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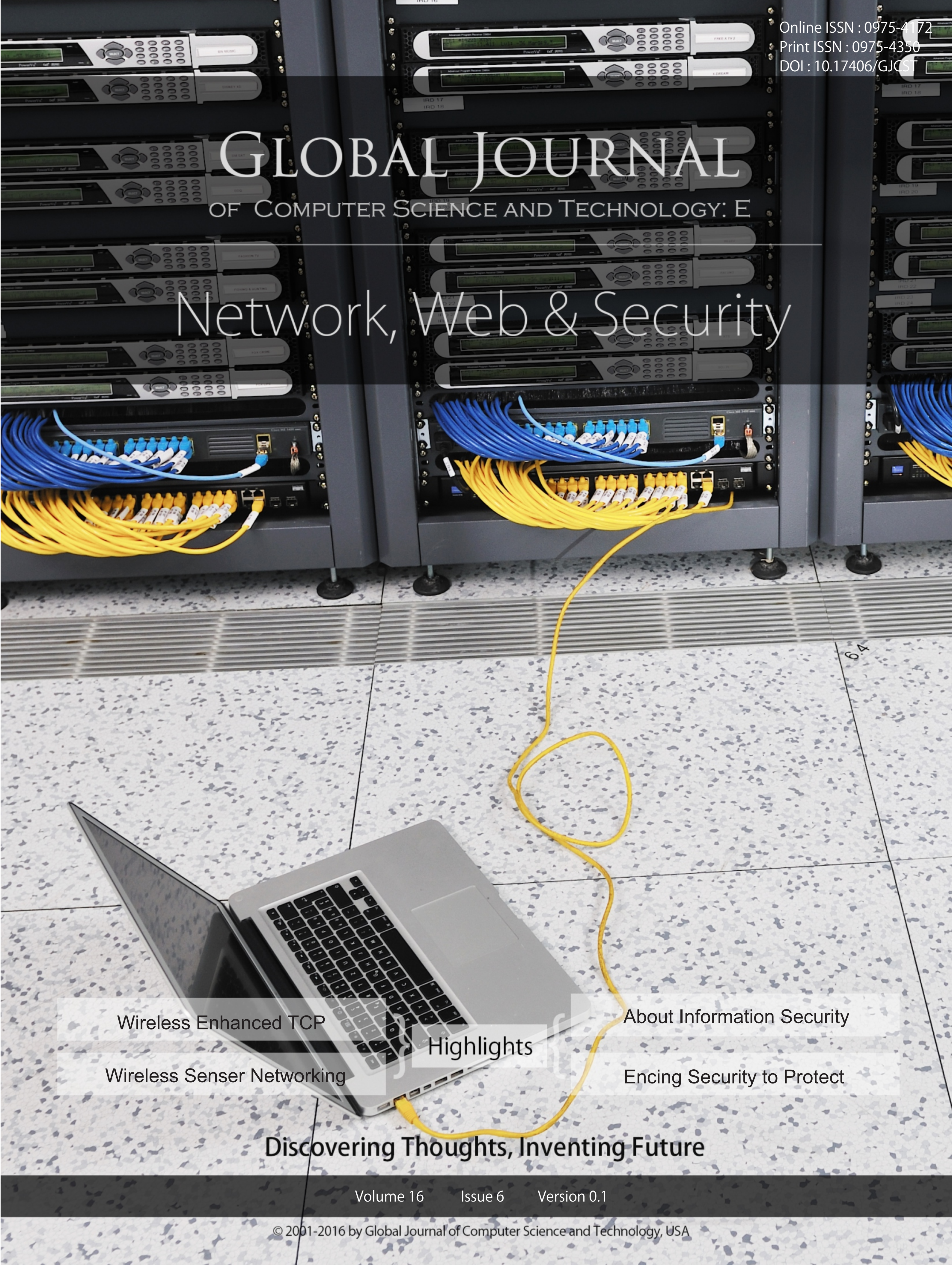

Highlights

- Wireless Enhanced TCP
- Wireless Senser Networking
- About Information Security
- Encing Security to Protect

Discovering Thoughts, Inventing Future

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We TCP-AP: Wireless Enhanced TCP-AP

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Abstract- Congestion control in wireless networks is strongly dependent on the dynamics and instability of wireless links. It is known that TCP experiences serious performance degradation problems in wireless networks. New approaches based on TCP try to overcome these problems but, although their performance is increased, they incur in congestion control errors, since they do not evaluate accurately the capacity and available link bandwidth in wireless networks. This is also the case of TCP-AP (Adaptive Pacing) that, although presenting clear advantages in wireless networks when compared to other TCP-based approaches, its performance is still lower than rate-based approache.

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WETCP-APWIRELESSENHANCEDTCP-AP

Strictly as per the compliance and regulations of:

We TCP-AP: Wireless Enhanced TCP-AP

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Abstract- Congestion control in wireless networks is strongly dependent on the dynamics and instability of wireless links. It is known that TCP experiences serious performance degradation problems in wireless networks. New approaches based on TCP try to overcome these problems but, although their performance is increased, they incur in congestion control errors, since they do not evaluate accurately the capacity and available link bandwidth in wireless networks. This is also the case of TCP-AP (Adaptive Pacing) that, although presenting clear advantages in wireless networks when compared to other TCP-based approaches, its performance is still lower than rate-based approaches.

In this paper we propose a new congestion control protocol based in TCP-AP, the Wireless Enhanced TCP-AP (WE TCPAP).This protocol relies on the MAC layer information gathere by a new method to accurately estimate the available bandwidth and the path capacity over a wireless network path. The new congestion control mechanism is evaluated in different scenarios in wireless mesh and ad-hoc networks, and compared against several approaches for wireless congestion control. It is shown that the new WE TCP-AP outperforms the base TCP-AP, with a more stable behavior and better channel utilization, and its performance gets close to the one of rate-based protocols. This is a very important result, as we show that TCP-based approaches are still able to have good performance in wireless mesh and ad-hoc networks.

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I. Introduction

Wireless networks have major factors that limit their performance, such as limited capacity and available bandwidth [5]. This results in severe congestion collapses. The support of a congestion control scheme that provides an efficient and accurate sharing of the underlying network capacity among multiple competing

applications is crucial to the efficiency and stability of wireless networks. Actively using link capacity and available bandwidth for congestion control will surely make these networks more efficient. Link capacity can vary due to a variety of factors, such as handoffs, channel allocation and, of course, channel quality. In [25] we proposed a new mechanism for measuring wireless link capacity and available bandwidth, called rt-Winf. rt-Winf uses the information already present in the network and available at the MAC layer to accurately determine the link capacity and available bandwidth. Another important characteristic of rt- Winf is that it can be used by any existing wireless equipment through a cross-layer shared database.

To address the congestion control problems of wireless networks, new congestion control techniques have been proposed, through TCP-based (AIMD - Additive Increase Multiplicative Decrease) and Rate-based schemes. In [12] we proposed new rate based congestion control protocols, based on eXplicit Congestion Protocol (XCP) [20] and Rate Control Protocol (RCP) [16], with link capacity and available bandwidth estimation through rt-Winf. The performance of these protocols is increased when compared to available wireless-enabled congestion control approaches. Although these protocols can work together with TCP, they are not able to inter-operate in an end-to-end system. Therefore, it is very important to develop a TCP-based approach that is able to efficiently work in wireless based environments, and that can provide comparable performance to rate-based approaches.

The Transmission Control Protocol with Adaptive Pacing (TCP-AP) [17] is a congestion control mechanism based on TCP [23], specifically designed for ad-hoc multi-hop wireless networks, being one of the wireless-enabled TCP protocols with better performance. TCP-AP uses a hybrid scheme between a pure rate-based transmission control and TCP's use of the congestion window. However, TCP-AP, as studied in [12], is very conservative and does not use very efficiently the medium. TCP-AP relies only on a 4-hop propagation delay technique to evaluate the link available bandwidth and capacity, not taking into consideration all the factors that influence link evaluation. New simulation results, presented in this paper, conducted in wireless ad-hoc scenarios, clearly show that TCP-AP lacks of efficiency and is not using correctly the medium; it is not evaluating correctly the parameters that are real constraints in such networks.

In this paper, an enhanced version of the work in [10], we propose a new approach to improve TCP-AP behavior, based on the integration of the on-line capacity and available bandwidth estimation technique, rt-Winf, with TCP-AP through a cross layer approach. Simulation results show that the rt-Winf integration is improving TCP-AP performance. However, it still reflects some of TCP-AP flaws, especially concerning fairness and the fact that it does not use the entire network information, as it relies on the knowledge of only 4 hop

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propagation delay. Thus, it is also important to improve its operations with the knowledge of all nodes along the path contending for available bandwidth and capacity, introducing the fairness factor and the network interaction behavior. Therefore, we propose a new approach to take this information into account. New simulation results show that the consideration of the node path effect and the integration of rt-Winf clear improve base TCP-AP performance. The simulation results were conducted on both ad-hoc and mesh wireless networks. These considerations represent a significant step towards congestion control in wireless networks, as they show that TCP-based schemes are able to efficiently work in these wireless adverse environments.

The remaining of this paper is organized as follows. Next section, section II, briefly presents the related work on congestion control mechanisms for wireless networks. Section III briefly describes the rt-Winf mechanism. Section IV presents a first evaluation of TCP-AP and addresses main TCP-AP problems. Then, section V describes how rt-Winf is integrated with TCPAP, and section VI presents a new approach for the node path contention count effect. Section VII depicts and discusses the results obtained through simulation, using mesh and adhoc scenarios with different characteristics. Finally, section VIII presents the conclusions and future work.

II. Related Work

New efforts have been made to improve congestion control in wireless networks. The Wireless Control Protocol (WCP) [24], WCP with Capacity Estimation (WCPCap) [24], Cooperative Neighborhood Airtime-limiting (CNA) [19], HOP [21], EZ-Flow [9] and Neighborhood Random Early Detection (NRED) [28] are some examples.

TCP, as the most used congestion control protocol, has also been the underlying development for some congestion mechanisms in wireless environments, such as TCP-AP [17]. More recent developments, based on rate based congestion protocols, like the eXplicit Control Protocol (XCP) [20] and the Rate Control Protocol (RCP) [16], are XCP-b [4], XCP-Winf [11] and RCP-Winf [11].

WCP is an AIMD-based rate-control protocol for multi-hop wireless networks. WCP was designed with the goal to be used on networks with arbitrary traffic pattern. During congestion, WCP signals all flows in a neighborhood of congestion and sets the control interval to the maximum Round Trip Time (RTT) of any flow in the neighborhood. WCP explicitly exchanges congestion information within a neighborhood, and all nodes within the neighborhood mark packets with congestion indicators, triggering rate reductions at the source.

WCPCap is a distributed rate controller that estimates the available capacity within each neighborhood, and divides this capacity to contending flows. With WCPCap it is evident that considering wireless congestion collectively over a neighborhood of a link is essential to any future design of wireless congestion control. WCPCap uses a sophisticated stochastic model for estimating the achievable rate region, given packet loss rates, topology, and flow information. It then allocates the achievable capacity fairly across flows, sending feedback to the sources.

CNA is a hybrid approach, in that it explicitly allocates the channel resources, but provides only imprecise feedback to the source. CNA achieves efficient airtime allocation by distributing available airtime within a wireless neighborhood, then monitoring the air utilization and dynamically redistributing unused airtime to improve overall airtime usage. The authors of CNA claim that it achieves transparency, low overhead, and responsiveness. CAN considers airtime to be the fraction of the time that a wireless link can occupy the shared channel; it does not consider, however, the time a node is waiting to transmit.

HOP is a clean-slate design of hop-by-hop congestion control. HOP tries to use reliable per-hop block transfer as a building block. HOP is referred by its authors as: fast, because it eliminates many sources of overhead as well as noisy end-to end rate control; robust to partitions and route changes, because of hop-by-hop control as well as in-network caching; and simple, because it obviates complex end-to-end rate control as well as complex interactions between the transport and link layers.

EZ-Flow is a back-pressure congestion control mechanism which does not require explicit signaling. A back-pressure mechanism flow control allows loss-free transmission by having gateways verify that the next gateway has sufficient buffer space available before sending data, thus EZ-Flow is a cooperative congestion control. EZ-flow operates by adapting the minimum congestion window parameter at each relay node, based on an estimation of the buffer occupancy at its successor node in the mesh.

