CHAPTER 4

DYNAMIC LOAD SHARING

4.1 INTRODUCTION

Wireless systems continue to attract immense research and development effort. Amongst many advantages, they provide the power and freedom of mobility. The recent boom of handheld and mobile devices has spurred the demand for new applications supporting human activities especially in the outdoor and working environment. A customer running multimedia applications requires a guaranteed and flexible bandwidth allocation for smooth presentations. Hence, the service providers should have a provision to satisfy the requirements of high priority applications. Service differentiation is helpful in providing QoS for multimedia applications under low to medium traffic load conditions. However, due to the inefficiency of IEEE 802.11 MAC, service differentiation does not perform well under high traffic load conditions. In this case, admission control and bandwidth reservation become necessary in order to guarantee QoS of existing traffic. So, it is desirable to have metrics for load sharing in the wireless internet.

4.2 OVERVIEW

WLAN is based on a cellular architecture where the system is subdivided into cells. The BSS is controlled by an AP. It is the fundamental building block of the IEEE 802.11 WLAN architecture. In a campus wide WLAN, it consists of several BSSs. The BSSs are connected via Distribution
System (DS). Each BSS becomes a component of an ESS. The IEEE 802.11 defines the ESS or infrastructure WLAN, as shown in Figure 4.1. The MCs within the same BSS communicate with each other with the help of the AP. MCs can move between BSSs. The Distribution System Services (DSS) provide various services like association, re-association, disassociation, distribution and integration.

**Figure 4.1 Distribution system in IEEE 802.11 AP implementation**

First three services deal with the MC’s mobility. When the MC moves between APs which are in the different BSS, it is called BSS transition. When the MC moves between BSSs of different ESSs, it is called ESS transition. DS always knows where the MC is, based on its association with the AP.

An MC associates itself with the AP by association process. Association process takes place dynamically because of MC’s mobility. Association process and re-association are initiated by the MC. Disassociation takes place when the association between the MC and the AP is terminated. Distribution is receiving the data from the sender to the intended MC. The message is sent to the local AP. It is then distributed through the DS to the AP.
where the recipient is associated with. The distribution service is logically invoked to check the data going via the DS or not. To provide QoS in a campus wide network, several APs are placed and installing several APs in a dense area causes load sharing among the APs.

4.3 RELATED LOAD BALANCING MECHANISM

The QoS management on hotspots environment becomes vital. Many new emerging applications such as mobile information access, real-time multimedia communications, networked games, immersion world and cooperative works require a minimum level of QoS (Lin and Gerla 1989, Lindgren et al 2001, Mangold 2002 and Qiang et al 2004). Papanikos and Logothetis (2001) proposed a load metric, which totally ignores the AP’s traffic load. The load sharing algorithm enters into play when overlapped coverage area of different APs exists and MC can attach to anyone of the APs. The existing load sharing methods are discussed here.

4.3.1 Associated Number of MC-Based Load Sharing Method

The MC selects the AP with minimum number of associated MCs. Thus, by counting the number of MCs associated with an AP may not provide proper estimation of the load in the wireless network. Load balancing mechanism attempts to balance AP load according to the number of users alone. This can perform an imbalance in the network.

4.3.2 Received Signal Strength - Based Load Sharing Method

The MC selects the AP based on the received signal strength of the AP. The MC selects the AP with stronger signal strength. The capacity of the AP and associated MCs is not considered. Received Signal Strength (RSS)
based on load sharing leads to unbalanced WLAN scenario. This method does not consider the load distribution over APs. Some APs may be overloaded while others may have light load. The overloaded AP will lead to performance degradation.

The key issues taken into account are (i) identification of the imbalance in over utilized or underutilized AP and (ii) Specifying limits for utilization and MC association in the overlapping region. In order to overcome these problems, the proposed capacity metric identifies the number of active MCs currently associated with the AP. Based on the actual capacity of the AP, the load is uniformly shared among the APs.

4.4 CAPACITY - BASED LOAD SHARING MECHANISM

The primary choice is to define a capacity metrics that is used by an MC when it is in the overlapping region. Basically, an MC gets the information about capacity of each neighbouring APs from the beacon management frame. Based on the capacity of an AP, the MC decides to handover to the suitable candidate AP.

