

PAC Productivity Suite (PPS)

Application Setup and Configuration Guide

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Acronyms and Abbreviations

- EGD Ethernet Global Data
- EMT EGD Management Tool
- ETM Ethernet Interface Module
- HMI Human-machine Interface
- IGMP Internet Group Management Protocol
- NIC Network Interface Card
- PAC Programmable Automation Controller
- PPS PAC Productivity Suite
- SMS Stop Mode Store

Related Documents

- PAC Productivity Suite Getting Started Version 2.10 (GFK-2847)
- PAC Productivity Suite Logic Function Blocks and Instructions

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Section 1: Overview

PAC Productivity Suite (PPS) is a process control system for continuous and hybrid process applications. It provides an integrated tool suite to set up, configure, implement, operate, and maintain a process control system throughout its lifecycle.

This document guides the user through setting up and configuring a PPS application so that system performance meets user expectations. It also provides a description of the PPS system architecture to provide the necessary context as it relates to the setup and configuration content.

Section 2: PPS System Architecture

PPS has eight different I/O count options: 100, 250, 500, 1000, 2000, 3000, 5000, and 5000+.

Each I/O is wired to a local or remote rack. For example, if you have 200 local I/O (analog and/or discrete) and 2000 remote I/O (analog and/or discrete), you have a total of 2200 I/O points.

Each Fieldbus device (Foundation Fieldbus, PROFIBUS, or others) is connected to the system, regardless of the number of internal variables used. For example, if you have 300 Foundation Fieldbus instruments and 200 PROFIBUS instruments, you have a total of 500 I/O points.

CAUTION

The number of SCADA tags is not equal to the I/O Points. Typically, each I/O point will generate several SCADA tags.

PPS uses CIMPLICITY for visualization.

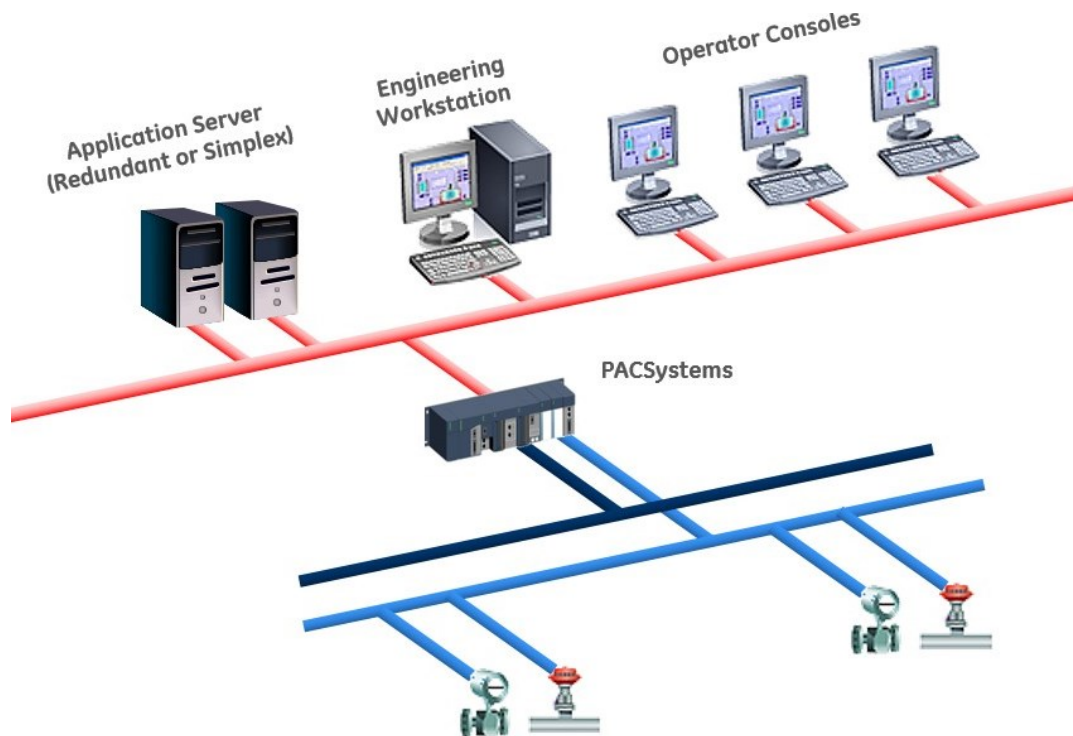
2.1 PPS Software Components

PPS is composed of four software components:

- Engineering Workstation (EWS)
- Application Server
- Operator Console

Each software component is a functional entity that can be combined to run on one computer or distributed to multiple computers depending on the requirements and size of the application.

