NUUO Crystal™ VM Performance Report

Abstract:

This report is intended to provide readers a reference design as well as the resulting performance of NUUO Crystal™ VM. This SKU, consisting of HP DL380p server and EMC VNX 5300 FC-SAN storage, has 8 virtual machines (VM), running at 64 channels for continuous recording mode, 128 channels liveviewing, and 16 channels playback per VM. Our performance test indicates the following performance for 3 days of test span.

- Recording throughput at 2Gbps (250Mbps/VM/volume group) for continuous video inputs,
- Liveview performance at minimal 27fps per channel

Introduction:

NUUO Crystal™ VM is one of the best VMS solutions, ready to be deployed on the virtualization environment. This solution is certified by VMware ready program and also inherits the concept of "One VM, one App", recommended by VMware to mitigate the potential risks of VM crashes. The synergy between NUUO's expertise in video management and VMware's bare-metal management capability can truly provide a "no-single-point of failure" reliability.

Since virtualization is a relatively new concept to the security world, NUUO initiates a SKU design to assist security users better designing their projects. This performance test is aimed to provide solutions of recording of 512 channels, liveview channels of 1,024 channels, and playback channels of 128 channels. The detail system architecture as well as the hardware and software are listed in the following chapter for reader's reference.

A performance testing kit (PTK) is prepared upon reader's request. This kit is for two purposes:

- Validate a new SKU performance
- Validate equipment from different server, switch, or storage manufacturers.

Test Equipment and Software:

This test is conducted with the equipment and software listed below.

Item	Manufacturer/ Model	Relevant specifications
Server	HP/ DL380p	CPU Intel Xeon E5-2695v2 x 2 128GB RAM
Switch	Cisco/ Catalyst 2950	2 x 10Gbps port 24 x 1Gbps port
FC-Switch	HP StorageWorks 8/8 FC-SAN	8Gbps
Storage	EMC VNX 5300	Dual Controller Fiber SAN Storage

Table 1: Performance Test Equipment List

Item	Manufacturer/ SW name/ OS	Version Info
Recording Server	NUUO Inc./ NUUO Crystal™ VM/ Linux	V2.1
Hypervisor	VMware Inc./ vSphere/ Linux	V5.5
Liveview Client	NUUO Inc./ NuClient/ Windows	V2.1
Playback Client	NUUO Inc./ Virtual Client/ Linux	V1.0
Virtual Camera	NUUO Inc./ Virtual CAM/ Linux	V1.1

Table 2: Performance Test Software List

NUUO Inc. (Taiwan Headquarters)
B1, No.207-1, Sec. 3, Beixin Rd., Xindian Dist., New Taipei City 231, Taiwan
Tel : +886-2-7739-2260 Fax : +886-2-7703-3377

NUUO US Inc.
690 N. Berry Street, Suite B, Brea, California 92821, USA
Toll Free: +1-877-241-7035 Fax: +1-714-990-1689

NUUO South Africa Office
Fancourt Office Park, Building 7, 1st Floor Right., Cnr Felstead & Northumberland, Northriding, South Africa
Tel: +27-11-704-6845

