ISSN:2413-6999
Journal of Information, Communication, and Intelligence Systems (JICIS)
Volume 1, Issue 1, August 2023

Enhanced Congestion Control Mechanism to Improving TCP Performance over Heterogeneous Wired-Cum-Wireless Environments

Hassan Sabri Abu-Almash

***Abstract*— The proposed idea in this paper based on identifying an optimum congestion window (cwnd) of Transmission Control Protocol (TCP) the sender side. The proposed mechanism includes a strategy to keeping the cwnd in fixed level to a point that is the reasonable portion in the link, and then reformed substantially since the occasion of the control of the magnitude of the last cwnd level. At this time, the TCP cwnd is estimated conferring to the environment of new situation. The suggested technique is mainly operative on wireless channels, that are have an fundamentally high packet drop rate, than the enhanced TCP cwnd being self-determining of packet drop but keeping the transmitted packet rate on the same level**

***Index Terms*— TCP, Westwood, Wired-cum-Wireless, cwnd.**

I. Introduction

The familiar threat in TCP congestion control mechanism over Wired–cum –Wireless environments is that it depend on the rate of packets drop as an pointer of link congestion point [1][2]. With the aim of affluence, the congestion status and to avoiding the congestion collapse. In TCP Reno, the sender ide decreases the cwnd and desists from transmitting packets. In wired network side, the congested gateway is habitually the conceivable motive of packet damage, although in the wireless side is suffer from loss and interference, the link is the further possible reason of packet drop. This generates difficulties in Reno performance, due to it doesn't have the competence to discriminating and separate the congestion packet drop from wireless link drop.

Hassan Sabri Abu-Almash, Cultural Relationship Directorate, Ministry of Higher Education and Scientific Research, Baghdad, Iraq.

The methods that are used to addressing this problematic have been deliberated and associated in the effort by Balakrishnan [3][4]. There are three alternate techniques: the first is End-to-End (E2E), and the second approaches is Split-Connection, while the third is Localized Link Layer (LLL) approaches were it will widely distinguished. In Split-Connection technique [5]-[6] TCP interrupts the semantic property in reliability of E2E, then this technique needs to many maintenance on the side of base station. TCP Westwood (TCPW)is one of new and popular protocol with an approach in congestion control that depends on estimation of the available E2E bandwidth [7][8].

The work of this article customs the TCP Westwood to estimating the bandwidth arrangement and moreover matches the concert of the improved Westwood in sender side with typical Westwood sender.

II. Bandwidth Estimation Technique

TCP Westwood in sender side is monitoring packet Acknowledgment (ACK) to estimating the bandwidth. This mechanism is defined fleetingly below.

If we suppose that an ACK is accepted by TCP sender at time equal to t_k, and informing that d_k packets (Bytes) have been accepted at the TCP Westwood in receiver side, then

we can estimate the next link bandwidth that are used via:

$$b_k = d_k / \Delta k,$$

$$\text{where } \Delta k = t_k - t_{k-1}$$

and the term t_{k-1} represents the time of the earlier ACK that were arrived at the sender.

DOI: https://doi.org/10.33193/JICIS.1.1.2023.5

ISSN:2413-6999
Journal of Information, Communication, and Intelligence Systems (JICIS)
Volume 1, Issue 1, August 2023

In the following filter which is based on discrete time which is achieved via discretize a continued low pass filter with approximation of Tustin:

$$b'_k = \alpha_k b'_{k-1} + (1 - \alpha_k)(b_k + b_{k-1})/2$$

Where:

b'_k: filtered estimation of the bandwidth that is available at the connection at time equal to:

$$t = t_k, \ \alpha_k = (2\tau - \Delta_k)/(2\tau + \Delta_k),$$

Where $1/\tau$ represents the filter cutoff frequency.

Algorithm after n duplicate ACKs is:

```
The pseudo code of the algorithm is the following:
if (n DUPACKs are received)
 ssthresh = (BWE * RTTmin)/seg_size;
 if (cwnd > ssthresh) /* congestion avoid */
    cwnd = ssthresh;
 endif
endif
```

Also, the function seg_size represents the measurement of the TCP Westwood consignment segments in bits unit.

Algorithm after coarse timeout expiration:

```
The pseudo code of the algorithm is:

if (coarse timeout expires)
 ssthresh = (BWE * RTTmin)/seg_size;
 if (ssthresh < 2)
    ssthresh = 2;
 endif;
 cwnd = 1;
endif
```

III. Proposed Mechanism

In the suggested technique, we are used an algorithm to estimating the available bandwidth over the current connection that is similar to the technique that are used in TCP Westwood to obtaining an estimation to the available fair-share of the connection.

