

Related Technologies for Robust Industrial Ethernet Switches

Kazushi Ono,
Tatsuya Okuro,
Yasushi Tateishi

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Abstract

As a pioneer in Japan, we developed industrial switch products which are designed to meet rigorous network requirements for infrastructure.

In a network for infrastructure, it is taken for granted that communication gears like Ethernet switches always work reliably. Generally, users are not aware of the robust level of network equipment. Once a problem occurs in a communication network, its negative impacts on systems are vast and serious. The market demand on reliability is very stringent in terms of environment resistance and continuous operation.

Further, the importance of network design in IT systems is increasing yearly, and the system value is determined by the quality of network design.

Against such a background, we proposed switch products based on a concept called “robust Ethernet switches” that are specialized for industrial applications.

1 Preface

The role of an industrial network is to “correctly transmit control information, terminal information, and to monitor network information without delay.” In short, the following three points have to be realized:

(1) Operate without stopping

Transmit information without interrupting performance of network equipment and lines 24/7/365.

(2) Transmit only correct information

Mission-critical systems always transmit only the correct information without being influenced by any environmental factors (environmental bad impacts like noise, temperature, etc.). Even in an environment vulnerable to the negative external influences, it never allows the loss of information.

(3) Transmit the data without delay.

Various network gears can be used in the transmission lines for a network. Application criteria can differ according to transmission distance, communication bandwidth, durability against noise, installation cost, and other specific characteristics. Even though there arises a great change in line characteristics, communication with minimal delay has to be realized without packet loss.

There is the concept for industrial Ethernet switch products that are excellent in environmental

resistance and it can build a robust network system that can support infrastructures. We call our industrial switches as “robust Ethernet industrial switch” or “Robust Switch” that can clear the three-points requirements discussed above. Different from general LAN products, we provide unique industrial Ethernet products to contribute to the network society. This paper introduces our “Robust Switch” concept.

2 Robust Design for Hardware

Table 1 explains the concept of “Robust Switches.” First, we have to examine performance characteristics of industrial network products such as robust requirements on hardware, durability (noise and environmental temperature) and anti-corrosion. We conducted various environmental resistance tests in accordance with the relevant standards. Based on the test results, we provide our industrial products that can withstand conditions in the installation environment.

Further, for any power interruption, it is required to have some redundancy on power supply in order to enable the continuous operation. In this case, we make the power source duplex. We can replace the faulty power source while the system is working on

Table 1 Concept of “Robust Switch”

Essential factors for “Robust Switch”-our industrial switch products are shown.

Design target	Action items	How to get there	
Robust design for hardware (Environmental resistance design)	Environmental measure (noise)	Adopt parts resistant to noise Design with anti-noise (Structural and electrical design)	Realize by the added costs
	Environmental measure (temperature)	Adopt industrial components Adopt high-reliability components	
	Environmental measure (Corrosion)	Adopt sulfur-resistant components Protect and seal corrosive sections	
	Redundancy (power source)	Realize redundancy and do maintenance during operation	
Secure the strength of communication data traffic (no packet loss)	Redundancy (line and communications)	Detour function by loop circuit Make detour function Faster (reduce loss time) Line redundancy (redundant configuration)	Realize by switch functions
	Priority control	Secure bandwidth by priority (bandwidth control)	
	Environmental measure (temperature)	Go lower energy	
Stabilize the control	Precise time synchronization	Adopt IEEE 1568-compliant devices	

a sound power source. This means we can conduct the maintenance work without stopping system operation.

By attempting various measures at the design stage such as circuit design and structure design, it can lead to the improvement of system performance. The design is such a factor. For such performance gain, a certain amount of cost is required. Such cost should be considered as necessary in order to establish a highly availability system.

3 Securing the Robustness for Communication Data

In order to secure the robustness in communication data, it is necessary to provide for redundancy against line errors and equipment malfunction by taking proper measures like the duplication of lines or alternative routing in the event of a system failure.

