Defence Science Journal, Vol. 69, No. 1, January 2019, pp. 80-86, DOI : 10.14429/dsj.69.11992

Self-managed Access Scheme for Demand Request in TDM/TDMA Star Topology Network

Trilok Kumar Saini* and S.C. Sharma#

*DRDO-Defence Electronics Applications Laboratory, Dehradun - 248 001, India
#Indian Institute of Technology, Roorkee - 247 667, India
*E-mail: trilok.saini@deal.drdo.in

ABSTRACT

In demand assignment protocol, resources are granted on the basis of demand, governing some rules, policies in resource assignment and after the completion of need, resources are released back to the central pool for further requests. In star topology TDM/TDMA network of very small aperture terminals with a common request channel, a large number of participating terminals generate signalling packets on the request channel. It is desired that these terminals have higher chances of successful access to the media with a minimal number of the collision over the shared channel. Under these circumstances, the performance of the media access protocol is really crucial. Aloha is the simplistic technique to access the shared channel but suffers from extremely low throughput. Its successor slotted Aloha improves the throughput by cutting down the vulnerable period to half by agreeing on transmission at slot boundaries. This improvement is also not adequate to provide the better chances of packets getting through when multiple nodes are participating. The large latency network where one hop delay is of the order of 270 ms, feedback time and timeouts are also of high order this further worsen the problem. A self-managed access scheme for demand request that tries to reduce the collision by managing the multiple requests and distributing them over different slots is proposed.

Keywords: Random access; Slotted Aloha; Media access control; Signalling; Terminal

1. INTRODUCTION

Recent multi-beam satellites have offered higher power and bandwidth. At the same time, maturity and improvement in ground terminals in terms of form-factor and capabilities has been observed. Instead of traditional voice services, terminals are now migrating to be data-centric. With the advancement of space & ground segments, network design, and multiple access techniques, there has been an improvement in the network capacity. In a large network, there are more chances of a large amount of bursty traffic and flow of significant amount of signalling packets for demand request. To handle such types of traffic patterns and for the optimum utilisation of satellite resources, there is a requirement of efficient media access protocol[2] to improve the channel utilisation and to optimally use the satellite transponder[3] bandwidth. Media access protocols are designed to coordinate transmission of packets among stations and resolving collisions during contention periods among stations. Based on bandwidth allocation, a medium access control scheme can be fixed assignment, random access, and demand assignment. But in terms of access to the medium, contention-free and contention-based are the two main categories of channel access scheme. In the first category, the channel is accessed in a contention-free manner and there are four classical methods that are used in this category. Each method has its own unique technique to allow access to the channel. In frequency division multiple access (FDMA), the spectrum is divided into frequency domain that means total bandwidth is divided into parts and terminals are assigned with the portion of the band generally separated by guard band to keep the signal well separated. Time division multiple access (TDMA) uses time domain partition where several users share a single carrier frequency but each of them using different non-overlapping timeslot. Each slot is used to transmit one packet, hence well suited for packet traffic. Code division multiple access, abbreviated as CDMA is based on spread spectrum where the same spectrum is allocated to each user however they have been assigned different codes that help to discriminate from each other. Space division multiple access (SDMA) uses the concept of transmitting information in different physical areas it serves the different users by spot beam antenna. The second category is the contention based random access method where users access the shared media randomly based on their local algorithm to access[11] the media where significant chances of collision exist although collision resolution and reservation techniques try to improve the situation. Random[2] access techniques[1] are preferably used when the transmission is of bursty nature.