NRED identifies a subset of flows which share channel capacity with flows passing through a congested node. However, it identifies only a subset of contending flows: it misses flows that traverse 2-hop neighbors of a node without traversing its 1-hop neighbors. Moreover, the mechanism to regulate the traffic rates on these flows is quite a bit complex (it involves estimating a neighborhood queue size and using RED-style marking on packets in this queue). NRED has an important disadvantage, being intimately tied to a particular queue management technique (RED) and requires special hardware for channel monitoring.

TCP-AP uses a 4-hop propagation delay technique, and it considers a hybrid scheme between a pure rate-based transmission control and TCP's use of the congestion window to trigger new data packets to be sent into the network. A TCP sender adaptively sets its transmission rate using an estimate of the current 4-hop propagation delay and the coefficient of variation of recently measured round-trip times. The 4-hop propagation delay describes the time elapsed between transmitting a TCP packet by the TCP source node, and receiving the packet at the node which lies 4 hops apart from the source node along the path to the destination.

XCP-b is a XCP based congestion control mechanism, as it tries to extend XCP for shared-access, multi-rate wireless networks by calculating, using very complex heuristics, the available bandwidth of the wireless channel. XCP-b uses indirect parameters such as queue sizes and the number of link layer retransmissions to obtain the desired measurements. XCP-b major drawback is that it becomes inefficient over highly dynamic wireless networks. In wireless environments with few nodes and less mobility, XCP-b can obtain good performance results in terms of stability, fairness, and convergence.

XCP-Winf and RCP-Winf are two new congestion control mechanisms that use MAC layer information through a cross layer communication process. The rt-Winf algorithm performs link capacity and available bandwidth calculations without interfering in the network dynamics, and without increasing network overhead; these parameters are then passed to the congestion control mechanisms based on explicit congestion notifications, XCP and RCP, to accurately determine the network status and act accordingly. The evaluation results of XCP-Winf and RCPWinf, obtained through ns2 [1] simulations, show that the rt- Winf algorithm improves significantly XCP and RCP behavior making them more efficient and stable. In [12] it was shown that these rate-based approaches have better performance in wireless scenarios when compared to TCP-based approaches. In this paper we will work on the enhancement of TCP-based approaches to target a similar performance than rate-based in end-to-end TCP compatible approaches.

Table I qualitatively compares the previous referred mechanisms along some dimensions. We will then work with TCPAP protocol, being the one TCP-based, and providing good performance when compared to other similar approaches.

III. Rt-Winf Description

The rt-Winf mechanism has been inspired by IdleGap [7], but with the purpose to mitigate IdleGap main issues and problems, and also with the intention to be compatible with all systems and being able to determine both the link capacity and available bandwidth without overloading the network. rt-Winf does not introduce any change to the OSI Model, as opposed to IdleGap, being able to obtain all the necessary times to obtain the path capacity and the available bandwidth. Another important aspect of rt-Winf, relatively to IdleGap [7], is that it does not use the DataRate value of the IEEE802.11 header [3] as the link capacity estimation.

This mechanism can be used with the Carrier Sense Multiple Access - Collision Avoidance (CSMA-CA) [13] Request To Send (RTS)/ Clear To Send (CTS) handshake enabled in the wireless communication or with probe packets when RTS/CTS packets are not present. The usage of RTS/CTS handshake is optional, but it is nowadays widely supported by all wireless equipments. Its usage, in a traditional wireless network, represents a negligible cost in terms of overhead [8].

a) RTS/CTS Packets

rt-Winf with RTS/CTS control packets enabled relies on this handshake to correctly retrieve the NAV values.

In order to evaluate the accuracy of the duration field on the IEEE802.11 header, we performed a large number of captures ($\sim$200). We concluded that the duration value on data packets is not reliable, because different sized packets have always the

Table I : Congestion Control Mechanisms Comparison.

	Cross-Layer	Control Param.	TCP based	AIMD based	Rate based	Inter. Node Feed-back	MAC Multi Rate
NRED	Yes	Buffer				Yes	
XCP-Winf RCP- Winf	Yes	Rate			Yes	Yes	Yes
WCP		Rate		Yes		Yes	
WCPCap		Rate		Yes	Yes	Yes	
CNA		Window				Yes	Yes
EZ-Flow	Yes	Buffer				Yes	
HOP		Window				Yes	Yes
TCP-AP		Window	Yes	Yes	Yes		Yes
XCP-b	Yes	Buffer				Yes	

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same duration. The RTS/CTS packets have accurate duration values, which can be used in the calculations.

With the obtained captures, it was possible to realize how each state managed the received packets. In the case of the Sender state, the node was able to capture the CTS, DATA and ACK packets. A node in the Receiver state was able to capture the RTS and the DATA packets, while a node in the Onlooker state was able to capture the complete set of packets: RTS, CTS, DATA and ACK. This different knowledge implied the conception of different algorithms for each state. Then, we proposed that each node state uses a different method to determine the Idle Rate. In the case of the Sender, it is considered the NAV of the CTS packets on the available bandwidth calculation. For the capacity calculation, it is considered the time that the channel is busy, that is, the difference between ACK time, CTS time and the duration of the occurred Short Inter-Frame Spacing - SIFS (where ACK time is the actual clock time when the ACK packet is Received, and CTS time is the clock time when CTS packet is received). The Receiver uses the NAV of the RTS packets to obtain the Idle Rate and the difference between the DATA time, RTS time and 3 times SIFS to obtain the capacity (where DATA and RTS times are, respectively, the clock time when DATA packet is received and RTS packet is received). The On looker uses the NAV value according to the existence, or not, of the RTS packet to obtain both the available bandwidth and capacity. If a node in the Onlooker state captures a CTS packet of a communication without capturing the RTS packet, this implies that the communication is suffering from the hidden nodes problem. Thus, the algorithm will only use the NAV from the CTS packet to retrieve the correct values. The total elapsed time represents the difference between the last captured ACK time and the initial time. The packet size considered is the DATA packet size. Figure 1 shows the different approaches for each state while Figure 2 represents the state diagram of the rt-Winf tool. It is possible to observe each state's transitions. When a CTS packet is captured by the Sender, it starts to evaluate the available bandwidth and capacity, while the Receiver starts this process when a RTS packet is received. The Receiver sends the calculated available bandwidth and capacity in an ACK packet to the Sender. When the Sender receives the ACK packet with that information, from the Receiver, compares it with the available bandwidth and capacity that it has previously calculated. If the information received through the ACK packet is lower than the obtained, the sender will use the available bandwidth and capacity received in the ACK packet. Otherwise, the sender will transmit using the available bandwidth and capacity calculated before. This cooperation is a great improvement when compared to IdleGap.

b) Probe Packets

If RTS/CTS packets are not present, rt-Winf can use probe packets in order to retrieve the transfer time values. Probe packets can be sent between nodes. These must be UDP generated packets with altered Frame Control IEEE 802.11 header: Type Data and Subtype Reserved. We used packets with Frame Control Type set to 10 (data) and Subtype to 1001 (Reserved). This way the Sender and the Receiver can successfully differentiate these packets from the ordinary data packets. IEEE802.11 standard defines that, for each successfully received packet, it must be sent a MAC ACK packet [3]. The whole process is very similar to the one with the RTS/CTS handshake.

The generated packets are used to retrieve the capacity and available bandwidth values, according to Equation 1 and Equation 2. These packets are only sent before a node wants to start a transmission and in the absence of traffic. This allows the system to initially determine the available bandwidth and capacity. Then, the existing traffic and the MAC layer ACK will be used to trigger the calculations. As NAV values are not correctly defined in DATA packets, rt-Winf uses clock time information to determine the busy time. So, NAV values are not considered in this specific implementation with probe packets. To be fully operational, both Sender and Receiver must be running the rt-Winf mechanism.

$$C = \frac{PacketSize}{TransferTime} \quad (1)$$

where TransferTime is equal to ACKTime□DataTime.

$$AB = 1 - \left(\frac{\sum TransferTime}{TotalElapsedTime}\right) * C \quad (2)$$

In a normal VoIP call using G.711 codec [2], the overhead introduced by this mechanism is _ 1:66%. For a flow with more than 1Mbps, the overhead is less than _ 0:15%.

IV. TCP-AP Evaluation

As TCP-AP tries to retain the end-to-end semantics of TCP, without any modifications on the link and routing layers or the need of cross layer information, as opposed to other proposals such as XCP-Winf or XCP-b, it is important to understand how it reacts under high density and high dynamic environments. TCPAP was developed with the main purpose to improve congestion control in ad-hoc wireless networks.

TCP-AP is a hybrid scheme that introduces the concept of a 4-hop propagation delay, which is the estimated elapsed time between the transmission of a packet by the source and its reception by a node that is 4-hops away. This estimation uses the Round Trip Time (RTT) of each packet. It implements rate-based packet transmissions within the TCP congestion window, and considers the standard AIMD scheme for the network congestion

State	Available Bandwidth	Capacity
On-looking	Captured RTS Packet? YES: $AB=C(1-\frac{\sum NAV_{RTS}}{\text{Total elapsed time}})$ NO: $AB=C(1-\frac{\sum NAV_{CTS}}{\text{Total elapsed time}})$	$C=\frac{\text{Packet Size}}{ACK_{Time}-CTS_{Time}-2SIFS}$
Sender	$AB=C_{Sender}(1-\frac{\sum NAV_{CTS}}{\text{Total elapsed time}})$	$C_{Sender}=\frac{\text{Packet Size}}{ACK_{Time}-CTS_{Time}-2\,SIFS}$
Receiver	$AB=C_{Receiver}(1-\frac{\sum NAV_{RTS}}{\text{Total elapsed time}})$	$C_{Receiver}=\frac{\text{Packet Size}}{DATA_{Time}-RTS_{Time}-3SIFS}$

Figure 1 : rt-Winf Algorithm

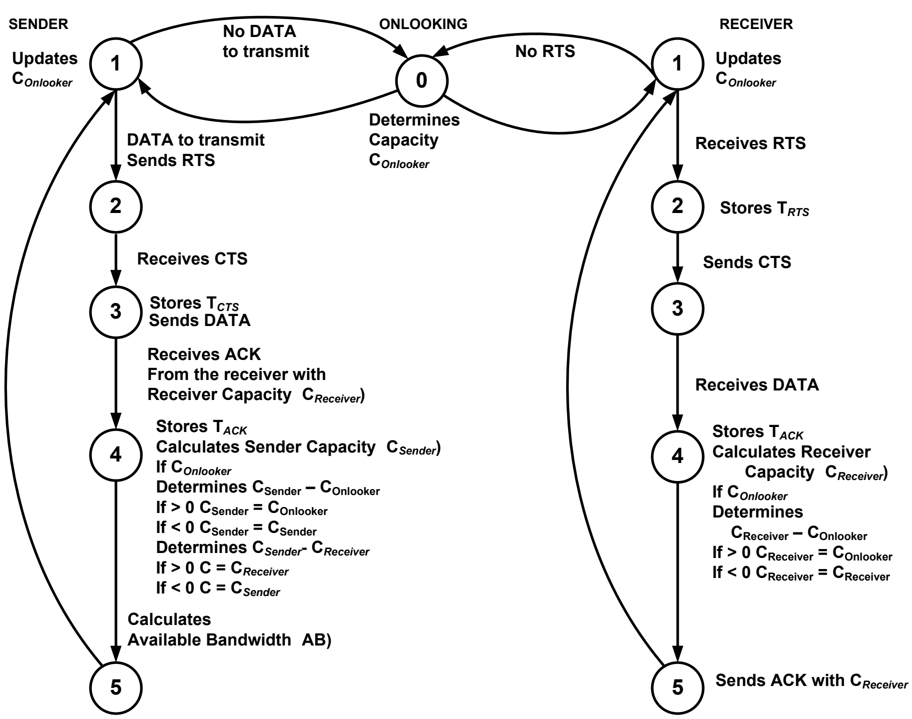

Figure 2 : rt-Winf sender and receiver state diagrams

control beyond the 4 hops. This is why TCP-AP is considered as a hybrid approach, since it is rate based as well as congestion window based.

In this section, we compare the TCP-AP approach, using ns-2 [1] simulations, against XCP-b, XCP-Winf and WCP. As WCP is also an AIMD and rate based approach, it is a good baseline for comparison purposes. The network scenario used is an adhoc network with nodes varying from 8 to 256 nodes (8, 16, 32, 64, 128, 256). Nodes are distributed randomly throughout the simulation area.