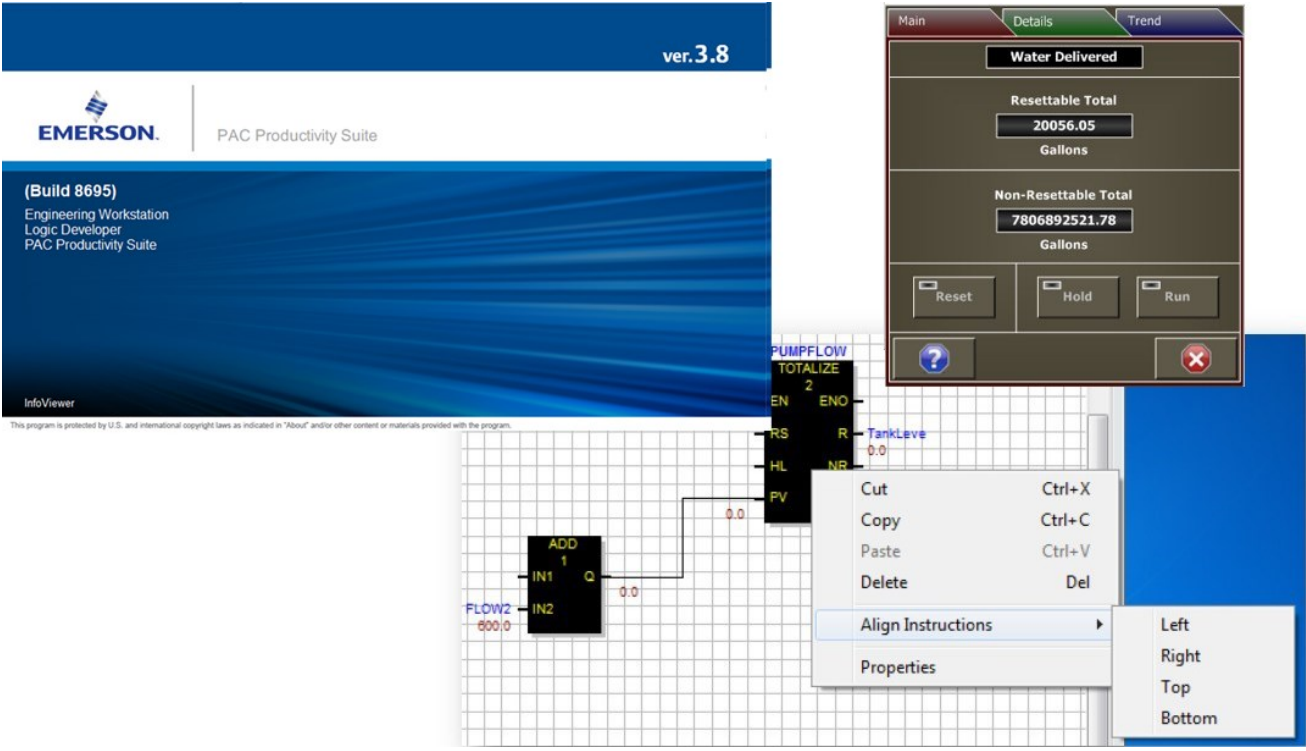
Figure 1: PPS Software Components



2.1.1 Engineering Workstation

The Engineering Workstation (EWS) is used to develop and configure the system. It includes a SCADA development/runtime server, PPS Logic Developer, and Ethernet Global Data (EGD) system tools. Included in the SCADA system are PPS mimic and faceplate objects that allow consistent and efficient development of HMI screens. The EGD system tools include a configuration server that provides a common database between the PPS Logic Developer and the SCADA development server.

Figure 2: PPS-EWS



2.1.2 Application Server

With the CIMPLICITY option, PPS supports the CIMPLICITY client/server architecture. The Application Server serves as the CIMPLICITY Server and communicates to the PACSystem controller(s) during runtime. The Operator Consoles receive data from the Application Server (CIMPLICITY) and do not communicate directly with the controller(s). The Application Server also allows 3rd party device connectivity with PPS. The option for redundant CIMPLICITY Application Servers is included in all offerings except the 100 I/O point system.

To display 3rd party device data on PPS visualization software, users must install a 3rd party use an OPC server capable of communicating to the 3rd party devices/controllers or use native drivers in the Application Server. The Application Server will collect data from the 3rd party devices and serve the data to the Operator Consoles.

2.1.3 Operator Console

The Operator Console is used to monitor and control the process.

2.2 PACSystems Controller

PPS Hardware Components supports PACSystem controllers and I/O hardware. The following table provides an example of the hardware components that would be used for a typical RX3i™ PPS application.

Note: PACSystems RX3i rack-based require a peripheral Ethernet module (IC695ETM001) be present in the rack. PAC Productivity Suite is not supported on RX3i embedded Ethernet interfaces.

Table 1: Part Number and Description

Part Number	Description
IC695CPE305	RX3i Single-slot CPU, 1.1 GHz Processor, 5 M user-memory
IC695CPE330	2-slot, Dual Core, 1 GHz 64 MB CPU with Embedded Ethernet
IC695CHS012	RX3i 12 Universal Modules Slots Base
IC695CHS016	RX3i 16 Universal Modules Slots Base
IC695PSD040	RX3i Power Supply 24 V dc 40 W
IC695PSD140	RX3i Multi-purpose Power Supply 24 V dc 40 W
IC695PSA040	RX3i Power Supply 120/240 V ac and 125 V dc 40 W
IC695PSA140	RX3i Multi-purpose Power Supply 120/240 V ac and 125 V dc 40 W
IC695ETM001	RX3i Ethernet Interface Module 10/100 Mbits 2 RJ-45 connections
IC695PNC001	Rx3i PROFINET Controller
IC695PNS001	Rx3i PROFINET Scanner

