Scheduling Algorithm for Wireless Mesh Networks based Defense Networks Incorporating Centralized Scheduling Architecture

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ABSTRACT

Wireless Mesh Networks (WMN) are the networks of the future which are flexible, easy to deploy and can support high data rate triple play (voice, video and data) services. WMNs are ideal for future defense networks. WMN can operate on multi protocols ranging from WiFi, WiMax and LTE. To enable the support of high data rate services WMN should incorporate optimum traffic scheduling algorithms which will improve the performance of the WMN in highly loaded traffic scenarios for a combat communication network. In this paper, we propose an efficient traffic scheduling algorithms to improve the overall blocking probability of the WMN employed for defense networks and the same is substantiated by the simulation results.

SCOPE

1. Future Wireless Mesh Networks (WMNs) to incorporate technologies like WiFi, WiMax and Long Term Evolution (LTE) to form Next Generation Networks (NGN) capable of handling guarantee high data rates.

2. Requirement perceived to optimally utilize the bandwidth provided by Wireless Mesh Networks.

3. Proposed Traffic Scheduling Algorithm (TSA) aims to do the above by incorporating Traffic Engineering.

4. The TSA effectively incorporates Class of Service Quantization and Prioritization of service requests, Implemented in a GMPLS based architecture.

WMN BASED DEFENSE NETWORKS

1. Defense networks should be adaptive to changes in the defense operations and should be established in no time. Further, defense networks should provide high data rates, hence LTE is the preferred technology.

2. However, during the time of actual operations, we may find overloading of user traffic in these defense networks and these networks may be prone to congestion in certain subnets.

3. Primary aim of WMN based defense networks is to perform at critical junctures and to optimally utilize the bandwidth during overloaded traffic conditions.

4. Defense networks should prioritize traffic according to the requirement of defense operations, which may be a problem dynamic in nature.

5. Proposed Traffic Scheduling Algorithm (TSA) aims to do the above by Incorporating Traffic Engineering.

6. The TSA effectively incorporates Class of Service Quantization and Prioritization of connection requests.

TRAFFIC SCHEDULING ALGORITHM (TSA)

TSA incorporates the following two processes:

(a) CoS quantization of traffic architecture: A Request Handler is loc at each ingress of traffic. Its functionality is to prioritize incoming traffic to guarantee Service Level Agreement. The classification of traffic: is done as given below:

- (i) EF traffic (S = 3): for real time traffic (for voice and live video applications).
- (ii) AF traffic (S = 2): for non real time traffic (for compressed video and transactional data traffic).
- (iii) BE traffic (S = 1): for delay tolerant traffic (transfer of files).

Prioritization helps in dropping low priority traffic, in congested subnets. Request Handler forwards the above data to a central Request Prioritizer on control plane.

(b) Prioritization of connection requests : The prioritization of connection request is done by extracting the following two parameters from each connection request:

- (i) data rate consumption
- (ii) No of hops utilized in the network

The above two parameters are forwarded by the Request Handler loc at each wireless node to the central Request Prioritizer on control plane for further processing.

ALGORITHM FUNCTIONALITY

The following parameters used in the Algorithm:

(a) Hop count (H): Number of Hops required to traverse in a WMN by each connection request.

b) Tolerable Delay (D): The delay in time a connection request can tolerate inside the WMN for the service to be accepted at the destination without the degradation in QoS.

(c) Required Data Rate (DR): The minimum data rate required by the connection request, throughout all links in the WMN.

(d) Service Priority (S): This is a classification of the type of service request that a client to the WMN is desirous to transmit (S = 1/2/3).

Step 1: Create a requirement matrix for all the requests in the network as Table 1.a.

Step 2: Calculation of weights for each connection requested using the formula:

$$W = H/Hmax + 1/S + DR / Md + D \quad \text{- (eq - 1)}$$

(a) 1st term of eq-1 – gives the ratio of number of hops used (H) by the request with respect to the maximum number of hops in the network (Hmax).

(b) 2nd term of eq-1– gives the value of CoS (S) assigned to the request with respect to the highest value of CoS.