Flows also vary according to the number of nodes: with 8 nodes we have 4 flows, with 16 nodes we have 8 flows, and so on. The routing protocol used is the Destination-Sequence Distance- Vector (DSDV) [22]. The configured default transmission range is 250 meters, the default interference range is 500 meters, and the channel data rate is 11 Mbps. The performance metrics used are: the throughput, the delay of the transmitted packets, and the number of received packets. Each flow presents a FTP application simulating a large file download. The mobility is emulated through the ns-2 setdest tool to provide a random node movement pattern. We configure setdest with a minimum speed of 10 m/s, a maximum speed of 30 m/s and a topology boundary of 1000x1000 meters. All results were obtained from ns-2 trace files, with the help of trace2stats [18] scripts adapted to our own needs. All simulations last 300 seconds and the simulations are repeated 30 times with different ns-2 seed values. The mean and 95% confidence intervals are presented in the results.

From Figure 3, Figure 4 and Figure 5 we can observe that TCP-AP is the one with the worst results, with a poor performance when compared to the other approaches. From the Figures it is possible to observe that TCP-AP presents lower performance results in terms of delay, throughput and received packets. This is due to the fact that TCP-AP is not obtaining correctly the network's maximum capacity, thus not avoiding congestion and not using efficiently the medium. TCPAP is over-estimating the available rate producing congestion,

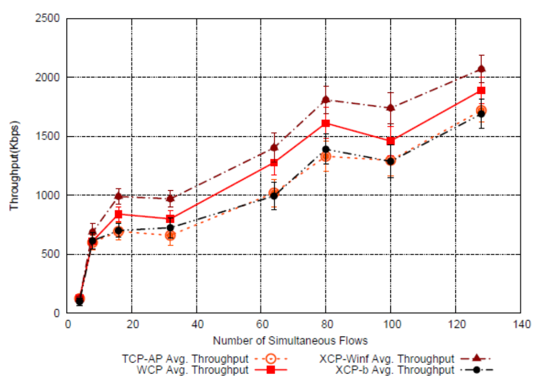

Figure 3 : Ad Hoc Scenario, Throughput

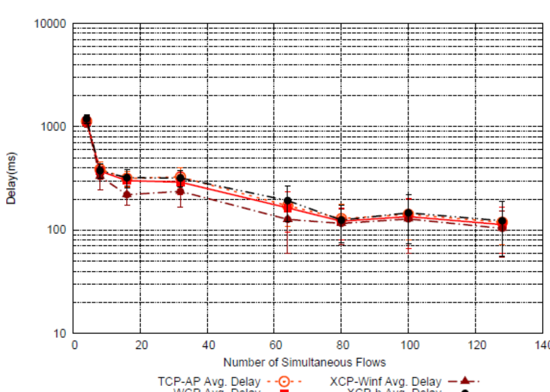

Figure 4 : Ad Hoc Scenario, Delay

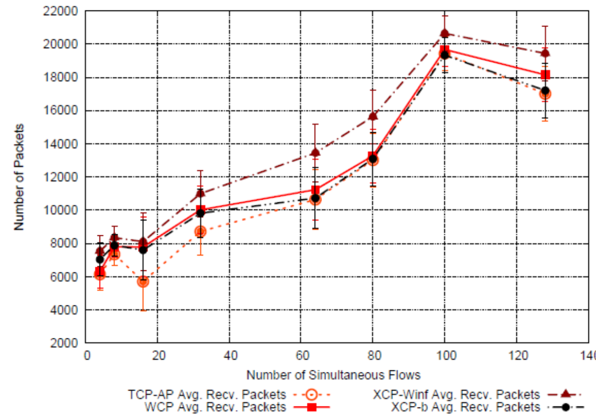

Figure 5 : Ad Hoc Scenario, Received Packets

represented by higher delays and less received packets. As TCPAP rate estimation technique is not using a reliable technique to evaluate the medium, the sender is generating more traffic than the medium supports, resulting in more packets queued, less packets in transit, hence its throughput is decreased, the delay is increased, and the number of received packets is also decreased. Another characteristic of TCP-AP is that it uses the standard AIMD process. This process is not suitable for wireless networks as it overloads the wireless channel. This behavior in conjunction with the estimation technique of TCP-AP results in inaccurate available bandwidth estimations and higher delays.

We can then conclude that TCP-AP is not evaluating correctly and not using efficiently the available bandwidth along the path, obtaining poor throughput and behaving very conservatively, resulting in a low number of received packets and high delay. TCP-AP is also not considering a fair share of the bandwidth to all flows, not using correctly the medium and having a significant degradation of performance.

From Figure 3 it is possible to conclude that XCP-Winf is using accurately the available bandwidth and link capacity information from the MAC layer, improving significantly network performance: it uses more efficiently the medium, resulting in better delay values. XCP-Winf, being a rate-based protocol, where bandwidth and capacity estimation is based on the MAC layer information, and providing node cooperation, it can effectively and quickly adapt to the links conditions, thus, improving network performance and making the network behave more fairly.

From the presented results, it is also possible to observe that WCP has better overall results than TCP-AP. WCP has a rate control mechanism that reacts explicitly to congestion, and a cooperative communication process between neighbor nodes that make WCP to react more efficiently to the network conditions, allowing to have a better medium usage.

XCP-b results are better than the ones obtained by TCPAP. However, its results are worse than the ones obtained by XCP-Winf and WCP. XCP-b, although a rate-based congestion control scheme, it uses complex heuristics based on measuring indirect quantities like queue sizes and the number of link layer retransmissions, to estimate the available capacity. Those direct measures are overestimating the available capacity and bandwidth, specially when the network is heavily utilized, resulting in performance degradation and instable behavior. This is shown by the good XCP-b results when the number of flows is relatively small.

Although TCP-AP scheme is a hybrid scheme of sender rate control and congestion control, TCP-AP is based on two assumptions: the rate control mechanism is efficient and the contention and spatial reuse is accurate. These assumptions may not be effective in some network topologies. This assumption is clearly not effective in high mobility wireless scenarios. The conservativeness of TCP-AP is observed in its throughput (Figure 3) results and received packets (Figure 5). While having good throughput results, they are obtained with less received packets. This is a consequence of using the hybrid scheme for congestion control.

TCP-AP is not using information from the MAC layer: it relies on the transmission of packets at the transport layer. This principle is failing effectively to transmit packets at the MAC layer, making it reacting with poor performance in terms of received packets. As TCP-AP is not relying in an effective available bandwidth and link capacity estimation mechanisms at the MAC layer, the sender assumes that the bandwidth of all links in the path is the same and the medium usage is clearly not efficient. Due to its 4 hop propagation delay assumption, TCP-AP available bandwidth and link capacity estimation is not considering the nodes along the route path, which are the nodes that contend from the available bandwidth along the path. This is specially relevant when we are dealing with a high density and high mobility network, introducing inaccuracy and lack of fairness on the TCP-AP performance.

V. Tcp-ap with Rt-Winf

The base TCP-AP considers network and transport layer information (RTT values) for its capacity and available bandwidth estimations. This technique is not very accurate introducing inefficiency to the congestion control process. This was already shown in wired networks, in works [15] and [6], which introduced packet dispersion to analyze the capacity and available bandwidth estimations. This problem is even increased when dealing with wireless networks, since their variation and instability increase.

We claim that it is important to have a cross-layer approach for bandwidth and link capacity estimation: using information provided by several layers, including the MAC layer, it is expected that the congestion control mechanism is more reliable and effective. Therefore, we propose TCP-AP with rt-Winf, which relies on the main functioning principles of TCP-AP, but uses information provided by rt-Winf [25] to determine the link capacity and available bandwidth.

As rt-Winf obtains the link capacity and available bandwidth in the MAC layer, this information has to be accessed by TCPAP through a cross-layer communication process. One example of such cross-layer communication process is the MobileMan [14] cross-layered network stack. This communication system uses a shared database architecture, with a set of methods to get/insert information from/in the database accessible by all protocol layers.

Our approach, when compared to the base TCP-AP, changes the way each node calculates the 4-hop delay (FHD) and the average packet queuing delay per node (t_q), with the rt-Winf link capacity and available bandwidth values. Thus,

$$t_q = \frac{1}{2}\left(\frac{T_{RTT}}{h} - \frac{S_{data} - S_{ack}}{C_{Winf}}\right) \tag{3}$$

where T_{RTT} represents the RTT value, h represents the number of hops between the sender and receiver, Sdata is the size of the data packet and Sack is the size of the ACK packet. Finally, CWin f corresponds to the rt-Winf link capacity. The previous equation allows to update the 4-hop delay (FHD) by:

$$FHD = 4 \times \left(t_q + \frac{S_{data}}{AB_{Winf}}\right) \tag{4}$$

where AB_{Winf} is the *rt-Winf* available bandwidth.

Considering that a high density and high mobility network suffers from a large number of collisions, *rt-Winf* mechanism was updated with the effect of collision probability. Notice that *rt-Winf* works on the IEEE 802.11 [3] MAC layer that uses the Distribution Coordination Function (DCF) as the access method. This function is based on the CSMA-CA principle, in which a host wishing to transmit senses the channel, waits for a period of time, and then transmits if the medium is still free. If the packet is correctly received, the receiving host sends an ACK frame after another fixed period of time. If the ACK frame is not received by the sending host, a collision is assumed to have occurred. Therefore, to improve efficiency and reliability of TCPAP with *rt-Winf*, collision probability is accounted for. When a sender cannot transmit due to collision, the back off mechanism is activated. This mechanism is also consuming bandwidth that is not really used by the channel. This unused channel contention bandwidth can be allocated as an extra bandwidth. This extra bandwidth, C_{extra}, is defined by:

$$C_{extra} = (\frac{T_{DIFS}}{T_{backoff}} T_m) \times W \quad (5)$$

where T_{DIFS} is the IEEE 802.11 DCF Inter frame Space, $T_{backoff}$ is the medium backoff time, T_m is the time between the transmission of two packets and W is the channel bit rate. The collision probability (P_c) can then be defined as $1\text{-}C_{extra}$. Applying this result to the *rt-winf* inference mechanism, the available bandwidth (AB) becomes:

$$AB = P_c \times AB_{Winf} \rightarrow AB = (\frac{1 - C_{extra}}{W}) \times AB_{Winf} \quad (6)$$

Algorithm 1: *WE TCP-AP* Source Node Operations.

foreach *ACK packet* **do**
  Node estimates node path (NP) from MAC ACK
  Node computes NP-1
  if $NP - 1 <= 4$ **then**
    $HD = FHD$;
  else
    $R = \frac{NP+1}{NP \times W}$;
    $HD = R \times FHD$

VI. Wireless Enhanced TCP-AP - we TCP-AP

In a wireless network, nodes along a multi-hop path (NP) contend among themselves for access to the medium, i.e, they contend for available bandwidth. To obtain the contention of nodes along the path, it is important to know the contention count of each node. The contention count at a node is the number of nodes on the multi-hop path that are located within carrier sensing range of the given node, and can be obtained as described in [26]. Considering that TCP-AP only implements adaptive pacing at the sender side, available bandwidth and capacity estimation must take into consideration nodes along the path between the source and the sink, that is, the bandwidth contending successors and predecessors on the route path. However, this is not true in TCP-AP, since it is considering only 4-hop neighborhood for these contending estimations. Therefore, to eliminate this inaccuracy, we changed TCP-AP with rt-Winf to use a coefficient (R is the unused bandwidth) that represents the proportion of bandwidth contention among other nodes on the path, thus, maximizing the throughput while guaranteeing fairness. If we consider NP as all nodes along the path and if NP□1 is equal or less than 4, then TCP-AP with rt-Winf is kept unchanged; if NP□1 is higher than 4, then the FHD equation, now called the hop delay (HD) is updated to:

$$HD = FHD \times R \quad (7)$$

Where

$$R = \frac{1 + \frac{1}{NP}}{W} \quad (8)$$

then,

$$HD = 4 \times (\frac{NP+1}{NP \times W}) \times (t_q + \frac{S_{data}}{AB_{Winf}}) \quad (9)$$

Algorithm 1 shows the pseudo-code of an WE TCP-AP source node.

As R represents the unused bandwidth due to node contention and queue management along the path, it introduces the fairness factor allowing an improved fair share of the available bandwidth among all contending nodes, not only the ones within the 4-hop propagation delay, improving WE TCP-AP behavior and making it behave more accurately.