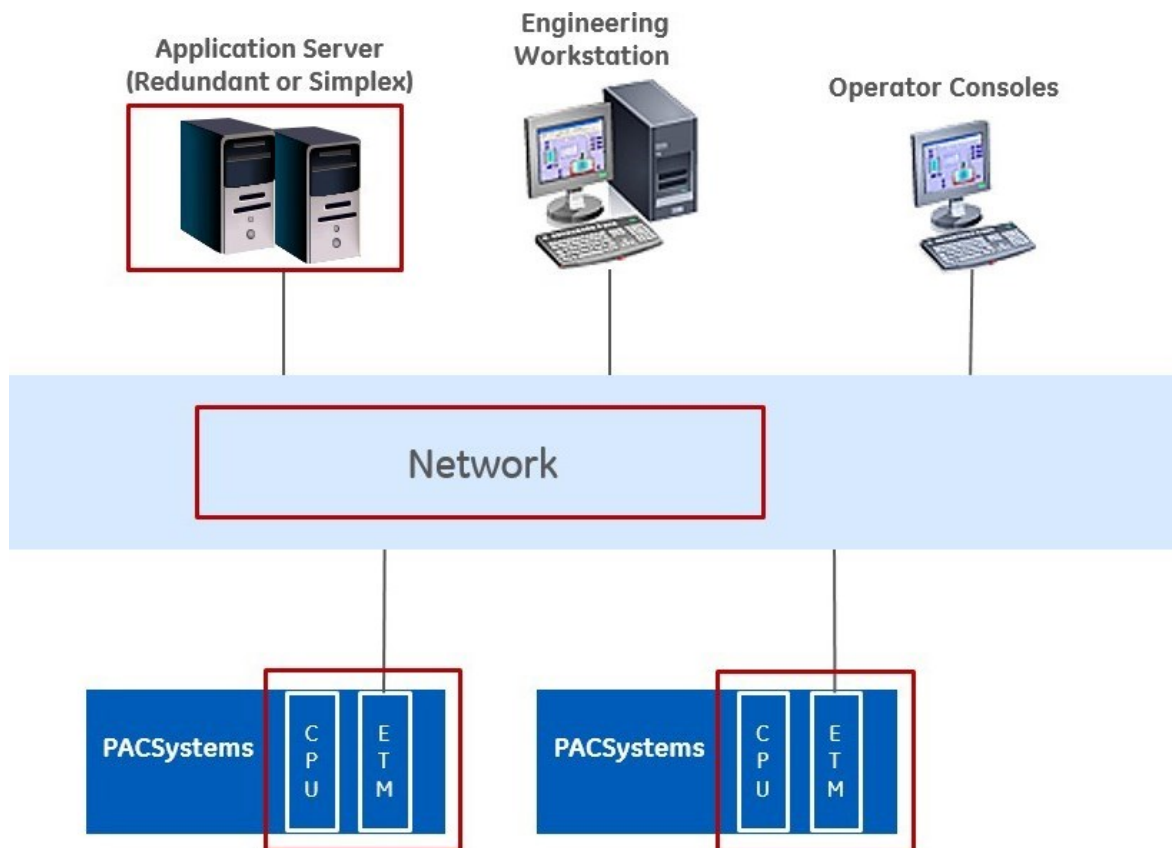
Section 3: PPS Application Setup and Configuration

The key to designing a top-performing PPS application is to ensure that the flow of Ethernet Global Data (EGD) throughout the system is not congested. It is important to understand how EGD works to correctly configure the system components that use EGD to meet the desired application performance requirements.

The main components of PPS that comprise the EGD network are:

- Central Processing Unit (CPU)
- PACSystems Ethernet Interface Modules (ETMs)
- Application Server(s)
- Network (switches, cables, and configuration)

Figure 3: PPS EGD Network Components



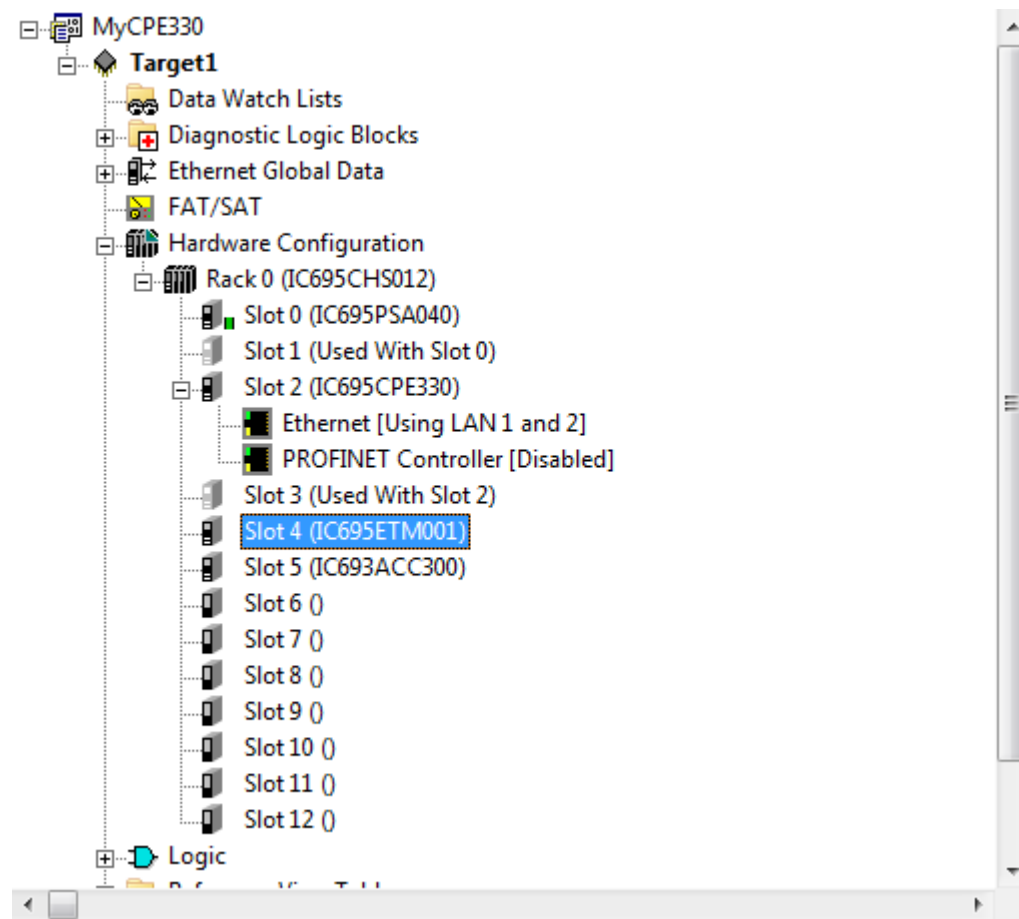
3.1 CPU and ETM Components

This section provides an overview of EGD configuration of the CPU and ETM components, and the guidelines to follow during configuration.

3.1.1 EGD Configuration Overview

The EWS is used to configure the CPU and ETM. The following figure illustrates the hardware configuration for an RX3i system within the EWS.

