

VoIP in Industrial Networks

Implementing VoIP quality of service (QoS) for reliable voice communication over Industrial Ethernet

Ethernet is fast becoming the preferred method for all industrial communications—including voice and other real-time traffic that is sensitive to delay and data loss. This white paper explains how VoIP QoS classifies, prioritizes, and shapes traffic to provide reliable voice communications over an industrial network.

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Printed in the USA.

Introduction

For many years, serial interfaces such as current loop, RS-232, and RS-485 have been the preferred methods for industrial communications. Ethernet offers high reliability with the proven ability to adapt to changing environments, especially new types of media (coaxial cable and wireless transmission, for example). As Ethernet becomes the common interface for interconnection, it becomes natural to use this resource for all communications requirements. Adding voice communications capabilities, by either extending a telephone or offering a hot-line/party-line facility, can be as easy as plugging in a box and a handset.

Why Industrial Ethernet?

While serial device networks offered a measured level of efficiency, their implementation was very inefficient. Often these networks were made up of many smaller networks. Strings of similar equipment on single-network segments were laid on top of each other over the shop floor.

Interestingly enough, this *ad hoc* architecture did provide a level of protection for the data on each network string. A new piece of gear on one network didn't affect any other network. If expansion was required, an element could be added without much trouble. If needed, a new string could be created. This practice made strings of equipment deterministic in their behavior at the expense of high operational and infrastructural overhead.

The move to Industrial Ethernet brings some serious advantages such as:

- Increased speed, performance, and distance.
- Improved interoperability and lower costs through the use of standard Ethernet-based protocols, devices, and interconnects.

- Multipoint and peer-to-peer architectures allow true networking, not just point-to-point links.

Ethernet by nature wants to interconnect everything and share the bandwidth. While in many cases sharing resources is appropriate, without proper management and control over the data, the network will begin to fail.

The Problem with Voice

While much of the data traffic in an Industrial Ethernet network is non-real-time, voice traffic and some types of PLC traffic are real-time in nature. This real-time traffic is sensitive to delay and data loss. Without the proper toolset, adding real-time traffic to an industrial network can cause delay and loss to non-real-time traffic as well. Ethernet resources are available on a first-come first-served basis. This characteristic is called best-effort service. There is no differentiation between time critical data such as VoIP and other traffic on the network.

To eliminate the best-effort problem, Quality of Service (QoS) tools can be used at points in the network to control the behavior of real-time and non-real-time data. To support voice within an industrial network, the network equipment will require QoS features to classify, prioritize, and shape traffic across the industrial network.

What is QoS?

The QoS toolset, as it applies to voice over IP (VoIP), manages data communications so that voice packets and other real-time data are delayed as little as possible.

QoS does the following:

- Sets traffic priorities across the network
- Supports dedicated bandwidth on a per-flow scheduled basis

- Shapes network traffic to predictable levels
- Improves or eliminates loss characteristics
- Reduces network congestion

How does QoS get done?

Patton SmartNode gateways and routers provide advanced QoS tools that manage and control all types of data, including voice. Once the traffic is classified, one or more scheduling techniques are applied to determine the order in which different traffic classes will be permitted to use the available bandwidth.

Traffic class

First, in order to allow voice and data to effectively coexist, the SmartNode marks the packets making up traffic into various classes. You can think of the traffic class as a tag attached to each packet in the SmartNode, noting the packet’s classification. Some examples of classification can be found in the Type-of-Service field in the header of an IP packet.

It is easy to see that voice and real-time industrial traffic will want to minimize delay whereas a security monitoring connection may want reliability. These values, and their meaning, are entirely up to the network implementer and can be modified and configured to suit the installation and communication requirements.

TOS value	SmartWare value	Meaning
1000	8	Minimizes delay
0100	4	Maximizes throughput
0010	2	Maximizes reliability
0001	1	Minimizes monetary costs
0000	0	All bits are cleared, normal service, “default TOS”

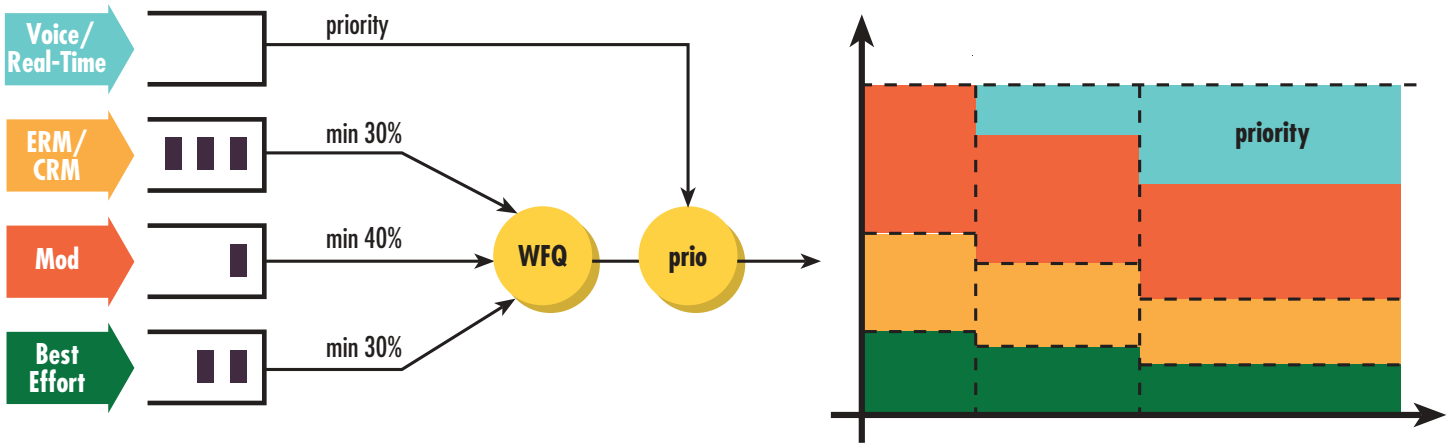
After a packet is identified or classified, it can now be managed. Priority is a way of ordering packets to give preference or priority to one traffic-class and to dynamically serve the other traffic-classes when the first has nothing to send. SmartWare uses this priority scheme to make sure that voice packets and real-time data will experience as little delay as possible. Priority classified data takes precedence over other flows only when required. After the real-time data transaction is completed, the entire bandwidth becomes available for all other traffic flows. Additionally, multiple real-time flows can be scheduled as they will not use up the entire available bandwidth.

