Heavy Duty VoIP Telephones

White Paper:

Designing Fiber Optic / Ethernet Networks for Industrial and Emergency Applications

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1.0. Introduction

Fiber Optic networks are increasingly being used to communicate Voice, Data and Video in Industrial and Emergency Applications. In this paper we will examine some of the evaluations a network engineer need to make when designing a VoIP network, including looking at open standard technology, voice quality and bandwidth capacity.

The use of fiber optics for reliable communications to monitor, analyse and control equipment are increasing safety and production efficiency in many different environments, including

- Inside Road and Train Tunnels
- On bridges and along highways
- Inside Underground Mining Applications
- In Offshore Wind Power Turbines
- Inside Utilities and Production environments
- And much more

These Fiber Optic networks are used to manage, control and interconnect a wide range of technology, including:

- SCADA systems
- VoIP Telephone systems
- Fire Detection systems
- Remote Video Monitoring systems
- Conveyor Belt, and Ventilation Control systems
- Public Address and Voice Alarm systems
- Traffic lights and signaling systems
- Interlocks, and Access Control systems

1.2. The Market for Industrial Fiber Optic Communication Technology

Fiber optics is the future of communications, and robust VoIP communication technology is one of the major profit centres within this market. All signal transmission, in their many and various forms, are being converted from electrical, using copper wire and coaxial cable, to fiber optics.

As a result, technologies such as the Norphonic Heavy Duty VoIP Telephones and the Norphonic Monitoring SCADA system are in the early stages of a fiber optics bull market. The annual global market for both IP SCADA systems and VoIP Telephones are projected to grow significantly over the coming years. However, it is worth bearing in mind some of the potential risks and pit-falls with buying into IP technology.

1.3. Fragmented Market

The popularity of using data / fiber optic networks in industrial and emergency applications have resulted in a multitude of manufacturers entering the market with new IP based technology solutions.

For the end user, the choice of products can be overwhelming and it is sometimes difficult to compare one solution with another, let alone what standards and protocols will be around for the entire lifetime of the installation, and last but not least judging what manufacturers will be around in 10 years time in order to support the installation.

In the remainder of this white paper we shall look at some of the things to evaluate when specifying your IP network and associated products.

2.0. Focus on Open Standard, Future Proof IP Technology

The first and most obvious issue when buying an IP product is to judge whether or not your technology is going to be supported in the future and if it can be expanded or changed without loss to the functionality. Many organisations have made the mistake (and still are) by purchasing proprietary technology that can not be changed or updated without significant costs or extra investments.

Proprietary / closed technology are often cheaper to buy into at the outset of a project because, once bought, the end user will be forced to live with that system for a long time and keep buying additional proprietary products for the whole life-cycle of the installation. There are also hidden costs in many proprietary solutions, like user licenses if you want to plug in other IP devices on your system etc. This enables the proprietary manufacturer to earn back the lower initial sales profit over the lifetime of the product installation. It is therefore worth keeping in mind that the cost for a proprietary system will be much more expensive in the long run.

The most critical evaluation for a network engineer must be: what will happen if the service levels for the product goes down, or your product functionality requirement changes in the future? More often than not, we find that proprietary customers get stuck with a solution which no longer match their needs, is expensive to maintain, along with a sinking realisation that they need to invest in another new solution to fix the problem(s).

This is why most network designers worldwide are now looking towards unified and consistent Open Standard technologies as a way to reduce costs by eliminating the inefficiencies of service-specific, proprietary, and non-reusable solutions. This basically means that a customer is free to chose what technology to interact with the IP device(s) whilst ensuring that the system can still work, even if other devices change in the future.

An example of a modern Open Standard telephone is the Norphonic Heavy Duty VoIP Telephone. Norphonic is based on open SIP standards and can therefore work with any type of routers, switches or switchboard / Public Branch Exchange (PBX) solutions, wether it is Asterisk, Alcatel, Cisco, Broadsoft or any other IP based PBX solutions.