VII. Simulation Results

This section presents simulation results of our proposed congestion control mechanism. The results are obtained using the ns- 2 simulator [1]. The underlying rt-Winf mechanism is configured with enabled RTS/CTS/ACK handshake packets. The proposed mechanism is evaluated against the base TCP-AP protocol, WCP and XCP-Winf. Two different scenarios were used: the same ad-hoc scenario presented in section V, and a wireless mesh topology scenario that is presented to understand how the new proposals behave under different conditions. This scenario is

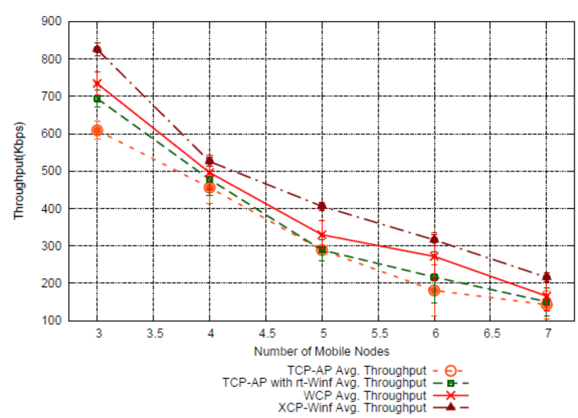

Figure 6 : 16 Mesh Nodes - Variable Number of Mobile Nodes, TCP-AP with rt-Winf Throughput

defined with a grid of 16 mesh nodes and a variable number of mobile nodes. The number of mobile nodes changes from 3 to 7. For the data transmissions, it is used a File Transfer Protocol (FTP) application with packets of 1500 bytes. It was used the same mobility tools and trace scripts as in the TCPAP evaluation in section V. First, we analyze the results of the TCP-AP with rt-Winf, and then we analyze the results with the enhanced contention approach, the complete WE TCP-AP. Again, all simulations last 300 seconds and the simulations are repeated 30 times with different ns-2 seed values. The mean and 95% confidence intervals are presented in the results.

a) TCP-AP with rt-Winf

Figure 6, Figure 7 and Figure 8 show the performance metrics for the mesh topology scenario. From the observation of the results, it is possible to conclude that TCP-AP with rt-Winf integrated clearly improves TCP-AP performance behavior, but its performance is still below the one of XCP-Winf. TCP-AP with rt-Winf is only taking into consideration rt-Winf information for the last 4 hop nodes; TCP-AP, as opposed to XCP-Winf, uses the standard behavior of TCP for the other hops of the network, considering that all links have the same bandwidth.

Another important drawback of TCP-AP with rt-Winf is the fact that it does not have a fairness module, resulting in a more conservative and less fair operation. The fairness module is a native mechanism used by XCP-Winf. As TCP-AP with rt-Winf uses, in most of its functioning, the standard AIMD process of TCP and is not entirely using the available information between the source and the sink, its results are not similar to the ones of XCP-Winf. XCP-Winf also relies on the overall node path interaction, using a cooperative approach to obtain the best available bandwidth and link capacity usage. In TCP-AP with rt-Winf, as the number of nodes or flows increases, it uses conservative mechanisms, reducing its performance especially concerning received packets.

WCP obtains better results than TCP-AP with rt-Winf. WCP uses explicit congestion information between nodes that trigger rate changes, making it behave with good efficiency and fairly. As XCP-Winf uses the rt-Winf mechanism as its base estimation tool, it has a precise feedback communication mechanism between all the nodes along the path using total network cooperation, and it is able to better use the channel with less losses, resulting in a more efficient and accurate behavior.

Figure 9, Figure 10 and Figure 11 show the results for the ad-hoc topology scenario. In this scenario, we can see that rt- Winf clearly improves TCP-AP performance, compared to TCPAP and WCP. However, TCP-AP with rt-Winf still reflects some

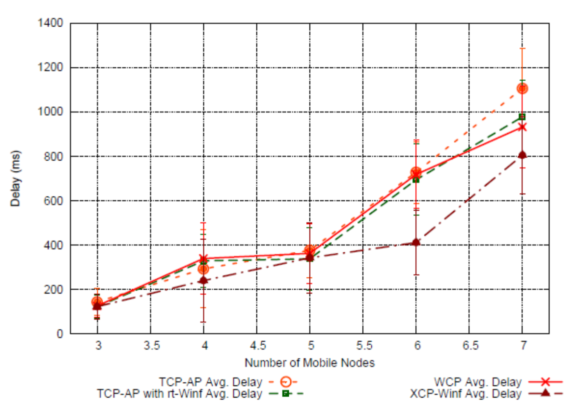

Figure 7 : 16 Mesh Nodes - Variable Number of Mobile Nodes, TCP-AP with rt-Winf Delay

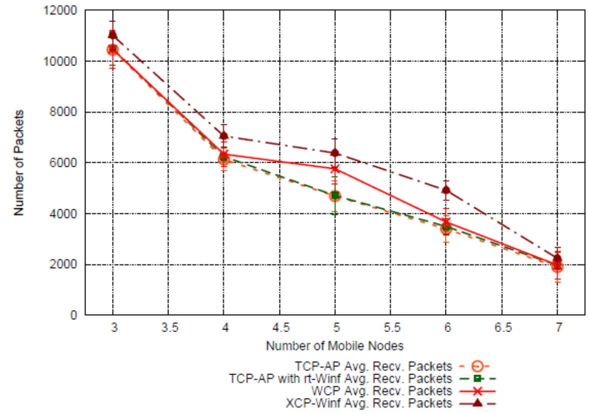

Figure 8 : 16 Mesh Nodes - Variable Number of Mobile Nodes, TCP-AP with rt-Winf Received Packets

of TCP-AP flaws. With the increase of the number of flows, TCP-AP with rt-winf becomes less efficient, as it is only relying on the 4-hop propagation delay and the AIMD process, not considering the entire network topology for its rate changes. This is shown by being able to obtain good throughput results, compared to XCP-Winf, when the network is not heavily loaded. When increasing the number of nodes, number of flows and the mobility density, TCP-AP with rt-Winf becomes more inefficient, reducing significantly its throughput and the number of received packets when compared to the other approaches. TCP-AP with rt-Winf is also more fair than TCP-AP to mobility changes, but it still shows an unstable behavior. WCP has overall good results: although being an hybrid approach, it uses a more effective congestion and control interval, as all nodes within the congestion neighborhood mark packets with congestion indicators, triggering rate reductions more efficiently at the source.

b) WE TCP-AP

This section presents the simulation results of WE TCP-AP in both mesh and ad-hoc scenarios.

Figure 12, Figure 13 and Figure 14 show the performance metrics. Figure 12 shows how throughput is improved in WE TCP-AP. The WE TCP-AP throughput values are between _20% and _ 40% better than the ones with the standard TCP-AP, and between _ 14% and _ 25% better than TCP-AP with rt-Winf.

In terms of received packets, as observed in Figure 14, it is possible to see that WE TCP-AP is able to use more efficiently

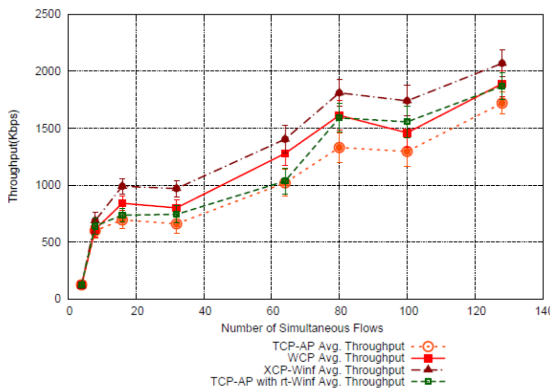

Figure 9 : Variable Number of Flows Ad-Hoc Scenario, TCP-AP with rt-Winf Throughput

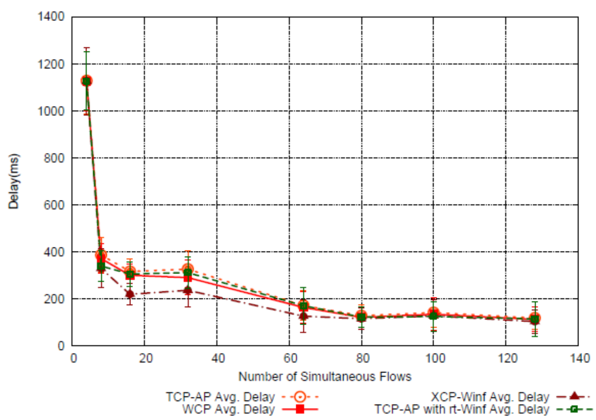

Figure 10 : Variable Number of Flows Ad-Hoc Scenario, TCP-AP with rt-Winf Delay

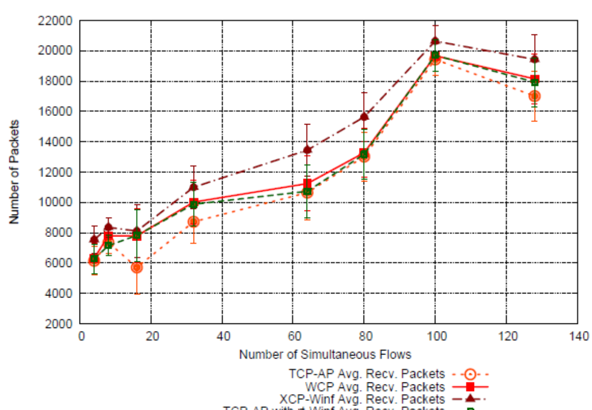

Figure 11 : Variable Number of Flows Ad-Hoc Scenario, TCP-AP with rt-Winf Received Packets

the medium, as it can transmit more packets increasing overall throughput results. More received packets means that more transmissions are allowed, thus WE TCP-AP is behaving more fairly. With these improvements, the network can transmit with a higher rate and incurring less losses. As more packets are transmitted, more throughput is obtained and the medium is better and more efficiently used. This allows to have a more stable and fair behavior. It is, however, important to say that

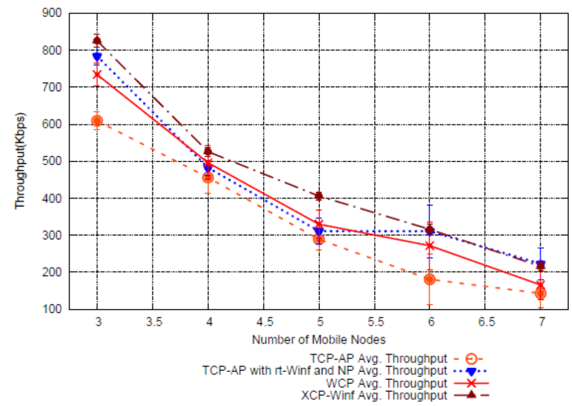

Figure 12 : 16 Mesh Nodes - Variable Number of Mobile Nodes, WE TCP-AP Throughput

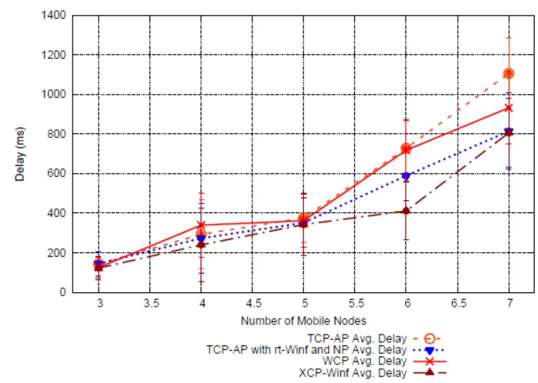

Figure 13 : 16 Mesh Nodes - Variable Number of Mobile Nodes, WE TCP-AP Delay

TCP-AP has a very conservative behavior, as it allows a good throughput with less received packets. This behavior is clearly improved with WE TCP-AP. The delay values, in Figure 13, are also reduced reinforcing the fact that this new proposal is much more efficient and fair, with better medium usage, than the base protocol. The better results are still obtained by XCP-Winf, but it is closely followed by WE TCP-AP: it is clear that the use of MAC layer information and the node path contention count is making WE TCP-AP to react more efficiently to the network dynamics.

Figure 15, Figure 16 and Figure 17 show WE TCP-AP results in the ad-hoc network scenarios, as defined before. From the obtained results, it is possible to observe that TCP-AP with rt- Winf integrated and node path contention clearly improves base TCP-AP performance behavior. It is possible to conclude that, with more nodes and flows in the network, WE TCP-AP is more efficient than the standard TCP-AP proposal. XCP-Winf uses an explicit congestion control notification mechanism for an accurate rate change and relies in the link capacity at the MAC layer information; in this scenario, it is also able to operate more efficiently than

WE TCP-AP, specially concerning the number of received packets. WE TCP-AP is not a pure rate-based congestion control mechanism with explicit feedback, thus it is not reacting quickly to network changes. The AIMD process of WE TCP-AP still introduces some instability and behavior problems.

