Survey On Multihop Wireless Networks Using Cross-Layer Framework

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Abstract:

In this paper, we take approach to the protocol architecture design in multihop wireless networks. Our goal is to integrate various protocol layers into a rigorous framework, by regarding them as distributed computations over the network to solve some optimization problem. Different layers carry out distributed computation on different subsets of the decision variables using local information to achieve individual optimality. Taken together, these local algorithms (with respect to different layers) achieve a global optimality. Our current theory integrates three functions—congestion control, routing and scheduling—in transport, network and link layers into a coherent framework. These three functions interact through and are regulated by congestion price so as to achieve a global optimality, even in a time-varying environment. Within this context, this model allows us to systematically derive the layering structure of the various mechanisms of different protocol layers, their interfaces, and the control information that must cross these interfaces to achieve a certain performance and robustness.

Keywords: Cross-layer design, Multihop wireless networks, Theory-based approach.

1. INTRODUCTION:

The communication network has largely been a result of adopting a layered architecture. With this architecture, its design and implementation is divided into simpler modules that are separately designed and implemented and then interconnected. A protocol stack typically has five layers, application, transport (TCP), network (IP), data link (include MAC) and physical layer. Each layer controls a subset of the decision variables, hides the complexity of the layer below and provides well-defined services to the layer above. Together, they allocate networked resources to provide a reliable and usually best-effort communication service to a large pool of competing users. However, the layered structure addresses only abstract and high-level aspects of the whole network protocol design. Various layers of the network are put together often in an ad hoc manner, and might not be optimal as a whole. In order to improve the performance and achieve efficient resource allocation, we need to understand interactions across layers and carry out cross-layer design. Moreover, in wireless networks there does not exist a good interface between the physical and network layers. Wireless links are unreliable and wireless nodes usually rely on random access mechanism to access wireless channel. Thus, the performance of link layer is not guaranteed, which will result in performance problems for the whole network such as degraded TCP performance.

So, we need cross-layer design, i.e., to exchange information between physical/link layer with higher layers in order to achieve better performance. Motivated by the duality model of TCP congestion control one approach to understand interactions across layers is to view the network as an optimization solver and various protocol layers as distributed algorithms solving optimization problem. This approach and the associated utility maximization problem were originally proposed as an analytical tool for reverse engineering TCP congestion control where a network with fixed link capacities and pre specified routes is implicitly assumed. A natural framework for cross-layer design is then to extend the basic utility maximization problem to include decision variables of other layers, and seek decomposition such that different layers carry out distributed computation on different subsets of decision variables using local information to achieve individual optimality, and taken together, these local algorithms achieve the global optimality.

We proposed to apply this approach to design an overall framework for the protocol architecture in multihop wireless networks, with the goal of achieving efficient resource allocation through Cross-layer design. We first consider the network with fixed channel or single-rate devices, and formulate network resource allocation as a utility maximization problem with rate constraints at the network layer and schedulability constraints at the link layer. We apply duality theory to decompose the system problem vertically into congestion control, routing and scheduling sub problems that interact through congestion prices. Based on this decomposition, a distributed sub gradient algorithm for joint congestion control, routing and scheduling is obtained, and proved to approach arbitrarily close to the optimum of the system problem

We finally apply the general algorithm to the joint congestion control and medium access control design over the network with single-path routing and to the cross-layer congestion control, routing and scheduling design in the network without pre specified paths.

2. Cross Layer Design

Cross Layer Design is a way of achieving information sharing between all the layers in order to obtain highest possible adaptively of any network. This is required to meet the challenging Data rates, higher performance gains and Quality of Services requirements for various real time and non real time applications. Each layer is characterized by some key parameters, which are passed to the adjacent layers to help them determine the best operation modes that best suit the current channel, network and application conditions