2. NETWORK TOPOLOGY

The architecture of very small aperture terminals

Received : 27 September 2017, Revised : 05 December 2018
Accepted : 14 December 2018, Online published : 10 January 2019

(VSAT) Satcom network encompasses the services of space segment and the ground segment. In typical S-band terminal configuration with C band Hub, there is the provision of Hub enabled services with broadcasting satellite service (BSS) band in the C×S forward link and mobile satellite service (MSS) band in the S×C return link. This combination can effectively be utilised for two-way communication services as well as for reporting and broadcast applications. In multi-beam architecture, the C-band feeder link to the satellite from the Hub is through the global beam. The corresponding downlink is in the S-band, with multiple spot beams to cover the desired foot-print with improved power. MSS ground segment comprises various types of user terminals and a central Hub station. The Hub station incorporates a large antenna, RF electronics with redundancy, baseband electronics including modems, various embedded processing modules, and network management system (NMS).

Network in the current context is based on a star topology and the terminals are networked in demand assigned multiple access (DAMA[12]) mode, though central control station. A star topology provides two hops connectivity between remote terminals through the central hub. Traffic between any two remote terminals must traverse the satellite link twice, once from the remote terminal to the hub, followed by a redirect back over the satellite to the destination remote terminal. The MSS Hub provides central control for terminals operating in DAMA mode[14] and acts as a network control centre. In the network, NMS at Hub controls all the resources and based on terminal service requests and current network state, it allocates communication resources to terminals. Broadly, there are two type of channels in the network, signalling, and traffic. Signalling channels are required to exchange the network control and management information, which includes call setup, call teardown, network synchronisation, and monitoring & control. Traffic channels are required for voice and data communication between the terminal to terminal and terminal to the hub. In addition, the hub may also provide the terrestrial network access and order-wire functions.

The TDM/TDMA network as illustrated in Fig. 1 consists of one Hub and associated remotely dispersed terminals. In the example configuration, there is one outbound TDM carrier from Hub to terminals and two inbound carriers shared between remote terminals as return channels one each for TDMA and random access. Number of channels in outbound and inbound links may vary and are governed by requirements depending on available bandwidth and link budget. On return channel, dispersed terminals attempt to send packets. Here, dedicated separate return channels have been assumed for both random access and TDMA mode of operation, where random access is used for signalling packets and TDMA is used for traffic packets. A terminal first tries to acquire the access slot present on the signalling carrier. On successful transmission, it is acknowledged by the NMS on a broadcast time division multiplexed (TDM) channel that is from Hub to the terminal. Those packets subject to error due to degraded channel conditions or lost due to the collision are not acknowledged from the Hub and are automatically retransmitted after the timeout. The TDM frame from the hub station is the

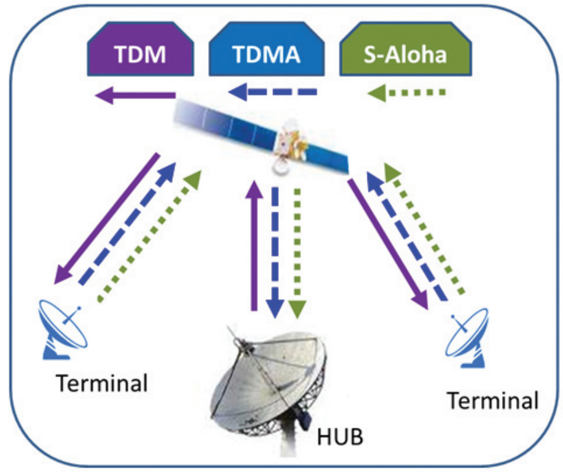

Figure 1. TDM/TDMA network deployment view.

combination of signalling information and variable length data packets multiplexed at the hub site and broadcast to all the terminals in the network. A synchronisation pattern is sent for the synchronisation of remote stations. This pattern also helps to derive the start of TDMA frames to all the terminals in the network. In the network, terminals utilise random access, narrowband slotted Aloha signalling channels for power-on, demand request, call request, call release, monitoring & control functions in return channel that is from the terminal to Hub. The traffic data is to be transmitted on non-contention TDMA channel for efficient utilisation of satellite bandwidth for voice and messages services and to support bandwidth-on-demand applications. On the forward link signalling and traffic are time multiplexed on high data rate TDM carrier.

