SOLUTION PAPER

MOTOROLA WIRELESS BROADBAND

Advancing Motorola Mesh Wide Area Networks with the Power of Opportunistic Radio Link Adaptation

Motorola's Mesh Wide Area Network (MWAN) product portfolio is embracing the power of ORLA, the Opportunistic Radio Link Adaptation, which is an improved element of Motorola's patented MeshConnex™ Routing Engine. The MeshConnex Routing Engine provides efficient routing, low hop latency, low routing overhead, high-speed handoffs and proven scalability. MeshConnex uses Motorola's patented Layer 2 routing technology to find and establish throughput-optimized connections.

ORLA DEFINED

The Opportunistic Radio Link Adaptation (ORLA) algorithm is a key decision-making element within MeshConnex™, designed to select data rates that will provide the best throughput. Instead of using local conditions to decide whether a data rate is acceptable or not, ORLA is designed to *proactively* probe other rates to determine if greater throughput is available. If these other rates do provide improved throughput, ORLA intelligently adjusts its selection tables to favour higher performance. ORLA provides improvements both on the client side of a mesh network as well as in the backhaul capabilities. ORLA is a key differentiator at the deployment and customer level and will be further explored in this paper.

WHY ORLA WAS CREATED

ORLA, the improved adaptive algorithm, addresses typical link adaptation algorithms that exist in two popular forms as outlined below:

Predictive Algorithms
These algorithms assume that a radio channel is deterministic and that a rate can be selected with accuracy by simply knowing some simple characteristics of the channel such as the noise floor and the path loss. Such algorithms overlook the fact that channel characteristics vary considerably and that packet collisions are never accounted for in propagation models.

Reactive Algorithms
These algorithms determine whether a current rate is acceptable and whether it needs to be increased or decreased. Most commercial implementations follow this principle. This method works for about 80% of cases, but there are circumstances involving interference and fading where higher data rates cause fewer collisions; therefore, lowering the data rate would make this worse.

Consequently, ORLA was developed to address the issues above and create a hardened link adaptation algorithm for clients and backhaul, mitigating any issues encountered with reactive and predictive style algorithms.

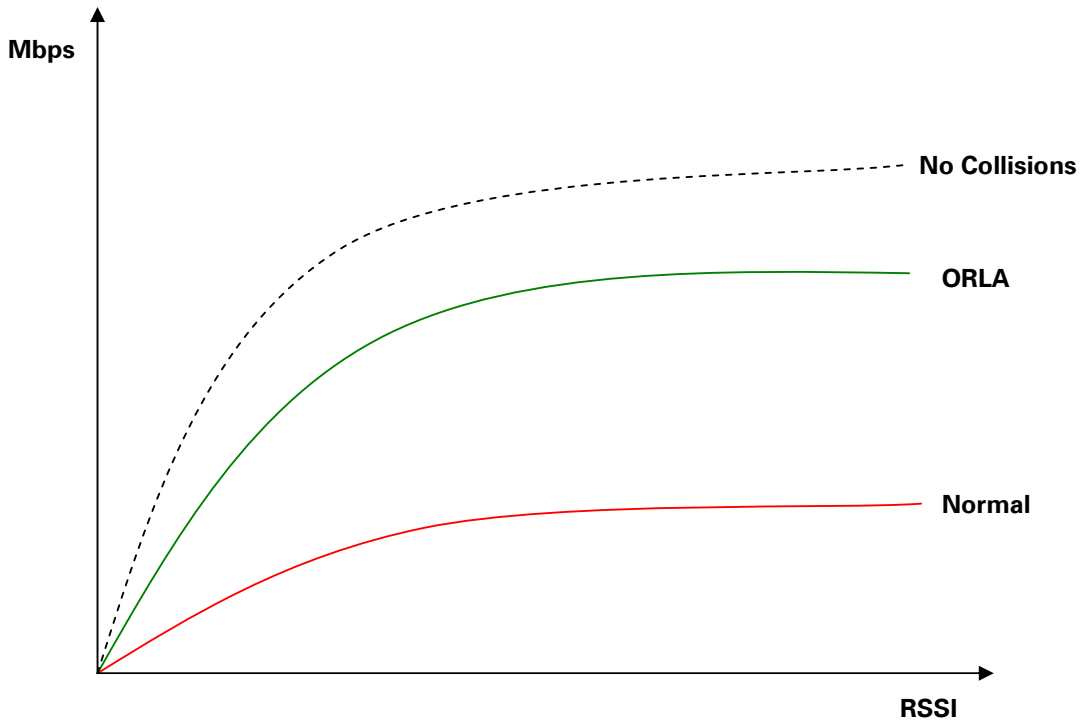
IMPROVING CUSTOMER SATISFACTION WITH ORLA

A customer will observe many direct benefits by using the new ORLA algorithm with a Motorola MWAN product.

