to several other nodes. If one node drops out of the network, due to hardware failure or any other reason, its neighbouring node can quickly find another route using a routing protocol.

Mesh Network types – Full Mesh and Partial Mesh



Full Mesh, which requires that every device have a dedicated point to point link to every other device. If you have 6 devices you need connection from and to each device in the network. In this topology, some or all nodes may be a router and some or all nodes may be an end point. It’s rare to achieve a full interconnection like this with most networks.



Partial Mesh, on the other hand, only requires some nodes be connected to a source which can then supply the remaining nodes.

Data flow in a mesh network – routing or flooding.

Routing sends data along a dedicated path, jumping from one node to node until it reaches its destination. In this scheme, any node can be a bottleneck or broken path, so there needs to be a mechanism for the connection to be maintained via a self healing protocol where broken links are repaired by substituting nodes.

Flooding involves distributing data from the source node to rest of the nodes in the network hierarchically. Unlike routing, it does not depend on every node to be alive to function, but it does have the potential to be inefficient as transmission of data from one node may not produce a duplicated or determinable output to the next.

Video surveillance over a wireless mesh network

The flexibility of a mesh network allows it to be deployed in any scenarios - point-to-point for backhaul and point-to-multipoint, or "true" mesh for complete redundancy. Some deployments start as point-to-multipoint, later to be reconfigured into a mesh topology, when security needs call for ubiquitous coverage.

How Wireless Mesh Networks Work

Wireless mesh networks can easily, effectively and wirelessly connect entire cities using inexpensive, existing technology. Traditional networks rely on a small number of wired access points or wireless hotspots to connect users. In a wireless mesh network, the network connection is spread out among dozens or even hundreds of wireless mesh **nodes** that "talk" to each other to share the network connection across a large area.

Mesh nodes are small radio transmitters that function in the same way as a wireless router. Nodes use the common WiFi standards known as **802.11a, b and g** to communicate wirelessly with users, and, more importantly, with each other.

Nodes are programmed with software that tells them how to interact within the larger network. Information travels across the network from point A to point B by hopping wirelessly from one mesh node to the next. The nodes automatically choose the quickest and safest path in a process known as **dynamic routing**.

In a wireless mesh network, only one node needs to be physically wired to a network connection like a DSL Internet modem. That one wired node then shares its Internet connection wirelessly with all other nodes in its vicinity. Those nodes then share the connection wirelessly with the nodes closest to them. The more nodes, the further the connection spreads, creating a wireless "cloud of connectivity" that can serve a small office or a city of millions.

Advantages of wireless mesh networks.

- Costs less to set up a network, particularly for large areas of coverage.
- The more nodes you install, the bigger and faster your wireless network becomes.
- They rely on the same WiFi standards (802.11a, b and g) already in place for most wireless networks.
- They are convenient where Ethernet wall connections are lacking -- for instance, in outdoor concert venues, warehouses or transportation settings.
- They are useful for Non-Line-of-Sight (NLoS) network configurations where wireless signals are intermittently blocked. If there are dozens or hundreds of other nodes around, the mesh network will adjust to find a clear signal.
- Mesh networks are "self configuring;" the network automatically incorporates a new node into the existing structure without needing any adjustments by a network administrator.
- Mesh networks are "self healing," since the network automatically finds the fastest and most reliable paths to send data, even if nodes are blocked or lose their signal.
- Wireless mesh configurations allow local networks to run faster, because local packets don't have to travel back to a central server.
- Wireless mesh nodes are easy to install and uninstall, making the network extremely adaptable and expandable as more or less coverage is needed.

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