4.4.1 Capacity Estimation

The hotspots environment is a set of APs covering overlapping cells and offering connections to a variable number of MCs. User applications are not similar in terms of QoS. This load sharing mechanism guarantees a minimum QoS. The throughput of an AP is defined by,

\[
\text{Throughput} = \frac{\text{Payload information transmitted in a slot time}}{((\text{MCA header length} + \text{FCS}) / \text{Bandwidth}) \text{in a slot time}}
\]  

(4.1)
Certainly, it is desirable to distribute load among available APs. This results in better network speed for an MC and an overall increase of bandwidth usage. The 802.11 MC compares the load on various APs in the overlapping area and selects the best AP with minimum capacity.

Load balancing is a way of better distribution of the traffic volume across AP. QoS is a means of allocating bandwidth and network access based on transmission priorities for different types of wireless traffic across the AP. The proposed capacity metrics is determined when the total capacity and the network usages are known. The proposed capacity metric is defined as the number of active MCs communicating with the AP. Determining the capacity of WLAN cell is not a straight forward process.

The various factors influencing the throughput of the 802.11 MAC mechanism is presented. The DRM framework model with load sharing mechanism based on anticipated capacity is represented. The conditions for which network initiated hand-off for load sharing beneficial are elaborated. The proposed algorithm aims at improving the resource allocation for ongoing calls in the overlapping region. The flow of an ongoing call is not rejected. They are redirected after satisfying the user needs in the wireless/mobile network.

4.4.2 Acquisition of Capacity Information

To identify the current active MCs, the active timer is defined for each MC communication with the AP. Figure 4.2 shows the IEEE 802.11 target architecture. Every AP monitors the traffic over the air link and produces the data about the available capacity. The APs associated with AR are updated with current capacity and number of MCs associated with an AP. To learn the available capacity information of AP1, AP2, AP3 and AP4, the
EACS protocol is used. The AR distributes the collected information to the MCs via management frame that is periodically transmitted and updated in the DRM server.

The infrastructure-based campus wide IEEE 802.11 b WLAN is considered as the target network. The maximum payload throughput of a BSS consists of an AP and a number of active MCs. The throughput capacity depends on many factors like MAC control, payload length, traffic pattern, number of MCs associated, queue size of MC and the interference level.

![IEEE 802.11 WLAN target architecture](image)

**Figure 4.2 IEEE 802.11 WLAN target architecture**

The IEEE 802.11b standard ANSI/IEEE (2000) defines two access methods: the Distributed Coordination Function (DCF) using CSMA/CA to allow for contended access to the wireless media and the Point Co-ordination Function (PCF) providing uncontended access via arbitration by a Point Co-ordinator residing in the Access Point. The DCF method provides a best effort type of service. PCF would be well suited for real-time traffic as it permits to allocate the radio channel according to application requirement. But the PCF method is not implemented in current 802.11 products. The DCF access method is based on the CSMA/CA principle in which an MC wishing to
transmit - scans the channel and waits for a period of time known as Distributed Inter Frame Space (DIFS). This transmits if the medium is still free. If the packet is correctly received, the receiving host sends an acknowledgement (ACK) frame after another fixed period of time termed Short Inter Frame Space (SIFS). If this ACK frame is not received by the sending host, then a collision is assumed to have occurred. The sending host attempts to send the packet again when the channel is free for a DIFS period augmenting for a random amount of time.

A single MC in an 802.11b cell transmits data frame. The overall transmission time is composed of transmission time, interframe transmission time, backoff time and acknowledgement time. The IEEE 802.11 basic access method is shown in Figure 4.3. It shows the cycle of the basic access mechanism for a successful transmission. After this cycle, all the stations may contend again for access to the medium. However, SIFS is always smaller than DIFS in order to prevent any other station trying to access the medium. Thus, priority is given to the current transmitting station. Collisions do not occur as a result of the inability of another station. This detects the medium as being idle for a DIFS until the end of the ACK. The back-off time following the DIFS is slotted. A station is allowed to transmit only at the beginning of each slot. This time slot size is the time required for any station to detect the transmission of a packet from another station.

