Design Concepts & Capacity Expansions of QNAP RAID 50/60
Insufficient protection of RAID 5?
Will performance be degraded when using RAID 50/60?
Why You Should Use RAID 50/60

- Number of disks and their capacities will affect RAID protection level
- With ServeTheHome RAID Calculator:

The failing rate of RAID 5/6 in 5 years:

<table>
<thead>
<tr>
<th>Disk NO.</th>
<th>RAID Type</th>
<th>Disk Capacity</th>
<th>RAID Failing Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>RAID 5</td>
<td>8 TB</td>
<td>0.07%</td>
</tr>
<tr>
<td>8</td>
<td>RAID 5</td>
<td>8 TB</td>
<td>0.77%</td>
</tr>
<tr>
<td>8</td>
<td>RAID 6</td>
<td>8 TB</td>
<td>0.001%</td>
</tr>
<tr>
<td>12</td>
<td>RAID 6</td>
<td>8 TB</td>
<td>0.01%</td>
</tr>
<tr>
<td>24</td>
<td>RAID 6</td>
<td>8 TB</td>
<td>0.64%</td>
</tr>
</tbody>
</table>

RAID 5/6 protection can be degraded when NAS capacity increases.

https://www.servethehome.com/raid-calculator/
Best Estimate Real World assuming bit error chance is $10^{-15}$, 150MB/sec rebuild speed
Better Protection with RAID 50/60

- **Protect** your data with **Lower** space redundancy
- On NAS with 8 bays, QNAP no longer recommends using RAID5
  - For enterprise models, RAID 6/RAID 10/RAID 60 is recommended:

Take 8TB disks as example:

<table>
<thead>
<tr>
<th>RAID type</th>
<th>No. of disks</th>
<th>Disk failure tolerance</th>
<th>Raw capacity</th>
<th>RAID failing rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAID 6</td>
<td>24</td>
<td>2</td>
<td>176 TB</td>
<td>0.64%</td>
</tr>
<tr>
<td>QNAP RAID 60</td>
<td>24</td>
<td>4 or more</td>
<td>160 TB</td>
<td>0.03%</td>
</tr>
<tr>
<td>RAID 10</td>
<td>24</td>
<td>12</td>
<td>96 TB</td>
<td>0.02%</td>
</tr>
</tbody>
</table>
QNAP RAID 50/60 Design Concepts

- Supported by NAS with 6 or more bays
- Supports Storage Pool, Static Volume and Qtier Pool
- Stripping Data Block to create RAID 50/60

**RAID 50 Storage Pool**

<table>
<thead>
<tr>
<th></th>
<th>A1</th>
<th>A2</th>
<th>B1</th>
<th>B2</th>
<th>C1</th>
<th>C2</th>
</tr>
</thead>
</table>

**RAID 5 Storage Pool**

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
</table>

**RAID 5 #1**

- Disk 1
- Disk 2
- Disk 3

**RAID 5 #2**

- Disk 4
- Disk 5
- Disk 6

**RAID 5**

- Disk 1
- Disk 2
- Disk 3
- Disk 4
- Disk 5
When expanding, new sub-arrays are not allowed

Number of RAID 50/60 Sub-arrays cannot be changed after creation
- No. of disks in Sub-arrays must be equal to avoid space waste
- Capacity can be expanded through new RAID 50/60 and JBOD (Liner)
Concept of RAID 50 "Write" Operation

1. Data Block A is striped into A1/A2 for writing operation
2. A1/A2 then are striped again within each sub-array

RAID 5 RMW (Read Modify Write) 1 Write =
Read Parity + Read Data + Calculate Parity + Write Parity + Write Data

RCW (Read Reconstruct Write) = Read all Chunk Data + Calculate Parity + Write Parity + Write Data
Performance Comparison For RAID 50/60

- Single RAID 0 = Performance can be N (No. of disks) * P (Disk performance)
- Single RAID 5 = (N*P) / RMW or RCW operations
- Compare RAID 50/60 to RAID 5/6 on HDD, performance can be reduced

<table>
<thead>
<tr>
<th>No. of disks (HDD)</th>
<th>RAID type</th>
<th>Sequential read</th>
<th>Sequential write</th>
<th>No. of disks (SSD)</th>
<th>RAID type</th>
<th>Sequential read</th>
<th>Sequential write</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>RAID 5</td>
<td>687</td>
<td>370</td>
<td>12</td>
<td>RAID 5</td>
<td>3098</td>
<td>1904</td>
</tr>
<tr>
<td>6</td>
<td>RAID 50 (2)</td>
<td>566</td>
<td>305</td>
<td>12</td>
<td>RAID 50(2)</td>
<td>3092</td>
<td>1859</td>
</tr>
<tr>
<td>12</td>
<td>RAID 5</td>
<td>1563</td>
<td>853</td>
<td>24</td>
<td>RAID 6</td>
<td>4606</td>
<td>4481</td>
</tr>
<tr>
<td>12</td>
<td>RAID 50 (2)</td>
<td>1536</td>
<td>858</td>
<td>24</td>
<td>RAID 60 (2)</td>
<td>4607</td>
<td>4422</td>
</tr>
</tbody>
</table>