3.0. Voice Quality Requirements

Telephone users often have a certain quality expectation for a telephone communication. And the expectation is no less when using VoIP telephones compared to a traditional analogue phone. In other words, a network designer should be careful to specify a VoIP Telephone which gives a good sound quality, by ensuring that the telephone incorporates the following:

3.1. Quality of Service (QoS)

Quality of Service (QoS) is a feature found in all Norphonic VoIP telephones and refers to the ability to provide different priority of voice and data flows, or to guarantee a certain level of performance to a data flow, ensuring impeccable delivery of voice communications in an IP network.

3.2. Type of Service (ToS)

Type of Service (ToS) is a feature found in all Norphonic VoIP telephones, delivering packet precedence (i.e., priority) in network traffic, thereby ensuring low delay, high throughput and high reliability.

3.3. Mean Opinion Score (MOS)

The quality of a call can be measured using one of several call quality metric calculations. The most commonly used system is the Mean Opinion Score (MOS). The MOS score of a call is between 1 (for unusable) and 5 (for excellent). VOIP calls that are working properly fall between 3.5 and 4.2 MOS. A score of 4.0 is defined as toll quality. MOS score is an indication of what users would think about the call. It was developed using surveys of users of different technologies, but today it is calculated through the use of engineering formulas.

When designing industrial IP networks to carry voice, you should not allow the MOS to drop below 3.0 at any time. For most emergency network applications, a MOS above 3.7 is recommended at all times. The Norphonic Heavy Duty VoIP Telephone can boost a high MOS listening quality score of 4.3.

MOS Listening Quality
5 Excellent
4 Good
3 Fair
2 Poor
1 Bad

Other systems for quality measurement are R-factor, PSQM, PESQ, and PAMS. These other systems produce scores for a call that can be mapped to MOS for comparison.

4.0. Redundancy - Back Up Service

In some applications, it is an express wish that the technology employed should be redundant, ie that there is a back up in the case that one line goes down. It is therefore sometimes important to design the system in such a way that this redundancy is possible.

As an example, the Norphonic Heavy Duty VoIP Telephone, comes with two single mode Ethernet ports, which supports redundant networking (RSTP). This means that the network designer can install the network in a loop formation which enables the signal to reach the telephone even if one network line goes down. This is often a requirement in emergency installations such as roadside fiber-based telephone systems.

5.0. Data Capacity and Bandwidth Planning

When designing an industrial fiber based network layout, it is important to estimate your data bandwidth needs. There are no specific or correct answer that we can provide here, other than that this process requires an understanding of how many users will be at each location, where the applications servers are in relation to the users of those servers, how much bandwidth each user of each application needs, etc.

When planning industrial data networks, it is usually recommended that network engineers plan in an extra 30% capacity to give extra room to accommodate the fact that IP data usage tends to come in bursts, OR be three times the Voice over IP bandwidth, whichever is the largest.

There are 3 other factors you should be aware of in terms of your network planning:

1. **Latency** - delay from data is transmitted until it is received. Noticable in conversations if latency goes above 100ms.
2. **Jitter** - variances in latency between packets. High jitter means large variance in packet latency and degrades speech quality.
3. **Out of order datapackets** - degrades speech quality, is often caused by jitter.

6.0. Summary

In summary, when designing a Fiber Optic Network, the network engineer should:

- Specify Open Standard SIP (VoIP) Telephones
- Specify technology that support QoS and ToS features as described in this paper
- Check if the telephone comes with two built-in fiber ports (if redundancy is required)
- Specify a MOS score above 4.
- Ensure that the overall bandwidth which is 30% larger than anticipated Voice + Data requirements, or at least 3x the Voice over IP bandwidth, whichever is the largest. Be aware of possible Latency, Jitter and out of order datapackets / plan your network accordingly.

More Information? In addition to this white paper, Norphonic has produced a range of Application Guides (on topics from Emergency Roadside Telephones, Industrial Telephones, Mining Telephones and more). These guides gives further information with regards to selecting fiber-based devices specifically for these applications.

7.0. About Norphonic

Norphonic is a privately held company, manufacturing Heavy Duty VoIP Telephones used in a wide range of industrial and emergency environments worldwide, including transport applications (rail, air, road, underground and metro systems), car parks, mines, production floors, public spaces and heavy duty industrial applications such as offshore wind farms and power manufacturing sites.

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