PI System Tuning and Optimization

Presented By

Jay Lakumb, Product Manager
jlakumb@osisoft.com

Denis Vacher, Development Lead
dvacher@osisoft.com
Agenda

• Types of PI Systems
  – Hardware, Virtualization, and Critical Resources
• PI Archive Performance
  – Exception & Compression: Myths and Mistakes
  – Archive Sizing and Reprocessing
  – Demo
• Performance Monitoring Tips
• Real World Scenarios
• Optimization Techniques
  – General, Interfaces, Servers, Data Access, Clients
• Point and Asset Count (S, M, L, XL, XXL)
  – 10K, 50K, 250K, 750K, 3M+
• Data Rates
  – Common R:W ratios are > 5:1
  – Heavy read workloads, e.g. central datamart
  – Write-only systems (flight recorder), e.g. WAMS/Phasors
• Concurrent Users
  – Ranging from 1 to 10,000
  – Dashboards/reports versus heavy-duty analytics/BI
• Server Applications
  – Batch, Performance Equations, Totalizer/Alarm
  – ACE, Notifications, MCN Health/IT Monitor
  – PI-to-PI Replication
Hardware Recommendations

- 64-bit platform, Windows 2008 R2 recommended
- Memory: 2GB minimum, up to 8KB per point
- CPU: as many cores as possible, based on client load
- Network: dedicated NIC(s), latency is most important
- Disk Controllers/Interface: key factors are I/O capacity and latency over bandwidth
- Storage: could be multi-tier, est. 5-20 bytes per event
- HA: PI Collectives mix up well with virtualization*

(*) assuming different hardware hosts per collective member
PI Server Virtualization

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PI Archive Performance Tuning

New Value from PI Interface → Exception Testing → Snapshot Table → Swinging Door Compression → Archive Files

Graphs showing temperature over time with points labeled A, B, C, and D, and lines indicating trends.
Efficient Signal Processing

1. Raw Values
2. After Exception
3. After Compression
Exception & Compression

• Exception Processing (PI Interfaces)
  1. Eliminates Instrument Noise
  2. Conserves Network Bandwidth
  3. Conserves Server Resources

• Real-time Compression (Buffer/Snapshot Subsystems)
  1. Eliminates Process Noise
  2. Conserves Disk & I/O Resources
  3. Increases Overall System Performance

• High Fidelity & Efficiency
  ✓ No Signal Averaging or Approximation
  ✓ Preservation of all Minima/Maxima
  ✓ No Additional Signal Latency
Demo

• Benefits of Exception/Compression Tuning
Basic PI Server Tuning

- **Security – Auditing**
  - Authentication Protocols: Server_AuthenticationPolicy
  - Administrative PI Trusts: AutoTrustConfig (recommended: 0)
  - Audit Trail: EnableAudit

- **Archive/Queue Management**
  - Auto Archive Creation: Archive_AutoArchiveFileRoot
  - Event Queue Settings: Snapshot_EventQueuePath, Snapshot_EventQueueSize (MB)

- **Network Connections**
  - Stale Connection: MaxConnIdleTime (seconds)

- **Updates**
  - Don’t Change These: MaxUpdateQueue, TotalUpdateQueue
Archive File Sizing

• Fixed Size or Dynamic?
  – Fixed size, with “auto-dynamic” growth
    (Note: Fixed size required for automatic archive creation.)
  – Keep dynamic archives for backfilling jobs only
  – See KB Article # 2998OSI8

• Sizing Rule of Thumb
  – Size in MB \geq 4,000 \times \text{(Point Count)}
  – For instance: 50,000 points \Rightarrow 200MB

• Optimal Sizing
  – No points with more than \sim10 index records
Archive File Contents

Primary Records

Overflow Records

Time

* -2h
File System Cache Efficiency?
After Archive Reprocessing
PI Server “KPIs”

Where PI geeks meet...
## Windows Counters

- **Core Process Health**
  - Process(...)\Creating Process ID
  - Process(...)\%Processor Time
  - Process(...)\Private Bytes
  - Process(...)\Working Set
  - Process(...)\Page Faults/sec
  - Thread(...)\ID Process
  - Thread(...)\Context Switches/sec