HDD : TS-1079  (6) TVS-EC2480U-SAS-RP R2 (12) Seagate ST1000NM0033 through SMB
Performance With RAID 50/60 (HDD)

- The random read/write performance for RAID 50/60 can reduce 10% when the RAID is consisted of HDD with more read head operations.
- RAID 50/60 on HDD is priority for data protection.

RAID performance calculating: https://www.storagecraft.com/blog/raid-performance/

<table>
<thead>
<tr>
<th>No. of disks</th>
<th>RAID type</th>
<th>Disk capacity</th>
<th>RAID failing rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>RAID 5</td>
<td>8TB</td>
<td>2.82%</td>
</tr>
<tr>
<td>12</td>
<td>RAID 50</td>
<td>8TB</td>
<td>0.29%</td>
</tr>
</tbody>
</table>

A RAID 50 can greatly increase RAID protection with little performance impact.
Why random RW performance is increased with RAID 50/60 (SSD)

- RAID 50/60 with SSD will not suffer from read head operations penalty
- With SSD RAID 50, Random Read and Write has increased
- Suitable for all flash applications
QNAP RAID 50/60 Use Case Suggestion

- **RAID 50/60 Value:** Ensure Protection Level for High Capacity NAS
- **General Application:** RAID 5 is not recommended, 6-14 Bays: RAID 6/10, Beyond 16 Bays: RAID 60 With SSD Cache
- **Backup Destination:** RAID 50 for NAS higher than 8 bays

<table>
<thead>
<tr>
<th>RAID Type</th>
<th>RAID 5</th>
<th>RAID 6</th>
<th>RAID 10</th>
<th>RAID 50</th>
<th>RAID 60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disk No. Requirement</td>
<td>&gt; 3</td>
<td>&gt; 4</td>
<td>&gt; 4</td>
<td>&gt; 6</td>
<td>&gt; 8</td>
</tr>
<tr>
<td>Disk Fail Tolerance</td>
<td>1</td>
<td>2</td>
<td>half</td>
<td>2~5</td>
<td>4~10</td>
</tr>
<tr>
<td>Capacity</td>
<td>★★★★</td>
<td>★★★</td>
<td>★</td>
<td>★★★</td>
<td>★★</td>
</tr>
<tr>
<td>Scenario</td>
<td>Backup</td>
<td>General Usage</td>
<td>VDI or Database</td>
<td>High-Frequency Backup</td>
<td>VDI and Video Editing</td>
</tr>
</tbody>
</table>

*Using 8TB disk with 16 bays NAS, RAID 6 5 years failing rate will beyond 0.1%*
How to expand QNAP RAID 50/60?
Add Disks to All Sub-arrays

- In Storage Management select "Expand"
- Using dedicated UI to add disk on all sub-arrays at once
Add new RAID Group for Expansion

- Add a new RAID 50/60 with same sub-array count for expansion
- Using Expansion Enclosure if Host NAS has no free slots
- The new RAID 50/60 must use same RAID type and sub-arrays count (Disk number can be different)

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**Expanding Storage Pool**

Select Disks(s):
- ENCLOSED (Total: 4 UNITS: REXP-1600U-RP)
  - Please select at least one disk.
  - RAID Type: RAID 5
  - Number of sub-arrays: 2

- Disk 1: TS-220LH01U-HX, HDD, SATA, 256-09-0G, Good
- Disk 2: TS-220LH01U-HX, HDD, SATA, 256-09-0G, Good
- Disk 3: TS-220LH01U-HX, HDD, SATA, 256-09-0G, Good
- Disk 4: TS-220LH01U-HX, HDD, SATA, 256-09-0G, Good

New Capacity: 3.55 TB

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TS-EC2480U

REXP-1600U-RP
Demo: Expand RAID 50/60 By Adding Disks
Use RAID 50/60 With Hot Spare

- Local and Global Hot Spare can be used for each or all sub-arrays
- It is recommended to reserve Global Hot Spare
- Create RAID > go to "Disks/VJBOD" and set free disk as spare
Using Qtier/SSD Cache with RAID50/60

SSD RAID 60 = High capacity/performance video editing server
SSD Cache RAID 10 + HDD RAID 60 = High capacity/performance file server
Qtier SSD RAID 50 + HDD RAID 60 = High capacity/performance VDI server
Qtier SSD RAID 10 + HDD RAID 60 = High capacity/performance Database
Thanks for listening