DCF uses an exponential back-off scheme to determine the random back-off timing. The back-off time is determined by:

\[
\text{Backoff Time} = \text{Backoff Counter} \times \text{Slot Time}
\]

(4.2)

where the back-off counter is uniformly and randomly chosen in the range [0, CW-1]. CW is the Contention Window.
If there are multiple hosts attempting to transmit, the channel may be sensed as busy and the hosts enter a collision avoidance phase and an MC executes the exponential backoff algorithm. It waits for a random interval distributed uniformly between \([0, CW] \times \text{slot time}\). The CW varies ‘\(CW_{\text{min}} = 31\)’ and ‘\(CW_{\text{max}} = 1023\)’. The value of slot time is 20 \(\mu\text{s}\). The ACK frame length is 14 bytes. When 802.11 MCs have a packet to send, it goes through a successful transmission period as shown in Figure 4.3. When there is only one sender and one receiver, the transmission is always successful. Let the payload size be ‘\(M\)’ bytes. The maximum throughput, \(TPut_{\text{max}}\), is determined as follows:

\[
\text{TimeSlot} = \text{DIFS} + E(\text{backoff time}) + 2 \times (\text{PLCP preamble + hdr}) + (M + \text{MAChdr + FSC}) / \text{BW} + \text{SIFS} + \text{ACK} + \text{air propagation time}
\]

\[ (4.3) \]
where $E$ (backoff time) is the average of the backoff time. Using the above formula (4.1)

$$TPut_{\text{max}} = \frac{\text{Payload size}}{\text{Time Slot}}$$ (4.4)

The maximum throughput $TPut_{\text{max}}$ for single user is 3.3 Mbps.

This is to validate the analytical expression given and to gain insight into the complex backoff mechanism developed. A simple 802.11 b model under Ns2 simulator with different payload values and data rates are simulated and results are shown in Figure 4.4.

The throughput from simulation and analytical expression for single MC is shown in Figure 4.4. The maximum throughput of 802.11b with data rate of 2 Mbps, 5.5 Mbps and 11Mbps for different payload values are considered. The length of the packet has a significant impact on the capacity of 802.11b AP. The traffic used in the simulation is Poisson with fixed packet length. It is observed that the throughput is packet length (payload length) dependent, especially for higher modes. This can be explained by the fact that the MAC overheads are considerably longer when compared with the data transmission duration if packets are small. Applications requiring high bit rates are therefore likely to use larger packets.
The simulation experiment is repeated for multiple senders. The throughput –load graph is shown in Figure 4.5 for multiple senders. The load varies from 2 Mbps to 12 Mbps with the payload size of 1024 bytes. The number of clients varies from 1 to 100 for the same payload.

The payload size is 1024 bytes and ‘N’ is the number of MCs. As the number of MC increases from 1 to 10, the peak throughput increases as well. As the throughput decreases, then the number of MCs increases further. It is because the collision probability increases a lot when many clients try to transmit packets, causing increase of average backoff periods.
Figure 4.5  IEEE 802.11 b Throughput (payload size 1024 bytes, N= No. of MCs)

Figure 4.6 shows that the case of heavy load, short payload and a larger number of MCs results in very low throughput. The throughput drops dramatically for 100 senders at heavy load. The general tendency is that 802.11 shows instability as the number of active nodes is large. This is because of the fact that the throughput decreases, as the load gets very heavier.

Figure 4.6  IEEE 802.11b throughput (payload size 256 bytes, N= MCs)
4.5 CENTRALIZED SERVER - BASED CAPACITY ESTIMATION

The capacity can be defined as the peak payload throughput. The peak payload throughput of a WLAN is affected by many factors such as number of active MCs, the packet length, the traffic type and geographical location of the MC. By reviewing various throughput-load graphs, the proposed dynamic resource sharing algorithm estimates the peak throughput and the active capacity of the WLAN cell. The performance metrics considered are the throughput and number of active MCs associated. The load sharing algorithm is computed by the DRM server for every 30 msec. The distribution process will occur in the following conditions:

i) When a new MC associates an AP.
ii) When an MC sends a re-association signal to an AP.
iii) When the application requirements in the MCs are changing.

The dynamic resource sharing algorithm checks if new distribution is balanced mainly by computing the balance index ($\beta$). The balance index is calculated based on the throughput in each AP. The traffic of each MC is considered as $T_i$; the balance index is:

$$\beta_j = \frac{\left(\sum_{i} T_i\right)^2}{N_p \times \sum_i T_i^2}$$

(4.6)

$$\rho_l = \frac{\left(\sum_i T_i\right)}{N_p} + \left(\alpha \times \frac{\left(\sum_i T_i\right)}{N_p}\right)$$

(4.7)
\[ \rho_2 = \left( \frac{\sum T_i}{N_p} \right) - \left( \alpha \times \left( \frac{\sum T_i}{N_p} \right) \right) \]  

where \( \beta_j \) is the balance index of an overlapping region ‘j’. \( T_i \) is the total traffic of an AP\(_i\) in the overlapping region with other AP in the region ‘j’. where ‘Np’ is the number of APs in the overlapping region j. \( \alpha \) is the tolerance parameter that defines the balance zone width. In WLAN, AP is over loaded when its load exceeds a certain threshold value \( \rho_1 \). ‘AP’ is under loaded if its load is under the threshold value \( \rho_2 \). The balance index is calculated and a check will be allowed based on the following conditions:

- If the current AP has two or more active MCs connected.
- If the current APs throughput is more than \( \rho_1 \) and less than \( \rho_2 \).