WE TCP-AP, as opposed to TCP-AP, is considering a fair share of the unused bandwidth, that results from the use of the node path contention count, making it behave more efficiently and

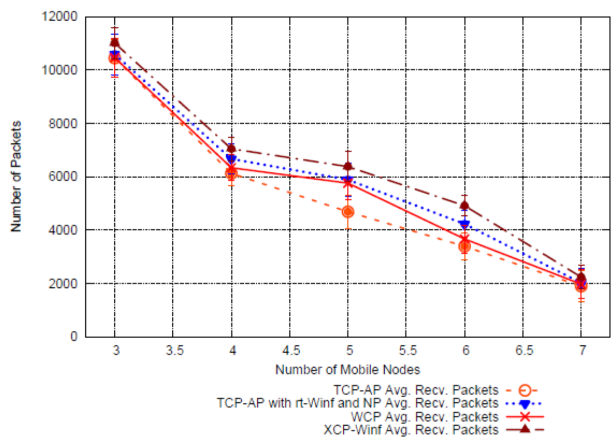

Figure 14 : 16 Mesh Nodes - Variable Number of Mobile Nodes, WE TCP-AP Received Packets

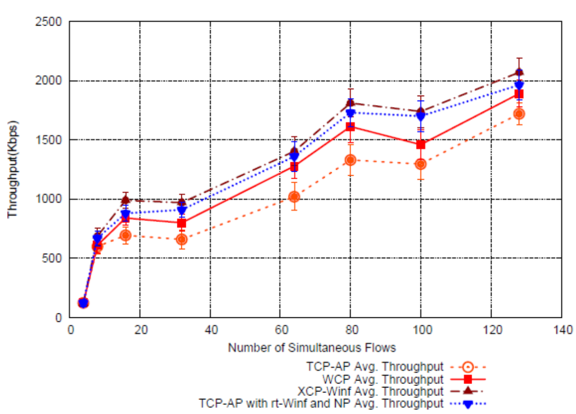

Figure 15 : Variable Number of Flows Ad-Hoc Scenario, WE TCP-AP Throughput

allowing it to increase the flow rate, and consequently increase the number of received packets and reducing the overall delay. We can conclude that the available bandwidth and capacity evaluation of rt-Winf, estimated at the MAC layer, the collision probability and the node contention count factors are relevant and surely make WE TCP-AP behave more consistently and with better channel utilization, which also leads to less channel losses. Comparing both ad-hoc and mesh results, it is evident that WE TCP-AP results have better performance on the ad-hoc environments; this is due to the fact that TCP-AP was developed having in mind ad-hoc networks; moreover, its underlying hybrid scheme is better suited for ad-hoc networks with high density and mobility.

For a better understanding of how the factor R is influencing WE TCP-AP behavior, a central network chain scenario was defined. It must be noted that the standard TCP-AP 4-hop propagation delay assumes that "every fourth node can transmit in a multi-hop chain topology". On this scenario, it was used the proposed version of WE TCP-AP and the TCP-AP with rt-Winf version. The chain scenario consists of a network divided in three parts. Figure 18 depicts the network topology with four chains of nodes. The application used simulates a FTP transfer. The results are shown in Figure 19, Figure 20 and Figure 21. The presented results clearly show that, with the increase of the chain nodes, TCP-AP with rt-Winf has worse results: it becomes less efficient an less accurate, as it is not considering the unused share of bandwidth. WE TCP-AP, on the other hand, is more accurate, since the available bandwidth and capacity

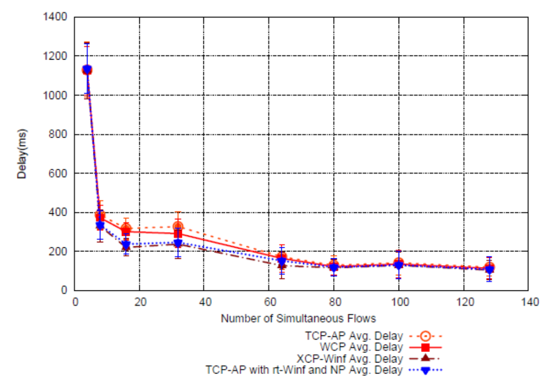

Figure 16 : Variable Number of Flows Ad-Hoc Scenario, WE TCP-AP Delay

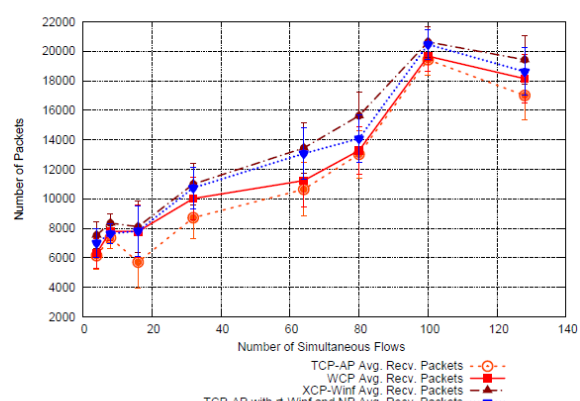

Figure 17 : Variable Number of Flows Ad-Hoc Scenario, WE TCP-AP Received Packets

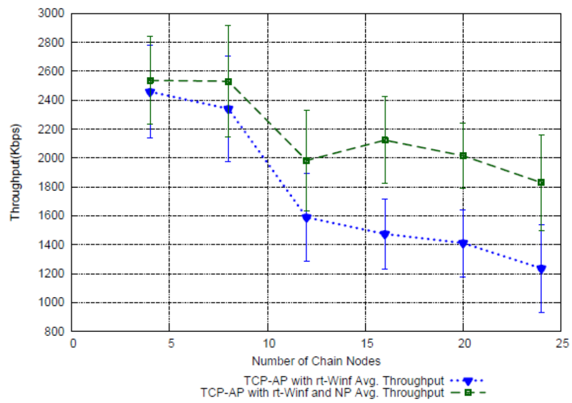

Figure 19 : Chain Scenario, Throughput

estimation are considering the nodes along the path between the sources and the sinks nodes, that is, the contending successors and predecessors on the route path. It is then shown that the factor R, which represents the proportion of bandwidth contention among other nodes on the path, is maximizing the throughput while guaranteeing fairness.

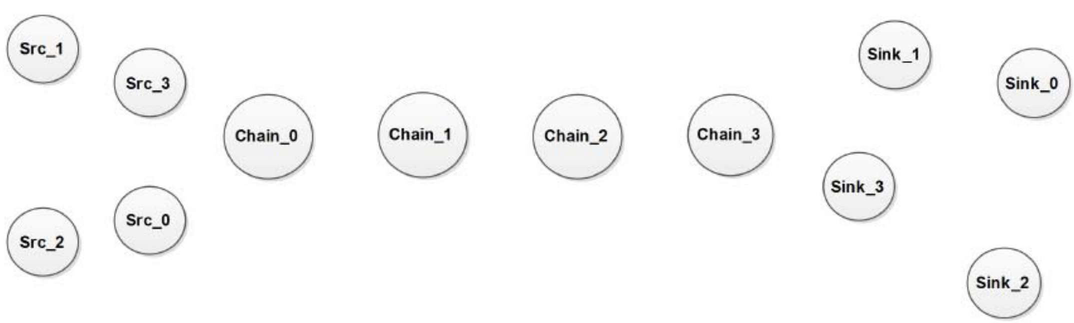

Figure 18 : Chain Scenario

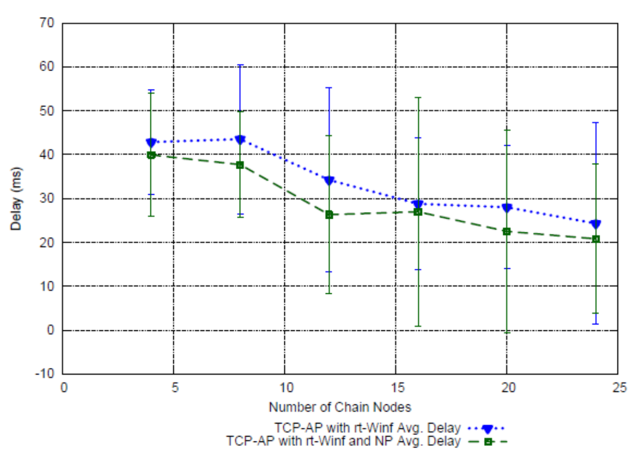

Figure 20 : Chain Scenario, Delay

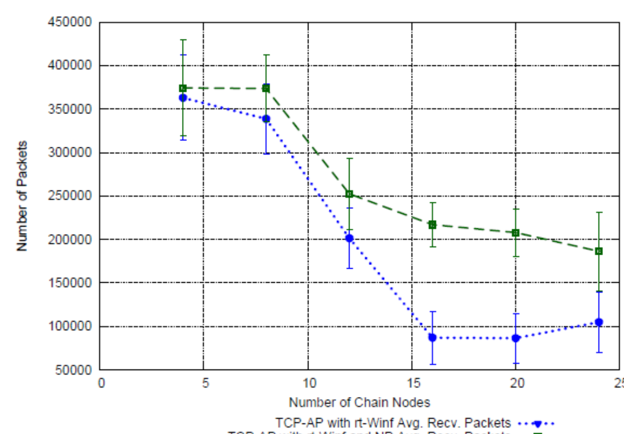

Figure 21 : Chain Scenario, Received Packets

c) Utility

As TCP is the most used and deployed congestion control protocol on the Internet, it is important, as described on [27], to analyze how WE TCP-AP flows interact and compete with TCP. To analyze how friendly WE TCP-AP is, we use the average data rate over time for each flow, thus allowing to observe how bandwidth is being managed between TCP and the WE TCPAP proposal. This is called the utility of a congestion control mechanism against TCP.

The evaluation scenarios consist of a 1000mx1000m area, divided in three distinct parts. In the left side area, with 250mx250m, we have two mobile source nodes: one source node is configured to use only the standard TCP, and the other source node uses the WE TCP-AP congestion control mechanism. The right side of the area has the same characteristics of the left area but, instead of source we have sink nodes. Finally, the middle area, with 500x500m, has two mobile nodes configured with the WE TCP-AP mechanism as their main congestion control mechanism. The average data rate is measured in these two nodes, as they will have TCP and WE TCP-AP-like flows competing.

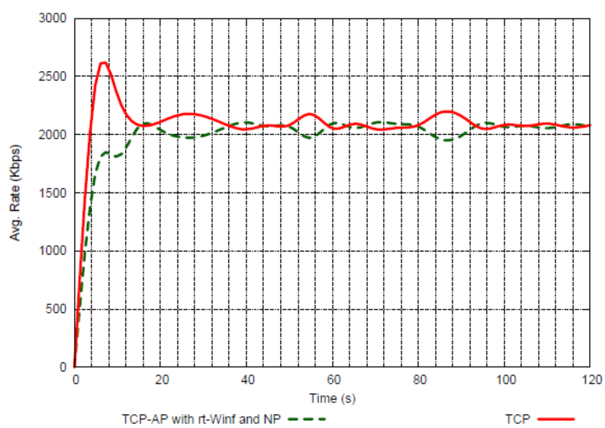

Figure 22 : Utility Results, 2 x 8 Flows

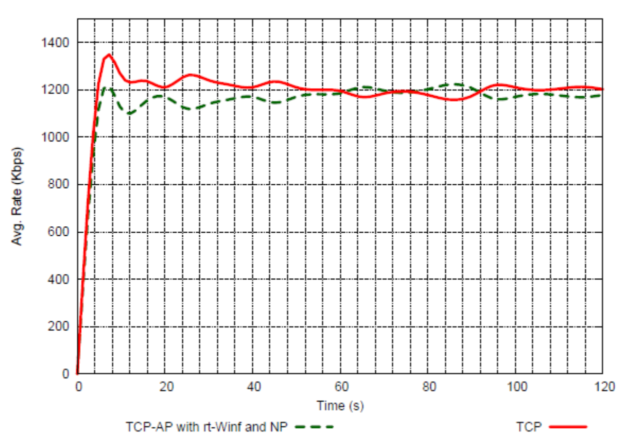

Figure 23 : Utili Results, 2 x 16 Flows

We have defined two evaluation scenarios. One scenario contains each source generating 8 FTP flows, with packets of 1500 bytes. In the other scenario we have each source generating sixteen FTP flows. The simulations last 120 seconds. The obtained results are shown in Figure 22 and Figure 23.

From the utility results, it is possible to observe that, on both situations, the TCP flow grows faster and gains more bandwidth on the beginning. However, as WE TCP-AP is a hybrid approach, keeping unchanged the AIMD process of TCP and being updated with an evaluation and measurement process, it quickly adjusts to TCP behavior, thus, allowing a fair share of network resources.

