**INTRODUCTION**

Wireless Mesh Networks (WMNs) is a promising technology for next generation wireless networks that are self-organized and self-configured. Unlike conventional WLAN, WMN is an “all wireless” network, where a wireless backbone is set up to achieve end-to-end wireless transmission. Due to the unique characteristics of WMNs, the conventional association and reassociation procedure of wireless stations (STAs) with the Access Points (APs) should be redefined. In the current implementations, each STA associates with the AP that has the highest Received Signal Strength Indicator (RSSI). RSSI is not a good decision metric as it can’t reflect many factors like network traffic load and link quality. In our association scheme, the AP selection is based on airtime metric of both access link and backhaul routing path so that end-to-end performance is improved. Current reassociation procedure latency can be as long as 500 msec, mainly due to periodic full channel scan. Our proposed reassociation algorithm makes use of mesh network peer management protocol to share neighbor AP information, so that the number of channels scanned as well as the scan frequency are reduced. STA sends probe request only when network load change or STA movement is detected. As a result, the total reassociation delay and data loss can be reduced significantly.

**CROSS-LAYER ASSOCIATION CONTROL**

- Figure on the left depicts a WMN topology. Each MAP has 2 interfaces, one for mesh network backbone, and the other for local access network. Each STA must associate with one MAP and reassociate with a better MAP dynamically when network condition changes.

  **Association Metric:**

  \[
  TC_{i,a} = (1 - \alpha)AC_{i,a} + \alpha BC_{a}
  \]

  **Airtime Cost:**

  \[
  C_a = \frac{O_c + O_p + \frac{B_r}{r} + \frac{1}{1 - e^{pt}}}{T_a}
  \]

  where \(TC\) is the total end-to-end airtime cost from STA \(i\) to its destination via AP \(a\). \(AC\) is access link cost and \(BC\) is sum of link costs on the backhaul path. The second equation shows how airtime cost is calculated, where \(O\), \(B\), \(r\), and \(e\) are fixed overhead, packet length, available link bandwidth, and packet error rate respectively.

  - The association metric has considered link quality, network load, and achievable bandwidth to select the AP that provides the best end-to-end performance.

**DYNAMIC REASSOCIATION PROCEDURE**

- Mesh Beacon: between Mesh Points, {Mesh network peer management information, MAP local access network information}
- Local Beacon: from AP to STAs, {BSSID, Operating Channel, Available Bandwidth}
- Each MAP sends Local Beacon periodically not only in its own operating channel but also in the channels of neighbor MAPs.
- Each STA listens to Local Beacons and compares the available bandwidth of current MAP as well as neighbor MAPs.

- Each STA monitors its position by comparing average RSSI received.
- If significant MAP load change or STA movement is detected, the STA initiates probing process.
- The associated MAP calculates its total association cost as well as that of neighbor MAPs’, and indicates the best AP in Probe Response.
- Finally, STA reassociates with the best AP and disassociates with current AP (if it is not the best).