ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

DASN: A Robust Handover Scheme for Video Streaming in MIMO Wireless Networks with Multiple Helpers

S.Arun Singh M.E., A.Amutha Ganga,

Assistant Professor, Department of ECE, Holycross Engineering College, Vagaikulam, Thoothukudi, India

M.E., Embedded System Technologies, Holycross Engineering College, Vagaikulam, Thoothukudi, India

ABSTRACT: The paper considers the design of a scheduling policy for video streaming in a wireless network formed by several users and helpers. In such networks, any user is typically in the range of multiple helpers. The users are allowed to dynamically select the helper nodes to download from. The problem is formulated as a Network Utility Maximization (NUM) where the objective is to fairly maximize users' video streaming Quality of Experience (QoE) and then derive an iterative control policy using Lyapunov Optimization, which solves the NUM problem up to any level of accuracy. A dynamic adaptive scheme is proposed that decomposes into two building blocks: 1) adaptive video quality and helper selection (run at the user nodes); and 2) dynamic allocation of the helper-to-user transmission rates (run at the helper nodes). Since all queues in the system are stable, all requested video chunks shall be eventually delivered. Also a quality-adaptive scheme for handover and forwarding that supports mobile-video-streaming services in MIMO-capable, heterogeneous wireless access networks such as those for Wi-Fi and LTE. Security of the network is achieved by the use of an authentication key provided by an auditor node. Randomness of the key is harvested directly from the network routing metadata. Through simulations, the performance of the proposed algorithm is evaluated under realistic assumptions of a network with densely deployed helper and user nodes, including user mobility.

KEYWORDS: Adaptive Video Streaming, Massive MIMO, Network Utility Maximization, Lyapunov Optimization, Dynamic allocation, Handover, Security.

I. INTRODUCTION

The demand for data such as video contents over wireless networks has grown tremendously in recent years and is predicted to keep on increasing the mobile data traffic.

This is due to the increase in on-demand video streaming, enabled by smart phones, tablets and other multimedia devices. These devices offer to the users the possibility to roam between different access networks, and a multitude of services. In Video on Demand (VoD) streaming, the users start their streaming sessions at random times, and demand different video files. Due to the growing usage of mobile devices, handover (HO) could occur when the user is streaming the video.

A handover is the process during which a mobile node (MN) creates a new connection and disassociates from its old one. The decision for a new association may be initiated due to movement, if we are moving away from the old connection point and we are approaching a new one; low signal quality, because of interference or other impairments in the wireless path; quality of service decision, trying to effect a balanced load among neighboring or overlapping cells; better service, if we recognize a network with services that we require; or policy and cost decision, where the network or the user decide that it is more appropriate, or advantageous to relate to a different location.

ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

Over recent years, "multiple input and multiple output"

(MIMO) technology has grown rapidly in the field of wireless communications. MIMO links have provided a high spectral efficiency in wireless environments through multiple spatial channels and without a need for additional bandwidth requirements. MIMO links provide the following two operational options: (a) simultaneous transmission of different data by multiple antennas that increases the data rate, called

"spatial multiplexing" (MUX), and (b) simultaneous transmission of the same data by multiple antennas that increases the reliability or the transmission range, called

"spatial diversity" (DIV). With the proliferation of MIMO capable, heterogeneous wireless technologies and mobile electronic smart devices such as iPhones and iPads, there is a fast-growing interest in mobile video-streaming traffic for such mobile devices.

One of the main challenges regarding MIMO-capable, heterogeneous wireless technologies is the provision of the support for a robust mobile video service, whereby fast and seamless handover and forwarding schemes are supported between heterogeneous wireless-access networks. In this environment, seamless mobility and data forwarding are coupled according to user preferences, enabling mobile users to be "always best connected" (ABC) so that quality of service and quality of experience (QoS and QoE) are optimized and maintained.

Automatic key establishment between two devices in a network is generally performed either by public-key-based algorithms (like Diffie-Hellman [14]), or by encrypting the newly-generated key with a special key-wrapping key [15]. However, in addition to the well-established, well-investigated keying information exchange, to ensure the security of the application it serves, the newly generated secret key has to be truly random. While minimum standards for software based randomness quality are generally being enforced [16], many applications rely on often costly hardware-based true random generators [17].