The variation in the Round Trip Time (RTT) estimations is used as a start to transfer to the re-calculate the current phase by the constant cwnd, where our technique is use the knee section in the curve of RTT curve as explained in [9] to detecting the variation in fare- share and then triggering the re-estimation again. The enhanced TCP in our proposed technique force the sender to moving in three phases through the congestion window period. These three distinct phases are the Slow-Start phase, Window Re-estimation phase, and constant window phase.

In slow-start phase and after connation is established, TCP sender have no suspicion of the expected scenario of the network, and to inform the dynamicity behavior, TCP sender exhortations since by characteristic evasion standards for these vital qualities of the linking [10]. While in re-estimation situation, if a variation in accessible fair-share is noticed via a trigger, then the sender of TCP arrives to re-estimation phase. This represents the greatest vital stage of the construction, so in this point, cwnd is considered is saved constantly throughout the following stage. Therefore, the TCP performance is to identifying how fine it exploits its sharing over the connection of the network, be contingent on the estimated cwnd.

On constant window phase, cwnd is saved with constant level and regardless of the ACKs number that are expected or any signs of packet dropping may happened. Additionally, the TCP sender retains the estimated RTT track via delivered segments or packets, and when the ratio of changing in curved RTT exceeds the previous RTT that are measured, then TCP sender departures this phase (constant window) and go in the window re-estimation phase again.

The pseudo code of the proposed algorithm is can described below:

DOI: https://doi.org/10.33193/JICIS.1.1.2023.5

```
if( slow_start_state)

slow_start(); /* open cwnd by one segment on each ACK
arrival */

else
{


  if(|rtt_arc−rtt_var|/rtt_arc>β) /* fractional increase greater than
threshold */

  {
    /* recalculate window and archive the value of rtt_var */
    cwnd_ = (Estimated_Bandwidth*rtt_min) / seg_size_;
    if(cwnd_ < 1) cwnd_=1;
       rtt_arc = rtt_var ;

  }

}
```

This pseudo code includes many parameters, where seg_size_ is expressed to the number of bytes that are construct the TCP segment, while; rtt_{min} refers to the measured of the minimum amount of rtt during the congestion period of the links, and also the Estimated_Bandwidth refers to the accessible bandwidth that are obtained via the proposed technique.

IV. Performance Evaluation

This part will discussing and reporting the behavior and the performance evaluation of the enhanced TCP and its impartiality over a links that are shared the same bottleneck connection.

This evaluation and comparison is completed with two TCP variants, Westwood and Reno with an identical simulation scenarios.

Figure 1 demonstrates the network topology of the proposed scenario that we are used for network simulation.

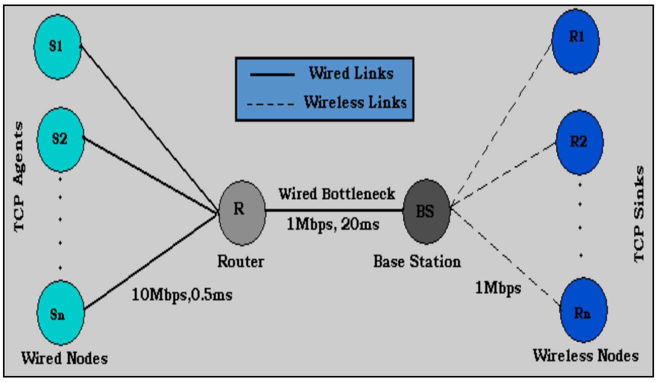

Fig. 1 Proposed network topology and scenario using NS-2 simulator

The evaluation process based on different measurements and experiments. Figure 2 shows that cwnd is stated in segment, and the obvious commencing in Figure 3 illustrates the constant cwnd level of TCP outdoes TCP Reno and TCP Westwood in sender side functioning and effective in similar network situations.

On other hands, about 10% to 15% the increasing amount in throughput has been gained as is apparent in Figure 3. Additionally, in Figure 3, the error or errors percentage are stated as percentage.

Figure 4 is demonstrated the comparison of the performance of TCP versions with multiple links or connections that are sharing the similar wired bottleneck link so, when the packet is drop due to congestion that can increasing the possibility to detect the behavior of the new technique as shown in this figure, where we can note the constant cwnd level of TCP in Reno and TCP Westwood.