VIII. Conclusions and Future Work

This paper proposed a new approach to congestion control, based on TCP-AP and a new wireless inference mechanism, rt- Winf. rt-Winf measures the wireless capacity and the available bandwidth of wireless links, and feeds this information to TCPAP, through a cross-layer communication process. Two different improvements were also considered on the new approach: the awareness of collision probability on the available bandwidth approach, and the node path contention count on the 4-hop propagation delay approach.

The performance evaluation study of the proposed congestion control mechanism shows that the integration of rt-Winf and the proposed enhancements allow to make TCP-AP behavior more efficient, resulting in better overall network performance. Using rt-Winf, that works in the MAC layer, it is possible to perform link capacity and available bandwidth calculations without interfering in the network dynamics, allowing to significantly improve TCPAP performance. The node path contention also significantly improves TCP-AP performance, with more noticeable results for larger chains of nodes. This congestion control mechanism is denoted as WE TCP-AP.

As future work, we plan to work on the wider evaluation of the congestion control approach, using for example, new comparison baselines and protocols. An effort will also be made in creating a future test bed for understanding how the proposed mechanism is affected by different conditions and parameters, in a real environment.

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Enhancing Security to Protect E-Passport against Photo Forgery

By Prof. Dr. Alaa Hussein Al - Hamami & Muna Amin Alabed Alhafez
Amman Arab University Amman

Abstract- Electronic Passport (e-passport) is one of the results of the electronic revolution in the World; since the passport is the document of the person in terms of identity and nationality and is the property of the country. One of the most important challenges is to protect this document from forgery. The common forgery for the passport is replacing its holder photo. The proposed system concentrates on the security part of the e-passport. It consists of two parts; the first part is hiding of the security code by using steganography and storing the same code in the RFID tag by the issuing country of the e-passport. The other part will be operated at the control point of the destination country to make sure of the e-passport validity by checking the hidden code using NFC and verify it with the one in the RFID tag. If the two values are equal, then the system will compute a key using Diffie-Hellman Key Exchange. This key will be used to read the secret information in the tag.

Keywords: steganography, nearest field communication, radio frequency identification, and epassport.

GJCST-E Classification : *D.4.6, H.2.7, K.4.4, I.4.8,*

ENHANCINGSECURITYTOPROTECTE-PASSPORTAGAINSPHOTOFORGERY

Strictly as per the compliance and regulations of:

Enhancing Security to Protect E-Passport against Photo Forgery

Prof. Dr. Alaa Hussein Al - Hamami [α] & Muna Amin Alabed Alhafez [σ]

Abstract- Electronic Passport (e-passport) is one of the results of the electronic revolution in the World; since the passport is the document of the person in terms of identity and nationality and is the property of the country. One of the most important challenges is to protect this document from forgery. The common forgery for the passport is replacing its holder photo. The proposed system concentrates on the security part of the e-passport. It consists of two parts; the first part is hiding of the security code by using steganography and storing the same code in the RFID tag by the issuing country of the e-passport. The other part will be operated at the control point of the destination country to make sure of the e-passport validity by checking the hidden code using NFC and verify it with the one in the RFID tag. If the two values are equal, then the system will compute a key using Diffie-Hellman Key Exchange. This key will be used to read the secret information in the tag.

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I. Introduction

Speed, time and security components have become the most important success factors in any developed system and at the same time number of travellers around the world is increasing continuously. Since the airports are the main ports of the States, the movement of passengers through the gates in order to verify the identity of travellers requiring high accuracy to make sure that no forgery and no impersonate the passport holder.

E-passport technology (Kundra & et al, 2014) has become an important substitution of the traditional passports in the access controls intended for travel around the world since the authentication of the passenger using it becomes faster, more secure, and more preserving of the privacy of passengers (Juels& et al, 2005). In addition, the forgery processes of the traditional passports are not available in the e-Passports.

Some of these challenges are cloning, and spoofing of RFID. Other challenges are the impersonation and eavesdropping attacks on the reader devices. The communication between the Tag and inspection system are controlled by the cryptography techniques to overcome these types of attacks.

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II. Literature Reviews

An Anti-Cloning and Anti-Skimming Protocol (ACASP) (Saeed & et al, 2009) has been proposed to counter the vulnerabilities of Basic Access Control and Active Authentication with respect to RFID chip skimming, and cloning. It takes advantage of public-private key pair stored in the chip and the optional data storage capacity in Machine Readable Zone (MRZ) of the passport. An advantage of ACASP is that it can be implemented without any modifications in the hardware of the reader and the Tag. And there is no need to make changes in the Logical Data Structure (LDS) of the RFID chip.

(Benssalah et al., 2012) proposed an authentication algorithm based on elliptic curves ElGamal encryption (ElGamal, 1985). The main benefits of this protocol are that fights against four types of security threats; Simple power analysis and timing analysis, Passive attacks, Man-in-the middle, and Replay attack.

Al-Hamami (Al-Hamami & Al-Anni, 2005A) suggested some new authentication method by using a firm authentication method by extracting some features for the original name of the holder with the passport number and digest them in a form, by applying some techniques, that can be hidden in the passport's photo.

A method for e-passport verification depending on watermarking (Wang & et al, 2013) has been proposed which is composed of multimodal biometric feature and the parity check code of that multimodal biometric feature. The need for the multimodal biometric feature is to verify the passport owner, and the parity check code is for the verification of the integrity of the passport itself.

The main idea in (Peeters et al., 2014) is to use mutual authentication protocol pattern instead of bootstrap from the low entropy value in MRZ. In order to protect the e-passport holder's privacy, terminal authentication takes place first, and then the e-passport authentication which uses Sigma-I or IBIHOP+.

(Al-Hamami & Al-Anni, 2005B) suggested a protocol to solve the problem of e-passport verification and authentication. (Al-Hamami & Al-Anni, 2005) suggested to use an invisible watermark to be hidden in the passport headshot to solve the problem of the passport verification, and they also suggested to use Diffie–Hellman to solve the problem of mutual

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authentication between the e-passport and the inspection system.

III. Statement of Problem

The aim of this paper is to propose a method to enhance the security part of the epassport. Since the epassport is an international issue, we tried to use an international security method. This will be done by using an international prime number code assigned for each country, using a secret code for every country for privacy, and using unified methods Diffie-Hellman key exchange to create the exchanged key and steganography method to hide the secret code for privacy and authentication (Hariri & et al, 2011).

IV. The Proposed Solution

This paper aims to use a global method for greater security of epassport at airports check points. This depends on giving each country its own prime (what's wrong in this key? The main idea of Diffie-Hellman and ElGamal is to use a large prime number) number. This number should be a prime number or it will be converted to a prime number so that it can be used in the proposed framework of scrutiny and increased passport security.

In general, the proposed method is to use Diffie-Hellman key exchange Algorithm to share a private key between the Tag and the Inspection System (IS). The inspection system will use NFC technology in the reader devices which allows the reader to communicate with RFID Tag without needing to touch the devices together or go through multiple steps setting up a connection and allows the exchange of information between devices through short-range waves about four centimeters a maximum so as to prevent contact by mistake to other devices.

A calculated value will be hidden in the passport photo by using steganography method. When, the passport holder arrives the access control, and during the Diffie-Hellman key exchange process, the reader obtains a value from the Tag. Then, the reader scans the passport photo and compares the value hidden in the photo with the obtained value; if they were identical, the reader can make sure that the Tag is not cloned and it is authenticated.

After the mutual authentication process between the Tag and the reader, and after each of them calculates the secret key using Diffie-Hellman, the Tag sends the identification data (which are stored in plaintext format) of the passport holder using asymmetric encryption algorithm (ElGamal encryption system) to convert the plaintext into cipher-text and then the reader reconverts the cipher-text into plaintext. Figure 1 explains the proposed framework.

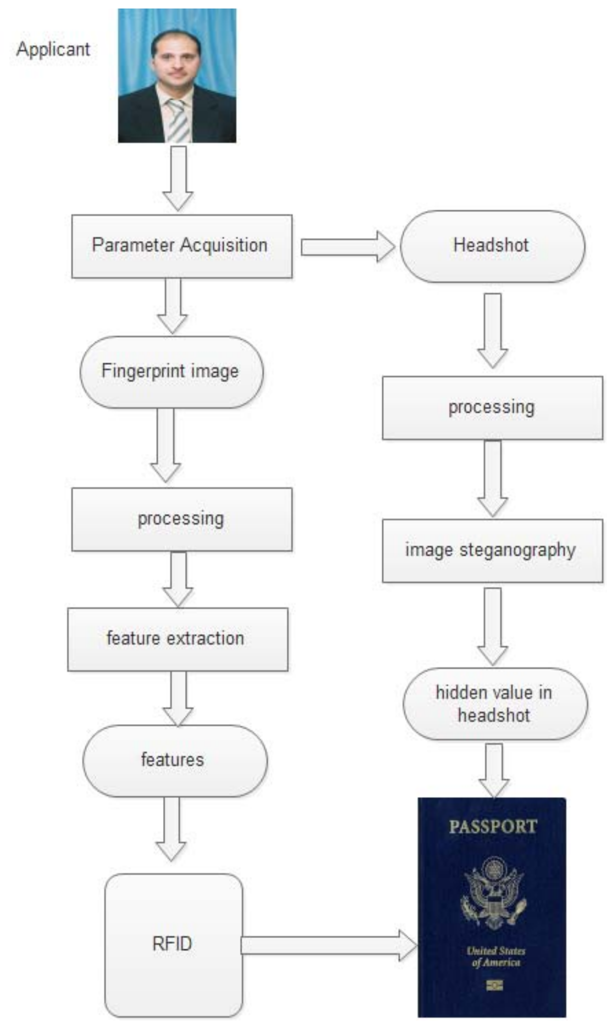

Figure 1 : A Phase one (e- passport generation)

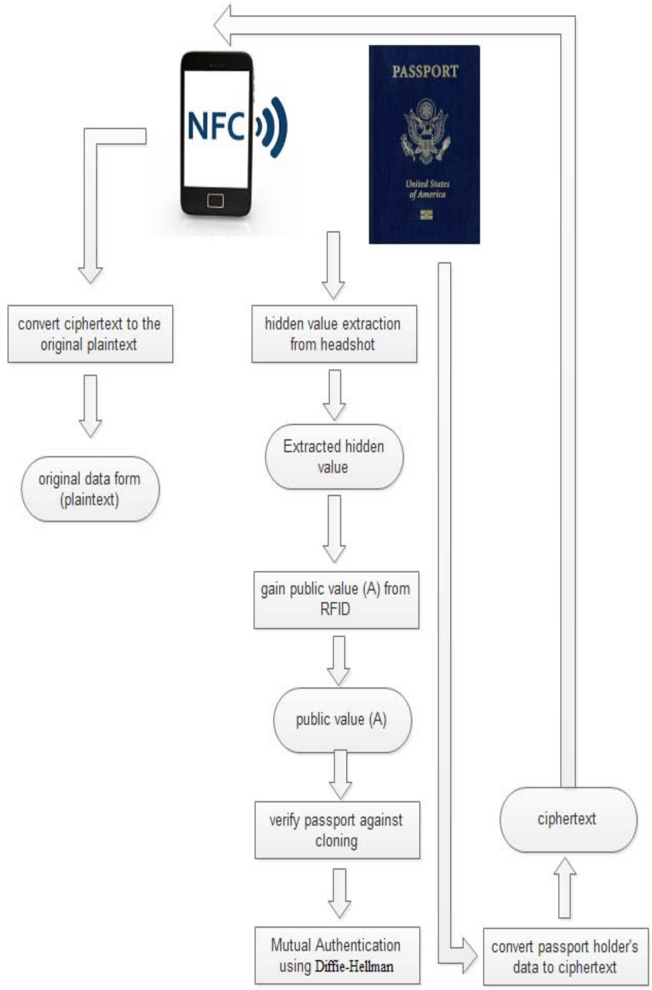

Figure 1 : B phase two (e-passport (verification and mutual authentication)

The proposed method consists of two phases; e-passport generation phase, represented in Figure 1.A, and e-passport verification and mutual authentication, represented in Figure 1.B.

a) Phase one is composed of three algorithms. Each one is responsible for one type of processes. These algorithms have to be performed by the originator country.

V. Algorithm One (Parameter Acquisition)

a) Read the applicant identification data.
b) Validate entries.
c) Store the entries in the e-passport chip.

VI. Algorithm Three (Text Steganography)

a) Using Diffie-Hellman algorithm, generate the public key (A).
b) Generate a random number (r) and store it in the Tag.
c) Scan the headshot of the applicant.
d) Hide the generated public key (A) in the headshot using Least Significant Bit encoding (LSB) steganography technique. Use the random number (r) as a password for the steganography process.
e) Phase two is composed of four algorithms. These algorithms have to be performed by the access control country.

