



Drive Analyzer®

# Monitoring Drive Health with DA Drive Analyzer

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# Contents

1. COMPUTER STORAGE DRIVES HAVE A LIMITED LIFESPAN . . . . .	1
2. THE DA DRIVE ANALYZER . . . . .	2
3. DA DRIVE ANALYZER FOR EVERYDAY USERS . . . . .	3
3.A. NAS App . . . . .	3
Installation . . . . .	3
Open the Overview Page. . . . .	3
4. DA DRIVE ANALYZER FOR ADVANCED USERS . . . . .	6
4.A. DA Portal . . . . .	6
Symptom Radar Chart . . . . .	6
Threshold Alerts . . . . .	11
4.B. DA Monitor . . . . .	16
5. WHAT SHOULD YOU DO WHEN A DRIVE IS AT RISK? . . . . .	23
REFERENCES. . . . .	24



## 1. COMPUTER STORAGE DRIVES HAVE A LIMITED LIFESPAN

Computer storage drives, both HDDs and SSDs, have a limited lifespan.

HDDs can develop problems with their disk surface when the read/write heads crash into their disks due to shock or when dust particulates scratch the surface of the disks after being batted around by the fast-rotating actuator arm.

When drives overheat or their mechanical components wear down, HDDs may also develop problems with their moving mechanical components, such as spindle motors.

Degraded flash memory cells, each capable of only a limited number of writes before they become unusable, can cause problems for SSDs.

Both kinds of drives utilize controllers that manage communication with the host as well as intricate circuitry. These are susceptible to breakage when power surges occur.

Data reveals that drives do indeed fail over time.

Recent data from Backblaze [1] revealed an annual failure rate of 1.47% for drives from datacenters typically housed in air-conditioned rooms. In 2023, ULINK's analysis revealed that drives from QNAP NAS units experienced a failure rate of 1.49%, resulting in their removal from the NAS due to RAID deterioration.

A study by Meta [2] found that the three drive models examined had higher failure rates as the drives aged.

## 2. THE DA DRIVE ANALYZER

**The DA Drive Analyzer is a tool that you can use to anticipate when a drive is nearing the end of its life.**

To deal with the reality of drive degradation and failure, both in controlled lab-like environments as well as home environments, ULINK Technology has developed a tool to predict drive failures and, more broadly, to monitor drive health metrics for signs of problems.

The DA Drive Analyzer, a commercially available tool, is compatible with more than 99% of commercial drives. DA Drive Analyzer has features to help both everyday users and advanced users keep track of their drives' health.

## 3. DA DRIVE ANALYZER FOR EVERYDAY USERS

Everyday users will benefit most from monitoring DA Drive Analyzer's main machine-learning-based (ML-based) Drive Health Predictions. This feature simply labels each drive's health status as either healthy, moderate risk, or severe risk.

By showing users the status of each drive, uncomplicated by additional details, users can decide in a simple way whether a drive is at risk of failure in the near future or not.

ULINK's main machine-learning algorithm generates the following statuses:

- A Healthy (or Normal) status drive is unlikely to fail in the near future.
- A Moderate-Risk (or Warning) status drive has a 70% chance of failing over the next 6 months.
- A Severe-Risk (or Critical) status drive has a 90% chance of failing within the next 6 months.

### 3.A. NAS App

If you are a NAS user, the quickest way to see the main ML-based Drive Health Predictions is to open up a DA Drive Analyzer NAS App, such as the DA Drive Analyzer App for QNAP NAS.

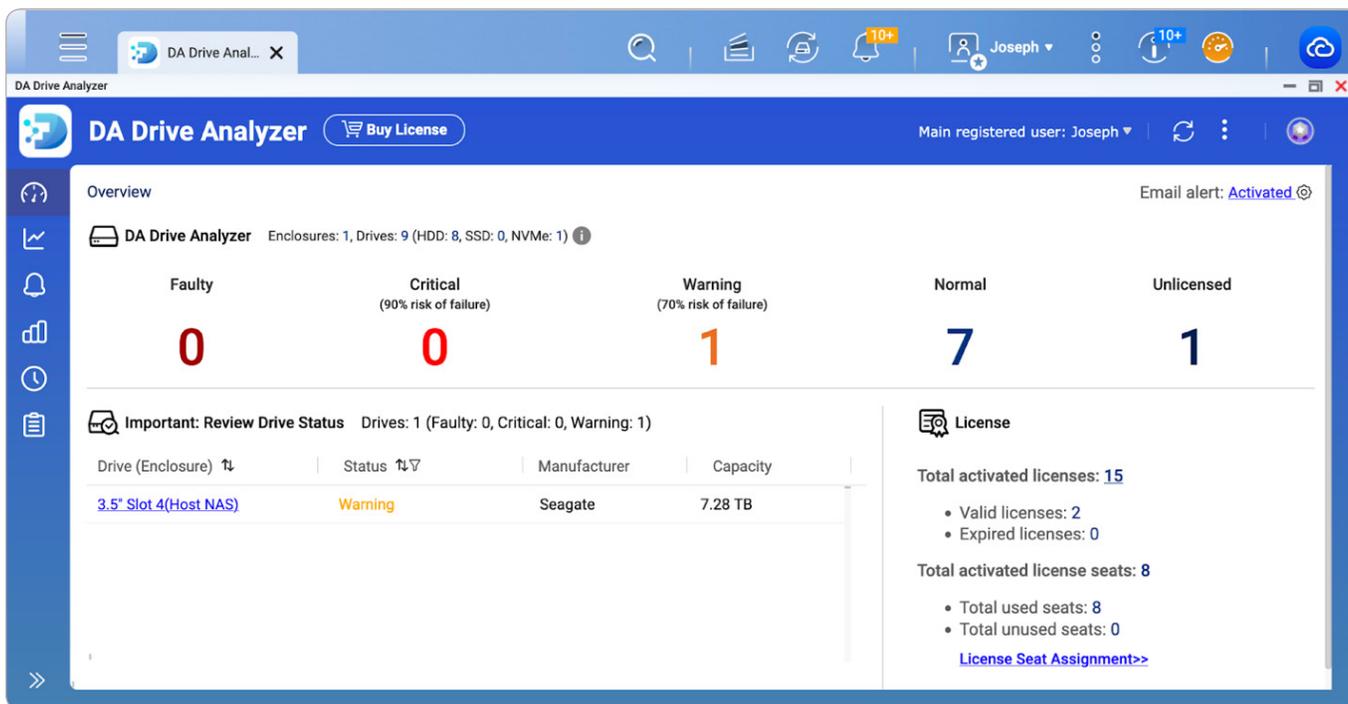
#### Installation

For detailed instructions on how to set up and license a DA Drive Analyzer on a QNAP NAS, see <https://www.qnap.com/en-us/how-to/tutorial/article/how-to-set-up-ulink-da-drive-analyzer-on-your-qnap-nas>.

For detailed instructions on how to set up and license DA Drive Analyzer on other supported NAS devices, see our Help Center at <https://ulinktechda.zendesk.com/hc/en-us>.

#### Open the Overview Page.

Once you've finished setting up the app and its licenses, please wait 24 hours for predictions to generate. The color-coded ML-based Drive Health Predictions are typically located on the app's Overview page.



*Color-coded ML-based Drive Health Predictions*

The example above shows that a single drive in our NAS has a Warning (At-Moderate-Risk) prediction. This lets us know that the drive may be at risk of failing in the near future. We can also see the offending drive's serial number, which is in slot 4 of our NAS.

The screenshot displays the DA Drive Analyzer interface. At the top, there's a navigation bar with a search icon, a document icon, a refresh icon, a notification bell with '10+', a user profile for 'Joseph', and a settings menu. Below this, the main header shows 'DA Drive Analyzer' with a 'Buy License' button and the user 'Main registered user: Joseph'. The main content area is divided into two sections. The top section, 'Drive Information', contains a table with columns: Slot, Interface, Type, Protocol, Status, Threshold A..., Manufacturer, Model, and Serial Number. The bottom section, 'Host NAS(TVS-871)', includes a 'Drive Life Prediction Score' bar chart and a 'Threshold Alerts (Last 7 Days)' table.

