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Routing Generalization of Control Policy for Humanizing Stability in Network Resource Allocation

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Abstract:
An elementary problem in networking concerns the allocation of network resources efficiently and fairly. These become customary to frame such questions in the language of welfare economics, postulating that resources should be allocated so as to solve a network utility maximization problem. Network resource allocation controls the number of different routes, where each connection is subject to congestion control. In non-cooperative users, the network stability and user-centric fairness can be enforced at the network edge. The issues in stability and fairness can be studied when routing of incoming connection is enabled at the edge router. Achieving user-centric fairness requires controlling the number of connections. We analyze a decentralized fashion that assumes users are cooperative. Since connections may use different routes, the required aggregate rate leads to congestion control. To handle this situation we propose a primal-dual congestion control. We analyze the performance of individual users from decentralized admission control. This mechanism helps to protect the network from greedy user.

.***Index Terms:*** Communication networks; User-centric; Stability; Fairness; Allocation; Multipath.

1. INTRODUCTION

Research in the areas of hardware and application development, users are demanding expecting reliable throughput and trusted transport from their service providers. In addition to traditional Internet application, new multicast, multimedia and voice service applications are in the rise. New applications are developed constantly. These applications have increased the demand for bandwidth support and dictate the need for newer services. Along with the exponential growth of the Internet, these new services place ever-increasing strain on the existing resources. In particular, these models apply to Internet congestion control by associating to each TCP flow a utility function that determines their response in rate to congestion signals or “prices”. The resulting equilibrium, if reached, achieves a notion of flow level fairness. In the language of the above is the “NETWORK problem”, on top of which it was proposed to add a “USER problem” through which users could express their preferences through a choice of weight in the TCP utility function, making the overall equilibrium optimize overall welfare, the “SYSTEM problem”. What has been lacking in both literature and practice is an implementation of this outer loop by the users. Without it, one is left with a network that strives to impose fairness between individual TCP flows, not user level fairness.

The fundamental problem in telecommunication network among the shared infrastructure is resource allocation with fairness and stability. An important question in the network case is at which level of protocol layer fairness should be imposed. The main trend in networking research in recent times providing a fairness in the transport layer. The Network Utility Maximization (NUM) problem captures various fairness notions between end-to-end flows and takes care of congestion control. Users can open n-number of connections across the network, skewing the overall rate allocation.

The main objective of this paper is to propose a fair allocation among a set of users, where each user owns a set of connection with the common router.

To achieve this objective, we propose number of flow control per user. The aggregate rate obtained from the user increases the number of connections in different routes. Thus users selfish an incentive crosses beyond the limit and obtain mutual destructive outcome. Achieving user-centric fairness requires controlling the number of connections. We analyze a decentralized fashion that assumes users are cooperative. Since connections may use different routes, the required aggregate rate leads to congestion control. To handle this situation we propose a primal-dual congestion control. We analyze the performance of individual users from decentralized admission control. This mechanism helps to protect the network from greedy user.

2. Existing System

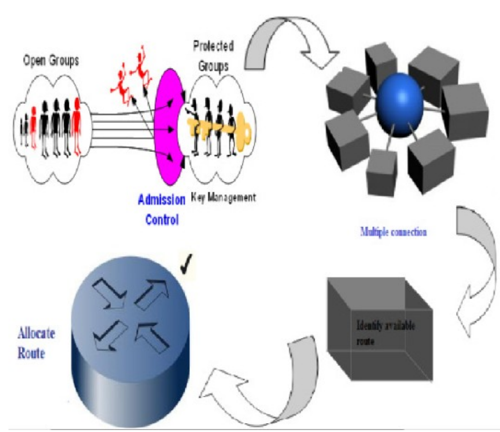
Our work touches on several topics that have been studied in other references; these are now viewed. The impact of parallel TCP connections on aggregate throughput is analyzed. The key issue we address concerns how the available bandwidth within the network should be shared between competing streams of elastic traffic (rate control algorithm). The network's optimization problem may be cast in primal or dual form: this leads naturally to two classes of algorithm, which may be interpreted in terms of either congestion indication feedback signals or explicit rates based on shadow prices. Our approach has similarities to the “coordinated congestion control”, but there are differences in the optimization objective sought and the connection dynamics considered.