Random access protocol slotted Aloha or its variants are especially important in VSAT networks due to their algorithm simplicity and suitability for bursty traffic. One of the main challenges here is to maximise the utilisation of random access signalling channel so that terminals could successfully send demand request and other signalling information to the central Hub. Slotted Aloha is the popular choice for random access signalling channel but there are related variants and the scope[17] of further optimisation[13].

3. RANDOM ACCESS PROTOCOLS

Random access schemes[15] with emphasis on media access control aspects for accessing the shared media are outlined as follows.

3.1 Aloha

Pure Aloha[4] concept is to simply transmit the packet whenever a packet is there. In case of collision, colliding frames are destroyed, and the transmitting stations need to try resending again. The pure aloha access method is unsynchronised that result in partial or sometimes full overlap of frames and both frames are destroyed. The vulnerable period in pure aloha is two time of the frame duration.

The probability $P[0]$ of no other traffic during the vulnerable period of 2 frame time, as deduced by the Poisson distribution is as given by Eqn. (1) where G = mean frames per frame time

$$P[0] = e^{-2G} \tag{1}$$

$$Throughput = \ Mean\ arrival\ time\ \times P[0]\ = GP[0]$$

$$Throughput = Ge^{-2G} \tag{2}$$

So the maximum throughput of Aloha protocol as obtained from Eqn. (2) =1/2*e*, that is equal to 18 per cent. This value indicates poor throughput of Aloha.

3.2 Slotted Aloha

Slotted Aloha (S-Aloha[4]) is an improvement over pure Aloha but it requires each user to agree over slot boundaries. Idea is to divide the time scale into discrete time intervals with each interval corresponding to one frame. Each user sends the packet at the beginning of the slot, so in this method either there is a full collision or no collision at all, this eliminates the problem of partial collision. Vulnerable period is reduced to one frame time as compared to two frames of pure Aloha and throughput is as given by Eqn. (3).

$$Throughput = Ge^{-G} \tag{3}$$

Maximum throughput value approx = 36 per cent.

3.3 Reservation Aloha

Reservation Aloha access scheme offers an implicit reservation of the slot and does not use an independent reservation sub-channel. A slot is presumed unused if it is empty or if it contains collision. Idle slots are considered available to all users for random access as in slotted Aloha. A slot is considered temporary reserved by the station that has successfully used it and becomes available in next frame if the user fails to use it. In reservation Aloha, slots are organised into the frame such that,

$$frame\ duration\ >\ round\ trip\ delay$$

This makes the user be aware of the state of the channel in the preceding frame. This scheme is useful when users have traffic consisting of multi-packet messages, long messages or continuously arriving short messages but may not be well suitable for a VSAT network having star connectivity. The throughput[5] of R-Aloha can be given by Eqn. (4).

$$S[RA] = \frac{S[SA]}{S[SA] + K} \tag{4}$$

where k = average packets in a user message and $S[SA]$ represents the throughput of slotted Aloha

3.4 Selective Reject Aloha

Selective[6] reject Aloha is a random access scheme that does not require timing synchronisation. It is based on sub-packetise the message and only collide part of the message is retransmitted with selective reject ARQ retransmission strategy. On the transmission of sub-packets, a timer is set for waiting the acknowledgment that can indicate the partial or complete success of transmission. Only sub-packets that are unacknowledged are scheduled for retransmission.

3.5 Framed S-Aloha

In framed[7] slotted Aloha shared access time is divided into frames and each frame is divided into some number of slots. Terminals are permitted to transmit their packet at most once per frame. Each user may transmit a packet in a frame with its probability to access the shared medium. Users should decide where to have their transmissions in a frame; it selects one of the timeslots in the frame to transmit its packet in that slot. Frame length may be either fixed or variable; it depends on the system implementation.

3.6 Diversity Slotted Aloha

Diversity[8] slotted Aloha (DSA) is an extension to the slotted Aloha in which multiple copies of the packet is transmitted on the same channel but diversified over random time intervals or these copies could be transmitted simultaneously over different frequency channels. Under light traffic conditions, transmission of multiple copies improves the chances that at least one copy of the packet is received successfully; this scheme gives better delay performance. The larger number of replicas results in more robustness to lose, but at the cost of lower overall capacity as multiple transmission increases the overall physical channel load.

