Mobile Users, Any Network:

The Case for Application-Specific QoS

A DISCUSSION PAPER BY

IPeak NETWORKS

SPRING 2011

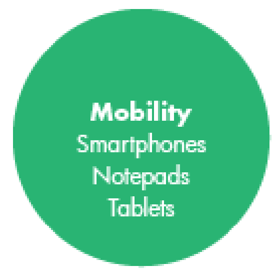
Introduction

The combination of three related megatrends – the trends toward real-time applications, mobile devices, and multiple network connections – has created a challenge to traditional approaches to QoS, and exciting new opportunities for application developers and service providers. To meet the challenge and take advantage of the opportunities, a new approach to QoS is required: a systems solution approach. This paper describes the new approach, introduces IPeak Networks' application-specific QoS systems solution model, and outlines the features functions and benefits of this model through a discussion of two important use cases.

Three Megatrends

There are three related and very important new megatrends working together to force application developers, infrastructure vendors, and service providers to find new ways to ensure that their products and services offer the consistently high quality of experience that users demand.

First, there is the trend toward the use of real-time IP network applications in the work place and in the home. Cost reduction, expanded accessibility, and shear convenience are fuelling the wholesale transition to voice over IP and video chat, live streaming, virtual desktops and applications, and cloud services... a new breed of real-time applications that require high quality IP networks to deliver the kind of performance users expect.



Second, there is the overnight explosion in the number and variety of highly desirable mobile devices making for an explosion in the numbers of mobile users demanding a high quality of experience from their real-time apps. Enterprise users and consumers alike are making the final transition away from the desktop. They now demand access to their real-time applications through notebook computers, tablets, and smartphones.

And third, there is the growing preference for nomadic computing with users roaming far from the traditional points of network access. Users want to access their real-time applications using their mobile devices wherever they may be: in or out of the office, anywhere in the home, and even while on the move. That means that real-time applications and mobile devices must be able to support and effectively overcome the inherent weaknesses of each of the many types of networks likely to be deployed in the enterprise and on the consumer side including the LAN, the WAN (Internet), and WiFi, 3G, and 4G "on ramp" networks.

QoE - Challenge and Opportunity

These three trends are coming together to challenge the application developers and service providers still relying on the old ways of ensuring network quality, application performance and user 'quality of experience' (QoE). Where once a single network, the LAN, was used to support a desktop-bound legacy application, there is now a requirement to master multiple networks and on-ramps connecting highly mobile users of real-time, network-sensitive applications.

For those who rise to the challenge, there is also a significant benefit to be realized. The megatrends will only continue and the opportunities at the intersection of real-time apps, mobile devices, and multiple networks will only grow. The application developers and service providers who succeed in delivering high QoE in this opportunity space will reap the greatest rewards.

QoS Solutions - Four Key Elements

To meet the challenge and reap the rewards, a new approach is required; a systems approach to delivering embedded, application-specific QoS solutions comprising in four key functional elements. Those elements are as follows:

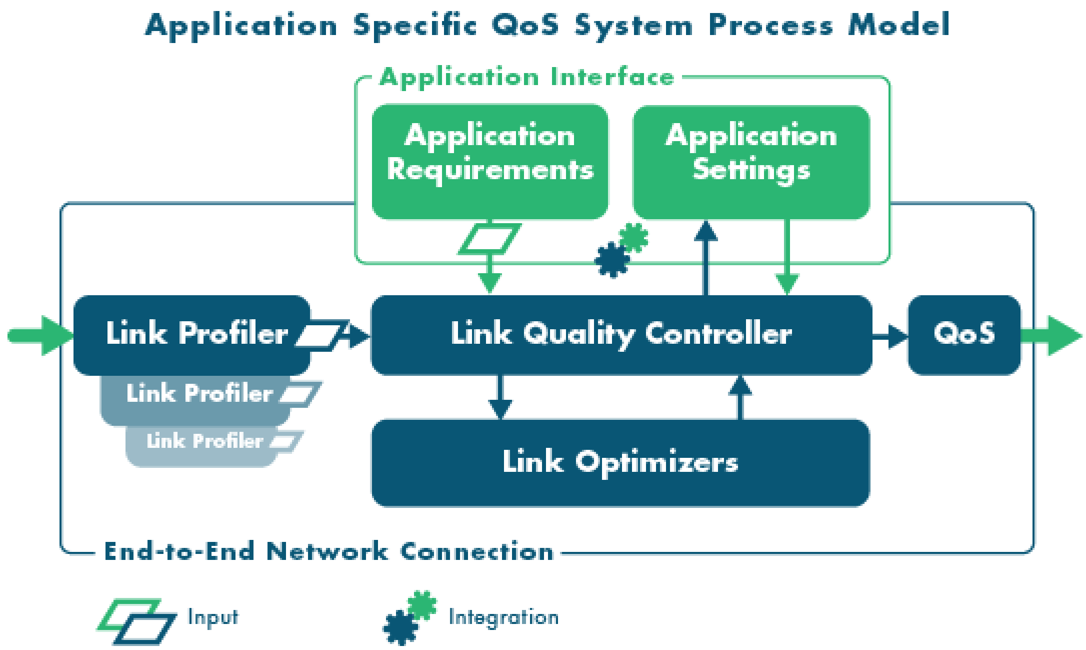
(1) The Application Interface
System input in re the requirements (bandwidth, loss, and latency) and sensitivities of the application and associated network protocol, and feedback to the application from the QoS solution