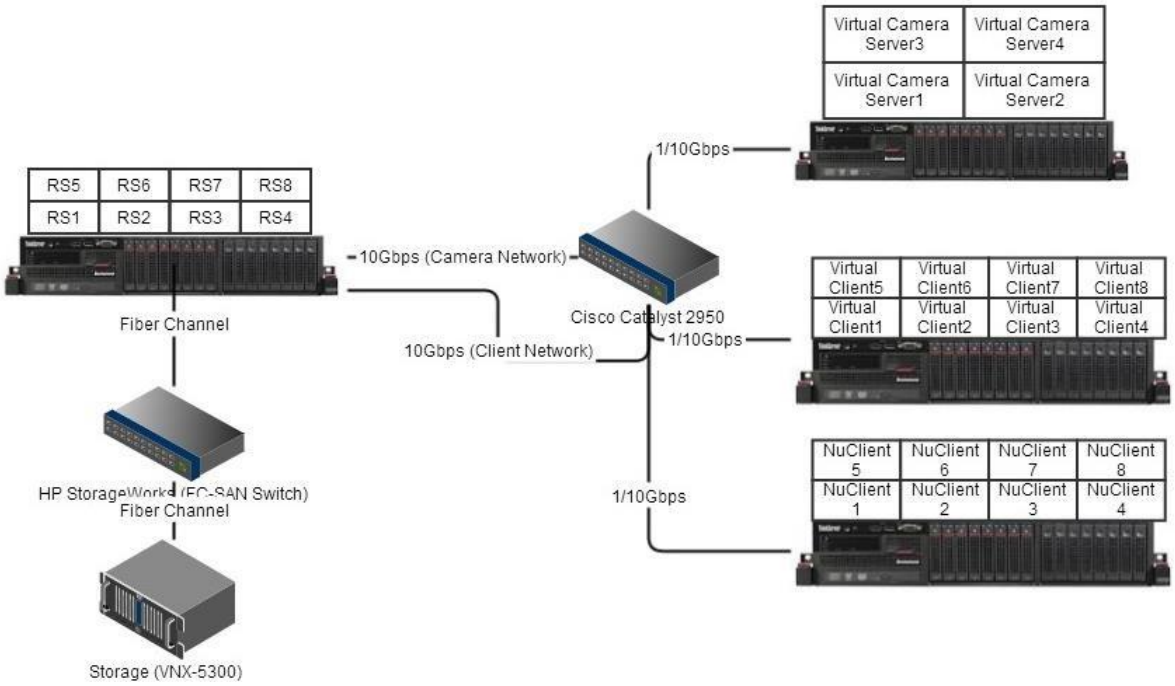

Figure 1: System Architecture Diagram

Procedure:

The entire setup can be divided into 5 stages. A step-by-step instruction for each stage is provided to assist reader's setting.

1. Prepare Video Source:

   Due to the great amount of video is required, this test is conducted using NUUO's proprietary fake video source, which is simulated as a H.264 IP camera. Each video is sourced from a pre-recorded file whose bit-rate and resolution is set to be full-HD with a constant bit rate at 4Mbps. During the test, each video source is connected mostly twice to ensure constant throughput.

2. Setup Virtual Machines:

   Eight VMs are setup for the experiment. Each VM is planned for 64 channels continuous recording at 250Mbps, 64 channels liveview, and 16 channels playback. The deployment is rather easy but using 「deploy OVF image」in vSphere client. Table 3 is the recommended resources for each VM. Please refer to「NUUO Crystal™ VM V2.1 Installation Guide」for a complete introduction.

Resource Name	Suggested Resource
CPU	2 cores (4,500MHz)
RAM	8GB

Table 3: NUUO Crystal™ VM Resource Configuration

3. Configure Storage:

   FC-SAN storage is highly recommended for 8 VMs scenario due to high bandwidth (2Gb/s downstream in total). In this report, EMC VNX 5300 and its fiber channel link are selected.

   One LUN(Logical Unit Number) is created for each VM. Each LUN consists of 3 HDDs and is configured as RAID 5(redundant array of independent disks) for data redundancy. Using 3 HDDs as RAID 5 creates a worst-case scenario since its disk performance maybe worse than a single HDD due to

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NUUO South Africa Office
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Tel:+27-11-704-6845

the write penalty[1]. The tested HDD is 1TB ES series from Seagate. Each LUN can accommodate 0.75 days data under the current throughput.

Once LUN is created, an additional disk is required to be added into VM. RDM (raw device mapping) disk is preferred over VMDK (virtual machine disk). The details can be checked in "NUUO Crystal™ VM V2.1 Installation Guide".

