Argonne NATIONAL LABORATORY

EPICS PV Gateway

Marty Smith
APS Controls Group

U.S. DEPARTMENT OF ENERGY

Overview

- What is a PV Gateway?
- What is a PV Gateway good for?
- Some Features and updated code
- Remote Administration Monitoring
- Remote Administration Control
- Getting Started Using PV Gateways
- PV Gateway Configurations
- References
- Questions

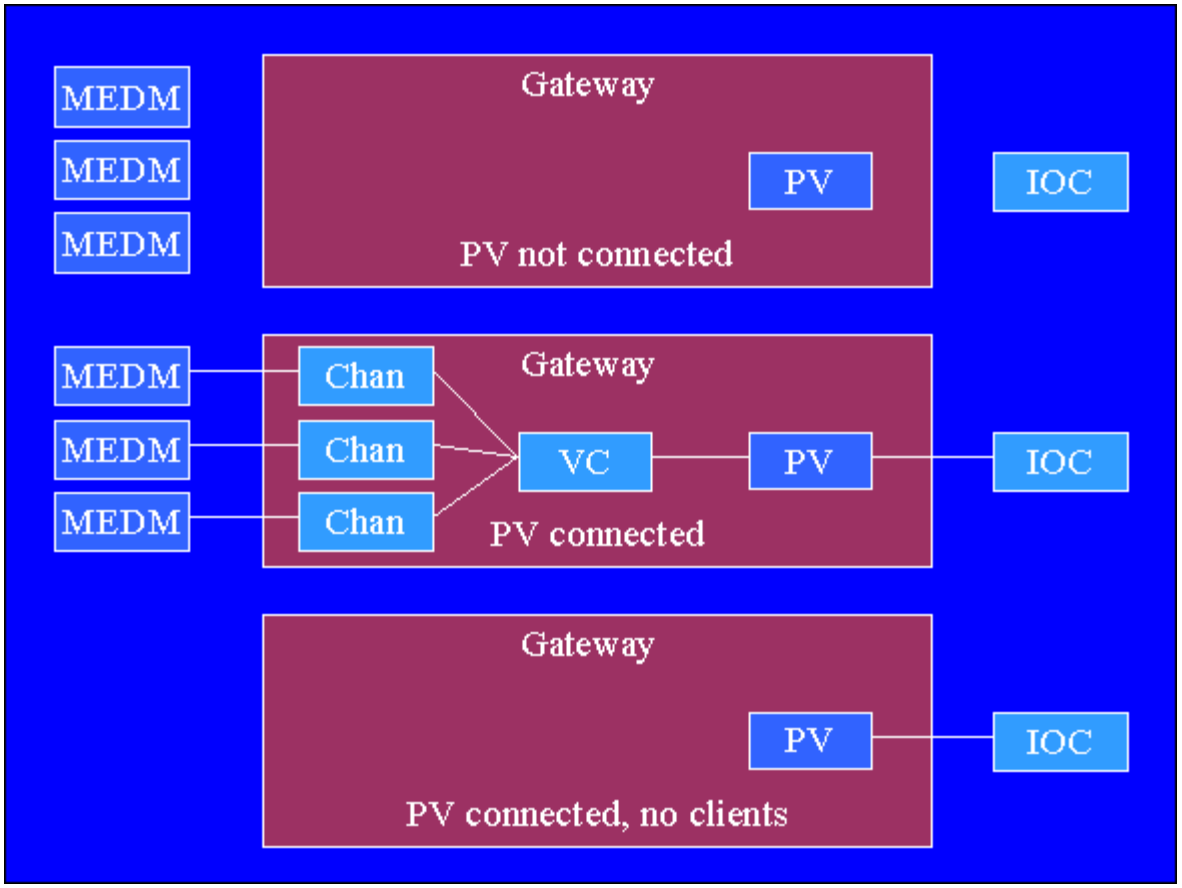
What is a PV Gateway

- EPICS Extension developed at APS by Jim Kowalkowski
- Further development was done by Janet Anderson (APS), Ken Evans (APS), Jeff Hill (LANL), and Ralph Lange (BESSY)
- A software application which uses a CA client to connect to EPICS PVs and set up CA monitors on those PVs
- Uses the Portable Channel Access Server (PCAS) to provide the PVs to other CA clients
- Five functional blocks: CA Server, Access Security, Virtual Connection, Data Cache, and CA Client