Slot	Interface	Type	Protocol	Status	Threshold A...	Manufacturer	Model	Serial Number
3.5" 2	SATA	HDD	SATA	Normal	--	Seagate	ST8000VN0022-2EL11 ZA1CWMYE	
3.5" 3	SATA	HDD	SATA	Normal	--	Seagate	ST8000VN0022-2EL11 ZA1CWXP	
3.5" 4	SATA	HDD	SATA	Warning	7	Seagate	ST8000VN0022-2EL11 ZA1CWEPD	
3.5" 5	SATA	HDD	SATA	Normal	--	WDC	WD80EFAX-68KNBN0 VAGXXMZL	
3.5" 6	SATA	HDD	SATA	Normal	--	WDC	WD80EFAX-68KNBN0 VAGVYSDI	

Threshold	Alert Date	Details
Number of Reallocation Logical Sectors	2024-03-16	<a href="#">View details</a>
Number of Reallocation Logical Sectors	2024-03-17	<a href="#">View details</a>
Number of Reallocation Logical Sectors	2024-03-18	<a href="#">View details</a>

*Drive information with their respective Serial Numbers.*

With this information in hand, we have identified vulnerable drives and are in a better position to protect our data from loss.

## 4. DA DRIVE ANALYZER FOR ADVANCED USERS

Advanced users may wish to go beyond the basic drive health predictions provided within the DA Drive Analyzer.

### 4.A. DA Portal

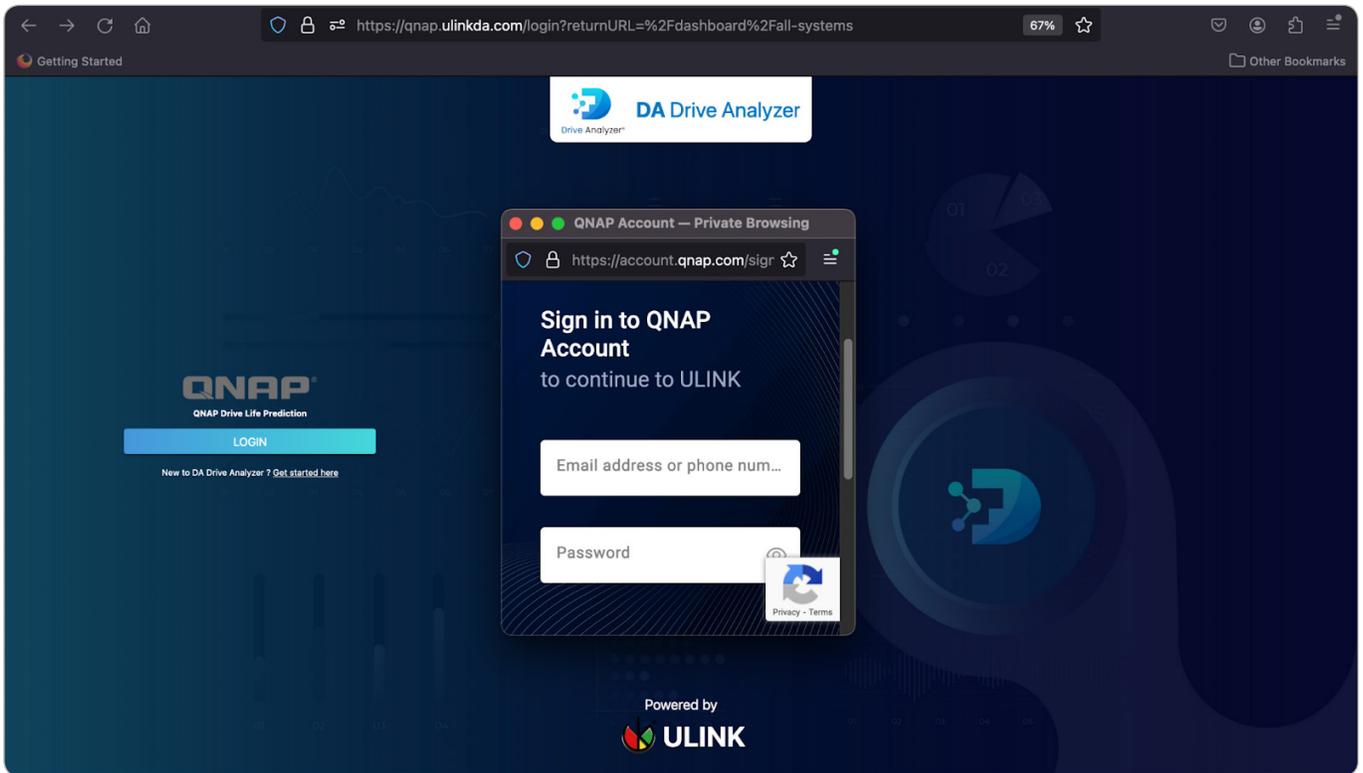
Advanced users can explore features such as the Symptom Radar Chart, Threshold Alerts, and Fault Alerts. They can do so from within our online dashboard, DA Portal (accessible from the menu of DA Drive Analyzer's homepage at <https://ulink-da.com>).

#### Symptom Radar Chart

The Symptom Radar Chart is an ML-based feature within DA Portal that allows users to see which of five health metric groups are showing signs of deterioration. This allows you to quickly narrow down which symptoms may be causing drive deterioration—something the main ML-Based Drive Health Prediction mechanism cannot do at this time.

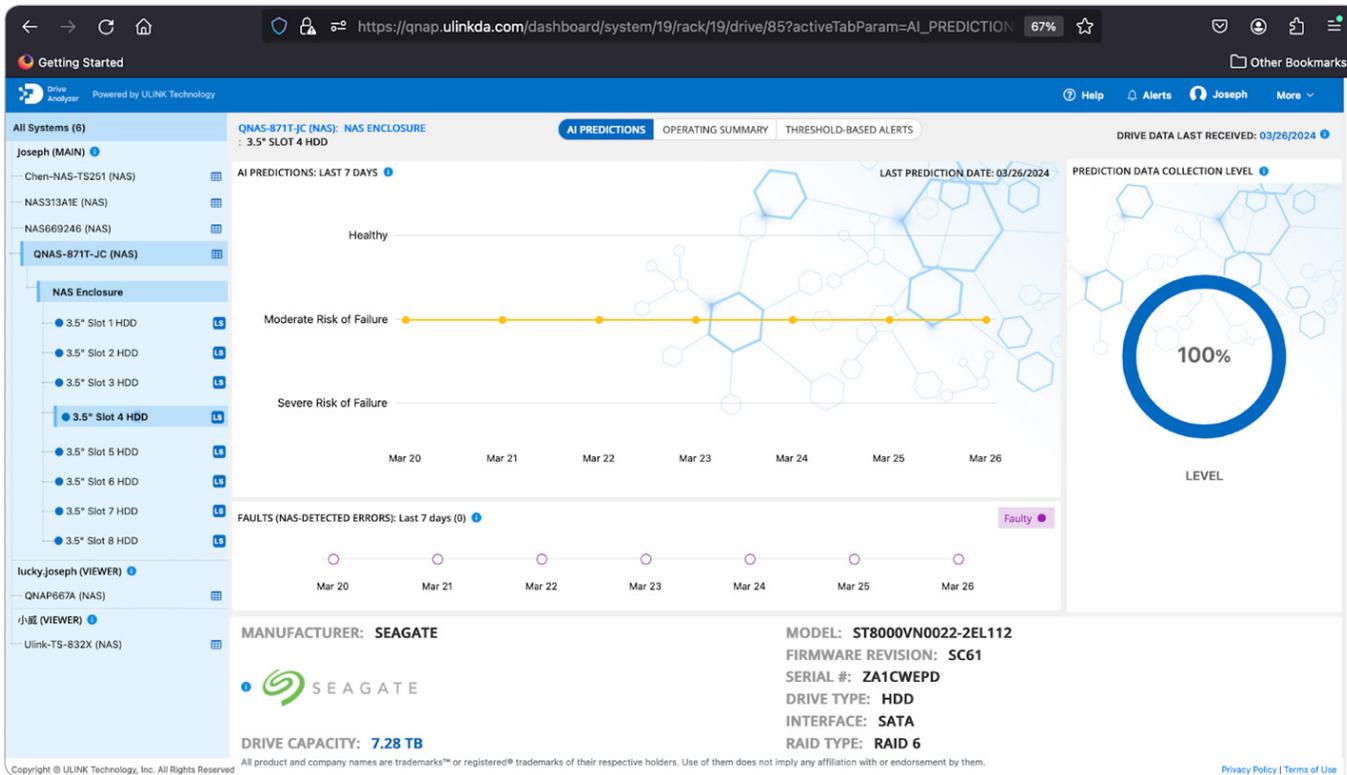
You can also think of the Symptom Radar Chart as an additional drive failure prediction mechanism, in which the lowest symptom score among any of the symptom groups represents the decile survival rate over the next year.

