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Novel Architectures and Algorithms for Delay Reduction in Wireless Multi Hop Networks

Deepa E. S.
Department of Computer Science & Engineering
NCERC, University of Calicut, Thrissur, India

Jasmine Joseph
Department of Computer Science & Engineering
NCERC, University of Calicut, Thrissur, India

Abstract

Contemporary wireless multihop networks work much underneath their capacity because of the poor coordination among transmitting nodes. Cross-layer architectures offer a radical option by upholding participation among the numerous layers of the protocol stack. At the center of these architectures is the backpressure scheduling algorithm which accomplishes the system limit. XPRESS is throughput-optimal backpressure architecture for wireless multihop networks. XPRESS is made out of a central controller, which performs backpressure scheduling taking into account the deliberate wireless network state, furthermore of the wireless nodes, which intermittently give the network estimations and execute the registered timetable utilizing a cross-layer protocol stack. One of the main drawbacks of this scheme is delay reduction. Delay reduction techniques give preferred delay execution over traditional backpressure as far as the most extreme throughput.
Keywords: Wireless Multihop Networks, Backpressure scheduling and routing, Design And Implementation, IEEE 802.11, Congestion Control

I. Introduction

Remote networks are getting to be progressively main stream in telecommunications, particularly for the provisioning of portable access to wired system administrations. As an outcome, endeavors have been dedicated to the provisioning of dependable information conveyance for a wide mixed bag of uses over diverse remote bases. In remote networks, paying little respect to the area, clients can access administrations accessible to wired-system clients. In this situation, the IEEE 802.11 gauges speak to a noteworthy turning point in the provisioning of system network for versatile clients. Then again, the 802.11 medium access control strategy and physical variability of the transmission medium prompts limits as far as control over data transfer capacity, inertness, data misfortune, and versatility. Also, the arrangement of the Transmission Control Protocol (TCP) over IEEE 802.11 networks is compelled by the low unwavering quality of the channel, hub versatility, and long and variable Round Trip Times (RTTs).

A. Wireless Network Architectures

In the following paragraphs, a brief classification of wireless networks is provided, based on the required coverage area.

1) Wireless Wide Area Network (WWAN)

WWANs offer associations over wide land territories with the utilization of numerous reception apparatus destinations (cells). Current WWANs are principally in view of second generation (2G) cell advancements, for example, GSM and CDMA. The third generation (3G) cell systems were imagined to supplant 2G advancements, yet experienced the gigantic expenses for spectrum licenses and troubles in distinguishing fitting executioner applications. As of now 3G advances compare to a littler cut of the general cell market than 2G, with a high entrance prove in Asia Pacific and North American district.

Fig. 1: Network Architectures

2) Wireless Metropolitan Area Network (WMAN):
WMANs speak to a decent option to optical fiber advancements, empowering substitutions between different areas inside a metropolitan zone. The key wireless technology considered for WMANs is taking into account IEEE 802.16 standard which is additionally alluded as Worldwide Interoperability for Microwave Access (WiMAX). At first, WiMAX technology was composed as a metropolitan spine for interconnection of littler systems or settled individual clients obliging broadband access. This is regularly alluded to as Fixed WiMAX and compares to IEEE 802.16 at last endorsed in 2004. At that point, Mobile WiMAX has been created – an air interface alteration pointed more at end-clients, instead of little systems. Portable WiMAX is in view of IEEE 802.16e standard correction endorsed in 2005. The technology is commonly used to provide internet to rural areas.

3) Wireless Local Area Network (WLAN):
WLANs technologies provide connectivity to the end-user terminal devices covering a small geographic area, like corporate or campus building. The IEEE 802.11 commonly known as WiFi, became the de facto standard for WLAN networking. While the original WiFi specification approved in 1997 aimed at 1 or 2 Mb/s at the physical layer, later physical air interface modifications increased the transmission rate: 802.11a (1999) for up to 54 Mb/s in 5GHz band, 802.11b (1999) for up to 11 Mb/s in 2.4 GHz band, 802.11g (2003) of up to 54 Mb/s in 2.4 GHz band, and 802.11n for up to 250 Mb/s in both 5GHz and 2.4 GHz bands. In WiFi, mobile stations establish connections to wireless access points which serve as a bridge between the radio link and a wired backbone network. As an option, in case mobile stations are located within the transmission range of each other and no network backbone access is required, an ad hoc network may be created.

4) Wireless Personal Area Network (WPAN):
WPANs are intended to unite client devices situated inside of individual correspondence range which is commonly considered of up to 10 meters from a man. Bluetooth is the main business standard for WPANs. These days, WPANs are upheld by mobile phones, PDAs, laptops and different wireless devices. By and by, the principle application for Bluetooth stays wireless headset association. A promising innovation in the WPAN situation is in light of Ultra-wideband (UWB) radio interchanges conceivably ready to give 1Gb/s interfaces over short range. UWB PAN is determined in IEEE 802.15.4a standard finished in March 2007. The innovation for WPANs is in its earliest stages and is experiencing fast advancement now a day.