PV Gateway Functional Blocks

- CA Server
  - Provides EPICS CA channels (PVs) to CA clients
- Access Security
  - Can be configured for virtual connections
- Virtual Connections (VC)
  - Either have a real PV name or a alias PV name mapped to an existing PV
- Data Cache
  - For each requested (or real) PV connection established data is monitored and cached for a configurable time period
- CA Client
  - Connects the EPICS PV to the CA server providing the channel

Functional Block Illustration



PV Gateway Key Features

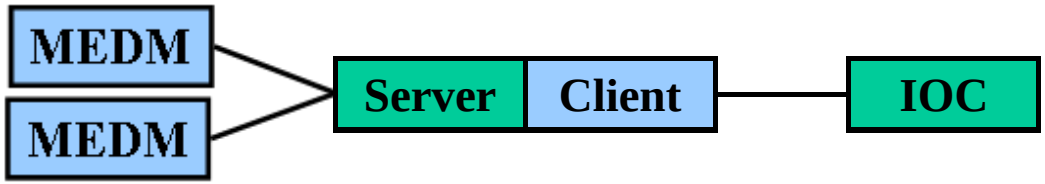
- Only one CA connection between gateway and PV server such as IOCs rather than one per client
  - Minimizes TCP connections to IOCs
  - vxWorks has open file limit
- Read access from clients is answered from data cache
  - No network traffic for read requests
  - IOC sends monitor events only to the gateway
- CA connection is held open by PV gateway after last client disconnects
  - Time is configurable

What is a PV Gateway Good For

- Getting CA clients on one network to connect to CA servers on another network
  - Typically host computer has two Ethernet interfaces on different subnets
- Aliasing PV names from the real PV name
  - Host computer may have multiple subnets connected or not
  - May use the internal loopback
- Adding CA security or another level of security
  - Add Channel Access security
  - Second level if IOC already has CA security running
- CA Put logging
  - Can see who changes a PV and from where change was made

Recap

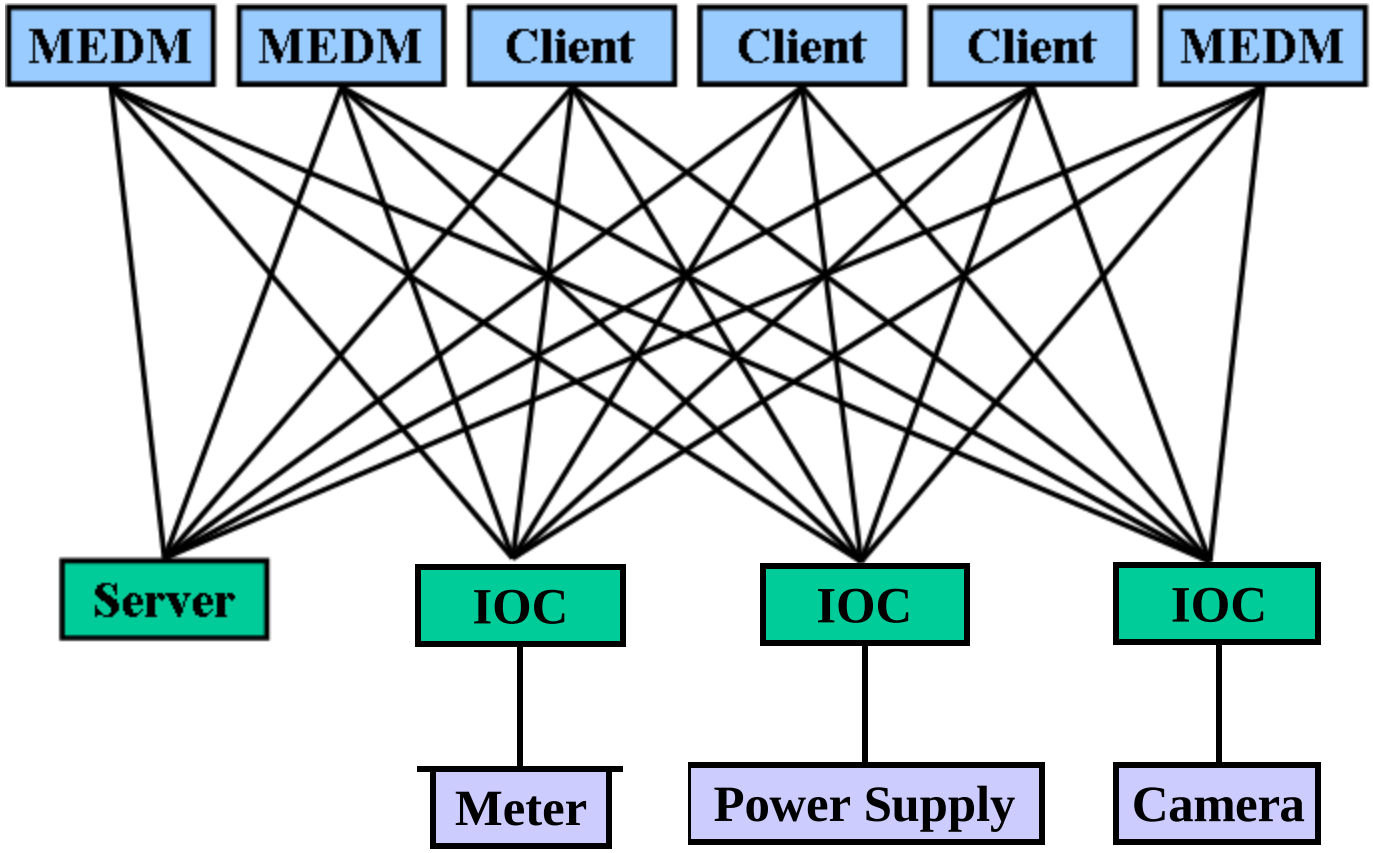
- Both a CA server and CA client
  - Allowing many CA clients to connect to a EPICS PV while making only one connection to remote server



