〈**Components**〉

Monitoring and Control System and Switching Hub Functions

Monitoring and control system, Communications equipment, Switching hub, Redundant Paths Control

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Abstract

MEISWAY SW/TX Series represents a group of industrial switching hub most suitable for markets requiring high reliability and environment-resistant features needed in electric power, plant systems, transport, and industry, among others.

With monitoring and control systems, this is a network where many devices are inter-connected and information is concentrated and where causing complicated network problems is a possibility. For example, if multiple devices try to communicate simultaneously, packet data will be concentrated and some may be discarded. Generally, such packets will be retransmitted by upper layer protocol, but recovery time is very limited in the case of a monitoring and control system. For this reason we have to avert or reduce the various traffic issues by using the functions of industrial switching hub in the network design.

1. Preface

Through concentrated connections, the monitoring and control system is used for status monitoring and control of remotely installed or widely distributed equipment units. In this system, the communication function is major function, and it requires a long-term stable operation.

When the Ethernet is applied to the networks, parts and communication protocols can be used in common. As a result, cost reduction is possible and expansibility can be enhanced. Unlike conventional networks where the secured packet delivery is ensured, the Ethernet technology is designed on the premise that some communication packets may not arrive. For these reasons, in system design, there are many network issues that need to be factored. These problems can be avoided or alleviated by using protocol design and various functions of the communication device (hub).

This paper introduces the functions of Meiden industrial L2 switching hubs, MEISWAY SW900/SW200, and L3 switching hubs MEISWAY TW700/TW900/TW200.

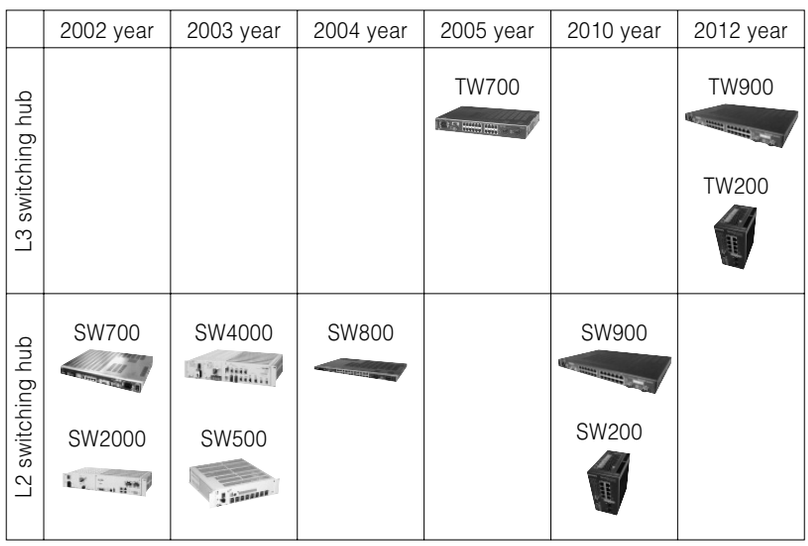

Fig. 1 Product Roadmap of Our Switching Hubs
The product has high reliability and an environment-resistant characteristic.

2. Roadmap

Fig. 1 shows the product roadmap of our switching hubs. The TW900 shown in Fig. 2 and the SW200 in Fig. 3 are all-port gigabits-ready hubs to improve the switching performance. The SW200 is a compact hub with 8 ports. It is mounted on DIN rail and runs on DC

Fig. 2 L3 Switching Hub, MEISWAY TW900
A 24-port gigabit interface is installed. A Flexible network structure can be established by virtue of network redundancy features in loop configuration.

Fig. 3 L2 Switching Hub, MEISWAY SW200
The unit can work on a DC 24V power source and it is DIN rails-ready.

24V. As for L3 switch we are developing TW700, as well as TW900 and TW200. Table 1 shows the product specifications.

3. Problems in Ethernet Application

When the Ethernet is applied to the monitoring and control system, the difficulty lies in the differences from other conventional data transmissions. Designing a transmission bandwidth is difficult. In the case of other conventional types of data transmission, communication is maintained at a designed timing and traffic volume with consideration due to communication error so that data can be delivered to a distant receiver successfully. On the other hand, the Ethernet is a transmission method with an expectation that the transmission packet may fail to reach the receiving party. In other words, a packet may be lost elsewhere between the sender and receiver.

Triggered by the progress of technologies, the increased bandwidth and the advanced hub switching function improved the data transmission performance dramatically. Under circumstances (1) to (4) described below, however, a transient increase in communication data traffic can cause a lack of buffer inside the hub, thus leading to the loss of packets.

(1) There are some slow network paths with low baud rates.
(2) Some packets are congested in a network path.
(3) There are many packets casting by broadcast and multicast.
(4) When the communication is going unilaterally in one direction, hub does not learn MAC addresses.
As a result, the packet flooded.