B. Performance Issues and Solutions in Wireless Networks

Nowadays, a large portion of the main wireless technologies are broadly sent at the last mile –connecting end-client to the center of the network, and take after infrastructure network association, where wireless links are basically used to interface end client supplies to the base station which thus gives integration to the altered network.

Undoubtedly, last mile is the most basic issue in today's network architectures. The qualities of the last mile interfaces frequently focus the execution of the general network, speaking to the genuine limit bottleneck on the whole way from the data source to the destination and affecting the attributes of traffic patterns moving through the network.

Furthermore, wireless networks experience the ill effects of a few execution limits, sometimes identified with unnecessary trouble getting from the layering ideal model utilized for the TCP/IP protocol stack design. Truth be told, TCP/IP initially designed for wired links (portrayed by high bandwidth, low delay, low packet misfortune likelihood - high unwavering quality, static routing, and no versatility) performs inadequately in wireless domain.

The principle purposes behind poor execution are in the very way of wireless technologies .One of the primary advances offered by wireless networks relates to client terminal mobility, which permits network access from distinctive areas while keeping up continuous administration. Then again, mobility - a crucial prerequisite for network provisioning on whenever, anyplace premise - includes some significant pitfalls While a large portion of the current wireless technologies advance into a focalized All-IP network the fundamental TCP/IP protocol stack reference model intended for the settled Internet does not permit smooth adjustment for mobility for the most part because of its layering model.

Generally, mobility management solutions dwelled inside a solitary layer, with a sensible division into system (layer-3) layer solutions and connection (layer-2) layer solutions. On the other hand, the choice about which layers ought to be included so as to give proficient mobility backing speaks to a hot discourse subject. What gets to be clear is that the solutions executed at distinctive layers are more reciprocal to one another as opposed to option. While a few layers seem to handle mobility better than others, it is clear that mobility help can't be actualized inside a solitary layer in a proficient way, and therefore obliges cross-layer mindfulness and collaboration. Cross-layer architectures offer a radical option by bolstering collaboration among the multiple layers of the protocol stack. At the core of these architectures is the backpressure scheduling algorithm which achieves the network capacity. Based on the theoretical concepts of backpressure scheduling algorithm, designed a cross-layer backpressure architecture called XPRESS which can yield maximal throughput. While XPRESS has shown significant improvements over IEEE 802.11, there are a few issues that must be dealt with for efficient operation. One of the main drawbacks of this scheme is delay reduction. One of the delay reduction scheme called Backpressure with Adaptive Redundancy (BWAR) and its theoretical concepts is also discussed.

II. RELATED WORKS

A. Backpressure architecture over TCP

The backpressure algorithm was presented by Tassiulas and Ephremides[1]. which demonstrated that, in wireless systems where nodes route and schedule packets taking into account queue backlog contrasts, one can settle the queues for any feasible traffic. This fundamental thought has produced a considerable measure of exploration investment. One vital commonsense issue that remaining parts open, and is the concentrated in [2]. Execution of backpressure with Transmission Control Protocol (TCP) streams is portrayed. TCP and backpressure are not perfect because of a confuse between the congestion control system of TCP and the line size based routing and scheduling of the backpressure structure. Proposed a TCP-mindful backpressure routing and scheduling that considers the conduct of TCP streams. TCP-mindful backpressure gives (i) throughput optimality ensures in the Lyapunov optimization framework, (ii) smoothly consolidates TCP and backpressure without rolling out any improvements to the TCP convention, (iii) enhances the throughput of TCP streams altogether, and (iv) gives reasonableness crosswise over contending TCP streams.Proposed TCP-aware backpressure directing and planning can address the inconsistency of TCP and backpressure while abusing the execution of backpressure steering and booking over remote systems. TCP-aware backpressure is created by considering the conduct of TCP flows, and smoothly consolidates TCP and backpressure without rolling out any improvements to the TCP protocol.

There has been far reaching deal with network architectures that backing multi-path routing to enhance execution in wireless mesh networks. Taking into account all hypothetical ideas of backpressure a framework composed, called Horizon for multi-path sending in wireless meshes [3]. The planned framework meets expectations with an unmodified TCP stack and on top of the current 802.11 MAC. Horizon is the first reasonable wireless system taking into account back-pressure, which keeps away from bottlenecks as well as ideally load-balances traffic crosswise over them when required, enhancing decency among contending streams. In a few evident instance of self-contention, Horizon does not work. Because of multi path routing and scheduling, making extra contention is an issue which diminish execution. These scheduling issues are regular to the majority of the multi-path routing conventions in wireless, and are created by the sub-optimality of the MAC layer scheduling.

