RAJANT

20+ Years of Game-Changing Wireless

Kinetic Mesh Networking

Ensuring the Ultimate Network Flexibility, Scalability & Throughput

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Part I: **Traditional Wireless**

The common topology and communication methodologies of wireless networks are similar to those of wired networks, only without the wires. Wi-Fi Access Points and Cellular data networks use a star topology with a central base station acting as a switch similar to a switch in a wired Local Area Network (LAN).

Both the switch and base station direct only those packets intended for a given node along the link connecting that node to the switch or base station. If node to node communications are needed, it is accomplished through the switch or base station. In such a wireless configuration, capacity, range and other performance attributes are primarily determined by the capabilities of the base station.

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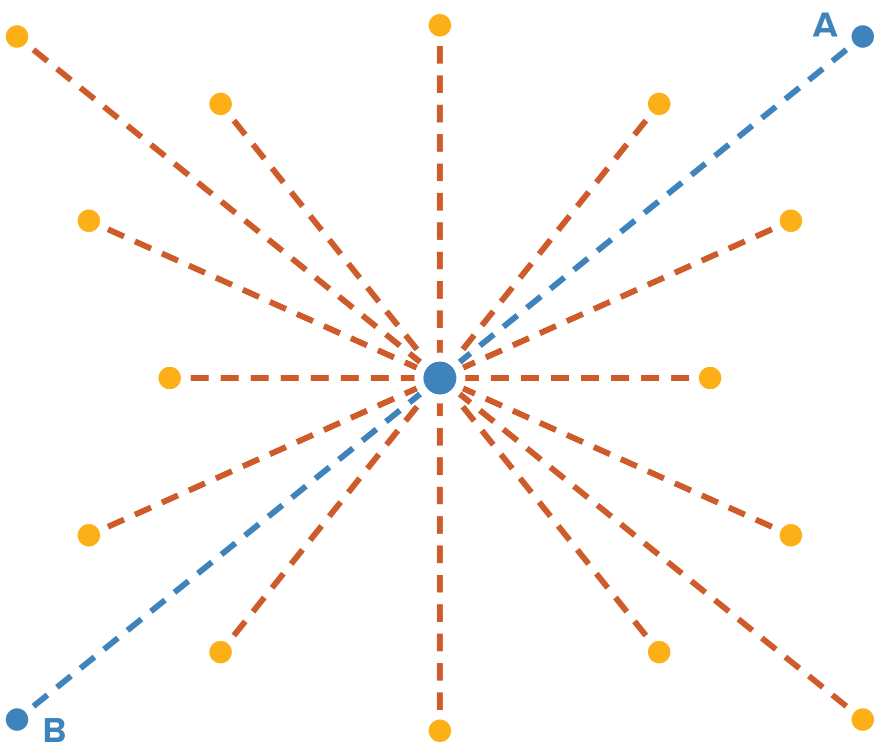

Figure 1. Traditional wireless star topology: communications between nodes A & B are through base station

Part II: **Physical Mesh**

An alternative networking approach is to utilize mesh topology to provide greater path redundancy, which can provide better reliability, data throughput and range. Because this requires decision making at each node rather than centralized at a base station, mesh network nodes require greater resources. Historically, the practical use for this technology has been to provide a backbone network linking smaller star networks.

Initially, routing nodes relied upon static routing methodologies in which the routing tables consisting of primary and alternate routes between source and destination nodes were manually configured and loaded into each routing node. The routing table ensures that a single route is used to forward packets. This is important in loop prevention and ensures a given packet is not received by any node multiple times while still allowing for failover to secondary routes, should a node or connection stop working.

Mesh topology provides **greater path redundancy,** which can provide better reliability, data throughput and range.

