APPLICATION NOTE

Protection and Redundancy for Routing Switchers

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The impact of routing switcher failures can be significant. This document details various technologies and implementations that are used to minimize the possibility of such failures.

Introduction

Any disruption of service with routing switchers is a constant concern to users. Due to the nature of routing switcher architectures used today, this concern is directly related to the size of the broadcast infrastructure in use.

It is very common in broadcast infrastructures to protect the signal path by using patch panels surrounded by input patches as well as output patches. In the past, the routing switcher was typically surrounded by patch panels to manually re-establish critical signal paths in case they were lost during a routing switcher failure. Considering the cable run when a patch is made—in addition to the impact of any interconnects and the use of different coaxial cable types—in most cases there will be no high data-rate signal present at the destination point. Therefore, patch panels have become obsolete and impractical to use for many applications, and new solutions need to be considered in case a routing switcher path or other critical element is lost.

There are other methods that could be used in broadcast infrastructure. One example would be a redundant routing switcher. In this case, the redundant routing switcher is put in service and allows the user to replace patch panels, but this can be too costly for many facilities.

The concerns of a service disruption often lead to a discussion of "mean time between failure" rates. Unfortunately, MTBF specifications are normally given for power supplies and ventilation units only, and not for specific board types. Also, the implementation of redundant matrix boards does not address the issue as signal paths can still be lost.

In general, board reliability is determined by board components with the lowest reliability expectation. The MTBF for a Grass Valley® Trinix® NXT matrix board would be in a range of 6,000,000 hours, which is not really defensible.

The Trinix NXT MTBF figures available are as follows:

- Trinix NXT power supplies: 150,000 hours
- Ventilation units: 75,000 hours

As these are the most critical parts inside a routing switcher, they are 100% redundant. Additionally, thanks to its 48 volt DC architecture, an N+N power redundancy level is easy achievable.

The availability of redundant matrix boards does not make a typical routing switcher more reliable as all implementations are based on switch-over technology combined with a single decision "engine" to put the redundant matrix board into the signal path. This switch-over technology is significantly more risky than the potential for failure of the matrix IC. The decision "engine" is in itself a single point of failure.

Since a routing switcher consists of many more subsystems—like input equalizers, output amplifiers, etc—which are not redundant, the redundant-matrix solution is itself flawed, and will protect the signal path only in the case of failure of the matrix itself. With so many other subsystems subject to failure, the path itself through the routing switcher is not protected by a redundant matrix board.

To achieve 100% reliability inside a routing switcher, all parts of the signal-path must be redundant. Grass Valley is the only manufacturer that is able to achieve 100% redundancy by using two routing switcher paths or two complete routing switchers passively split at the input side and passively combined at the output side. This passive splitting and combining assures 100% redundancy on any protected signal path.

Signal Path

Signal handling within a typical routing switcher is influenced by eight major circuits, each with its own failure risk factor:

1.	Impedance Conversion	0.010%
2.	Input Equalizer	0.003%
3.	Impedance Conversion	0.010%
4.	Matrix IC	0.001%
5.	Impedance Conversion	0.010%
6.	Reclocker	0.003%
7.	Output Amplifier	0.003%
8.	Impedance Conversion	0.010%

Trinix NXT is very unique in the market as it uses a technology called impedance matching, which reduces the amount of impedance conversions and maintains the impedance throughout the entire path. This reduces the typical signal handling steps by two:

1.	Input Equalizer	0.003%
2.	Impedance Conversion	0.010%
3.	Matrix IC	0.001%
4.	Impedance Conversion	0.010%
5.	Reclocker	0.003%
6.	Output Amplifier	0.003%