B. Congestion Control

Congestion control in wireless multi-hop networks is testing on account of two reasons. First and foremost, show is a characteristic gimmick of wireless networks and propels numerous imaginative protocols including astute routing and network coding. These protocols empower the utilization of numerous various, yet progressively changing routing ways. Congestion control for these protocols utilizing customary end-to-end protocols, for example, TCP may bring about excessively moderate rate control. Second, the wireless medium is imparted among neighboring hubs; subsequently bandwidth must be distributed reasonably among neighboring streams that don't essentially have the same link. There have been no viable answers for congestion control for these networks. Motivated by existing hypothetical arrangements of crosslayer advancement, created a protocol, called DiffQ, for congestion control in wireless multi-bounce systems. DiffQ can help congestion control for system streams that utilization either single-path or shrewd multi-path routing. It is watched that DiffQ extraordinarily enhances the productivity and decency of existing transport protocols that utilization application-level multi-path routing and single-path routing.

Developing investment and infiltration of wireless networking technologies is underlining new difficulties in the configuration and improvement of communication protocols. Generally, protocol architectures take after strict layering standards, which guarantee interoperability, quick sending, and effective executions. Nevertheless, deficiency of coordination between layers limits the execution of such architectures due to the specific troubles acted by wireless nature of the transmission links. To overcome such impediments, cross-layer outline has been proposed. Its center thought is to keep up the functionalities related to the first layers yet to permit coordination, cooperation and joint improvement of protocols crossing diverse layers. So presented XPRESS, a cross-layer backpressure architecture intended to achieve the limit of wireless multihop networks. As opposed to a gathering of insufficiently formed wireless routers, XPRESS changes a cross section system into a wireless switch. Transmissions over the network are scheduled utilizing a throughput-optimal backpressure algorithm.

XPRESS is a throughput-optimal backpressure architecture for wireless multihop networks. In XPRESS, a mesh network is changed into a wireless switch, where packet routing and scheduling choices are made by a backpressure scheduler. XPRESS is made out of a focal controller, which performs backpressure scheduling taking into account the deliberate wireless network state, furthermore of the wireless nodes, which occasionally give the network estimations and execute the figured calendar utilizing a cross-layer protocol stack.

While XPRESS has shown significant improvements over 802.11, there are a few issues that must be dealt with for efficient operation. One of the main drawbacks of this system is delay reduction.

Delay Reduction is the problem that should be handled. In backpressure scheduling, there are no pre-established routes; the route taken by a packet depends on the network congestion. As a result, packets may visit the same node more than once and create loops. This is particularly common in under loaded networks.

III. BACKPRESSURE WITH ADAPTIVE REDUNDANCY (BWAR)

Adaptive redundancy technique for backpressure routing yields the benefits of replication to reduce delay under low load conditions. While at the same time preserves the performance and benefits of traditional backpressure routing under high traffic conditions. This technique creates copies of packets in a new duplicate buffer upon an encounter, when the transmitter's queue occupancy is low. These duplicate packets are transmitted only when the original queue is empty.

IV. DELAY EFFICIENT SCHEDULING VIA REDUNDANT CONSTRAINTS

Another throughput-optimal delay-based back-pressure scheme for multi-hop wireless networks is delay efficient scheduling via redundant constraints (DESC). Introduce a new delay metric suitable for multi-hop traffic and establish a linear relation between queue lengths and delays in the fluid limit model, which plays a key role in the performance analysis and proof of throughput-optimality. Delay-based schemes provide a simple way around the well-known last packet problem. that plagues the queue-length based schedulers, and avoid flow starvation. As a result, the excessively long delays that could be experienced by certain flows under the queue-length-based scheduling schemes are eliminated without any loss of throughput.

V. PERFORMANCE EVALUATION AND RESULTS

In this section we evaluate performance of the XPRESS compare to proposed system. The simulation results are used to compare the performance of proposed protocol with XPRESS in multi-hop networks.