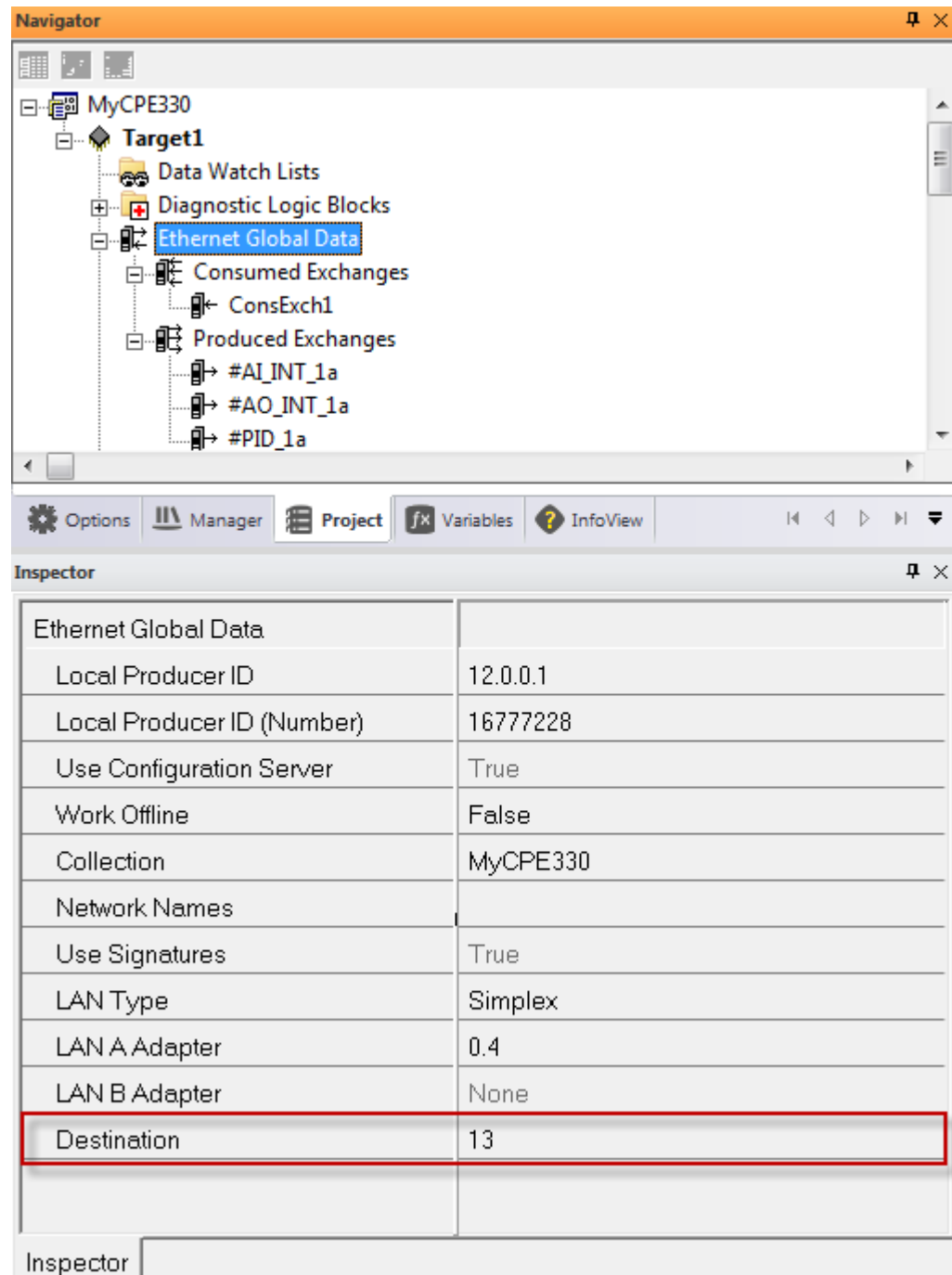
Figure 4: CPU and ETM Hardware Configuration



In this example, IC695ETM001 (slot 4) is the ETM that will be used to produce and consume EGD within the context of PPS.

EGD configuration is shown in the following figure. The LAN Type is Simplex, which means that the network does not have dual cabling, and the LAN Adapter is in slot 4, which aligns with the configuration.

