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Improving the Fairness and Stability in Allocating the Resource with Multiple Connections

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Abstract

Network resource allocation controls the number of different routes, where each connection is subject to congestion control. A cooperative users control the number of active connections based on congestion prices from the transport layer to emulate primal-dual dynamics in the aggregate rate. This achieves user-centric allocation. 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. The stability region can be obtained which can be served with routing alone and a generalization of admission control policy to ensure user-centric fairness when the stability condition is not met.

Key Terms: *Primal-dual, user-centric, stability, fairness*

1. Introduction

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 should fairness 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 take 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 incentives 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 rates 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. Related works

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 in [2]. The key issue we address in [3] 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" studied in [4], 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. We also employ single-path connections, but we add congestion-based routing

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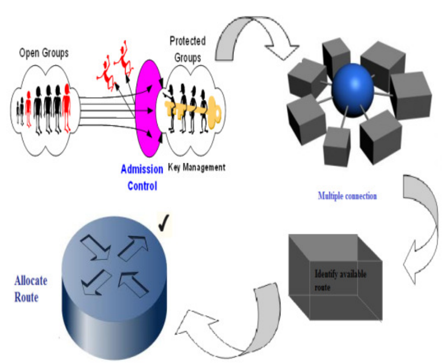
in a way that allows us to cover the full stability region [5].

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 is independent of the congestion control applied. Some authors [6], [7] 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



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 disconnect 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 connection, the router identifies the available routes. If the requested resources are not available then the admission controller merges multiple routing connection 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.

The architecture includes the following modules:

3.1. Resource allocation

There are two works carried out in the resource allocation i.e., Internal work and External work.

In external work, capacity for the each user is allocated at begin. so that the user is allowed to use certain limit of the resource.

In internal work, the users are checked that how they are using the resource.

3.2. Utility Based Admission Control

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 route r 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. Condition for stability

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.

3.4. Decentralized routing policy

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.

3.5. Combining admission control and routing

We combine the admission control and routing policies in here. It is performed by comparing the marginal utility with route price. the end-user may choose among several routes, and thus the natural way to merge with the connection level routing. If admitted a new user, route connection through the cheapest path. The network dynamics in this case converges to 0 whenever the stability is met.

4. Proposed Scheme

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.

End-to-End connection travel through a single path specified by the routing matrix R. The rate of single connection along a route r is denoted by x_r. n_r denote the number of such connections where the aggregate rate is represented as $\rho_{r=}n_{r.}x_r$ and the rate through the single link is expressed as,

$$Y_{l=}\sum_r Rl_r\rho_{r=}\sum_r Rl_r\, n_r x_r$$

We propose a connection level dynamics for n_r and represent the network entity that receives aggregate rate ρ_r. Thus it returns congestion price q_r per route.

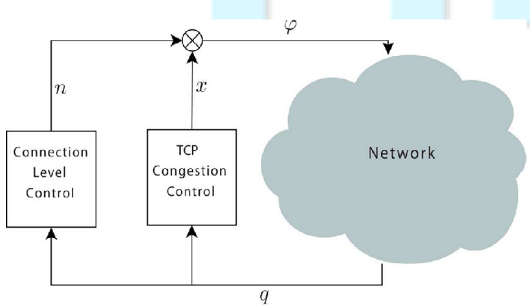


Fig 1:Block diagram for connection level control

In order to achieve fairness, each user must increase its number of connections i.e., the user marginal utility is greater than the current congestion price. If on the other hand the inequality reverses, the number of connections must be decreased.

If $U`_i(\rho^i)>q_r$ admit connections on route *r*
If $U`_i(\rho^i)<=q_r$ drop connections on route *r*

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 condition is 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.

Admission control over a route was performed by comparing the marginal utility with the route price.(allocating the marginal utility is not based upon the users capacity. but consider the user requirement). 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.

$$\pi\,[t] = \mathrm{Max}_{\pi\epsilon r}\ \sum_{(n,m)} C^{\pi}_{\ nm}\, w_{nm}[t]$$

(π-valid selection, n,m-set of node, t-time slot, w_{nm} -determine the flow going through the link, backlog-something that need to avoid, f-each flow)

$$w_{nm}[t]=\mathrm{Max}_{f:(n,m)\,\epsilon L(f)}(\vec{Q}^{f}_{\ n}[t]-\vec{Q}^{f}_{\ m}[t])$$

($\vec{Q}$ represents the value of all paths)

Now the results will be in best rate, routing policy(stability, fairness), nesh equilibra.

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This algorithm takes care of providing stability in networking when there is heavy load, select a set of route and put them into a single path.