3.7 Contention Resolution DSA

Contention Resolution DSA (CRDSA)[9] scheme uses the diversity transmission of data packets with interference cancellation techniques. It generates two replicas[1] of the same packet at two randomly selected slots within the frame. The basic concept of this protocol lies in resolving the most of the packet contention by clearing up the burst collisions using iterative interference cancellation technique. Each of the replicas contains the information of the slot position of the corresponding twin replica within the frame. Each burst has the signalling information pointer to its twin location. In this scheme recovered information from a successful reception is used to cancel the effect of the interference that its twin may impose in another slot. This process is iterated to recover most of the packets that suffered from collision initially.

3.8 Slotted Aloha with Acknowledgment

In this approach, data is carried in contention mode on the channel as in S-Aloha with a variation that all packets are acknowledged by the recipient. This scheme has been also referred to as random access TDMA[5]. In terms of capacity performance, it is similar to S-Aloha but suffers from the twice propagation delay before the acknowledgment is received by the sender.

3.9 Fixed Frame and Reservation TDMA

In fixed frame[5] TDMA, pre-assigned time slots are allocated to each user in TDMA format. In reservation TDMA, time slots are assigned to the user on real time as per requirement. In this approach, a user sends its request on a separate reservation channel which can be S-Aloha or non-contention TDMA with smaller slot size. On request, a central entity, network manager assign the time slots to the user as per the demand requested by the user.

4. SELF-MANAGED ACCESS SCHEME

4.1 Scenario

To illustrate the scheme, a scenario has been taken in which there are two return channels and one forward channel. One of the return channels is based on random access and other is contention-free TDMA[16]. The random access channel is mainly intended for signalling information and demand requests. Signalling information is acknowledged by the central controller and demand requests are replied back in the form of resource assignments. All these acknowledgments, assignments packets and some other information are multiplexed on TDM channel over the forward link. Network formulates the star topology that has the advantage of the availability of central controller and the broadcast capability in forward-link. The main objective is to improve the utilisation of random access channel. Popular slotted Aloha approach does not require any coordination from remote terminals except that all of them should agree on common slot boundaries. By exploiting the continuous broadcast nature of the outbound channel and the central controller capabilities, additional access coordination could be introduced in the random-access nature of slotted Aloha to improve its performance.

To further reconnoiter the issue, first, we elucidate the TDM frame structure considered here as a part of the network. TDM frame[10] contains a unique word, frame number, control information, data packets along with checksum. The remote terminals should have intelligent algorithm so that they could derive the listening frequency and could decode the desired information. By listening to TDM and its information containment, the remote terminals may also extract information related to network configuration and dynamic changes in the network. Multiple frames in TDM formulate a super-frame and each frame may contain multiple slots as shown in Fig. 2.

Terminals calculate the slot boundary for random access slotted Aloha and TDMA using the special markers in the TDM frame, as depicted in Fig. 3. As TDM is being broadcast to all terminals, thus it is possible to establish slot synchronisation in the network. Once terminals get the marker they can maintain the slot boundary using the precision clock. Slots in forward-links are either of the same duration or may have some multiplication factor with the access slot on return links[12]. The frame number of the current frame and the number of time slots in a frame is used to calculate the total slots passed in forward-link, which is used to derive the current slot number in return channel. The frame number designates the distance of the current frame from the start frame of the cycle. Based on this timing information, remote terminals can derive the slot number on the return channel. Thus each of the remote

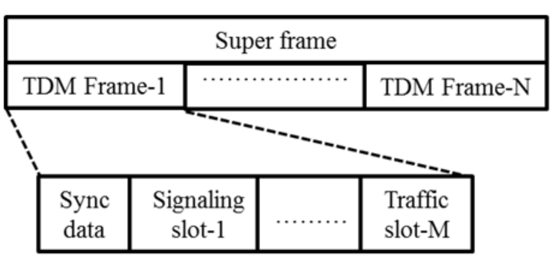

Figure 2. Super-frame and frame composition.