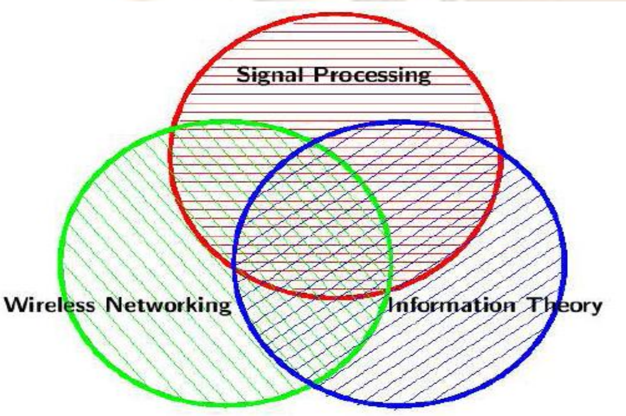

Fig:2.1 cross layer architecture

The architecture of cross layer consists of

2.1 Wireless Networking

Architecture: Connection Vs Connectionless, Energy efficient analysis of Manets and Traffic theory & protocols

2.1Signal processing

Increasing the spectral efficiency**,** Reducing Bit Error Rate and reducing transmission energy

2.3 Information Theory

Developing capacity limits, designing efficient source coding and channel algorithms.

And system design of cross layer for wireless networks shown in fig 2.2

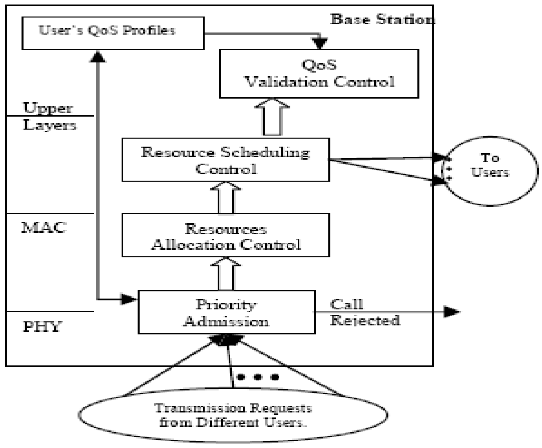

Fig 2.2 Cross Layer Design for Wireless Network

3 .Design modules:

For the efficient multi-hop wireless networks design, namely:

-Network protocols and

-Network operations and management (O&M)

The designs include both in a cross-layer design paradigm to ensure the notion of service quality, such as quality of service (QoS) in wireless mesh networks (WMNs) and quality of information (QoI) in wireless sensor networks (WSNs). The implementation stage involves careful planning, investigation of the existing system and it's constraints on implementation, designing of methods to achieve changeover and evaluation of changeover methods.

3.1 Flow Contention Graph and Schedualbility Constraint:

The interference among wireless links is usually specified by some interference model that describes physical constraints regarding wireless transmissions and successful receptions. For example, in a network with primary interference, links that share a common node cannot transmit or received simultaneously but links that do not share nodes can do so. It models a wireless network with multiple channels where simultaneous communications in a neighborhood are enabled by using orthogonal CDMA or FDMA channels. In a network with secondary interference, links mutually interfere with each other whenever either the sender or the receiver of one is within the interference range of the sender or receiver of the other. Given an interference model, we can construct a flow contention graph that captures the contention relations among the links. In the contention graph, each vertex represents a link, and an edge between two vertices denotes the contention between the corresponding links: two links interfere with each other and cannot transmit at the same time.

3.2 Stochastic Stability:

Congestion price takes discrete values. Thus, congestion price evolves according to a discrete-time, discrete-space Markov chain. We need to show that this markov chain is stable, i.e., the congestion price process reaches a steady state and does not become unbounded. It is easy to check that the Markov chain has a countable state space, but is not necessarily irreducible. In such a general case, the state space is partitioned in transient set T and different recurrent classes Ri. We define the system to be stable if all recurrent states are positive recurrent and the Markov process hits the recurrent states with probability one. This will guarantee that the Markov chain will be absorbed/reduced into some recurrent class, and the positive recurrence ensures the periodicity of the Markov chain over this class.

3.3 Scheduling over Multihop Networks:

Scheduling over Multihop networks is a difficult problem and in general NP-hard. To see this, note that problem is equivalent to a maximum weight independent set problem over the flow contention graph, which is NP-hard for general graphs. It is easy to design some heuristic algorithm but is hard to bind its performance.

4. PROCEDURE:

A Multihop wireless network is dynamically self organized and self configured with nodes in the network automatically establishing and maintaining Multihop connectivity among themselves .Multi hop wireless network designed for different types of applications scenarios ..In wireless ad hoc mobile network ,every node has the responsibility to act as a router and forward packets for each other .Because nodes normally have limited transmission ranges .Multihop delivery is necessary for communication among nodes outside the transmission range.