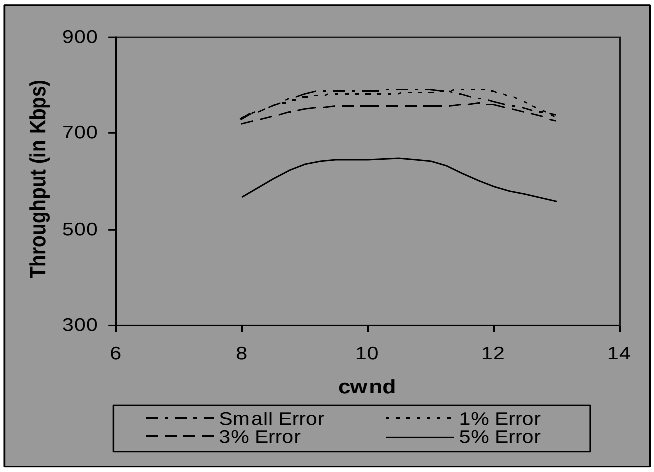

Fig. 2 Evaluation and comparison of TCP throughput high congestion link and four bit error rates ration

DOI: https://doi.org/10.33193/JICIS.1.1.2023.5

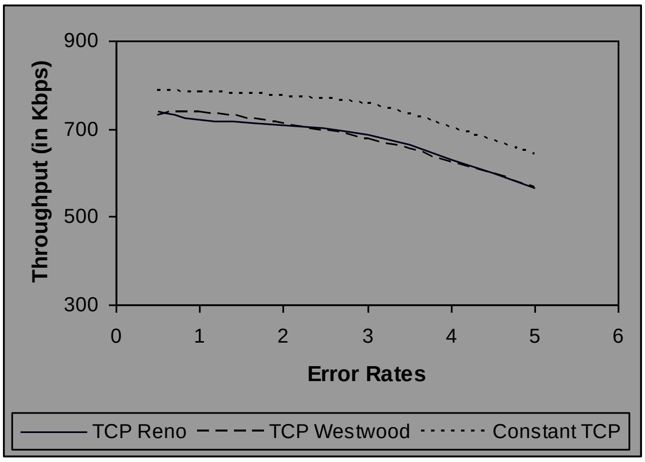

Fig. 3 Evaluation and comparison of throughput for TCP Reno, Westwood, and constant TCP

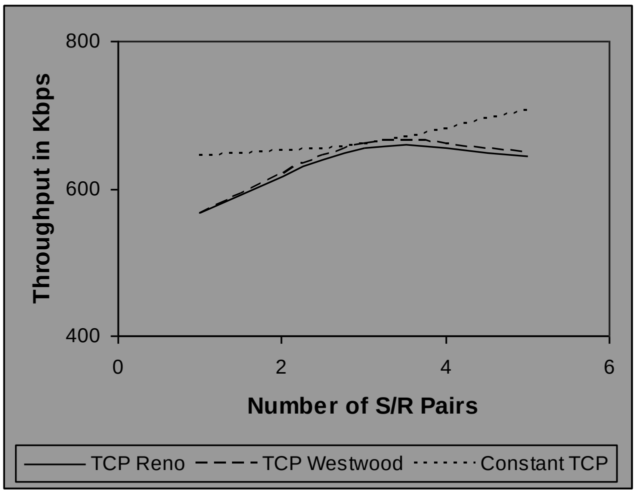

Fig. 4 Evaluation and comparison of throughput of TCP Reno, Westwood, and constant TCP with loss of 5%

V. Conclusions

This article is proposed a novel technique to modifying TCP congestion control mechanism. Also, Additionally, this paper is offered we an evaluation and comparison to the performance of improved TCP throughout a specific phase called the constant cwnd phase. The imitations achieved has exposed a throughput improvement about 10% to 15% compared with TCP Reno and TCP Westwood with constant error rates and around 10% to 20% with burst error. One significant feature of the enhanced TCP is cwnd must be established to an optimal amount for a specified connections, and for this purposes, an effectual Bandwidth Estimation technique is considered that are automatically estimating the connection fair-share grounded on confident experimental factors.

