Technical Information

Vnet/IP Network
Construction Guide

TI 30A10A05-01E

YOKOGAWA

Yokogawa Electric Corporation
2-9-32, Nakacho, Musashino-shi, Tokyo, 180-8750 Japan

TI30A10A05-01E

5th Edition Mar. 2019 (YK)

Blank Page

Introduction

The purpose of this document is to ensure that users who use a Vnet/IP control bus understand the Vnet/IP system configuration, necessary precautions to set up the system, and the settings required to create a control network system before they set up a Vnet/IP system.

Chapter 1 describes Vnet/IP. Chapters 2 and 3 provide the information required to configure a Vnet/IP system. Ensure that you read Chapter 1 first if you are not familiar with the background of Vnet/IP.

Chapter 1 provides an overview of the Vnet/IP system configuration when it is used as a control network, and the devices required for the system.

Chapter 2 describes the Vnet/IP network settings based on system configuration examples. It provides examples of the basic system configuration, multiple domain configuration, and connection with existing systems. These examples describe the required devices, settings, and information when setting up the network. We recommend that you evaluate the general Vnet/IP system configuration by following these examples. You must read Chapter 1 first to understand Chapter 2.

Chapter 3 describes the Vnet/IP network settings in a system configuration that does not use information network but uses Vnet/IP to perform communication that is normally done on an information network. It provides examples of the basic system configuration and multiple domain configuration. These examples also describe the required devices, settings, and information when setting up the network. To set up a system without using information network, you have to fully understand the conditions described in Chapter 1.6 of this document, and then configure and run the system appropriately. You must read Chapter 1 first to understand Chapter 3.

Chapter 4 describes the layer 2 switches, layer 3 switches, cable for Vnet/IP, time synchronization in the Vnet/IP system, and necessary precautions when installing network devices. Time synchronization is important for the electronic records; electronic signatures (21 CFR Part 11) compliant system of Food and Drug Administration (FDA) or for the Sequence of Event (SOE) system.

This document addresses the Vnet/IP network configuration as a control network. When Vnet/IP is connected to an external network, it is necessary to take security issues into consideration. Therefore, this document does not provide complete information on the required network configuration or settings. When connecting to an external network, contact the network administrator to determine the appropriate network configuration.

With the release of CENTUM VP R5.01 and ProSafe-RS R3.01, the guidelines are changed so that Vnet/IP is used as a network for control communications, and other communications are performed on an information network other than Vnet/IP. This document is customized to address this change. Refer to “TI 30A10A10-01 Vnet/IP Network Construction Guide (Legacy Edition)” for the legacy guide.

Related documents

TI 30A10A10-01E	Vnet/IP Network Instruction Guide (Legacy Edition)
TI 30A10A20-01E	Vnet/IP Built-In security Features
TI 30A10A30-01E	Network Switch for Vnet/IP

Glossary

The following table describes the terms commonly used in this document.

Table Glossary terms (1/2)

Term	Description
1000BASE-LX	A gigabit Ethernet optical interface standard specified in IEEE 802.3 with a transmission rate of 1 Gbps.
1000BASE-T	A gigabit Ethernet UTP interface standard specified in IEEE 802.3 with a transmission rate of 1 Gbps.
100BASE-TX	A Fast Ethernet UTP interface standard specified in IEEE 802 with a transmission rate of 100 Mbps.
APCS	An Advanced Process Control Station (APCS) performs control functions with a station to improve advanced control and plant efficiency.
BCV	A generic name for Bus Converter. It connects V net stations to V net or HF Bus stations in other domains.
BCV-H	A Bus Converter for HF Bus. It connects V net stations to HF Bus stations in other domains.
BCV-L	A Bus Converter for RL Bus. It connects V net stations to RL Bus stations in other domains.
BCV-V	A Bus Converter for V net. It connects V net stations to V net stations in other domains.
CENTUM	A generic name for Integrated Production Control System CENTUM VP and CENTUM CS 3000.
CENTUM system	A system that consists of CENTUM components.
Control bus TCP/IP communications	The TCP/IP protocol communications on the control bus V net.
Control Communications	A generic name for the control data communication between CENTUM or ProSafe-RS stations.
Control network	The transmission path for control communication between CENTUM and ProSafe-RS systems.
DCOM	A Microsoft-defined specification for distributed object technology. It enables software components referred to as COM objects to communicate and exchange data and processing requests on a network.
ENG	A station with engineering functions that performs CENTUM system configuration and maintenance management. It can be the same station as the HIS.
Exaopc	A station on which Exaopc OPC Interface Package is installed.
Exapilot	A station on which Exapilot Operation Efficiency Improvement Package is installed.
Exaquantum	A station on which Exaquantum Plant Information Management System is installed.
FCS	A Field Control Station (FCS) is a component of the CENTUM system that performs process control and manages communications with subsystems such as PLCs.
Firewall	A generic name for functions and devices that protect the local network against unauthorized access from an external network.
Gigabit Ethernet	An Ethernet standard for 1 Gbps transmission rate, as defined by IEEE802.3.
GSGW	A Generic Subsystem Gateway Station (GSGW) collects and configures data of various subsystem types through OPC DA servers. It is a station with the Generic Subsystem Gateway Package.
HIS	A Human Interface Station (HIS) serves as a human machine interface of the CENTUM system. It is used for operation and monitoring.
HUB	A device that connects network devices on an Ethernet network.
Information network	The transmission path for file transfer and data communication between CENTUM or ProSafe-RS stations and generic Ethernet devices. The information network uses Ethernet standard protocols.
IP address	An Internet Protocol (IP) address is a logical address that identifies network devices.
Layer 2 switch (L2SW)	A network device that relays packets at Layer 2 (Data Link Layer) of the OSI reference model.
Layer 3 switch (L3SW)	A network device that relays packets at Layer 3 (Network Layer) of the OSI reference model.
MAC address	Abbreviation of Media Access Control address which is a unique address that is assigned to each Ethernet interface for identification.

Table Glossary terms (2/2)

Term	Description
OPC	A standard interface that supports the development of measurement control system using COM or DCOM of Microsoft.
OPC DA	Refers to OPC Data Access, which is an OPC based real-time data access.
Open Communications	The communications with Ethernet-based standard protocols on a Vnet/IP network.
Optical Fiber cable	A cable used for optical communication. It is required for extending transmission cables and cables between buildings or noisy locations because it has low attenuation and immunity from electromagnetic interference. The two types of optical fiber cable are single-mode and multi-mode.
PCS	Process Control System (PCS) is a generic name for systems that perform process control such as CENTUM and its subsystems or PLC instrumented systems.
PLC	Programmable Logic Controller (PLC) is a generic name for controllers that perform sequence control.
PRM	A station on which Plant Resource Manager (PRM) is installed.
ProSafe-RS	A generic name for Safety Instrumented System ProSafe-RS R3, ProSafe-RS R2, and ProSafe-RS R1.
ProSafe-RS system	A system that consists of ProSafe-RS components.
SCS	A Safety Control Station (SCS) is a safety controller of ProSafe-RS that performs logic functions such as interlock, emergency shutdown, and fire and gas protection.
SENG	A station of ProSafe-RS that performs engineering functions such as application configuration, downloading, application testing, and carrying out of maintenance tasks on SCSs. You can install the SENG functions on a station that has HIS or ENG functions.
SFP	A Small Form-factor Pluggable (SFP) is an MSA-compliant detachable optical transceiver for network communication devices.
SIOS	A System Integration OPC Station (SIOS) integrates third party process control systems (PCSs) with the CENTUM system.
SNTP server	A station that provides time in response to client requests by using the Simple Network Time Protocol (SNTP), which is a standard protocol for synchronizing time on the network.
UGS	A Unified Gateway Station (UGS) is a Vnet/IP dedicated station that integrates subsystem controllers such as STARDOM controllers (FCN/FCJ) or third party PLCs with the CENTUM VP system.
UTP cable	The most commonly used Unshielded Twisted Pair (UTP) cable. 100BASE-T uses Enhanced Category 5 (CAT5e) UTP cables or higher. UTP cables usually use RJ45 plugs as connectors.
V net	A process automation control network that uses the token passing method. It has a transmission rate of 10 Mbps.
V net router	A device that connects a Vnet/IP domain to a V net or VL net domain. It is used to relay control communications.
VL net	A control network for CENTUM CS 1000.
Vnet/IP	A process automation control network based on gigabit Ethernet that complies with the international standard (IEC 61784-2 Ed.2.0).
Vnet/IP domain	A region in which devices are connected without using L3SW or V net router in a Vnet/IP network.
Vnet/IP protocol	A control communication protocol on Vnet/IP that conforms to IEEE 802.3 and UDP/IP.
Vnet/IP stations	A generic name for devices such as FCS and SCS for Vnet/IP, V net router, and stations in which a Vnet/IP interface card is installed.
WAC router	A device used for connecting two Vnet/IP domains via wide area network (WAN) through a public network or a dedicated network.

Symbol Marks

Throughout this Technical Information, you will find several different types of symbols are used to identify different sections of text. This section describes these icons.

WARNING

Indicates precautions to avoid a danger that may lead to death or severe injury.

CAUTION

Indicates precautions to avoid a danger that may lead to minor or moderate injury or property damage.

IMPORTANT

Identifies important information required to understand operations or functions.

TIP

Identifies additional information.

SEE ALSO

Identifies a source to be referred to.

Trademark

Trademark

- Vnet/IP, CENTUM, ProSafe, Exaopc, Exapilot and Exaquantum are either registered trademarks or trademarks of Yokogawa Electric Corporation.
- PRM is registered trademarks of YOKOGAWA in the United States and/or Japan.
- Windows is registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.
- Ethernet is a registered trademark of XEROX Corporation.
- Other company and product names appearing in this document are trademarks or registered trademarks of their respective holders.
- TM or ® mark are not used to indicate trademarks or registered trademarks in this document.
- Logos and logo marks are not used in this document.

Blank Page

Vnet/IP Network Construction Guide

TI 30A10A05-01E 5th Edition

CONTENTS

1. Overview of Vnet/IP

Vnet/IP is a highly reliable and responsive control network that is developed by YOKOGAWA.

This section provides an overview of Vnet/IP by describing its functions and specifications.

1.1 Vnet/IP Features

Vnet/IP is a process automation control network that is based on gigabit Ethernet. It has the features that are important for a stable plant operation, namely high reliability, and real-time response. It also provides security against threats from an external network, such as cyber attacks.

Vnet/IP connects the devices that make up the CENTUM and ProSafe-RS systems. It allows the exchange of control data among these devices. Vnet/IP can also connect to other systems that use V net or VL net as their control network by using a V net router.

You can use network devices such as Layer 2 Switch (L2SW) or Layer 3 Switch (L3SW), and transmission media such as UTP cables or optical fiber cables to set up Vnet/IP.

Vnet/IP is a control network that complies with the international standard (IEC 61784-2 Ed.2.0) and conforms to IEEE 802.3 and UDP/IP.

High reliability

Vnet/IP is a control network with dual redundant buses and consists of independent subnets, bus 1 and bus 2. The control communication is usually performed by using bus 1. However, when a problem occurs in bus 1, the path switches immediately and automatically so that the control communication is performed by using bus 2.

Real-time response

Vnet/IP implements a dedicated protocol for performing high-quality communication on UDP/IP, which is a protocol that is suitable for real-time communication.

The transmission scheduling function prevents transmission delays and packet loss by stopping packets from being accumulated. Real-time response is achieved by prioritizing among the different communication types.

Security

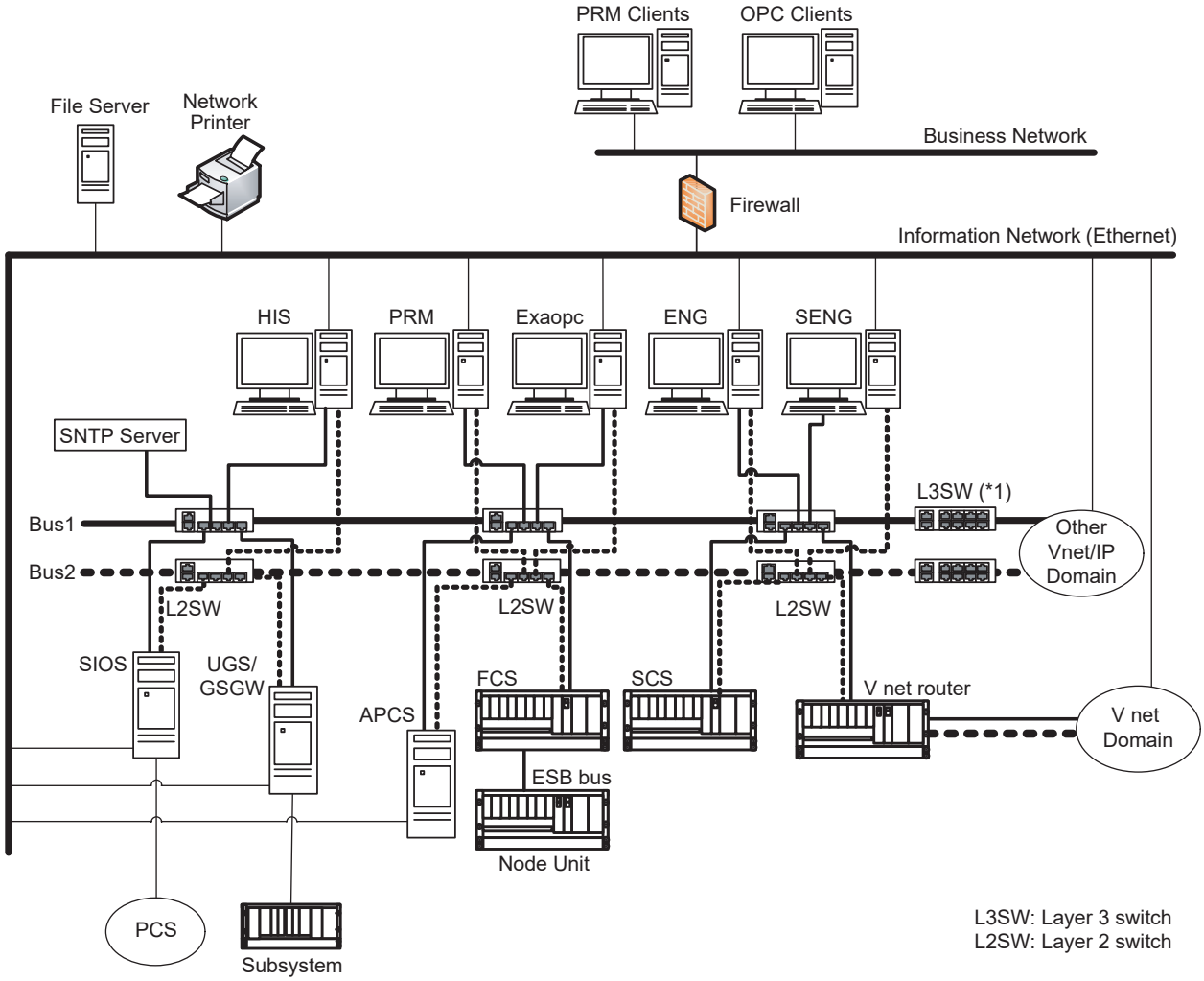
Vnet/IP takes security into account. It performs authentication by using a shared secret key that is updated periodically to prevent cyber attacks such as data eavesdropping, falsification, and spoofing.

SEE ALSO For more information about Vnet/IP security features, refer to the following.
“Security Standard of System Product” (TI 30A10A20-01E)

In this document, we recommend that you perform non-control communication, which is information communication, on an information network other than Vnet/IP. If the information network is not used but Vnet/IP is used for both control communication and information communication, refer to the conditions described in Chapter 1.6 of this document

1.2 Vnet/IP System Components

The following figure shows an example of a Vnet/IP system configuration.



*1: WAC router is used for connecting to other Vnet/IP domain via WAN.
(Refer to GS 33J01A10-01EN for an example of system configuration including WAC router.)

Figure System Configuration Example

In this document, devices such as stations in which a Vnet/IP interface card is installed, FCS and SCS for Vnet/IP, and V net router are all referred to as Vnet/IP stations. Vnet/IP stations support Vnet/IP protocols.

Vnet/IP stations:

- HIS
- ENG
- FCS
- APCS
- UGS
- SIOS
- GSGW
- Exaopc
- PRM (Field Communications Server)
- SENG
- SCS
- V net router
- WAC router

1.2.1 Vnet/IP Stations

HIS

An HIS serves as a human machine interface of the CENTUM system that is used for operation and monitoring. Software packages installed on a computer or on a console HIS, consisting of a computer and Open Display Console Assembly. You can install and run operation and monitoring functions, and/or engineering functions on an HIS as necessary.

A Vnet/IP interface card is required to connect to Vnet/IP.

ENG

An ENG is a station with engineering functions that performs CENTUM system configuration and maintenance management. It can be the same station as the HIS.

A Vnet/IP interface card is required to connect to Vnet/IP.

FCS

An FCS performs process control and manages communications with subsystems such as PLCs.

The following types of FCS are available for Vnet/IP and FIO:

AFV30S:	Field Control Unit (for Vnet/IP and FIO, 19-inch Rack Mountable)
AFV30D:	Duplexed Field Control Unit (for Vnet/IP and FIO, 19-inch Rack Mountable)
AFV40S:	Field Control Unit (for Vnet/IP and FIO, with Cabinet)
AFV40D:	Duplexed Field Control Unit (for Vnet/IP and FIO, with Cabinet)
AFV10S:	Field Control Unit (for Vnet/IP, 19-inch Rack Mountable)
AFV10D:	Duplexed Field Control Unit (for Vnet/IP, 19-inch Rack Mountable)

APCS

An APCS performs control functions with a station to improve advanced control and plant efficiency.

