ACTi
Knowledge Base

RAID Storage System of Standalone NVR

Contents

- Introduction
- RAID Types
- RAID Comparison
- Storage Calculator
- Compatible Hard Disks

Introduction

ACTi Standalone NVR models support flexible storage system – it is possible insert up to 6 hard disks into **XNR-4200** and up to 5 hard disks into **GNR-2000** for the recording purposes. At the same time, the operating system itself and the firmware are stored on the separate DOM[1] so that all the hard disks could be used solely for storing videos only.

XNR-4200 with 6 HDD slots   **GNR-2000 with 5 HDD slots**

In order to make the storage management as simple as possible, **all the hard drives of standalone NVR appear as one single accumulated volume for the system**. Furthermore, in order to make the whole system more reliable, **there are recovery options available in case of physical damage of any of the hard disks.**

Those two features above are possible thanks to the **built-in RAID system**. The RAID (Redundant Array of Independent Disks) system is able to manage multiple hard disks to achieve following:

- All the hard disks together appear as one single volume for the system
- Allow user to define how the data is stored on those hard disks regarding protection against the physical failure of one or more hard disks.
- Increase the speed of writing and reading data.

---

[1] Disk on Module, attached to motherboard; removable.

There are several types of RAID configurations available in ACTi standalone NVR. There are configurations by which the video recordings on disks can be recovered even in case of physical failure of several hard disks; however, while using such secure configurations, the total available storage space will be smaller compared to less secure configurations. **It is up to the user to decide whether one prefers to have more available storage space or more security.** It is good to know that whichever RAID type the user chooses, it can be configured with just 1 click in the Setup of Standalone NVR.

The following chapter explains the available RAID types. **After reading through that chapter you will be able to choose suitable RAID type for each video surveillance project.**
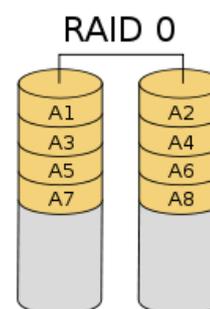
RAID Types

There are 4 different RAID types (0, 1, 5, 10) supported by ACTi Standalone NVR servers. Depending on the number of inserted disks, there will be different RAID options available.

RAID 0

Under this configuration every inserted disk will be used for storing data. No disks are used for data backup purposes. Should one of the disks be damaged, the recordings on all disks will be lost and are not recoverable, and the use of all remaining disks will be suspended until the broken disk has been replaced and the whole RAID configuration has been reset. On the other hand, RAID 0 provides fastest possible writing and reading speed. How is that possible?

Compared to CPU and RAM, hard disks are so much slower, therefore, the bottleneck of data transferring from or to the disk lies in mechanical part of each hard disk. The solution is to split the data into small blocks and spread them around multiple hard disks. Each disk will then be responsible for saving a tiny part of information and will finish the processing much sooner compared to the case of just using one disk for doing all the job. The more disks you have in your system, the faster the data reading and writing will be. XNR-4200 allows adding up to 6 hard disk under RAID 0 configuration, which means 6 times of increased speed!

On the example image, there are two disks running under RAID 0 configuration. The data blocks A1, A2, …, A8 are split between two disks so that blocks A1 and A2 are stored at the same time, then followed by A3 and A4, etc. Eventually, all 8 portions of data are stored on those 2 disks use twice less time than it would take in case of just having 1 disk. This is the power of RAID system!

It is important to know that for any RAID type, the hard disks have to be equal in storage capacity. If you insert disks with different capacity then all the disks will automatically be formatted to adopt the size of the smallest hard disk in the whole system. For example, if you have 5 disks with 2TB, 2TB, 2TB, 1TB and 500GB, then all the 5 disks will be formatted as 500GB each and under RAID 0 configuration you will be having total of 5x500GB=2.5TB storage space available. As it is an obvious waste of resources, therefore it is highly recommended to insert disks with same sizes. In this case, if you have no possibility of replacing the 1TB and 500GB disks, then just remove them from the system completely – in that case you will have 3x2TB=6TB available, which is still much more than 2.5TB with 5 disks.

In case of GNR-2000 you may use 1,2,3,4 or 5 disks under RAID 0 whereas in case of XNR-4200 you may use 1,2,3,4,5 or 6 disks.

RAID 0 is suitable for the projects with lower security risk where the potential risk of lost video records is acceptable while the usable storage space should be as big as possible in order to serve more cameras with one standalone NVR server. Example: schools, hospitals, bus stops, etc.

Advantage of RAID 0: Biggest possible usable storage space and faster speed of reading and writing.
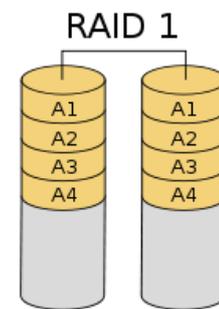
Disadvantage of RAID 0: No protection against possible hard disk failure. If one disk fails, the whole RAID system will stop working.

RAID 1

RAID 1 is a solution designed to make mirror copy of from one disk onto one or more disks for recovery purposes. In case of ACTi Standalone NVR servers, you need to have exactly 2 disks to configure RAID 1. As mentioned in the chapter of RAID 0, the sizes of the disks have to be equal. If they aren't, both disks will be re-formatted according to the size of the smaller disk.

