Milestone Certified Solution

Pivot3 Surveillance Series

Date Certified: August 2018

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About Pivot3

Pivot3 is a global leader in providing modern infrastructure solutions for video surveillance, security, IoT, and safe/smart city environments. Pivot3's Surveillance Series enables organizations to consolidate data storage, video management, access control and other related security applications onto a single, all-in-one IT infrastructure that delivers the performance, resiliency and scalability required by modern surveillance technologies. This new approach, called hyperconverged infrastructure (HCI), combines server and storage resources into modular, scalable appliances that provide advanced resiliency capabilities, so organizations can store video data without loss, protect their data during failure events, and ensure their data is always available when and where it is needed. And with its simple, single-pane-of-glass management, designed for ease of use by non-technical personnel, Pivot3 reduces IT complexity so organizations can focus on their business. Visit www.pivot3.com for more.

About Milestone Systems

Milestone Systems is a global leader in providing open platform IP video surveillance software. Milestone has provided easy-to-use, powerful video management software in more than 150,000 installations, worldwide.

Milestone XProtect® provides open architecture products that are compatible with more IP cameras, encoders, and digital video recorders than any other manufacturer. Because Milestone provides an open platform, you can integrate today's best business solutions and expand what's possible with future innovations. Visit www.milestonesys.com for more.

Executive Summary

The Milestone Technology Partner (MTP) Certification program seeks to confirm that server, storage, and network solutions provided by qualified MTP vendors meet the performance benchmarks required to support the Milestone XProtect® VMS applications, and to measure the maximum performance available to Milestone customers if they choose to build a solution using certified MTP products. MTP certification efforts include building a test surveillance system, gathering performance data while the system is in operation at the benchmark levels, and capacity testing to determine the upper limits of performance. Certification of Pivot3's Surveillance Series will ensure that any surveillance system built using this product in combination with the Milestone XProtect® components will be able to record and archive an amount of video consistent with the recommendations of Pivot3 and Milestone.

This report highlights the performance results of certification tests performed using an example configuration of Pivot3's Surveillance Series hyperconverged infrastructure (HCI) solution. The Pivot3 HCI solution combines compute and storage resources into a single appliance (node), and Pivot3 software aggregates multiple nodes together to form a single, scalable compute and storage environment. In this testing, a configuration of nodes provided both the storage for the live Milestone database, and CPU and Memory resources for up to 6 Milestone virtual machines (VMs), each running Milestone XProtect Corporate 2018 R2 in a single recording instance configuration.

Certified Products

- Pivot3 Surveillance Series
- Milestone XProtect Corporate 2018 R2[1]

Example Use Cases

Pivot3 Surveillance Series solutions are used by companies globally to provide a modular infrastructure to consolidate data storage and applications including, video management, access control, video analytics, and other related security applications onto a single, all-in-one IT infrastructure.

Pivot3 has customers globally across multiple industries and use cases using the Milestone XProtect Corporate VMS, with several examples listed in detail below.

Transportation & Logistics

Major airports use the Pivot3 Surveillance Series to ensure that mission critical video is protected, and passengers can rest assured that the maximum levels of resilience and safety are maintained in an increasingly complex threat landscape. By providing a high performing, modular infrastructure it becomes possible to deploy advanced analytics without having to invest in additional hardware, with performance being maintained through having the analytics software in close proximity to the video data.

Mass Transit systems covering some of the major cities in the continental USA, dealing with millions of passengers per day, use Pivot3 to protect and store their video surveillance data.

Finally, Pivot3 is used by logistics organizations in the private sector, bringing advanced video surveillance systems to bear to reduce loss prevention and deliver business improvements through use of video data.

Gaming & Hospitality

In the gaming world, Pivot3 has a global presence, including a number of famous brands, delivering a flexible and scalable infrastructure as regulatory demands change, and the reliance on video data becomes ever greater. Pivot3 allows for the protection of direct revenue generating activities, by providing highly resilient infrastructure (up to 6x 9's of availability), ensuring that gaming tables stay open and the house continues to always win.

In hospitality, Pivot3 is used by some of the most iconic and luxury hotel brands and has aided those hotels in moving video surveillance from being a purely safety-led exercise to improving guest experiences and further enhancing the reputation of the hotel.