- **Overall CPU**
  - Processor\% Processor Time

- **Overall Memory**
  - Memory\Pages/sec
  - Memory\%Committed Bytes In Use
  - Memory\System Cache Resident Bytes

- **Overall Disk**
  - PhysicalDisk(...)\Avg. Disk Queue Length
  - PhysicalDisk(...)\Disk Transfers/sec

- **Overall Network**
  - Network Interface(...)\Bytes Total/sec
  - Network Interface(...)\Packets Received Errors

## PI Server Counters

- **General Health**
  - PI Server Statistics(...)\Is Available
  - PI Server Statistics(...)\Is In Sync
  - PI Network Manager(_Total)\Connections
  - PI Network Manager(...)\Bytes Received/sec
  - PI Network Manager(...)\Bytes Sent/sec

- **Core Subsystem Health**
  - PI Subsystem Statistics(...)\RPC Request in Queue
  - PI Subsystem Statistics(...)\RPC Thread Active
  - PI Subsystem Statistics(...)\Transaction Completed/sec
  - PI Session Statistics(...)\Messages Received/sec
  - PI Session Statistics(...)\Messages Sent/sec

- **Data Flow Monitoring**
  - PI Snapshot Subsystem\Snapshots/sec
  - PI Snapshot Subsystem\OutOfOrderSnapshots/sec
  - PI Snapshot Subsystem\Queued Events/sec
  - PI Snapshot Subsystem\Events in Overflow Queues
  - PI Archive Subsystem\Archived Events/sec
  - PI Archive Subsystem\Total Unflushed Events
  - PI Archive Subsystem\Cache Flush Operations/sec
  - PI Archive Subsystem\Events Read/sec
  - PI Archive Subsystem\Current Cache Record Pool
PI Archive Tuning

- **Plarchss_ThreadCount**
- **Archive_CacheRecordPool**
- **Archive_SecondsBetweenFlush**
- **ArcMaxCollect**

Size of the subsystem message thread pool. Message threads are dedicated to RPC request processing. Depending on the number of processors on the machine, this value may be increased so more RPC requests can be handled simultaneously. If all the threads are busy, RPCs are queued up and processed in chronological order. The subsystem limits CDM Connector RPC request processing threads (called pending CC threads) to maximum of half of this number.
Plarchss_ThreadCount

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Windows Counters

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  - Process(...)
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  - Working Set
  - Process(...)
  - Page Faults/sec
  - Thread(...)
  - ID Process
  - Thread(...)
  - Context Switches/sec

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  - PhysicalDisk(...)
  - Avg. Disk Queue Length
  - PhysicalDisk(...)
  - Disk Transfers/sec

- **Overall Network**
  - Network Interface(...)
  - Bytes Total/sec
  - Network Interface(...)
  - Packets Received Errors

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PI Server Counters

- **General Health**
  - PI Server Statistics(...)
  - Is Available
  - PI Server Statistics(...)
  - Is In Sync
  - PI Network Manager(...)
  - Connections
  - PI Network Manager(...)
  - Bytes Received/sec
  - PI Network Manager(...)
  - Bytes Sent/sec

- **Core Subsystem Health**
  - PI Subsystem Statistics(...)
  - RPC Request in Queue
  - PI Subsystem Statistics(...)
  - RPC Thread Active
  - PI Subsystem Statistics(...)
  - Transaction Completed/sec
  - PI Session Statistics(...)
  - Messages Received/sec
  - PI Session Statistics(...)
  - Messages Sent/sec

- **Data Flow Monitoring**
  - PI Snapshot Subsystem
  - Snapshots/sec
  - PI Snapshot Subsystem
  - OutOfOrderSnapshots/sec
  - PI Snapshot Subsystem
  - Queued Events/sec
  - PI Snapshot Subsystem
  - Events in Overflow Queues
  - PI Archive Subsystem
  - Archived Events/sec
  - PI Archive Subsystem
  - Total Unflushed Events
  - PI Archive Subsystem
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  - PI Archive Subsystem
  - Events Read/sec
  - PI Archive Subsystem
  - Current Cache Record Pool
Windows Counters

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  - Process(...)
  - Process(...)
  - Process(...)
  - Process(...)
  - Process(...)
  - Process(...)
  - Thread(...)
  - Thread(...)