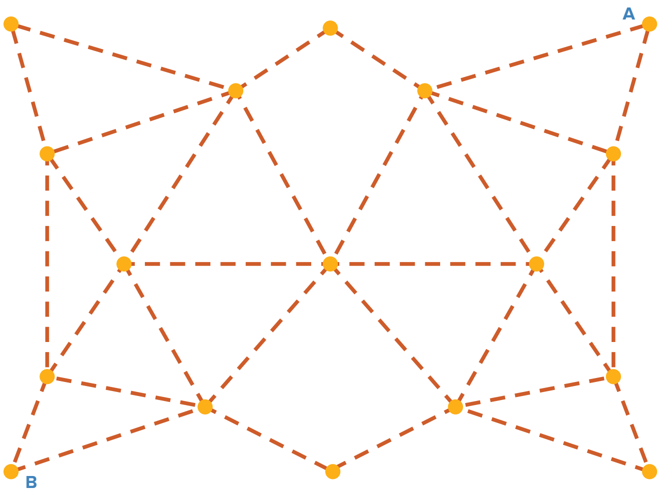

Figure 2. Physical mesh topology

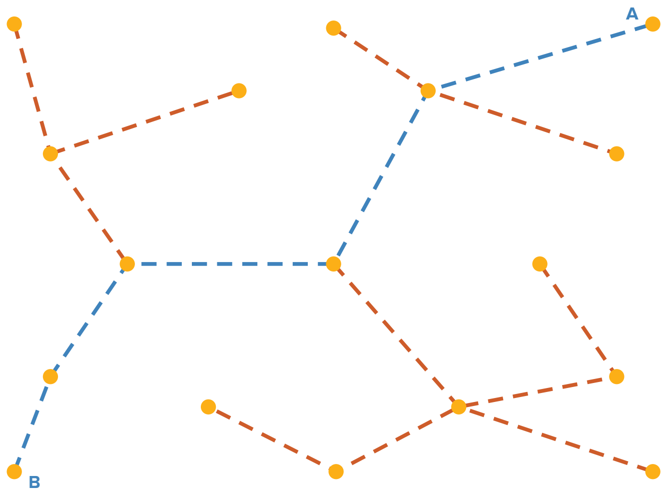

Figure 3. Links are logically trimmed to allow use of only the best route between node pairs

Part III: **Dynamic Routing**

As networks continued to grow, it became a challenge to manually configure and manage the complex routing tables needed. Dynamic routing was developed to address the frequency with which network change might necessitate routing table changes, routing algorithms were developed to automatically construct routing tables, and protocols were developed to update the routing tables in each forwarding node. This allowed the network to act nearly autonomously in trying to respond to connection changes. Dynamic routing has become the dominant methodology used by the Internet.

Dynamic routing requires that each node share performance information about its connections to other network nodes. Using this information, routing tables are calculated allowing each node to select the most appropriate route for any given destination. Two commonly used approaches for route construction include Distance Vector and Link-state algorithms.

Because link changes are often more frequent in wireless networks, dynamic routing algorithms have been specifically developed for them. Optimized Link State Routing (OLSR) and Ad Hoc On-Demand Distance Vector (AODV) are two popular examples. While reduced, the management message volume can still be substantial and may grow exponentially as the network scales or the frequency of change increases.

As processing resources have improved and costs lowered, it has become increasingly practical to drive the use of mesh networking technologies deeper into the network and closer to the end-user computing devices. This offers obvious reliability and capacity advantages, but has disadvantages for wireless networks in terms of scale and bandwidth consumption by creating overhead traffic.

Distance Vector Approach

A Distance Vector approach uses the information shared by each node to assign a cost number for each node-to-node link in the network. The routing table calculation and construction is accomplished by determining the lowest total cost path between each source and destination, and the table is then sent to every node on the network.

Link-state Approach

In the Link-state approach, each node floods the network with information about its links to other nodes on the network. The nodes individually determine the least cost path to every other network node by creating a tree graph with itself at the root.

As processing resources have improved and costs lowered, **it has become increasingly practical to drive the use of mesh networking technologies deeper into the network** and closer to the end-user computing devices.

Part IV: **Kinetic Mesh**

Kinetic Mesh was developed specifically to address the shortcomings of dynamic routing when used in wireless networks subject to frequent change, such as when mobility is involved. The functional difference is that Kinetic Mesh is better able to accommodate rapid change and significant scaling while maintaining low end-to-end latency and high data throughput. Operationally, this allows Kinetic Mesh to be used outside of backbone and backhaul functions in wireless networks.

Functionally, Kinetic Mesh does not utilize the process of calculating or communicating source-to-destination routes. Kinetic Mesh nodes may utilize any viable connection on a packet by packet and node by node basis without calculating routes. The benefits of not depending upon the calculation and dissemination of multi-link routes are low administrative overhead and the ability for a packet to alter course while in transit.

Kinetic Mesh is better able to **accommodate rapid change and significant scaling** while maintaining low end-to-end latency and high data throughput.

