Mean-Field Interaction Models for Large TCP Networks

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This presentation will review various dynamical interaction models allowing one to analyze the throughputs obtained by a large collection of TCP controlled flows sharing many links and routers, from the sole knowledge of the network parameters (capacity, buffer sizes, topology) and of the characteristics of each flow (RTT, route, persistent or on-off structure etc.).

In the droptail case persistent flow case, the mean-field limit can be described geometrically as a billiards in the Euclidean space. This billiards has as many dimensions as the number of flow classes and as many reflection facets as there are routers and links. This allows one to determine the possible stationary behaviors of the interacting flows and provides new ways of assessing TCP's fairness.

In the on-off flow case, the mean-field limit can have several stable regimes, even in the single link case. Some phenomena similar to turbulence are identified.

The RED case can also be investigated by such mean-field techniques. In the single link case, this allows one to determine in closed form the stationary distribution of the stationary throughputs obtained by the flows.

When aggregated, the traffic generated by these models exhibits TCP and network-induced fluctuations that will be compared to statistical properties observed on real traces.

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