To see this feature, log in to the DA Portal.



*The DA Portal login page*

To navigate to a specific drive, use the left navigation bar.



Navigate to the specific drive via the left navigation bar

Go to the Threshold-Based Alerts tab, and expand the Symptom Radar Chart.

The screenshot shows the 'Threshold-Based Alerts' tab in the Drive Analyzer interface. A 'Symptom Radar Chart' is expanded, showing a score of 4 for the 'Raw Read Data Rate' symptom group. The dashboard also displays a table of drive statistics and SMART attributes.

Stat Name	Stat Type	Alert Criteria	Latest Value	24-hr change	7-Day Trend
Number of Reallocation Log...	lifetime coun...	24-hr change is gre...	60000	664	
Address Mark Not Found (A...	daily count o...	Value is greater than...	0	0	
Command Aborted (ABRT) ...	daily count o...	Value is greater than...	0	0	
Device Error Count	lifetime coun...	24-hr change is gre...	260	0	
Drive Not Ready Failure	daily count o...	none	0	0	
Drive Read Operation Failure	daily count o...	Value is greater than...	0	0	
Drive Write Operation Failure	daily count o...	Value is greater than...	0	0	
Host Software Command TI...	daily count o...	none	0	0	
ID Not Found (IDNF) Count	daily count o...	Value is greater than...	0	0	
IDENTIFY Failure	daily count o...	Value is greater than...	0	0	
Interface CRC Error (ICRC) ...	daily count o...	Value is greater than...	0	0	
Long Latency Read Count	daily count o...	none	900	900	
Long Latency Write Count	daily count o...	none	14438	14438	

SMART ATTRIBUTES	SMART ID (DEC)	Normalized (HEX)	Worst (HEX)	Threshold (HEX)	Raw Values (HEX)
Raw Read Data Rate	1	4D	31	2C	32A0460
Spin-Up Time	3	56	54	0	0
Start/Stop Count	4	62	62	14	B9C
Reallocated Sectors ...	5	13	13	A	4EA60
Seek Error Rate	7	5D	3C	2D	72019622
Power-On Hours (PO...	9	33	33	0	A96D
Spin Retry Count	10	64	64	61	0
Power Cycle Count	12	64	64	14	3C
End-to-End error	184	64	64	63	0
Reported Uncorrecta...	187	1	1	0	104
Command Timeout	188	64	64	0	0
High Fly Writes	189	64	64	0	0
Temperature Differen...	190	37	2F	28	3229002D

*Expand the Symptom Radar Chart via the Threshold-Based Alerts*

Here, we see a drive with 3 out of 5 symptom groups experiencing deterioration (anything less than a score of 10 is deterioration). The SMART symptom group receives the lowest score of 4. This means that this drive has an approximate 40% chance of being usable a year from now.

The screenshot displays the QNAP Drive Analyzer dashboard for a system named 'QNAS-871T-JC (NAS)'. The interface is divided into several sections:

- Left Sidebar:** Lists systems under 'Joseph (MAIN)' and 'luckyjoseph (VIEWER)'. The '3.5" Slot 4 HDD' is selected.
- Top Section:** Shows 'THRESHOLD-BASED ALERT SUMMARY' with a timeline from Mar 20 to Mar 26. A 'SYMPTOM RADAR CHART' is visible, with 'Drive-Detected Issues' highlighted in blue and a 'PATENT PENDING' label.
- Table 1: OTHER DRIVE STATS**

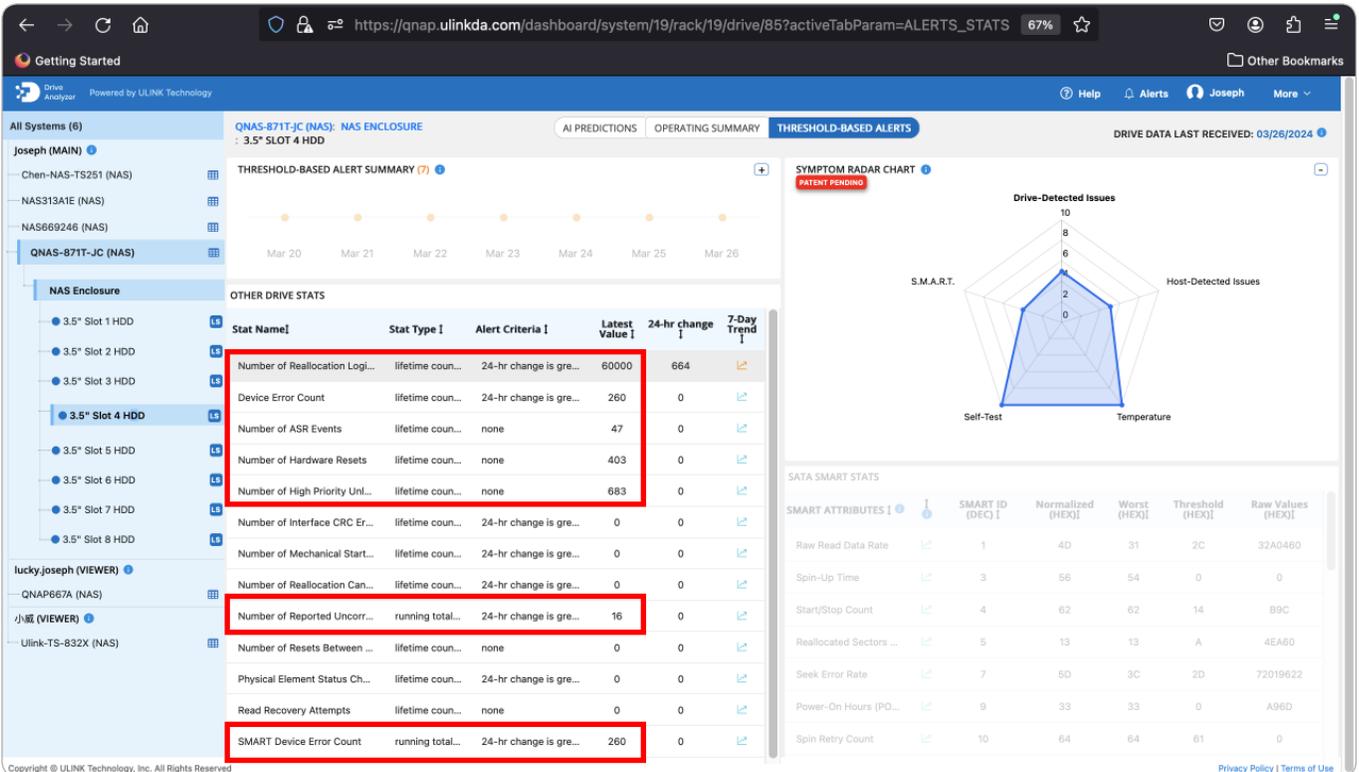
Stat Name	Stat Type	Alert Criteria	Latest Value	24-hr change	7-Day Trend
Number of Reallocation Log...	lifetime coun...	24-hr change is gre...	60000	664	
Address Mark Not Found (A...	daily count o...	Value is greater than...	0	0	
Command Aborted (ABRT) ...	daily count o...	Value is greater than...	0	0	
Device Error Count	lifetime coun...	24-hr change is gre...	260	0	
Drive Not Ready Failure	daily count o...	none	0	0	
Drive Read Operation Failure	daily count o...	Value is greater than...	0	0	
Drive Write Operation Failure	daily count o...	Value is greater than...	0	0	
Host Software Command TL...	daily count o...	none	0	0	
ID Not Found (IDNF) Count	daily count o...	Value is greater than...	0	0	
IDENTIFY Failure	daily count o...	Value is greater than...	0	0	
Interface CRC Error (ICRC) ...	daily count o...	Value is greater than...	0	0	
Long Latency Read Count	daily count o...	none	900	900	
Long Latency Write Count	daily count o...	none	14438	14438	

SMART ATTRIBUTES	SMART ID (DEC)	Normalized (HEX)	Worst (HEX)	Threshold (HEX)	Raw Values (HEX)
Raw Read Data Rate	1	4D	31	2C	32A0460
Spin-Up Time	3	56	54	0	0
Start/Stop Count	4	62	62	14	B9C
Reallocated Sectors ...	5	18	13	A	4EA80
Seek Error Rate	7	5D	3C	2D	72019622
Power-On Hours (PO...	9	33	33	0	A96D
Spin Retry Count	10	64	64	61	0

*Click on a symptom group to highlight it's respective health metrics.*

Clicking on a symptom group highlights health metrics related to that group, as we can see by clicking on the Drive-Detected Issues group below. A quick glance tells us that within the Drive-Detected Issues group, several health metrics are showing elevated values, such as the number of reallocated logical sectors, device error count, and ASR events.