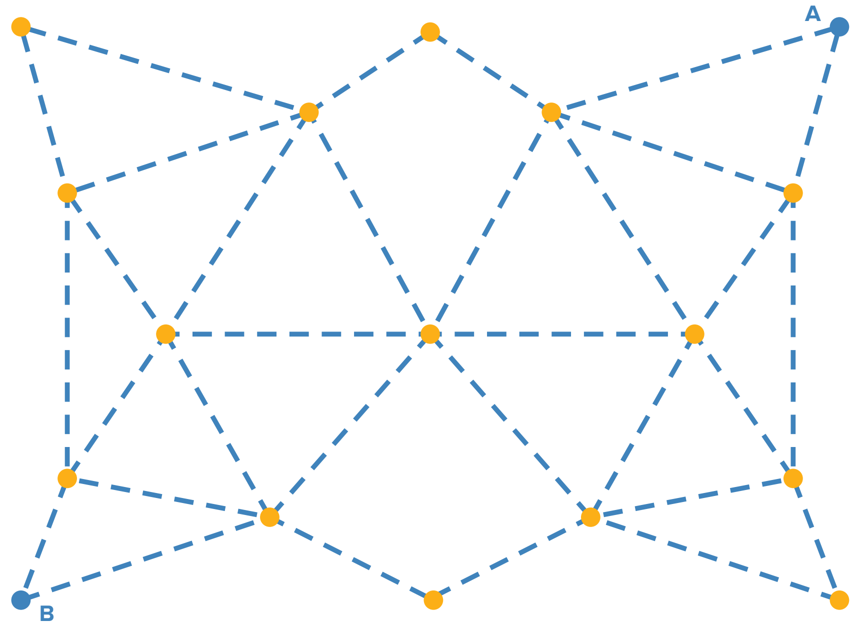

Figure 4. Kinetic Mesh enables the use of any viable connection at any time

Part IV: **Kinetic Mesh**

Using the InstaMesh™ networking protocol for costing and forwarding decisions, a Kinetic Mesh node autonomously analyzes the source address and age of each received packet. When a new packet arrives at a given node, a determination is made whether it is to be forwarded. If it is, the connection on which the youngest packets have been received from the new packet's destination is used to forward the new packet. This sequence is then repeated by each node until the packet arrives at its destination node. The forwarding decision at each node is opportunistic and not dependent upon any previous or known source-to-destination analysis or decisions.

While on the surface, the use of temporal costing and opportunistic link selection appears less difficult than other, more complicated costing and routing methodologies, the successful implementation of Kinetic Mesh networking is dependent on how complex change scenarios are handled. The InstaMesh protocol is specifically designed to address the myriad exceptions that can occur during network transit. These exceptions are also addressed autonomously at each node without the need to request, provide or exchange routing or other parameters with other network nodes.

Another important advantage is that the temporal costing methods and opportunistic link selection, used by the InstaMesh networking protocol, are not exclusive to wireless network implementations, and therefore Kinetic Mesh is not exclusive to wireless networking. Node connections may consist of any combination of radio, wired, fiber optic, microwave, free-space optics (lasers) or other communication mediums.

The weighted parameter costing used by wireless dynamic routing algorithms are typically derived from some combination of processing parameters, such as hop count; radio parameters, such as noise level; and load-leveling parameters, such as congestion avoidance. While each of these can be successful in providing route selection in many circumstances, they have proven inferior to the methods used by Kinetic Mesh networking. The age of received packets, used exclusively by Kinetic Mesh technology, is superior because it correlates directly to the transit time needed to reach the source of a packet. Opportunistic link selection at each node between the source and final destination and basing that selection on which link has received the youngest packets from the final destination, allows Kinetic Mesh networking to ensure the fastest packet delivery, quickest change response, and lowest administrative overhead as compared to other wireless mesh networking technologies.

About Rajant Corporation

Rajant Corporation is the exclusive provider of private wireless networks powered by patented Kinetic Mesh technology, BreadCrumb® network nodes, and InstaMesh® networking software. With Rajant, customers can rapidly deploy a highly adaptable and scalable network that leverages the power of real-time data to deliver on-demand, critical business intelligence from the field. Rajant BreadCrumbs can seamlessly integrate with any Wi-Fi or Ethernet connected device to deliver low latency, high throughput data, voice and video applications across the meshed, self-healing network. With the ability to take private network applications and data everywhere, Rajant networks are used across a broad array of industries including military, industrial, transportation, utilities, telecommunications, and all level of governments. For more information, visit www.rajant.com.

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