This customer experience also extends to shopping malls, where Pivot3 has enabled a flexible, modular infrastructure, with highly secure multi-tenancy that has allowed the security departments of some of our customers to not only become cost neutral but become a profit centre through the provisioning of a video surveillance as a service platform. This further serves to reduce the incoming cost for the mall tenants and makes the mall more desirable as a shopping location. The cost savings associated with Pivot3 and Milestone are then able to be re-invested to provide more cutting-edge security solutions and truly drive the malls towards a more customer-centric IoT strategy.

Safe Cities & City Wide IoT Projects

As our world moves towards IoT and Safe/Smart Cities become the norm, Pivot3 enables city leaders to be uniquely placed to adopt a wide-range of Smart City initiatives designing to improve city-wise safety and the quality of life for the denizens of the city.

The ability to ingest large volumes of video (and other IoT) data into a single platform allows advanced analytics to deliver additional services and extra levels of safety, while always ensuring a clear crisp image, operating with zero frame-loss, critical to being able to analyse the incoming data.

State- & Local- Government & Education

Pivot3 plays a critical role in protecting schools, universities and government agencies to ensure safety and security in an ever-increasing threat landscape. By reducing the footprint of the solution, guaranteeing high quality video images and delivering a modular infrastructure, already strained budgets can be stretched to their limits. The simple, single point of management for all video surveillance infrastructure affords the limited personnel in the IT teams a global view of security and reduces management overhead dramatically.