(c) 3rd term of eq-1- Fraction of Data Rate (DR) utilized by the request with respect to the maximum data rate engineered in the network (M_d), which has been assumed to be 7 megabits per second.

(d) 4th term of eq-1- The delay in time a request can tolerate inside the WMN for the service to be accepted at the destination without the degradation in the required QoS.

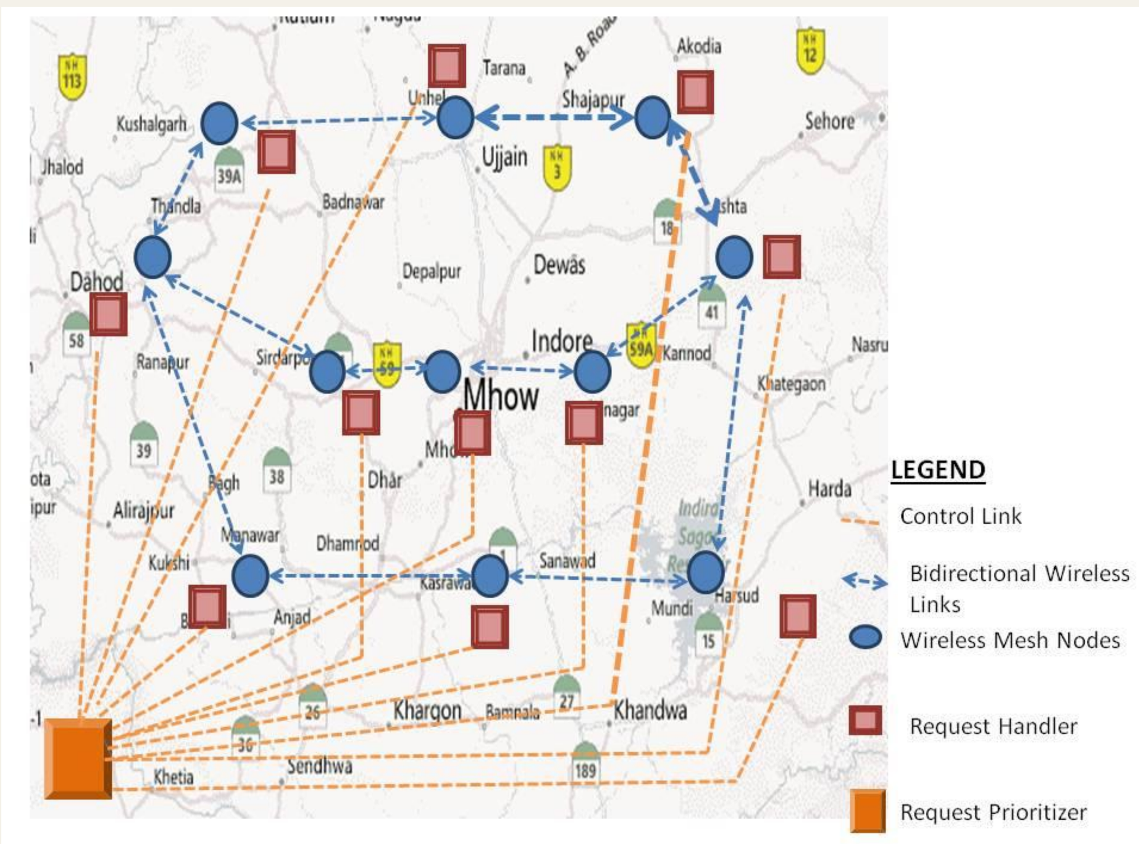
By calculating the weights (W) for each connection requests, create a new Requirement Matrix as TABLE 1.B.

Step 3: Rearrange TABLE 1.B in ascending order of weights (W), and get Prioritized Queuing Table as TABLE 2.

Step 4: Central Request Prirotizer uses the Prioritized Queuing Table (for each node) , Table 2 from Step 3.

Top entry of Table 2 assigned best link from available wireless links. If no wireless link available, connection request blocked. Process repeated for next entry of Table 2, till no entries left. Step 4 repeated for all wireless nodes in the network.