In this paper, it is built upon the observation that a readily available source of randomness is usually neglected: the network dynamics. Indeed, by their very nature, wireless networks are highly dynamic and largely unpredictable. Their randomness is usually evident in easily-accessible networking metadata such as traffic loads, packet delays or dropped-packet rates. However, the source of randomness discussed in this paper is one that is specific to infrastructure-less networks: the routing information itself. Another interesting feature of the routing information, in addition to its randomness, is that it can easily be made available to the devices that took part in the routing process, but it is usually unavailable to those devices that were not part of the route.

The rest of this paper is organized as follows: Related work and the System model for the proposed scheme are presented in Sections II and III; the problem formulation is described in Section IV; Section V presents the analysis and performance results; and lastly, the paper is concluded in Section VI.

II. RELATED WORK

A cross layer optimization approach has been proposed in several works (e.g. see [1]–[7]). In these works, the video streaming QoE is defined in terms of performance metrics such as video quality, probability of stall events (i.e., when the playback buffer is empty and video playback stops), pre-buffering time, and re-buffering time. However, the joint optimization of these metrics by directly controlling the dynamics of the playback buffers of all the users in the network requires solving a Markov Decision Problem (MDP) which is typically quite difficult. For instance, [2] considers adaptive video transmission in a much simpler setting of a point-to-point wireless link and formulates the problem as an MDP which is then solved using the value iteration algorithm. However, even in such a simple point-to-point scenario, the value iteration policy requires extensive computation to be done offline and stored in a lookup table which is then used for the actual transmission.

ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

On the other hand, the work [6] takes a cross-layer approach and considers video delivery in the general case of a multiuser wireless network where users are served by wireless helper nodes. In order to obtain a tractable formulation for the multiuser network, [6] adopts a "divide and conquer" approach where first the problem of maximizing a function of the time-averaged video qualities, subject to queue stability is solved, and then the delay jitter is taken care of by appropriately dimensioning the pre-buffering and re-buffering times, exploiting the fact that the playback buffer can absorb the delay fluctuations around the (bounded) mean. However, in [6] a "push" scheduling policy is considered, for which video chunks can be served out of order and may result in data loss in the presence of intermittent connectivity and/or mobility. In this paper, this problem is fixed and introduces a new "pull" strategy, which is robust to fast topology variations. The proposed scheme allows each user to opportunistically pull data always in the correct sequential order from neighboring helper nodes. This results in smoother and more reliable performance.

The authors of [12] propose a cross-layer and reactive handover procedure which employs optimized movement detection and address configuration schemes based on the standard specification for HMIPv6 mobility support. For that, they utilize the advantage of link layer notification in the link layer of an AP's protocol stack and the network layer of the

AR which has a connection with the AP. However, their assumption that an AP knows the exact AR to which it is attached is strict nowadays and they did not consider MIMO and video streaming.

In [13], the authors investigated the potentiality and benefits of a novel vertical-handover algorithm for which both hard and soft handovers are exploited in a dual-mode configuration, and it was compared with the traditional hard approach. Regarding the hard vertical-handover mechanism, the connectivity between the mobile users and the serving network is broken before the connection with a new network is established (namely, "break-before-make"); alternatively, the soft vertical-handover mechanism is "make-before break" and generally improves the seamless connectivity. The algorithm of [13] aims to maintain seamless connectivity for those users moving in heterogeneous-network environments (i.e., comprised of WLAN hotspots and UMTS base stations), while still guaranteeing the user-QoS requirements. Notably, though, a fully forwarding MN scheme that is based on the MIMO mode from the pAR to the nAR in terms of the handover was not considered for these schemes. Different from the previous works [8-11], the main goal of our proposed scheme is a mechanism that selects the "best," according to an appropriate metric, wireless technology for a robust mobile-video-streaming service among all of the wireless technologies, whereby the handover and video latency are reduced on average, and the effects of perfect and imperfect handover predictions are analyzed in terms of MIMO-capable, heterogeneous wireless technologies.