4. Functions of Switching Hubs

4.1 Interface

In communication, the responsiveness tends to improve the baud rate increases. This improves the

Table 1 Product Specifications of SW900, SW200, TW700, TW900, and TW200
TW900 and TW200 have the same interfaces of SW900 and SW200. These products are a L3 switching hub with improved performance than conventional TW700.

Item	Specifications		Remarks
Switching engine spec.	24-port 10/100/1000Mbps included CPU and peripheral devices		
Port configuration	10/100/1000BASE-T 24ports 8 ports for SW200 and TW200 (2 ports used as combo-port with SFP slot)		Connector: RJ-45 UTP (with shield) traffic status display LED built-in type Auto-MDI/MDIX (disabling possible)
	SFP 2slot	100BASE-FX 2ports	Connector: LC type Multi-Mode Fiber (MMF) Single-Mode Fiber (SMF)
		100BASE-LX 2ports or 1000BASE-BX 2ports	Connector: LC type SMF or Long-distance SMF (Not BX-ready at TW700)
	Setup serial port 1port		Dsub 9-pole to EIA/TIA-232-E-compliant
Network functions	L2 switch function		—
	Redundant paths control function (standard) Loop or mesh configuration		Spanning tree protocol (IEEE802.1D) High-speed spanning tree protocol (IEEE802.1W)
	Redundant paths control (Meiden proprietary spec.) / Improved spanning tree protocol (RTP)		Convergence time: within 1s Max. (within 0.5s in 1000BASE-BX) All constitutive nodes shall be of RTP-ready type
	Routing control (L3 only)		Static, RIP,OSPF, PIM-SM
	Packet priority control		IEEE802.1P-compliant / 4 levels per port for TW700 only; other hubs for 8-level transmission queue
	Network management (SNMP and MIB)		SNMPv1 (Conforming to RFC1157-compliant); MIBⅡ (RFC1213-compliant); Bridge MIB (partly ready); SNMP-trap (delayed transmission possible)
	Network operation (telnet, http)		Network login by telnet; Firmware rewritable by rewritable by remote using http
	VLAN		IEEE802.1Q-compliant; Port/tag base VLAN; Max. groups: 256
	Multicast-ready		IGMP snooping (IGMPv1 and IGMPv2) / PIM-SM (L3 only)
	Flow control		IEEE802.3x: full duplex Back pressure: half-duplex
	Storm suppression function		Arrangeable by setting to broadcast or multicast or disposal of unicast packets with no specific destination
	Access list (L3 only)		Packet filtering according to access list / MAC address filtering (included in above ACL)
	Port mirroring		Traffic monitoring enabled in any port possible
RAS function	Self-diagnostic feature at start-up period		Executable at both start-up and during operation
	Error message recording function		Information stored in flash memory
	Saving and re-writing function on setting values		Via http and console (zmodem)
	Firmware remote re-writing		Via http and console (zmodem)

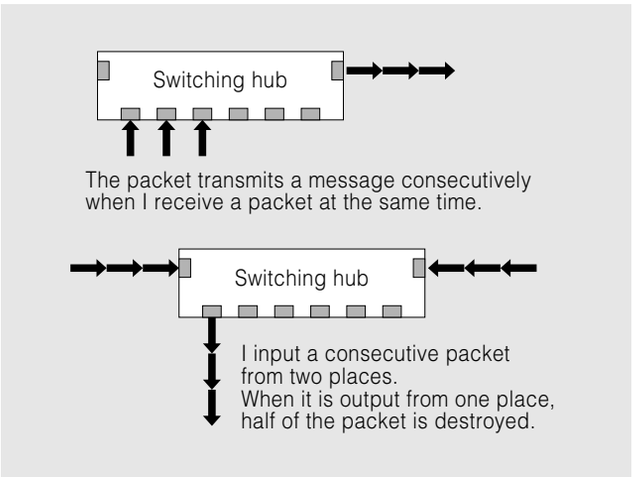

Fig. 4 About Packet Destruction in Hub
When input is bigger than the output, hub discard a packet easily at extremely short time. It occurs easily.

deterioration issue with efficiency of the overall system transmission which is caused by a low speed part. However, it is not always better to do faster. As shown in the Fig. 4, packets are discarded when an unbalance between hub input and output is occured. When 1Gbps is changed down to 100Mbps on the input side, traffic per hour is suppressed and the burden on the output side becomes 1/10. In this state, spare time is available on the output side and this margin can be used for a momentary increase of data traffic.

In monitoring and control system as well as many other systems, the system configuration tends to cause heavy data concentration at the higher-level side of the system. As such, if a lower-level side of the system set is slowed, it may clear the data traffic problem. For communication from the upper-level side to the lower-level side, it requires that the packet intervals extend on the transmission side.