(2) Link Profiler
System input in re the actual conditions on each link in the end-to-end network connection (bandwidth, loss, and latency)

(3) Link Optimizers
Techniques and technologies to protect traffic over best-effort networks and optimize the network links in re of the protocols, transports, and physical layers involved

(4) Link Quality Controller
A control plane that matches the link protection and/or optimization technology to the application requirements and actual link conditions, and supports real-time interworking with the application.

The relationship between these four key functional elements and how they work together to provide application QoS—and optimized user QoE—is shown in the Application Specific QoS System Process Model diagram, below.



This model allows application developers and service providers to embed fully dynamic network quality solutions within their products and services, solutions that address the three key problems that accompany the three megatrends, namely:

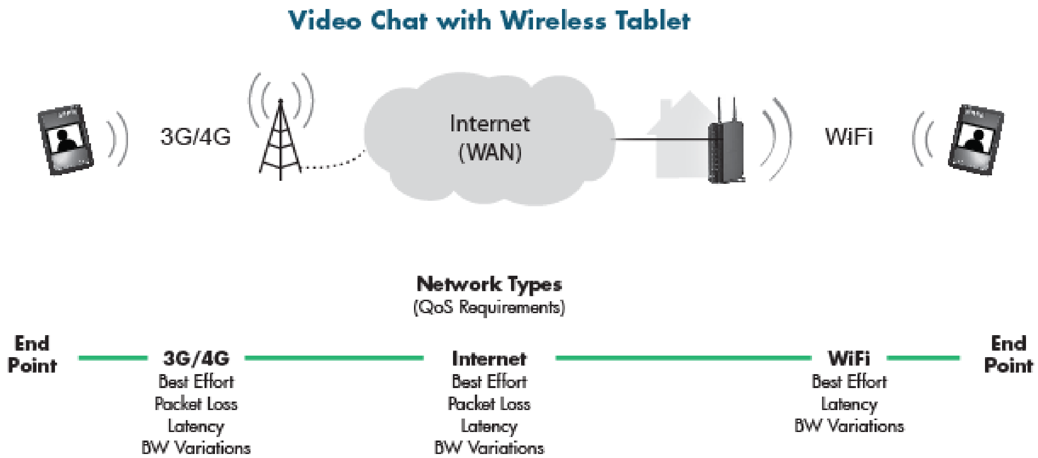
(1) the LAN is no longer the only network in play, nor even the dominant network in play,
(2) actual network conditions are dynamic, changing from session to session and from minute to minute, and
(3) different applications require different types and levels of network protection and optimization to ensure application performance.

Applications and services with an embedded QoS capability capable to addresses these key problems can deliver maximized user QoE from any combination of applications, devices and networks.

There are two emerging use cases that illustrate the effectiveness of this approach: video chat over wireless tablets (a decidedly consumer-oriented use case) and thin client computing (a use case that is notably popular in the education market place and finding growing acceptance in the wider enterprise market.)

Use Case - Video Chat with Wireless Tablet

The trend toward Mobile Devices with front and back high-resolution cameras on- board has expanded the possibilities for interpersonal video communications but the success of those communications applications depends entirely on the quality of the user experience. Users will not accept a bad video experience. The user QoE is in turn a function of the video chat application's ability to withstand sub-optimal conditions on the several networks carrying the video data traffic. The illustration below shows a typical consumer video chat application including the networks involved and the network characteristics that can have an impact on the performance and quality of the video chat application.