The APCS requires installation of the “LFS1200 APCS Control Functions.” A Vnet/IP interface card is required to connect to Vnet/IP.

UGS

A UGS is a station that integrates subsystem controllers such as STARDOM controllers (FCN/FCJ) or third party PLCs with the CENTUM VP system. It is connected by subsystem controllers and various communication protocols such as Modbus, EtherNet/IP, and OPC DA. Similar to the FCS, you can operate and monitor UGS from the HIS.

The UGS requires installation of the “LBC1500 Unified Gateway Station Standard Function (UGS).” A Vnet/IP interface card is required to connect to Vnet/IP.

SIOS

An SIOS integrates third party process control systems (PCSs) with the CENTUM system.

The SIOS is a station on which the “LBC2100 System Integration OPC Client Package” is installed. A Vnet/IP interface card is required to connect to Vnet/IP.

GSGW

A GSGW collects and configures data of various subsystem types through OPC DA servers.

Subsystem data is assigned to GSGW function blocks. Similar to the FCS, you can operate and monitor function blocks from the HIS.

The GSGW is a station on which the “LFS1250 Generic Subsystem Gateway Package” is installed. A Vnet/IP interface card is required to connect to Vnet/IP.

Exaopc

Exaopc provides an open OLE for Process Control (OPC) interface. The Exaopc station works as an OPC server on which the “NTPF100 Exaopc OPC Interface Package” is installed. A Vnet/IP interface card is required to connect to Vnet/IP.

PRM (Field communications Server)

The Field Communications Server of PRM is a station that collects and configures field device information online.

A Vnet/IP interface card is required to connect to Vnet/IP.

SENG

A SENG is a station of ProSafe-RS that performs engineering functions such as application configuration, downloading, application testing, and carrying out of maintenance tasks on SCSs.

You can install the SENG functions on a station that has HIS or ENG functions. A Vnet/IP interface card is required to connect to Vnet/IP.

SCS

An SCS is a safety controller of ProSafe-RS that performs logic functions such as interlock, emergency shutdown, and fire and gas protection.

The following types of SCS are available for Vnet/IP:

SSC60S:	Safety Control Units (Rack Mountable Type, for Vnet/IP)
SSC60D:	Duplexed Safety Control Units (Rack Mountable Type, for Vnet/IP)
SSC50S:	Safety Control Units (Rack Mountable Type, for Vnet/IP)
SSC50D:	Duplexed Safety Control Units (Rack Mountable Type, for Vnet/IP)

V net router

A V net router is a device that connects a Vnet/IP domain to a V net or VL net domain. It relays communication between Vnet/IP stations and V net or VL net stations.

The following V net router is available:

AVR10D: Duplexed V net Router (redundant use of communications modules and power supply modules)

Wide Area Communication Router (WAC router)

A WAC router is the hardware used for connecting two Vnet/IP domains via a wide area network (WAN) through a public network or a dedicated network. It enables the operation and monitoring of FCS/SCS distributed in a remote Vnet/IP domain. Satellite communications can also be used as a WAN.

AW810D: Wide Area Communication Router

1.2.2 Vnet/IP Network Devices

Layer 2 Switch (L2SW)

Layer 2 switches connect devices in a Vnet/IP domain. Vnet/IP uses the recommended layer 2 switches that support a transmission rate of 1 Gbps.

Layer 3 Switch (L3SW)

Layer 3 switches are network switches with routing functions that connect Vnet/IP domains to each other. If a Vnet/IP system consists of multiple domains, the routing function of layer 3 switches relays communications among the domains. Vnet/IP uses the recommended layer 3 switches that support a transmission rate of 1 Gbps.

SNTP server

An SNTP server synchronizes the Vnet/IP station time with the Coordinated Universal Time (UTC). It synchronizes the time of all the stations through Vnet/IP by generating highly accurate time information from GPS signals.

1.2.3 Cable for Vnet/IP

Vnet/IP uses cables, such as Enhanced Category 5 (CAT5e) UTP cables or optical fiber cables, to connect devices in the system.

For optical fiber cables, we recommend that you use the single-mode type.

1.2.4 Ethernet Communication Devices

Peripherals such as network printers, file servers, or firewalls are connected to the information network. They are not connected to the Vnet/IP network and are not protected by the Vnet/IP security. Therefore, ensure that they do not become a vulnerability to security during operation.

Peripherals

You can use Windows-compatible peripherals such as printers because an HIS, ENG, and SENG support Microsoft Windows.

Contact YOKOGAWA for more information on the peripherals that you can use with the system.

1.3 Vnet/IP Main Specifications

This section describes the main specifications of Vnet/IP.

1.3.1 Communications Specifications

Control communications

Communication method:	Read/write communications, message communications, and link transmission
Link transmission period:	100 msec

Transmission path

Network topology:	Star topology (tree or ring topology for multiple connection)
Transmission path redundancy:	Dual redundant paths (control communications only)
Transmission rate:	1 Gbps

1.3.2 Achieving high reliability with Redundancy

Vnet/IP is a control network with dual-redundant buses. Statuses of both Vnet/IP stations and communication paths are constantly monitored. The most suitable control communication path is always selected to ensure stable plant operations.

Status of Vnet/IP stations and communication paths

Vnet/IP stations can exchange their statuses and the statuses of communication paths with each other. Therefore, the statuses of Vnet/IP stations and communication paths on Vnet/IP are stored and updated periodically in Vnet/IP stations.

Communication path selection

A Vnet/IP station comprehends the path status for a communication destination from its own communication path information, and chooses a normal bus to transmit the control data required.

Vnet/IP usually uses bus 1 for the control communication path. It does not use bus 1 and bus 2 alternately. When a problem occurs in bus 1, the communication path switches to bus 2. However, after bus 1 recovers, the communication path reverts to bus 1. The switching of buses is performed on the respective communication paths that lead to the destination.

On the left side of the following figure, a communication error occurs in the cables between station C and layer 2 switch for bus 1. In this case, bus 1 is used between stations A and B, while bus 2 is used between stations A and C. On the right side of the same figure, the layer 2 switch for bus 1 is not working. In this case, bus 2 is used between stations A and B, and between stations A and C.

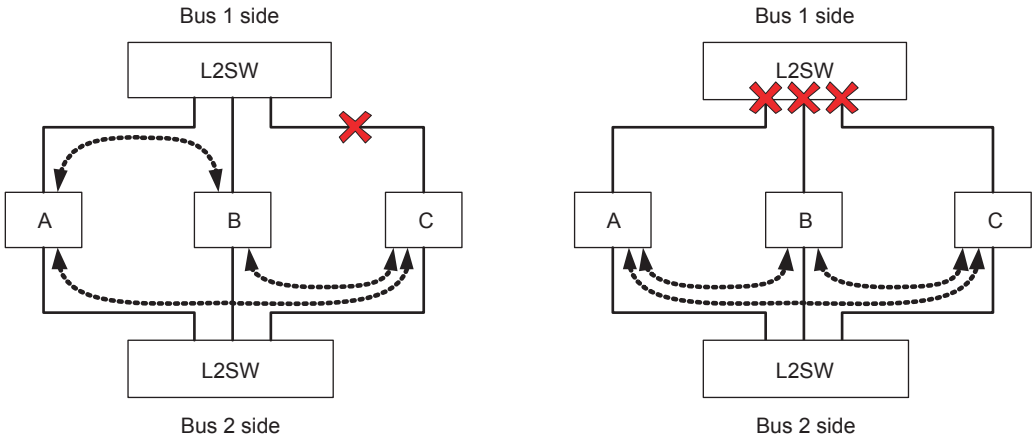


Figure Selection of Transmission Path

Redundant CPUs in Vnet/IP stations

The duplexed FCSs, duplexed SCSs, and duplexed V net routers have two CPUs. Each of the two CPUs is connected to layer 2 switches in a dual-redundant Vnet/IP.

As mentioned earlier, a Vnet/IP station stores information of other stations that are on Vnet/IP. This includes information about CPU control rights. The sending station uses the control rights information of the receiving station to determine the path to take for sending the control information, and the CPU module to which the information is sent.

In the following figure, station A determines that CPU2 has the control rights for station B, and therefore communicates with station B CPU2 through the layer 2 switch for bus 1. On the other hand, CPU1 has the control rights for station C. However, a communication error occurs in the path between station C CPU1 and layer 2 switch for bus 1. Therefore, station A CPU1 and station B CPU2 communicate with station C CPU1 through the layer 2 switch for bus 2.

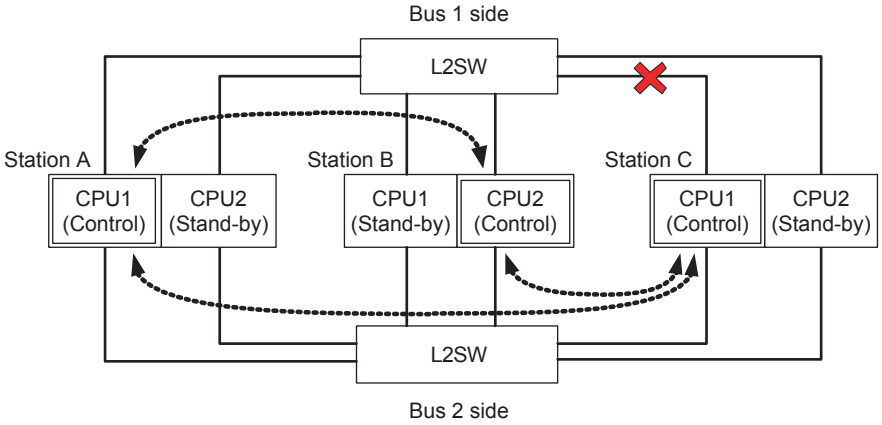


Figure Transmission Path for Redundant CPUs

1.3.3 Achieving high reliability with Ring Configuration

Vnet/IP is a dual-redundant control network. When bus 1 fails, the communication is continued by switching the route to bus 2. When the bus 1 and bus 2 are installed in parallel, there may be a case when both of the buses fail at the same time caused by an incident. In such case, connecting multiple network switches in ring configuration, redundancy of the communication route can be established. Using this redundant communication route, the communication among Vnet/IP stations is continued.

What is Ring network?

Ring network is a network connecting switches in ring configuration. The feature of the ring network is that having redundant communication routes by its network topology, even one of the communication routes fails, the rest of the routes continue communications.

Detouring communication path by Ring network

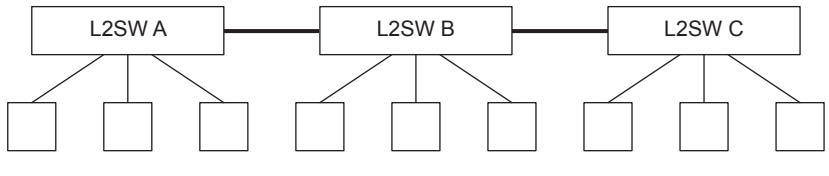
Suppose a system configuration in which L2SWs are connected in series as shown in the following figure.

In the system shown in Fig. (1) in which the L2SWs are connected in series, when the communication failure occurs at one of the L2SWs, the communication among the Vnet/IP stations are disturbed at the failed L2SW.

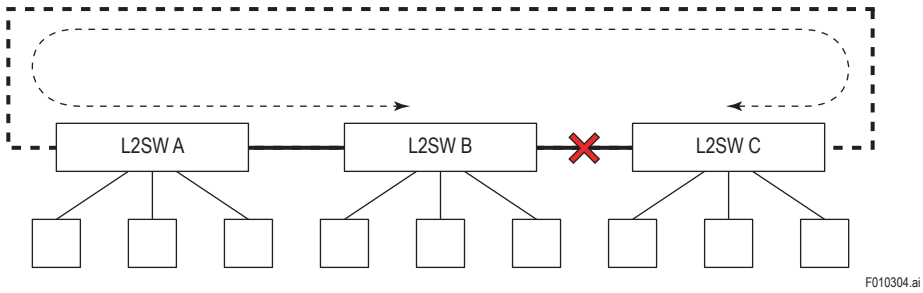
However, by connecting among L2SWs “A” to “C” in ring network, as shown in Fig. (2) and (3), to provide ring protocol settings to the switches, the communication path can be switched to detour if there is a communication failure point in the communication path.

In this way, the ring network achieves high reliability in communication by redundancy.

(1) An example which L2SWs are connected in series by tree topology.



(2) In case where a cable between L2SWs fails in a ring topology network.



(3) In case where a L2SW is defective in a ring topology network.

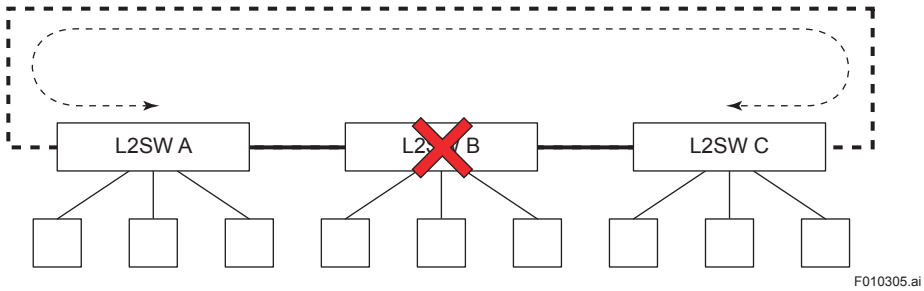


Figure Detour of Communication Path by Ring Network

The single line in the figures actually represents two communication lines of bus 1 and bus 2. When the bus 1 cable fails, as in the figure (2), bus 1 switches to detour by the ring structure and continue Vnet/IP communication.

As in the figure (3), when the L2SW “B” on the bus 1 fails, the bus 1 switches to detour by the ring structure; however, the failure point (the communication to the Vnet/IP station connected to the switch B) will not recover and the Vnet/IP communication switch to the bus 2.

By adopting the ring structure, reliability of the Vnet/IP communication increases.

In case both bus 1 and bus 2 break at the same time and the switching of the dual redundancy bus and the ring structure take place simultaneously, the following phenomenon may rarely occur.

- A system alarm of “Communication Error” may occur.
- HIS message(s) may be lost.
- Process data on face plates and graphics may be temporarily displayed as “asterisk.”
- Trend data may be temporarily lost.

1.4 Vnet/IP System Structure

In Vnet/IP, a region that uses only layer 2 switches for connections without using devices such as a V net router or layer 3 switch is referred to as a Vnet/IP domain. Vnet/IP builds a network for each domain.

When building networks, it is important to consider the limitations for each domain and for all the domains.

Vnet/IP domain

In a Vnet/IP domain, Vnet/IP stations are connected to layer 2 switches that are configured by star or ring topology.

There can be up to 64 Vnet/IP stations connected in a Vnet/IP domain. If more than 64 Vnet/IP stations are connected, domains can be separated to increase the number of stations connected. In a CENTUM and ProSafe-RS system, you can configure up to 16 domains, which can be a combination of Vnet/IP, V net, and VL net (CENTUM only) domains.

You can connect up to seven levels of layer 2 switches in a Vnet/IP domain. There is no limit on the number of layer 2 switches that you can use in the domain. However, there should not be more than seven layer 2 switches used in between stations.

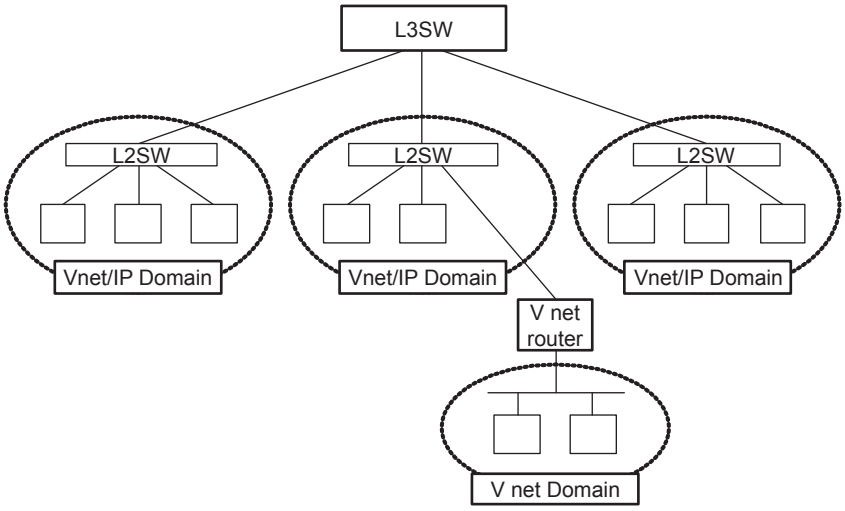


Figure Sample Structure of Multiple Domains

- Number of Vnet/IP stations per domain: Up to 64 stations
- Levels of layer 2 switch connection per domain: Up to 7 levels
- Number of domains in the system: Up to 16 domains

Connection within a Vnet/IP domain

A dual-redundant Vnet/IP bus consists of independent subnets, bus 1 and bus 2. A Layer 2 switch is installed in each line.In Vnet/IP stations with dual redundant CPU modules, each CPU module has ports for bus 1 and bus 2, which connect to layer 2 switches in their respective paths. You can extend the paths up to 5 km by using optical fiber cables between layer 2 switches (*1). From the operation and maintenance perspective, we recommend that you use the same number of levels of layer 2 switches and path length for bus 1 and bus 2.

*1: In case further length is required, contact YOKOGAWA for details.

The following figure shows an example of a Vnet/IP domain configuration in which the central control room is in a different location from the control device room.