Weighted fair queuing (WFQ) is a technique which assures a given minimum amount bandwidth for a certain traffic class. For example: you may specify that traffic class A gets three times the bandwidth of traffic class B. So now traffic A will get a minimum of 75% and traffic B will get a minimum of 25% of the bandwidth. Each traffic-class is in fact assigned a relative weight, which is used to share the available bandwidth among the currently active classes.

Shaping is another commonly used way to assign bandwidth. Shaping ensures that each traffic-class will get a specific slice of bandwidth. This is useful if there is traffic which wants to dominate the entire link but doesn’t need the entire link to function correctly.

When multiple classes are scheduled for the same time, some of them will be served too late, resulting in data loss. Burst-tolerant shaping prevents data loss by assigning additional buffers to bursty traffic classes. When a device starts transmitting data, burst-tolerant WFQ allows a higher initial throughput rate. This permits giving a higher weight or preference to short data transfers and improving transactional communications. This feature is sometimes referred to as the service curve.

Figure 1. Example QoS implementation



Conclusion

Clearly, the behavior of different network services can be better controlled if the real-time and non-real-time traffic can be distinguished. New job programs for PLC's and query data from weigh scales are not time-critical applications. On the other hand, paging, hot-line phones, call boxes, alarm alerts, emergency dispatching, and VoIP telephone calls are very time critical with consequences ranging from poor voice quality

on telephone calls to late or non-existent alarm or emergency dispatching.

Offering real-time data assurance and flow management, Patton has solved the problem of voice on industrial networks with its SmartWare QoS. Now, the industrial network architect can deploy Patton SmartNodes and implement voice over their industrial networks with QoS and ensure that all the data, voice, and video gets through end-to-end.

SmartNode Product Line Summary

Product Line	Series	Description
Residential 	M-ATA	Micro-Analog Telephone Adapter
	M-AFA	Micro-Analog Fax Adapter
	S-ATA	Residential Smart Analog Telephone Adapter
	S-DTA	Residential Smart Digital (BRI) Telephone Adapter
	S-WTA	Wireless Analog VoIP IAD
Branch Office SOHO 	SN411X	Multi-Port Analog VoIP Gateway
	SN402X	Analog VoIP SOHO Router
	SN4552	ISDN BRI VoIP SOHO Router
	SN452X	Multi-Port Analog VoIP IAD
Enterprise 	SN483X	Multi-Port Analog IAD with Integrated WAN Access
	SN4960	Multi-Port T1/E1 VoIP IAD
	SN463X	Multi-Port ISDN VoIP IAD
Carrier 	SN465X	Multi-Port ISDN VoIP IAD with Integrated WAN Access
	SN2300	Modular VoIP Routers
	SN4900	IpChannel Bank
	SN2400	4-Slot Modular VoIP Routers

Medium Enterprises
Large Enterprises

Product Highlights



Low Cost Analog & ISDN Adapters

- Low Cost simplified VoIP Gateways
- Plug and Go Feature Set
- Two Models for both Analog and ISDN Phones
- Single and Multiline with full FAX support



Branch Office Routers with VoIP

- SOHO VoIP with seamless connection to enterprise voice and fax
- Analog or digital options for one or two lines
- Network compatibility features allowing use virtually any IP service network with VPN, QoS, and Firewall features
- Single box LAN/WAN integration



Multiport Analog & ISDN with integrated WAN

- Small enterprise; branch/satellite office
- Voice extension and PBX voice and data networking; any-access-to-any-network
- PSTN access with FXS and FXO and FXS/FXO combinations; or ISDN BRI So
- Complete LAN/WAN routing with QoS, VPN, and network integration for a single-box solution
- Integrated WAN options for full routed connections with PPP/Frame Relay



IpChannel Bank

- Analog trunking VoIP
- Multipoint analog connections for call centers
- Expansion slot for integrated WAN uplinks using PPP/Frame Relay
- Reliability with redundant power and redundant Ethernet
- Low to high density (from 12 to 32) analog ports

SmartNode™/SmartLink™ VoIP...more than just talk!



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Document 07MD-VO-IND-ENET-WP