An abundance of interfaces results in the expansion of the application range in design. As for the transmission rate, fixed settings or auto-negotiation are possible. It can be limited to 10Mbps and 100Mbps in the auto-negotiation. Regarding interfaces for the SW/TW Series and in case of the twisted-pair cabling, this series works for 10BASE-T, 100BASE-TX, and 1000BASE-T (All-port gigabit Ethernet-ready models: SW900, SW200, TW900, and TW200). For fiber optic cabling, this series works for 100BASE-FX (MMF, SMF), 1000BASE-LX, and 1000BASE-BX are available.

4.2 Access Control

Since a critical monitoring and control system does not require any external communications, it avoids the unauthorized intrusion of external communication by physically closing the network system. In the IT systems in Japan or abroad, however, there are some cases where it could not completely close the IT system and consequently allowed the unauthorized intrusion by external connection causing the system failures. Going forward, these systems need to be reconstructed in order to take adequate countermeasures for full assurance security.

Access control function of the L3 switch can permit or deny packets by establishing the proper packet conditions such as each MAC address, IP address, port number, etc. In this manner, only the specified packets will be able to pass through the network while denying any unauthorized access.

The above function is not only a measure for security, but it also works as a means to reduce issues related to heavy congestion of data traffic. The discarding of unnecessary packets will lead to reduction of the traffic load. An access control function is integrated in the L3 switch.

4.3 Priority Control

In the current Ethernet technology, a momentary congestion of packets will cause the discarding of packets. Discarding depends on the receiving timing, the loss of critical packet will have an adverse influence in the monitoring and control system.

The priority control is a function in sending a specified packet inside the hub. As a result, low priority packets may be discarded first and this can reduce the negative impact on the system. In ordinary IT systems, images and audio data are required to emphasize the real-time property and they tend to have higher priority. However, a low priority is set because an image and the audio are not important according to the monitoring and control.

4.4 Long-Term Stable Operation and Fault Investigation

In the monitoring and control system which is the major application of the hub, around-the-clock continuous operation is essential. Therefore, the product life shall be factored in the product design; therefore no fan is used and it utilizes an air-cooled design. The component selection like the aluminum electrolytic capacitors is based on the product life. In the past, a large casing was used for cooling but since each components power consumption levels have recently become low, a compact design with a long life can be realized. At some project sites, the presence of gas and dust during the operation can be a cause of failure. The printed circuit board has a surface coating that secures a long operational life.

In Meiden hub products, we utilized the remote monitoring function and data-logging function such as the Simple Network Management Protocol (SNMP). We can check the log data at the time of error occurrence; such functions support long-term operation. Table 2 shows part of environment specifications of SW900 and SW200.

4.5 Redundant Paths Control Functions of Network

Due to aged deterioration or any other external

Table 2 Operating Condition Specifications of SW900 and SW200

Long-life electrolytic capacitors are used. Because of fan-less type, no maintenance parts are required.

Operating ambient temperature	0～55℃ (fan-less)
Ambient temperature for storage	−20～70℃
Vibration resistance	5.9m/s^2 (0.6G) 1000min^{-1}
Environment-resistant treatment	Coating applied to the PWBs used
Withstand voltage	AC 2000V for 1 minute
Insulation resistance (Power source primary and FG)	5MΩ or more at DC 500V
Applicable standard	B-402 Standard
Power source impulse	Rectangular impulse noise 1μs, 50ns 2.0kV period of 55Hz
Electrostatic noise	Contact 6kV; Air 8kV
Operational life	Fan-less type; Easy-maintenance is enabled for 10 years.

factors, the hub or a communication channel may fail. In such a case, monitoring and control can be continued without being affected by this failure if the hub can automatically switch the failed link to redundant link.

The Ethernet is generally constructed in a star topology. It will be either in a mesh topology or ring topology if any redundancy is required. In either case, redundant paths of control are indispensable. With the ring form, one should not lay a cable to detour around in the same location in order to avoid possible failure.

Although high redundancy is assured by the mesh topology, a large amount of cables must be laid. Therefore in many cases, the ring topology is adopted in consideration of less cabling complexity and high network availability.

The standard protocols are Spanning Tree Protocol (STP) (IEEE802.1D) and Rapid Spanning Tree Protocol (RSTP) (IEEE802.1w); however, a substantial amount of time is needed for the convergence of the two (re-establishing the network connectivity). Accordingly, it is a challenge to apply this protocol to monitoring and control system.

Meiden Real-time Transport Protocol (RTP) is our proprietary protocol by us. It realizes the fast convergence (Only applicable to the ring topology).

Fig. 5 shows the RTP operation during normal communication. One connection or path is closed according to the specifications and packets flow through the bus topology. Fig. 6 shows abnormal operation when the failure is detected in connection or path. A closedown position moves to the location that the communication abnormality occurred and communication can continue in unaffected sections.