4. Setup Network:

Each VM provides two network interfaces. One is recommended for Client viewing and configuration; while the other one is for retrieving video streams from IP cameras. Each interface is supposed to connect to one virtual switch, supported by a physical network card. Note that the IP address of the VM may be different from the IP address of the physical network card.

Once VM is configured successfully, click "Power on" button in vSphere Web Client to execute the VM. Please open the console in vSphere Web Client to check the true ip address of the VM.

5. Configure NUUO Crystal™ Application:

Install NuClient.exe from NUUO Website. Use "NUUO Crystal™ Installation Wizard" to search for server's ip address. Note that the client and the configuration network interface of each VM shall be in the same local area network (LAN).

Pick one of the VMs as the combination of management server and recording server and the rest ones as the recording servers as shown in figure 2.

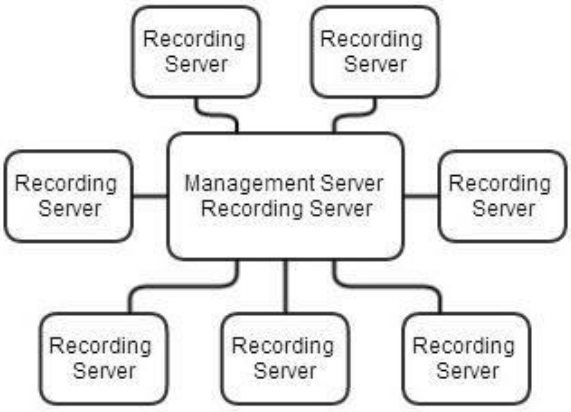

Figure 2: NUUO Crystal™ configurations in this test

After finishing the wizard, please start NuClient and connect to the management server. Go to the "Config" tab to add volume into volume group as well as cameras into each of the recording servers. Keep in mind that each video source shall not be added more than twice in order to have a constant throughput.

6. Setup NuClient and Virtual Client:

Open "Liveview "tab in NuClient. Select a layout with more than 8x8 grids. Drag one of recording servers into the layout and the Client will automatically populate all the video sources to grid. In order to test for 128 channels per VM, two NuClients are required. Note that our test is to test the streaming capability of the recording server; therefore, no video decoding is necessary for NuClient. Virtual client is linux-based and requires logging in as an administrator to execute. The details please refer to the user manual of the virtual client.

[1] http://theithollow.com/2012/03/understanding-raid-penalty/

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After setup, the test, including recording, liveview, and playback, ran for 3 days to ensure the disk space is fully recycled for at least 3 times. Normally, disk recycling would result in inconsistent performance. However, with NUUO's patented file-ring technology, a constant throughput at 250Mbps per volume is guaranteed.

Report:

1. Recording Performance:
   8 LUNS are used to store video data from 8 VMs. The system is running for 3 days and a recording throughput is recorded every 5 seconds. Since disk I/O has its own buffering mechanism, one minute window is used for running averaging the data.
   Figure 3 uses quartiles for showing the consistency of the data.
   - Central box shows the 3rd quartile, median, and the 1st quartile,
   - Top whisker is the difference between maximum and 3rd quartile,
   - Bottom whisker is the difference between minimal and 1st quartile.

   The result shows very consistent recording throughput over 3 days span. The minimal recording throughput is around 30.2MBps, around 1.6% of the median value among a 3 days span.