- Connections across subnets
  - Such as from an office network to a machine network
- Additional access security
  - Can provide access security or can be used without it
- Can provide PV name aliasing
  - An alias can be provided for a real PV name

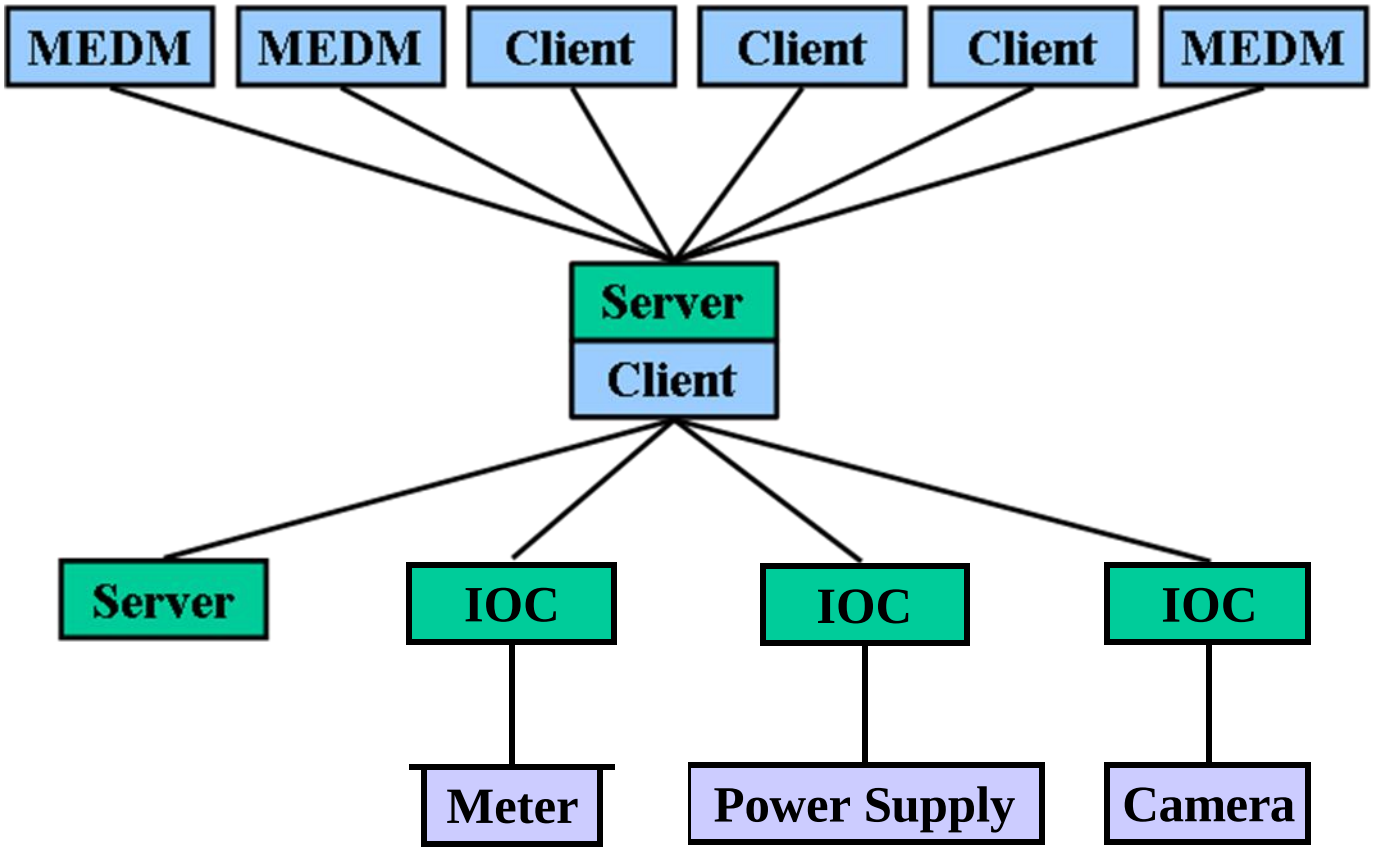
Recap

- No PV gateway running
  - Many CA connections to each IOC



Recap

- With PV Gateway running
  - Only one CA connection to each IOC