The QoS requirements for this use case are driven by the three different network types in play. The problems that are characteristic of these networks are as follows.

Best Effort – Each of the networks involved offers only a 'best effort' level of service. There is no guarantee that all of the video data sent from one end point will actually be received by the other end point and there is no guarantee that data that does make end-to-end will make it without delays. These data transmission problems manifest as packet loss and latency.

Loss – 3G and 4G networks and the Internet suffer data packet loss. Even a small amount of packet loss can make real-time video communications unusable.

Latency – All networks demonstrate latency to some degree, of course: data transmission cannot occur instantaneously. However, TCP-based best effort networks suffer greater latency as a function of the effort to recover from the loss discussed above. TCP will make several attempts to retransmit lost packets at the cost of a delay in the delivery of those packets. This is the form of latency that does the most damage to real-time applications.

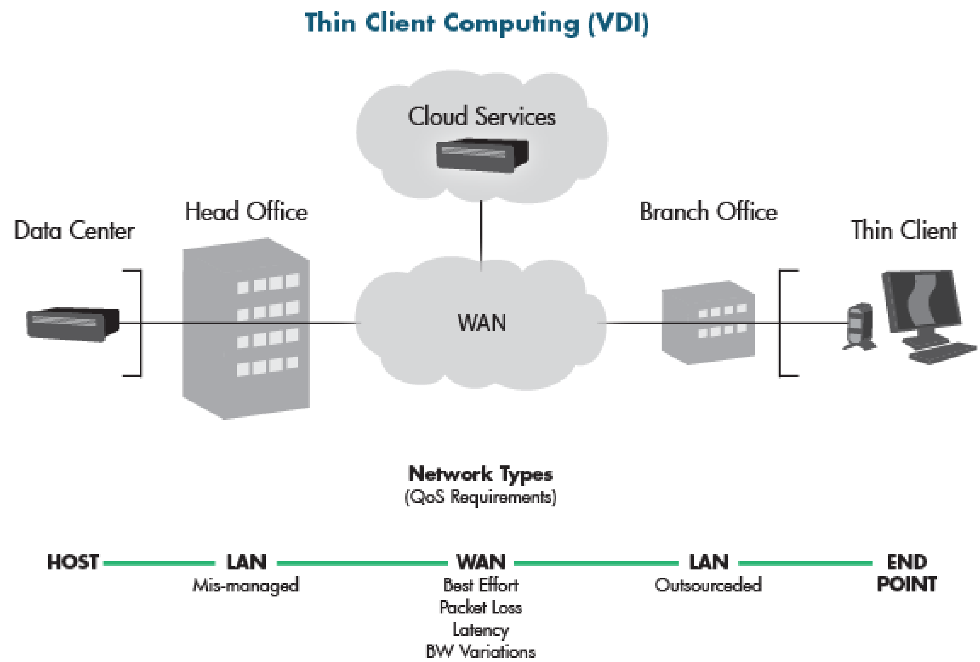
Bandwidth Variations – Best effort networks are finite resources that are shared among many, many users and applications. 3G/4G, the Internet, and WiFi networks each support techniques for accomplishing the equitable distribution of the finite resource among all users and apps. When the numbers of users and apps changes, whether up or down, the bandwidth available to each increases and decreases. These changes in bandwidth wreak havoc on real-time video chat applications and similar conferencing and collaboration apps that are designed for and expect a stable network.

Network Problems and Video Chat QoE

Real-time Video applications are highly sensitive to the poor conditions that can plague best effort networks leading to a very poor user QoE. The video application QoE is poor The packet loss, latency, and bandwidth variations that are common to the Internet, WiFi, and 3G/4G networks manifest as smearing, comet trails, digital artefacts, prolonged frame freezes, and ultimately, as dropped calls. Users will simply reject Video chat with wireless tablets that does not support an acceptable QoE. A QoS solution is required for this use case.

Use Case – Thin Client Computing (VDI)

Recent advances in virtualized desktop infrastructure (VDI) technologies are driving the growing interest in the advantages of thin client computing within the enterprise but user acceptance and adoption depends on how much the virtual desktop or application "feels" like a local desktop or application. The illustration below shows a typical enterprise thin client computing deployment including the networks involved and the network characteristics that can have an impact on the performance and quality of virtualized desktops and applications.



