Peer Networks – High-Speed Solution or Challenge?

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Abstract. Application, transport, and network-layer overlays are becoming a dominant force to provide ubiquitous, large-scale network architecture. These 'peer networks', such as Gnutella, Freenet, and Napster, demonstrate the power of automatic network configuration, achieving world-wide deployment of a virtual topology in a matter of weeks. This deployment simplicity comes with costs, e.g., current systems reimplement core network functions at the application layer, potentially introducing inefficiency, incompleteness, and incorrectness.

Peer to peer networks flatten and democratize the conventionally hierarchical network topology. The current Internet is based on IP addresses and Autonomous System (AS) numbers, allocated as hierarchies which rely on managed global identifiers to provide packet forwarding using local information. By contrast, peer networks often allow more local management, at the expense of forwarding efficiency. In some systems, packets take $O(\sqrt{N})$ hops (vs. $O(\log N)$ in hierarchies); in others, paths meander or even backtrack. Such expenses are tolerated in exchange for simpler, automatic configuration which enables rapid, ubiquitous deployment.

Peer networks can defeat the careful aggregation of provisioned bandwidth. The use of application or transport layer tunnels can result in traffic traversing a network-layer link multiple times. Separate links which would have been multiplexed together nearer their sources can be tunneled far into the core before being multiplexed, obscuring queuing interactions that would have been detected or reacted to more efficiently at the edge. Application layer routing can contradict network layer routing, resulting in meandering paths, or sometimes cycles.

This panel examines these aspects of peer networks, and how best to utilize their strengths to enable network scale while avoiding their potential pitfalls.

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