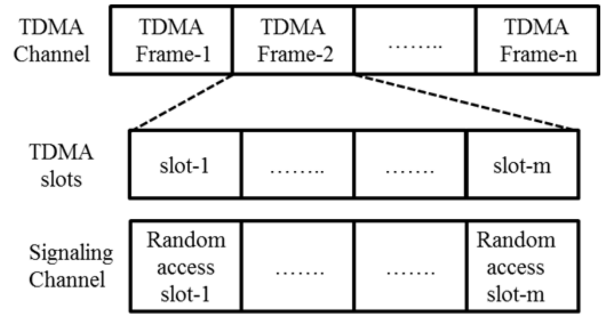

Figure 3. Inbound TDMA and random access slots.

terminals has derived information of slot boundary and the current slot number to access the return channels. If demand request channel being accessed using slotted Aloha, achieving good throughput is one of the objectives. But other issues that are of concerns in using this access scheme are the waiting time before the successful transmission which can be very high in case of high load condition, also S-Aloha does not support any prioritisation and even no guarantee of successful transmission in low traffic conditions.

4.2 Scheme

To access the random-access channel, we propose the self-managed scheme for the managed access in which terminals transmission has been correlated with slot numbers according to their numeric identifications. Each slot is the basic unit of transmission to send a burst on the contention-based channel.

$$\textit{Frames in superframe} = \{F_1, F_2 \ldots F_N\}$$

$$\textit{Slots in a frame} = \{S_1, S_2 \ldots . S_M\}$$

$$\textit{Slots in superframe} = \{S_1, S_2 \ldots . S_{M\times N}\}$$

In each super-frame, time slots can be identified by their unique numbers starting from 1 to N×M. It is assumed that slot duration in forward and return-channel is same and terminals on return channels derive the similar slot numbers as in the forward link. In the proposed self-managed access scheme, terminals can access a slot only if the terminal ID maps with the slot number as per the mapping rule. Three rules i.e. odd-even mapping (OEM), unit digit mapping (UDM) and priority random-access (PRA) have been defined and are described below. As per the requirement, any of the three rules may be applied to access the media.

4.2.1 Self-managed OEM

In odd-even slot mapping, terminals having IDs ending with an odd digit are allowed to contend for slots with odd numbers while terminals having IDs ending with even digit can contend for even numbered slots as shown in Fig. 4. Initial digits of terminal IDs in the figure are represented by X which indicates that the initial digits are don't care for the mapping rule defined here. In this scheme, the number of timeslots in a frame preferably should be multiple of two so that slots are uniformly distributed between even and odd type of terminals. In order to give an advantage to any of the two groups of terminals, less number of IDs of that particular category could be assigned to

Terminal ID	Slot No
XX1, XX 3, XX5 XX7, XX9	1, 11 3, 13 5, 15 7, 17 9, 19 ...
XX0, XX2, XX4 XX6, XX8	2, 12 4, 14 6, 16 8, 18 10, 20 …

Figure 4. Self-managed odd-even mapping.

terminals. If at any point in time, there are only two terminals in the network with even and odd Ids respectively, their packets will never collide.

4.2.2 *Self-managed UDM*

In the scheme of one-to-one unit digit mapping, terminals check the last digit of their IDs and contend for the slots that have a similar number in its last digit. So for each terminal, there is not any single slot to contend but a group of slots ending with the same digit. A similar category of terminals in terms of their last-digit contend for the slot numbers having the same digit in their last position. For example, all the terminals having two in its last digit of terminal ID will contend for the slots that have digit two in its least significant position in the decimal number system. That implies that more than one terminal may content for the same slot, but restricted to the group of terminals demarcated by the last digit as depicted by Fig. 5. In this scheme, frame size is suggested such that each frame contains the slots in the multiple of ten for fair distribution of slots.