Configuration Details

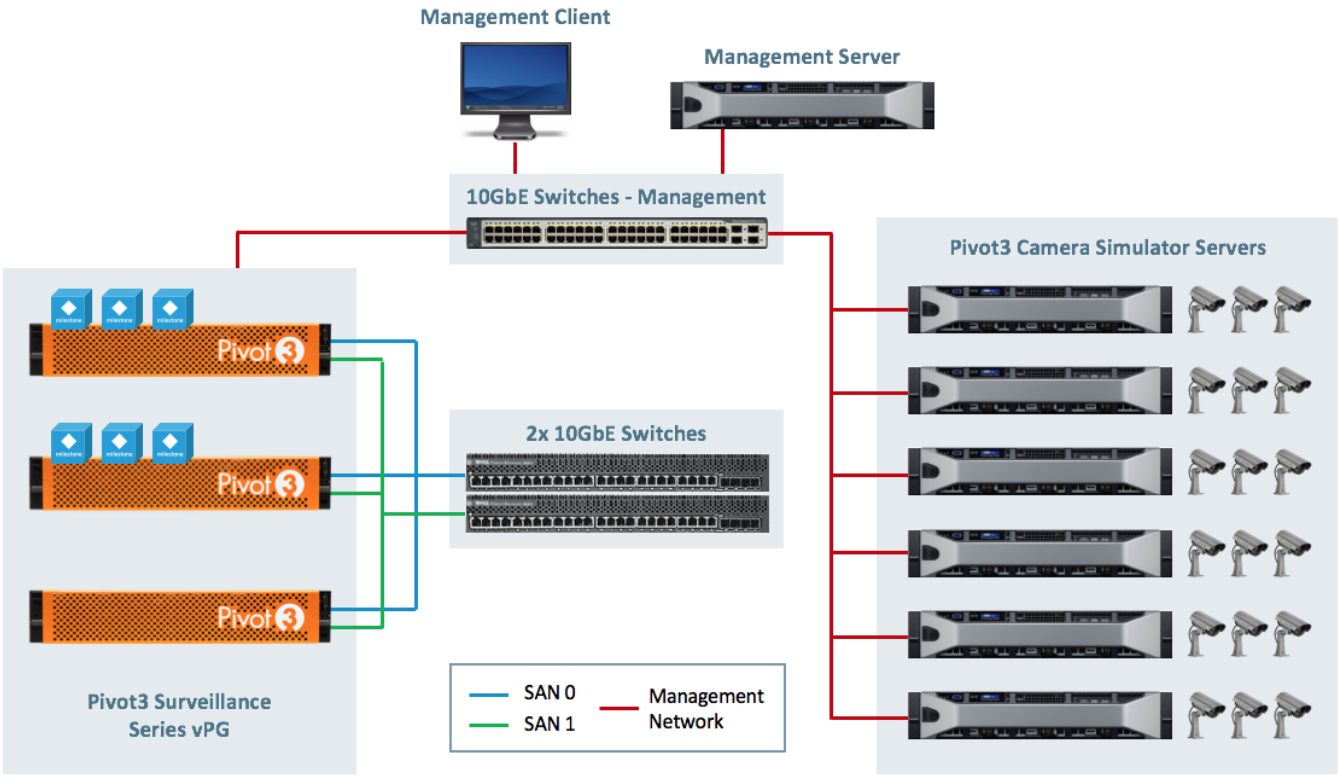
Topology

The testing was conducted at Pivot3's Solutions Engineering Lab located in Houston, Texas. The system topology included:

- One (1) Microsoft Windows x64 based Server 2012 R2 operating system hosting the Milestone XProtect® Corporate 2018 R2 Management Server.
- One (1) Milestone XProtect® Corporate 2018 R2 Management Client running on a separate workstation.

- Three (3) Pivot3 Surveillance Series appliances (nodes) were installed in a 3-node cluster (vPG) hosting six (6) virtual machines running Microsoft Windows x64-based 2012 R2 operating systems, each hosting a single instance of the Milestone XProtect® Corporate 2018 R2 Recording Server.
- Twelve (12) Pivot3 Camera Simulator Virtual Machines' hosted on Microsoft Windows x64 based Server 2012 R2 operating system.

The Pivot3 storage was presented to the Milestone XProtect© Corporate 2018 R2 recording using iSCSI connections through two (2) 10Gbe network interfaces. Pivot3 Surveillance Series nodes use 10Gbe iSCSI interfaces for both the storage controller interfaces and for camera traffic.