Figure 5: EGD Configuration



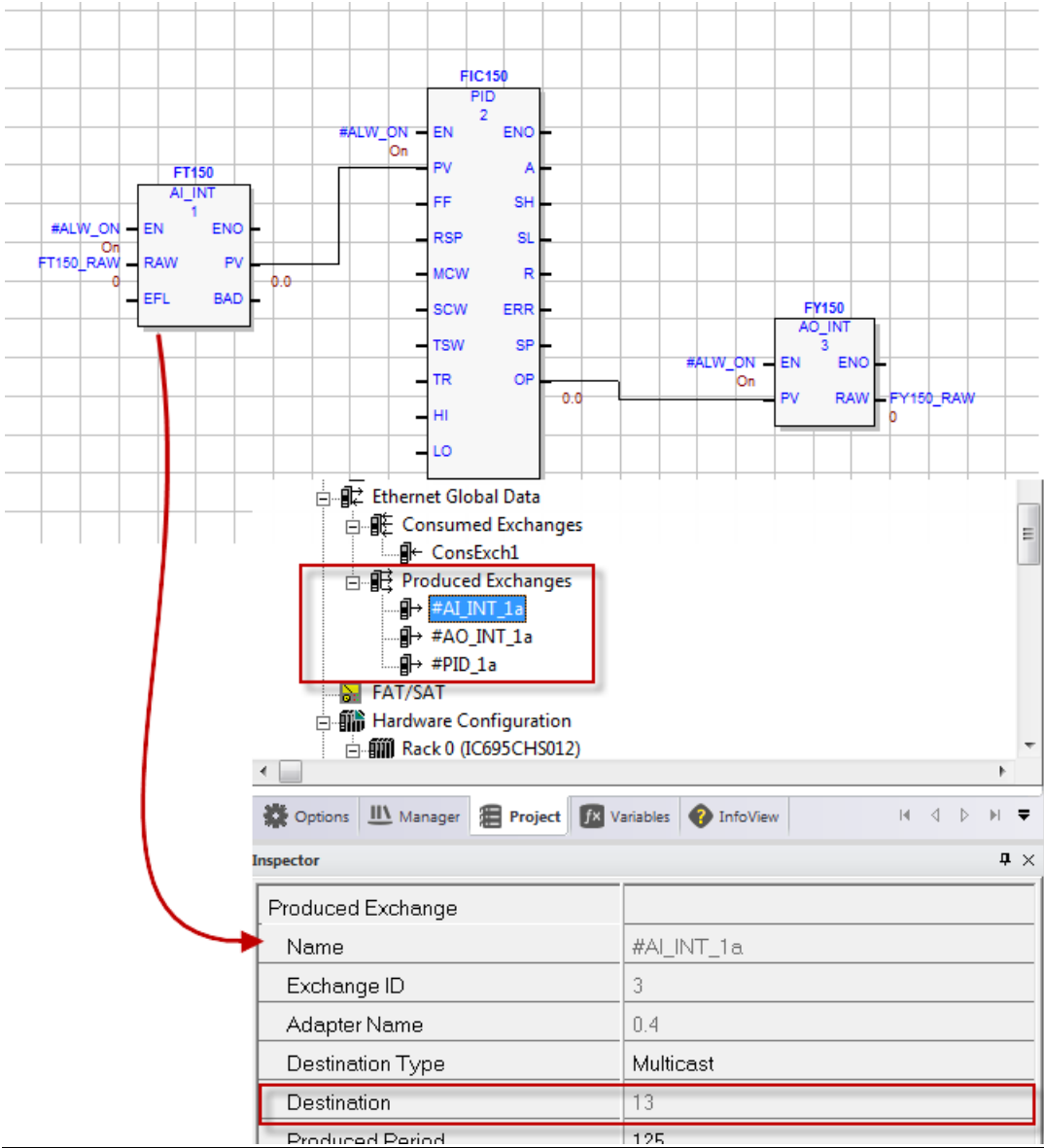
The screenshot shows the PPS software interface. The Navigator pane on the left displays the project hierarchy for 'MyCPE330'. Under 'Target1', the 'Ethernet Global Data' block is selected and highlighted. The Inspector pane on the right shows the configuration parameters for 'Ethernet Global Data'.

Ethernet Global Data	
Local Producer ID	12.0.0.1
Local Producer ID (Number)	16777228
Use Configuration Server	True
Work Offline	False
Collection	MyCPE330
Network Names	
Use Signatures	True
LAN Type	Simplex
LAN A Adapter	0.4
LAN B Adapter	None
Destination	13

Note If the network has dual cabling, then the LAN Type would be Dual.

The configuration parameter **Destination** in this figure is important because it is used by PPS as a result of a Build EGD command to auto-configure produced EGD exchanges. During runtime, these exchanges are consumed by Application Servers that belong to the corresponding multicast group. For example, the following PPS function block diagram uses three blocks that automatically generate exchanges in response to a Build EGD command.

Figure 6: PPS Auto-generated EGD Exchanges



It is also possible to have the controller (through the ETM) consume EGD from other controllers and produce EGD for other controllers. This is referred to as *inter-controller communication*.

Figure 7: Consumed Exchanges

The screenshot shows the PPS software interface. The top panel is the 'Navigator' window, which displays a tree structure under 'Target1'. The tree includes 'Data Watch Lists', 'Diagnostic Logic Blocks', 'Ethernet Global Data', 'Consumed Exchanges', 'Produced Exchanges', and 'FAT/SAT'. Under 'Consumed Exchanges', 'ConsExch1' is selected. The bottom panel is the 'Inspector' window, which displays the properties of the selected 'ConsExch1'. The properties are listed in a table:

Consumed Exchange	
Name	ConsExch1
Producer ID	1.25.28.18
Group ID	25
Exchange ID	1
Adapter Name	0.4
Consumed Period	200
Update Timeout	0
Run Mode Store Enabled	False

3.1.2 Design Guidelines

This section provides the guidelines to follow when configuring the ETM in the EWS.