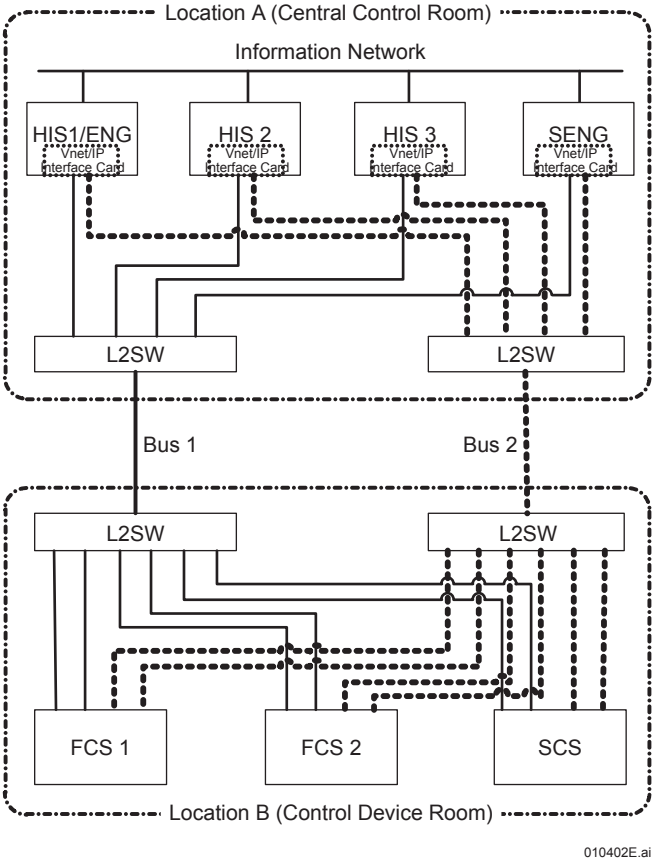


Figure Example of a Vnet/IP Domain Configuration

Connecting Vnet/IP domains with each other

Layer 3 switches connect Vnet/IP domains with each other. There can be up to 16 domains connected in a system. Ensure that the communication bandwidth between domains is 1 Gbps or more. To connect wide-area communication services in a narrow band network where the link speed is less than 1 Gbps, contact YOKOGAWA.

The following figure shows the connection topology between domains. Layer 3 switches that are installed for bus 1 and bus 2 connect the two Vnet/IP domains.

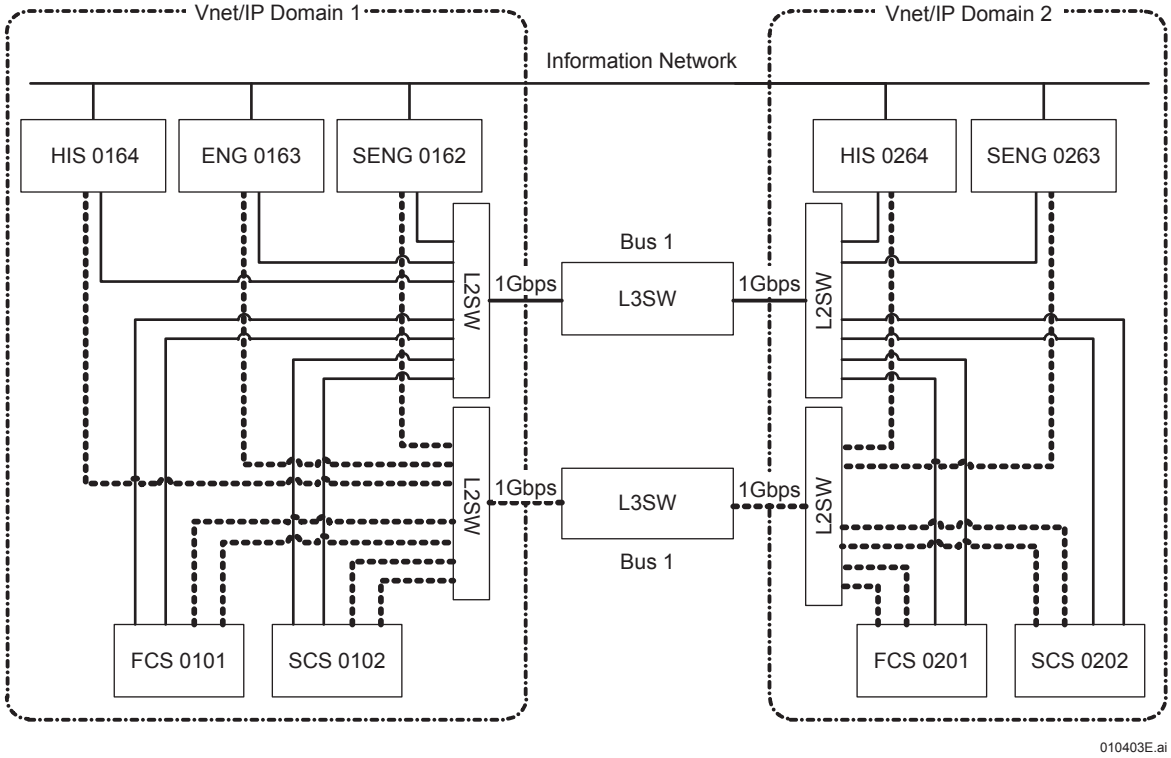


Figure Example of Connecting Vnet/IP Domains

Connection topology

The interconnection topology of Vnet/IP domains includes bi-directional, hierarchical, and bridge connections.

Bi-directional operation and monitoring of control data are available for any of the connection topology. The differences among the topologies depend on whether the domain receives the following messages from other domains:

- HIS messages: e.g. operation logs and stop buzzer commands
- FCS or SCS messages: e.g. process alarm and system alarm messages

Bi-directional connection

A connection without hierarchical structure. Messages from FCS, SCS, and/or HIS generated from one of the domains are received by the Vnet/IP stations in both domains.

Hierarchical connection

A connection with hierarchical structure between domains. Messages from FCS, SCS, and/or HIS generated from the lower domain are received by the Vnet/IP stations on the upper domain.

Bridge connection

A connection securing independence of the domains. Messages from FCS, SCS, and/or HIS generated in one of the domains are not received by the Vnet/IP stations in the other domain. Time synchronization between the domains can also be disabled.

TIP

The multiple-domain connection is supported by CENTUM system and ProSafe-RS system integrated with CENTUM. An independent ProSafe-RS system does not support multiple-domain connection.

Multiple-domain connection by ring topology

A ring topology network in a Vnet/IP domain can be configured using L2SW, with which to connect other domains as shown in the figure below.

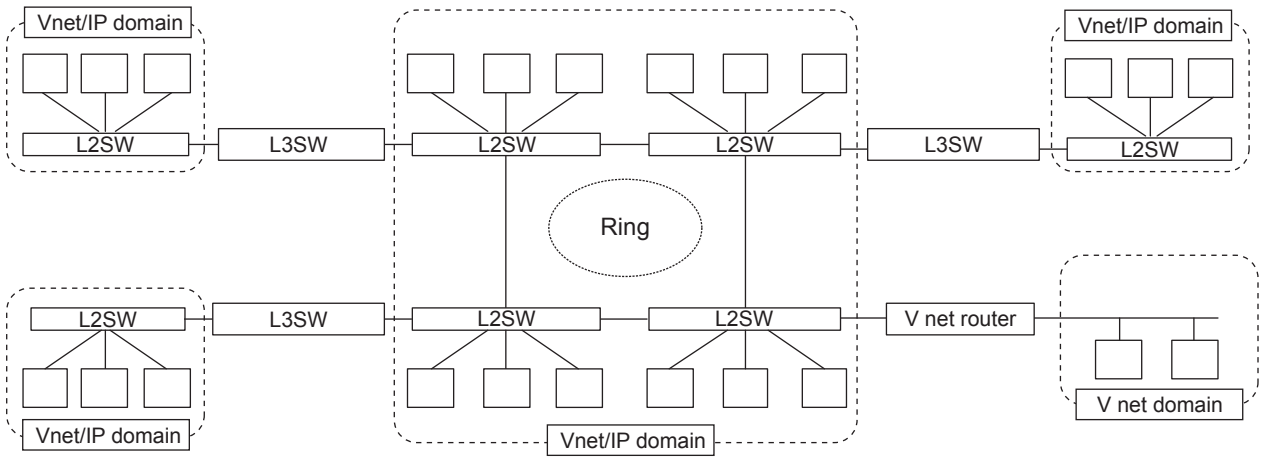


Figure Sample Structure of Multiple Domains (Ring Topology)

In this figure, buses and switches are drawn in single; however, buses actually have dual-redundant configuration in the Vnet/IP. The ring network is configured for bus 1 and bus 2 individually.

Connection with existing systems

You can use V net routers to connect systems that include V net or VL net domains to Vnet/IP domains. You cannot connect Vnet/IP domains directly to HF Bus domains of the CENTUM XL system or RL Bus domains of the CENTUM µXL system. However, you can set up the connection by passing through a bus converter (BCV) from the V net domain that is connected to the V net router.

Devices connected: V net routers and bus converters

Number of hierarchical connections through a V net router (*1):
Three (two levels of bus converters, three levels of control buses)

*1: The number of levels of Vnet/IP domains and V net routers are not counted as an acceptable number of hierarchical V net connections.

The following figure shows the number of levels in a specific hierarchical structure.

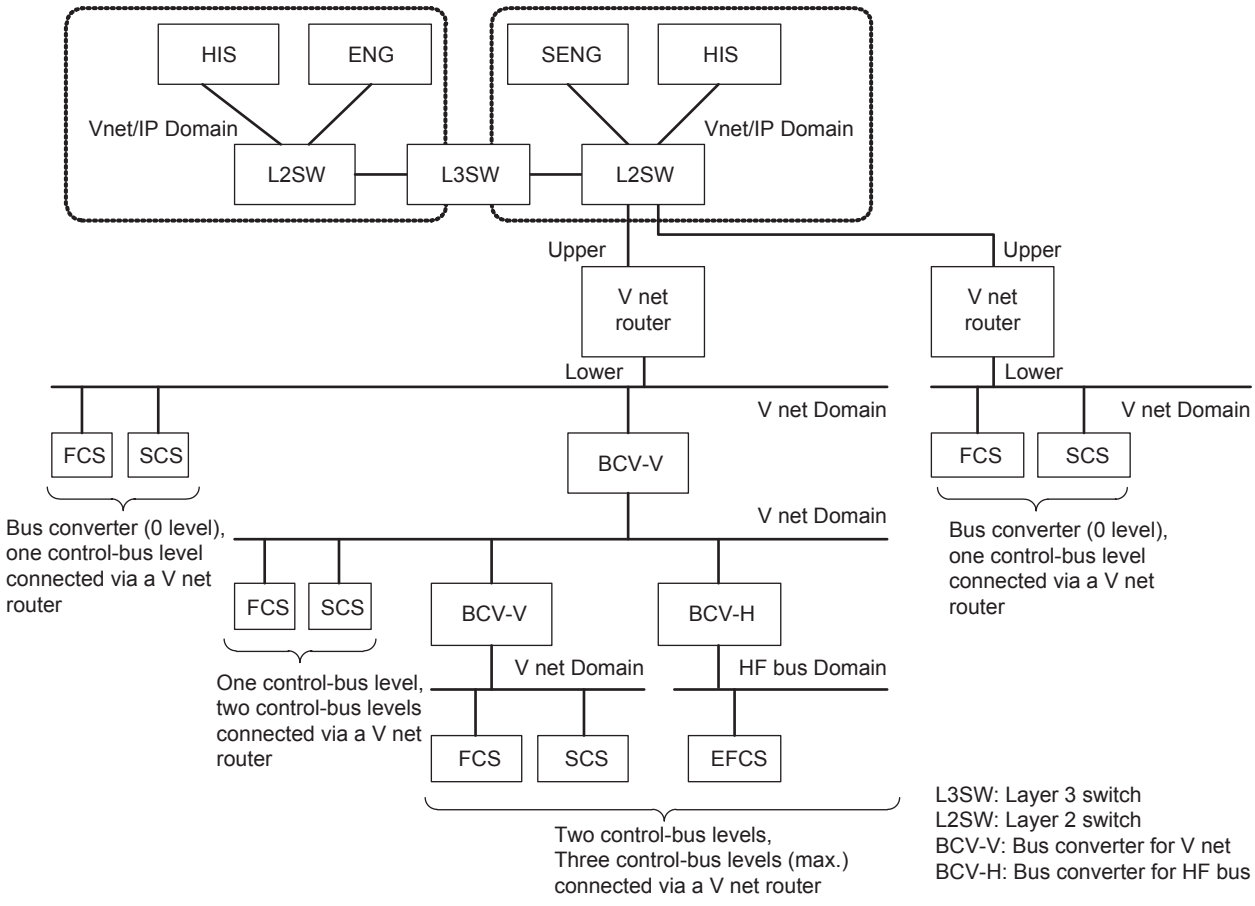


Figure Example of Expanded System Configuration

Connection between Vnet/IP domains through V net

When using AVR10D style S3 V net routers, you can set either Vnet/IP or V net as the upper domain. However, you must set Vnet/IP as the upper domain for AVR10D style S2 V net routers.

You can connect Vnet/IP and V net in an alternating series by using the AVR10D style S3 V net router. In this case, you can connect only up to two V net routers where V net is set as the upper domain. This limitation does not include the number of V net routers where Vnet/IP is set as the upper domain.

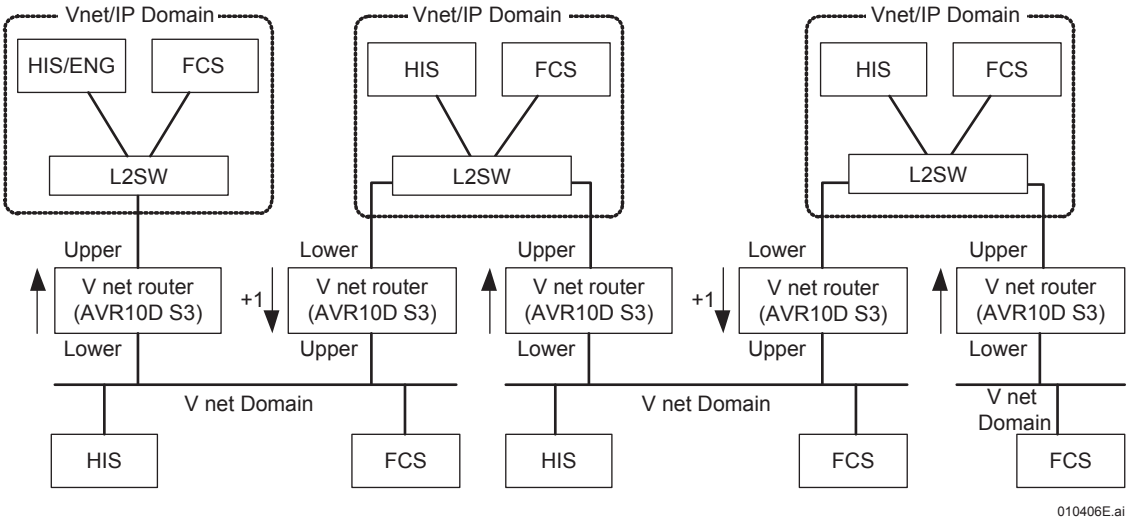


Figure Example of connection between V net domain and Vnet/IP domain

IMPORTANT

You must check the communication bandwidth if you are connecting Vnet/IP domains to Vnet domains. Estimate the communication bandwidth used by V net, including the volume of communication between Vnet/IP domains that passes through V net.

TIP

Upgrade all Vnet/IP stations to Vnet/IP firmware revision 16 or later to enable Vnet/IP domains to communicate with each other through V net domains.

Example of an incorrect connection

You cannot set one V net domain as the lower domain of multiple V net routers. You also cannot have more than one communication path between domains.

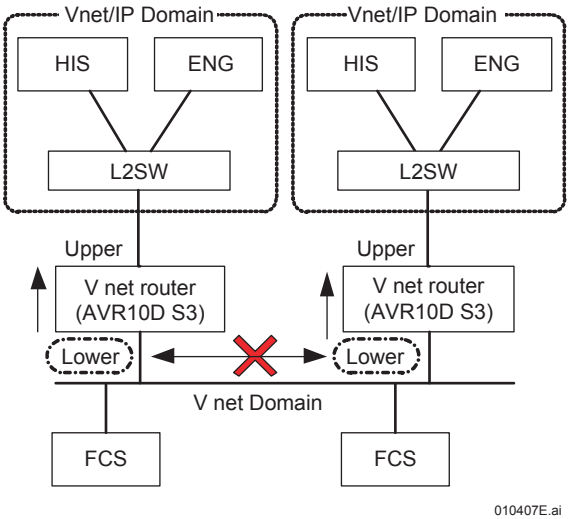


Figure Example of Connection of Vnet/IP Domain via V net

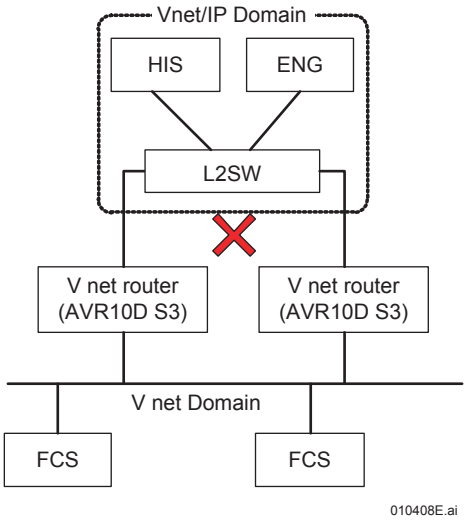


Figure Example of where there are multiple paths to V net from Vnet/IP

1.5 Information Network Communication

Data communications with other Ethernet communication devices and between Vnet/IP stations are performed on the information network that is connected to the network interface card of a computer.