The Cross-layer Design of Multihop Wireless Networks is focusing dual decomposition .consider a Multi hop wireless network with a set of N nodes and a set L Directed logical links .we assume a static topology and each link l Є L which has finite capacity .here we assume a wireless channel with a fixed a rate .wireless channel is interference limited .we will use flow Contention Graph to capture the contention relation links. The Flow Contention Graph and Schedualbility constraint that captures the contention relations among links, its each vertex represent a link an edge between two vertices denotes the contention between the corresponding links and the two links interfere with each other and cannot transmit at the same time. The given flow contention graph can identify all its independents sets of vertices .the link is an independent set can transmit simultaneously .let E denote the set of all independent sets with each independent set indexed by e. we represent an independent set e as a L dimensional rate vector r-e where the length entry .

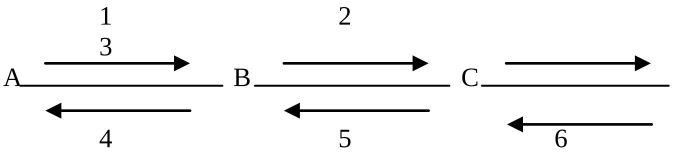

Fig 4.1 Logical Links and corresponding flow contention Graph

we formulate rate constraints for networks with different kinds of routing .The network with single-Path Routing of each source S uses a path considering of a set ‘ Ls’ Subset ‘S ‘ links the set Ls define an L × S routing matrix. The aggregate link should not exceed the link capacity. The network without pre specified paths will use multi commodity flow model for routing .here we are denoting D as destination of network layers. The aggregate capacity of link allocated to flow for incoming and generated flow to the destination should not exceed the summation of the capacities for its outgoing flows. The wireless channel is a shared medium and interference –limited .the capacity they obtained depends on band width sharing .this may results in various TCP performances of wireless networks .the problems of TCP unfairness over Multihop wireless networks .The following section says about related work of this paper .

5. Related work:

In proposed paper we have did survey and its related work on multi hop wireless networks and cross-layer protocols, protocol improvements, and design methodologies for wireless sensor networks (WSNs) is reviewed and taxonomy is proposed. The communication protocols devised for WSNs that focus on cross-layer design techniques are reviewed and classified based on the network layers they aim at replacing in the classical open system interconnection (OSI) network stack. Furthermore, systematic methodologies for the design of cross-layer solution for sensor networks as resource allocation problems in the framework of non-linear optimization are discussed. Open research issues in the development of cross-layer design methodologies for sensor networks and possible research directions are indicated. Finally, possible shortcomings of cross-layer design techniques such as lack of modularity, decreased robustness, and instability and precautionary guidelines are presented. Scheduling component in this optimal cross-layered rate control scheme has to solve a complex global optimization problem at each time, and hence is too computationally expensive for online implementation. In this paper, we study how the performance of cross-layer rate control can be impacted if the network can only use an imperfect (and potentially distributed) scheduling component that is easier to implement. We study both the case when the number of users in the system is fixed and the case with dynamic arrivals and departures of the users, and we establish desirable results on the performance bounds of cross-layered rate control with imperfect scheduling. Compared with a layered approach that does not design rate control and scheduling together, our cross-layered approach has provably better performance bounds, and substantially outperforms the layered approach. The insights drawn from our analyses also enable us to design a fully distributed cross-layered rate control and scheduling algorithm for a restrictive interference mode.

6. Conclusion:

We proposed an alternative cross-layering architecture for autonomic communications which is based on local information as well as global information and gossiping will be the mechanism to collect the global view related information. We are currently engaged in exploring how we may provide cross-layer optimization of TCP/IP, simulating existing TCP enhancements and comparing them to a novel version whose adaptations are driven from a knowledge plane populated using our gossiping technique. This will allow us to evaluate both the gossiping approach and the various cross-layer parameters that can be used to influence TCP behavior, as well as comparing them against established approaches with less cross-layer influence. Our current theory integrates three functions—congestion control, routing and scheduling—in transport, network and link layers into a coherent framework.

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