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Judging NVR Performance Using Throughput Measurement

White Paper

Judging NVR Performance Using Throughput Measurement

How do you effectively gauge the performance capabilities on a network video recorder (NVR)? Unlike frames per second (fps) or maximum resolution, there is no standard specification that measures the ability of NVRs to capture, process and record video, especially from megapixel IP cameras.

With an analog system, it is simple to compare performance because the hardware components have a hard specification and the video devices conform to a standard format. For example, an analog digital video recorder (DVR) will have a specific total frame per second specification such as 480 fps at CIF resolution. If it is a 32 channel recorder, it can record each camera at 15 fps at 352x288 pixels. Since analog cameras output NTSC standard video, the DVR performance is mainly defined by the capabilities of the hardware video capture card. The capture card has finite capabilities for capture and compressing analog video.

One of the advantages of using IP cameras is that the resolution can exceed VGA resolution and frame rates can be controlled at the camera. 1.3, 2, 3 and 5 megapixel cameras are available in IP video. However, because of this flexibility the NVR performance specification is dependent on the camera model, resolution, frame rate and compression as well as the NVR's own performance capabilities. Many NVR manufacturers have calculators that will determine the CPU speed, amount of RAM and hard disk space that is required given the specifications of the cameras used. Although this is usable, it does not give users a quick snapshot comparison of performance capabilities.

A more useful measurement of an NVR's performance is throughput. Throughput is a measurement of the amount of data processed over a given time period. In networking terms, throughput is typically measured in bits per second (bps). For NVRs, throughput is expressed in megabits per second (Mbps).

Throughput provides a quick measurement specification across different NVR manufacturers for evaluating how capable the product is at handling IP cameras, especially megapixel IP cameras. This white paper will discuss the problem that NVRs have with megapixel video, how throughput can be used to effectively compare NVRs and how Toshiba NVRs achieve higher throughput and more support for megapixel video.

The Problem with NVRs and Megapixel Cameras

With surveillance video moving from analog to IP, the burden of processing the video has moved from the video capture card to the CPU. In an analog digital video recorder, the capture card was a dedicated hardware device responsible for the capture, encoding and compression of the analog video signal.

The CPU then processed that video data for motion detection and writing it to disk. The video from the capture card is also sent directly to the video display card, bypassing the CPU for live video display. Figure 1 shows the flow of data from an analog camera to the different components in an analog DVR.

With an NVR, the video data is captured via the network interface card (NIC). Although the NIC is a hardware device that allows the CPU to communicate with the IP camera, it does not replace the video capture card because it does not perform any encoding or compression of the video data. The encoding and compression tasks are left to the CPU. Figure 2 shows the multiple tasks that the CPU handles in an NVR.