Load sharing will be performed whenever the associated AP’s load increases by two or more MCs. The increase is at least 25% of the total load (e.g. a load increase from 20 to 22 would not cause a load sharing since two is not 25% of 20, but a load sharing would be performed if the load increases from 20 to 25). Load sharing is permitted for every 30 ms. In addition, load sharing will undergo some randomization, because multiple clients will not simultaneously react to a changing load situation. This will be done by forcing a pseudo-random delay, of 0-15 seconds, between the times in which a load sharing is determined to be necessary. When the MCs enter the zone-2, MC will enable to receive the balance index of the neighbouring APs from its current AP.
Algorithm 4.1: AP Selection algorithm

AP selections are performed on the following condition:

1. When the RSS received by the MC is lesser than the Threshold minimum value \((T_{\text{th}_{\text{min}}})\) (i.e -65dBm).

2. When the RSS value of the APs in the overlapping region is greater than the \(T_{\text{th}_{\text{min}}}\) of the current AP.
   
   // Scan for the best AP starts
   
   // DRM load sharing server broadcast the balance index to all the APs

3. Count for number of APs in the overlapping region \((N_p)\)
   
   For each AP \(i\) do
   
   Count for number of active MCs \((M_{N_i})\) associated with this AP
   
   Calculate the load (throughput) \((T_i)\)
   
   End

4. If \(M_{N_i} > 2\) AND \((T_i > \rho_1\) and \(T_i < \rho_2\)) of the target AP’s \((T_j)\)
   
   Perform roaming from current AP to target AP

   else
   
   Update AP as best AP in the BSS table in the AR
   
   Reset the load as the minimum load in the BSS table and in the AR.

   end if

5. Send re-association signal to the current AP

4.5.1 Application of Dynamic Load Sharing Algorithm

The dynamic load-sharing algorithm is incorporated in an AP as well as in the client card firmware. In the experimental setup, there are two access points AP1 and AP2. These two APs are connected to the DRM server. The MC associates itself based on the received signal strength from the APs.
The unbalanced WLAN scenario considered is shown in Figure 4.7. The description of the traffic rate and number of MCs associated with the APs are shown in Table 4.1. The average network traffic load is updated in the DRM server whenever there is a change in the MC association with an AP. The balance index is calculated and updated in the DRM server for hand-off process. There are two APs and nine MCs. Six MCs are in the overlapping region of AP1 and AP2. The MC number and its associated traffic are given inside the circle. MC1, MC2 and MC4 are associated with AP1 and the remaining MCs with AP2 in zone-1.

![Figure 4.7 Unbalanced WLAN](image)

<table>
<thead>
<tr>
<th>Access points</th>
<th>Signal Strength (-dBm)</th>
<th>MCs Associated</th>
<th>MCs in the Overlapping region</th>
<th>APs Throughput in Kbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP1</td>
<td>-72</td>
<td>1,2,4</td>
<td>3,4,5,6,7,8</td>
<td>650</td>
</tr>
<tr>
<td>AP2</td>
<td>- 62</td>
<td>3,5,6,7,8,9</td>
<td></td>
<td>1700</td>
</tr>
</tbody>
</table>
Table 4.2 Capacity-based scenario description

<table>
<thead>
<tr>
<th>Access points</th>
<th>Signal Strength (-dBm)</th>
<th>MCs Associated</th>
<th>APs Throughput in Kbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP1</td>
<td>-72</td>
<td>1,2,3,4,6</td>
<td>1150</td>
</tr>
<tr>
<td>AP2</td>
<td>-62</td>
<td>5,8,9,7</td>
<td>1200</td>
</tr>
</tbody>
</table>

The link layer load shared between two APs (AP1, AP2) is explained with ethereal capture. From this ethereal capture, it is clear that before the sharing of the load the number of clients connected to AP1 (37:67) is three and AP2 (cd:fb) is six as shown in Figures 4.8 and 4.9 respectively.

Figure 4.8 Number of Clients with 37:67 AP (RSS-based load sharing)
The RSS received from AP2 is greater than the RSS from AP1. The clients which come into the overlapping region select the stronger signal strength based AP. The number of MCs associated with AP2 is 6 and AP1 is 3.