Data transferred to an information network

The HIS, ENG, and SENG transfer the following types of data to the information network:

- Equalization communications (between ENG and HIS) (with shared files)
- Network printer (with shared printer)
- Multihost-based engineering (with shared files)
- Sequence table, drawing, SEBOL, and SFC status display data acquisition (between ENG and HIS) (with shared files)
- Trends of other stations (between HIS and other HISs) (socket communications)
- Download, IOM download, and tuning parameter save process in an operating status display window (between HIS and ENG) (with shared files)
- Long-term data archive (when data is saved in another computer disk) (with shared files)
- HIS recipe equalization (between HIS and other HISs)
- Process management client/server processing (between HIS and other HISs)
- Downloads to APCS, GSGW, SIOS, or UGS database (between ENG and APCS, GSGW, SIOS, or UGS)
- CENTUM integration information transfer (between SENG and ENG)
- CAMS (between HIS and other HISs) (socket communications)

1.6 Conditions without an Information Network

For Ethernet communication, we usually recommend that you use an information network that is independent from Vnet/IP. However, you can perform Ethernet communication by using Vnet/IP bus 2 without the information network if all the following conditions are satisfied:

- **A system is composed of only Vnet/IP network and has no connection with V net or VL net via V net router.**
- **A system includes none of the followings – Exaopc (*1), HIS-TSE, UGS (*2), SIOS, GSGW, or APCS.**
- **No integration with ProSafe-RS.**
- **When using PRM, PRM server and field communications server run on the same PC, and PRM client runs on a PC with Vnet/IP Interface Card, such as HIS or PC on which field communications server runs.**
- **16 or less PCs with Vnet/IP interface card for HIS and ENG. (*3)**
- **Instruments connected with L2SW for Bus 2 are Vnet/IP interface card's Bus 2 port mounted on the PC, a network printer (*4), and a file server (*4) only.**

*1: NTPF100 Exaopc OPC Interface Package (refer to GS 36J02A10-01E). This condition is not applied for LHS2411 Exaopc OPC Interface Package (for HIS).

*2: For the dual-redundant configuration of UGS, it is strongly recommended to perform Ethernet communication by the network connected to a UGS's Ethernet card, and do not use Vnet/IP Bus 2 communication. For more information about the dual-redundant configuration of UGS, refer to "LBC1501 Dual-redundant Package (for UGS)" (GS 33K20C10-50E).

*3: When the number of PC with Vnet/IP interface card exceeds 16, it is suggested to perform Ethernet communication by the network connected to a PC's Ethernet card, and do not use Vnet/IP Bus 2 communication. When the number of PC exceeds 50, this method is strongly recommended.

*4: When the Vnet/IP Bus 2 performs Ethernet communication, it is possible to connect a network printer or a fileserver to the Vnet/IP Bus 2. However, the sum of the communication band by these equipments should not exceed 300 Mbps.

Open communication refers to the information network communication that is performed through Vnet/IP bus 2. In Vnet/IP, bus 1 usually performs control communication and bus 2 performs open communication. However, when bus 1 fails, bus 2 performs both control and open communications.

For more information about using Vnet/IP bus 2 to perform information network communication, refer to Chapter 3 of this document.

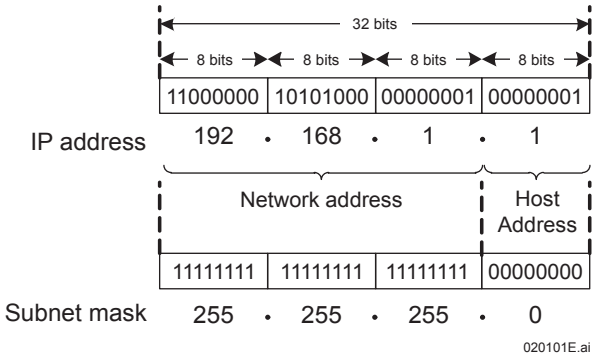
2. Vnet/IP Network Configuration

When setting up a Vnet/IP network, you have to consider some settings regarding the system configuration. This section describes the information required to set up a Vnet/IP network and provides detailed examples. It also describes the normal configuration where Vnet/IP performs only control communication, while other data communications are performed on the information network.

2.1 IP Address Setting

Set the IP addresses of the devices that are connected to Vnet/IP. This section describes the IP addresses that are used in Vnet/IP.

Vnet/IP uses IPv4 addresses that consist of a network address and host address, as shown in the following figure.



Network address

Vnet/IP uses a network address that is determined by the domain number and bus line, as shown in the following table. A domain number is set for each Vnet/IP station by using a DIP switch. Domain numbers must not be duplicated within their respective Vnet/IP and V net domains.

Table Network address

Bus line	IP address	Subnet mask
Bus 1	192.168.<domain number>.0	255.255.255.0
Bus 2	192.168.128+<domain number>.0	255.255.255.0

Host address for control communications

In each Vnet/IP station, the host address for control communications is automatically set to the station number 2 to 129. A station number is set for each Vnet/IP station by using a DIP switch. A host address is assigned to each CPU module in duplexed FCS, duplexed SCS, and duplexed V net routers.

The default host address for SNTP server is set to 254. You can change this setting from the domain properties. (*1) (*2)

*1: You cannot use host address 1 because it is reserved.
*2: You cannot change host addresses in CENTUM CS 3000 R3.07 or earlier.

Virtual IP address for control network TCP/IP communications

The control network TCP/IP protocol is used for communications such as downloading recipes in CENTUM from HIS to FCS. It is also used for communications between SENG SCS Manager and SCS in ProSafe-RS. Vnet/IP protocols support encapsulated control network TCP/IP protocols or TCP/IP over V net to remain compatible with the existing V net system. For this purpose, you have to set a virtual IP address. In normal conditions, use the following default IP address that is automatically determined by the domain number and station number:

- IP address: 172.16.<domain number>.<station number>
- Subnet mask: 255.255.0.0

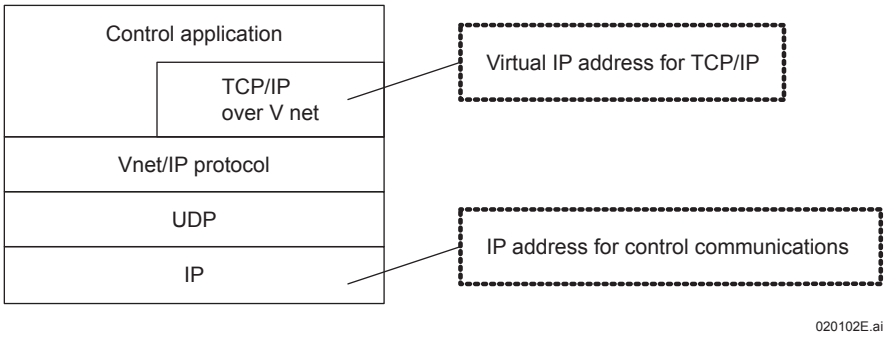


Figure Virtual IP address for control network TCP/IP communications

Vnet/IP station IP address

The following table provides the Vnet/IP station IP addresses corresponding to the Vnet/IP station types. The IP addresses for control network TCP/IP protocol communications are recommended for CENTUM and ProSafe-RS. This table also provides the recommended IP addresses for network interface cards that are used for information networks.

Table Vnet/IP station IP address (1/2)

Station		Required IP addresses	IP address	Setting procedure
HIS, ENG, SENG		For bus 1	192.168.<dd>.<2×ss>	Automatically set by the DIP switch in Vnet/IP interface cards.
		For bus 2	192.168.<128+dd>.<2×ss>	
		Control bus TCP/IP communications	172.16.<dd>.<ss>	Manually set from the Windows operating system, System View of ENG, or SENG SCS Manager.
		For information network	172.17.<dd>.<ss>	
FCS, SCS	Single CPU	For bus 1	192.168.<dd>.<2×ss>	Automatically set by the DIP switch.
		For bus 2	192.168.<128+dd>.<2×ss>	
		Control bus TCP/IP communications	172.16.<dd>.<ss>	Set from either the System View of ENG for FCS or from the SENG SCS Manager for SCS.
	Duplexed CPU	For bus 1(CPU1)	192.168.<dd>.<2×ss>	Automatically set by the DIP switch.
		For bus 2(CPU1)	192.168.<128+dd>.<2×ss>	
		For bus 1(CPU2)	192.168.<dd>.<2×ss+1>	
		For bus 2(CPU2)	192.168.<128+dd>.<2×ss+1>	
		Control bus TCP/IP communications	172.16.<dd>.<ss>	Set from either the System View of ENG for FCS or from the SENG SCS Manager for SCS.
APCS		For bus 1	192.168.<dd>.<2×ss>	Automatically set by the DIP switch in Vnet/IP interface cards.
		For bus 2	192.168.<128+dd>.<2×ss>	
		For information network	172.17.<dd>.<ss>	Manually set from the Windows operating system, System View of ENG.
UGS		For bus 1	192.168.<dd>.<2×ss>	Automatically set by the DIP switch in Vnet/IP interface cards.
		For bus 2	192.168.<128+dd>.<2×ss>	
		For information network	172.17.<dd>.<ss>	Manually set from the Windows operating system, System View of ENG.
		For communications (interface with PLC on Ethernet)	IP address for other PLC network	Manually set from the Windows operating system.
GSGW		For bus 1	192.168.<dd>.<2×ss>	Automatically set by the DIP switch in Vnet/IP interface cards.
		For bus 2	<128+dd>.<2×ss>	
		For information network	172.17.<dd>.<ss>	Manually set from the Windows operating system, System View of ENG
		For communications (interface with PLC on Ethernet)	IP address for other PLC network	Manually set from the Windows operating system.
SIOS		For bus 1	192.168.<dd>.<2×ss>	Automatically set by the DIP switch in Vnet/IP interface cards.
		For bus 2	192.168.<128+dd>.<2×ss>	
		For information network	172.17.<dd>.<ss>	Manually set from the Windows operating system, System View of ENG
		For communications (interface with PLC on Ethernet)	IP address for other PLC network	Manually set from the Windows operating system
Exaopc		For bus 1	192.168.<dd>.<2×ss>	Automatically set by the DIP switch in Vnet/IP interface cards.
		For bus 2	192.168.<128+dd>.<2×ss>	
		For information network	172.17.<dd>.<ss>	Manually set from the Windows operating system.

dd: Domain number
ss: Station number

Table Vnet/IP station IP address (2/2)

Station	Required IP addresses	IP address	Setting procedure
PRM	For bus 1	192.168.<dd>.<2×ss>	Automatically set by the DIP switch in Vnet/IP interface cards.
	For bus 2	192.168.<128+dd>.<2×ss>	
	For information network	172.17.<dd>.<ss>	Manually set from the Windows operating system.
V net router	For bus 1 for control communications (for CPU 1)	192.168.<dd>.<2×ss>	Automatically set by the DIP switch.
	For bus 2 for control communications (for CPU 1)	192.168.<128+dd>.<2×ss>	
	For bus 1 for control communications (for CPU 2)	192.168.<dd>.<2×ss+1>	
	For bus 2 for control communications (for CPU 2)	192.168.<128+dd>.<2×ss+1>	

dd: Domain number
ss: Station number

2.2 Network Configuration Example

2.2.1 Connection within a Domain

System configuration for a single domain

There can be up to 64 Vnet/IP stations in one domain.

The following figure shows an example of a system configuration that consists of two HISs, one SENG, two duplexed FCSs, and one duplexed SCS.

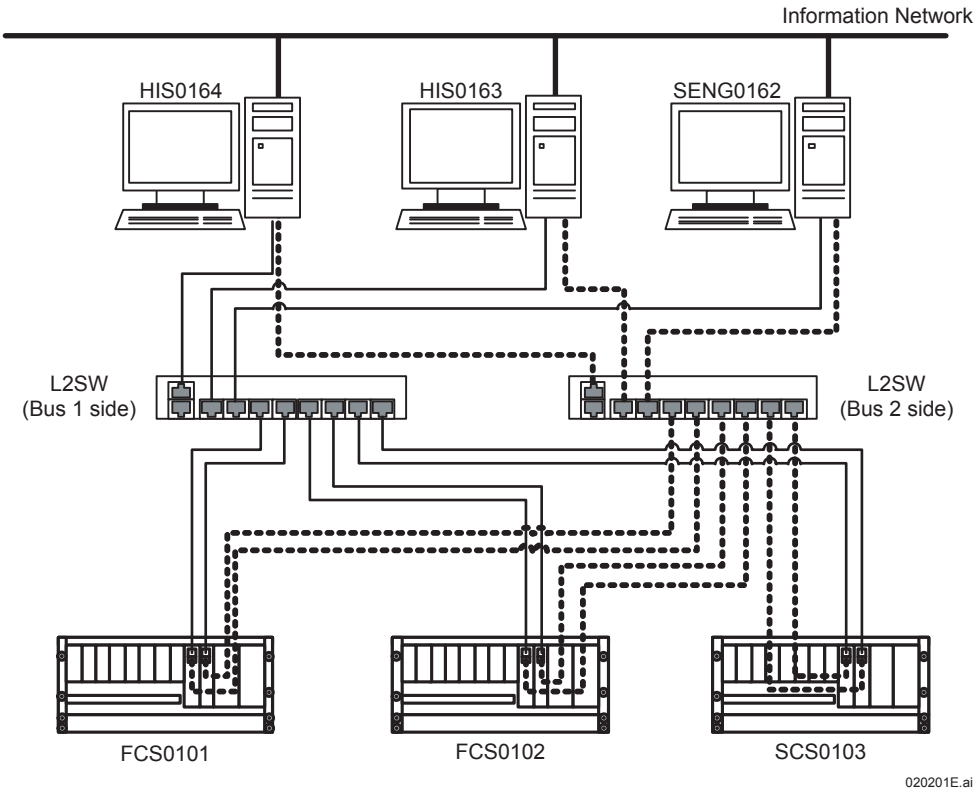


Figure Example of system configuration for a single domain

Number of ports required for layer 2 switches

One layer 2 switch manages the network of one bus. You need at least one layer 2 switch for each bus 1 and bus 2. Use the following equation to calculate the number of ports required for a layer 2 switch.

Number of ports required for a layer 2 switch
= (number of Vnet/IP stations that use Vnet/IP interface cards)
+ (number of single FCSs and single SCSs)
+ (number of duplexed FCSs and duplexed SCSs) x 2

In the previous figure, the system configuration uses two HISs, one SENG, two duplexed FCSs, and one duplexed SCS. The number of ports required is calculated as (2+1) + (2+1) x 2 = 9. Therefore, nine ports are required on bus 1 and nine ports are required on bus 2.

2.2.2 Connecting Multiple Domains

System configuration for multiple domains

If there are more than 64 Vnet/IP stations in a system, you have to split the Vnet/IP domain. To connect the split domains, use a layer 3 switch for each bus 1 and bus 2 of the split domains. Use a HUB to connect the information network between domains.

The following figure shows an example of how to split a Vnet/IP domain. The IP address for each port in the recommended layer 3 switch is set by default. Therefore, to set up a system, you only have to connect to the layer 2 switches in each domain and to those ports with the same number as the domain number.

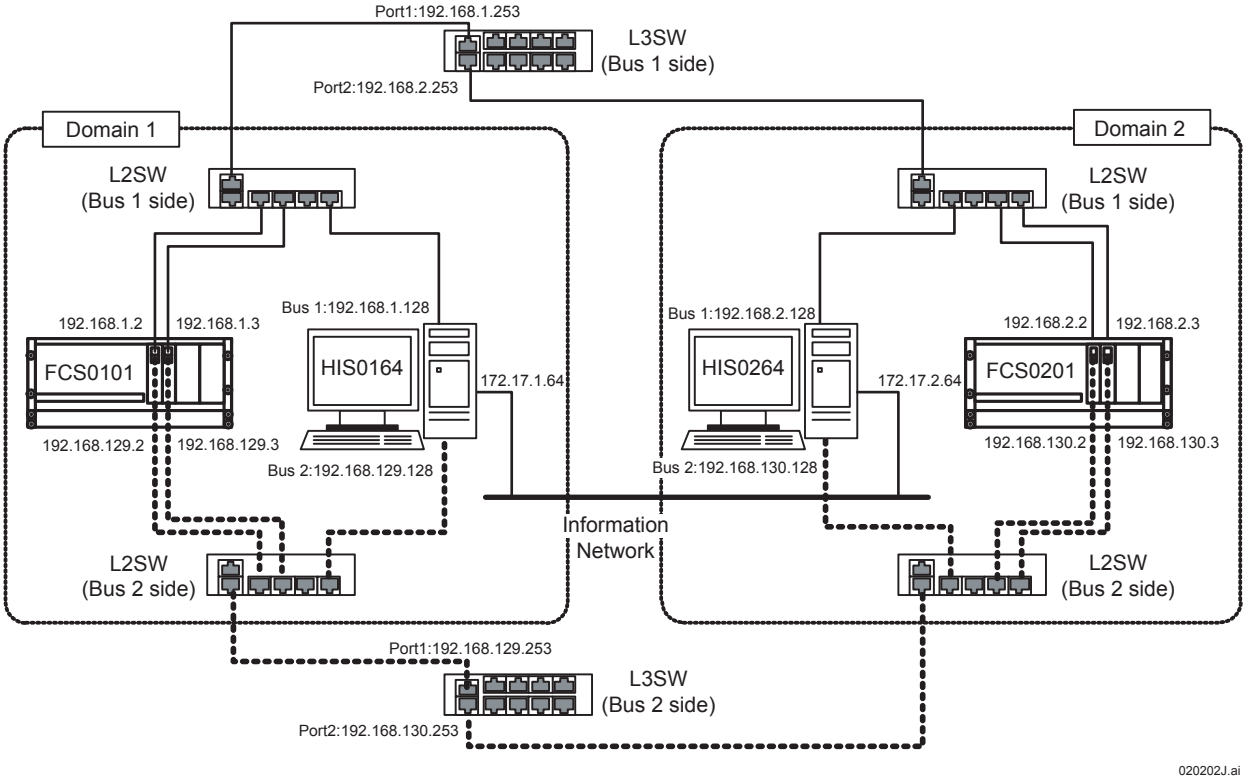


Figure Example of system configuration for multiple domains

Cascade connection between domains

If one set of layer 3 switch is not enough to connect all domains, you can use multiple sets of layer 3 switches to connect Vnet/IP domains in a cascade.