References

[1] Jiwen chen, yeng-zhong Lee, Mario perla “Performance comparison of AODV and OFLSR in wireless networks”
[2] David remondo “Wireless adhoc Networks”
[3] Raad al Turki and Rashid mahmood “Multimedia Ad hoc networks :Performance analysis”
[4] Ns2 tutorial-http://www.isi.edu/nsnam/ns/
[5] C.K.Toh “ad hoc mobile wireless networks protocols and systems”
[6] Luks klein-Berndt “A quick guide to AODV routing”
[7] “ Tutorial Wireless Ad-Hoc Networks “ David Remondo.
[8] “Wireless Mesh Networking , third generation”, magazine, EFY Enterprises.
[9] Ghassan A. Abed, Mahamod Ismail and Jumari Kasmiran, (2012). Exploration and evaluation of traditional TCP congestion control techniques. Journal of King Saud University - Computer and Information Sciences, 24(2), 145–155.
[10] Ghassan A. Abed, Mahamod Ismail and Jumari Kasmiran, "A Survey on Performance of Congestion Control Mechanisms for Standard TCP Versions", Australian Journal of Basic and Applied Sciences, vol. 5, no. 12, 2011.
[11] Ghassan A. Abed, Mahamod Ismail and Jumari Kasmiran, "The Evolution To 4g Cellular Systems: Architecture And Key Features Of LTE-Advanced Networks", spectrum, 2012.
[12] Ghassan A. Abed, Mahamod Ismail and Jumari Kasmiran, “Traffic Modeling of LTE Mobile Broadband Network Based on NS-2 Simulator,” Computational Intelligence, Communication Systems and Networks (CICSyN), 2011 Third International Conference on,2011, pp. 120-125.
[13] Ghassan A. A., Mahamod I. and Kasmiran J.:” Modeling and Performance Evaluation of LTE Networks with Different TCP Variants”. International Scholarly and Scientific Research & Innovation 5(3), pp 443-448. (2011).
[14] Ghassan A. Abed, Mahamod Ismail and Jumari Kasmiran, "Behaviour of cwnd for Different TCP source Variants over Parameters of (LTE) Networks, " Information Technology Journal, ISSN: 1812-5638, Science Alert, 2011.
[15] Ghassan A. Abed, Mahamod Ismail and Jumari Kasmiran, Characterization and observation of (transmission control protocol) TCP-vegas performance with different parameters over (long term evolution) LTE networks. Sci. Res. Essays 6, 2003–2010 (2011).
[16] Ghassan A. Abed, Mahamod Ismail and Jumari Kasmiran, "A comparison and analysis of congestion window for HS-TCP Full-TCP and TCP-Linux in long term evolution system model", 2011 IEEE Conference on Open Systems, pp. 358-362, 2011.
[17] Ghassan A. Abed, Mahamod Ismail and Jumari Kasmiran, “Distinguishing employment of stream control transmission protocol over LTE-Advanced networks,” Research Journal of Information Technology, vol. 3, no. 4, pp. 207–214, 2011.
[18] Ghassan A. Abed, Mahamod Ismail and Jumari Kasmiran, "Architecture And Functional Structure Of Transmission Control Protocol Over Various Networks Applications," Journal Of Theoretical And Applied Information Technology, Vol. 34, 2011.
[19] Ghassan A. Abed, Mahamod Ismail and Jumari Kasmiran, "Improvement of TCP Congestion Window over LTE-Advanced Networks", Faculty of Engineering and Built Environment The National University of Malaysia. International Journal of Advanced Research in Computer and Communication Engineering, vol. 1, no. 4, June 2012.
[20] Ghassan A. Abed, Mahamod Ismail and Jumari Kasmiran, "Appraisal of Long Term Evolution System with Diversified TCP's," in 5th Asia Modelling Symposium (AMS), may 2011, pp. 236-239.
[21] Ghassan A. Abed, Mahamod Ismail and Kasmiran Jumari, A Realistic Model and Simulation Parameters of LTE-Advanced Networks, Selangor, pp. 2278-1021, 2012.

DOI: https://doi.org/10.33193/JICIS.1.1.2023.5

[22] Ghassan A. Abed, Mahamod Ismail and Jumari Kasmiran, Influence of Parameters Variation of TCP-Vegas in Performance of Congestion window over Large Bandwidth-Delay Networks, 2011 17th Asia-Pacific Conference on Communicaions, 434-438, 2011.

[23] Ghassan A. Abed, Mahamod Ismail and Jumari Kasmiran, "Comparative Performance Investigation of TCP and SCTP Protocols over LTE/LTE-Advanced Systems", International Journal of Advanced Research in Computer and Communication Engineering, vol. 1, no. 6, pp. 466-471, 2012.

[24] Ghassan A. Abed, Mahamod Ismail and Jumari Kasmiran, Integrated approaches to enhance TCP performance over 4G wireless network. In: IEEE Symposium on Computers and Information, Penang, pp. 154–158 (2012).

[25] Ghassan A. Abed, Queue size comparison for standard transmission control protocol variants over high-speed traffics in long term evolution advanced (LTE-A) network. Sci. Res. Essays – Acad. J. 9(23), 984–987 (2014).

[26] Ghassan A. Abed, Mahamod Ismail, S. I. Badrawi and B. M. Sabbar, "An Empirical Model of Correlated Traffics in LTE-Advanced System through an Innovative Simulation Tool", International Journal of Electrical Robotics Electronics and Communications Engineering, 2013.

[27] Ghassan A. Abed, Mahamod Ismail and Jumari Kasmiran, "Experimented goodput measurement of standard TCP versions over large-bandwidth low-latency bottleneck", J. Comput., vol. 4, no. 5, pp. 212-216, 2012.

DOI: https://doi.org/10.33193/JICIS.1.1.2023.5