



# The World Bank — Global Network Goes to Pure IP to Provide Integrated Data/Voice/Video Services via Satellite & Multiple Network Platforms

## Effective Quality of Service Features in Cisco IOS® Software Bring Cost Efficiency, Ease of Management and Dependability

More than 2.8 billion people — half of the inhabitants of developing countries — live on less than US\$700 a year. Of these, 1.2 billion earn less than a dollar a day. In 2003, the World Bank provided US\$18.5 billion in loans and grants to the neediest of the world's regions. Along with loans and capital, technical assistance is also a key part of the World Bank's charter. Supporting and complementing field workers in regional offices and learning centers, a global, satellite-based network brings two-way high quality multipoint videoconferencing, toll quality telephony, and data communications to World Bank audiences as well as Global Development Learning Network (GDLN) Centers. Cisco Systems has worked closely to help make this integrated multimedia network stable, high-performance, and cost-effective in a gradual transition from multiple infrastructures to Internet Protocol (IP) with Cisco IOS® Software's quality of service (QoS) features.

### Network as Tool of International Development

The World Bank's Global Development Learning Network (GDLN) serves 111 field offices and 26 learning centers. Government officials and public employees attend lectures, meetings, and classes both face-to-face and online at the learning centers, which are owned and managed by partner institutions in each country. Each learning center includes rooms for meetings, classes, videoconferencing, Web access, and access to the distance-learning tools. Thousands of participants each year learn how to create and manage budgets and run a wide variety of municipal services related to health, education, trade, and the environment.

In 2002, when travel restrictions resulting from Severe Acute Respiratory Syndrome (SARS) impacted business, the Chinese Ministry of Finance relied on the GDLN for its main connection to World Bank programs. During this time, the Beijing GDLN Center hosted a series of discussions on SARS for the Canadian International Development Agency and the local Canadian Embassy after SARS cases were reported in Toronto. At a time of armed conflict in the Middle East, participants at GDLN Centers in Afghanistan, Egypt, and Jordan have taken advantage of online videoconferencing to attend meetings like those hosted by the International Development Law Organization in Rome on using information and communication technologies in governance.

### Reducing Complexity While Increasing Performance

Since the World Bank's global network was first deployed in 1995, it has grown to incorporate different transport technologies, such as Time Division Multiplexing (TDM), Time Division Multiple Access (TDMA), and Demand Assign Multiple Access (DAMA), over a three-satellite network operated by Intelsat. The primary solution for automated bandwidth distribution between multiple services (e.g., voice, video, and data), was Frame Relay.

"Frame Relay is very expensive solution to implement, which also brings a significant overhead," says Dr. Vili Brajovic, technical director for GDLN. "To use it over the DAMA network, we had to manually allocate bandwidth for pre-assigned videoconferencing sessions. That's time-consuming and inefficient. Also, a TDM/TDMA satellite solution, although it provided a better match with Frame Relay, was extremely inefficient to operate in C-Band environments due to uneven satellite footprints and a tremendous waste of power."



To reach field offices and GDLN learning centers around the world, the network operates on 140 MHz of bandwidth from three satellites that can reach countries that lack a wired network infrastructure on the ground. Over time, due to the various issues related to voice, video, and data transport mechanisms, the global networking staff has been grouped in three separate engineering groups supporting voice, video, and data services.

### **IP-Based Integrated Networking Solution — Meeting Demanding Network Requirements**

“The three services were becoming more complex and expensive to maintain,” recalls Brajovic. “For example, we run 15,000 videoconference sessions a year to between five to ten locations at the same time. Those conferences had become a nightmare to schedule and manage. We attended a Cisco Executive Briefing session and discussed the challenges we were facing with segmented networks and services we operate. We were looking for some uniform integration strategy.”

The World Bank required more than 50 simultaneous connections be in place for data, telephony, and video applications. Any attempt to run integrated services over the satellite WAN using QoS would have to overcome connectivity limitations at most of the field offices. Different classes of traffic had to be supported. And the solution had to be able to scale along with the growth of the World Bank’s network growth.

Cisco convinced the World Bank to integrate all three services over a pure IP network, using QoS features in Cisco IOS Software to manage the different requirements of each service. World Bank engineers had experimented with integration of voice, video, and data in 1999 over their local area network (LAN) in Washington, D.C. But “QoS wasn’t mature enough then, and we ended up integrating only voice and data applications with brute force,” says Brajovic.

Any attempt to run integrated services over the satellite WAN using QoS would have to overcome satellite connectivity limitations that are not common for LANs. Therefore, the existing QoS solutions have to be modified to support different classes of traffic. Furthermore, the solution has to be able to scale along with the growth of the World Bank’s network growth.