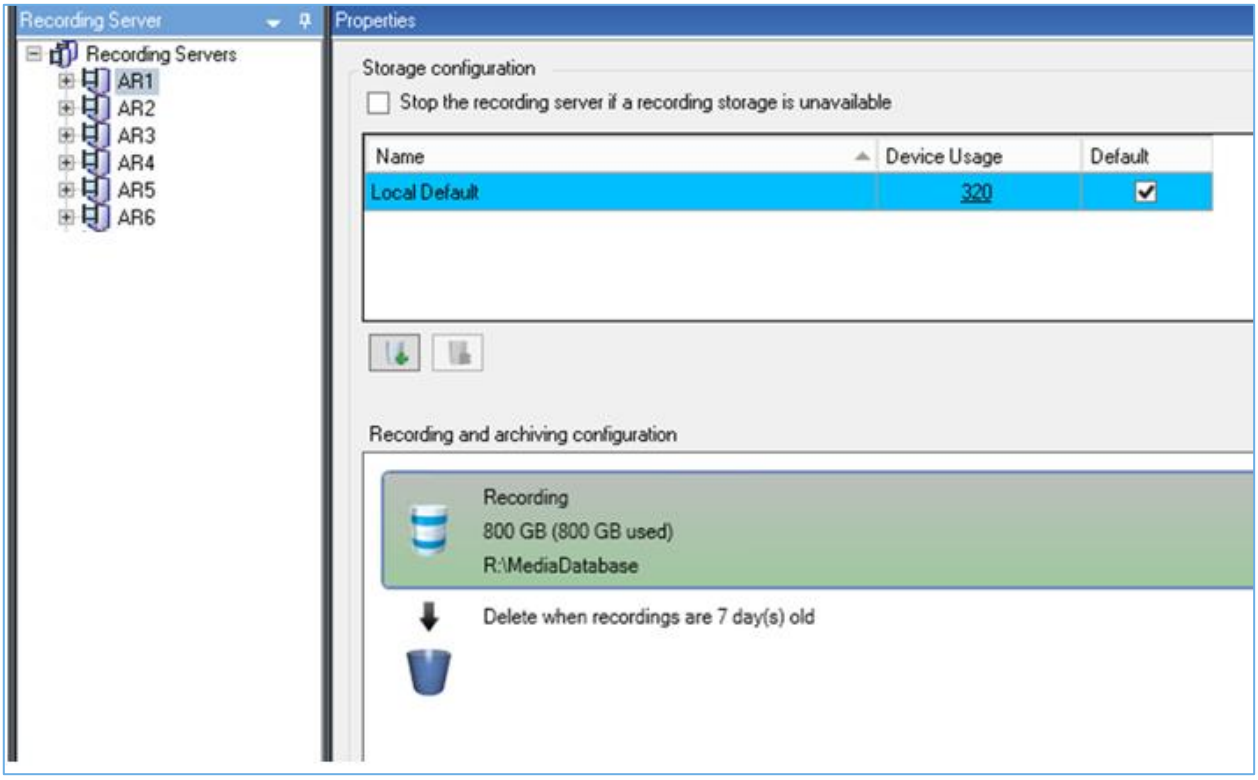


Component	Purpose/Usage
(3) Pivot3 Surveillance Series Nodes	(2) Intel® Xeon® CPU E5-2640 v4 @ 2.40GHz per node
	64GB RAM Base per node
	VMware ESXi 6.0 (build 6921384)
Pivot3 Software Version	vSTAC 7.6.0.0811
Recording Server VM Resource Allocation	
vCPU	1 Socket, 10 vCPU (not reserved)
Memory	14GB (not reserved)
Pivot3 VM Resource Allocation	
vCPU	1 Socket, 10 vCPU (fully reserved)
Memory	16GB (fully reserved)
Software	
Milestone XProtect Corporate 2018 R2	Video surveillance management and recording software
Windows Server 2012 R2 Standard	For virtual machines running recording software
Management	
Pivot3 vSTAC Software Platform version 7.6.0	Physical and logical storage configuration, dynamic expansion, security access, data protection and tier setting by volume
SNMP Alerts	Set traps for physical state changes within the Pivot3 cluster (vPG)
Network Switches	
(2) 10Gbe SAN Switches	Extreme Summit X670 48 Port
(1) 10Gbe Application (CAM) Switch	Dell N4032 24 Port
(1) 1Gbe Management Switch	Cisco Catalyst 3750 24 Port
Pivot3 Camera Simulator	
(12) VMs, Windows Server 2012 R2 running Pivot3 Camera Simulator software.	Virtual Machines, running Windows Server 2012 R2 running (1) Pivot3 Camera Simulator (each) supporting up to 80 streams per camera simulator instance

(12) Virtual machines, each running 1 Pivot3 Camera Simulator provide looped, motion video feed to the Milestone XProtect© Corporate system. In this configuration, video streams are delivered via the IP network to be recorded on the Pivot3 system. Placing the Camera Simulators on physical servers outside the array removes any potential network bottlenecks between cameras and the recording servers themselves as well as unnecessary system resource use on the solution.

Pivot3 System Configuration

Pivot3's management UI is used to create a shared storage pool, create storage volumes and amend various settings. Utilizing Pivot3's patented erasure coding (EC) technology, data is written across all drives, in all nodes within the array and protected from up to five (5) simultaneous drive failures. There are multiple Pivot3 EC levels to choose from, providing choice for data protection levels (EC1, EC3, EC5). EC3, used in this testing, allows three (3) simultaneous drive failures or a full appliance failure and one (1) additional drive failure. Testing configuration comprises six (6) virtual machines, (3 VMs each on 2 of the 3 appliances) running a single instance of the Milestone XProtect® Corporate 2018 R2 Recording software in each VM. The third appliance in the vPG (cluster) contributes its storage, cache and network bandwidth to the systems aggregated pool of resources and functions as a failover node for high availability. Each VM used iSCSI connections to attach recording volumes to the Milestone VMs.



Testing was configured to illustrate Pivot3's performance under the most rigorous conditions. The camera simulators were set to continuous recording at 15 fps using the H.264 Video Codec, with a resolution of 1920 x1080 (1MP, HD) for continuous recording throughout the duration of the testing process (for a total bitrate per camera of 2.3Mbps). 20% of the cameras streams were configured for continuous recording with server-side motion detection for the duration of the testing. The cameras streams configured for motion detection also recorded at 15fps.

Test Plan Summary

Test Process

After installation and configuration of all required system components, the first step in the test was to establish a benchmark performance level against which to measure the performance of the system under data-intensive levels of video recording. Once the benchmark was established, the system remained in operation at this level in-order to completely fill the live video database

The process of tuning the parameters involved manipulating the number of simulated cameras to and from the camera simulator virtual machines. This process used 1920x1080 resolution streams, at a frame rate of 15 fps. H.264 was chosen due to its position as the "standard" codec used in almost all video surveillance solutions.