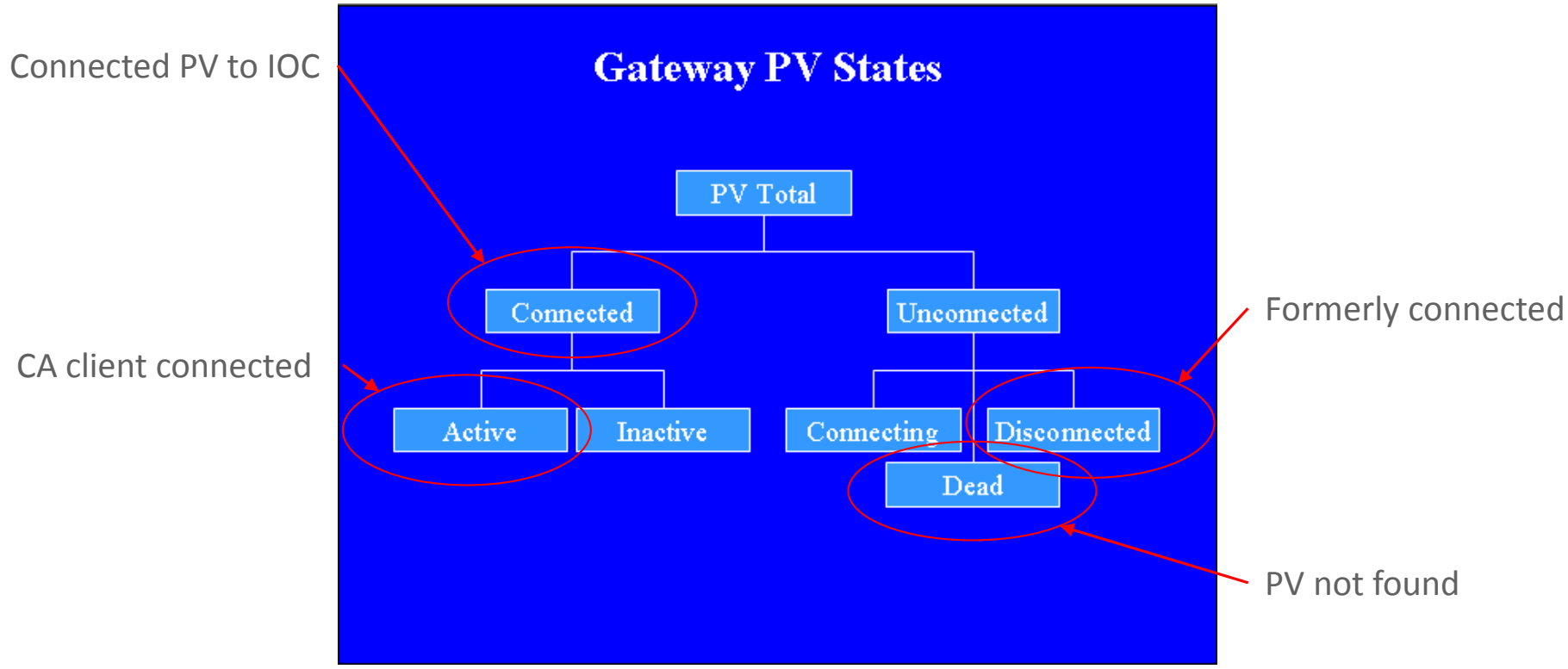
Features

- Runs on Linux and Windows (Only Linux used at APS)
- Extensive diagnostics via internal EPICS PVs
  - These can only be seen from the server side of PV gateway
- CA put logging to a file
- Can be monitored and controlled remotely
- APS PV gateways running version 2.0.4.0
  - Newer version available 2.0.6.0
- Can optionally be built with a heartbeat PV