Figure 1

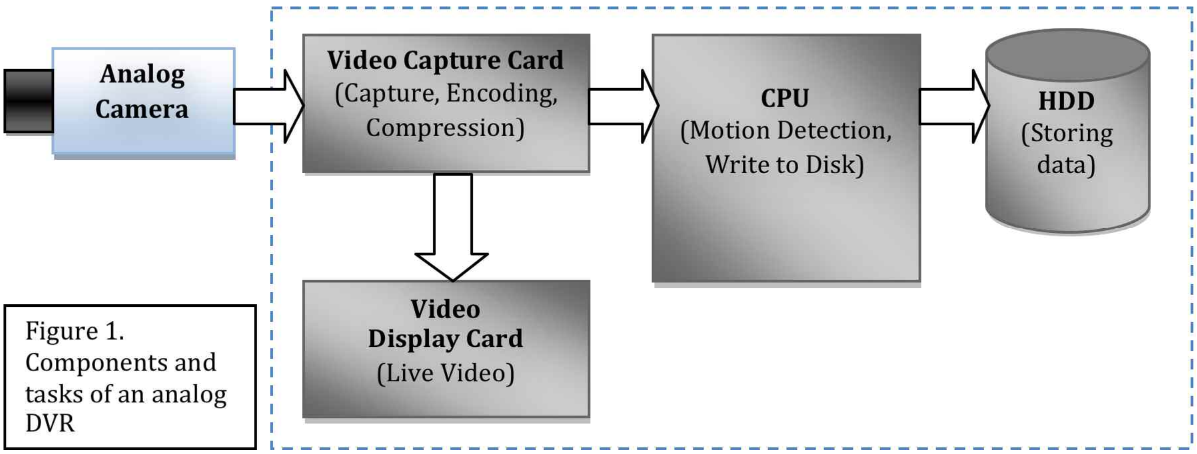

Figure 1. Components and tasks of an analog DVR

Figure 2

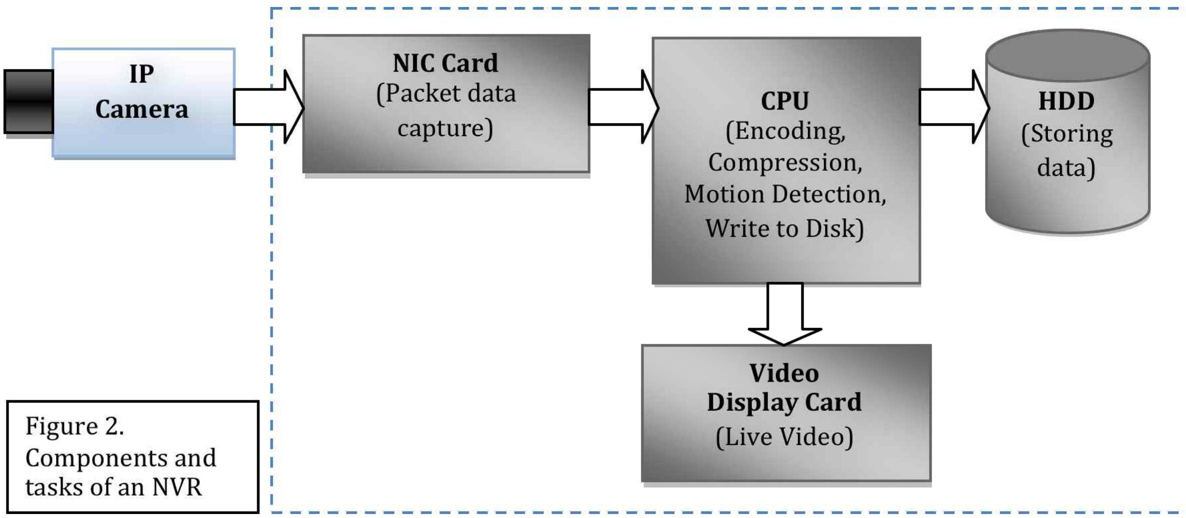

Figure 2. Components and tasks of an NVR

The increased load on the CPU is multiplied by the added resolution of IP cameras. With analog cameras, the standard resolution is 640 x 480. With megapixel IP cameras, the resolution has increased to 1280 x 960, 1600 x 1200 and more. The task of encoding, compressing, performing motion detection, transferring the video to the video display card and writing it to disk places a heavy load on the CPU. Motion detection and live video is especially taxing on the CPU. Performing pixel based motion detection on every frame of a 1600 x 1200 image at 15 fps or more can quickly overload an NVR's resource capacity. Also, displaying more than 4 live megapixel cameras at once can use valuable CPU resources. When the CPU usage approaches 100%, the NVR can experience drastic slowdown or shutdown0.

To lessen the load on the CPU, it is recommended to limit the number of cameras that will be displayed live. A viable option is to display a maximum of 4 live IP cameras simultaneously at the server or use client based live display and configuring the surveillance system to detect motion at the camera. Most IP cameras have built-in motion detection and the NVR can detect if the camera motion detection has been triggered via the video header information or a separate data flag from the IP camera. In testing, it has been shown that utilizing the IP camera motion detection and using client based live display reduces the CPU load by 70%.

Because the CPU plays such a critical role in the performance of an NVR, it is important to have a robust hardware CPU to handle megapixel video. Although throughput is a measurement of the entire NVR capability, the CPU is the main factor for throughput specification. Several components in an NVR contribute to the total throughput of the system. The NIC, system bus, hard drive, and CPU all affect the throughput. Toshiba NVRs all use Gigabit NIC cards. The 1,000 Mbps throughput is more than sufficient for supporting 64 or more 2-megapixel IP cameras.