Configure Inter-controller Communications

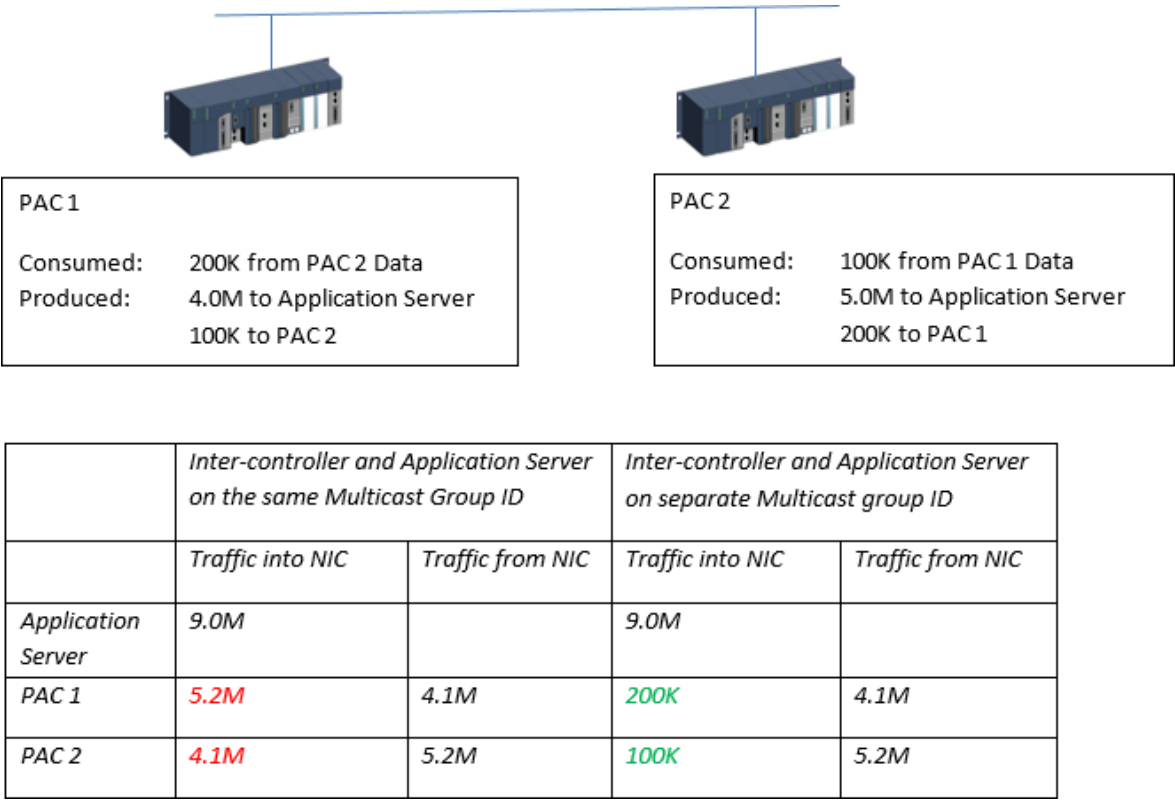
The volume of inter-controller exchanges is typically not large and would only be between ~200 to 400 bytes with a production rate of around 200 milliseconds. In some cases, high-speed inter-controller data exchanges are required and should be handled in a separate exchange with the smallest possible data size. The exchange production time should be no less than two times the scan of the producer controller and 1.5 times the consumer controller scan.

If inter-controller exchanges are only required by one other controller then they should be configured as unicast. Otherwise, they should be configured as multicast.

Separate Inter-controller and Application Server Traffic

It is critical that the inter-controller exchanges be configured with a different Multicast Group ID than the produced exchanges that are destined for the Application Server. This is illustrated in the following figure.

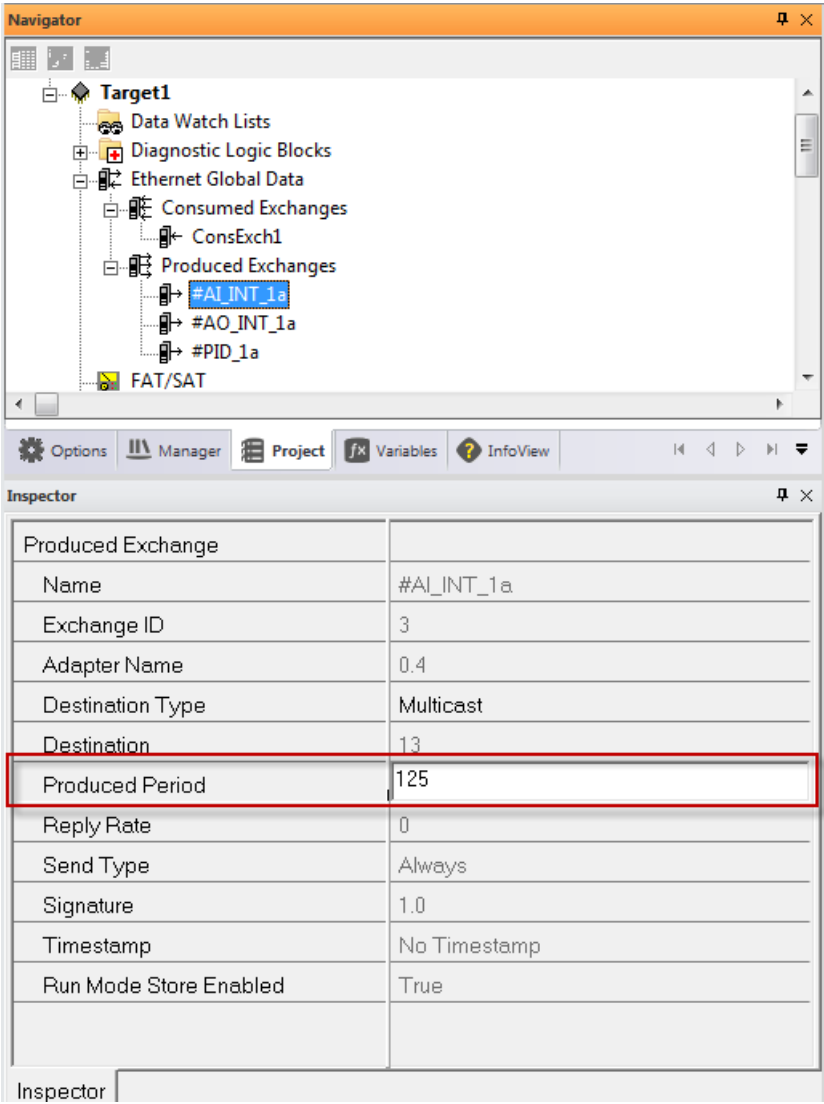
Figure 8: PPS Separate Application Server and Inter-controller Communication



Configure Produced Period of Exchanges

Each Produced Exchange has a Produced Period as shown in the following figure.

Figure 9: Produced Exchanged Produced Period



It is best to eliminate exchanges being produced simultaneously. By default, PPS has a default Produced Period for each type of exchange (such as #AI_INT) and they are staggered. A strategy to improve this is to use prime numbers for the Produced Period to eliminate the alignment of productions, thus reducing the amplitude of data rate peaks from a single controller. For example, it would be better to use 47 ms to replace 50 ms, 97 to replace 100 ms, and so on. The best result is a wide, even distribution based on data volume not quantity of exchanges.