An “uncoordinated” control of single-path connections may not in general be able to stabilize the complete region. Finally, that such stochastic stability results are of an open-loop nature: Either the loads are stabilized and users are satisfied, or the network is unstable, and this independent of the congestion control applied. Some authors have argued from here that admission control of connections is required. While any reasonable admission control may over-come such instability by discarding excess connections ,the distinguishing feature of our utility-based admission control of is that a desired fairness between users is imposed in such situations of overload.

3. SYSTEM ARCHITECTURE

3.1. Resource allocation difficulty

Our architecture enforces the accessing rights of individual users and manages the overall routing policies. The network rate of each user is assigned externally and the users are authorized when they sustain within allocated limit. The controller is connecting the net usage when the user found to be unauthorized. Each user authentication is validated by the admission control. Authorized users are protected by the key management and admission control monitors the behavior of each user connection.



The request for resource allocation is validated by the admission control. When multiple users insist for multiple connections, the router identifies the available routes. If the requested resources are not

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available then the admission controller merges multiple routing connections into a single path. The multiple routing connections are merges in a single path by using the back pressure algorithm. It defines a flow of route in a confined place.

3.2. A Primal-dual Congestion Control

Based on the past successes and the theoretical foundation, currently the prevailing thinking is that all traffic should participate in congestion control in a TCP friendly way. Anyone who looks into a new idea for traffic control would likely be asked whether the new control is TCP-friendly. Others are busy building standards in IETF that try to ensure multimedia flows would be TCP friendly. In this paper, we claim that significant changes to the Internet and its applications are posing new challenges for network resource allocation. These new challenges will require new perspectives and new models to our favorite problem of network resource allocation.

We first argue that the existing notion of TCP friendliness, which requires each flow to adapt to a rate similar to the competing TCP flows, is too narrow. Different types of applications may have their own natural way of dealing with congestion. For example, inelastic flows may use admission control to avoid congestion. We present some evidence to show that it is better to let these different cultures co-exist rather than force them to adopt a single culture - processor sharing (which is an abstract view of TCP-friendly sharing).

Admission control performs the role of controlling connection numbers and used to ensure the stochastic stability of the system when the average load is larger than the link capacity; this is done without addressing fairness in the resulting resource allocation. We derive a decentralized admission control rule that can be enforced at the network edge, and such that in case of overload, resources are allocated according to the User Welfare Problem. Admit connections on router and Drop connections on route r are calculated for new incoming connections. Some sub-modules are

- Admission Control in the Single-Path Case
- Fluid Limit Analysis
- Admission Control in the Multi-Path Case

3.3. Decentralized Routing Strategy

An interesting conclusion is that a form of TCP friendly admission control performs better than TCP friendly congestion control for inelastic flows. The reason for implementing this TCP-friendly admission control rather than any other form of admission control is then justified in based on stochastic properties of the model without any assumptions about utility functions. Interestingly, if the inelastic flows are too aggressive in admitting themselves (rather than trying to be TCP friendly), then there will be more accumulated work from elastic flows which will eventually block more inelastic flows. In summary, we are proposing a different perspective in how different types of traffic may co-exist. Instead of requiring them to assimilate and implement the same traffic control (per-flow TCP-friendly control), it appears better to let them co-exist each implementing its own natural traffic control (fair share congestion control for elastic flows and TCP-friendly admission control for inelastic flows).

Assume that the network is composed by a set of parallel bottleneck links. Each user in this network has a set of routes established in any subset of the links. Moreover, assume that all users have identical -fair utilities denoted by and file sizes are equal for each user, so we can take without loss of generality .In such a network, the resource allocation can be explicitly computed as a function of the current number of flows. In particular, all flows through bottleneck face the same congestion price, and as they have the same utility, they will get the same rate.