4.2.3 *Self-managed PRA*

In priority random access of self-managed scheme, one or more terminals can access a slot. Each terminal may access to any of the slots in a frame only once like frame S-Aloha but the probability to access the frame is different for each of the terminals as govern by the priority policy. Terminals have been categorised into three priority group with the level routine, medium and high with increasing order of probability to access the slot in a frame as shown in Fig. 6. This scheme

Terminal ID	Slot No
XX1	1, 11 …
XX2	2, 12
XX3	3, 13
XX4	4, 14
XX5	5, 15
XX6	6, 16
XX7	7, 17
XX8	8, 18
XX9	9, 19
XX0	10, 20 …

Figure 5. Self-managed unit digit mappings.

Terminal ID	Category	Slot No & Frame
XX1, XX2 XX3, XX4 XX5, XX6 XX7, XX8 XX9, XX0	Routine Medium High	1, 2, 3…M (slot) (Frame-2…..N)
XXX	Privilege	1, 2, 3…M (slot) (Frame-1)

Figure 6. Self-managed priority random access.

also supports privilege policy for the first frame of the super-frame marked as privilege frame.

Terminals categorised as routine, attempt to access the slots in a frame with less probability and hence have less chance to acquire the slot. While the terminals with medium and high priority try to access the slot in a frame with increasing probabilities and hence has better chances to acquire the slot. This scheme also grants the special provision for the first frame of the super-frame in which only special privilege terminals are permitted to access and this privilege can be assigned only to selected terminals as per the policy. The number of terminals that can be assigned privilege status has to be kept minimum and should not exceed the twice the number of slots in a frame in order to provide the fair possibility of collision-free access to the slot.

4.3 Algorithm

The pseudocode of the proposed self-managed access scheme is shown in algorithm1 and the used notations and their interpretations are as given in Table 1. The basic algorithm flow for the proposed scheme is as given in Fig. 7.

Algorithm1: Self managed access scheme

Self Managed Rule (T_i, S_i)

in: *Terminal Id* (T_i); *Slot number* (S_i)

out: *Slot number to transmit* (S_t)

$U \leftarrow T_i \ mod \ 10$

$S \leftarrow S_i \ mod \ 10$

if $R = R_1$ *then*

if U *is even then*

  if S *is even then* $S_t \leftarrow S$

  else $S_t \leftarrow S+1$ *end if*

else

  if S *is odd then* $S_t \leftarrow S$

  else $S_t \leftarrow S+1$ *end if*

end if

else if $R = R_2$ *then*

  if $S = U$ *then* $S_t \leftarrow S$

  else $S_t \leftarrow S+1$ *end if*

end if

else if $R = R_3$ *then*

  $w \leftarrow 1/p$

  $S_t \leftarrow S + rand\ (w)$

  end if

end if

return S_t

Table 1. Explanation of various notations

Notation	Definition
T_i	Id of the i^{th} terminal
U	Unit digit of terminal Id
S_i	i^{th} slot number
S_t	Slot to transmit packet
P_i	i^{th} signalling packet
R_i	Self-managed mapping rule
R_i	Rule to apply
P	Terminal priority

Once slot boundary and slot numbers have been identified, transmit the packet in contention slot based on the mapping rule and terminal id.

An appropriate mapping can be adopted based on requirements and the number of terminals participating in the network. This scheme is referred to as managed because terminals have been grouped and the population of each of the group can be managed. All the terminals of the network are not the contender of each other but only terminals of similar group contend with each other. By assigning a different ID, terminal migration from one group to other may be done as per the policy.