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- **Overall Memory**
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  - Memory\System Cache Resident Bytes

- **Overall Disk**
  - PhysicalDisk(...)

- **Overall Network**
  - Network Interface(...)

PI Server Counters

- **General Health**
  - PI Server Statistics(...)
  - PI Server Statistics(...)
  - PI Network Manager(...)
  - PI Network Manager(...)

- **Core Subsystem Health**
  - PI Subsystem Statistics(...)
  - PI Subsystem Statistics(...)
  - PI Session Statistics(...)
  - PI Session Statistics(...)

- **Data Flow Monitoring**
  - PI Snapshot Subsystem
  - PI Snapshot Subsystem
  - PI Archive Subsystem

Where PI geeks meet…

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ArcMaxCollect

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Where PI geeks meet…

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Satellite or WAN Connection

Add HA Web Parts
Or Smaller PI Server

Use PI WebParts (updates, caching, connection pooling)
Geographical Distribution

Where PI geeks meet...

Add Terminal Server (app virtualization)
Or PI WebParts Server
Collect Large Volumes of Data

Where PI geeks meet…

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Data

PI Interface

Poll interval
Or Advise (OPC)

Buffering (choose pibufss)

PI for StreamInsight
(edge processing)

Exception and compression

Use high speed drives
(e.g. SAN, SSD)
Access Large Volumes of Data

High speed drives (e.g. SAN, SSD)  PE, Totalizer tags (data aggreg.)

Scale out analytics and data access

HA PI Secondary (load distribution)

PI SDK techniques (e.g. PlotValues)

PI for StreamInsight (edge processing)
Optimization Techniques: General

- Ensure system/virtual machine is sized appropriately
  - “Hardware and System Sizing Recommendations” spreadsheet on Tech Support site
- Disable unused services, e.g. IIS, Indexing, etc. or use Windows Server Core
- Clamp or prevent expensive queries
- Provide sufficient network bandwidth
- Choose an optimal deployment configuration
- Upgrade to latest releases of PI and Microsoft products
- Leverage High Availability (PI/AF/Notif, Interface failover, SharePoint server farms, etc.) to achieve higher uptime
Optimization Techniques: Interfaces

- KB #00266 – “When using the PI to PI interface, is it better to push or pull the data?”
- Scale out (multiple instances) to handle more/faster data
- Use Buffering to minimize data loss
- Configure disconnected startup
- Choose appropriate scan times
- Separate instances for different scan times, output points
- Check for Stale or Bad points
- KB #00260 – “How does the number of Advise tags per group in OPC interface affect throughput?”
Optimization Techniques: Servers

- “PI Server Performance Monitoring” White Paper on TS site
- KB #00159 – “What is the Offline Archive Utility (piarchss) and how do you use it to reprocess archives?”
- Apply multiple conditions to each notification (not 1:1)
- Increase periodic time rule (ACE, PINotifications), or try natural scheduling (uses snapshot caching)
- Minimize number of COM Connector tags
- Aggregate data (using PE or Totalizer tags)
- Scale out (PI, AF, PE, ACE, Notifications) to handle more users/queries with High Availability functionality
- Separate heavy and casual users with HA functionality
Optimization Techniques: Data Access

- “SQL Optimization” White Paper on TS site
- Use PI OLEDB and PI OLEDB Enterprise as in-process
- Break queries into smaller chunks (e.g. fewer tags/assets, shorter time ranges)
- Builder’s Café Webinar on “Optimizing your PI SDK apps”
- Use bulk queries (e.g. PI SDK ListData functions, AF SDK elements), PlotValues, asynchronous calls, multithreading
- Choose appropriate binding for PI Web Services
- Leverage PI Data Access products that implement (and abstract) advanced techniques such as connection pooling, caching, and event pipes (e.g. PI Web Services)
Optimization Techniques: Clients

• Move PI Calc/ODBC datasets to server (PE, AF, ACE)
• Minimize data loaded/displayed on startup – use drill down for more details
• Split large amount of data across multiple displays/pages
• Try HTTP Compression with PI WebParts
• Use SharePoint server farms, load balancing with WP
• Increase update interval (PB, DL, WP)
• Run PI Clients as close to data sources as possible – leverage application virtualization
Thank You!