Updated PV Gateway 2.0.6.0

- Corrected CA Put logging
- Now builds against base 3.15.1
- Fixed Windows builds
- Support for Perl Compatible Regular Expressions
- Fixed crashes when forwarding empty arrays
- Now uses variable length arrays for CA client side subscriptions

Remote Administration



- Internal PV Gateway PVs

Remote Administration (Monitoring)

Sector:	Alive:	Active:	Inactive:	Dead:	Total VC:	Total PV:	Client Rate:	Post Rate:	Exist Rate:	Loop Rate:	CPU Load:	Server Post:	Server Event:	Gateway:
1	37	22	15	0	22	37	7.60	7.60	0.00	54.60	0.00	15.90	15.90	431
2	181	166	15	1	166	182	40.60	40.60	3.20	63.80	0.01	236.59	236.59	
3	89	74	15	0	74	89	7.00	7.00	0.00	54.90	0.00	21.90	21.90	
4	156	141	15	0	141	156	13.80	9.80	0.00	55.10	0.00	56.90	56.90	

- Client event rate: Rate in Hz at which client events are happening
  - IOC related
- Client Post Rate: Rate in Hz at which events are posted from VC to CAS
  - Events posted to MEDM and other CA clients
- Exist Test Rate: Rate in Hz at which the gateway receives search requests
  - High or persistent non-zero numbers may indicate non-existent PV searches
- Loop Rate: Rate in Hz at which the gateway executes the main loop
  - Should always be above 10
- CPU Load: Fraction of available CPU time used by gateway process
- Server Post Rate: Rate in Hz at which events are posted to CAS
- Server Event Rate: Rate in Hz at which CAS processes events

Remote Administration (Control)

- Virtual Connection Report (VC)
  - Report of all CA client connections to all EPICS PVs
- Process Variable Report (PV)
  - Report of all PVs grouped by state
- Access Security Report (AS)
  - Report of all allowed and denied PVs from pvlist file
- Stop Gateway
  - Stops the current gateway process using internal gateway PV
- Edit, View, and Start
  - These are commands connected to a MEDM shell script button

Remote Administration (Control)

- Edit and View controls on MEDM
  - Command to open and editor running in a x-terminal
  - Can be used for access security, pvlist, putlog, or any file
- Start command button

ssh <gateway_user>@host /usr/bin/xterm –e path_to_startup_script>

- Start command button
  - Uses special script which causes xterm to wait for input before closing
- Re-load access security (LOAD)
  - Button to reload the access security files gateway.access and gateway.pvlist without re-starting gateway process

Getting Started

- Necessary files
  - Pvlist – List of regular expression patterns to match
  - Access Security – Access security file to be used
  - Command – List of commands for gateway kill signal
  - gateway.starter – Shell script to start the PV gateway
    - For this I use a soft link to the executable code; you can use command line
- When started PV gateway produced files
  - Putlog – Filename specified on command line, must use access security and have a WRITE, TRAPWRITE rule defined
  - Log file – Filename specified on command line
  - gateway.reserve – Used to reserve a system file descriptor
  - gateway.killer – Shell script when run stops the gateway process
  - gateway.restart – Shell script can be run to restart gateway process

Typical Command Line Options

- -log <filename> - Specifies file name for log file
- -putlog <filename> - Specifies filename for CA put log file
- -prefix <string> - Sets the prefix for gateway internal PVs
- -cip <ip-address-list> - List of IP addresses gateway client uses to find real PVs
  - Sets the environment variables EPICS_CA_AUTO_LIST=NO and EPICS_CA_ADDR_LIST
- -sip <ip-address> - IP address where gateway listens for CA requests coming from CA clients
- -home <directory> - Directory where gateway writes output files and reads input files
- -server – Starts gateway in server mode with daemon to watch gateway process, starts a new gateway if process dies

PV Gateway Command Line

- With all options command line can be long

gateway -log gateway.log –putlog gateway.putlog –signore IP_Addr -prefix “MyGW:" -cip “Net_Broadcast" -sip “Eth_Interface" -home /home/server/MLS/gateway/hog -uid 265 –server

- Because of this at APS we use a script (Covered later)

Minimum Access Security File

UAG(GatewayAdmin) {<gateway_process_user_name>}

```
ASG(DEFAULT) {
  RULE(1,READ)
}
ASG(GatewayAdmin) {
  RULE(1,READ)
  RULE(1,WRITE,TRAPWRITE){
    UAG(GatewayAdmin)
  }
}
```