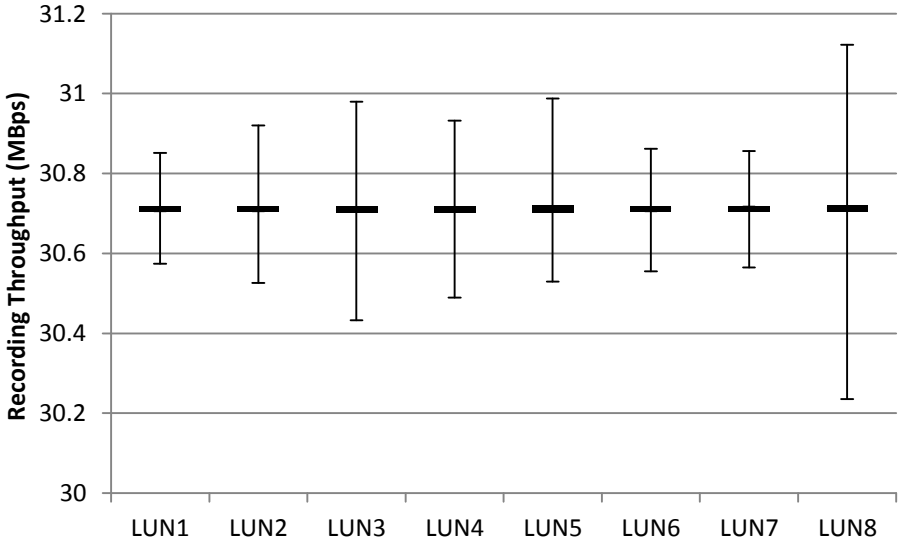

Figure 3: Recording Throughput for individual LUNs

2. Liveview Performance:
   For each VM, 128 out streams are requested. Every minute, the average frame rate per channel is recorded. There are more than 5.5 million data points per LUN over 3 days of measurement. Figure 4 uses quartiles to demonstrate the consistency of the data. Our record shows each VM is capable of supporting more than 27 frames per second which is 90% of the source frame rate. The median (50% chance) of the frame rate is above 30.

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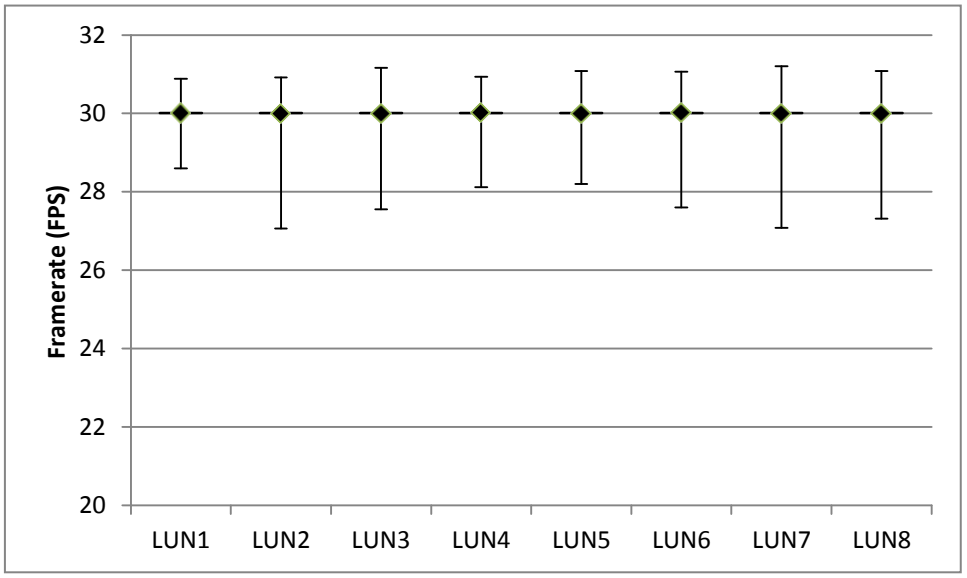

Figure 4: Liveview performance for individual LUNs (Diamond: Averageframe-rate)

Summary:

This report shows the combination between our reference design, consisting of HP DL380p and EMC VNX 5300, and NUUO Crystal™ VM can work seamlessly. Recording, liveview, and playback all demonstrates consistent performance within 3 days of testing period.

Our consistency is established upon:

- Total recording throughput for a 5 minutes running average window is above 95% of expected throughput.
- Liveviewing frame rate is above 90% of the frame rate of the video source.

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