Do you honestly believe you can really build a single-radio technology based wireless mesh network that provides reasonable performance for both user access and backhaul connectivity?

And do you really think adding a second radio will solve the problem?

The answer is STILL ***NO!***

First, the fundamental problem that plagues a single-radio technology based wireless network is the number of traffic collisions that take place on a single channel supporting all the nodes and users of that Entire network. This is the main characteristic of a one radio mesh - everything is in one channel! Just imagine hundreds of people at a party and only one person can speak at a time, how unpleasant and inefficient it would be!

Now imagine that you add another radio, performance may improve slightly, however, not enough to support more than two hops without significant degradation in performance for backhaul and client connectivity.

The Problems:

#1: A wireless user can not transmit when a node in the vicinity is sending traffic to other nodes or other users. This is applicable not only to the users associated to <u>that</u> particular node but, <u>to all users</u> that can see (detect signals from) that node, even if they are already associated with other nodes, all of those wireless users must wait. To make matters worse, especially when higher power radio nodes with omni directional antennas are used to cover larger areas, a greater number of users will be waiting while just one node is transmitting. For example, if a user can see three single-radio mesh nodes, it will need to wait for all three nodes to free the air, AND wait for all other users in the vicinity, regardless of their association to nodes, to finish their communications before it can continue its own transmission.

#2: With a single-radio solution, users can delay the network when they connect at a data rate that is lower than the backhaul data rate. Users that have more attenuation from a node because they are behind walls, or are a using a PDA, will sync at lower speeds, in many cases at 1Mbps. (<u>At first reading, this may seem like a trivial issue, but it's actually not</u>). While a user is sending or receiving a packet to a node, if the link rate is 1Mbps the entire node then operates at 1Mbps. i.e. A 1500 byte packet transmitted at 1Mbps stays in the air 54 times longer than if the user syncs up at 54Mbps and sends the same packet. **So the entire node, everyone and the backhaul associated with it, is delayed because of that user.** This is common behavior in all access points but in the case of one radio networks, that user is taking airtime away from nodes and other users since all of them are in the same channel.

The important thing to consider is that this packet at 1Mbps delays all the traffic in that node including the backhaul traffic coming from other nodes even if they are sync at higher speed. To make it more impacting, imagine what happens if a user syncs up in a node at 1Mbps and that node is the wired node. **The data-rate of the entire network is brought down to 1Mbps.**

#3: Utilizing IP routing as a way to manage a wireless mesh network. This potentially creates a tremendous amount of overhead, especially with single-radio solutions. In a wireless configuration, connectivity and the strength of a connection will frequently change. Therefore, the IP routing algorithm must re-route and stabilize quickly, sending all adjacent nodes the relevant information about its routing path neighbor(s). Theoretically an IP routing protocol should provide some performance benefit as a routed network becomes more populated. Eliminating gratuitous broadcasting of packets throughout the network, routable packets may be optimized on a per-path basis, however, in a wireless mesh network, multiple paths must be built and re-built on a continuous basis. Collisions and link-state changes of the wireless node connections can cause a routing algorithm to bounce back and forth and even get stuck in a decision process. But problems #1 and #2 have to get fixed first before you run into this one…

#4: A second radio will, to a small degree, help reduce the massive number of collisions seen on a single-radio system, but this doesn't solve the issues related to hand-off contention, multi-hop performance, scalability or the effective use of frequency spectrum. The ability to automatically and dynamically adjust to the environment, select the most optimal paths and maintain the highest performance within a single multi-radio node supporting, let's say "10" hops is unique to the those who have already deployed the largest multi-radio node networks. Layer 3 routing protocols can not optimize the use of spectrum at the physical level when the spectrum is already saturated or at its limits. Once the spectrum is saturated there is little hope, and the only option is to perform frequency multiplexing which is equivalent to using different and dedicated radio channels for different purposes. Management of paths, radio's and radio frequency bands shouldn't require layer 3 routing and customers pay a performance penalty as a result. To adequately meet the performance and scalability needs of a metropolitan network, the functions of sectorized user access, sectorized infrastructure and egress interfaces must be dedicated to ensure the optimal level of performance. Automatic configuration may provide decent performance, however, in many cases performance is impacted by antenna selection and the fine-tuning each connection is critical to the CapEx, OpEx, customer performance and long-term viability of the network.