The performance of the Pivot3 system was monitored while the number of cameras was increased until we reached the pre-defined stop conditions for write latency, CPU consumption, live database recording event duration, or video frame loss. At that point the data load was reduced, and the performance was re-evaluated. If the system operates at the reduced level of data load within acceptable parameters, then a full data capture takes place and the maximum performance of the storage array is defined to be at the observed levels of data and video stream parameters. Acceptable levels of operation are defined according to the following stop criteria:

- Frame loss over 1% indicated by media overflow in the XProtect System Log.
- CPU values over 70% average on any of the Milestone Recording Servers.
- Write latency values higher than 200 ms

In the test scenario 1 below, the XProtect© Corporate 2018 R2 Recording Server, which was recording video to databases located on the Pivot3 Surveillance Series system, was configured to ingest the video from 240 simulated cameras on the recording server; these cameras were all configured for continuous recording.

In the test scenario 2 discussed in this document, the XProtect© Corporate 2018 R2 Recording Server's, which were recording video to databases located on the Pivot3 Surveillance Series system, were configured to record 155 simulated cameras each instance (6) for a total of 930 cameras; these cameras were all configured for continuous recording.

Benchmark / Continuous Recording / Continuous Recording with Motion Detection Scenario

Pivot3's Scale-Out Report was used to determine the benchmark value for the system. The video stream profile was the H.264 codec, 1920x 1080 resolution, 15 fps, 2.3MBps total bitrate per camera. The video stream profile remained identical over all four tests. Motion detection was configured for 20% of the cameras for any given test scenario.

The variables between scenarios were the total number of cameras under test and the distribution of cameras between recorder VM's.

In test scenario 1 there were a total of 240 cameras connected to a single (1) recording server VM with 20% of the 240 (48 total) configured for motion detection.

In test scenario 2 there were a total of 155 cameras connected to each of the recording server VM's (6) with 20% of the 155 (32 total) configured for motion detection. In test scenario 2 this resulted in a total of 930 cameras with 192 configured for motion detection.

Test Scenario 1

Continuous Recording without Motion Detection

Cameras	Codec	Frames/sec	Resolution	Mbps
192	H. 264	15	1920 x 1080	2.3 each

Continuous Recording with Motion Detection

Cameras	Codec	Frames/sec	Resolution	Mbps
48	H. 264	15	1920 x 1080	2.3 each

Test Scenario 1 was to validate the configuration of both the Pivot3 Surveillance Series system and the Milestone XProtect© configurations were valid and performing as expected prior to conducting Test Scenario 2.

The total number of cameras used in the continuous recording and continuous recording with motion test scenario were kept to 240 total cameras (192 without motion detection and 48 with motion detection) in-order to ensure that the system would be operating under a predictable and easily maintained data load.

As previously, the Stop Criteria were Archiving Time, CPU, and Frame-loss.

Performance levels were determined to be at their maximum based on any one of these three factors during each test scenario.

1. If the CPU utilization of the recording servers was measured consistently over 70%,
2. If write latency was observed to be over 200ms
3. If there was repeated frame loss, then the test was stopped.

The Microsoft Performance Monitor was configured to capture 4-hours of data examining the hard disk I/O, and the performance of the virtual servers in-order to measure the performance of the system at maximum data load levels.

The following thresholds were set on data capture on each recording server in each iteration of the test.

- Physical disk average disk sec/read <200ms
- CPU usage (total % processor time) <70%
- 4hr archiving duration
- System logs for Milestone
- Frame loss over 1%

Test Scenario 2

Continuous Recording without Motion Detection

Cameras	Codec	Frames/sec	Resolution	Mbps
738	H. 264	15	1920 x 1080	2.3 each

Continuous Recording with Motion Detection

Cameras	Codec	Frames/sec	Resolution	Mbps
192	H. 264	15	1920 x 1080	2.3 each

The goal of Test Scenario 2 was to validate the maximum performance levels capable with this specific 3 node Pivot3 Surveillance Series configuration with Milestone XProtect© Corporate 2018 R2.

The goal of each maximum performance test was to determine the maximum amount of video data which could be recorded to the system, given this specific configuration.