Health metrics show elevated values.

Each of the elevated symptoms potentially tells us something about the problems that this drive is experiencing. For example, the increased number of high-priority unload events (5th symptom from the top) indicates that the drive may have experienced shock or power supply issues in the past that necessitated emergency retraction of the read/write head.

## Threshold Alerts

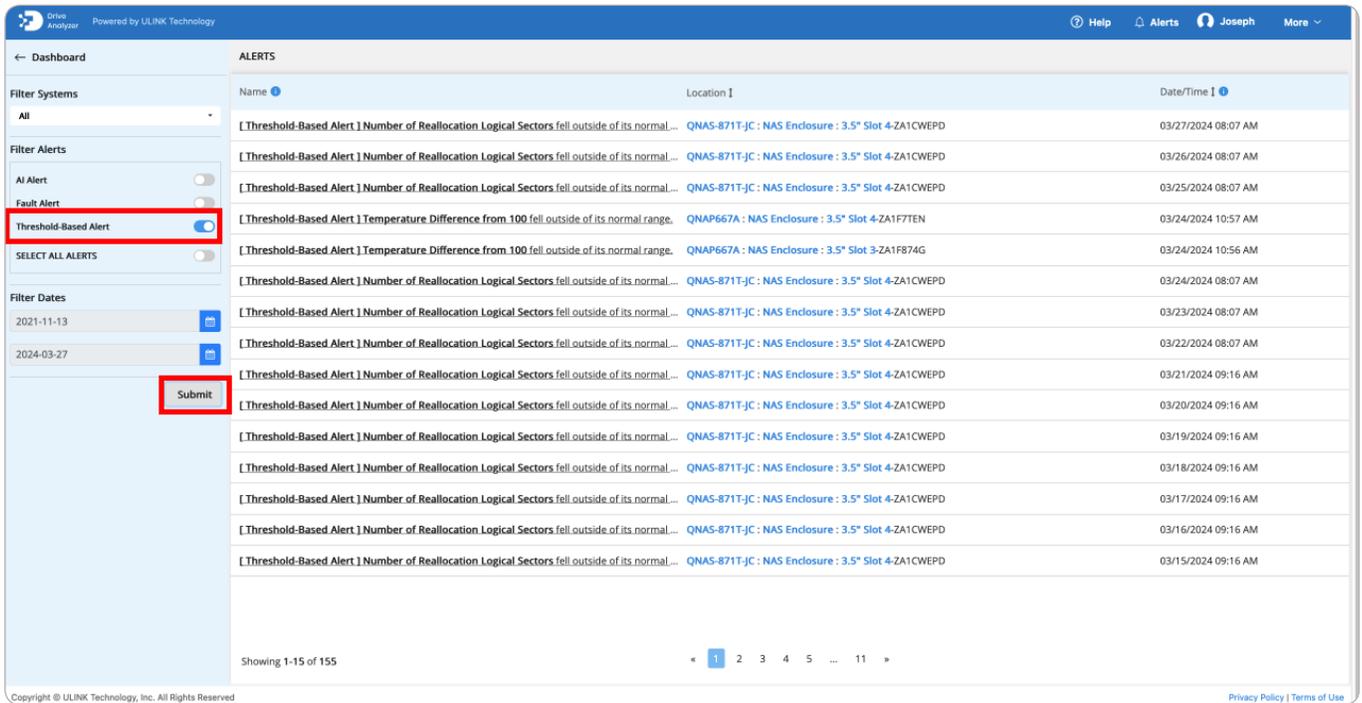
Threshold Alerts are a feature of the DA Drive Analyzer, which is similar to the Symptom Radar Chart in that it can help you pinpoint the cause of drive problems. Unlike the Symptom Radar Chart, it does not rely on ML. Instead, ULINK triggers this alert system whenever certain important symptoms exceed a predefined threshold.

The easiest way to see Threshold Alerts in the DA Portal is by clicking on Alerts in the DA Portal.



Click on Alerts in the DA Portal's top navigation to view Threshold Alerts.

Then select Threshold-Based Alerts on the filter and hit Submit.



The screenshot shows the 'Alerts' page in the Drive Analyzer interface. On the left sidebar, under 'Filter Alerts', the 'Threshold-Based Alert' toggle is turned on and highlighted with a red box. Below it, the 'Submit' button is also highlighted with a red box. The main area displays a table of alerts with columns for Name, Location, and Date/Time. The table contains 15 rows of alert data, all starting with '[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...'. The footer of the page shows 'Showing 1-15 of 155' and a pagination control with page numbers 1, 2, 3, 4, 5, and 11.

Name	Location	Date/Time
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/27/2024 08:07 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/26/2024 08:07 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/25/2024 08:07 AM
[Threshold-Based Alert] Temperature Difference from 100 fell outside of its normal range.	QNAP667A : NAS Enclosure : 3.5" Slot 3-ZA1F77EN	03/24/2024 10:57 AM
[Threshold-Based Alert] Temperature Difference from 100 fell outside of its normal range.	QNAP667A : NAS Enclosure : 3.5" Slot 3-ZA1F874G	03/24/2024 10:56 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/24/2024 08:07 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/23/2024 08:07 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/22/2024 08:07 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/21/2024 09:16 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/20/2024 09:16 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/19/2024 09:16 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/18/2024 09:16 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/17/2024 09:16 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/16/2024 09:16 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/15/2024 09:16 AM

Select Threshold-Based Alerts on the filter, and hit Submit.

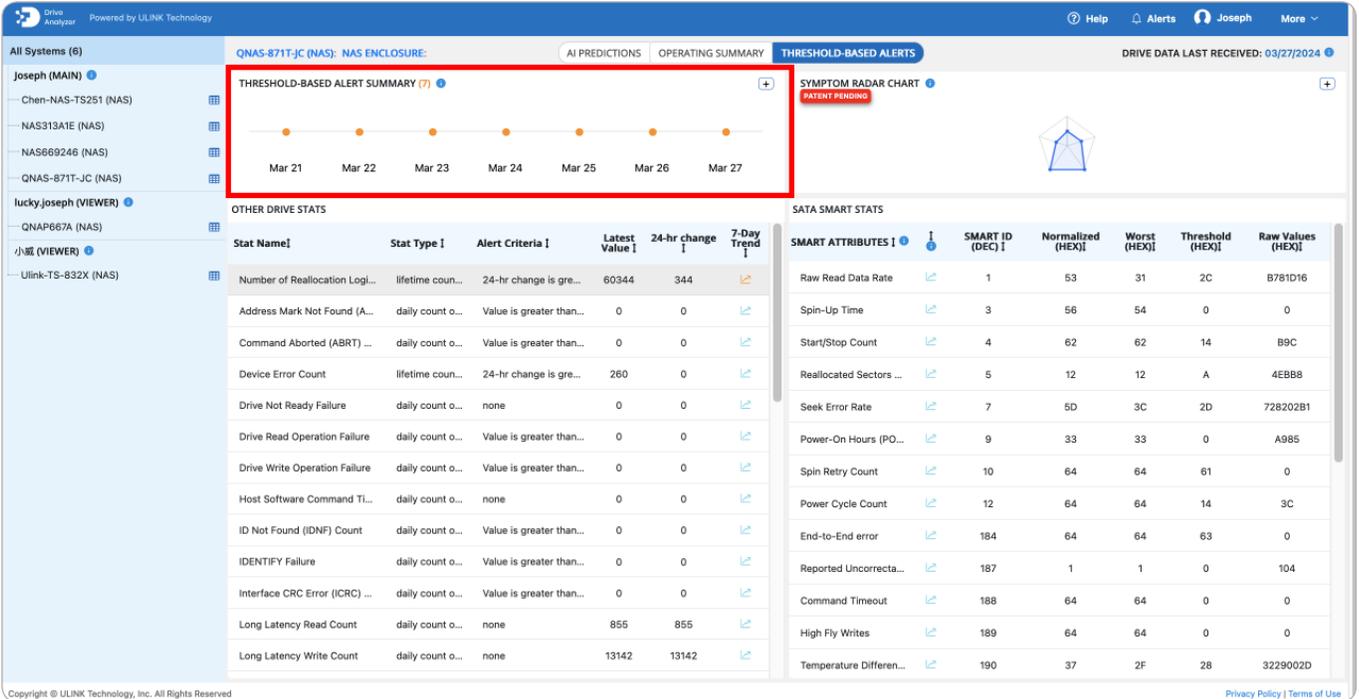
Threshold Alerts will appear on the table to the right. Click on the slot of any Threshold Alert to go to the drive that generated the Threshold Alert.