The ideas of [18], [19] have been recently applied to secret key generation in wireless systems, where secure common randomness is attained by exploiting reciprocal properties of wireless channels or other auxiliary random sources in the physical layer by the authors of [20], [21], [22], [23], [24], [25], [26].

III.SYSTEM MODEL

The proposed scheme considers a wireless network with multiple users and multiple helper stations sharing the same bandwidth. Each user requests a video file which is formed by a sequence of chunks. Each chunk corresponds to a group of pictures (GOP) that are encoded and decoded as stand-alone units. Chunks have fixed playback duration. The streaming process consists of transferring chunks from the helpers to the requesting users such that the playback buffer at each user contains the required chunks at the beginning of each chunk playback deadline. The playback starts after a short pre-buffering time, during which the playback buffer is filled by a determined amount of ordered chunks. A cross layer approach is considered where the queue sizes maintained at the users act as a bridge between the layers.

Generally, regarding MIMO-capable, heterogeneous wireless technologies, several heterogeneous wireless networks can coexist; moreover, the Internet serves as a backbone that connects a home network and several heterogeneous visited networks including Wi-Fi and LTE. The home network is where the global IPv6 address (home address) of an MN exists. The IPv6 address that is based on the 48-bit MAC address of the MN is 128 bits and consists of the AR prefix (64bits) and the Modified EUI-64. The home address is a unicast routable address that has been assigned to the

ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

MN and is used as the permanent MN address. Standard IP-routing mechanisms will deliver packets that are destined for an MN home address. The domain of a visited network comprises several Access Routers (ARs) and wireless Access Points (Aps). Assuming that each AR comprises an interface that is connected to a distinct set of APs and that the same network prefix cannot be assigned to the interface of a different AR; that is, ARs are distinguished by their own prefix. Generally, a Care of Address (CoA) can be used to enable an MN so that it can send and receive packets to a Home Agent (HA) or a Correspondent Node (CN); the HA is a router in the MN-home network that the MN has registered its CoA with. While the MN is away from the home network, the HA intercepts the packets that are destined for the MN-home address, encapsulates them, and tunnels them to the MN's registered CoA; furthermore, the association between an MN's home address and a CoA is known as a "binding" for the MN. While away from the home network, an MN registers its new CoA (nCoA) with a home address, whereby the MN performs a binding registration by sending a binding update message to the HA; the HA reply to the MN is in the form of a Binding Acknowledgement message. The CN that can be either mobile or stationary is a peer node that the MN communicates with. The nCoA that is composed of the new AR (nAR) prefix in a new visited network, and the MAC address of the MN is a unicast routable address that is associated with an MN while a new visited network is being visited. The nCoA is made after the Duplicate Address Detection (DAD) is completed. The DAD corresponds to most of the handover latency because it requires time in the order of seconds to detect whether the nCoA of the MN has been duplicated. Different from [10], the MN in this paper sophisticatedly selects the best wireless technology from among multiple wireless network interfaces (WNICs) and a MIMO forwarding scheme for robust mobile video streaming.

The paper considers mobile video streaming over MIMO-capable, heterogeneous wireless networks where the AP can forward video packets to other APs with a combination of both the wireless network(i.e., Wi-Fi or LTE) and the MIMO transmission mode (i.e., MUX or DIV) based on the distance and channel quality. Similarly, through an inspection of the relation between the AP and the MN, the MN can also select the wireless technology (i.e. Wi-Fi or LTE) and the MIMO-transmission mode for a robust mobile-video-streaming service. To achieve secret common randomness, authorization is provided based on the routing metadata which is easily available for the members of the network.

IV. PROBLEM FORMULATION

The paper proposes DASN – Dynamic Adaptive Secure Network, a system for efficient delivery of video content over a wireless network formed by a number of densely deployed wireless helper nodes serving multiple wireless users over a given geographic coverage area and on the same shared channel bandwidth. DASN addresses the problem of dynamic adaptive video streaming in a wireless network by jointly optimizing the video quality adaptation at the DASH layer (application layer) and the transmission scheduling of users at the PHY/MAC layer. This is obtained through a cross layer approach where the appropriate queue sizes maintained at the users act as a bridge between the layers.