The following figure shows an example of an inter-domain cascade connection.

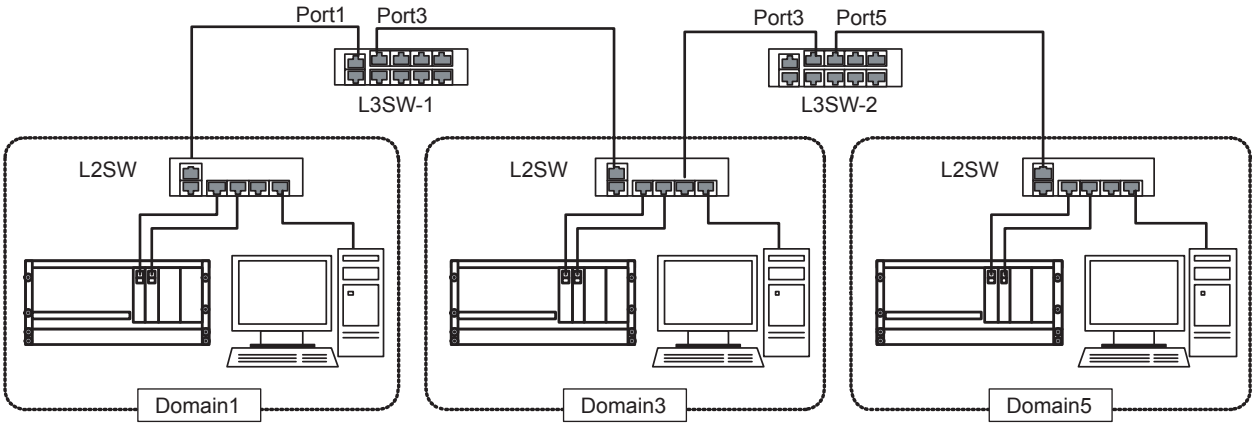


Figure Example of an inter-domain cascade connection (Bus 1 only)

It is necessary to change the settings of the recommended layer 3 switch to connect domains in a cascade. By default, the host address of all ports in the recommended layer 3 switch is set to 253. In the previous figure, the IP address is duplicated in the layer 3 switch ports connected to domain 3. Therefore, you have to change the IP address of layer 3 switch-2 to the following values:

- Bus 1 port 3: 192.168.3.252
- Bus 2 port 3: 192.168.131.252

Layer 3 switch-1 port 5 and Layer 3 switch-2 port 1 are not used. However, you have to clear the IP address settings because their IP addresses are duplicated with IP addresses that are used in other layer 3 switches.

Operating a system with split domains

Even if there are 64 or less Vnet/IP stations in a system, you can split the domain according to the operation scope and maintenance unit to enable optimal management of messages in each domain.

The following figure shows an example of a connection between domains that are split according to the operation scope for a system integrated with CENTUM and ProSafe-RS. In this example, CENTUM operation scope A has more than 64 Vnet/IP stations and is split into domains 2 and 3. Operation scope B and ProSafe-RS are located in independent domains, while domain 1 monitors and controls the entire system. By connecting domains as shown in the following figure, domain 1 can centrally monitor the entire system, while the individual operation scopes can operate without handling system alarms and operation logs from other operation scopes.

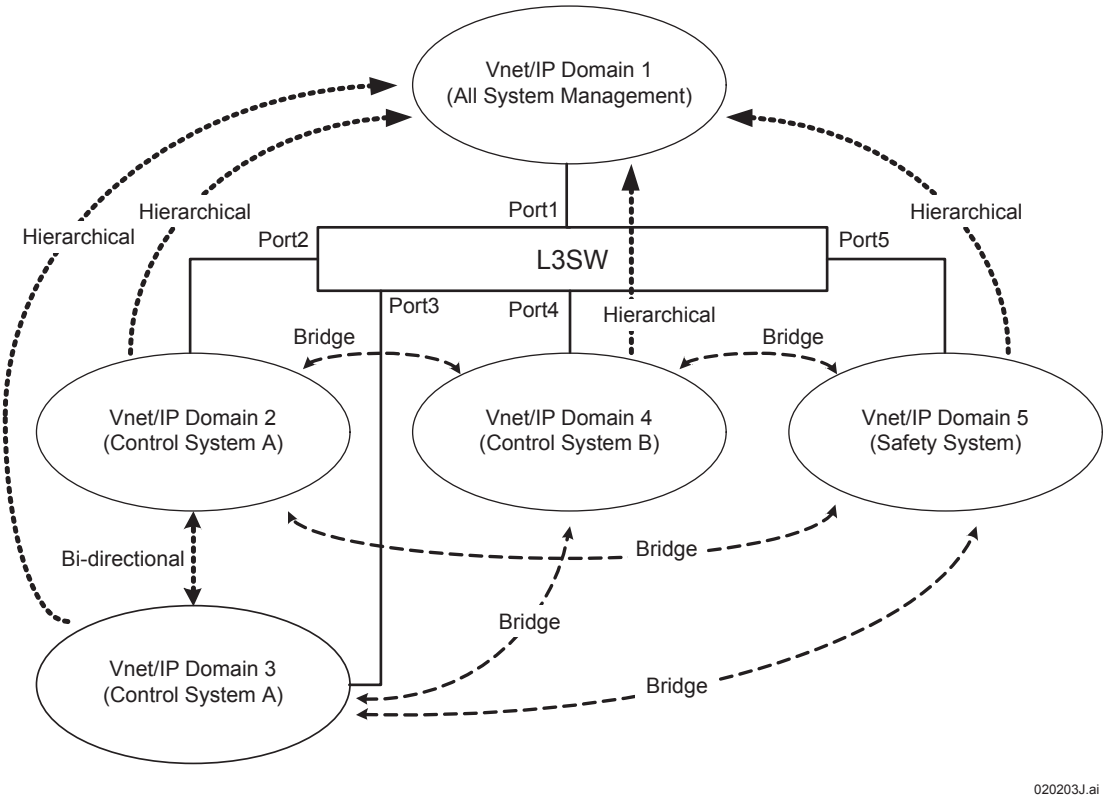


Figure Example of a connection between Vnet/IP domains

You can set the following inter-domain connection methods from the CENTUM engineering function properties:

- Bi-directional connection: Both domains can receive messages from each other
- Hierarchical connection: Only the upper domain can receive messages
- Bridge connection: Both domains cannot receive messages

If you are downloading recipes from HIS to FCS through domains or performing inter-domain communications in a ProSafe-RS system, set the “FCS TCP” to “ON” in the domain properties of the CENTUM engineering function.

2.2.3 Connection with Existing Systems

You can connect an existing V net or VL net system to Vnet/IP by using a V net router. You cannot connect existing control networks such as HF Bus or RL Bus to Vnet/IP directly. However, you can do so by using a BCV on V net.

Connection types

Use bi-directional or hierarchical connection when integrating Vnet/IP and V net projects.

Bi-directional connection

Both upper-level and lower-level projects can operate and monitor each other. The HISs in both projects can operate and monitor the other project. You can apply bi-directional connection only for CENTUM VP or CENTUM CS 3000 systems that are connected to each other.

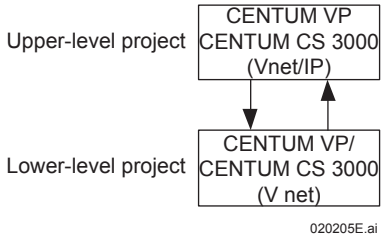


Figure Bi-directional connection

Hierarchical connection

The HIS from the upper-level project can operate and monitor the lower-level project. However, the lower-level project cannot run or monitor the upper-level project. The following figure shows an available configuration for a hierarchical connection. (*1)

*1: To connect Vnet/IP and V net projects that use CENTUM CS 3000 R3.04 or earlier, set Vnet/IP as the upper-level project.

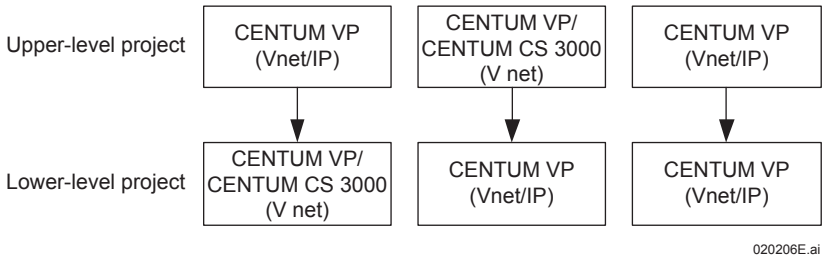


Figure Hierarchical connection

TIP

When connecting a Vnet/IP domain to an existing V net domain, the V net HIS has the following functional limitations:

- If the Vnet/IP bus has an abnormal status, a message appears, indicating that there is a control bus communication failure in all Vnet/IP domains.

To connect Vnet/IP domains with existing V net domains, the HIS function running in CENTUM CS 3000 R3.04 or earlier has the following restrictions.

- The network type appears as “V net” on the Vnet/IP side.
- The System Status Overview window of Vnet/IP domains calls up a window by window name specification.

There are no limitations for the Vnet/IP HIS.

Connection example

The following figure shows an example of a bi-directional connection where the Vnet/IP system (domain 2) is built on top of the existing V net system (domain 1) for CENTUM CS 3000 and ProSafe-RS.

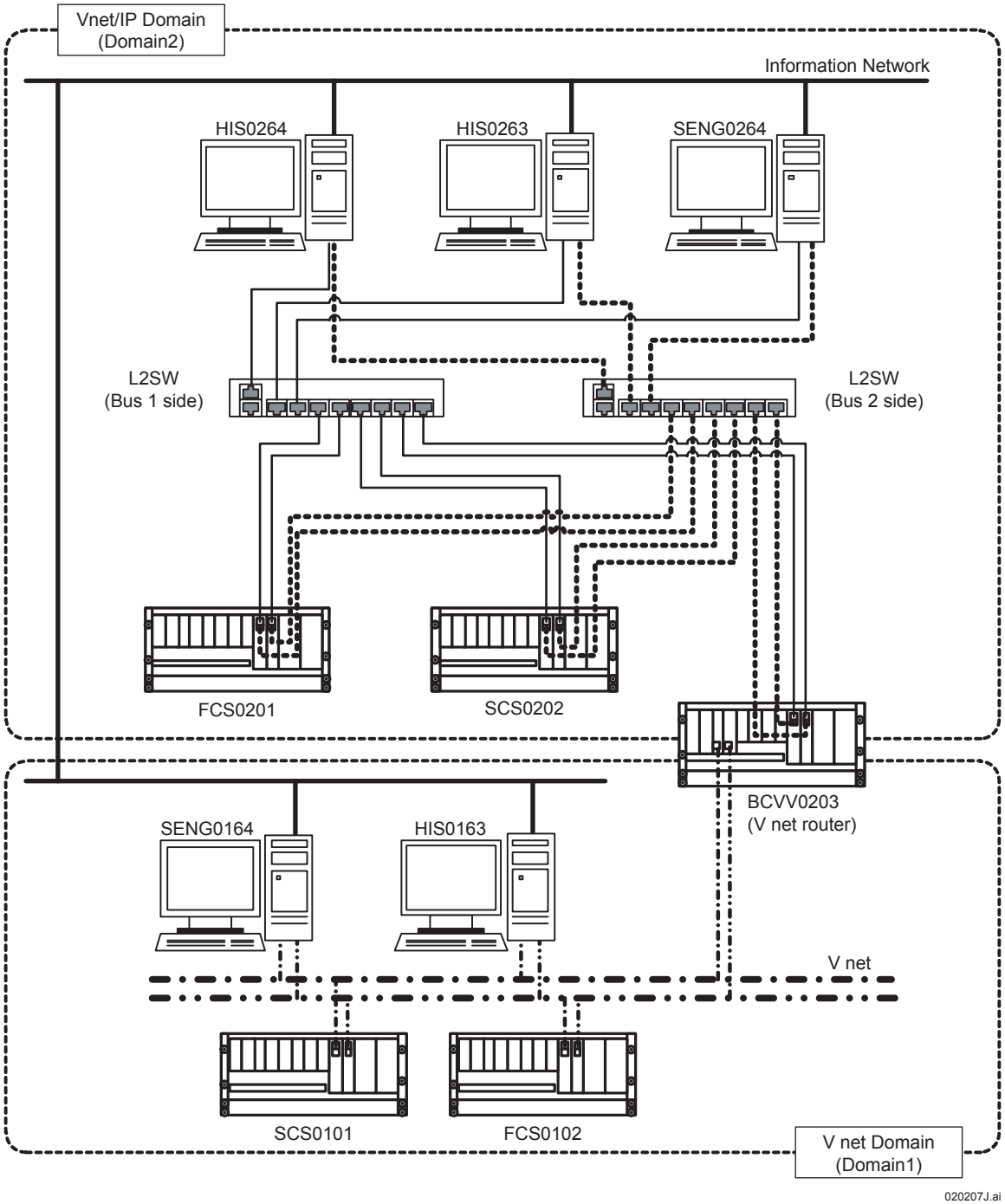


Figure Example of a connection between Vnet/IP and existing V net

V net router setting

You can configure the V net router by using the CENTUM engineering function in Vnet/IP. You can also configure the AVR10D style S3 router from CENTUM in V net. The following table shows an example of a V net router configuration as shown in the previous figure.

Table Example of a V net router configuration (1/2)

Classification	Setting item	Setting value	Description
Type	Station Type	AVR10D	Type of V net router.
	Apply Vnet/IP to Upper-Level Domain	Check	Bus type of the upper-level domain. The upper upper-level domain can be Vnet/IP or V net.
	Domain Number	2	Domain number of the upper-level domain.
	Station Number	3	Station number of the upper-level domain.
	Component Number	(Up to 4 single-byte characters)	Used for device identification. This setting can be omitted.
	Station Comment	(Up to 24 single-byte characters)	Used for device identification. This setting can be omitted.
	Alias of Station	(Up to 8 single-byte characters)	An alternative station name. This setting can be omitted.
	Station Status Display	(Up to 16 single-byte characters)	A window can be assigned to display the station status on the HIS instead of using the HIS station status display panel. This setting can be omitted.
	Upper Equipment Name	(Equipment name defined by Plant Hierarchy Builder)	Name of the upper-level process equipment. This setting can be omitted.
Constant	Lower Address	Domain Number: 1 Station Number: 3	Domain number and station number of the lower-level domain.
	FCS Message Communication - Transfer upper	Check	Specify whether or not to transfer FCS and SCS messages generated on the lower-level domain to the upper-level domain.
	FCS Message Communication - Transfer lower	Check	Specify whether or not to transfer FCS and SCS messages generated on the upper-level domain to the lower-level domain.
	HIS Message Communication - Transfer upper	Check	Specify whether or not to transfer HIS messages generated on the lower-level domain to the upper-level domain.
	HIS Message Communication - Transfer lower	Check	Specify whether or not to transfer HIS messages generated on the upper-level domain to the lower-level domain.
	Own Station Message Communication - Transfer upper	Check	Specify whether or not to transfer messages generated on the V net router to the upper-level domain.
	Own Station Message Communication - Transfer lower	Check	Specify whether or not to transfer messages generated on the V net router to the lower-level domain.
	Transfer TCP/IP to FCS	Check	Specify whether or not to transfer TCP/IP communication between an HIS and FCS. Select the check box to transfer the control bus TCP/IP communication.
	Operation Mode	Standard Mode	Behavior of the V net router. Specify one of the following modes: • Standard Mode: if you are using a new AVR10D style S3 router • Backward Compatible Mode: if you are using the AVR10D style S3 router to replace an AVR10D style S2 router
	Repeating Capability	770pps	Number of packets that the V net router can send. Specify 450pps to achieve the same performance as that of the AVR10D style S2 router.
	Virtual Domain Link Transmission	Invalid	Specify whether or not to perform link transmission between Vnet/IP and V net domains.

Table Example of a V net router configuration (2/2)

Classification	Setting item	Setting value	Description
Constant	Transfer system time	Transfer lower	Direction where to transmit system time during time synchronization. Specify one of the following directions (*1): • Transfer lower: Upper domain to lower domain • Transfer upper: Lower domain to upper domain
Vnet/IP Domain	Target Domain	(Check the check box of the target domain.)	When the transmission destination address of a frame from a V net domain matches the Vnet/IP domain definition, that frame is transferred. In addition, only a broadcast frame from a Vnet/IP domain specified in the Vnet/IP domain is transferred to a V net domain. It is not necessary to set a Vnet/IP domain to which this V net router is connected because a frame is always transferred in this case.
V net Gateway	Station Name	(Station name) (*2)	Specify the station address and domain number of the bus converter defined in a V net domain. When the transmission destination address of a frame from a Vnet/IP domain matches the lower domain definition, that frame is transferred. In addition, only a broadcast frame from the domain specified in the V net domain definition is transferred to a Vnet/IP domain. It is not necessary to set a V net domain to which this V net router is connected because a frame is always transferred in this case.
	Domain Number	(1~64)	

*1: If operation mode is set to “Backward Compatible Mode”, this setting is fixed at “Transfer lower.”
*2: BCVVddss, BCVHddss, or BCVLddss (dd:domain number, ss:station number)

2.2.4 Connecting network switches by Ring Topology

Configuring a network using Ring Topology

A ring network can be configured by connecting multiple L2SWs in a loop in a Vnet/IP domain.

A system configuration where Vnet/IP network is configured in a ring network is as shown below.

(1) Setting Ring protocol

Ring protocol has to be set to both Bus 1 and Bus 2 of the network switch for Vnet/IP to make both of the Bus 1 and Bus 2 have ring configuration.