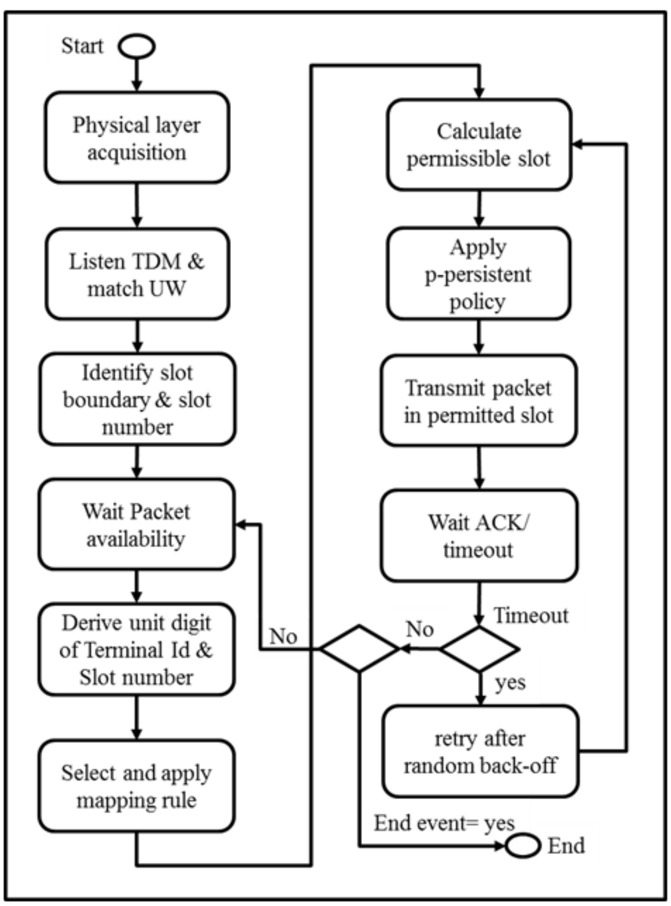

Figure 7. Self-managed scheme.

5. CONCLUSIONS

In TDM/TDMA network, terminals first need to access the random access channel to send the demand request packet in order to acquire the slot on TDMA channel for sending contention-free traffic later on. Multiple access schemes play an important role to get the access of the channel and slotted Aloha is the popular choice for random access to media. Slotted Aloha is random in nature, only slot boundaries are synchronised. Paper suggests the self-managed access scheme in which utilisation of channel can be improved as the collision domain is reduced. Three technique i.e. odd-even, unit digit and priority random access have been proposed for managed access of the contention based channel. Further, as future work, authors consider that terminals are deployed in remote areas and battery life is an important concern, therefore, suggests the dynamic sleep for improvement of the battery consumption in remote terminals.

REFERENCES

1. Herrero, O.D.R. & Gaudenzi, R.D. Generalized analytical framework for the performance assessment of slotted random access protocols. *IEEE Trans. Wireless Commun.,* 2014, **13**(2), 809-821. doi:10.1109/TWC.2013.121813.130435
2. Gaudenzi, R.D. & Herrero, O.D.R. Advances in random access protocol for satellite networks. *In* IEEE International Workshop on Satellite Space Communications. 2009. pp. 331-336. doi:10.1109/IWSSC.2009.5286351
3. Manohar, R. A comparison of various VSAT multiple access techniques with reference to the Indian context. *In*Fourth IEEE Region 10 International Conference TENCON. 1989, pp. 908-915. doi:10.1109/TENCON.1989.177079
4. Tanenbaum, A.S. & Wetherall, D.J. Computer Networks, 5th ed., Pearson Education, Inc., 2011. pp. 262-265.
5. Wolejsza, C.J.; Taylor, D.P.; Grossman, M. & Osborne, W. P. Multiple access protocols for data communications via VSAT networks. *IEEE Commun. Magazine*, 1987, **25**(7), 30- 39. doi: 10.1109/MCOM.1987.1093648
6. Hadjitheodosiou, M.H.; Coakley, F.P. & Evans, B.G. Next generation multiservice VSAT networks. *Electron. Commun. Eng. J.,*1997, **9**(3), 117–126. doi:10.1049/ecej:19970305
7. Wieselthier, J.E.; Ephremides, A. & Michaels, L.A. An exact analysis and performance evaluation of framed ALOHA with Capture, *IEEE Trans. Commun.*, 1989, **37**(2), 125-137. doi:10.1109/26.20080
8. Choudhury, G.L. & Rappaport, S.S. Diversity ALOHA - A random access scheme for satellite communications. *IEEE Trans. Commun.*, 1983, **31**(3), 450-457. doi:10.1109/TCOM.1983.1095828
9. Casini, E.; Gaudenzi, R.D. Contention resolution diversity slotted Aloha (CRDSA): An enhanced random access scheme for satellite access packet networks. *IEEE Trans. Wireless Commun.*, 2007, **6**(4), 1408-1419.