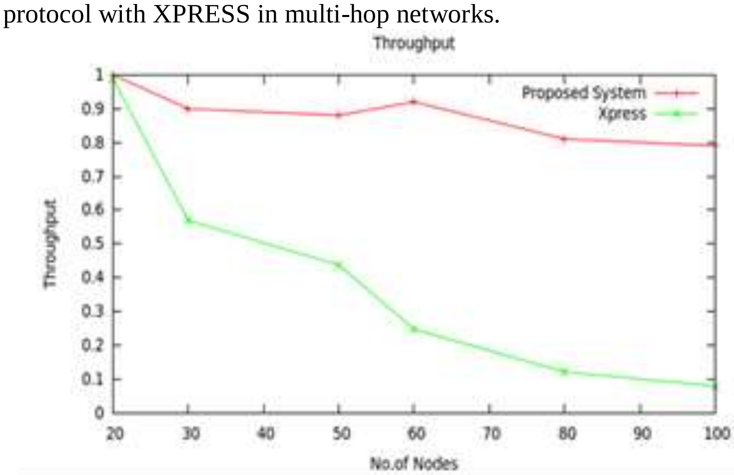

Fig. 2: Throughput vs No of Nodes

We use the simulation results obtained from scenarios in which different nodes are kept in different channels which lead to missing of broadcast packet. On the basis of obtained results, we plot a graph between throughput of XPRESS and proposed protocol in multi-hop networks and it is as shown in Fig.2. From the graph shown below it is clear that our proposed work performs better than Existing system XPRESS. The throughput obtained while using XPRESS as well as proposed is taken for comparing and analyzing the performance result. In XPRESS, as the no: of nodes increases the chance of missing broadcast packets increases which inturn affects the network performance and we may not get desired throughput.

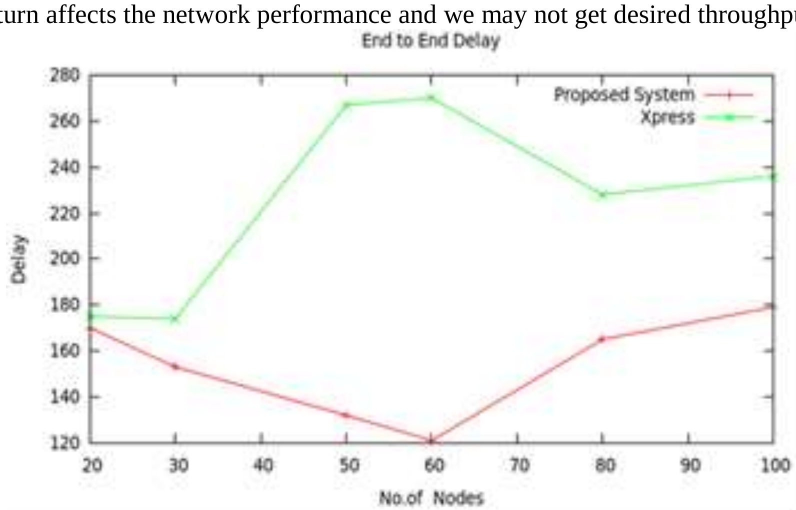

Fig. 3: Average End to End Delay vs No of Nodes

Fig. 3 shows the average end-to-end packet delay (the time duration for a packet to be received correctly by its destination) which is important for real time applications. The factors affecting end to end delay are queuing, back-off, propagation, access, switching, and transmission time. The queuing size of each node is 50 packets. The proposed work achieves less delay compared to XPRESS because the channel selection and transmission are done at right time.

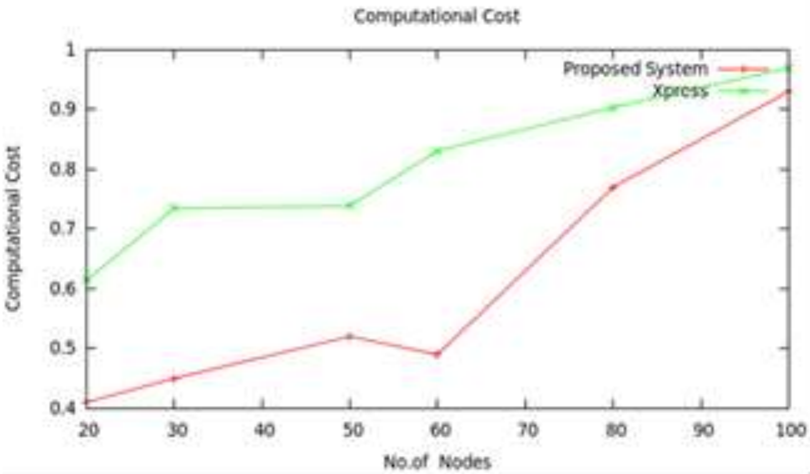

Fig. 4: Computational Cost vs No of Nodes

Fig. 4 shows total computational cost vs no of nodes. Existing system has high computational cost compare to our proposed system.

VI. CONCLUSION

Cross-layer design represents a suitable technology to overcome some of the current limitations of TCP/IP stack, especially in the case of wireless networks. At the core of these architectures is the backpressure scheduling algorithm which achieves the network capacity. XPRESS is backpressure architecture for wireless multihop networks. It integrated backpressure scheduling with a TDMA MAC protocol to allow precise timing in transmissions. Delay reduction is the one of the main issues related with XPRESS. Here we discuss delay reduction technique such as BWAR and DESC which provides better delay performance than traditional backpressure in terms of the maximum throughput.

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