(2) Acknowledgment of occurrence of and recover from failures

The system has to be engineered to generate alarms when ring failures occur as well as recover from failures. Specifically, a signal from a FAULT output terminal of the network switch assigned as the Ring manager (RM) has to be received by a digital input module of CENTUM VP's FCS, and its on/off is to be notified to an HIS.

(3) Identifying failed point

Identification of the failed point in the ring network is done by the network management system (PMS) in a computer independent from HIS or by manually.

When configuring a ring network, the network has to be segregated by VLAN for security and prioritize traffics.

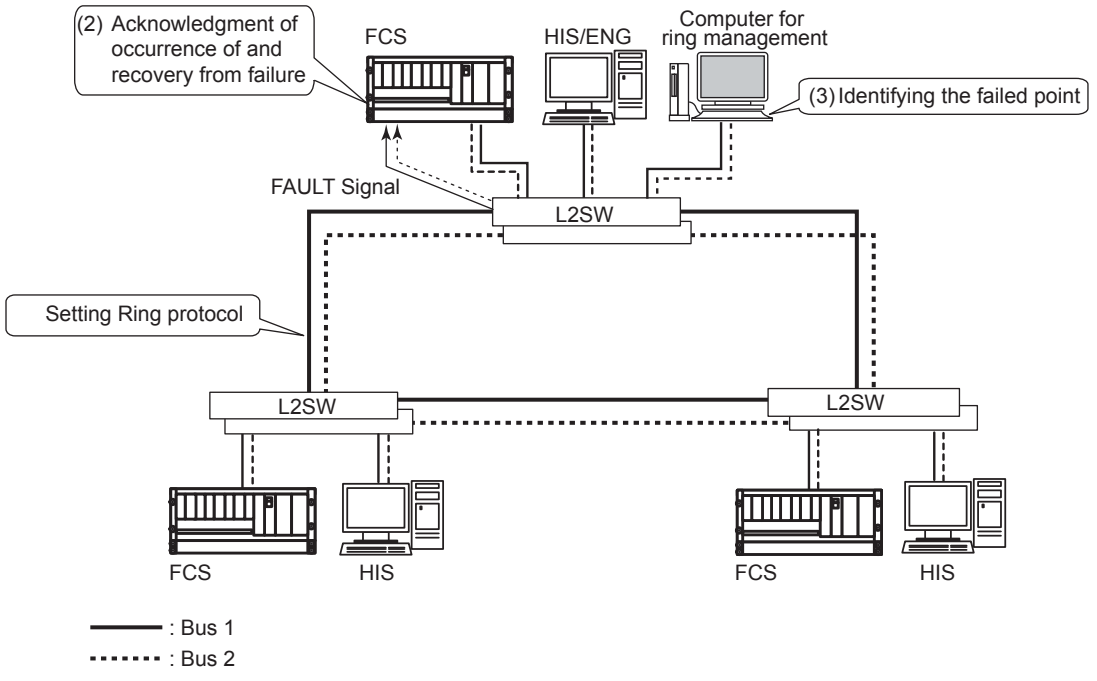


Figure Ring Network Structure

Contact Yokogawa for more details about how to configure a network using Ring topology.

2.3 Connection with External Network

Vnet/IP is a control network. For security purposes, do not connect it to external networks directly. If Exaopc is installed on the system, you have to implement security measures such as using a firewall when connecting to OPC clients on external networks from the information network. Contact the network administrator to determine the security policy to apply for the firewall.

SEE ALSO For more information about the security countermeasures, refer to the following:
"Security Standard of System Product" (TI 33Y01B30-01E)

3. Vnet/IP Network Configuration without using Information Network

In Vnet/IP systems, we usually recommend that you set up an information network that is separate from Vnet/IP. However, you can choose not to use an information network if certain conditions (*1) are satisfied. In this case, use Vnet/IP bus 2 to perform information network communication. The information network communication that is performed through Vnet/IP bus 2 is referred to as open communications.

This chapter provides detailed examples to describe the information required when creating a Vnet/IP network that uses open communications.

*1: For more information about conditions of this setup, refer to Chapter 1.6 of this document.

3.1 Bandwidth used for Open Communications

In Vnet/IP, bus 1 usually performs control communications and bus 2 performs open communications. However, when bus 1 fails, bus 2 performs both control and open communications. To ensure stable control communications, restrict the bandwidth of open communications used in the Vnet/IP domain to 500 Mbps or less, which should already include the 200 Mbps used for communication between Vnet/IP stations. Therefore, you have to restrict the bandwidth used by other Ethernet communication devices such as network printers or file servers to 300 Mbps or less.

To ensure that the bandwidth used by Ethernet communication devices does not exceed 300 Mbps, connect Ethernet communication devices to layer 2 switches through low speed 100 Mbps HUBs. HUBs restrict the communication speed, thus maintaining the bandwidth used in Vnet/IP domains below the acceptable limit. On the other hand, you can connect Vnet/IP interface cards to layer switches directly because Vnet/IP interface cards can restrict the communication bandwidth.

When you connect multiple Vnet/IP domains and there is open communication coming from Ethernet communication devices in other domains, restrict the total communication bandwidth of all domains to 300 Mbps or less. The following figure shows an example of connecting Ethernet communication devices to Vnet/IP domains through 100 Mbps HUBs used only for bus 2. In this example, there are three 100 Mbps HUBs used in the system to ensure that the total communication bandwidth used by all Ethernet communication devices does not exceed 300 Mbps.

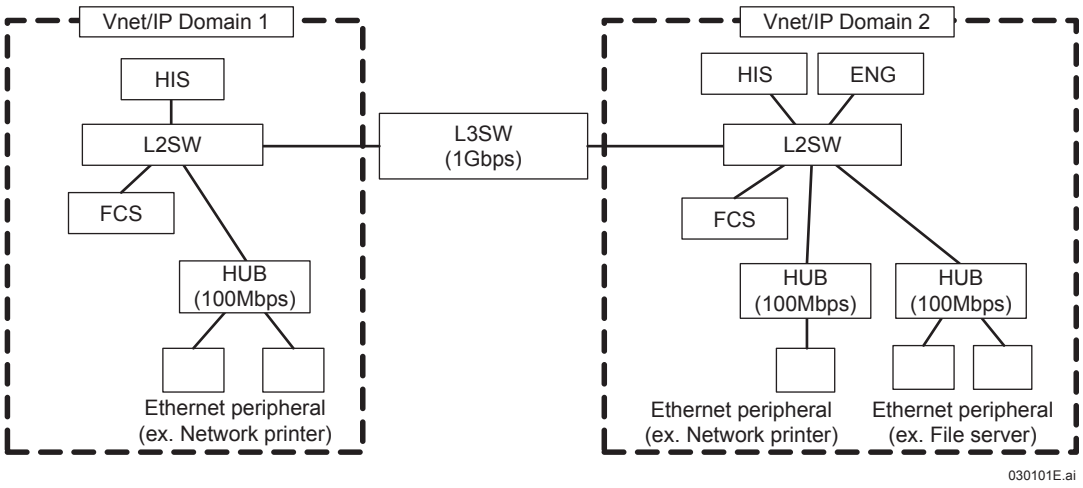
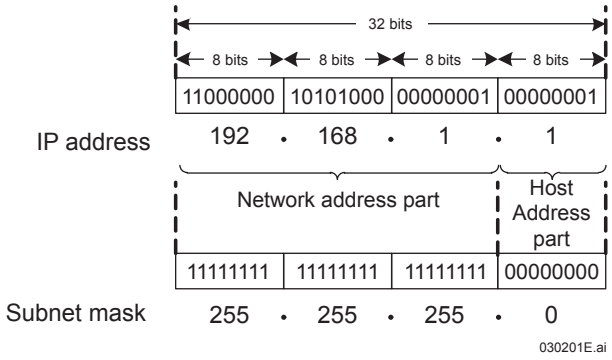


Figure Example of connecting Ethernet communication devices to Vnet/IP domains (Bus 2 only)

3.2 IP Address Setting

Set the IP addresses of the devices that are connected to Vnet/IP. This section describes the IP addresses that are used in Vnet/IP.

Vnet/IP uses IPv4 addresses that consist of a network address and host address, as shown in the following figure.



Network address

Vnet/IP uses a network address that is determined by the domain number and bus line, as shown in the following table. A domain number is set for each Vnet/IP station by using a DIP switch. Domain numbers must not be duplicated within their respective Vnet/IP and V net domains.

Table Network address

Bus line	IP address	Subnet mask
Bus 1	192.168.<domain number>.0	255.255.255.0
Bus 2	192.168.128+<domain number>.0	255.255.255.0

Host address for control communications

In each Vnet/IP station, the host address for control communications is automatically set to the station number 2 to 129. A station number is set for each Vnet/IP station by using a DIP switch. A host address is assigned to each CPU module in duplexed FCS.

The default host address for SNTP server is set to 254. You can change this setting from the domain properties. (*1) (*2)

*1: You cannot use host address 1 because it is reserved.
*2: You cannot change host addresses in CENTUM CS 3000 R3.07 or earlier.

Host address for open communications

Select the host address for open communications from the range of Vnet/IP network addresses—which are 130 to 253—that you can use in open communications. The default host address for recommended layer 3 switches is set to 253. Ensure that the host address is not duplicated in Vnet/IP stations and all other devices in a Vnet/IP domain.

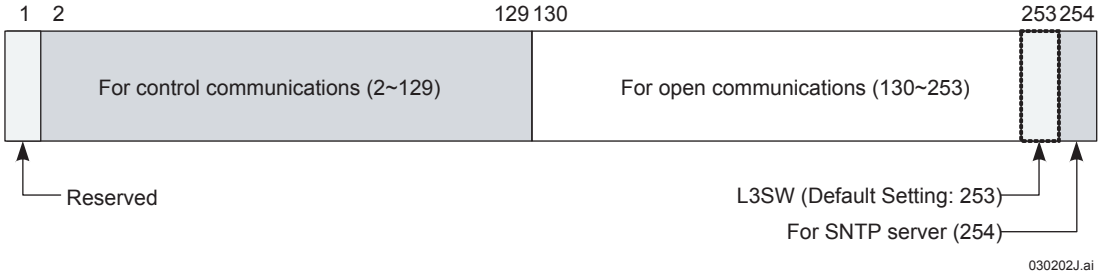


Figure Host Address Allocation

Virtual IP address for control network TCP/IP communications

The control network TCP/IP protocol is used for communications such as downloading recipes in CENTUM from HIS to FCS. Vnet/IP protocols support encapsulated control network TCP/IP protocols or TCP/IP over V net to remain compatible with the existing V net system. For this purpose, you have to set a virtual IP address. In normal conditions, use the following default IP address that is automatically determined by the domain number and station number:

- IP address: 172.16.<domain number>.<station number>
- Subnet mask: 255.255.0.0

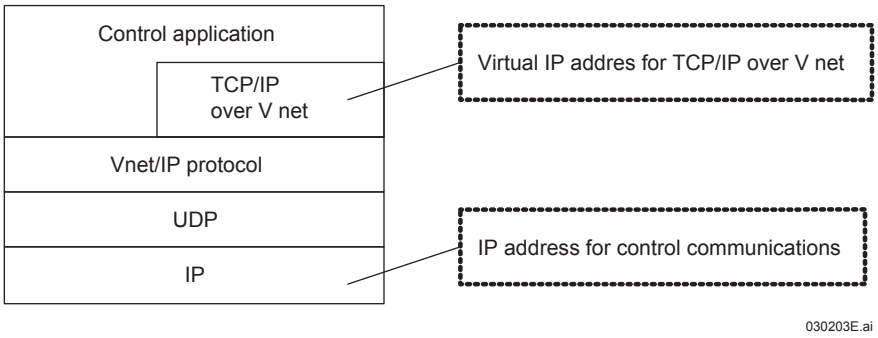


Figure Virtual IP address for control network TCP/IP communications

Vnet/IP station IP address

The following table provides the Vnet/IP station IP addresses corresponding to the Vnet/IP station types. The IP addresses for open communications and control network TCP/IP protocol communications are recommended for CENTUM.

Table Vnet/IP station IP address

Station		Required IP addresses	IP address	Setting procedure
HIS, ENG		For bus 1	192.168.<dd>.<2×ss>	Automatically set by the DIP switch in Vnet/IP interface cards.
		For bus 2	192.168.<128+dd>.<2×ss>	
		Open communications	192.168.<128+dd>.<129+ss>	Manually set from the Windows operating system, System View of ENG.
		Control bus TCP/IP communications	172.16.<dd>.<ss>	
FCS	Single CPU	For bus 1	192.168.<dd>.<2×ss>	Automatically set by the DIP switch.
		For bus 2	192.168.<128+dd>.<2×ss>	
		Control bus TCP/IP communications	172.16.<dd>.<ss>	Set from either the System View of ENG for FCS.
	Duplexed CPU	For bus 1(CPU1)	192.168.<dd>.<2×ss>	Automatically set by the DIP switch.
		For bus 2(CPU1)	192.168.<128+dd>.<2×ss>	
		For bus 1(CPU2)	192.168.<dd>.<2×ss+1>	
		For bus 2(CPU2)	192.168.<128+dd>.<2×ss+1>	
		Control bus TCP/IP communications	172.16.<dd>.<ss>	Set from either the System View of ENG for FCS.
PRM		For bus 1	192.168.<dd>.<2×ss>	Automatically set by the DIP switch in Vnet/IP interface cards.
		For bus 2	192.168.<128+dd>.<2×ss>	
		Open communications	192.168.<128+dd>.<129+ss>	Manually set from the Windows operating system.

dd: Domain number
ss: Station number

3.3 Network Configuration Example

3.3.1 Connection within a Domain

System configuration for a single domain

The following figure shows an example of a system configuration for a single domain.

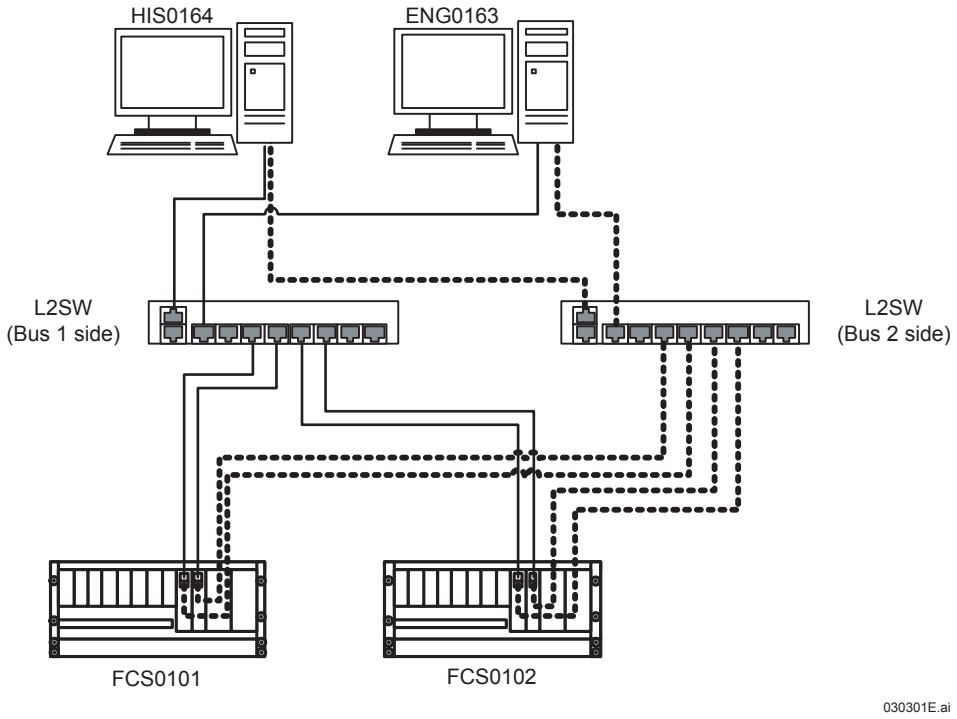


Figure Example of system configuration for a single domain

Number of ports required for layer 2 switches

One layer 2 switch manages the network of one bus. You need at least one layer 2 switch for each bus 1 and bus 2. Use the following equation to calculate the number of ports required for a layer 2 switch.

Number of ports required for a layer 2 switch
= (number of Vnet/IP stations that use Vnet/IP interface cards)
+ (number of single FCSs and single SCSs)
+ (number of duplexed FCSs and duplexed SCSs) x 2

In the previous figure, the system configuration uses one HIS, one ENG, and two duplexed FCSs. The number of ports required is calculated as (2) + (2) x 2 = 6. Therefore, six ports are required on bus 1 and six ports are required on bus 2.

3.3.2 Connecting Multiple Domains

System configuration for multiple domains

By splitting Vnet/IP stations in a system according to the operation scope and maintenance unit, you can enable optimal management of messages in each domain. To connect the split domains, use a layer 3 switch for each bus 1 and bus 2 of the split domains.

The following figure shows an example of how to split a Vnet/IP domain. The IP address for each port in the recommended layer 3 switch is set by default. Therefore, to set up a system, you only have to connect to the layer 2 switches in each domain and to those ports with the same number as the domain number.