The QoS requirements for this use case are driven by the two different network types in play. The problems that are characteristic of these networks are as follows.

WAN, Best Effort – The WAN offers only a 'best effort' level of service. There is no guarantee that all of the remote display data sent from the host will actually be received by the thin client and there is no guarantee that the data that does make it successfully from the data center to the thin client will make it without delays. These problems manifest as packet loss and latency.

Loss – The WAN is subject to sometimes large amounts of packet loss. Even a small amount of packet loss can reduce the responsiveness of virtualized desktops and virtualized applications. When combined with latency, packet loss causes greatly diminished virtualized application performance and leads to an unacceptable user QoE.

Latency – All networks demonstrate latency to some degree and even relatively small amounts of latency will impact the performance of all of the major remote display protocols used in VDI deployments. TCP-based remote display protocols fare worst when latency is present.

LAN, Mismanaged/Outsourced – The enterprise LAN is often outsourced and just as often suffers from poor management. Packet loss, both random and burst, can be a serious problem on the LAN and a serious threat to real-time application performance.

Network Problems and Thin Client Computing QoE

All virtualized desktops and applications are sensitive to even small amounts of packet loss and latency. Users experience input lag with their word processors, stalls and delays when scrolling through documents, and abrupt jumps instead of smooth transitions between presentation slides. Desktop and application performance are greatly diminished and the poor user QoE is amplified in comparison to the experience with the same desktop and applications running locally. A QoS solution is required for this use case.

IPeak Networks' QoS Solutions

Using a proprietary systems solutions development platform, IPeak Networks has developed QoS solutions for the video chat use case and the thing client computing use case. All IPeak Networks QoS solutions implement the four key elements outlined above (see page 3) and each implements the combination of patented and proprietary solvers—network link protection and optimization techniques and technologies—that is required to ensure QoS for the given application running over the given networks.

These technologies and techniques include the following:

For WiFi network links:
Prioritization techniques to reduce latency
TCP optimization techniques to reduce TCP chattiness and thereby reduce latency

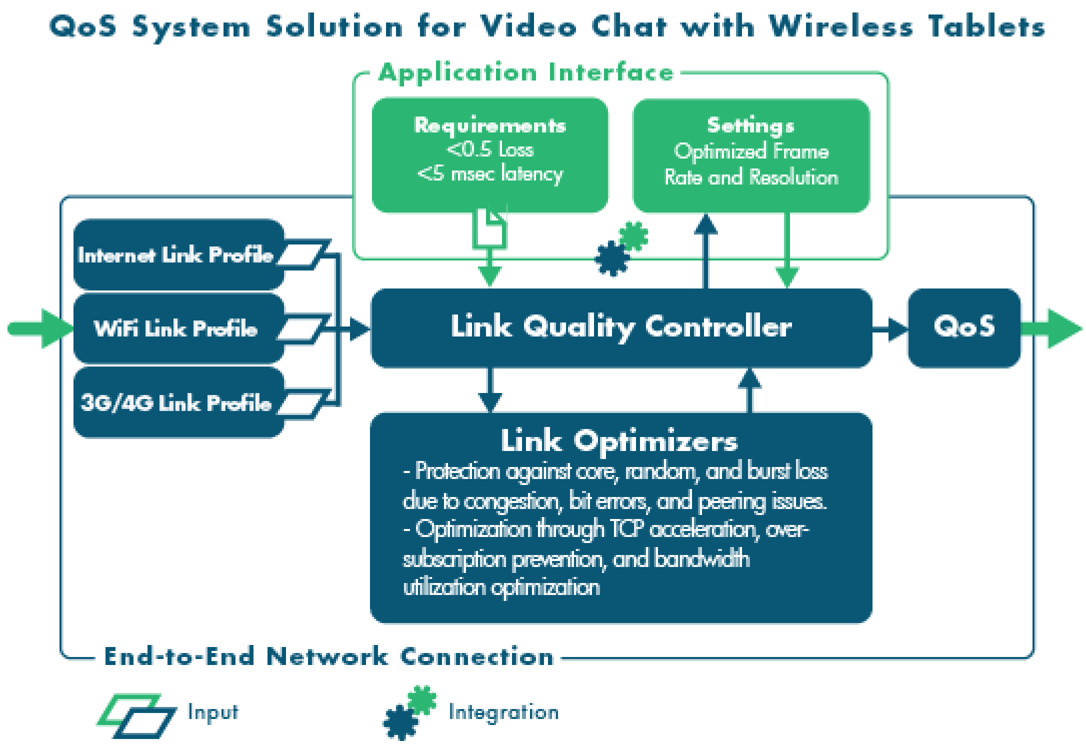
Proprietary bandwidth optimization techniques to support maximum goodput steady state
WiFi version-specific (B,G,N) optimization modes
Patented packet loss protection