- UAG – User Access Group
- ASG – Access Security Group

Allows everyone read access to all PVs where the ASG field is not defined

Allows everyone read access to all PVs where the ASG field is GatewayAdmin

Allows everyone in UAG GatewayAdmin write access to PVs where ASG field is GatewayAdmin

Minimum Pvlist File

```
#Allow rules override deny rules
EVALUATION ORDER DENY, ALLOW
.*              ALLOW
<Your_PV_Match_Pattern>.*              ALLOW
<gateway_Prefix>:.*             ALLOW
<gateway_Prefix>:.*Flag         ALLOW   GatewayAdmin 1
```

- Must have most general rules at the top of file
- Can be used to alias PV names by having something like:
  - PVprefix:MyPv.* ALIAS NewPVname.* ASG ASL
    - Where ASG is the access security group and ASL is access security level

Command File Contents

```
# R1 - generate a complete PV report to log file
# R2 - generate a PV summary report to log file
# R3 - generate an access security report to log file
# AS - reread the access security file
R1
#R2
R3
AS
```

- The uncommented ones shown here (R1, R3, AS) will be the actions performed when using the kill –USR1 from gateway.killer file
- gateway.killer file excerpt

```
# use the following to execute commands in command file:
#    kill -USR1 some_system_PID
```

Gateway Startup Script

```
#!/bin/sh
# Get the host machine name
MACHINE=`uname -n | awk -F. '{print $1}'`
DIR=aliasgw
HOME_DIR=/home/phoebus/MLS/gateway/$DIR/$MACHINE
# PV prefix for internal gateway PVs to monitor health and status
PREFIX="GW:ALIAS"
# Gateway Server IP address (Typically Ethernet interface IP)
SIP="164.54.8.33:5064"
# Gateway client IP address (Typically broadcast IP for SIP above)
CIP="164.54.11.255"
# List hosts to ignore requests from
IGNORE="-signore 164.54.8.33"
# Name the gateway putlog file for using TRAPWRITE
PUTLOG="-putlog gateway.putlog"
```

Gateway Startup Script (continued)

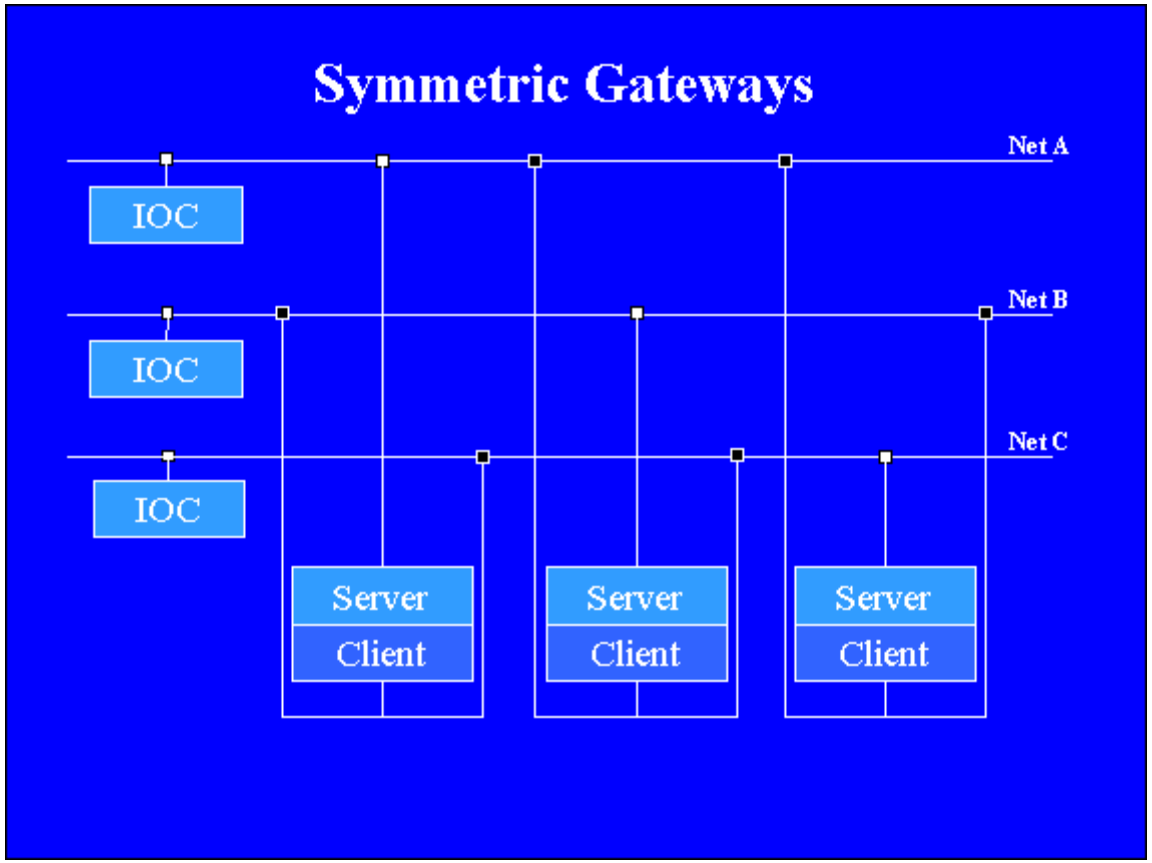
```
cd $HOME_DIR
# Check to see if gateway process is already running
TEST=` ps -ef | awk ' /pvaliasgw/ ' | wc -l `

if [ $TEST -lt 2 ]
then
        if [ -f $GATEWAY ]
        then
                echo "Starting EPICS CA gateway $PREFIX on $MACHINE"
                $GATEWAY -log gateway.log $PUTLOG $IGNORE -prefix "$PREFIX" -cip "$CIP" -sip "$SIP"
-home $HOME_DIR -uid 265 -server;
        else
                echo "Executable file $GATEWAY does not exist"
 fi
else
        echo "EPICS CA gateway $PREFIX Already Running on $MACHINE"
fi
```