As previously, the Stop Criteria were Archiving Time, CPU, and Frame-loss.

Performance levels were determined to be at their maximum based on any one of these three factors during each test scenario.

1. If the CPU utilization of the recording servers was measured consistently over 70%,
2. If write latency was observed to be over 200ms
3. If there was repeated frame loss, then the test was stopped.

The Microsoft Performance Monitor was configured to capture 4-hours of data examining the hard disk I/O, and the performance of the virtual servers in-order to measure the performance of the system at maximum data load levels.

The following thresholds were set on data capture on each recording server in each iteration of the test.

- Physical disk average disk sec/read <200 ms
- CPU usage (total % processor time) <80%
- 4hr archiving duration
- System logs for Milestone
- Frame loss over 1%

Test Results

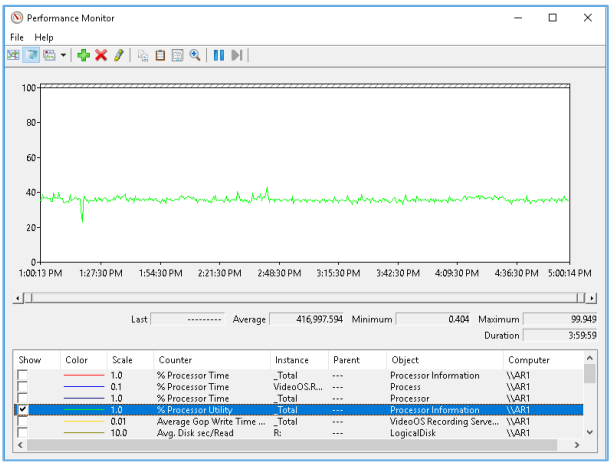
Test Scenario 1 – Configuration Verification Test

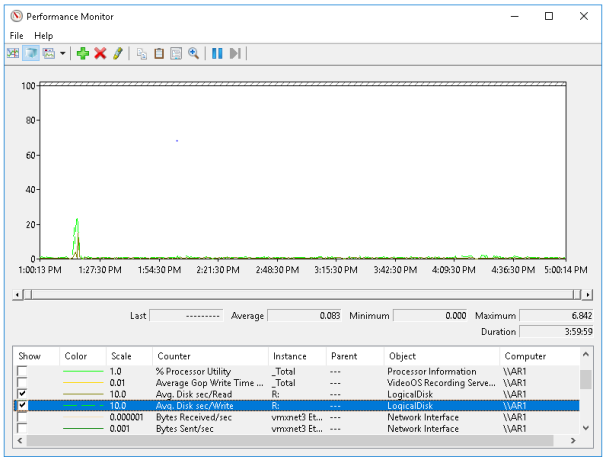
The data load used in the test scenario included the following parameters:

Continuous Recording Test:

- 240 cameras per recording server (1)
- 192 cameras recorded continuously, 48 cameras continuous recording with motion detection
- 1920x1080 resolution
- H.264 video codec
- 15 fps
- 100% recording
- 20% Motion Detection
- Erasure Coding Level 3

Test duration was 4 hours, seen in the screen shots below of the total disk read throughput charted through Performance Monitor (Perfmon). The Perfmon capture also charted the total CPU use for the recording server and has been provided as well. Pivot3 uses its continuous recording results as our benchmark to judge all other testing to include continuous recording with motion detection testing.





Test Scenario 1 Results:

Average Recorder Throughput (I/O)	650 Mbps (81 MB/s)
Average Pivot3 Per Node Storage Throughput (I/O)	648 Mbps (81 MB/s) per node
Average Camera Stream	2.3 Mbps (287 MB/s)
Average Recorder Server CPU Utilization	38.6 %
% Frames Lost	0.0%
Average Disk Latency	{1.0ms Disk Read} {3.9ms Disk Write}

Test duration was 4hrs. for the verification test (test scenario 1) with continuous recording/continuous recording with motion detection set at 20% of the camera streams, 192 cameras recorded continuously while, 48 cameras continuous recording with motion detection at 15 fps on one recorder instance per VM. CPU use and Disk Read numbers were well below the Stop Conditions for testing.

There were no problems noted with frame loss, video latency or CPU utilization caused by the hardware or software integration.