Also to reduce the handover latency, an appropriate wireless-technology metric, the MIMO mode, and the temporal reuse of verified tentative CoAs are selected for robust mobile video streaming in MIMO-capable, heterogeneous wireless networks. To ensure the security of the network, secret common randomness is achieved based on the routing information of the network.

1) First the NUM problem is formulated, where the network utility function is a concave and component wise non-decreasing function of the time averaged users' requested video quality and the maximization is subject to the stability of all the request queues in the system.

2) Then the NUM problem is solved using the Lyapunov Optimization framework and obtain the drift-plus-penalty (DPP) policy which adapts to arbitrarily changing network conditions and in fact is optimal (with respect to the NUM problem) under non-stationary and non-ergodic evolution of the underlying network state process.

ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

3) Since all the request queues in the system are ensured to be stable, the requested video chunks are eventually delivered. However, in order to ensure that all the video chunks are delivered within their playback deadline, it suffices for every user to choose a pre-buffering time which exceeds the largest delay with which a chunk is delivered.

4) *MIMO Transmission Mode selection:* The DIV provides a long transmission possibility, and it improves the reliability of the wireless link for the same data with multiple antennas. As a result, even a disconnection scenario between two nodes in the DIV mode can form a well-designed forwarding method. In the case of MUX, the different data streams per each antenna can be transmitted between two nodes; therefore, if we use the MUX mode over reliable wireless links, the throughput can be improved very effectively.

5) *Tentative Address Management (TAM):* Unlike the previous works [8-11], each Access Router (AR), such as the new AR and the previous AR, manages each tentative address pool containing the unused IP addresses that can be used as a temporal Care of Address (CoA) by a visiting MN regarding the wireless technology; these addresses are denoted by the verified tentative CoAs. The AR ensures that the verified tentative CoAs that are registered in the pool are not currently used by the other MNs by performing the Duplicate Address Detection (DAD) for each verified tentative address periodically. Basically, it is assumed that each AR maintains as many of the verified tentative CoAs according to the number of neighbor ARs in each of the possible wireless technologies. A verified tentative CoA is deleted from the pool if it is proven that it is being used by another node through the DAD. If the number of verified tentative CoAs is smaller than the number of neighbor ARs, then the router adds new verified tentative CoAs into the pool by searching the available IP addresses using the already used MAC address of the other MNs and the AR prefix.

6) *Secret Key Generation:* To ensure the security of the network only an authorized user with the secret key could access data from the network. To achieve randomness of the secret key generation, the network routing metadata from the routing protocol is used. The routing metadata such as Route request sequence number, Number of nodes traversed etc. are used. This routing information is easily available to the devices that are part of the network, but unavailable to those devices that are not part of the network. Thus, unauthorized users cannot access data from the network.

A. The Lyapunov Drift-Plus-Penalty Algorithm

Lyapunov Functions are scalar functions that are used to prove the stability of dynamical systems and control theory. Lyapunov optimization refers to the use of a Lyapunov

function to optimally control a dynamical system. A Lyapunov function is a non negative scalar measure of this multi-dimensional state. Typically, the function is defined to grow large when the system moves towards undesirable states. System stability is achieved by taking control actions that make the Lyapunov function drift in the negative direction towards zero. Minimizing the drift of a quadratic Lyapunov function leads to the back pressure routing algorithm for network stability, also called the max-weight algorithm. Adding a weighted penalty term to the Lyapunov drift and minimizing the sum leads to the drift-plus-penalty algorithm for joint network stability and penalty minimization. The Drift Plus Penalty method can be used to optimize performance objectives such as time average power, throughput, and throughput utility. The implementation of the DPP policy decomposes into the pull congestion control decisions at the users and the transmission scheduling decisions at the helpers. The pull congestion control decisions are implemented independently at each user using only the local knowledge of the queue lengths.

B. The Soft Handover Algorithm

Handoff refers to a process of transferring an ongoing call or data session from one channel connected to the core network to another. Soft handoff is also called as Mobile Directed Handoff as they are directed by the mobile telephones. Soft handoff is the ability to select between the instantaneous received signals from different base stations. Here the channel in the source cell is retained and used for a while in parallel with the channel in the target cell. In this the connection to the target is established before the connection to the source is broken, hence this is called “make-before-break”.

ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

Soft handovers may involve using connections to more than two cells: connections to three, four or more cells can be maintained by one phone at the same time. When a call is in a state of soft handover, the signal of the best of all used channels can be used for the call at a given moment or all the signals can be combined to produce a clearer copy of the signal.

C. Ad-hoc On-demand Multipath Distance Vector Routing Protocol

Ad-hoc On Demand Multipath Distance Vector Routing Algorithm (AOMDV) employs the "Multiple Loop-Free and Link-Disjoint path" technique. In AOMDV only disjoint nodes are considered in all the paths, thereby achieving path disjointness. For route discovery, route request packets are propagated throughout the network thereby establishing multiple paths at destination node and at the intermediate nodes. Multiples Loop-Free paths are achieved using the advertised hop count method at each node. This advertised hop count is required to be maintained at each node in the route table entry. The route entry table at each node also contains a list of next hop along with the corresponding hop counts. Every node maintains an advertised hop count for the destination. Advertised hop count can be defined as the

"maximum hop count for all the paths". Route advertisements of the destination are sent using this hop count. An alternate path to the destination is accepted by a node if the hop count is less than the advertised hop count for the destination.

V.PERFORMANCE EVALUATION

Our simulations are based on a network topology formed by a 1200 x 1200 region with 200 nodes forming multiple users and helpers as shown in Fig. 1. It is assumed that all the users request chunks successively from VBR-encoded video sequences. Each video file is a long sequence of chunks, each of duration 0:5 seconds and with a frame rate 30 frames per second. A specific video sequence formed by 800 chunks, constructed using several standard video clips from the database. With the cross-layer scheme, the user helper association is dynamic and it changes during the course of control policy depending on the transmission scheduling decisions which in turn depend on the achievable rates of the users and their dynamically changing request queue lengths. Such dynamic user-helper association implicitly balances the load across all the helpers in the system leading to fairness in QoE performance across the user population.

A new user is considered to enter the network. The user first gets authorized by the network controller and once authorized, the network controller broadcasts the new user's information to the existing nodes in the network. Now, the user requests data from the network. Since the user is an authorized entity, the user is able to stream data from the network. Since the user is a mobile node, on movement the user starts moving away from the area of coverage which results in decrease of signal strength. The mobile user detects for a strong signal and when the user gets nearer to another coverage area, it establishes a connection with the new area of coverage. Meanwhile, the
older connection will not be dropped since the proposed scheme considers soft handover. Once a stronger connection is established with the second area, the older connection is dropped, thus providing a seamless video streaming improving the throughput and reducing the delay.

ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

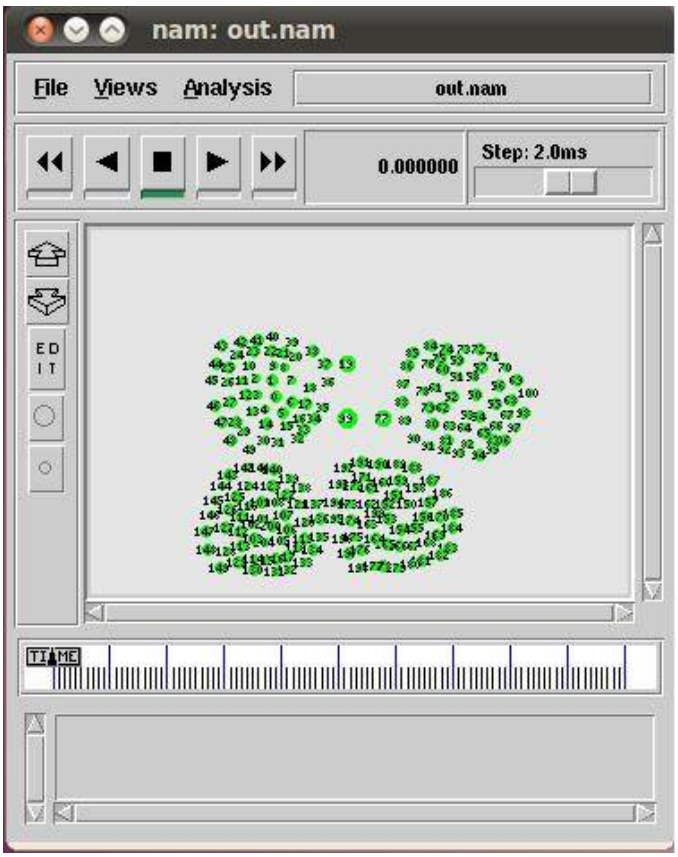

Fig. 1: Simulation setup

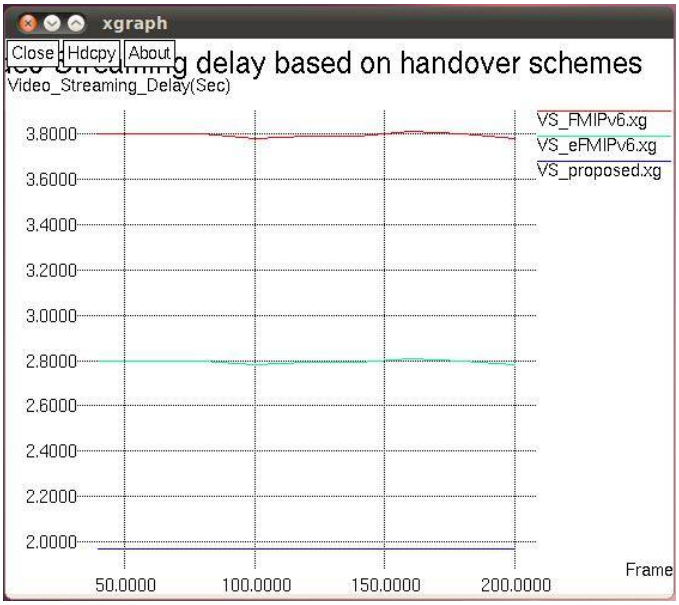

Fig. 2: Video-streaming delay based on handover schemes

ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

Figure 2 shows the video-streaming delay based on handover schemes such as FMIPv6, eFMIPv6 and the proposed. The video-streaming delay of the proposed scheme was prominently reduced. This improvement is a direct result of the ability of the MN whereby it can receive video packets from the pAR until the MN sends the LP to the pAR, and the MN can also receive video packets as soon as it moves to new visited networks by using verified tentative CoAs that are based on the appropriate selection of the wireless technology with the MIMO-transmission mode.