Figure 4.9 Number of clients with cd:fb AP (RSS-based load sharing)

The average network load is 1175. ‘α’ is considered as 5%. The ρ1 is 1116.25 and ρ2 is 1233.75. The traffics associated with AP1 and AP2 are 650Kbps and 1700 Kbps, respectively. The balance index value β is 0.776. This leads to unbalanced WLAN scenario. The throughput of AP2 decreases as the MC increases. The available bandwidth of WLAN link depends strongly on the number of active MCs and their traffic. For various values of ‘α’, the threshold values are calculated. Figure 4.10 shows the threshold values for different tolerance values. The average deviation of traffic between AP1 and AP2 is 525 Kbps.
From Figure 4.10 it is observed that tolerance value should be less than 25% to achieve load balance among the APs in WLAN for the above scenario. The load is shared among the AP1 and AP2, as shown in Figures 4.11a and 4.11b.

Figure 4.11a Number of clients with 37:67 AP (Capacity-based load sharing)
As per the proposed capacity-based load sharing algorithm, the client starts its association based on the throughput capacity of the AP. When the client enters the overlapping region, it listens to the management frame signal and selects a neighbouring AP based on its capacity. The number of MCs associated with another AP(37:67) is four which is shown in Figure 4.11a. The number of MCs associated with AP(cd:fb) is five which is shown in Figure 4.11b.

![Figure 4.11b Number of clients cd:fb AP(Capacity-based load sharing)](image)

The client performs educated decision making based on the capacity of the AP before associating itself with any AP. Figures 4.11a and 4.11b show that the clients associate with the AP. The clients entering into the overlapping region decide its next point of attachment based on the balance
index and capacity of the neighbouring APS. The network resources are uniformly shared among APs based on the balance index value assigned.

4.6 DRM FRAMEWORK

The centralized architecture with a resource sharing server DRM is the ideal location to maintain and update the current state information of each AP in the campus wide network. There are a number of benefits in using this approach. The DRM server is a centralized server which maintains all the APs and MCs state for the network it monitors and controls the use of the wireless bandwidth on the entire network. The architectural framework is shown in Figure 4.12. The key idea behind the framework is the emulation of the physical mobility of a ubiquitous or mobile computing device. The software logical mobility has been designed to run on the device over various networks.

Figure 4.12 DRM framework
When the MC keeps moving from one AP to another, AP it is updated in the DRM server. The inter-AP communication is eliminated when MCs are redistributed. The QoS Data Base (QoS DB) in DRM maintains the information about each AP and state table. The QoS DB maintains the total load in each AP and per state that includes the QoS profile of the associated mobile clients. The dynamically varying parameters like number of MCs associated and throughput of each AP are updated in the DB. This information is updated at regular interval of time to mention 25ms. This does not impose heavy demands on the system and communication overhead, because only 8 bytes are dynamically varying.

4.6.1 The Components of DRM Framework

Depending on the capacity of the AP the required bandwidth is assigned to the MC.

- **QoS Data Base and Bandwidth Manager.** QoS consists of the network utilization details, application profile of the mobile clients which are in the overlapping region. The balance index of each AP is stored in the QoS database. Bandwidth Manager monitors the bandwidth availability in the network and controls the association of MC to an AP. The Bandwidth Manager calculates the balance index of each AP. Based on balance index, the value of the hand-off notification is initiated. The bandwidth manager in client side (MC) assigns the minimum required bandwidth for the incoming call. Based on the availability, the bandwidth is gradually increased. The real-time calls are given high priority based on the Tspec and priority. The balance index is calculated whenever there is a change in the number of MCs associated with each AP. The current status of the AP is sent via the
backbone network to the DRM server for performing proper load sharing among the APs.

- **Resource Redirection Object:** The network initiated hand-off takes places when the real-time traffic balance index is greater than 1 or less than 1. Based on the resource availability, the network-initiated hand-off or ongoing call redirection operations are performed. The redirection server is incorporated in the DRM server with the redirection server object (RSO). This RSO initiates AP to send a disassociation signal to the MC. When the wireless card and the APs are from different manufacturers, the network initiated hand-off is performed by the DRM server.

DRM framework consists of distributed objects in the server side as well as in the client side, which is shown in Figure 4.13. The MC may be moved and attached to an AP object in each FN. AP object offers a runtime system for executing and migrating distributed objects.