SIMULATION ARCHITECTURE

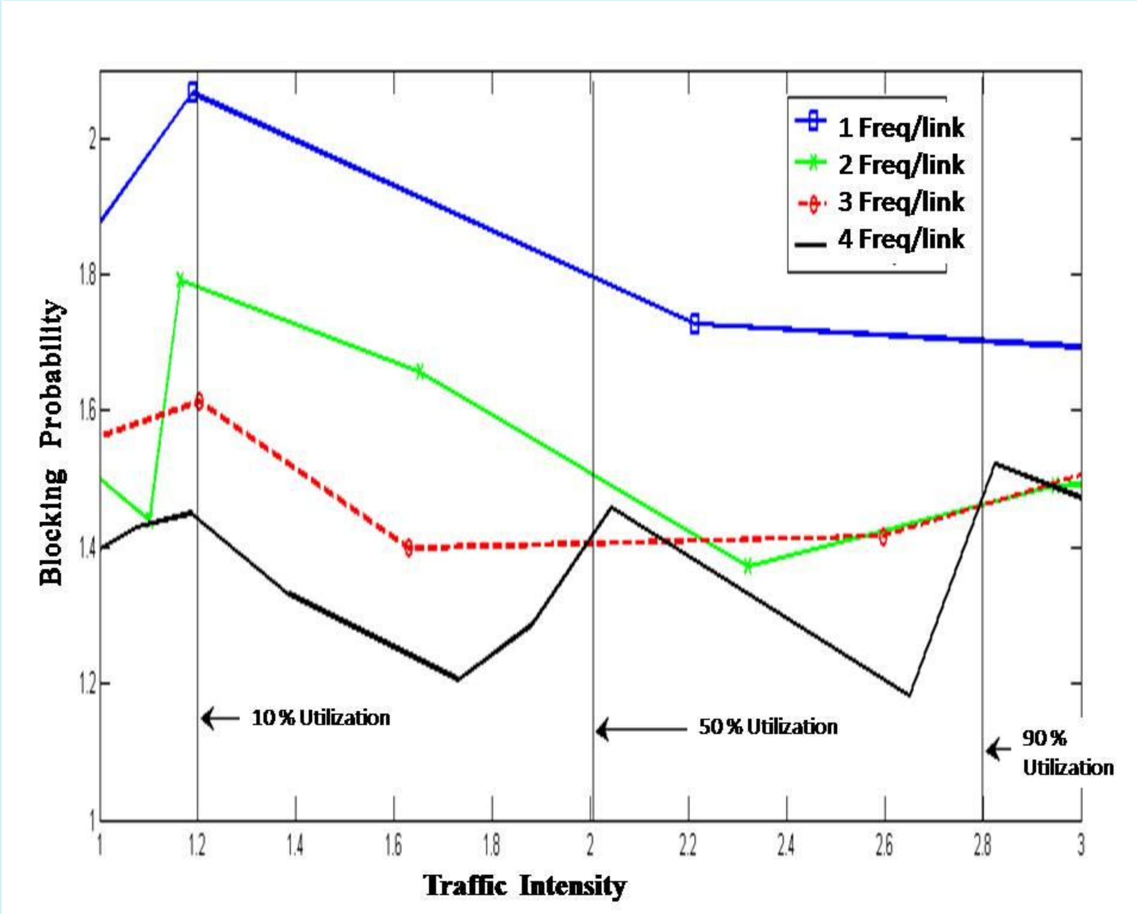


SIMULATION PROCESS

1. Carried out in GMPLS based architecture.
2. Architecture : 11 wireless nodes and 14 bidirectional wireless links.
3. Each wireless link capable of multiple frequencies.
4. GMPLS RSVP-TE used as the Routing model.
5. The connection requests are random in nature and established as a Poisson process.
6. The inter arrival times of connection request, follows an exponential distribution.
7. Each bi-directional link : max data rate – 7 Mbps.
8. Packets randomly generated among all possible s–d pairs.
9. No of packets generated by each node into the network has been slowly increased in the simulation process to upto 5000 packets, generated from each node into the network.
10. Connection request blocked, if frequency not available.
11. Performance of proposed TSA algorithm : in terms BP.
12. Lower the BP : better performance of network.
13. Simulation carried out in 2 phases.