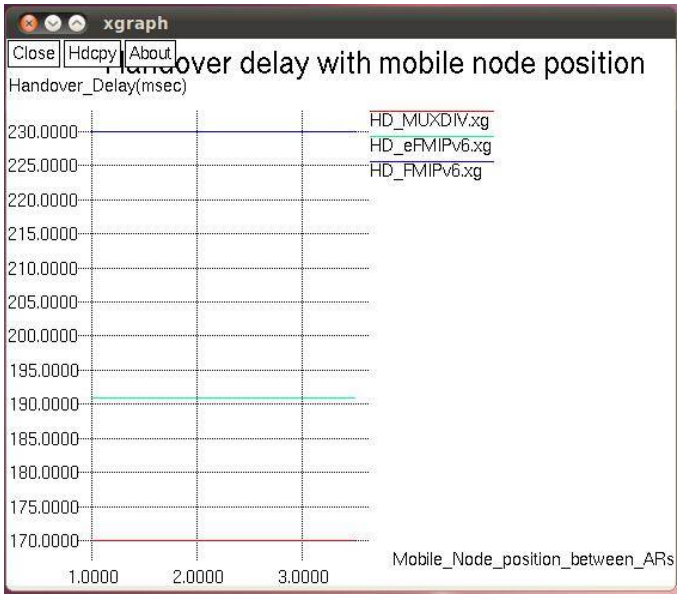

Fig. 3: Handover delay with MN position

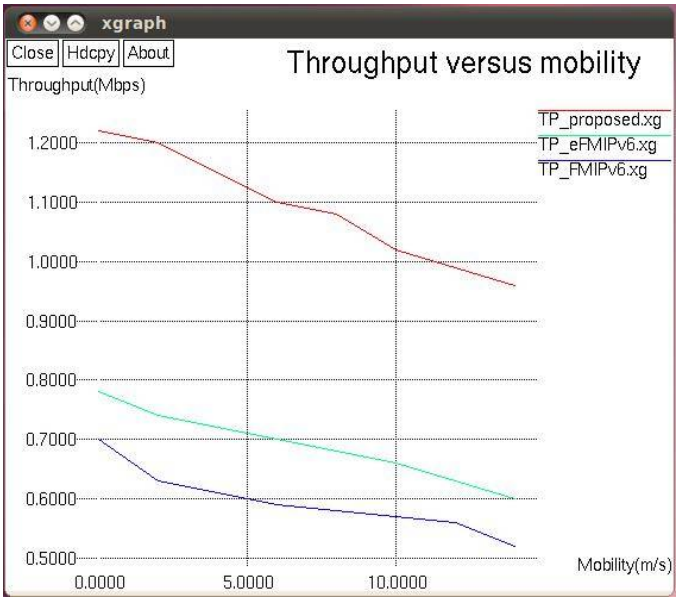

Fig. 4: Throughput

Figure 3 shows that the proposed scheme achieves lower handover latency with the MN position compared with the other schemes; that is, when the transmitted flows are mobile video streams, the proposed scheme selects the proper

ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

wireless network that comprises the temporal CoAs and the MIMO mode to minimize not only the handover delay but also the video delay. Figure 4 shows throughput gain of the proposed scheme with MIMO transmission techniques.

VI.CONCLUSION

The paper proposes DASN, a system for efficient streaming of video content in a network of helpers capable of implementing the advanced physical layer technique massive MU-MIMO. By deploying the network with multiple helpers, the load on the server is reduced, thus improving the QoS of the video streaming. The soft handover algorithm is used to reduce the handover latency along with the MIMO transmission modes – MUX and DIV and thus providing a seamless video streaming session. The security of the network is ensured with the generation of secret random key based on the routing protocol metadata. Through a performance evaluation with Network Simulator, it is shown that the proposed scheme is more robust than the other schemes for mobile video streaming.