Name	Location	Date/Time
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/27/2024 08:07 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/26/2024 08:07 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/25/2024 08:07 AM
[Threshold-Based Alert] Temperature Difference from 100 fell outside of its normal range.	QNAP667A : NAS Enclosure : 3.5" Slot 4-ZA1F7TEN	03/24/2024 10:57 AM
[Threshold-Based Alert] Temperature Difference from 100 fell outside of its normal range.	QNAP667A : NAS Enclosure : 3.5" Slot 3-ZA1F874G	03/24/2024 10:56 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/24/2024 08:07 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/23/2024 08:07 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/22/2024 08:07 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/21/2024 09:16 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/20/2024 09:16 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/19/2024 09:16 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/18/2024 09:16 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/17/2024 09:16 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/16/2024 09:16 AM
[Threshold-Based Alert] Number of Reallocation Logical Sectors fell outside of its normal...	QNAS-871T-JC : NAS Enclosure : 3.5" Slot 4-ZA1CWEPD	03/15/2024 09:16 AM

Showing 1-15 of 155

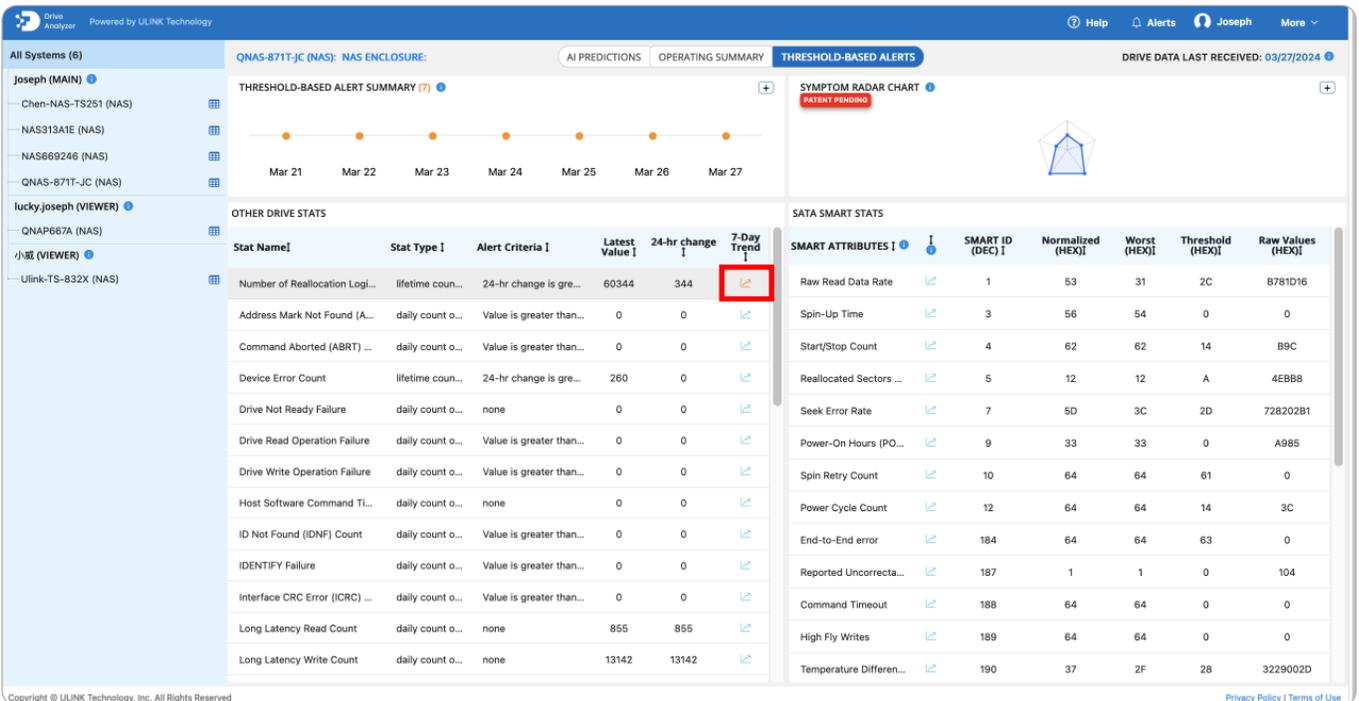
*Click on the Slot of the specific Threshold Alert.*

Once you are at the drive level, click on the Threshold-Based Alerts tab. The top left will display recent dates in the form of orange dots where threshold alerts have occurred.



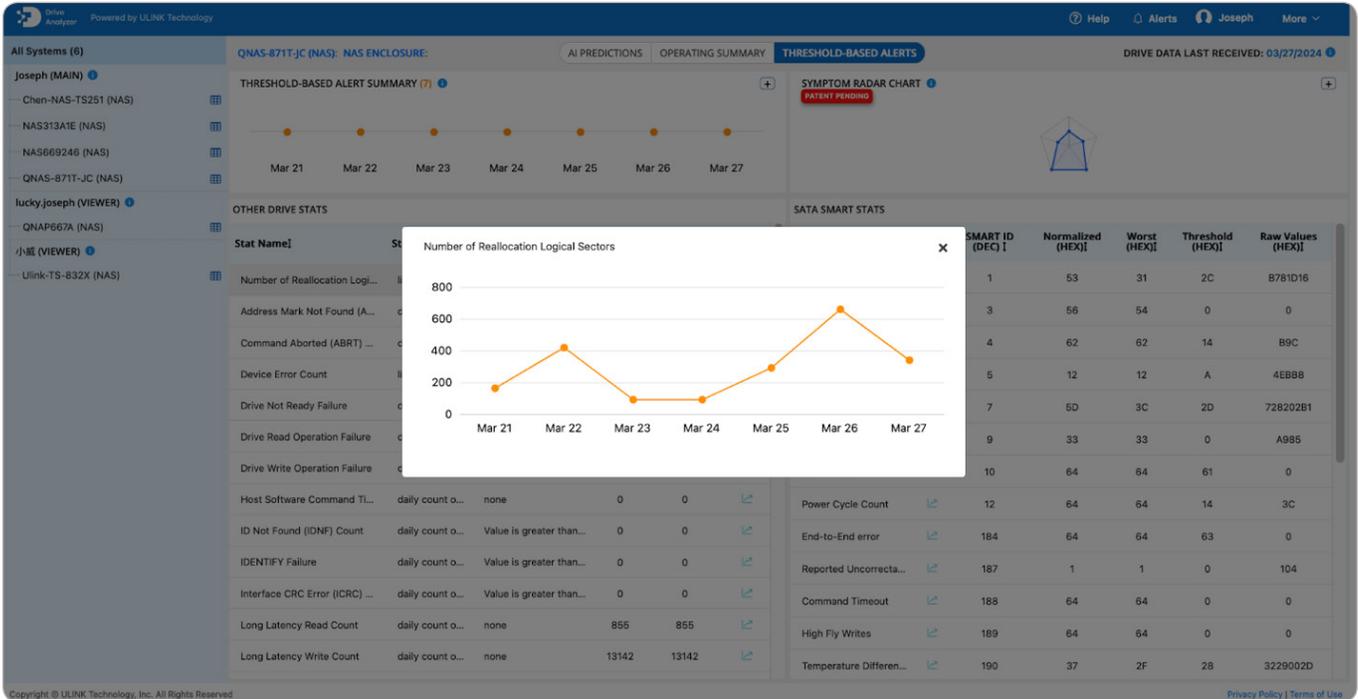
Threshold alerts for recent dates are shown on the top left as orange dots.

An orange trend symbol will indicate individual threshold alerts at the bottom left or bottom right.



Individual threshold alert on the bottom right with an orange trend symbol.

In the example drive above, the health metric, the number of reallocated logical sectors, changed in the last 24 hours, which triggered a Threshold Alert. Clicking on the trend symbol allows us to view this metric over the last 7 days, revealing a recent elevation that suggests damage to the disk's surface.



Clicking on the trend symbol shows the metric of the last 7 days.

