A. The traffic problem of P2P streaming:

P2P streaming could alleviate the server load (less bandwidth requirement of servers), but doesn't have controls on the cross-ISP traffic and traffic in Internet core. This makes P2P streaming have no advantage in the view point of ISPs, and may even consume much inter-ISP bandwidth as peers scale, which makes ISP providers block P2P traffic.

B. Methods to solve the problem:

1. P2P adopts localized peer selection:
2. ISPs deploy caches/proxies:
3. ISPs collaborate with P2P: offer P2P information on network layer to peers.

First, we intend to model the case that P2P adopts localized peer selection:

- P2P adopts localized peer selection:
    - The localization embodies in peer selection strategy: considering the RTT, IP address of peers besides other information such as upload bandwidth and download bandwidth.
    - Intuitive and basic localization mechanism: limit the cross-ISP partners of peers: we call the peers have
    - Using the buffer to trigger the selection of the cross-ISP partners: at beginning, peers except Inter-Peers only download from intra-ISP partners, if the buffer couldn't be filled up after some time, then, start to download from cross-ISP partners.

C. Mathematical Model:

Let us divide the ISPs into two types, one is the ISP that has deployed servers, the other is the ISP that hasn't deployed servers. For the ISP that has no servers deployed, the peers in it need to get original chunks from ISPs with servers, and then disseminate chunks among themselves. Much work has been done to achieve the optimal streaming capacity and dissemination delay under no traffic locality mechanism.

a) No locality mechanism:

Under no locality mechanism, if the average upload capacity is the same, the heterogeneous case has less chunk dissemination delay than the homogeneous case.

i) Homogeneous case:

In homogeneous case, the peer's upload capacity is the same. Snow-ball Chunk Dissemination achieves the minimum delay performance. And this minimum delay performance could be achieved by snow-ball streaming in continuous streaming.

ii) Heterogeneous case:

In the heterogeneous case, peers' bandwidth are different. To have good performance, the peers with larger upload capacity are put closer with servers. Then, a hierarchical structure of peers based on the upload capacity is formed.

As the P2P streaming systems under no traffic locality mechanism strive to achieve the optimal streaming performance, they contribute much inter-ISP traffic which increases the cost of ISPs. Several locality mechanisms have been put up to reduce the inter-ISP traffic without much impact on the performance. Below is our mathematical model to analyze the locality mechanism in P2P live streaming systems.

b) Locality mechanism:
Under no locality mechanism, the peers in an ISP have no limitations to connect to the neighbors outside the ISP. Under locality mechanism, the connections between peers in different ISPs are limited. We name the peers in one ISP that download chunks from peers outside the ISP Inter-Peers. For ISPs without servers deployed, the Inter-Peers are the source of the chunks, and when they get chunks from outside the ISP, they disseminate them among the peers in the ISP. The Inter-Peers of one ISP also increase the total upload capacity of that ISP due to the flow-in bandwidth from other ISPs.

First we assume the peers in one ISP have the same upload capacity. The upload capacity of peers in different ISPs may be different.

Case 1: Two ISPs have the same average upload capacity which equals to the playback rate. One ISP is deployed with servers, the other one isn't deployed with servers. So the ISP without servers has at least one Inter-Peer.

Case 2: The ISP with servers deployed has larger average upload capacity than the ISP without servers.

Case 3: The ISP with servers deployed has smaller average upload capacity than the ISP without servers.

Second, we analyze the case that in one ISP, there are some peers with larger upload capacity and the other peers with smaller upload capacity.

D. Evaluation and Validation: Simulation

After the model of the locality mechanism, we intend to validate and evaluate the modeling through simulation.