Figure 10: Primer Numbers for Configuring Produced Period

	2	3	5	7	11	13	17	19	23
29	31	37	41	43	47	53	59	61	67
71	73	79	83	89	97	101	103	107	109
113	127	131	137	139	149	151	157	163	167
173	179	181	191	193	197	199	211	223	227
229	233	239	241	251	257	263	269	271	277
281	283	293	307	311	313	317	331	337	347
349	353	359	367	373	379	383	389	397	401
409	419	421	431	433	439	443	449	457	461
463	467	479	487	491	499	503	509	521	523
541	547	557	563	569	571	577	587	593	599
601	607	613	617	619	631	641	643	647	653
659	661	673	677	683	691	701	709	719	727
733	739	743	751	757	761	769	773	787	797
809	811	821	823	827	829	839	853	857	859
863	877	881	883	887	907	911	919	929	937
941	947	953	967	971	977	983	991	997	

Note The Produced Period for exchanges should be at least 2 to 3 times scan rate of the controller.

Load ETMs

ETMs perform several tasks to which priorities are applied. The highest priority is placed on processing consumed EGD exchanges, then producing EGD exchanges, then responding to network commands such as ping and Internet Group Management Protocol (IGMP) requests. It is important to understand that as an ETM becomes overloaded its overall performance will decrease by approximately 20%.

Overloading the ETMs will not affect the controller scan time; a low controller scan time does not provide a useful indication of ETM loading.

The best possible performance from a single ETM is around 5 MB Produced Exchanges (EGD to Application Servers and inter-controller communications) and 2-3 MB Consumed Exchanges (inter-controller communications).

Also, the total packets per second produced by one ETM should not be more than 750. Since each EGD Produced Exchange generates one UDP packet per Produced Period where Produced Period is in milliseconds, the number of packets an exchange generates per second is equal to the inverse of the Produced Period in seconds. For example, if exchanges have a Produced Period of 125 milliseconds, it produces eight packets per second. Refer to the following table for an example of how to determine Produced packets per second.

Table 2 Example Produced Packet per Second Calculation:

Produced Exchanges	Produced Period (milliseconds)	Inverse (seconds)	Packets per Second
#AI_INT_1a	125	1/0.125 =	8
#AO_INT_1a	100	1/0.100 =	10
#PID_1a	200	1/0.200 =	5
			23 (must be < 750)

Consumer Group ID

The Destination used in the PPS auto-generated exchanges (refer to the figure [PPS Auto-generated EGD Exchanges](#)) cannot be in any Consumed Exchange's Group ID (refer to the figure [Consumed Exchanges](#)) on any controller or it would result in the controller EMT being flooded with the sum of all traffic intended for an Application Server.

3.2 Network

The primary requirement for the network is to direct traffic to its required destination and not flood the network with unnecessary traffic. Internet Group Management Protocol (IGMP) and IGMP snooping are used to accomplish this.

IGMP is implemented on a particular host and within a router. A host requests membership to a group through its local router while a router listens for these requests and periodically sends out subscription queries.

IGMP snooping is a function of the Layer 2 switch and is not enabled by default. IGMP snooping is generally enabled over the entire switch or on an individual VLAN basis. It will enable multicast traffic groups to maintain isolation over the network. Within a PPS architecture, different multicast groups such as Produced Exchange's Destination should be used to route PPS / EGD traffic to the Application Server and route inter-controller traffic between controllers. The key is to take the time to understand how IGMP works.

If IGMP is not enabled, the result in a PPS architecture can be quite extreme and result in several issues from slow Human-machine Interface (HMI) updates to stale data, program download failures, and edropouts of inter-controller communications. This is caused by the ETM overloading due to its internal task scheduling. The ETM task priority is to

consume and validate incoming EGD first, then process outgoing EGD exchanges followed by other communications. Users must keep consumed data to a minimum as this will block other tasks.

For example, if we consider a system with two controllers using multicast inter-controller EGD communications on a common network to one Application Server, it is possible that a single controller can produce up to 7 MBits of data. If both Application Server and inter-controller exchanges are in the same multicast group the second controller will now be consuming 7 MBits. In processing the consumed data it will begin to stall and start failing to produce exchanges.

CAUTION

IGMP and IGMP snooping and forwarding must be enabled on all switches.