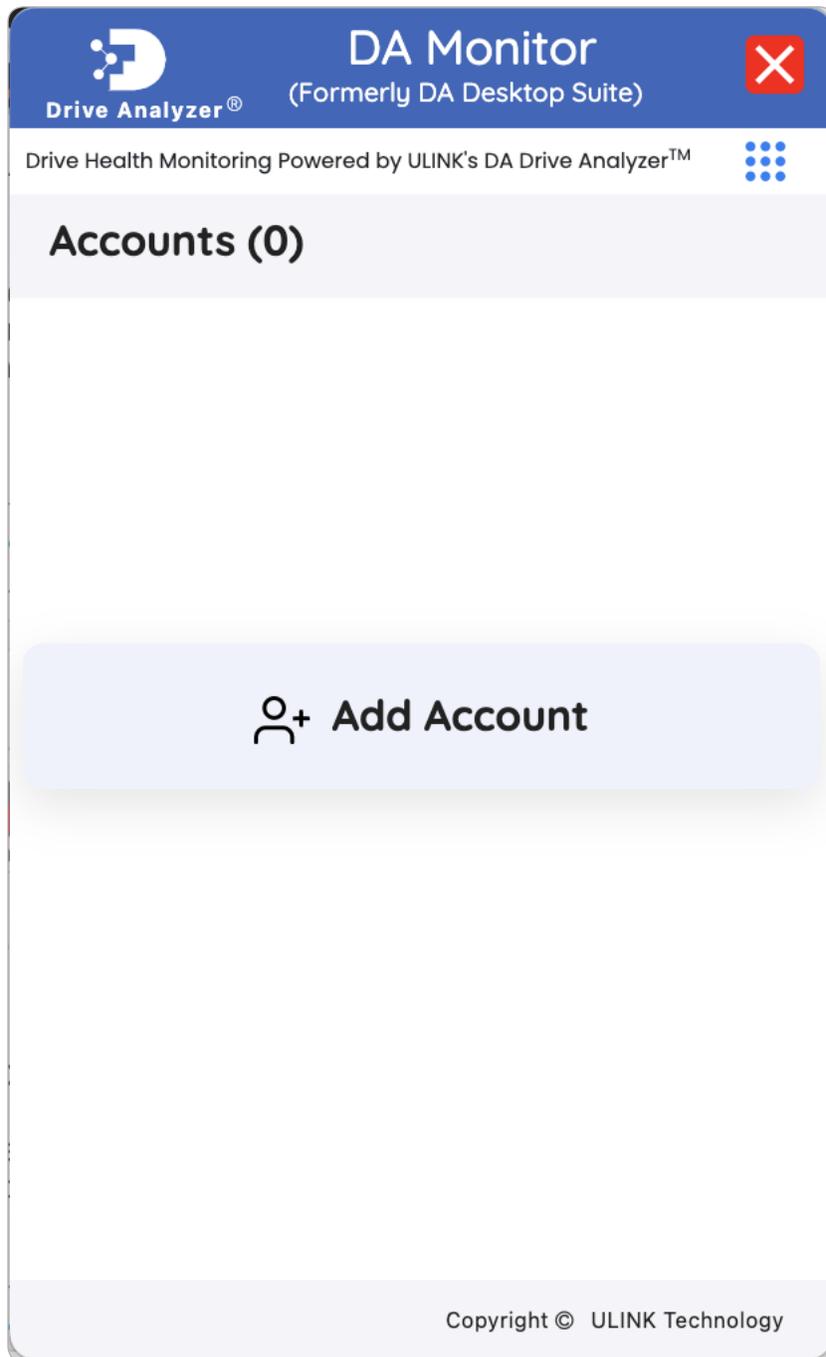
## 4.B. DA Monitor

There may be times when an advanced user, such as an IT manager, needs to monitor the health of drives for several people, each of whom has one or more computer or NAS systems monitored by a DA Drive Analyzer. The fastest way to do this is to use DA Monitor, which allows for quick and centralized drive monitoring.

DA Monitor is a desktop application that lets you add DA Drive Analyzer users and then view the number of at-risk drives for each user at a glance. It runs on Windows and Mac.

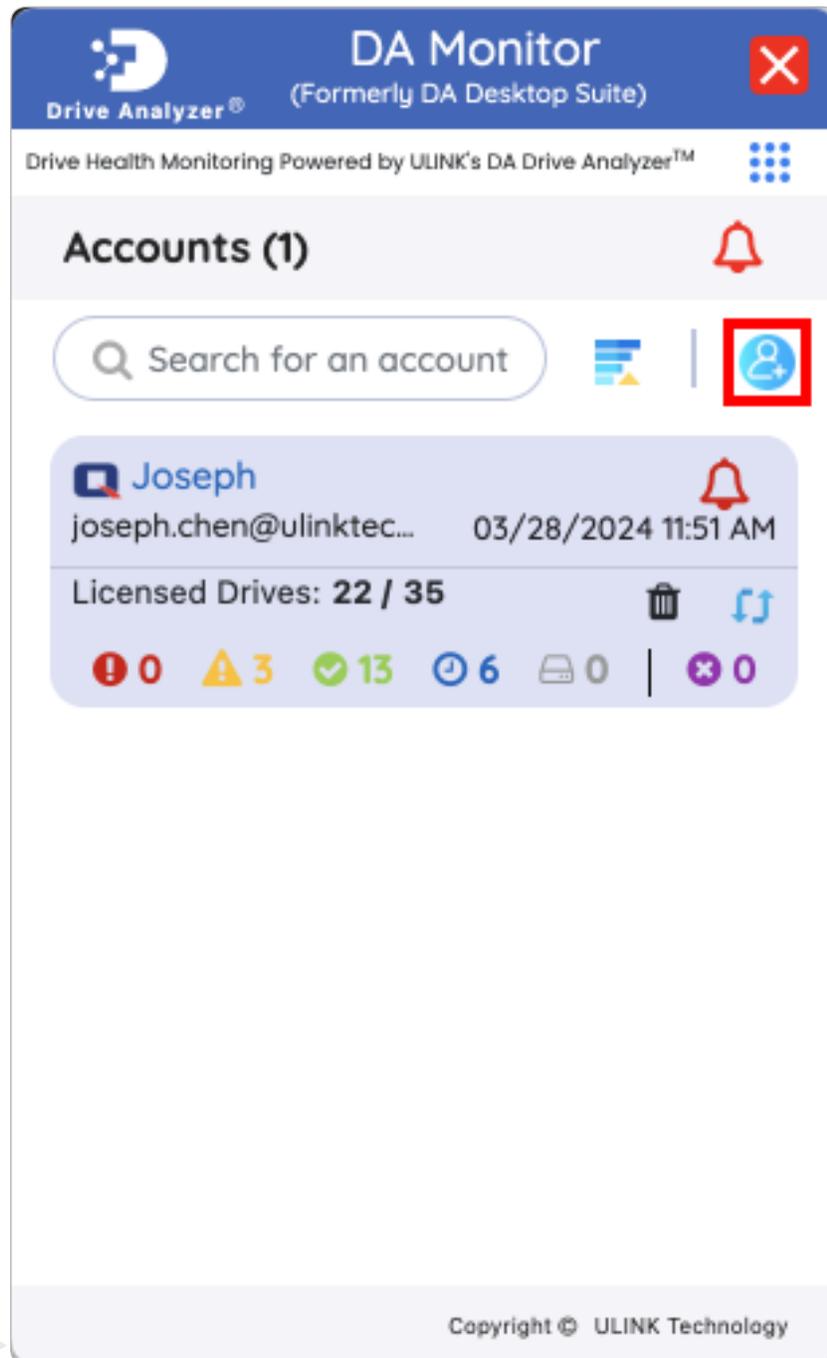
You can download DA Monitor from [https://ulink-da.com/da\\_monitor/](https://ulink-da.com/da_monitor/).

Once you have installed the application, you can create your first account by clicking Add Account. Follow the instructions and enter the account name and password for the user you are trying to add.



*Add your first account by clicking on Add Account*

To add additional user accounts, click on the Add Account button, which looks like a user profile.