Fig. 1 shows the performance of Ring Topology Protocol (RTP) for Meiden ring type network. When a blocking port is set up in the ring type configuration, the occurrence of looping can be prevented. If any error occurs, the blocking port is moved (bypassed) to the faulty section. In this manner, communication can continue. The time needed for detouring is within 0.5 seconds for Meiden switch products. This is a guaranteed value at the maxi-

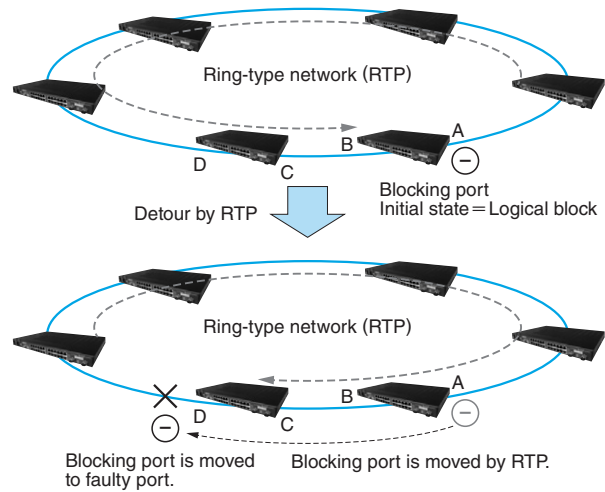


Fig. 1 RTP Operation

Operation for RTP is shown under the condition that a blocking port is moved by RTP from Default Blocking Port A of loop-type network to Port D where an error has occurred.

mum 32 nodes.

Almost no problems take place within the range of ordinary communication traffic so long as adequate measures are effectively used such as data retransmission by protocols, or flow control or detour.

There is, however, an upper limit in the volume of data that can be carried through the communication network. It is necessary to be aware of the fact that packet loss can easily occur if communication loads become heavy.

In ordinary Ethernet, a broad communication bandwidth such as 100Mbps or 1Gbps can be used. In the case of long-distance communication, a broad communication bandwidth may be available in case costly optical fibers are used. However, in the case of a low-cost copper wire network a bandwidth of only some hundreds of kbps is available.

In a network where different communication bandwidths are intermingled, some designing consideration is needed in order not to exceed the limitation of communication bandwidth. However, It is still difficult, however, to control the momentary concentration of packets. In such a case, countermeasures have to be taken by adopting bandwidth control of switch products or priority control based by priority.

Fig. 2 shows the transmission state where a narrowband circuit exists in the communication route. If there is communication traffic momentarily exceeding the bandwidths, any packet exceeding the bandwidths is generally discarded. By using the

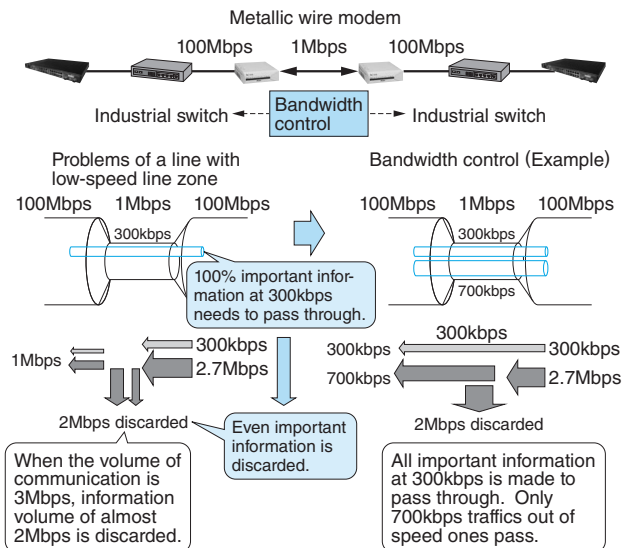


Fig. 2 Operation of Bandwidth Control

The behavior of bandwidth control is shown. In a network with a narrowband line, a packet is discarded if its communication traffic exceeds the specified bandwidth. On the other hand, the other illustration shows packets of higher priority are made to pass through the network.

bandwidth control function, packets are examined and selected so that all of the important packets are transmitted and all other non-essential packets can be selectively discarded.

For Meiden switch products, we always adopt the latest cutting-edge bandwidth control technologies and priority control functions are always adopted.

4 Stability in Control

In order to make the system run continuously, it is desirable that the system runs the information at the same time rather than each system unit run by the different individual times.