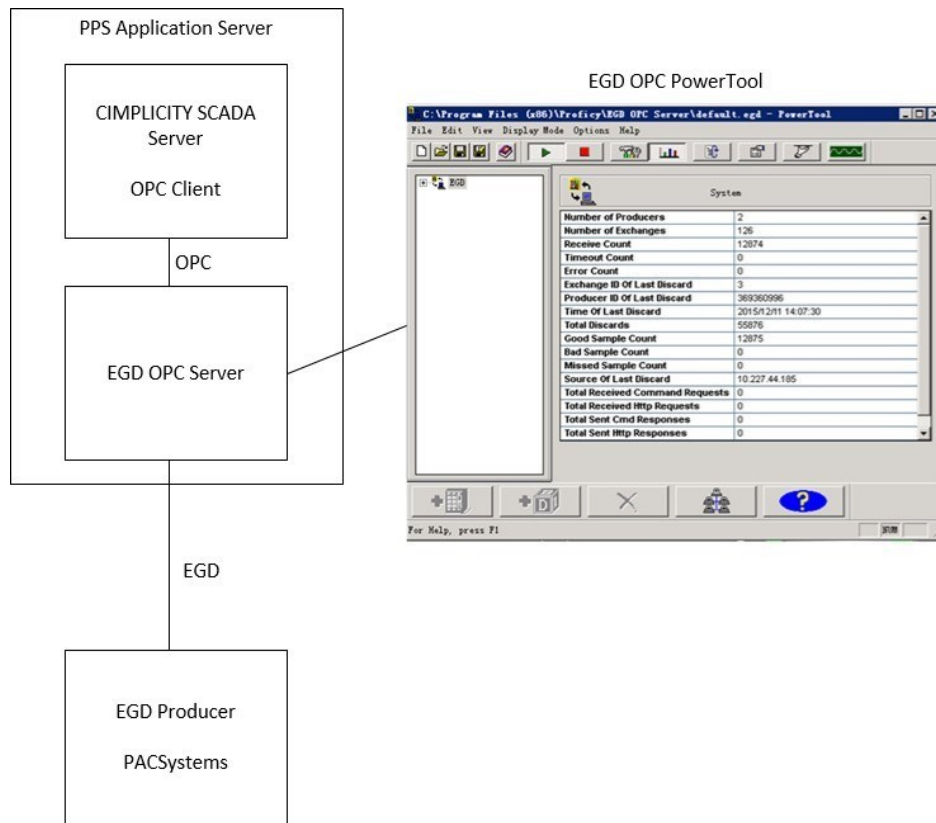
3.3 Application Servers

This section provides an overview of the Application Servers tools and the guidelines to follow during configuration.

3.3.1 Application Servers Tool Overview

The PPS Application Server is comprised of several tools. The following figure focuses on three of these tools that are of special concern when considering performance: the SCADA server, EGD OPC server, and the EGD OPC PowerTool.

Figure 11: PPS Application Server Components



The EGD OPC PowerTool is used to examine the network health from the OPC server point of view. It is important to understand that the PowerTool is just a client to the OPC server. The PowerTool displays errors and discarded packet. Very few errors should be occurring on a regular interval so the error count should not be rolling. By drilling down into the device tree users can determine which device and which exchange is causing problems.

The PowerTool displays discards as either 0 or a rolling count as a result of packets being consumed or not consumed. This means that if the data in the packet is not being requested by the SCADA system, it will be discarded. The most obvious cause of an increase in discards is after a PPS object has been added to a controller in a new exchange but has not been added to the SCADA Server. Discards will continue until the SCADA Server requests the tags relating to that object. However, the most useful thing is the discard tallies, which indicate if multicast groups are misaligned. In the figure [PPS Separate Application Server and Inter-controller Communication](#), the example shows two controllers using multicast for inter-controller EGD communications on a common network to one SCADA server. If the controllers and SCADA exchanges are on the same Multicast Group ID, or IGMP is not enabled on all switches, the OPC Server will identify and then discard the exchanges that are inter-controller because the SCADA Server is not requesting this data.

3.3.2 Design Guidelines

This section provides the guidelines to follow during configuration of the Application Server.

EGD Management Tool Restriction

The EGD Management tool, which is different from the PowerTool, should never be opened on a server. As soon as it is opened, the EMT online / snooping feature that will read all exchanges from the EGD Configuration Server and subscribe to all groups. This opens the Network Interface Card (NIC) to all exchanges and the OPC Server will start discarding all but the data intended for the SCADA Server.

Multiple Application Servers and Multicast Group ID

In a multi-server configuration it is important to have a Multicast Group ID allocated to each server and a separate Group ID for multicast inter-controller data. From a PPS object point of view this means a controller will be assigned to an individual SCADA Server. Depending on production count and size, 8 to 10 PLCs will be the limited per SCADA / per group; however, a single SCADA Server could have as many as 20+ very small controllers if the production rate is low. The overall limiting factor will be the SCADA Server should have no more than ~120 K tags or about 3 K changes per second (*On Change*).

When designing a multi-server system, if these rules are applied and grouping, IGMP, and the ETM and data limits are observed, a system could in theory contain 120 K tags x 31 available Group IDs + inter PLC Communications Groups (if not Unicast) (3.7 Million tags).

The limiting factor becomes the EGD Configuration Server, which can grow to several hundred Mbytes in size on a system on three or four servers. Currently, there is no way of distributing the EGD Server.

PPS OPC Scan Rate

In CIMPLICITY, the global parameter **PPS_OPC_SCANRATE** should be set equal to half of the desired screen refresh.

Section 4: Glossary of Terms

Term	Definition
PPS Software Component	A software component within PAC Productivity Suite (PPS) that provides specific functionality and can be distributed onto PC-based hardware depending on the requirements of the application. PPS software components include Engineering Workstation (EWS), Application Server, and Operator Console.
PPS Editions	Premier or Standard Premier includes additional activation for systems with an I/O count greater than 100.
I/O Points	The number of field I/O that an application uses to sense and actuate process equipment. PPS product structuring and pricing is based on the number of I/O points that a customer has in their application. This quantity does not necessarily equate to the number of SCADA points.
EGD Data Signatures	EGD signatures can be used to verify that the format of the data from the producer matches that expected by the consumer. The EGD signature is a numeric value that has two parts: the major number and the minor number. The major number reflects the primary format of the data. The minor number reflects backward-compatible changes made to the EGD exchange (such as adding data to the end of the exchange). An EGD signature has the format major . minor. The primary format of the data is first established when the EGD exchange is defined. At that time the signature is assigned the value of 1.0. Any change that reorders, removes, renames, or changes the type or offset of a variable in the exchange is a primary format change that causes the signature's major number to be incremented. The signature major number must match between the producer and the consumer for the consumer to consume the data. Packets that are received when produced and consumed exchange signatures are enabled and incompatible (different major signature values) will result in an error consumed exchange status.
IGMP	The Internet Group Management Protocol (IGMP) is a communication protocol used by hosts and adjacent routers to establish multicast group membership. IGMP is an integral part of IP multicast.
IGMP Snooping	The process of listening to IGMP network traffic. This feature allows a network switch to listen to the IGMP conversation between hosts and routers. By listening to these conversations the switch maintains a map of which links need which IP multicast streams.
Multicast	Group communications on a network where information is addressed to a group of destinations.

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