VII. Algorithm One (Mutual Authentication)

Continue the Diffie-Hellman algorithm, which has been started in step (a) of algorithm three of phase one, in order for the chip and the reader to obtain a shared secrete key (K).

VIII. Algorithm Two (E-Passport Chip Verification)

a) Using ElGamal algorithm, obtain the random number (r).
b) Extract the hidden value from the headshot, and use the value (r) as the password for that.

Obtain the public key value (A) from the chip during Diffie-Hellman algorithm.

Compare the extracted value in step (b) with obtained value in step (c); if they were identical, so the chip is the original one and not cloned. Otherwise, the chip is cloned and the e-passport holder must not pass the access control, and there is no need to perform the algorithms two, three, and four.

Identification and Biometric Data Conversion to Cipher (Using ElGamal Encryption)

Use ElGamal decryption algorithm to convert the identification and Biometric, which were stored in the chip, into cipher text. Send the cipher text to the reader device.

X. Decryption of the Cipher Text (using ElGamal Decryption)

a) Receive the cipher text from the e-passport chip.
b) Use ElGamal encryption algorithm to convert back the cipher text to its original plaintext value.

Example for non-forged passport

Suppose that the value of the automatically generated prime number (p) is 23, the value of the modular number (g) is 5, the value of (p) and (g) are common between the RFID and the reader. Suppose also the secret number of the RFID (a) equals 6, and the secret number of the reader device (b) equals 15. Now these values have to be followed across the overall process.

At the passport side, it calculates the public key (A). (A = g^a mod p), (A) = 8. On the other hand, the reader device calculates its public key (B). (B = g^b mod p), (B) = 19.

After generating the public key (A), it will be hidden in the headshot of the passport bearer. When the passenger arrives to the access control of the destination country communication between the E-Passport and the inspection system carries on. The RFID sends the value A to the reader, and the reader sends the value B to the RFID. Based on Diffie-Hellman algorithm, when the E-Passport calculates its secrete key K_{RFID} = B^a mod p (K_{RFID} = 19^6 mod 23=2).and the reader calculates its secrete key K_{Raeder} = A^b mod p (K_{Raeder} = 8^{15} mod 23=2), and after checking the equality state of them, if they were identical, a message saying that Mutual authentication passed will appeared. Now the system will Extract the hidden value (A) from the headshot, and compare it with obtained value from the RFID chip; if they were identical, so the chip is the original one and not cloned.

After the passport authentication and verification, it has to encrypt the identification data using ElGamal encryption algorithm in order to send them to the reader device. The final step happens in the access control country in which the reader needs to decrypt the encrypted identification data sent to it from the E-Passport.

X. Conclusion

The use of e-Passport is technology increasingly used in different countries overall the world. It aims to fight against the forgery activities of the traditional passports. This paper proposed to develop a security technique to be used with the e-passport in the airports to read its holder information by using Radio Frequency technique (RFID).

The proposed security method proved that it works correctly in identifying the forgery if it is existed. The authentication of the validity of the epassportis confirmed by the double checking for the hidden code. The proposed security method kept the privacy of each country in dealing with its secret code.

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Gateway Placement in Mesh Network Using Traffic off Loading Through 2g/3g Networks

By Nanda P & Dr. Josephine Prem Kumar
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Abstract- Wireless mesh network is a new network paradigm to provide seamless internet services. In this network, users interact with access points also called router are placed at various points in cities and user can access the internet by connecting to these access points. Access points in turn connect via multi hop to internet gateway. Internet gateway provides internet services. Wireless Mesh network suffers from congestion problems with increasing user base. Many solutions have been examined previously like increasing the gateways, optimum location of gateways, etc., but all these still solutions have a constraint on maximum scalability and many times traffic load is maximum only at a certain period of time and later load is less, so scaling is not a profitable solution in this case as the access point is not loaded to capacity most of time and cost spent on it is not fruitful.

GJCST-E Classification : C.2.6, C.2.1

GATEWAYPLACEMENTINMESHNETWORKUSINGTRAFFICOFFLOADINGTHROUGH2G3GNETWORKS

Strictly as per the compliance and regulations of:

Gateway Placement in Mesh Network Using Traffic off Loading Through 2g/3g Networks

Nanda P [α] & Dr. Josephine Prem Kumar[σ]

Abstract- Wireless mesh network is a new network paradigm to provide seamless internet services. In this network, users interact with access points also called router are placed at various points in cities and user can access the internet by connecting to these access points. Access points in turn connect via multi hop to internet gateway. Internet gateway provides internet services. Wireless Mesh network suffers from congestion problems with increasing user base. Many solutions have been examined previously like increasing the gateways, optimum location of gateways, etc., but all these still solutions have a constraint on maximum scalability and many times traffic load is maximum only at a certain period of time and later load is less, so scaling is not a profitable solution in this case as the access point is not loaded to capacity most of time and cost spent on it is not fruitful. Considering this problem, we have proposed a hybrid mesh network solution integrating 2G/3G network into mesh network [1] to handle the load on a mesh network. But the location of the gateway is fixed in this approach, based on the traffic offloading pattern, if the gateway can be moved, we can still achieve some more QOS. In this paper, we explore this idea and propose a solution for effective placement of gateway for the offloaded mesh network.

I. Introduction

Wireless Mesh Network (WMN) is emerging as a promising technology for providing internet services in cities and urban area with minimal infrastructure cost and fast deployment.

WMNs are multi-hop infrastructure based wireless networks that are interconnected by a set of relatively stationary wired gateways connected to the Internet. The routers that relay traffic and the client may or may not be mobile. Most of the traffic in a WMN flows from the client to the gateways.

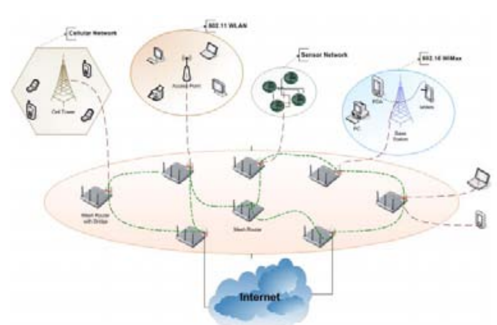

Figure 1: Wireless Mesh Network

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a) WMN consists of following types of nodes

WMN Clients: These are the end-user devices like PDAs, laptops, smart phones, etc., that can access the network for using applications like email, web surfing, VoIP, and alike. These devices are assumed to have limited power, having none or limited routing capabilities, and may or may not be always connected to the network. Mobile Ad-hoc Networks (MANETs) can be assumed to be a special case of WMNs that are formed purely by WMN clients.

WMN Routers: These network elements are primarily responsible for routing traffic in the network. Traffic does not originate or terminate at a router. The routers are characterized by limited mobility and relatively high reliability. Compared with conventional wireless routers a wireless mesh router can achieve the same coverage with much lower transmission power consumption through multi-hop communications. Additionally, the Medium Access Control (MAC) protocol in a mesh router supports multiple-channels and multiple interfaces to enable scalability in a multi-hop mesh environment..

With increasing user base, congestion happens in routers or gateways and due to this quality of service degrades in the Wireless Mesh Network. Many solutions have been proposed to increase the quality of service in wireless mesh network and this is surveyed in the section 2 of this paper. We have proposed a concept of hybrid mesh network with some of the mesh clients doing 2G/3G offloading of internet services. When offloading clusters are created in the network, we can still increase the QOS if the Gateway can be repositioned according to the location of offloading clusters. In this work, we evaluate this concept and measure the QOS due to Gateway repositioning according to offload clusters.

II. Related Work

We categorize the existing works on QOS improvement as below

1. MAC Layer optimization
2. Optimized Routing Protocols
3. Optimized Gateway Placement
4. Optimized Router Placement
5. Cross Layer Protocols

a) MAC Layer Optimization

In [1], S-TDMA based MAC was proposed for wireless mesh network in which continuous power control is done to reduce the noise interference and rate allocation is done to increase the capacity.This solution relies on conflict free scheduling, to increase the throughput by avoiding collisions, but the solution does not address delay due to conflict free scheduling, Mesh Routers and Mesh client have to wait in turn for time schedule and as delay increases buffer overflow occurs in routers and QOS is affected. So it is not a scalable solution.

In [2], solution based on increasing the contention window size to lower the collision is proposed. By reducing the collision throughput can be increased. A spatial extension of the TXOP concept called 'express forwarding' to clear multi-hop flows sooner, and a new mechanism called 'express re-transmission' to reduce collisions on retransmission were also proposed.

In [3], use of smart antenna to do directional transmission and link scheduling algorithm to activate the links in such a way to increase the network capacity was proposed. But this is not a scalable approach as new routers are deployed to existing network; placement becomes a difficult operation and has to place without interfering with the path of another router. Also the use of smart antenna will increase cost of Routers.

In [4], STDMA based scheduling was done at MAC layer with admission control. Admission control ensures clients have a minimum guarantee of bandwidth and maximum delay. It works for VOIP services, but it is not profitable to apply this solution as clients will switch to a different operator if strict admission control is enforced.

b) Optimized Routing Protocol

In [5], the routing protocol in WMN is adapted to choose the relay nodes in the path on estimation of wireless link quality and bandwidth. But without any control on the rate of transfer, this approach is not useful as a path found efficient based on link quality and bandwidth can later be congested due to a variable rate of usage from clients.

In [6], Weighted Contention and Interference routing Metric (WCIM) is proposed. Based on interference, bandwidth available, quality of link, etc., a metric is calculated for each node. Routing is done in such a way next node with the highest value of the metric is choosen as relay node in the route. The problem with these approaches is that it requires frequent exchange of information between nodes to calculate the metric and also it is not end to end decision. When end to end is considered there may be a better path with more WCIM value than the current chosen path and the solution converges in local minima.

In [7], routing based on opportunistic method is proposed. Every node overhearing other nodes in wireless medium can assist in routing in case of failure. But this method has many practical difficulties in deciding the cooperation and also increases the network communication overhead.

c) Optimized Gateway Placement

In [8], the controllers are placed optimally in the network using Particle Swarm optimization technique for maximizing the flaws in network found out by using a Ford Fulkerson algorithm. But this method requires frequent movement of controller based on traffic observation over a period of time.

In [9] wireless mesh network is clustered based on the degree/number of Wireless mesh routers connections, while ensuring Delay, Relay load and Cluster size constraints.

In [10], is proposed a genetic algorithm based solution for gateway placement. This solution optimized variation of MR-IG-hop counts (VAR-MRIG-Hop) among MRs to ensure that the Gateways are placed in the appropriate positions. But during loading, the solution cannot maintain QOS.

d) Optimized Router Placement

In [11], a heuristic solution, called PRACA (Placement, Routing And Channel Assignment) has been proposed to find the optimal position for the router in the Mesh Network. The solution jointly considers routing channel assignment and placement to get the optimal solution for placement. In this way it tries to eliminate interference and improve QOS.

In [12], solution for placement of multi rate routers in mesh network was considered. It presented a heuristic placement algorithm called ILSearch which takes into account both multiple transmission rates and co-channel interference. The ILSearch consists of two components: (1) Coverage MR determination which greedily exploits the capability of each selected MR to cover mesh clients (MCs); and (2) Relay MR determination that incrementally chooses the additional MRs for traffic relaying through the local search.

In [13], the nearest cell association algorithm was proposed to reassign users to routers in different times and a greedy search to find optimal positions for the router. They have proved that QOS is improved due to switching users between routers in this way.

e) Cross Layer Protocols

In [14], cross layer mixed bias algorithm was proposed. The cross-layering will provide information on the link-quality and distance between nodes. Link quality will be provided from the physical layer while distance can be provided in many ways. The Distance could be computed by the number of hops between two points, by measuring the delay or by using real life coordinates if the nodes are equipped with Global Positioning

Systems (GPS). In this paper the author used the number of hops. A portion of the scheduling resources will be biased according to a set of heuristics that penalize nodes for various "bad behaviors" such as distance from the gateway, overuse of traffic, poor link quality and so on. Each heuristic will be assigned a different proportion of the network resources which will be determined experimentally. Another portion of the resources will be left for absolute fairness in order to ensure that none of the links are starving and that some minimum level of service is maintained. Then the collective system will be optimized to produce high throughput fair scheduling for wireless mesh networks.