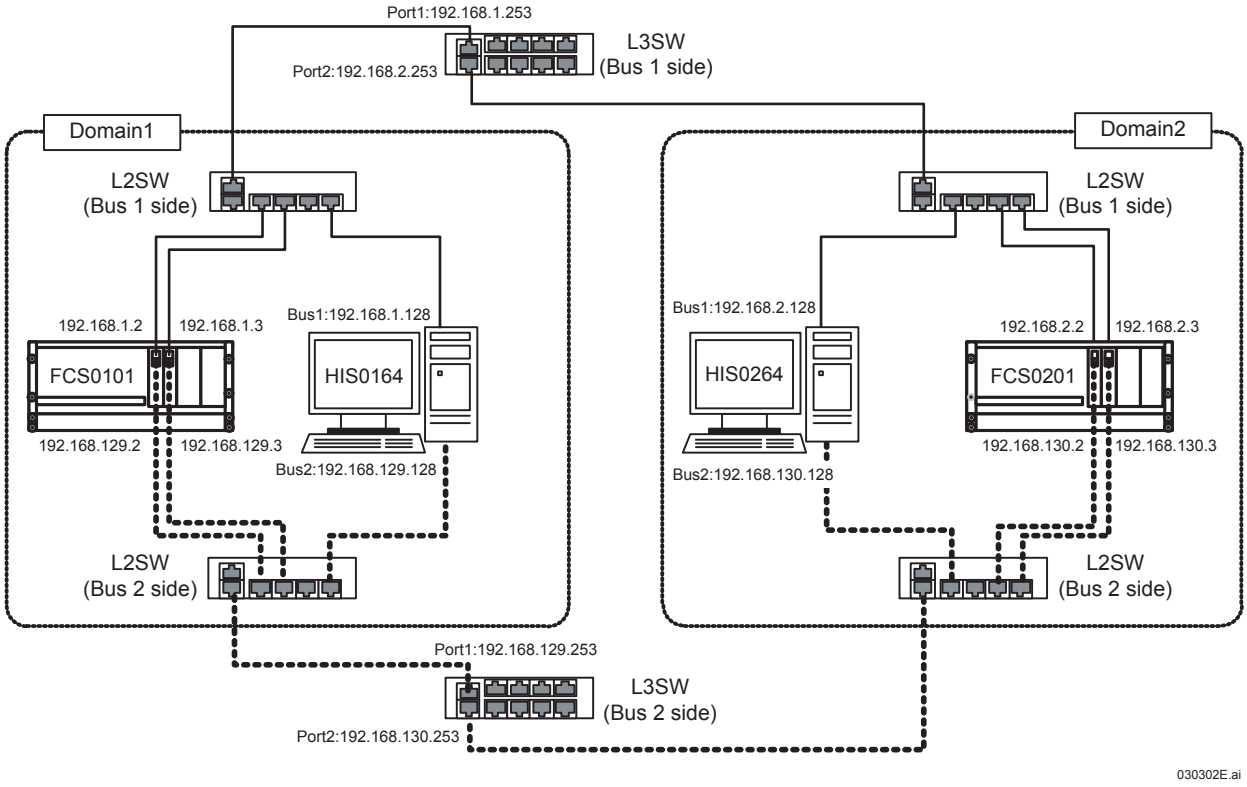


Figure Example of system configuration for multiple domains

Operating a system with split domains

The following figure shows an example of a connection between domains that are split according to the operation scope for a system integrated with CENTUM. In this example, CENTUM operation scope A is split into domains 2 and 3. Operation scope B is located in independent domains, while domain 1 monitors and controls the entire system. By connecting domains as shown in the following figure, domain 1 can centrally monitor the entire system, while the individual operation scopes can operate without handling system alarms and operation logs from other operation scopes.

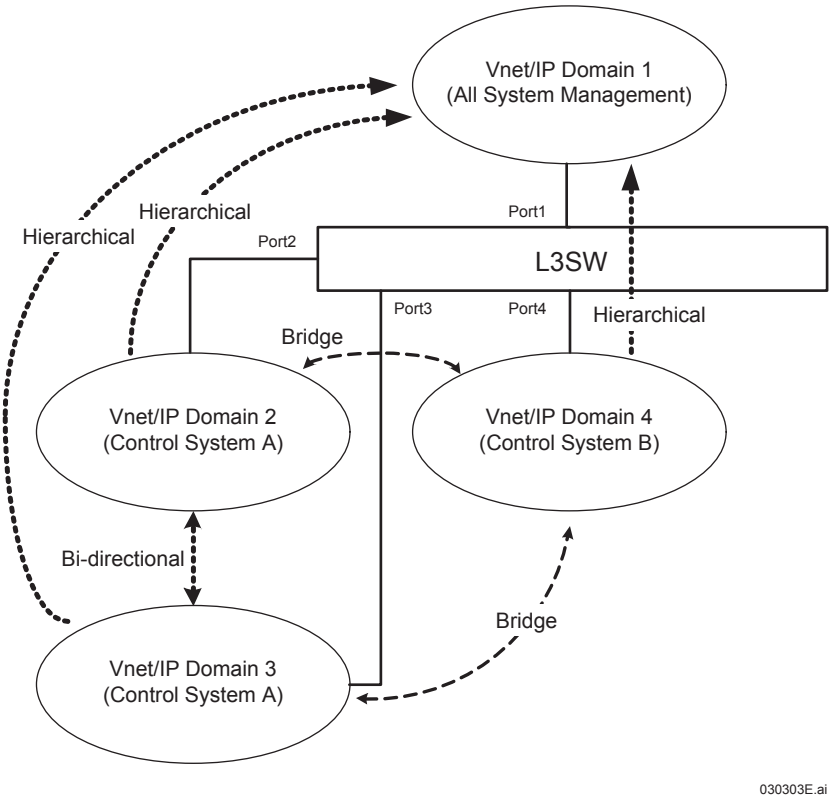


Figure Example of a connection between Vnet/IP domains

You can set the following inter-domain connection methods from the CENTUM engineering function properties:

- Bi-directional connection: Both domains can receive messages from each other
- Hierarchical connection: Only the upper domain can receive messages
- Bridge connection: Both domains cannot receive messages

If you are downloading recipes from HIS to FCS through domains, set the “FCS TCP” to “ON” in the domain properties of the CENTUM engineering function.

Cascade connection between domains

If one set of layer 3 switch is not enough to connect all domains, you can use multiple sets of layer 3 switches to connect Vnet/IP domains in a cascade.

The following figure shows an example of an inter-domain cascade connection.

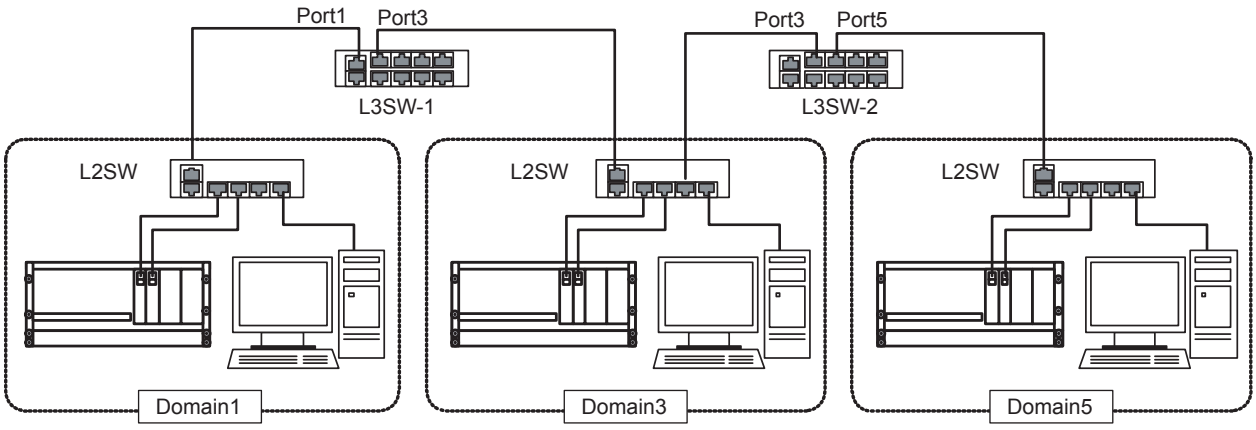


Figure Example of an inter-domain cascade connection (Bus 1 only)

It is necessary to change the settings of the recommended layer 3 switch to connect domains in a cascade. By default, the host address of all ports in the recommended layer 3 switch is set to 253. In the previous figure, the IP address is duplicated in the layer 3 switch ports connected to domain 3. Therefore, you have to change the IP address of layer 3 switch-2 to the following values:

- Bus 1 port 3: 192.168.3.252
- Bus 2 port 3: 192.168.131.252

Layer 3 switch-1 port 5 and Layer 3 switch-2 port 1 are not used. However, you have to clear the IP address settings because their IP addresses are duplicated with IP addresses that are used in other layer 3 switches.

4. Appendix

4.1 Layer 2 Switch (L2SW)

If there are no requirements for network monitoring or security strengthening, you can connect Vnet/IP stations to any ports of the recommended layer 2 switch in its default state. Even if you use the layer 2 switch as a trunk port between layer 2 switches or with layer 3 switches, you do not have to use a cross cable or change any of the layer 2 switch settings.

To connect recommended layer 2 switches with optical fiber cables, use combo ports that can use an SFP. You must use the recommended SFP product that is implemented in this layer 2 switch. You do not have to change the settings of layer 2 switches because SFP combo ports automatically adjust to the optical interface.

SEE ALSO For more information about recommended layer 2 switches, refer to the following.
“Network Switch for Vnet/IP” (TI 30A10A30-01E)

4.2 Layer 3 Switch (L3SW)

The routing protocol parameters for connecting to Vnet/IP are already configured in the recommended layer 3 switch. By default, the IP addresses of the ports are also configured to enable connection to domains. You can enable inter-domain communication by connecting the layer 2 switch of each domain to the port that matches the domain number. There is no special configuration required. (*1)

In Vnet/IP, the network address is different for bus 1 and bus 2. Therefore, there are two types of recommended layer 3 switches, one for bus 1 and another one for bus 2. You must differentiate the use of layer 3 switches for each bus.

To connect recommended layer 3 switches with optical fiber cables, use combo ports that can use SFP. You must use the recommended SFP product that is implemented in this layer 3 switch. You do not have to change the settings of layer 3 switches because SFP combo ports automatically adjust to the optical interface.

*1: Change the settings of layer 3 switches if you want to connect domains in a cascade.

SEE ALSO For more information about recommended layer 3 switches, refer to the following.
“Network Switch for Vnet/IP” (TI 30A10A30-01E)

4.3 Cable for Vnet/IP

Interface specifications

Both 100BASE-TX and 1000BASE-T interfaces use UTP cables. The 1000BASE-LX interface uses optical fiber cables.

The following table shows the relationship between Vnet/IP connection interface standards and their maximum transmission distance.

Table Connection interface for Vnet/IP devices

Connection	Interface standard	Transmission speed	Maximum transmission distance
Between Vnet/IP station and Layer 2 switch	100BASE-TX (IEEE802.3u)	100 Mbps(*1)	100 m
	1000BASE-T (IEEE802.3ab)	1 Gbps	100 m
Between Layer 2 switches	1000BASE-T (IEEE802.3ab)	1 Gbps	100 m
	1000BASE-LX (IEEE802.3z)	1 Gbps	5 km (*2) (*3)
Between Layer 2 switch and Layer 3 switch	1000BASE-T (IEEE802.3ab)	1 Gbps	100 m
	1000BASE-LX (IEEE802.3z)	1 Gbps	5 km (*2) (*3)

*1: Applicable only for SCS, V net routers, or WAC router. There is no special configuration required for recommended layer 2 switches because the transmission speed is detected automatically.
*2: According to 1000BASE-LX interface specifications as defined by the IEEE802.3 standard.
*3: In case further length is required, refer to “Network Switch for Vnet/IP” (TI 30A10A30-01E.)

Depending on system configurations and device location, you may have to use optical fiber connections due to limitations on transmission distance and electromagnetic interference.

UTP cables

The Vnet/IP network uses Enhanced Category 5 (CAT5e) UTP straight cables, which comply with ANSI TIA/EIA-568-B.

UTP cables usually use RJ45 plugs as connectors. The maximum length of UTP cables is 100 m.

We recommend that you use cables with different coating colors for Vnet/IP bus 1 and bus 2 for easier maintenance.

IMPORTANT

- Do not use cables with broken RJ45 connector latches. We recommend that you use connector cables with boots to avoid breaking connectors during device maintenance.
- Be sure to confirm each connection for all devices (Vnet/IP stations, L2SW, and L3SW) connecting to Vnet/IP is linked up with the correct link speed as shown in “Transmission speed” of the table “Connection interface for Vnet/IP devices”.
  Refer to section 4.3.3 “Confirm port status (show port all)” in TI “Network Switch for Vnet/IP” (TI 30A10A30-01E) with to confirm the link speed.

Optical fiber cables

To connect switches in a Vnet/IP domain, we recommend that you use the single-mode optical fiber cable type, which conforms to IEC 60793-2-50 B1.1, ITU-T G.652.B, or JIS C 6835 SSMA-9.3/125. (*1)

LC connectors are compatible with the SFP for recommended layer 2 switches and layer 3 switches. Use optical fiber cables with LC connectors on both ends. We recommend that you use optical fiber cables with duplex LC connectors to avoid incorrect connections.

According to 1000BASE-LX interface specifications as defined by the IEEE802.3 standard, the maximum length of a single-mode optical fiber cable is 5 km. (*2)

*1: We do not recommend the use of multi-mode optical fiber cable type for connecting switches in a Vnet/IP domain. Use the single-mode optical fiber cable type when installing new optical fiber cables.
If you are reusing existing multi-mode cables, ensure that the installed cables satisfy the following conditions:
If the core diameter is 50 um (GI 50/125):
- Transmission loss: 1 dB/km or less (wavelength range of 1310 nm)
- Modal bandwidth: 500 MHz/km or more (wavelength range of 1310 nm)

If the core diameter is 62.5 um (GI 62.5/125):
- Transmission loss: 1 dB/km or less (wavelength range of 1310 nm)
- Modal bandwidth: 500 MHz/km or more (wavelength range of 1310 nm)

The maximum transmission distance for multi-mode optical fiber cable is 550 m. To use the multi-mode optical fiber cable, you have to connect mode conditioning patch cords to the output terminal of the SFP.

*2: In case further length is required, refer to “Network Switch for Vnet/IP” (TI 30A10A30-01E.)

4.4 Time Synchronization

Vnet/IP synchronizes the time between the Vnet/IP stations connected to a Vnet/IP network.

Types of clock time

A Vnet/IP station has the following types of clock time:

- System time: Managed by the Vnet/IP station system software.
- Network time: Clock time retained by the Vnet/IP station hardware. It is synchronized as the standard time following the time master.

Time accuracy of a Vnet/IP station

The time synchronization process standardizes the network time for all Vnet/IP stations connected to the Vnet/IP network.

Furthermore, the system software for Vnet/IP stations updates its system time to match the network time. The following table describes the deviation between the network time and system time in Vnet/IP stations.

Table Accuracy of the system time

Vnet/IP stations	Error from network time	Time adjustment method
HIS, ENG, SENG	Max. 0.5 sec	The deviation between the network time and system time is checked. If there is a deviation of 0.5 seconds or more, the system time is adjusted to match the network time.
FCS, SCS, and V net router	None	The system time always synchronizes with the network time.

Time synchronization within a Vnet/IP domain

The time is synchronized in each Vnet/IP station within a domain so that the clock time is set to its own domain master station clock.

The domain master station manages the setting of information within a domain. It broadcasts its own network time and periodically performs clock time multicasting to the Vnet/IP stations. It is not necessary for you to identify the domain master station. It is selected automatically from the Vnet/IP stations within the domain.

Vnet/IP stations that receive time synchronization broadcasting communications from the domain master station synchronize the time by comparing their own network time to the time broadcasted from the domain master station.

The time synchronization accuracy of the network time within a domain is expressed as follows:
± 1 msec (When one bus is abnormal, the accuracy may become worse than ± 1 msec)

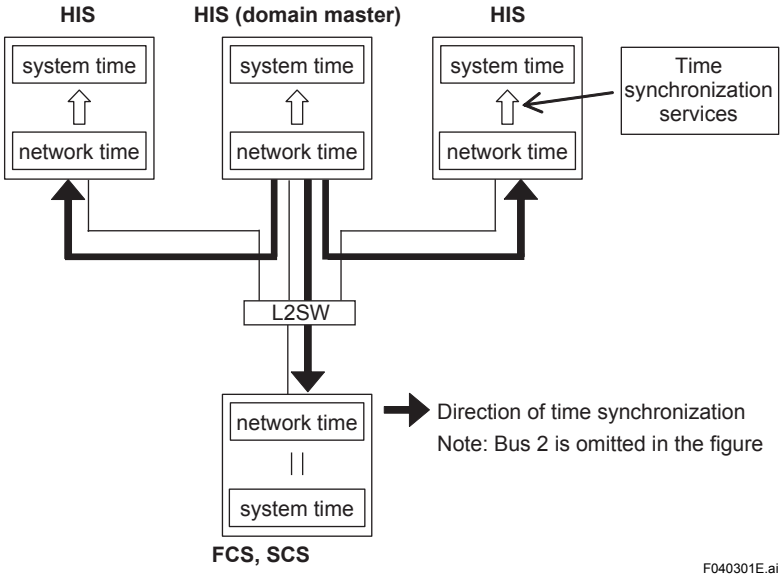


Figure Time Synchronization within a Vnet/IP Domain

Time synchronization between Vnet/IP domains

If there are multiple domains, the time is synchronized between domains that belong to the same time group.

A time group enables selection of a network time master from the domain master station within domains that belong to the same time group. A network time master is also selected automatically. It is not necessary for you to identify the network time master.

Vnet/IP defines time groups in the domain properties of the CENTUM engineering function on a domain-by-domain basis. The time group is specified by using numbers 0 to 7. The time is not synchronized for domains whose time group is 0.

The time synchronization accuracy of the network time between domains is expressed as follows:
±5 msec (When one bus is abnormal, the accuracy may become worse than ±5 msec)

The time synchronization accuracy becomes worse in proportion to the transmission delay time variations between domains.