Since the 2nd disk is used as a mirror of the first disk, the total available storage will be twice smaller compared to RAID 0. On the other hand, if one of the two disks fails then the system will still keep running on another disk without any problems. Once you replace the damaged hard disk, all the information will be copied from a healthy disk into the newly added disk, to recover a healthy RAID 1 condition.

On the example image you can see the RAID 1 configuration with two hard disks. Data blocks A1, A2, A3 and A4 are written on both disks at the same time. As a result, there is no improvement in writing speed compared to traditional single-disk computers. However, the reading speed will be twice faster – when the user requests for data that consists of blocks A1, A2, A3 and A4, then the system can read blocks A1 and A3 from disk 1 and A2 and A4 from disk 2 at the same time. This function is very useful for instant playback of video clips.

RAID 1 is suitable for the projects with high security risk and with small number of cameras due to the limited storage space. Example: Currency exchange booths, etc.

Advantage of RAID 1: Excellent protection against failure of hard disk and twice faster speed of reading.

Disadvantage of RAID 1: Available storage space is twice smaller compared to RAID 0.

RAID 5

RAID 5 is probably the most popular configuration of all because it provides both disk recovery options and quite efficient use of storage space. Furthermore, the more hard disks you add into RAID 5 configuration, the faster will be the writing and reading speed, for the similar reason as in case of RAID 0.

It takes at least 3 hard disks to build up a RAID 5. In case of GNR-2000 you may use 3, 4 or 5 disks and in case of XNR-4200 you may use 3, 4, 5 or 6 disks.

While only 50% of the storage space is available under RAID 1 configuration, RAID 5 only uses 1 disk for recovery purposes. The rest of the disks can fully be used for storing videos. Therefore, the more disks you have in RAID 5 system, the more efficient is the use of total storage space. For example, if you have 6 disks inserted into XNR-4200 and each of them with the size of 1TB, then the total available storage space will be 5TB. In other words, 83% of the storage space in given example will be used for storing videos and 17% will be used for recovery purposes.

If any of the disks of RAID 5 system fail, the system will continue using the remaining disks until you replace the broken disk. In the meantime, the system is able to recover the missing information based on the data on remaining healthy disks. The explanation is given below. Once you have replaced the broken disk, the system will fully recover the RAID 5 configuration.

Please note that, if one more disk fails before you manage to replace that broken disk, then the data in the whole RAID system will be lost and is not recoverable. Furthermore, no new data can be written onto the disk before the RAID system has been fully re-formatted.

Here comes a bit technical explanation of how RAID 5 is able to recover data in case of a disk failure. You may skip this part and move on to part that explains in which projects RAID 5 is most suitable. ☺
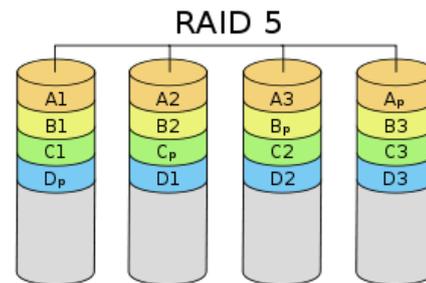
On the example image, the data blocks A1, A2 and A3 are considered the same data group or a stripe. *Ap* represents the special portion of data that is created based on the values of A1, A2 and A3 for recovery purposes. Such value is called *parity*. Ap is the parity of all the data within same stripe. What does it mean?

The data is hard disk is stored in bytes. Each byte consists of 8 bits of data, where each bit value is either 0 or 1.
For example, the data of A1, A2 and A3 is following:
A1: 10011011
A2: 00110100
A3: 10101110
The system calculates the sum of each of 8 columns of bits – if the sum is an even number, then the corresponding parity value will be 0, whereas if the sum is an odd number then the parity value will be 1. In given example, the parity of A1, A2 and A3 is:
Ap: 01000001

For example, if the disk 2 containing A2 data block is damaged, then it will be possible to recover the missing data by adding up the blocks A1, A2, and comparing the result against *Ap* using the same concept of parity:
A1: 10011011
A3: 10101110 ⎫
         ⎬— A2: 00110100
Ap: 01000001 ⎭

This way it is possible to restore the data block of A2 that was lost because of the failure of the 2nd disk. Actually, it is not as hard as you may have thought, is it? ☺

RAID 5 is suitable for nearly all types of projects that are somewhat demanding about data recovery options and yet need to work with quite many cameras and therefore would like to use as much storage space as possible. Example: Retail, city surveillance, commercial buildings, etc.

Advantage of RAID 5: Basic protection against failure of hard disks and excellent speed of reading and writing (only a bit slower than RAID 0).