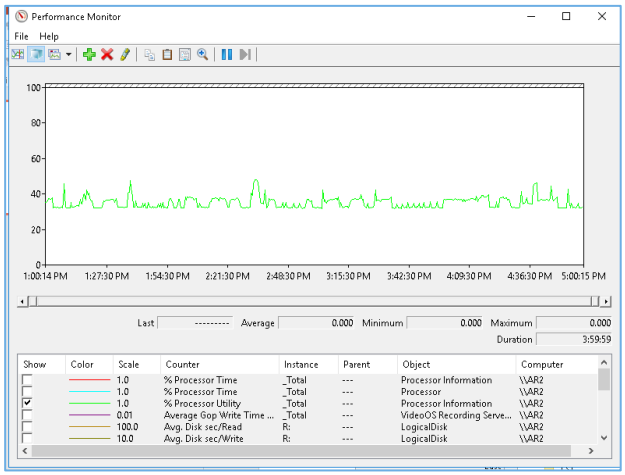
Test Scenario 2 – Maximum Performance Test

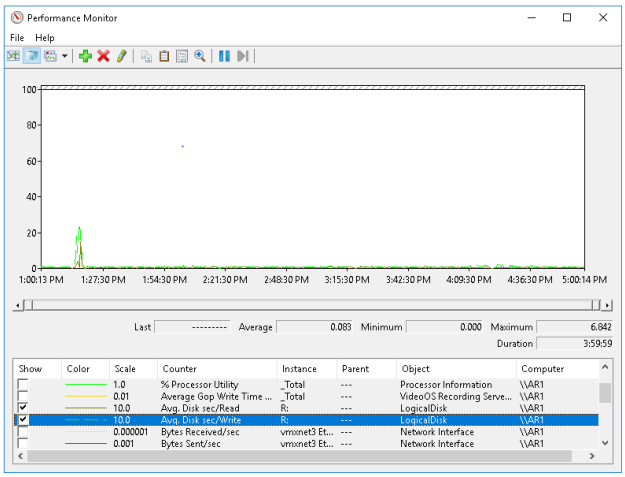
The data load used in the test scenario included the following parameters:

Continuous Test:

- 930 total cameras
- 155 cameras per recording server (155 cameras x 6 recording servers = 930 total)
- 1920x1080 resolution
- H.264 video codec
- 15 fps
- 100% recording
- 20% Motion Detection
- Erasure Coding Level 3

Test duration was 4 hours, seen in the screen shots below of the total disk read throughput charted through Performance Monitor (Perfmon). The Perfmon capture also charted the total CPU use for the recording server and has been provided as well. Pivot3 uses its continuous recording results as our benchmark to judge all other testing to include continuous recording with motion detection testing.





Test Scenario 2 Results:

Average Recorder Throughput (I/O)	350 Mbps (44 MB/s)
Average Pivot3 Per Node Storage Throughput (I/O)	1320 Mbps (306 MB/s) per node
Total System Throughput	2640 Mbps (612 MB/s)
Average Camera Stream	2.3 Mbps (287 MB/s)
Average Recorder Server CPU Utilization	37.4 %
% Frames Lost	0.0%
Average Disk Latency	{5.01ms Disk Read} {8.41.3ms Disk Write}

Test duration was 4 hours. For the Maximum Performance Test (test scenario 2) with continuous recording with motion detection with motion detection set at 20% of the total camera stream, 738 cameras recorded

continuously while, 192 cameras recorded motion at 15 fps for across the (6) recorders. CPU use and Disk Read numbers were well below the Stop Conditions for testing.

There were no problems noted with frame loss, video latency or CPU utilization caused by the hardware or software integration.

Conclusions

As demonstrated by the test results, Pivot3 achieves a high density of cameras per node, while using a low level of CPU resources to deliver the performance required for lossless video at HD quality. It is also worth noting that this is a minimal Pivot3 configuration, and due to the linear scaling capable when you add additional appliances (nodes) to the Pivot3 cluster (vPG), much larger camera counts can be supported in a small footprint to meet the needs of large-scale environments.

Customers can remain assured that Pivot3 and Milestone XProtect© Corporate 2018 R2 will provide a cost-effective, high performance, and resilient video surveillance solution and scale to meet their requirements comfortably, no matter the demands of video system being designed and deployed both Initially and as requirements grow.