REFERENCES

[1] V. Joseph and G. de Veciana, "Nova: Qoe-driven optimization of dash based video delivery in networks," *arXiv preprint arXiv:1307.7210*, 2013.
[2] C. Gong and X. Wang, "Adaptive transmission for delay-constrained wireless video," *Wireless Communications, IEEE Transactions on*,vol. 13, no. 1, pp. 49–61, January 2014.
[3] A. A. Khalek, C. Caramanis, and R. W. Heath Jr, "Loss visibility optimized real-time video transmission over MIMO systems," *arXiv preprint arXiv: 1301.3174*, 2013.
[4] M. Zhao, X. Gong, J. Liang, W. Wang, X. Que, and S. Cheng, "Scheduling and resource allocation for wireless dynamic adaptive streaming of scalable videos over http," in *Communications (ICC), 2014 IEEE International Conference on*, June 2014, pp. 1681–1686.
[5] C. Chen, R. Heath, A. Bovik, and G. de Veciana, "Adaptive policies for real-time video transmission: A markov decision process framework," in *Image Processing (ICIP), 2011 18th IEEE International Conference on. IEEE*, 2011, pp. 2249–2252.
[6] D. Bethanabhotla, G. Caire, and M. J. Neely, "Adaptive video streaming for wireless networks with multiple users and helpers," *Communications, IEEE Transactions on*, vol. 63, no. 1, pp. 268–285, Jan 2015.
[7] K. Miller, D. Bethanabhotla, G. Caire, and A. Wolisz, "A control theoretic approach to adaptive video streaming in dense wireless networks," *Multimedia, IEEE Transactions on*, vol. 17, no. 8, pp. 1309–1322, 2015.
[8] H. Oh, "A robust mobile video streaming in heterogeneous emerging wireless systems," *KSII Transactions on Internet and Information Systems*, 2012.
[9] H. Oh, J. Yoo, C.-K. Kim, and S. H. Ahn, "VMIPv6: A seamless and robust vehicular MIPv6 for vehicular wireless networks and vehicular intelligent transportation systems (V-Winet/V-ITS),"*Journal of Information Science and Engineering*, vol. 26, no. 3, pp.833–850, 2010.
[10] H.Oh, K. Yoo, J. Na, and C. Kim, "A seamless handover scheme in IPv6-based mobile networks," *International Journal of AdHoc and Ubiquitous Computing*, vol. 4, no. 1, pp. 54–60, 2009.
[11] H. Oh, K. Yoo, J. Na, and C.-K. Kim, "A robust seamless handover scheme for the support of multimedia services in heterogeneous emerging wireless networks," *Wireless Personal Communications*, vol. 52, no. 3, pp. 593–613, 2010.
[12] Y.-H. Han, J. Choi, and S.-H. Hwang, "Reactive handover optimization in IPv6-based mobile networks," *IEEE Journal on Selected Areas in Communications*, vol. 24, no. 9, pp. 1758– 1772,2006.
[13] A. M. Vegni and E. Natalizio, "A hybrid (N/M) CHO soft/hard vertical handover technique for heterogeneous wireless networks," *Ad Hoc Networks*, vol. 14, pp. 51–70, 2014.
[14] W. Diffie and M. E. Hellman, "New directions in cryptography,"*Information Theory, IEEE Transactions on*, vol. 22, no. 6, pp. 644– 654, 1976.
[15] M. Bellare and C. Namprempre, "Authenticated encryption: Relations among notions and analysis of the generic composition paradigm," *in Advances in Cryptology ASIACRYPT 2000. Springer-Verlag, 2000*, pp. 531–545.
[16] S. K. Park and K. W. Miller, "Random number generators: good ones are hard to find," *Communications of the ACM*, vol. 31, no. 10, pp.1192–1201, 1988.
[17] B. Sunar, "True random number generators for cryptography," in *Cryptographic Engineering. Springer*, 2009, pp. 55–73.
[18] U. E. Maurer, "Secret key agreement by public discussion from common information," *Information Theory, IEEE Transactions on*, vol. 39, pp.733–742, May. 1993.
[19] R. Ahlswede and I. Csiszar, "Common randomness in information theory and cryptography – Part I: secret sharing," *Information Theory, IEEE Transactions on*, vol. 39, pp. 1121–1132, July 1993.
[20] J. W. Wallace and R. K. Sharma, "Automatic secret keys from reciprocal MIMO wireless channels: measurement and analysis,"*Trans. Info*. For. Sec., vol. 5, pp. 381–392, September 2010.
[21] A. Agrawal, Z. Rezki, A. Khisti, and M. Alouini, "Non coherent capacity of secret-key agreement with public discussion," *Information Forensics and Security, IEEE Transactions on*, vol. 6, no. 3, pp. 565 – 574, sept. 2011.
[22] Q. Wang, H. Su, K. Ren, and K. Kim, "Fast and scalable secret key generation exploiting channel phase randomness in wireless networks," *in INFOCOM, 2011 Proceedings IEEE*, April 2011, pp. 1422 –1430.
[23] K. Ren, H. Su, and Q. Wang, "Secret key generation exploiting channel characteristics in wireless communications," *Wireless Communications, IEEE*, vol. 18, no. 4, pp. 6 –12, august 2011.
[24] T.-H. Chou, S. Draper, and A. Sayeed, "Key generation using external source excitation: Capacity, reliability, and secrecy exponent,"*Information Theory, IEEE Transactions on*, vol. 58, no. 4, pp. 2455 – 2474, April 2012.
[25] C. Ye and P. Narayan, "Secret key and private key constructions for simple multi terminal source models," *Information Theory, IEEE Transactions on*, vol. 58, no. 2, pp. 639 –651, Feb. 2012.
[26] A. Khisti, S. Diggavi, and G. Wornell, "Secret-key generation using correlated sources and channels," *Information Theory, IEEE Transactions on*, vol. 58, no. 2, pp. 652 –670, Feb. 2012.