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4. IMPLEMENTATION

We propose a new paradigm for resource allocation in networks, which intends to bridge the gap between classical NUM applied to congestion control and the user centric perspective for fairness. The number of connections can be used to achieve this fairness, either through cooperative control or through network admission control. The admission control ensures both network stability and user centric fairness. Thus the uncontrolled flow rate is controlled through aggregate rate of connections. It overcomes multiple TCP connections for serving a common user with multiple paths. User-centric fairness can be focused on multiple flow rates.

Routing policy to exist, it is necessary that the network is "stabilizable" in the sense that there is a partition of the user loads such that the underlying single-path network is stable. Of course, if each user has only one possibility and we recover the single-path stability condition. The same conditions used for stochastic stability in the case of multipath TCP. In that case, however, the TCP layer must be modified to make full simultaneous use of the available routes. Here, each route remains single-path, with standard congestion control, and the routing policy is used to achieve the same stability region. The random splitting policy sends an incoming connection on route with probability stabilizes the system. This is because the system is equivalent to a single-path process with arrival rates due to the Poisson thinning property, the random splitting policy mentioned is not useful in a network environment which is not decentralized.

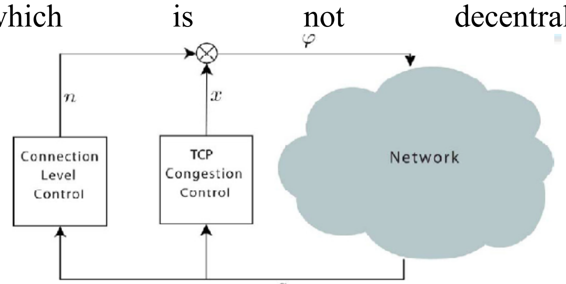

Fig 1: Block diagram for connection level control

Admission control over a route was performed by comparing the marginal utility with the route price. The end user may choose among several routes to merge the connection level routing. The multiple routing connections are merges in a single path by using the back pressure algorithm. It defines a flow of route in a confined place.

Fairness via Admission Control:

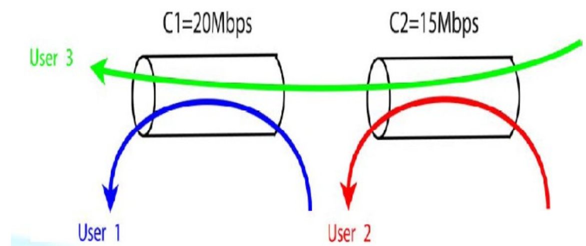

Fig 2: Topology for fairness via admission control

Since selfish incentives of users do not encourage this behavior, we cannot generally count on this cooperation. In such cases, the network must take the role of controlling connection numbers, for which the simplest means is admission control. This approach was advocated where a stochastic model of connection arrivals and departures is discussed, and admission control is used to ensure the stochastic stability of the system when the average load is larger than the link capacity; this is done without addressing fairness in the resulting resource allocation.

5. CONCLUSION

This paper contributes to bridging the gap by modeling user behavior in terms of the aggregate rate of all its connections, and controlling this aggregate through a combination of rate control of each connection, and admission control of the number of connections. The number of connections can be used to achieve this fairness, either through cooperative control or through network admission control. We showed how the control of the number of connections can be used to impose these new notions of fairness, and how the users can cooperate in order to drive the

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network to a fair equilibrium. We showed how the control of the number of connections can be used to impose these new notions of fairness, and how the users can cooperate in order to drive the network to a fair equilibrium. Moreover, we showed how admission control and routing based on typical congestion prices can be used to protect the network in overload and simultaneously impose fairness between its users. Finally, we showed practical implementations of the mechanisms derived in our work, simulations based on these implementations show that the proposals accomplish their goals, and merging the multiple routing connections into a single path when requested resources are not available.

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