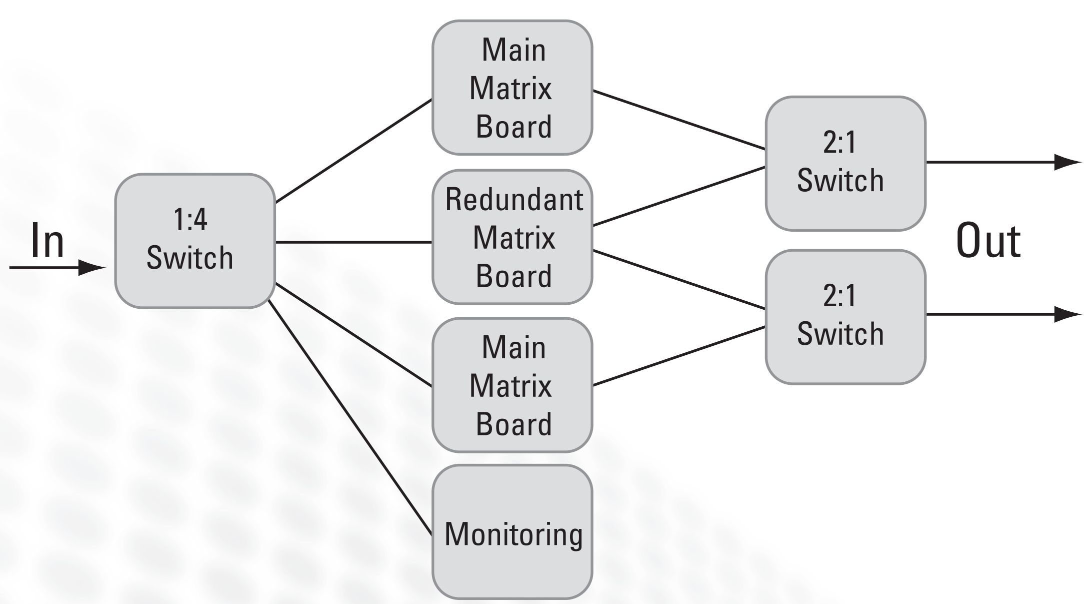
With fewer signal handling steps, the Trinix NXT signal path is already less critical than any other routing switcher. Additionally, the matrix block itself has the lowest risk for failure across all other signal handling circuits within a signal path. In other words, there are many other components which can cause a failure before the matrix IC itself would fail. Furthermore, matrix IC failures are typically on a cross-point by cross-point basis, not affecting the entire matrix block, so the impact is minimized relative to the entire routing switcher.

That said, 100% redundancy is only achievable by duplicating everything using dual paths. Grass Valley is unique in that Trinix NXT can scale its protection and its cost by providing protected paths for only specific signals through the same physical chassis all the way to a true 100% redundancy for some, or for all paths with a passively mirrored routing switcher.

Other manufacturers have introduced very risky routing switcher architectures that use very large scale matrix boards. One manufacturer has started using 576x288 matrix boards while another has started using 576x576 matrix boards. As a result, two matrix boards from one supplier can create a 576x576 routing switcher, while one matrix board from another supplier can create a 576x576 routing switcher, with two matrix boards creating a 576x1152 routing switcher. This new practice of using very large scale matrix boards introduces an extremely high risk factor.

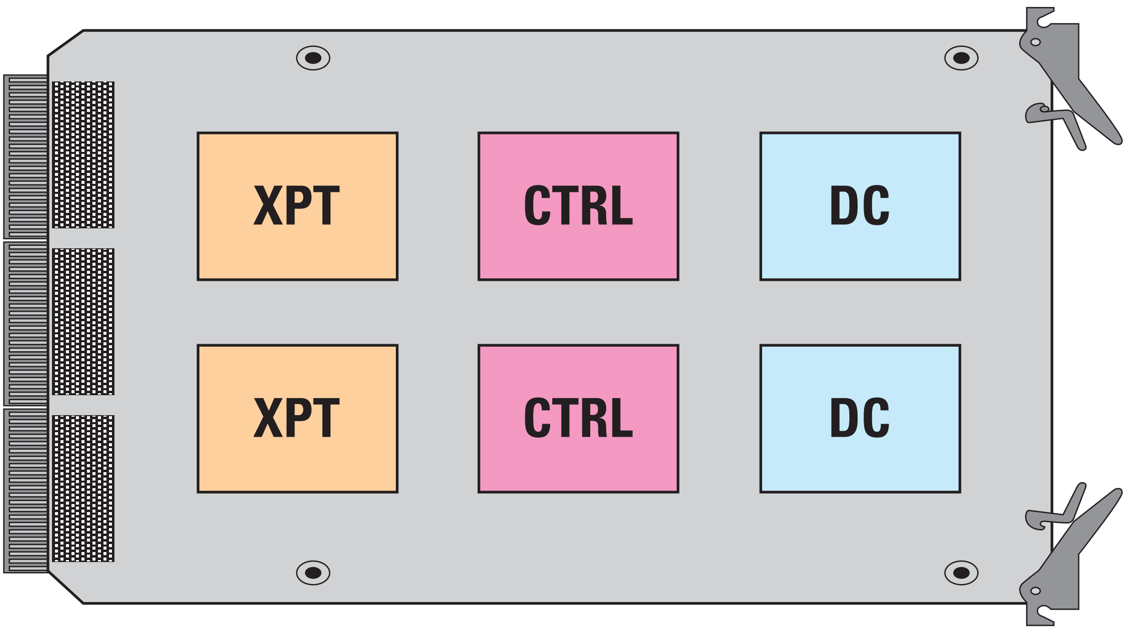
To avoid catastrophic failures, these manufacturers were forced to introduce a redundant matrix board solution to try and overcome this specific objection.