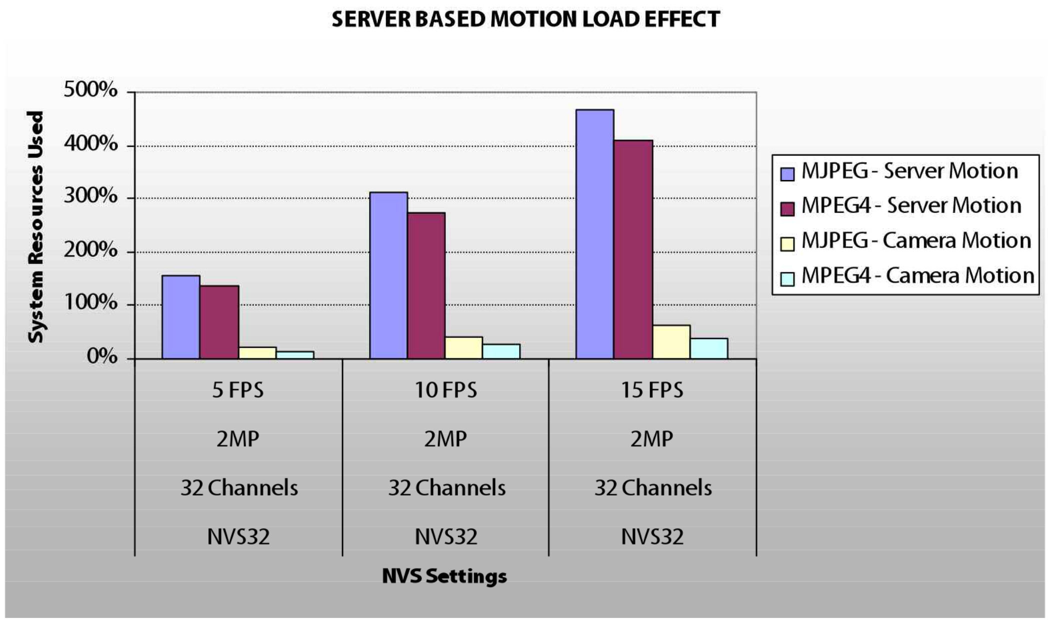

Figure 3: Reduction of CPU load by using camera motion detection and client based live display

Toshiba NVRs also use a motherboard with 800MHz front-side system bus and server grade SATA hard disk drives. These components have throughput specs of 25,600Mbps and 3,000Mbps respectively. The Toshiba NVRs use an Intel® Core 2 Quad processor for high data throughput. Actual tests on the Toshiba NVS with 2-Megapixel IP cameras have measured the throughput to be greater than 256Mbps. This effectively means that it can support up to 64 2-Megapixel IP cameras at 15fps each provided camera based motion detection and client based live display is used.

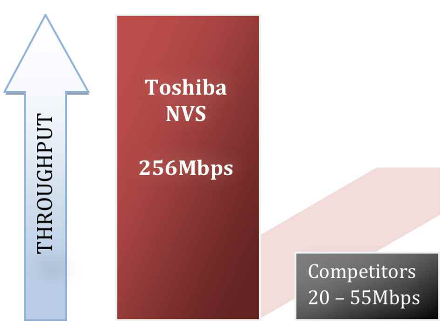

Figure 4

When comparing NVRs, it is important to know the throughput so that a quick comparison can be made between different manufacturers. While some manufacturers may not publish throughput specifications, estimations can be deduced from the processor used. Throughput measurements on Intel® Atom based processors range from 20Mbps to 55Mbps. Figure 4 shows the throughput of a Toshiba NVS vs competitor NVRs.

Because of the new method by which IP camera video is captured, the CPU of an NVR is the main determining factor in performance. This performance reflects the number of megapixel cameras and frame rate that an NVR can support. Like the performance of servers and PCs, the more robust the CPU, the more megapixel IP cameras an NVR can support. By looking at the throughput specification of NVRs, a quick comparison can be made between different NVR manufacturers. The Toshiba NVRs use Intel® motherboards and Intel® Core 2 Quad processors which result in a high performance, robust NVR with throughput of 256Mbps equating to 64 2-megapixel IP cameras at 15fps.

Questions to ask when evaluating an NVR

1. What is the total throughput of the NVR?
2. What CPU is used?
3. What is the maximum number of 2-Megapixel cameras at X frame rate that can be supported?
4. What is the maximum total frame rate at D1 resolution?
5. Does the NVR have live display at the server?
6. What is its impact on throughput?