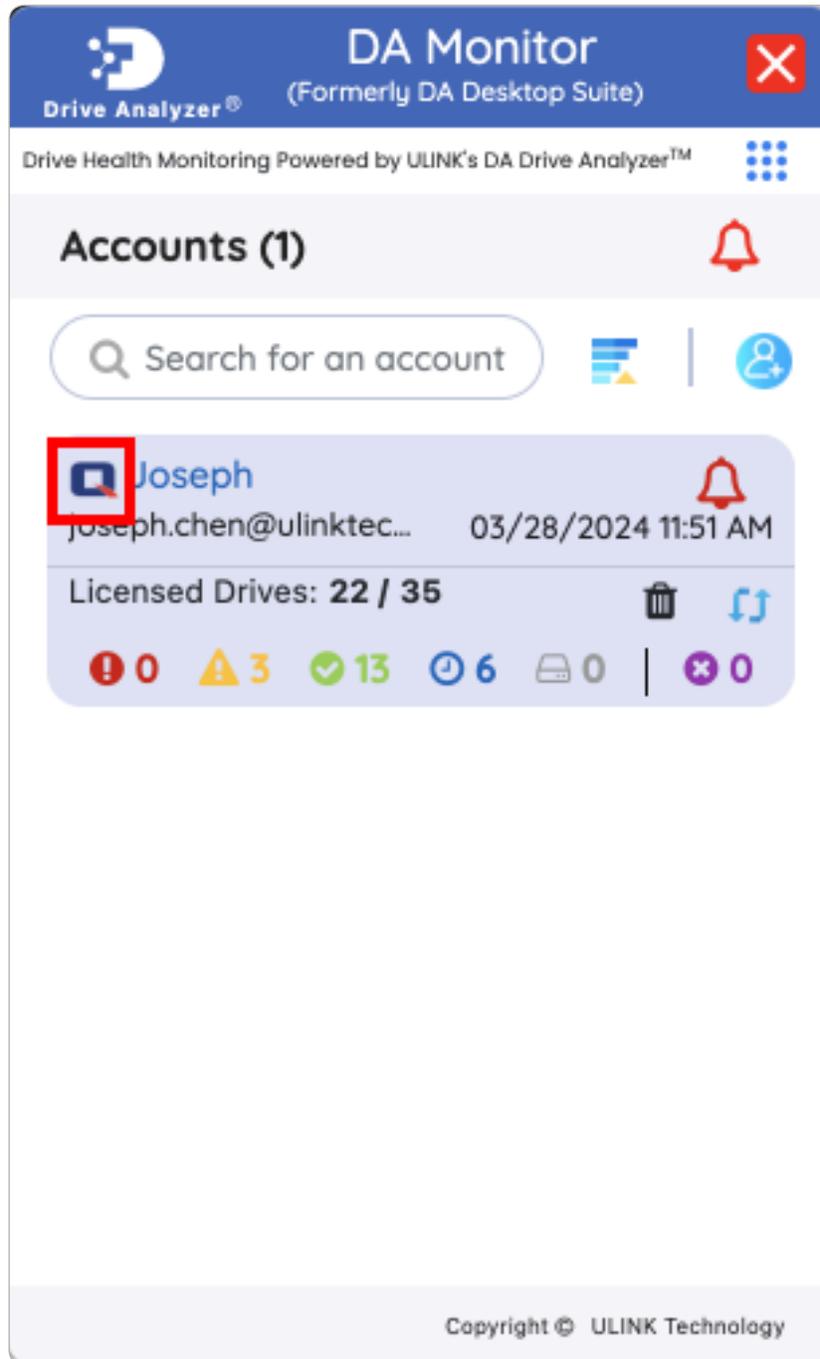


*Click on the Add Account button to add additional user accounts.*

If a user has any drives predicted to fail soon by DA Drive Analyzer, you will see a non-zero number next to the red (Severe Risk) or yellow (Moderate Risk) icons. In the aforementioned example, a “3” appears next to the yellow

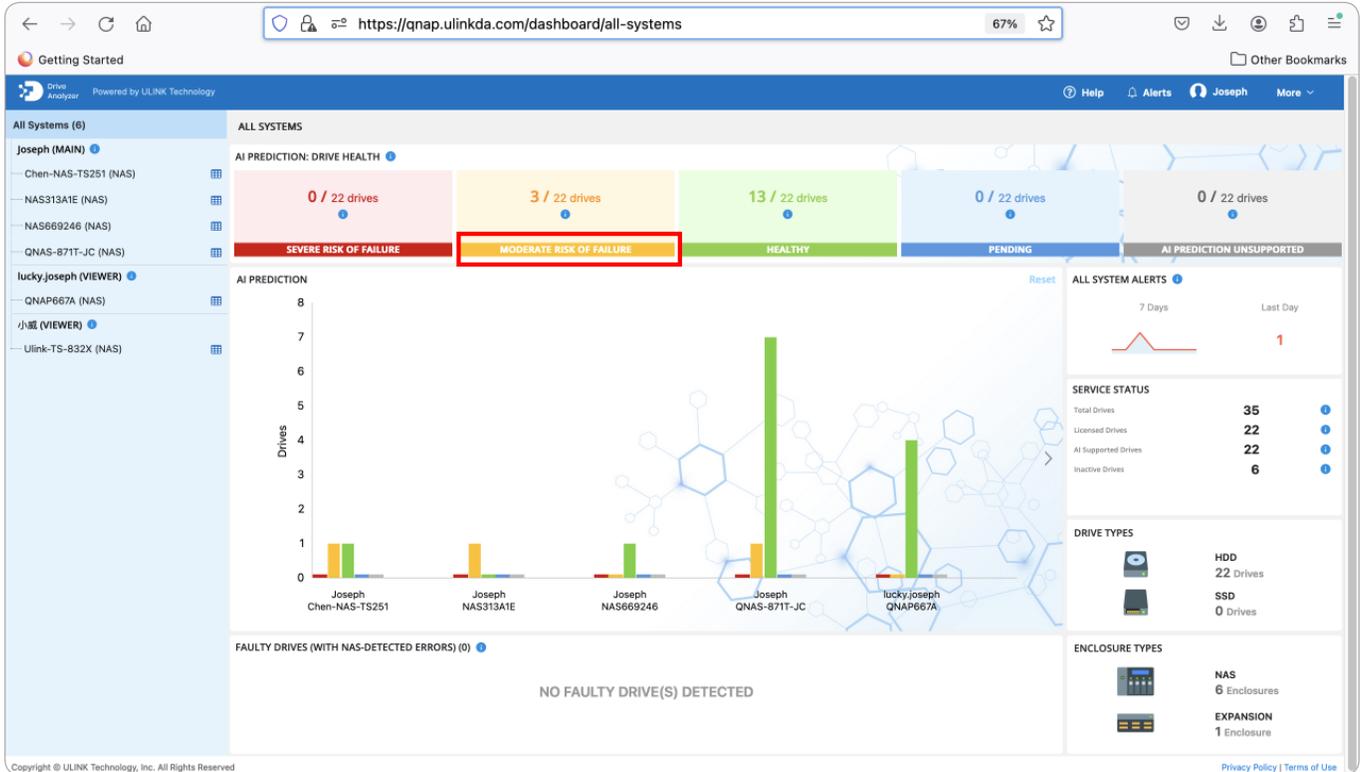
Moderate Risk icon, indicating that Joseph, the user, has three drives on the verge of failure.

To check the location of these 3 drives in the DA Portal, click on the logo on the top left corner of the user's card, which will take us to the DA Portal.