Those manufacturers currently sell this as an advantage, but in fact their routing switcher systems have become less reliable as the added components (such as 1:4, 2:1, or 3:1 switches and the switch-over decision electronics) are far more likely to fail than the actual matrix IC.



Grass Valley's Approach

All Grass Valley routing switchers are built with the highest possible reliability and long life cycles with uncompromised architecture. Grass Valley has not followed the trend of increasing density as others have. Furthermore, Grass Valley believes in trying to use fewer components to gain more security. As the most at-risk parts should be made redundant, the Trinix NXT matrix board architecture uses dual DC/DC converters as well as a dual XPT bus control on each physical matrix board. Each matrix board contains two matrix ICs and each is 128x128. Therefore two matrix boards creates a 256 matrix block, which is the largest Grass Valley uses in its routing switchers. To create a 512x1024 routing switcher, eight matrix blocks based on 16 matrix boards are used.



Conclusion

It is easy to understand that switch-over redundancy adds risk instead of decreasing risk. This is comparable to an airplane with two engines where only one is active and the other first has to start up if there is a primary engine failure. In addition, someone is needed to make the decision as to when to switch over, and they cannot be sure that the redundant part is up and running correctly. In addition, there is the risk that the switch-over itself doesn't execute properly.

Grass Valley has never used such methods and believes that true redundancy can only be achieved by using a "load-sharing model" in which all components are active at all times—and it is only a matter of which component takes how much of the load, and when.

The Grass Valley matrix board architecture is based on this principle and is at least 60% less prone to failure when compared to the other two leading routing switcher manufacturers—just based on the physical size and the impact this has on reliability. There is also the previously mentioned issue of individual component parts not being redundant.

With all critical elements being redundant, power consumption the lowest possible, and the most efficient natural airflow within a Grass Valley routing switcher, the logical benefit to the user is long life with high reliability.

Signal protection is heavily impacted by input equalizing as well as output amplifying; the matrix board itself has the lowest risk within the signal path. That is the reason Grass Valley has implemented "Protected-Path" load sharing by running all critical signals over independent input-, matrix-, and output-boards twice.

The information presented here should clarify any discussion of redundant matrix boards. True redundancy can only be achieved by having true system replication.

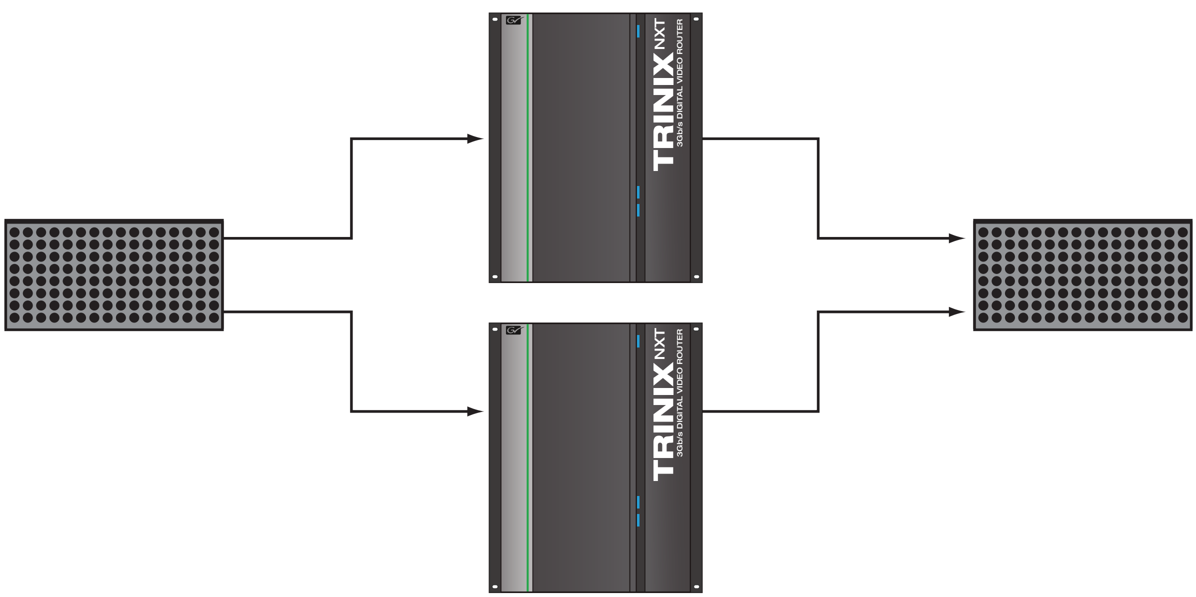


Illustration of a fully redundant routing switcher solution called "Protected Router."