A time required for the convergence is 0.5 seconds. When the ring topology and Meiden RTP are used, the redundant paths control can be applied to monitoring and control.

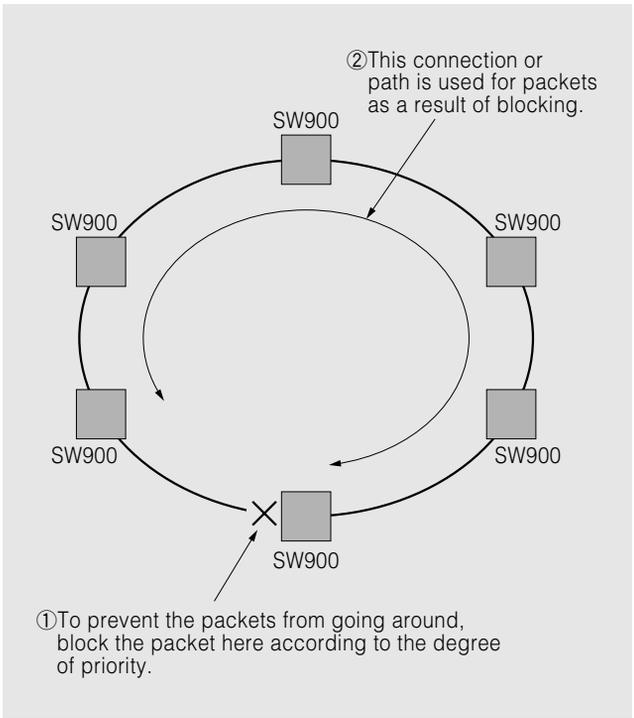

Fig. 5 RTP Operation During Normal Communication

For a network connected in a ring topology, packets may keep turning endlessly. Therefore, hub makes a block.

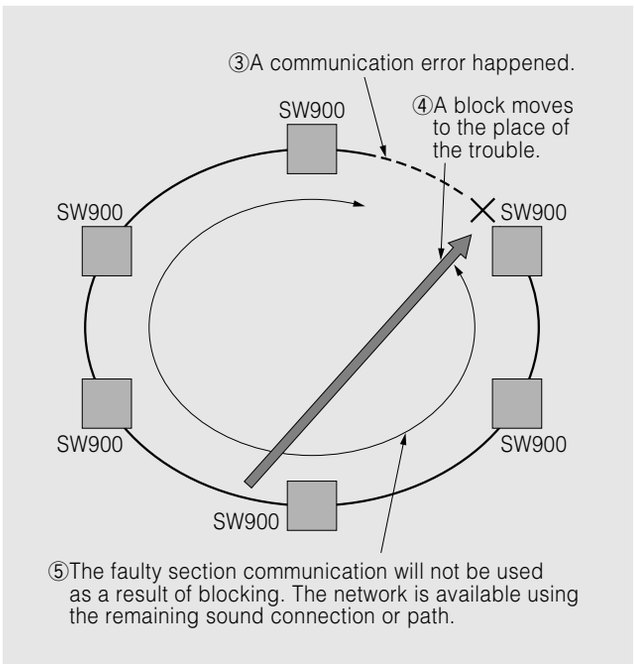

Fig. 6 RTP Operation During Communication Fault

If a communication path or a hub fails on the loop, the blocking point moves to the faulty section of connection or path. As long as the failed section is only one point, the network is still available.

4.6 VLAN Functions

The VLAN is a function to divide traffic into multiple networks in a hub.

The L2 switch can constitute VLAN, but the communication between the VLAN cannot be maintained. The L3 switch, however, allows the communication among these VLANs by its IP-routing function.

4.7 IP Routing Functions

Isolating the communications network takes place when there is an increase of connecting devices or there is a need to manage network with the different locations or among different organizations. When the network is isolated, a normal L2 switch may not allow communication among the isolated groups; therefore routing by L3 switch is required.

The isolation has positive effects not only on the network management, but also on limiting the influencing area by broadcast or limiting the failed area.

L3 switches routing protocol meets with Static, RIP, OSPF, and PIM-SM. Routing is a hardware-based processing and it is very fast.

PIM-SM is a routing protocol of multicast. Multicast packets like videos and audio data are efficiently streamed to such data collecting devices. This protocol improves the impacts against communications with other inter-connected devices. This routing can be used in combination with the Meiden RTP with redundant paths control.

5. Postscript

It has been almost 15 years since the Ethernet was first applied to a monitoring and control network. However, various communication problems have not been resolved fully.

Going forward, we would like to continue to improve reliability and long-term stable operation of monitoring and control systems through enhancing such factors as higher processing capability, speedy redundant path control function, faster judgment function of locating the faulty parts, and a more efficient bandwidth control.