Directory Structure Used at APS

- Keep all files in a gateway directory someplace
- Within the gateway directory keep a versions directory
  - Keep different executable versions here if needed
- Within the gateway directory make a directory for each gateway that you will run
  - This will help you to keep things straight
- Within each of the gateway/gateway_name directories make a soft link back to the versions directory executable you will run
  - This way you can point your link to different versions of code

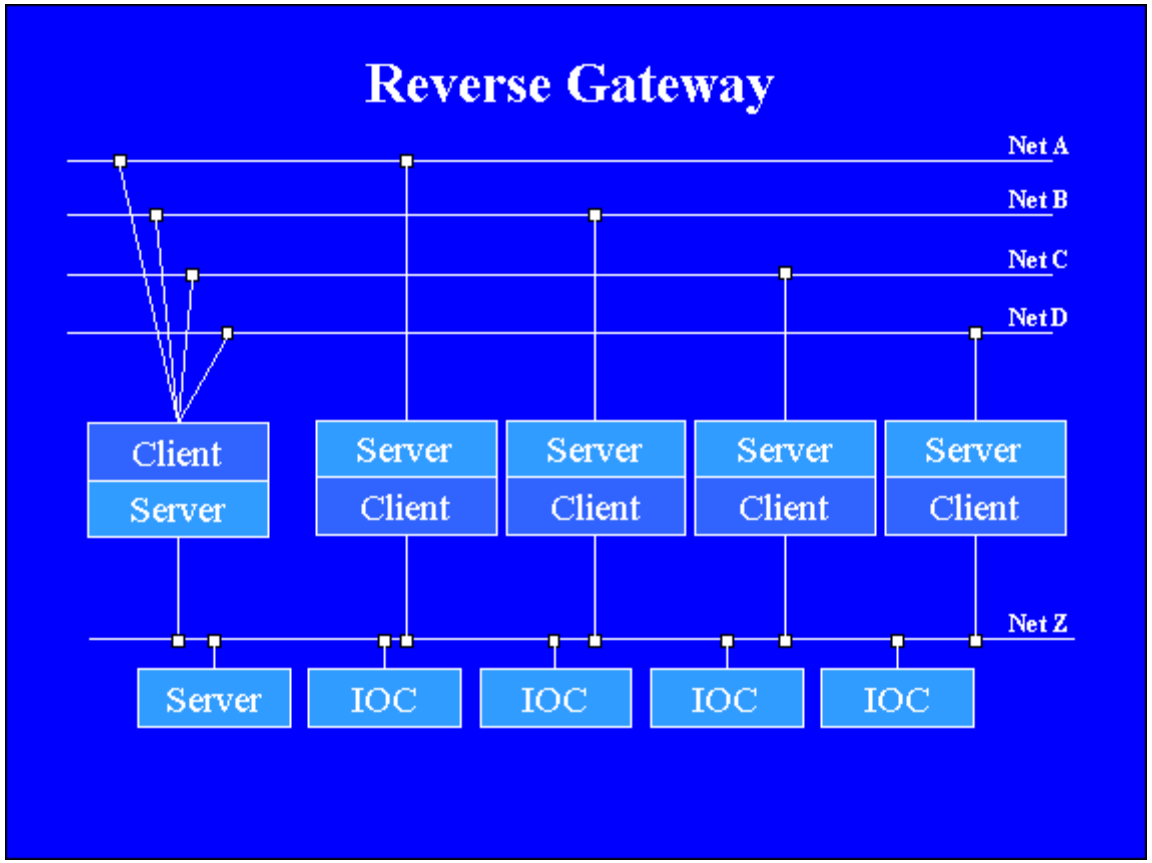
PV Gateway Configurations

Gateway for Net A has direct access to Nets B & C and the gateways