doi:10.1109/TWC.2007.348337
10. Celandroni, N. & Ferro, E. A multi-frequency TDMA/TDM system for a VSAT terminal network operating in Ka-band. *J. Commun. Networks,* 2001, **3**(2), 1-10. doi:10.1109/JCN.2001.6596857
11. Chen, S.; Huang T.; Lin, K.C.; Hong, Y.W.P. & Sabharwal, A. Probabilistic medium access control for full-duplex networks with half-duplex clients. *IEEE Trans. Wireless Commun.*, 2017, **16**(4), 2627-2640. doi:10.1109/TWC.2017.2669992
12. Kissling, C. & Munari, A. On the integration of random access and DAMA channels for the return link of satellite networks. *In* IEEE International Conference on Communications (ICC), June 2013, pp. 4282-4287. doi:10.1109/ICC.2013.6655237
13. Gallinaro, G.; Alagha, N.; Gaudenzi, R.D; Kansanen, K.; Müller, R. & Rossi, P. S. ME-SSA: An advanced random access for the satellite return channel. *In* IEEE ICC – Satellite and Space Communications, June 2015, pp. 856-861. doi:10.1109/ICC.2015.7248429
14. Chang, R.; He, Yizhou; Cui, G.; & Wang, W. An allocation scheme between random access and DAMA channels for satellite networks. *In* IEEE International Conference on Communication Systems (ICCS)*,* Dec 2016. doi:10.1109/ICC.2013.6655237
15. Gaudenzi, R.D; Herrero O.D.R; Gallinaro G.; Cioni, S. & Arapoglou, P. D. Random access schemes for satellite networks, from VSAT to M2M: a survey. *Int. J. Satell. Commun. Network*, 2018, **36**, 66-107. doi: 10.1002/sat.1204
16. Shin, Min-Su; Ryu, J. & Oh, D. On the mixed support of TDMA and SCPC for satellite disaster communications network. *In* International Conference on Information and Communication Technology Convergence (ICTC), Oct 2017, pp. 1213-1215. doi:10.1109/ICTC.2017.8190901
17. Paolini, E.; Liva, G. & Chiani, M. Coded slotted ALOHA: A graph-based method for uncoordinated multiple access. *IEEE Trans. Info. Theory,* 2015, **61**(12), 6815-6832. doi:10.1109/TIT.2015.2492579

CONTRIBUTORS

Mr Trilok Kumar Saini is MTech (Computer science & engineering) from IIT Roorkee. He is a scientist in DRDO-Defence Electronics Applications Laboratory, Dehradun. He is the recipient of *Laboratory Scientist of the year award* and the team member for *Group Technology award* and *Performance Excellence award*. He is pursuing PhD from IIT Roorkee. His work areas are mobile ad hoc network, layer 3 and 4 protocols, and satellite communication.
In current study, he proposed the scheme and designed the algorithm.

Dr S.C. Sharma received MSc, MTech and PhD from IIT Roorkee (erstwhile UOR) in 1981, 1983, and 1991 respectively. He is a professor at Indian Institute of Technology Roorkee. His research interest includes wireless and cloud computing, ad hoc, and sensor networks. He has published more than 130 research papers in journals/conferences.
In current study, he guided to improve the concept.