### **Pilot Benchmarks Global Solution**

Cisco assisted the World Bank in running a pilot project based in a lab in the Washington, D.C. data center. Set up to emulate a World Bank field office, the lab was equipped with a Cisco 3745 Router, a Cisco Catalyst 3548 switch, and a legacy telecom system. A 384 Kbps connection connected the lab to the data center network. By connecting the data center’s Cisco 3640 Router to the production network, the testing environment could access the existing video endpoints and hosts. The pilot routers were configured to support voice over IP, low-latency queuing, and link fragmentation and interleaving (LFI).

In the pilot test, a field office was represented by a Cisco 2600 router connected via a T1 line to a legacy telephone system. On the field office LAN, a workstation was installed for data traffic generation and a Polycom IP Videoconferencing station for video traffic. Headquarters was represented by a Cisco 3640 router connected via T1 to the World Bank’s production telephone system. The LAN interface of the router was connected to the World Bank’s corporate LAN, where other workstations and another Polycom IP Videoconferencing station were located. A delay simulator mimicked the latency of satellite connections.

The test involved loading the link with data and then simultaneously running a 256 Kbps videoconference, and placing several phone calls. Using, QoS, greater priority was given to voice (to avoid jitter and packet loss rendering conversations unintelligible); second priority was given to video (to support videoconferencing); and finally a low priority was given to data, since e-mail and other data transmissions are not as sensitive to delay.

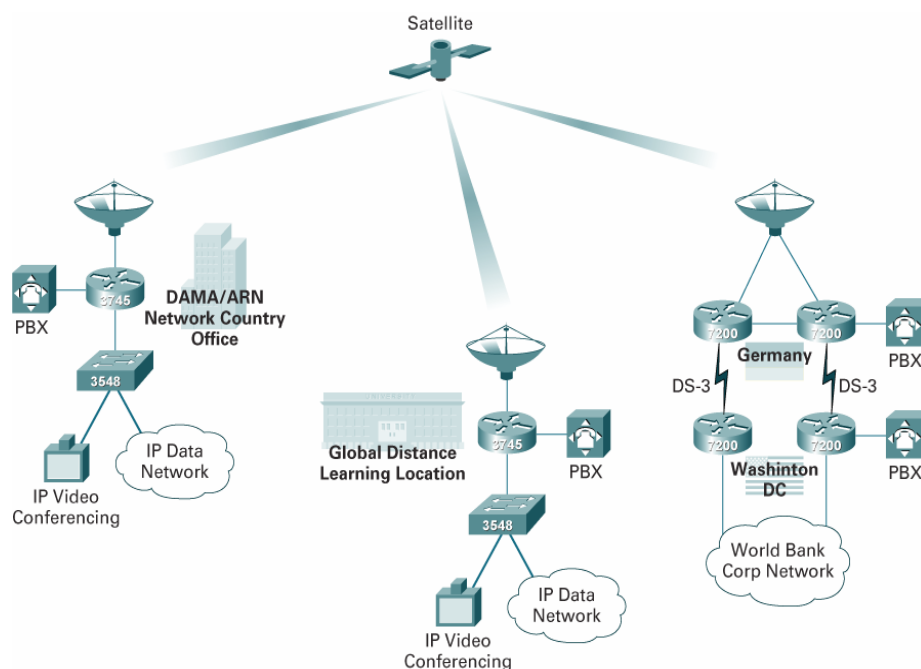


“We used low latency queuing to bring strict priority queuing features to voice, classed-based bandwidth assurances for video and flow-based fair queuing for data,” says Brajovic. “Based on the link speed, which was below 768 Kbps, we had to fragment and interleave to get the traffic through the narrow bandwidth pipe.”

The tests successfully proved that using QoS, each application running over an IP network could be configured with the appropriate levels of service. Every Cisco router could be modularly configured to support bandwidth guarantees and classes of service for the different applications under all conditions.

### QoS Goes Live with Immediate Benefits

Deployed in 2003, the multiservice IP network infrastructure for field offices and distance learning centers includes one Cisco 3700 Series routers and between two to four Cisco 3550 Series switches at each site, as well as a Cisco 2600 Series router to support distance learning at selected sites [Figure 1]. For security reasons, the distance learning traffic is tunneled through the network back to the headquarters DMZ network.



**Figure 1.** The World Bank’s GDLN Network includes satellite links to World Bank offices in member countries, Global Distance Learning Centers in urban and more remote regions, and the organizations primary data centers in Germany and the U.S.

Cisco helped the World Bank implement a variety of QoS features for the newly integrated network. These features included: low-latency queuing (to meet the bandwidth requirements of each traffic type); Link Fragmentation and Interleaving (LFI) to reduce delay; Voice over IP (VoIP); Generic Route Encapsulation (GRE) and Frame Relay switching to tunnel certain traffic through the network.