For example, in the case of a long trace upon the occurrence of a communication error, sequential relationship among operations can be easily clarified if the time-based information is synchronized. In a system where schedule management is stringent, more stabilized system management is possible if the operation of each unit is synchronized. For these purposes, a precise time synchronization function is applied.

5 Release of Robust Switches

We adopted a new switch engine that is applicable to “our robust switch” products. Our switching

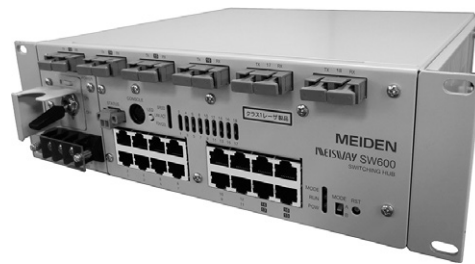


Fig. 3 Switching Hub for Power Industry, MEISWAY SW600

This is a gigabit layer 2-switch model compliant with Power Utility Standard B-402. It can replace SW500 as a successor model.

Table 2 Transmission Specifications for the SW600

A total of 16 ports of 10/100/1000BASE-T and maximum 6 optical ports (100BASE-FX or 1000BASE-LX) are incorporated.

Item	Transmission specifications
Switching mode	Store-and-forward
Switch capacity	13.7Gbps 2.66Gbps (For 100Mbps full duplex / all ports)
Transmission method	Full duplex / half duplex
Port configuration	10/100/1000 BASE-T 16 ports (4 ports for optical port components)
	6 ports Max. for optical system
	100 BASE-FX Connector used: SC Applicable to Multi-Mode Fiber (MMF) Applicable to Single-Mode Fiber (SMF)
	1000 BASE-LX Connector used: LC Applicable to SMF Applicable to 10km and long distance (40km)
Error output terminal	1 contact point
MAC address capacity	8000
Flow control	IEEE802.3x (Full duplex), Back pressure (Half duplex)
VLAN	Tag and port based VLAN conforming to IEEE802.1Q
Error packet filtering function	Short packet, long packet, FCS error packet, symbol error packet
Network control	SNMPv1 (RFC1157-compliant), MIB II
Network management	telnet, http, ICMP, IP
Storming suppression	Where properly set, it is possible to discard broadcast, multicast, and unknown address packets.
Serial console	By round connector conforming to EIA/TIA-232-E
Setup save, write in, firmware updating	By Web (http) or via serial port

hub for electric power industry in Japan called “MEISWAY SW600” (“SW600” hereafter) comes loaded with this type of engine. It was released in February 2015. Fig. 3 shows its external appearance.

This product is a successor model of our switching hub MEISWAY SW500 for the electric power industry, and it realized our “Robust Switch”

Table 3 Environmental Specifications for the SW600

A ventilation hole is removed from the unit top and the operating temperature range is expanded to -20°C to 55°C. As a result, it saved power consumption by about 30% and total weight by about 20%. It is compared with the former model SW500.

Item		Environmental specifications
Type		UT226 / * * * A (* depends on type)
Power connector		3P inlet type (AC) / 3P terminal board (DC)
Power voltage range		AC85~242V (47~63Hz) / DC80~143V
Power consumption (in operation)		25W Max.
Working temperature range (in operation)		-20~55°C
Withstand voltage	Source primary - FG or SG	AC 2000V for 1 minute
Insulation resistance	Source primary - FG or SG	DC 500V 5MΩ or above
Durability against power noise		Rectangular wave impulse noise 2kV, 50ns/1μs
Mass		Approx. 4kg
External dimensions		W255 × H88 × D250mm (Excluding embossed parts)
Applicable standard		Power Utility Standard B-402 (Except for inrush currents)

platform and it comes with a new-generation switch engine (features of bandwidth control and precise time synchronization function will be available in near future.). **Table 2** shows the transmission specifications for the SW600 and **Table 3** shows the environmental specifications.

6 Postscript

So far, our industrial switch products developed in the past received positive reviews from our customers as a high environmental resistance product. At the time of initial product release after development, there was no concept of such industrial switches. Consequently, we could not say that our product concept of switch products was not widely known in Japan.

This time, we made our product concept of Meiden industrial Ethernet switches as a “Robust Switch.” We hope our customers could have a clearer product image.

Going forward, we will work on further improving reliability and expand functions. In so doing, we intended to contribute to the networked society.

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