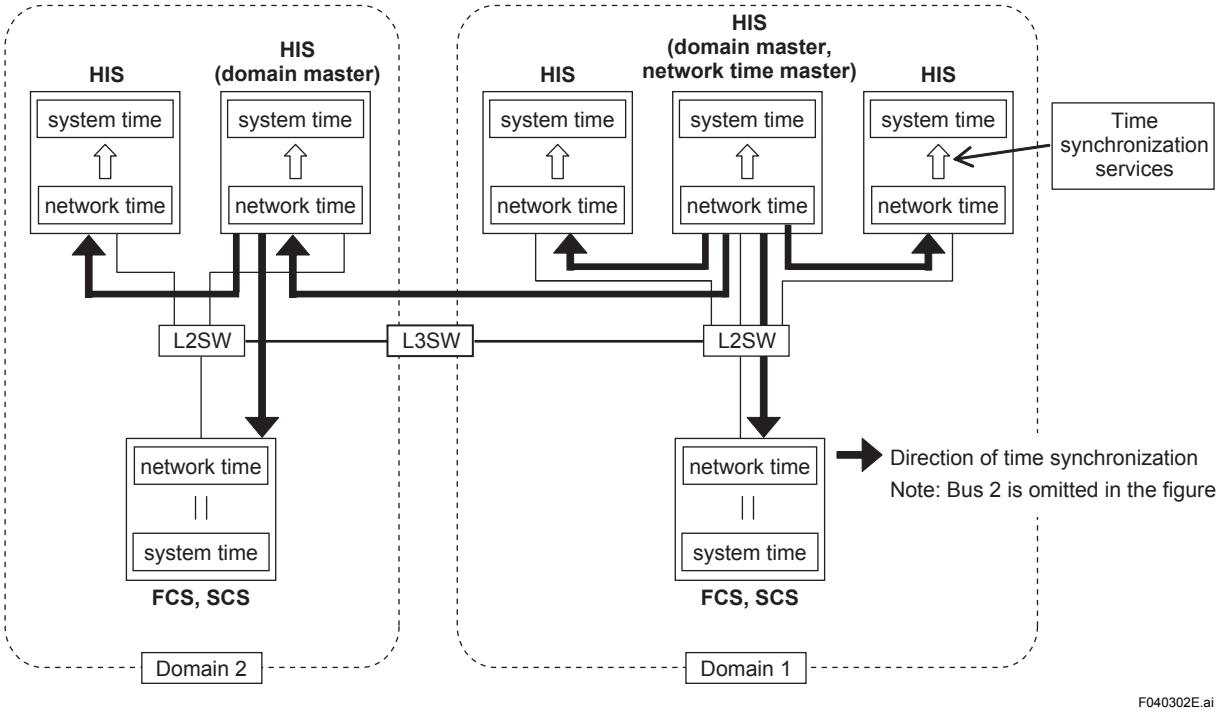


Figure Time Synchronization Between Domains in the Same Time Group

Time synchronization with the Coordinated Universal Time (UTC)

To synchronize the Vnet/IP station time with the Coordinated Universal Time (UTC), connect Vnet/IP bus 1 to the SNTP server that provides the UTC time. Alternatively, you can have a redundant configuration by setting up an SNTP server for bus 1 and bus 2, respectively. If there is an SNTP server in both bus 1 and bus 2, the station time is usually synchronized with the SNTP server time in bus 1.

In Vnet/IP systems, the domain master station of the Vnet/IP domain connected to the SNTP server synchronizes its time with the SNTP server time, and notifies the Vnet/IP stations within the domain about the time. Between domains, the domain master station is considered as the network time master. It synchronizes its time with the domain master stations that belong to the same time group.

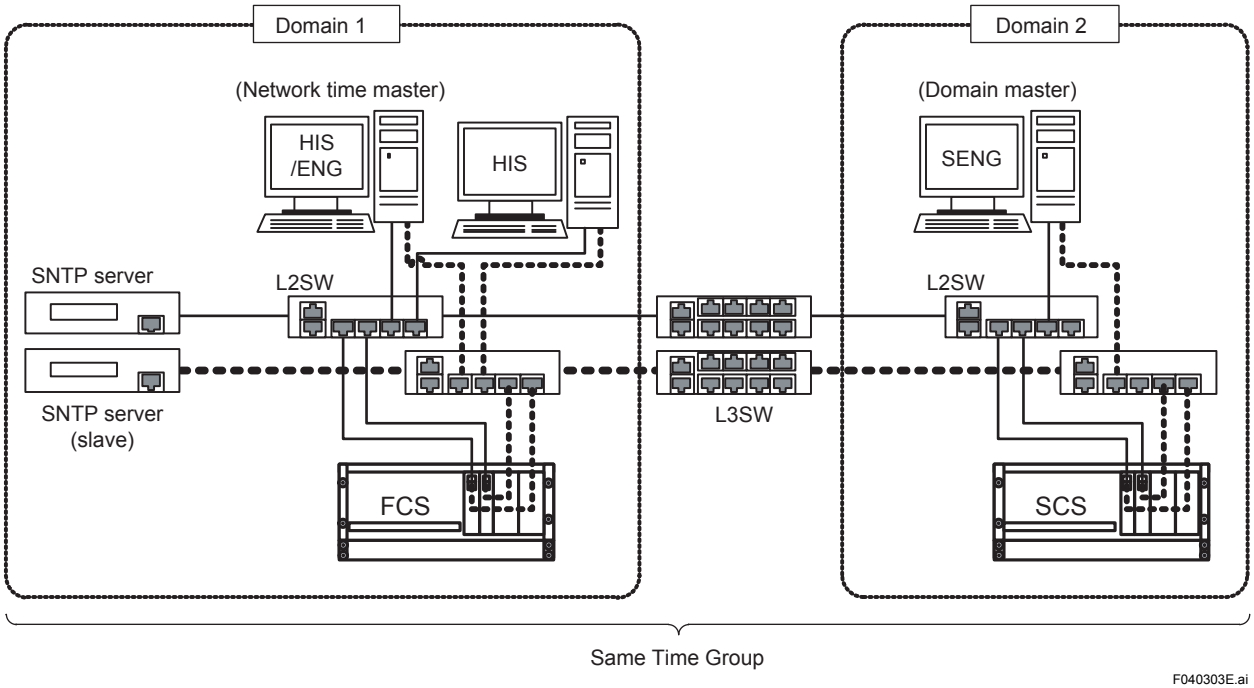


Figure Example of SNTP server connection

Set up an SNTP server for one domain in the time group. Set the following IP addresses for SNTP servers by using the domain number to be connected:

- SNTP server for bus 1: 192.168.<domain number>.254
- SNTP server for bus 2: 192.168.<128 + domain number>.254

If there are multiple Vnet/IP domains in a time group, you can set the IP address for SNTP servers only through the CENTUM engineering function of the domain that is connected to the SNTP server. If the IP addresses of SNTP servers are blank, specify the IP addresses provided earlier. You do not have to set the IP addresses for SNTP servers that do not belong to the domain.

Time synchronization with a V net domain

When a V net domain is connected to a Vnet/IP network, the time on Vnet/IP is used as the master time, and the time of V net domains synchronizes with it. You can set the time on V net as the master time. (*1)

The V net router compares the time of Vnet/IP domains with the time of V net domains every 2 minutes, and then synchronizes its time with the Vnet/IP domain time if a deviation of 5 seconds or more occurs twice.

*1: If you are using V net routers of AVR10D style S2, you cannot set the time on V net as the master time.

Operational precautions

The network time is a master clock in stations operating on a computer, such as an HIS.

Even though the system time is adjusted from the Windows Control Panel, the correct time is not set because the time synchronization service program sets the system time to the network time. Use the time set dialog box in the HIS system status display window to adjust the network time.

If the network time is synchronized with the SNTP server time, you cannot adjust the network time from the HIS or SENG.

A V net router obtains time information from the domain master on its starting up as it does not keep time information. Ensure to power on V net router only after other Vnet/IP stations are powered on so that the V net router does not become the domain master.

In case the network time becomes incorrect due to V net router being powered on prior to other Vnet/IP stations, adjust it to the correct time by using the time set dialog box in the HIS system status display window.

4.5 Precautions when Installing Network Devices

Power supply for network devices

To avoid redundant Vnet/IP network devices connected to bus1 and bus 2 from failing at the same time during a power failure, you must separate the power supply for network devices connected to bus 1 and bus 2. In addition, use an uninterruptible power supply (UPS) for each power supply system to prepare for temporary power failure of both systems. A temporary power failure occurs in situations such as when switching from a commercial power supply to standby generators.

*1: When power is restored after a power failure, network devices cannot communicate immediately. It may take a few minutes for the network devices to start up and resume communication. Therefore, ensure that you take precautionary measures for all network devices against power failures.

Vnet/IP cable connection

Connect appropriate cables and confirm the link is up with the correct transmission speed. Please refer to section 4.3 “Cable for Vnet/IP”.

Environmental conditions

We provide recommended layer 2 switches and layer 3 switches that are suitable for harsh environments. Use a device that is suitable for the environment where you want to use it. To install network devices that are not suitable for harsh environments, modify the system configuration based on the installation environmental specifications of the device.

Installing lightning protection and GPS antenna for SNTP servers

GPS antennas for SNTP servers are usually installed outdoors for them to capture signals from multiple GPS satellites. If you install a GPS antenna outdoors, ensure that you install it in a location that is protected by a lightning conductor. Ensure that you take safety measures against lightning by adding a lightning surge protector.

4.6 Notes on System Power-on

Notes on system start-up

To establish the Vnet/IP connection certainly, the power of the Layer 2 (or the Layer 3) switches has to be turned on prior to any of the Vnet/IP stations.

If the Vnet/IP stations are powered-on prior to the Layer 2 (or the Layer 3) switches, the local security zone may be automatically configured by the Vnet/IP's security function. This causes the failure of the Vnet/IP stations communication establishment.

SEE ALSO For more information about the Vnet/IP's security functions, refer to "Vnet/IP Built-in security Features" (TI 30A10A20-01E).

Notes on system maintenance

Do not turn off the Layer 2 (or the Layer 3) switches for both buses at the same time such as during the system maintenance. In such case the local security zone for each station group segmented by the Layer 2 switches may be automatically configured, then the communications among Vnet/IP stations are not established. The communication cannot be established even though the Layer 2 switches are rebooted.

If the Layer 2 (or Layer 3) switches of both buses must be turned off at the same time, turn off the Vnet/IP stations included in either one of the station groups segmented by the Layer 2 switches. Once the Layer 2 switches are rebooted after maintenance, then turn on the Vnet/IP stations.

4.7 Ring network configuration

About Ring network

A ring network is a network topology where each network switch connects to two other switches, forming a communication pathway in a ring. The ring topology provides a redundant communication path. The advantage of the ring network is that even a failure occurs at a point on the network, the communication is not disturbed.

Background of why ring network is requiring in control network

Vnet/IP has achieved redundancy by isolating the network using bus 1 and bus 2, and the ring network has not been supported in its standard network structure. However, when the bus 1 and bus 2 cables are routed in the same location, both of the communications break in cases the place is disturbed by a natural disaster or alike. Control networks are required to be configured in the ring network of which redundancy is established by having different routes.

Ring network method

In order to establish the ring network with Vnet/IP, L2SWs in a domain must be structured in a ring. Several protocols for redundancy are available to form the ring network; however, the Media Redundancy Protocol (MRP) is adopted for the Vnet/IP for the following reasons.

- MRP is specified by the international standard of IEC 62439
- Switching of the communication path is performed in high speed

Structure of ring network

The MRP is one of the most versatile protocols relatively easy to form the ring network.

The figure below shows how the ring network performs using the MRP.

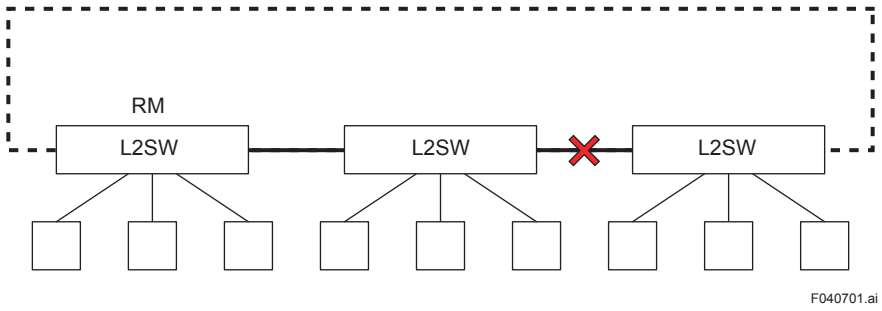


Figure Ring network

The above figure is the ring network using three switches connected in a loop. In the ring network, Ring Master (RM) which is a switch to manage the ring has to be specified. Under the normal status, the communication is done through the path shown as the solid line. A port on a side (i.e. left in this figure) of the RM is disabled and the communication is not performed. When a failure occurs on the path shown as the solid line, the RM activates the disabled port and the communication is performed via the broken-line path.

Vnet/IP in the Ring network

When applying the ring network to the Vnet/IP, following points must be considered.

(1) Limitation in network delay

In the Vnet/IP's communication among the domain, the delay in the network between any two of the stations has to be designed as 1 msec or less. Therefore, even a failure occurs at any point on the ring network, the delay time should not exceed 1 msec. As described in the GS, the network delay is within the limitation when up to 7 levels of L2SWs are connected in the overall cable length of 40 km or less. In case of configuring a large scale communication network by the ring topology, contact Yokogawa in advance.

(2) Detecting a single failure on network

Failure monitoring function of the Vnet/IP is implemented by monitoring the communication status among stations. When a failure occurs in the ring network and the network device itself switches the communication route to the redundant path, the failure is not detected by CENTUM System because the communication status between the stations does not change. As a countermeasure, CENTUM system has to be engineered to adopt a FAULT output terminal as a DI signal in the FCS to generate alarms.

Requirements for Vnet/IP Ring network

Network switch

The table below shows the list of Vnet/IP network switches applicable for structuring a ring network. Do not use any other switches for the ring networks.

Table Vnet/IP network switches applicable for Ring network

Layer	Vnet/IP Bus	MS-Code (Vender model name)	Product Family
L2SW	Bus 1 Bus 2	GRVSW-660FA RS40-0009CCCCEDBPYY	RS40
		GRVSW-663FA MACH104-20TX-F	MACH104
		GRVSW-664FA MACH104-20TX-FR	
		GRVSW-665FA MAR1040-4C4C4C4C9999EM9HPYY	MAR1040
		GRVSW-666FA MAR1040-4C4C4C4C9999EMMHPYY	
		GRVSW-667FA MAR1040-4C4C4C4C9999ELLHPYY	
L3SW	Bus 1	GRVSW-668FA MAR1040-4C4C4C4C9999EM9HRY1	
		GRVSW-669FA MAR1040-4C4C4C4C9999EMMHRY1	
		GRVSW-670FA MAR1040-4C4C4C4C9999ELLHRY1	
	Bus 2	GRVSW-671FA MAR1040-4C4C4C4C9999EM9HRY2	
		GRVSW-672FA MAR1040-4C4C4C4C9999EMMHRY2	
		GRVSW-673FA MAR1040-4C4C4C4C9999ELLHRY2	

Notes: MACH102, which is fit for a small-scale system, is not applicable for a ring network.

Use the Vnet/IP network switch firmware revision of "Software Release 09.0.06" for the ring network.

CENTUM VP

For detecting failures and acknowledging recovery of alarms of the ring network, the following components are required.

- HIS × 1 unit
  For detecting failures/acknowledging recovery of alarms. An HIS in the existing system can be utilized.
- FCS × 1 unit
  For detecting failures/acknowledging recovery of alarms. An FCS in the existing system can be utilized. A digital input module shown below must be mounted on the FCS.
- Digital input module
  A digital input module is required to receive an output from the FAULT terminal of the network switch. An open channel per ring is needed. In case a ring in bus 1 and another ring in bus 2 exist, total of 2 open channels are required. An existing DI module available with required number of open channels can be utilized.

Network Management System

Introducing a network management system (NMS) is strongly recommended for structuring the communication network in ring topology. In this case, dedicated IT skills for network engineering is required. For the NMS, a computer independent from HIS and ENG has to be prepared. An Ethernet port for a ring is required on this computer. (Two open ports for bus 1 and bus 2 must be available.)

Revision Information

- Title : Vnet/IP Network Constrction Guide
- Manual No. : TI 30A10A05-01E

Aug.2011/1st Edition
Newly published

Mar.2012/2nd Edition
1.6 Added *2
4.1 Added “SEE ALSO”
4.2 Added “SEE ALSO”
4.3 Revised *3 of “Interface specifications”
Revised *2 of “Optical fiber cables”

Aug. 2014/3rd Edition
4.4 Added “Operational precautions”
4.6 Newly added

Dec. 2016/4th Edition
Glossary Revised several terms.
1.3.1 “Ring topology” is added to the network topology.
1.3.3 A new chapter “High Reliability with Ring Configuration” is added.
1.4 The description of “Vnet/IP domain” is revised to add “ring topology.”
A figure “Sample Structure of Multiple Domains (Ring Topology)” is added.
2.2.2 Changed the pages order of “Cascade connection between domains” and “Operating a system with split domains.”
2.2.4 A new chapter “Connection using by Ring Topology” is added.
4.7 A new chapter “Ring Network Configuration” is added.

Mar. 2019/5th Edition
Introduction Added WAC router in the Glossary list.
1.2 Added description of WAC router as a device linked up with 100 Mbps.
4.3 Added a precaution of link speed confirmation.
4.5 Added “Vnet/IP cable connection.”

Written by Yokogawa Electric Corporation

Published by Yokogawa Electric Corporation
2-9-32 Nakacho, Musashino-shi, Tokyo 180-8750, JAPAN

Printed by KOHOKU PUBLISHING & PRINTING INC.