![Figure 4.13 Components of DRM framework](image)

*Figure 4.13 Components of DRM framework*
Each AP object in the runtime environment allows MCs attachment to the local DRM FN server. Bandwidth manager monitors the available bandwidth in the DRM FN server. Local bandwidth manager makes decision about redirecting the ongoing call of an MC to the nearest DRM FN server. The redirection or network-initiated hand-off is updated in the redirection server object and also in the DRM server. The physical movement of an MC from one network and attachment to another is simulated by the target applications from an AP object in the source network to another AP object in the destination network.

4.7 PERFORMANCE EVALUATION

The performance of the proposed capacity based load sharing mechanism is analyzed using NS2 simulator. The simulation is done for a rectangular area covered by four APs, as shown in Figure 4.2. Each AP operates at a raw data rate of 11 Mbps. The number of MCs considered is 100 and with the different payload size for simulation. Each MC arrival is simulated by changing the start time of each user’s network activity within the AP. The start time is followed by an independent exponential distribution. In the two classes of users, each class has a different application profile reflecting the traffic mix generated by users of the particular class.

For best effort traffic user, represents high workload that generate a burst traffic mix with QoS bounds. Real-time applications say voice connection tolerates a maximum delay of 30 ms. Traffic is generated during period at the rate of 60kbps. The voice traffic is modelled using source with exponentially distributed ON and OFF period of 300ms and 600 ms.

The local bandwidth manager monitors the network utilization in each AP. There are 60 mobile clients in the overlapping region of AP2 and
AP3. 10 MCs are associated with the remaining APs. There are 13 voice users and 17 MCs with web browsing applications connected with AP2. With AP3 there are 30 mobile clients with best effort type of traffic is connected. The utilization of AP2 and AP3 are much higher than the rest of the APs due to the higher concentration of mobile clients, as shown in Figure 4.14. The objective of load sharing algorithm is to reduce this imbalance in the network.

![Network Utilization Graph](image)

**Figure 4.14 The network utilization in each AP using RSS - based association**

The traffic intensity on each AP is fluctuated and sometimes one AP is overloaded while the other is not. From Figure 4.14, it is observed that the AP2 and AP3 are overloaded in most of the simulation time. The traffic intensity at the two APs has steadier patterns in capacity-based load sharing method than the RSS-based hand-off. The balanced network utilization is shown in Figure 4.15. The load is equally distributed between the two APs based on the balance index and the capacity of the AP. This indicates that the load balancing mechanism successfully distributes the load among the APs.
Figure 4.15 The network utilization in each AP using capacity-based association

The balance index as a function of simulation time is shown in Figure 4.16 and the balance index is 0.37 with conventional RSS-based load sharing. The balance index of network utilization is calculated based on the capacity of the AP in the proposed capacity based load sharing method. The balance index is improved to 0.82. In this method, the load is spread across the entire network and achieves greater balance and corresponding utilization. The drop ratio is defined as the ratio of the user traffic amount dropped due to buffer overflow versus the throughput.
Figure 4.16  Network utilization based on the various values of balance index

Figure 4.17 shows the drop ratio at different hand-off control methods and different average on-off periods. The absolute value of the drop ratio depends on how each AP is overloaded. It depends on the configuration of traffic generators.

Figure 4.17  Traffic drop ratio Vs Hand-off time (RSS and proposed capacity based load sharing)
It is observed that the drop ratio is generally lower compared to the conventional RSS-based method. In RSS-based load sharing mechanism the call dropping is 50% greater than the proposed capacity-based load sharing mechanism.

4.8 SUMMARY

The proposed load sharing mechanism based on the capacity of APs in campus wide WLAN is evaluated. The heuristic free capacity estimation algorithm is not complicated, but provides good estimate even when the network environment changes abruptly. Each AP and AR in the campus wide network is aware of the capacity of its neighbouring APs and ARs. The enhanced active channel scanning protocol is a tool that enables such operation. The proposed mechanism can be realized in 802.11 WLANs. Even though the load balancing mechanism is elaborated and tested in the 802.11 WLAN environments, the mechanism can be applied to other wireless packet networks. The architecture maintains centralized control information about the load on each AP.

The load sharing algorithm accommodates more users with minimum required QoS and improves the network utilization. The simulation results show that the proposed DRM framework performs well in a variety of user configurations. Balance index is used to evaluate the utilization of the network. The performance benefit of the capacity-based load sharing mechanism is presented in terms of the traffic drop ratio. It is shown that the traffic drop ratio is decreased by more than 50% compared to the unconventional method.