In [15], two cross layer routing was proposed a loosely coupled cross-layer scheme and a tightly coupled cross-layer scheme. In the loosely coupled cross-layer scheme, routing is computed first and then the information of routing is used for link layer scheduling; in the tightly coupled scheme, routing and link scheduling are solved in one optimization model. The two cross-layer scheme involves interference modeling in multi-hop wireless networks with omni directional antenna. A sufficient condition of conflict-free transmission is established, which can be transformed to polynomial-sized linear constraints, and a linear program based on the sufficient condition is developed.

In [16], the authors proposed a new routing metric for wireless mesh network—CAETT (Congestion Avoidance Expected Transmission Time). With the queue's utilization rate and the transmit situation of control frames in 802.11 protocol's MAC layer, a reasonable path is chosen in terms of the channel competition status, link data frame delivery rate and the node's queue utilization rate.

From the survey we notice that each solution tries to achieve maximum QOS by reducing interference, parallel data rate, smart antenna, network component placements, etc.

One of the most important points noticed in all the solutions suffer from scalability issues and gateway can get overloaded soon with internet service requests. To reduce the overload on the gateway, multi gateway is suggested, but still there is a scalability problem.

III. Problem Definition

Given a wireless mesh network with mesh nodes, access points and gateways and some of the mesh nodes have internet connectivity through their 2G/3G and when the load on mesh network is high and some of access points in the network are, offloading network load through some of mesh nodes using their 2G/3G interfaces. By this way offload clusters are created in the network, the gateways has to be repositioned according to the location of offload clusters. The objective of this work is to find the best location for gateway, so that QoS is improved by the network due to the new location of gateways.

IV. Hybrid Mesh Network With 2G/3G

The architecture of the hybrid offloading scheme is given below in figure 2.

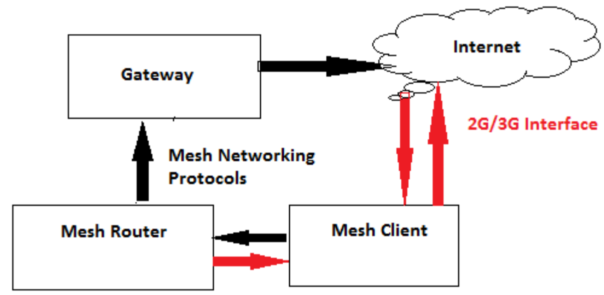

Figure 2 : Hybrid Mesh network with 2G/3G Interface.

From the traditional architecture, we introduce a offloading facility at Mesh Client for sharing its unused 2G/3G interface to wireless mesh network.

The mesh router's routing protocol is modified to enable the 2G/3G offloading capability.

Mesh clients who are interested in offloading their traffic must register their interest to the mesh router. Also Mesh client at any point of time when it needs the additional bandwidth can unregister its interest for offloading to mesh router.

By this way offload clusters are created in certain spots in the network. Offload clusters provide internet services. The gateway positioning according to load of network is an existing solution for improving quality of service.

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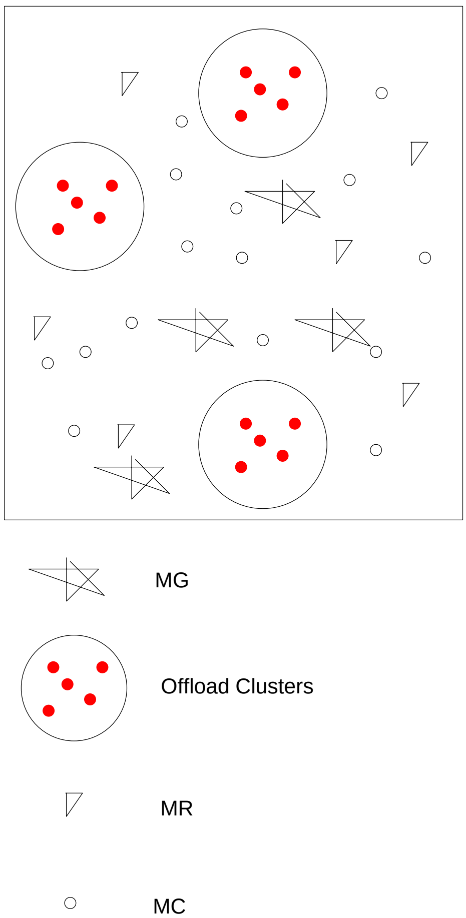

Figure 3 : Offload clusters and other hybrid mesh network elements

In this work, we use three important information to position the gateway, the prediction of load at different spots, current load at spots and the location of offload clusters.

The wireless mesh network is split to lots of grids. The historic traffic generated at each of these grids are collected and we train a AIRMA model to predict the load on the grid in the next interval of time called epoch. As a result of this, we know the current load at grid and predicted load at next interval of time.

Suppose that there are Ng mesh gateways located on the network and Nc offload clusters created in the network with current load and the predicted load known at each of the grid, the Ng mesh gateway has to reposition to provide a better QOS.

QOS we model as dependent parameter on distance and load at the gateway. QOS is better if the node finds a gateway at the nearest distance with less load.

$Q \propto 1 / (Dg * Dg)$

$Q \propto 1 / (Lg)$

$Q = k / Dg^2 * Lg$

Where

Q is the Qos

Dg is the distance to gateway

Lg is the load at gateway.

For each Grid, the current QoS and predicted QoS for each of the N gateway and the offload clusters is calculated. From the current QOS values we find the average QOS values and find the number of gateways with QOS less than average and number of gateway above the average.

A fitness function is modeled for the entire network as

F = w1 * Ngabove - w2 * Ngbelow

The w1, w2 value can be set to any value from 0 to 1 such a way that w1 + w2 = 1.

The best position of Gateway is found using GSO(glowworm swarm optimization) with the maximization of the fitness function (F) defined above.

In GSO, glowworm swarm S, which consists of m glowworms, is distributed in the objective function search space. Each glowworm gj (j =1...m) is assigned a random position pj inside the given search space. Glowworm gj carries its own Lucifer in level Lj, and has a vision range called local-decision range rdj. The Lucifer in level depends on the objective function value and the glowworm position. The glowworm with a better position is brighter than others, and therefore, has a higher Lucifer in level value and is therefore closer to the optimal solution. All glowworms seek the neighborhood set within their local decision range, and then move towards the brighter ones within the neighborhood set. Finally, most of the glowworms gather in compact groups in the function search space at multiple optimal locations. GSO works in an iterative process that consists of several Lucifer in updates and glowworm movements, which are executed to find optimal solutions. The Lucifer in level Lj is updated using the following equation:

$$L_j(t) = (1-\rho)L_j(t-1) + \gamma F(p_j(t))$$

After that, each glowworm j explores its own neighborhood region to extract the neighbors that have the highest luciferin level by applying the following rule:

$$z \in N_j(t) \;\; \textit{iff} \;\; Distance_{jz} < rd_j(t) \;\; and \;\; L_z(t) > L_j(t)$$

where z is one of the neighboring glowworms close to glowworm j, Nj (t) is the neighborhood set, Distance jz is the Euclidean distance between glowworm j and glowworm z, rdj (t) is the local decision range for glowworm j, and Lz (t) and Lj (t) are the Lucifer in levels for glowworm z and j, respectively. After that, each glowworm selects the movement direction using the roulette wheel method. Therefore, the glowworm position (pj) is adjusted based on the selected neighbor position (pz) using the following equation:

$$p_j(t) = p_j(t-1) + s\,\frac{p_z(t) - p_j(t)}{Distance_{jz}}$$

pj(t−1) is glowworm j's previous position, s is a step size constant, and Distancejz is the Euclidean distance between glowworms j and z.

The glowworm runs in iteration to the find best position for the gateway based on the maximization of the Fitness function. Once the iteration is completed, the best position for the gateways are known and the gateway is moved to that point if the predicted load is less than the current load in the current position of the gateway.

V. Results

We simulated the proposed solution on the wireless mesh network simulator Jprowler where some of the nodes are randomly chosen for offloading. Service requests are generated from the node with Poisson distribution over the simulation duration configurable by user.

We compared our solution without movement of gateway with just offload alone.

By varying the number of offload clusters, we measured the effective QOS in the network in terms of packet delay and the result is figure 5.1.

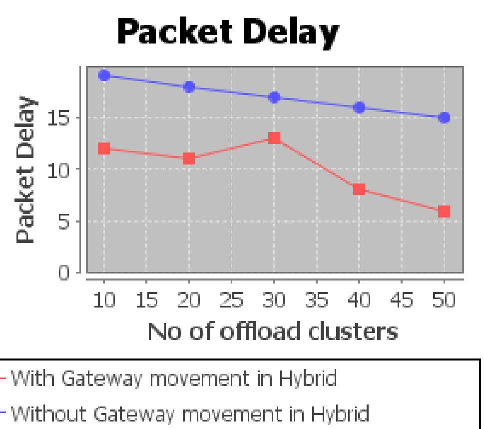

Figure 5.1 : Packet delay vs No of offload clusters

By varying the number of gateways in the network, we measured the effective QOS in the network in terms of packet delay and the result is Figure 5.2.

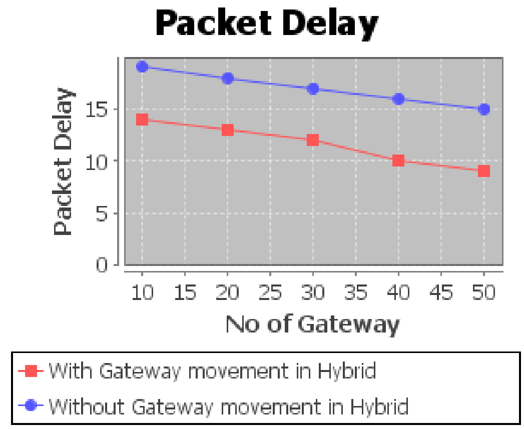

Figure 5.2 : Packet delay vs No of Gateway

By varying the number of offload clusters, we measured session drop ratio and the result is figure 5.3.

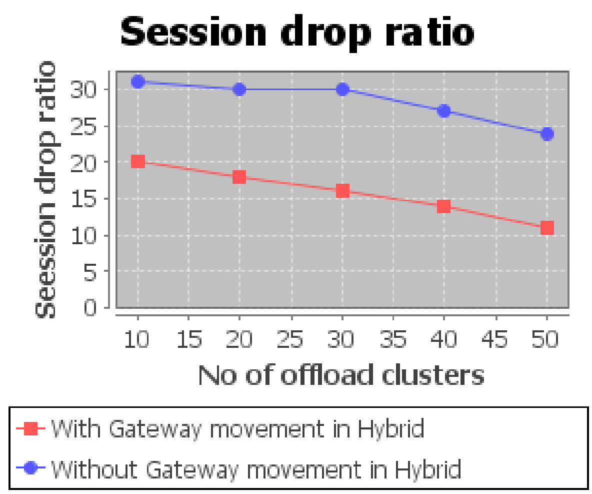

Figure 5.3 : Session Drop ratio vs No of offload clusters

By varying the number of gateways in the network, we measured the session drop ratio and the result is figure 5.4.

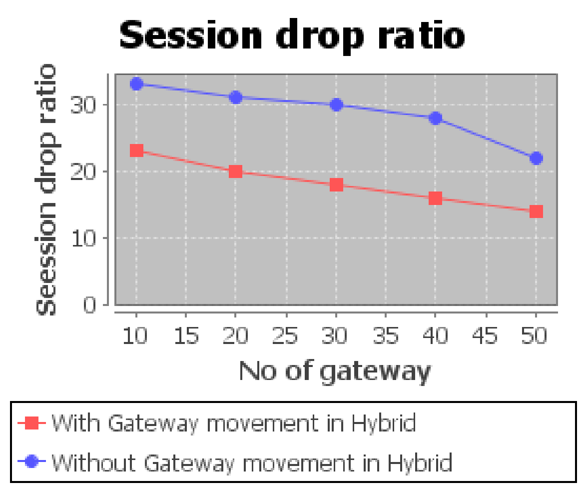

Figure 5.4 : Session Drop ratio vs No of Gateway

VI. Conclusion

The proposed offload solution with gateway movement is implemented through simulation, and we have proved that the QOS is improved in the network in terms of session drop ratio reduced and the average packet delay is reduced in the network.

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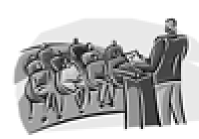

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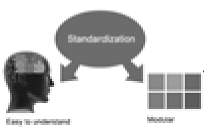

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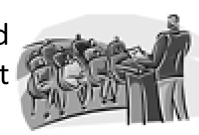

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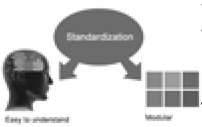

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Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
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