**Disadvantage of RAID 5:** Available storage space is one disk less than the maximum.

RAID 10

RAID 10 (also called 1+0) combines RAID 1 and RAID 0 configurations – think of it as a group of mirrored disks. From that it is possible to conclude that there has to be even number of disks and at least two pairs, which means that you can use 4 disks for GNR-2000, and 4 or 6 disks for XNR-4200.
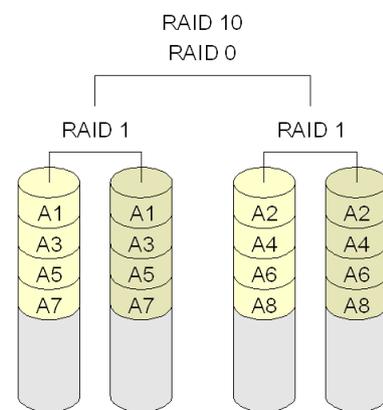
Since you are already familiar with RAID 1 and RAID 0, therefore explaining RAID 10 is easy. The data blocks A1 and A2 are written on disks 1 and 3 as if they were under RAID 0 and disks 2 and 4 will be used as their mirrors, just as if they were RAID 1 counterparts of disks 1 and 3. The system keeps working and is recoverable even if one disk from each mirrored pair fails.

Here is the example of RAID 10 using 6 disks (possible in XNR-4200). Data blocks A1, A2 and A3 can be written to disks at the same time, resulting with as powerful speed as in case of RAID 0. The same goes for reading the data from the disks.
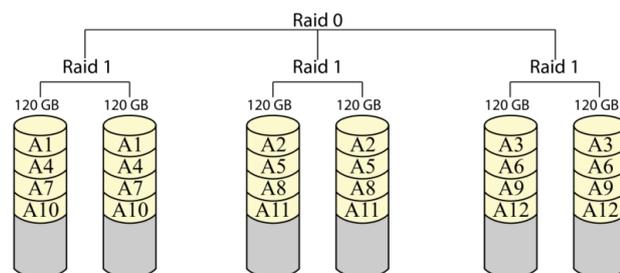
RAID 10 is suitable for the projects with high security risk and with medium number of cameras. Example: Branches of banks, etc.

Advantage of RAID 10: Excellent protection against failure of hard disks and excellent writing and reading speeds.

Disadvantage of RAID 10: Only 50% of the total storage is available for writing data.

RAID Comparison

The table below is based on the available RAID configurations of ACTi Standalone NVR:

RAID Type	Number of disks (n)	Tolerates the failure of disks	Usable Storage Space	Read Speed	Write Speed
RAID 0	1-6	0	n	nX	nX
RAID 1	2	1	n/2	2X	1X
RAID 5	3-6	1	n - 1	(n-1)X	(n-1)X
RAID 10	4 or 6	1 of each pair	n/2	nX	nX

The same table in human-readable way (the more stars the better):

RAID Type	Number of disks	Tolerates the failure of disks	Usable Storage Space	Read Speed	Write Speed
RAID 0	1-6	none	★★★★★	★★★★	★★★★
RAID 1	2	★★★★	★★★	★★★	★★★
RAID 5	3-6	★★★	★★★★	★★★★	★★★★
RAID 10	4 or 6	★★★★	★★★	★★★★	★★★★

Storage Calculator

If you have already decided the RAID type that fits best with your project requirements then you can take good use of our MS Excel based storage calculator that not only helps you with calculating the total storage space available in given RAID configuration, but also tells you how many cameras or which bitrate or how many days the videos can be kept in the system for each case.

Download the Storage Calculator from ACTi website:

http://www.acti.com/download_file/KnowledgeBase_UploadFile/ACTi_standalone_NVR_RAID _storage_calculator_v_1_0_20110504_001.xlsx

Compatible Hard Disks

ACTi has tested and announced the full compatibility with following hard disks:

Brand	Class	Model	Capacity	Interface	Cache	Spin Speed
Seagate	Enterprise	ST2000NM0011	2TB	SATA 6 Gb/s	64MB	7200
	Desktop	ST3250318AS	250GB	SATA 3 Gb/s	8MB	7200
		ST32000641AS	2TB	SATA 6 Gb/s	64MB	7200
Western Digital	Enterprise	WD1002FBYS	1TB	SATA 3 Gb/s	32MB	7200
		WD2002FYPS	2TB	SATA 3 Gb/s	64MB	IntelliPower
		WD2003FYYS	2TB	SATA 3 Gb/s	64MB	7200
		WD1003FBYX	1TB	SATA 3 Gb/s	64MB	7200
	Desktop	WD2002FAEX	2TB	SATA 6 Gb/s	64MB	7200
		WD1002FAEX	1TB	SATA 6 Gb/s	64MB	7200

Desktop and **Enterprise** are two common product classes most hard drive manufacturers use to differentiate drive models of two different usages. The differences between these classes may vary in degree or designs depending on the manufacturer. In general, manufacturers do not recommend installing desktop class hard drives for RAID environment.

Desktop class hard drives are designed for balanced performance and reliability for everyday use (8 hours/day, 5 days/week), while **Enterprise** class hard drives are designed especially for RAID system environment which requires higher performance for 24 hours/day, 7 days/week mission critical applications.

Note: Any other hard disk that is not bigger than 2TB will theoretically also work, however, in such cases ACTi does not guarantee the performance of those uncertified hard drives.

Note: Hard disks with capacity bigger than 2TB are not supported!