Throughput

When deploying a mesh network it should be designed to give the clients the highest available data rate, together with a robust and stable TCP/UDP connection within the environment deployed. One of the key advantages of having ORLA is the prevention of "cratering", which affects the data rate and connection. For example, there may be a device or backhaul connection that is able to sustain higher data rates, but an event causes that client/backhaul link to adjust itself to a lower data rate. This event could have an object passing through the Fresnel Zone, ORLA is designed to prevent and overcome such an event from affecting the throughput and maintains the higher desired data rate for the clients and the backhaul connections.

The graph below illustrates throughput being mapped against typical RSSI (Received Signal Strength Indication) in three operational states. In a perfect world there would be no collisions in the 802.11 domain and the sustained throughput against RRSI would be ideal. The graph shows the operational difference between a regular 802.11 mesh node and ORLA running within the MeshConnex algorithm in a Motorola MWAN product.



Sustained Throughput with ORLA

CUSTOMER EXPERIENCE IN A REAL WORLD SITUATION

Customers typically using other mesh networks have seen 802.11g cards connect initially at 54 Mbps, but eventually this data rate would decrease to 1 Mbps due to poor rate control algorithms. Normally it would require a re-association to the AP to restore the higher data rates. However, ORLA has resolved this performance gap for both UDP and TCP protocols, maintaining and sustaining the highest possible data rates. The algorithm is also smart enough to know when to stay at a higher rate even though the packet completion rate may be lower. For example, it is better to be at a 50% packet completion rate at 11 Mbps than 100% packet completion rate at 1 Mbps.

FASTER MWAN NODE CONVERGENCE AND ROUTING

Mesh networks should be self-forming and self-healing. As ORLA is part of Motorola's mesh routing algorithm, it is important that there is convergence for both backhaul links and client access. As an example, from a client perspective the connection must enable optimal download speed quickly and not have to wait to throttle to the optimal level, which would represent itself as a period of inactivity. Clients should not have to wait for the network to determine to the best level, which would represent itself as a period of inactivity. ORLA achieves this rapid convergence for both clients and backhaul connectivity.

In addition to this, ORLA enables links with marginal SNR (signal-to-noise ratio) to provide increased throughput; therefore, the routing metric of these links will also improve. This means in poor RF environments with increased interference, "stickier" routes can be provided, allowing marginal links to be used as hops within the networks, aiding with tricky design problems. By choosing shorter routes and maintaining sustained and consistent data rates it may also be possible to reduce the average number of hops in a network
The key with ORLA has been its ability to consistently and intelligently select the right route allowing the client track to reach its destination irrespective of the environmental conditions.

IN CONCLUSION

ORLA has been proven to be a consistent and robust link adaptation algorithm, and is a key component of the Motorola Mesh Wide Area Networks portfolio today. Going forward ORLA will optimize new radio technologies such as 802.11n as well. The higher throughput and data speeds of this wireless technology will take advantage of the link adaptation algorithm, which is part of Motorola's patented MeshConnex™ routing engine. This will provide an opportunity to maximize the 802.11n data rate in any given environment, and maintain robust throughput.

With ORLA, the end result for a customer using a Motorola Mesh Wide Area Network is sustained throughput at the highest possible data rate.

Motorola Wireless Broadband Solutions

Motorola's comprehensive portfolio of reliable and cost-effective wireless broadband solutions provide and extend coverage both indoors and outdoors. The Motorola Wireless Broadband portfolio offers high-speed Point-to-Point, Point-to-Multipoint, Mesh, WiFi and WiMAX networks that support data, voice and video communications, enabling a broad range of fixed and mobile applications for public and private systems. With Motorola's innovative software solutions, customers can design, deploy and manage a broadband network, maximizing uptime and reliability while minimizing installation costs.

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