To prevent CA loops use –signore command line option
-signore “GW:NetB GW:NetC”



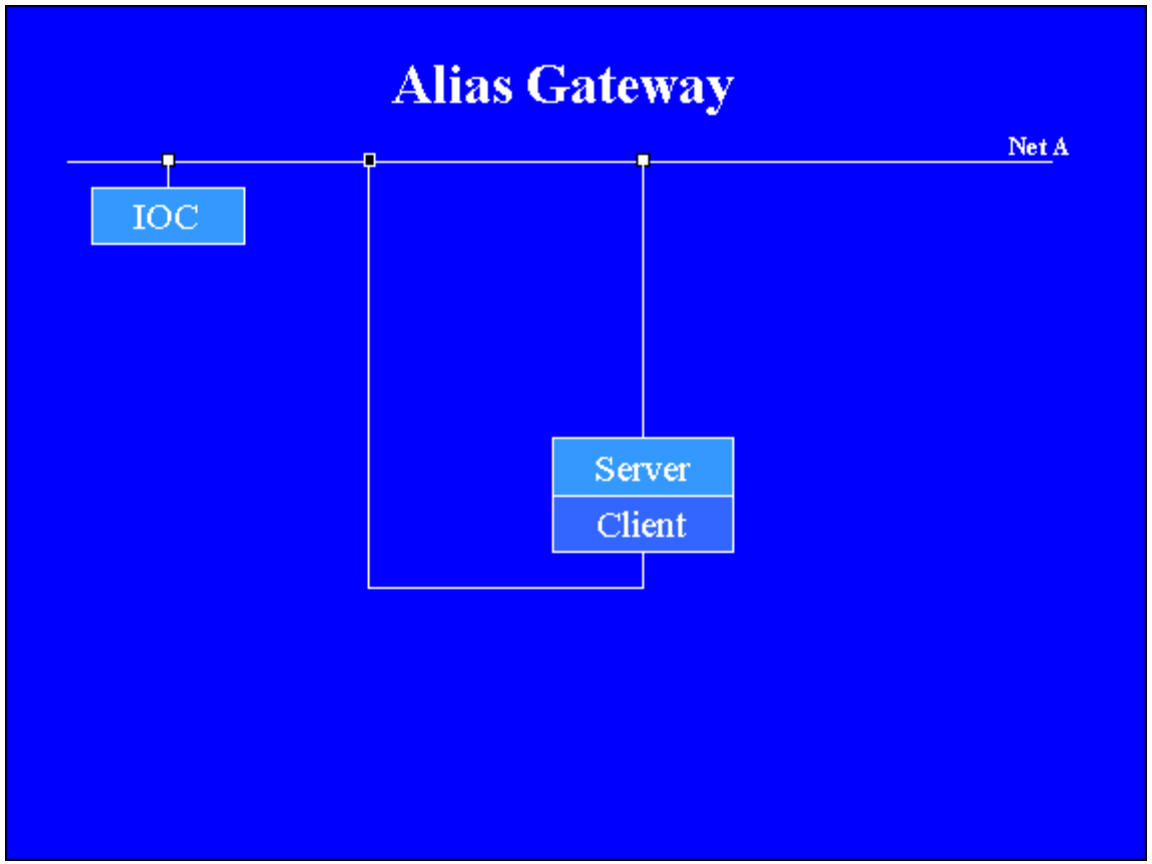
PV Gateway Configurations

APS configuration
Each of four gateways get PVs from Net Z
Internal gateway PVs can only be seen from server side, reverse gateway provides monitor to other gateway internal PVs



PV Gateway Configurations

Single network gateway used for aliasing PVs



References

- User Manual
  - http://www.aps.anl.gov/epics/EpicsDocumentation/ExtensionsManuals/Gateway/Gateway.html
- Other References
  - http://www.tarla.org.tr/epics/www.aps.anl.gov/epics/extensions/gateway/index.php

Questions