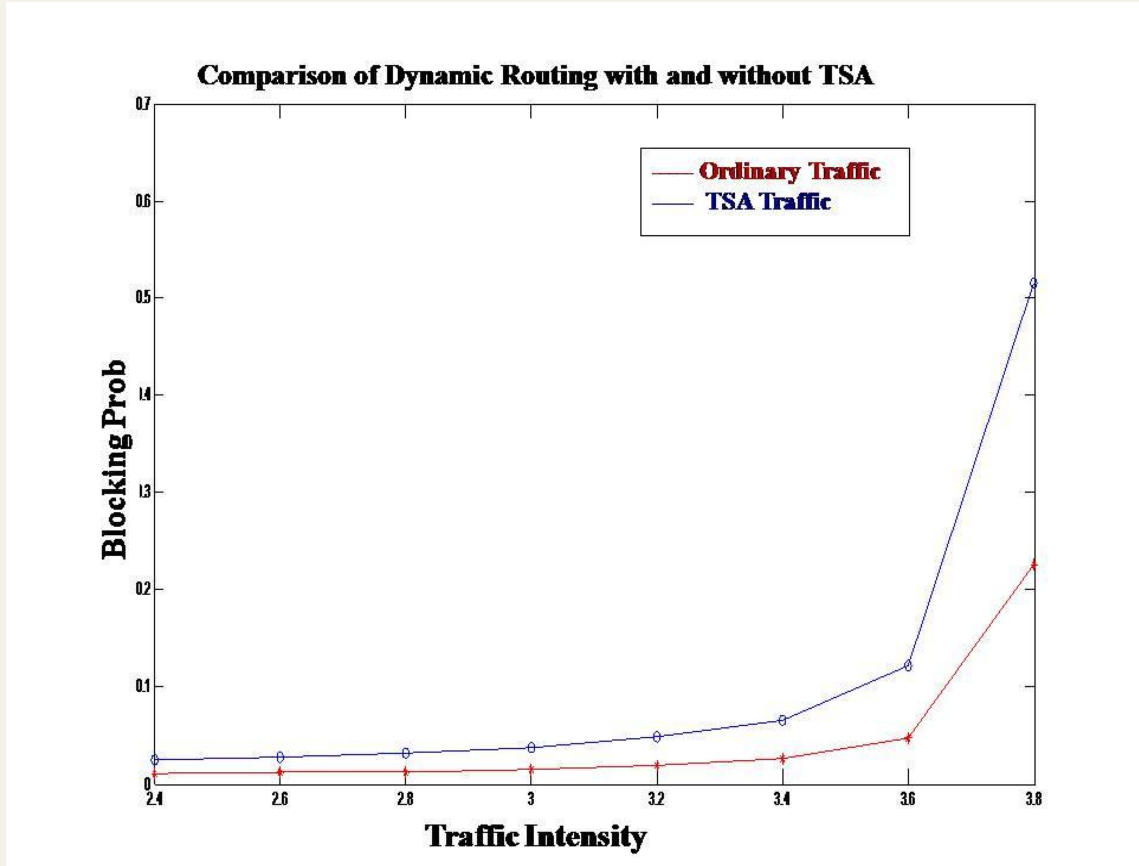
Phase 1

1. Performance of TSA evaluated with increasing Frequencies per Link.
2. BP plotted with r/o increasing Traffic Intensity (TI) for one, two, three and four Frequencies.
3. TSA curve has been kept in the X-axis that is given a value of 1, and the non-TSA curves are plotted to this normalized TSA case (X-Axis)



Phase 2

1. Next TSA has been combined with the dynamic OSPF-TE routing algorithm and its performance evaluated by comparing it with a dynamic OSPF-TE routing model without TSA.
2. The BP has been plotted with respect to increasing TI for four frequencies per bidirectional wireless link.



CONCLUSION

1. Proposed TSA has substantially improved the BP performance of the WMN based Defense network.
2. Hence, provides more utilization of network resources in high traffic loaded conditions in the network.
3. Efficient TSA tends to reduce delay, packet loss and promote the efficient usage of available bandwidth, even at high traffic scenarios, in the WMN based Defence networks.

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