For 4G network links:
Over-subscription prevention techniques
Patented packet loss protection against loss at peering points
Patented loss protection against bit errors

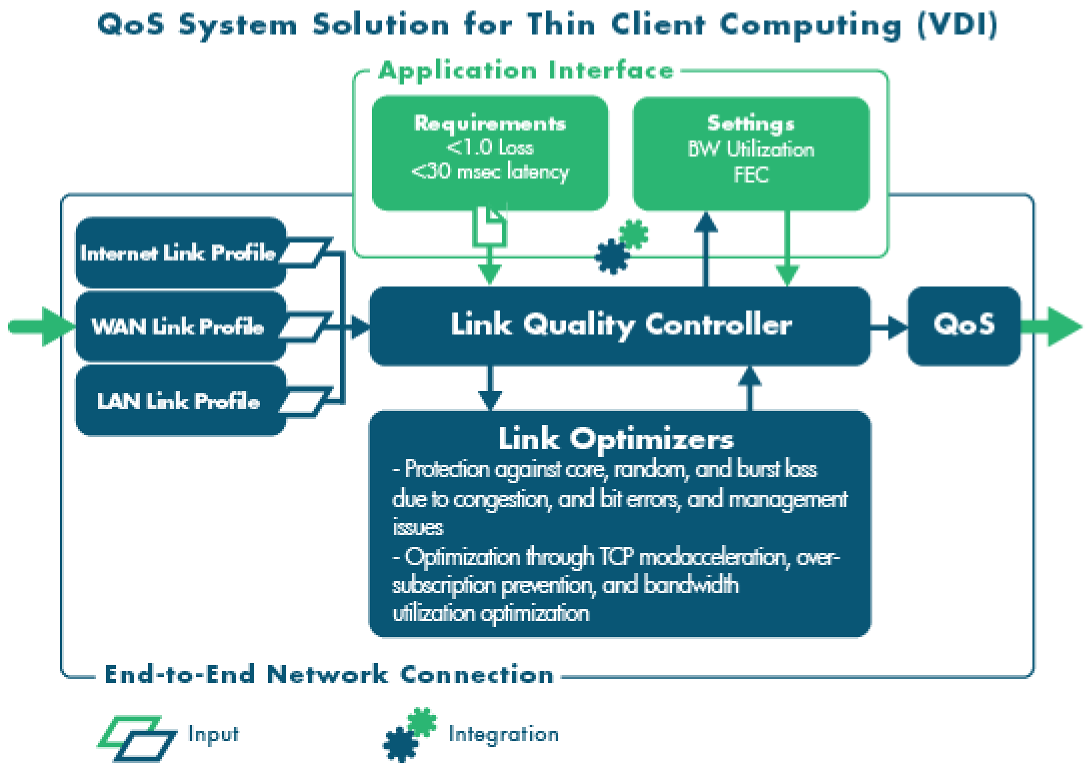
For 3G network links:
Over-subscription prevention techniques
Patented packet loss protection against loss at peering points

For WAN (Internet) network links:
Patented packet loss protection
Over-subscription prevention techniques

The networks involved, the application requirements and settings, and the techniques and technologies (from the list above) that comprise the IPeak Networks QoS Solution for the Video Chat use case are all as shown below.



The networks involved, the application requirements and settings, and the techniques and technologies (from the list above) that comprise the IPeak Networks QoS Solution for the Thin Client Computing use case are as shown below.



The megatrends continue and the opportunities at the intersection of real-time apps, mobile devices, and multiple networks are growing. The application developers and service providers that are taking advantage of IPeak Networks systems solution development platform to add QoS to their offerings are delivering best-in-class QoE to their users: meeting the challenges, and seizing the opportunities.