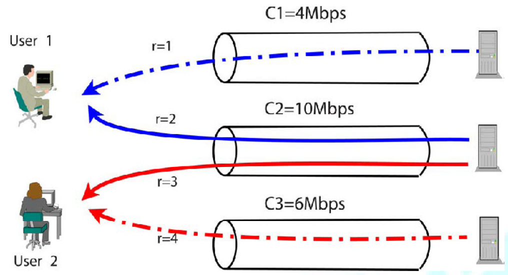

Fig 2: Marginal utility with route price

Admission control over a route was performed by comparing the marginal utility with the route price. In the new setting, the end-user may choose among several routes, and thus the natural way to merge with the connection level routing. If admitted a new user, route connection through the cheapest path. The network dynamics in this case converges to 0 whenever the stability is met.

5. Implementation and Simulations

Controlling the Number of Connections

We have two users that download data from three servers, with the topologies and link capacities depicted in Fig. 2. In order to introduce an imbalance between users, routes have different round-trip times (RTTs). Each user then begins with a single TCP connection per route, governed by TCP/Newreno. With this choice, the congestion price q_r on route is the packet-loss probability along that route, and this is measured by the users counting the number of retransmitted packets within connections. The users then maintain a variable for each route, which is the target number of connections. This variable is updated periodically.

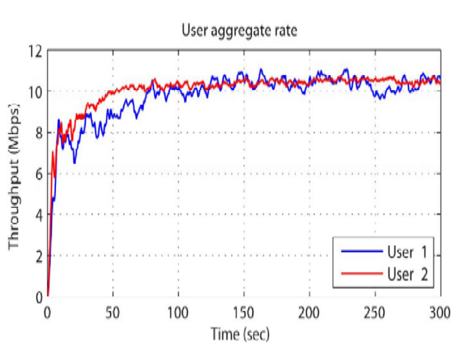

Fig 3:Result for Controlling the Number of Connections

Fairness via Admission Control:

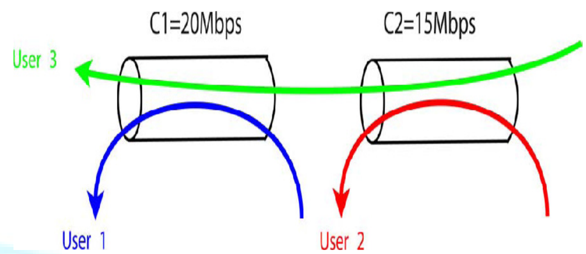

Fig 4:Topology for fairness via admission control

The users already allocated to use the fixed amount of resources in the network. User1 is allocated to use the capacity C1= 20Mbps and user2 is allocated to use capacity C2=15Mbps. But the two users are using the resource less than they requested. If the user3 needs more resource than he requested, the admin control will allocate the unused resource of user1 and user2. So that the both users can achieve the resource with fairness.

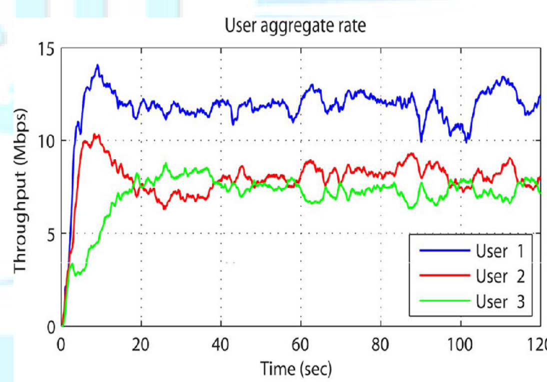

Fig 4.1:Result for Fig 4(fully overloaded case)

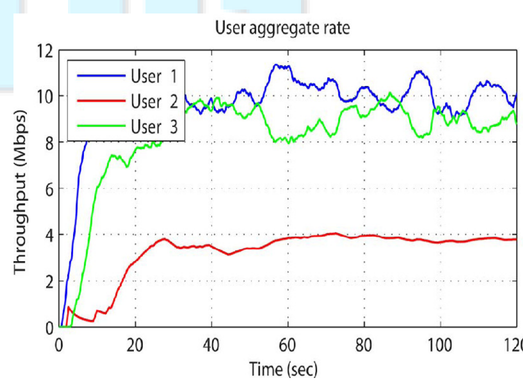

Fig 4.2:Results for Fig 4(when one source is below its share.)

6. Conclusion

In this paper we analyzed 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. 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 connection into a single path when requested resources are not available.

In future work, we plan to address several theoretical questions that are still open. Decentralized admission control mechanisms scalable to large network is an important theoretical questions. In practical terms, it would be interesting to explore new network implementation based on current congestion notification protocols.

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