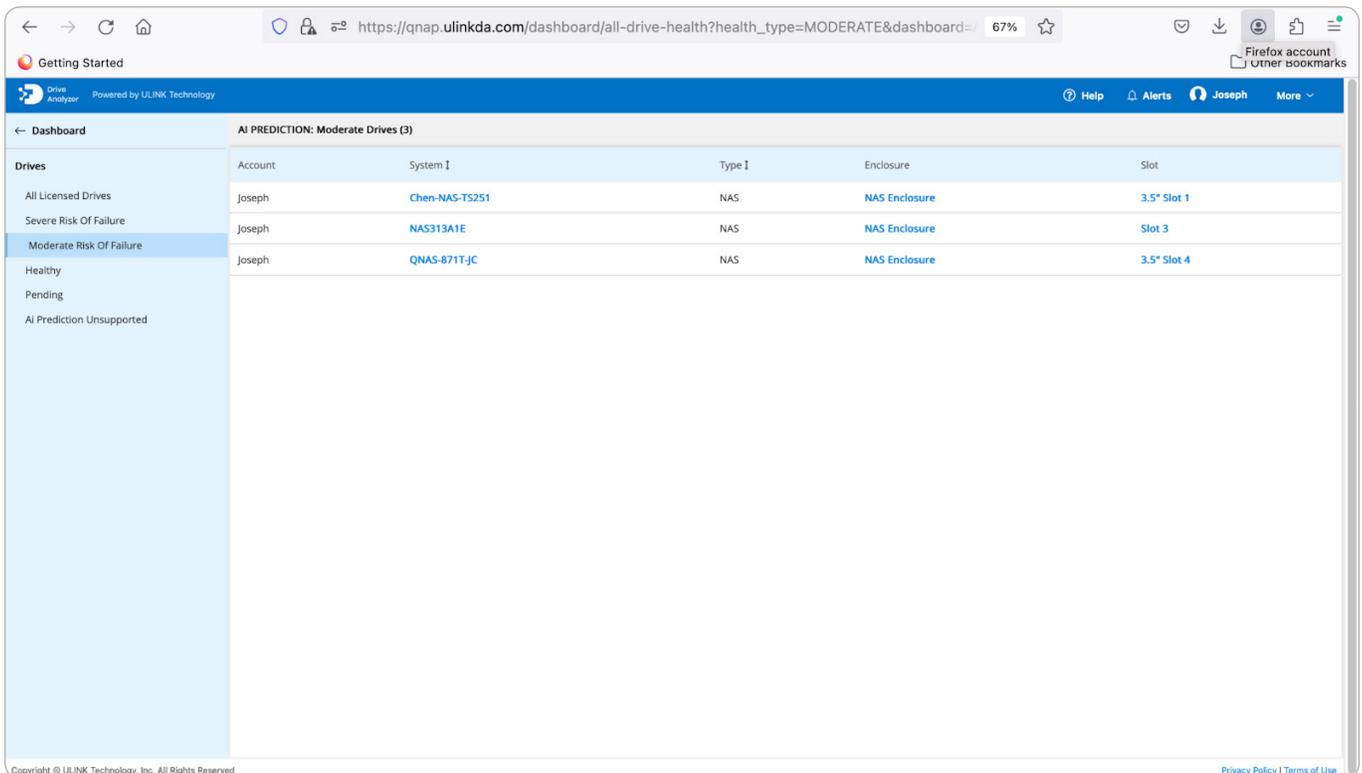
*Click on the logo on the top left corner of the user's card to check the location of the drives.*

Once we are in DA Portal, we can click on the yellow MODERATE RISK OF FAILURE (or the red SEVERE RISK OF FAILURE if DA Portal showed any red Severe Risk drives), which will take us to a table containing the three drives we saw in DA Monitor.



*A table containing the three drives we saw in DA Monitor.*

In this table, we can see the computer or NAS system, drive enclosure, and slot number of the three yellow Moderate-Risk drives, which let's locate the physical drives.



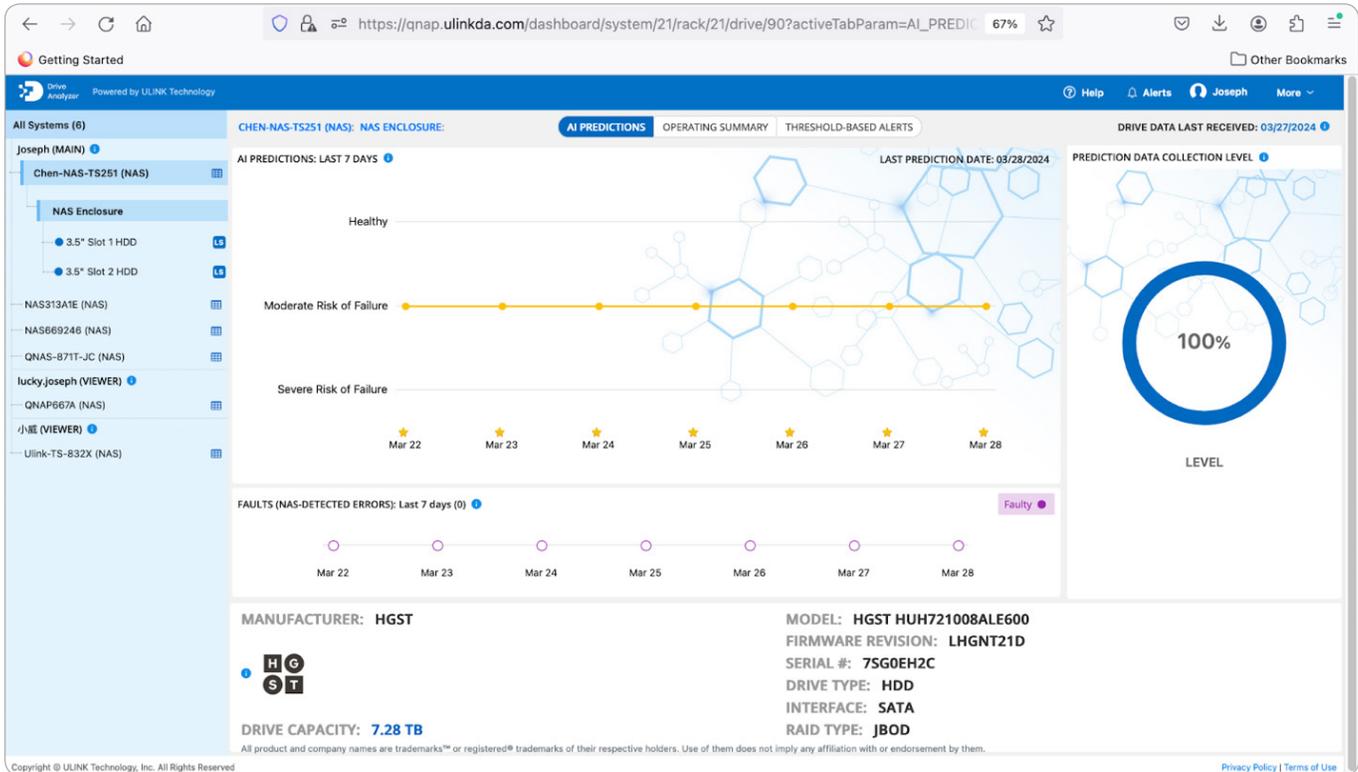
The screenshot shows the QNAP Drive Analyzer dashboard. The browser address bar displays the URL: [https://qnap.ulinkda.com/dashboard/all-drive-health?health\\_type=MODERATE&dashboard=](https://qnap.ulinkda.com/dashboard/all-drive-health?health_type=MODERATE&dashboard=). The dashboard header includes "Getting Started", "Drive Analyzer Powered by ULINK Technology", and user information for "Joseph". The main content area is titled "AI PREDICTION: Moderate Drives (3)" and contains a table with the following data:

Account	System I	Type I	Enclosure	Slot
Joseph	Chen-NAS-TS251	NAS	NAS Enclosure	3.5" Slot 1
Joseph	NAS313A1E	NAS	NAS Enclosure	Slot 3
Joseph	QNAS-871T-JC	NAS	NAS Enclosure	3.5" Slot 4

The left sidebar shows navigation options: "All Licensed Drives", "Severe Risk Of Failure", "Moderate Risk Of Failure" (highlighted), "Healthy", "Pending", and "AI Prediction Unsupported". The footer contains "Copyright © ULINK Technology, Inc. All Rights Reserved" and "Privacy Policy | Terms of Use".

*Clicking on the slot number of any of these drives to view that drive's page.*

Clicking on the slot number of any of these drives will take us to that drive's page, where we can see recent health trends for that drive as well as its serial number.



The Drive's page with its health trends and its serial number.

## 5. WHAT SHOULD YOU DO WHEN A DRIVE IS AT RISK?

What should you do if you see a drive that has been predicted Moderate Risk or Severe Risk by the DA Drive Analyzer?

To protect your data, we recommend either backing up that drive immediately and frequently going forward or replacing it. Two levels of risk, Severe and Moderate, are provided by the DA Drive Analyzer so that the user can better weigh how to act based on their risk tolerance, budget, and SLAs in the case of businesses.

Once at-risk drives have been identified, advanced users can additionally explore the cause of drive deterioration with the Symptom Radar Chart, or Threshold Alerts.

Perhaps the drive enclosure temperature is excessive. Or perhaps a loose cable is causing problems. With these features, the DA Analyzer can help you pinpoint possible causes of drive failures.

## References

1. <https://www.backblaze.com/blog/backblaze-drive-stats-for-q3-2023/>
2. Miller, Z., Medaiyese, O., Ravi, M., Beatty, A., & Lin, F. (2023, June). Hard Disk Drive Failure Analysis and Prediction: An Industry View. In 2023, the 53rd Annual IEEE/IFIP International Conference on Dependable Systems and Networks—Supplemental Volume (DSN-S) (pp. 21–27) IEEE.



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