The World Bank’s end-to-end Cisco network uses Cisco Catalyst 6500 switches in the core and Cisco 3600 and 3700 Series routers at the edge and as access devices. The Cisco 7206 router is used as an aggregation platform.



Still a challenge is the ability to implement voice compression that gets traffic streams down to 11 Kbps. Different voice compression standards deployed complicates the issue. Cisco and the World Bank are testing Compressed Real-Time Protocol (cRTP) to reduce overhead by compressing headers of voice traffic once it is encapsulated in IP. In the meantime, the voice streams were reduced to 15 Kbps by increasing the voice payload size for the G.729 codec to 60 bytes.

The newly integrated network has already led to savings in staffing. "Now we're training everybody in IP," says Brajovic. "It's a much simpler approach."

Network management costs are also lower; the network administrators use Simple Network Management Protocol (SNMP), a network management protocol used in TCP/IP networks to control routers. SNMP provides a means to monitor and control network devices and to manage configurations, statistics collection, performance, and security. And the QoS features scale easily because as capacity and channels are added for voice, video, or data traffic, routers can be reprogrammed in minutes.

"In the past, we did not have the ability to monitor many voice and satellite devices," says Brajovic. "Now, using SNMP-enabled devices, we can control the whole network automatically. We also use SNMP to do online protocol analysis. We are planning to develop special tools to generate reports, including the quality of each individual voice or video session. We are enjoying the much more simplified management of our integrated network. The ability to automatically and optimally distribute bandwidth between multimedia services is like a dream come true in this business."

## **EXECUTIVE SUMMARY**

### **Background**

The World Bank is an agency of the United Nations whose charter is to reduce poverty by providing loans, grants, interest-free credit, and technical assistance to 184 member countries. Starting in 1995, the Bank introduced a global satellite communications network to support its business in the field as well as its decentralization. In 1997, the World Bank also began piloting the use of distance learning technologies for development learning and knowledge sharing. Responding to the success and growing demand for network services, the World Bank upgraded the network to include a rich array of learning programs, two-way videoconferencing capabilities, and Internet access. Programs were beamed via satellite to thousands across the globe each day.

### **Challenge**

Limitations in international connectivity infrastructure, especially in developing countries without a high-speed infrastructure on the ground, posed a challenge for the World Bank in building its own satellite-based network. Although the bank succeeded in building a robust satellite network, it did not have an efficient solution for multimedia service, implementation, and integration over its network.

### **Cisco Solution**

After attending a Cisco Executive Briefing, World Bank management saw the potential benefits of moving to converged network services over IP. The benefits included far lower cost of ownership and administration, superior and more consistent service, and decreased management complexity. Working closely with Cisco Systems, the World Bank subsequently tested and successfully deployed an integrated IP network with QoS parameters in Cisco IOS Software. QoS features included low-latency queuing (LLQ), Link Fragmentation and Interleaving (LFI), Voice over IP (VoIP), Generic Route Encapsulation (GRE), and Frame Relay switching



to tunnel certain traffic through the network. Together, these Cisco IOS features support the stable and efficient use of voice, video, and data applications each day by thousands of World Bank users and their audiences.

### **Results**

Today, the World Bank Global Development Learning Network (GDLN) includes more than 135 nodes that include Field Offices and GDLN Centers around the world. All multimedia services delivered over the network are supported by the latest end-to-end Cisco technology. This network, which uses extremely effective and cost efficient QoS mechanisms in Cisco IOS®, is considered one of the most advanced satellite networks, bringing the most sophisticated voice, video, and data services to some of the most remote regions on the planet.



#### **Corporate Headquarters**

Cisco Systems, Inc.  
170 West Tasman Drive  
San Jose, CA 95134-1706  
USA  
www.cisco.com  
Tel: 408 526-4000  
800 553-NETS (6387)  
Fax: 408 526-4100

#### **European Headquarters**

Cisco Systems International  
BV  
Haarlerbergpark  
Haarlerbergweg 13-19  
1101 CH Amsterdam  
The Netherlands  
www-europe.cisco.com  
Tel: 31 0 20 357 1000  
Fax: 31 0 20 357 1100

#### **Americas Headquarters**

Cisco Systems, Inc.  
170 West Tasman Drive  
San Jose, CA 95134-1706  
USA  
www.cisco.com  
Tel: 408 526-7660  
Fax: 408 527-0883

#### **Asia Pacific Headquarters**

Cisco Systems, Inc.  
Capital Tower  
168 Robinson Road  
#22-01 to #29-01  
Singapore 068912  
www.cisco.com  
Tel: +65 317 7777  
Fax: +65 317 7799

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