CHANGING THE WAY OPERATORS DELIVER TV

Mute-On-Error

&

Monitor-In-Out

For X platform

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2 Revision History

Version	Date	Name	Comment
1.0.0	21.06.19	David Mitchinson	Initial version
2.0.0	04.07.19	David Mitchinson	Additions and enhancements
3.00	23.06.20	David Mitchinson	Minor corrections to text
4.00	26.02.21	David Mitchinson	Addition of example alarm triggers

3 Introduction

Appear TV has a long history of expertise in designing high density modular solutions. One of the issues with having a flexible product that invites customers to build many different types and styles of solution, is how to implement redundancy and provide protection against both source, distribution network and equipment failure.
Appear TV offers an extensive toolkit of redundancy options on both XC and X platforms. Three in particular can serve a hybrid role and protect outgoing services against equipment failure and network failure; these are MUTE ON ERROR, MONITOR IN OUT and OSPF OUTPUT REDUNDANCY.

This document focuses on two of these redundancy options MUTE ON ERROR and MONITOR IN OUT because they are technically related. Although both are supported on the XC platform, this document focusses on the implementation provided on X platform and since it is not really possible to understand MONITOR IN OUT without understanding how MUTE ON ERROR works, this topic will be presented first.

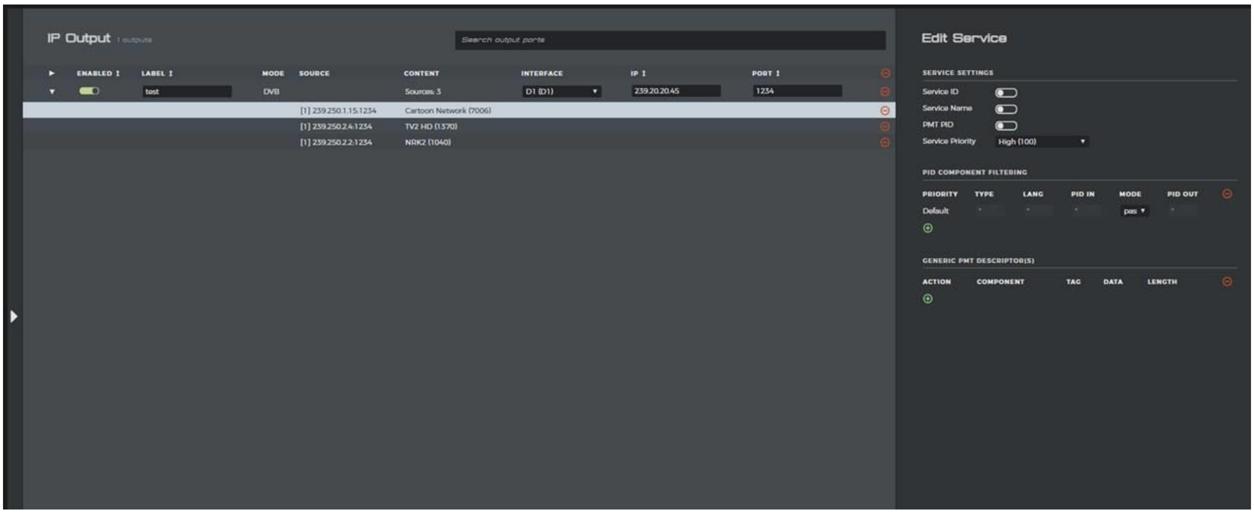
5 Mute-On-Error

5.1 Description

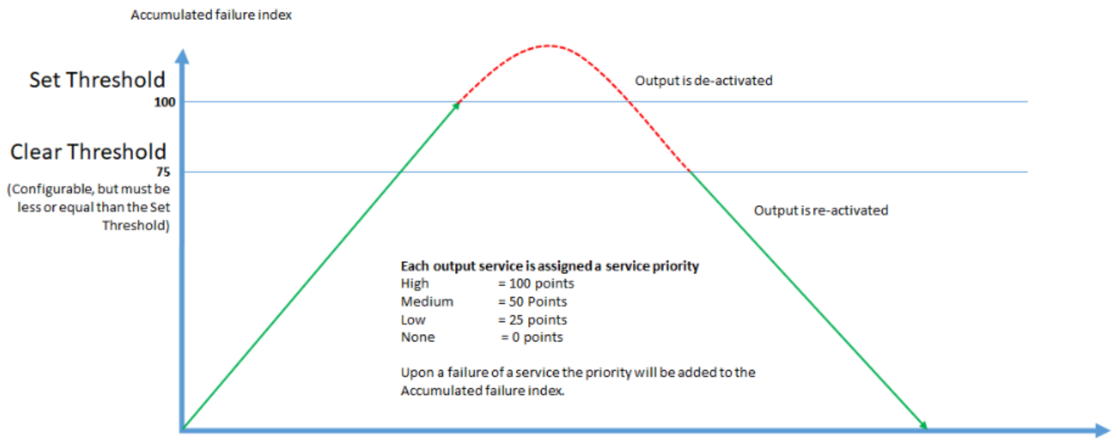
The Mute-On-Error redundancy scheme ensures that defective output streams are stopped and not sent out of the chassis.
This raises three important considerations;

1. What granularity does Mute On Error (MOE) act?
2. How and what does MOE monitor within the system to determine if there is a problem?
3. Why can muting a failed output help and be beneficial within the overall system?

Answering these questions in order, we will consider the system granularity first. An optimal redundancy scheme should protect outputs at a level where the flow can be easily replaced by switching it to a backup. For example, within the IP domain this is typically a multicast or unicast flow and this is exactly the level at which the MUTE ON ERROR redundancy process operates.
Each protected IP flow could contain a single service (SPTS) or multiple (MTPS). This means that you may wish the entire IP output flow containing an MPTS of several services to become disabled if only a single service is missing, or you may wish to trigger only if all are absent. Clearly, a degree of user configurability is required: On XC platform, Appear TV provides the ability to select whether ALL services must be missing within the MPTS to trigger a switch or the MAJORITY of services or just ONE service. On X platform, Appear TV offers a more refined system allowing each service in the MPTS to be assigned a priority. This means a high priority service could be set to 100, where as a low priority service might be set to say 25. The service priority field has been shown below;

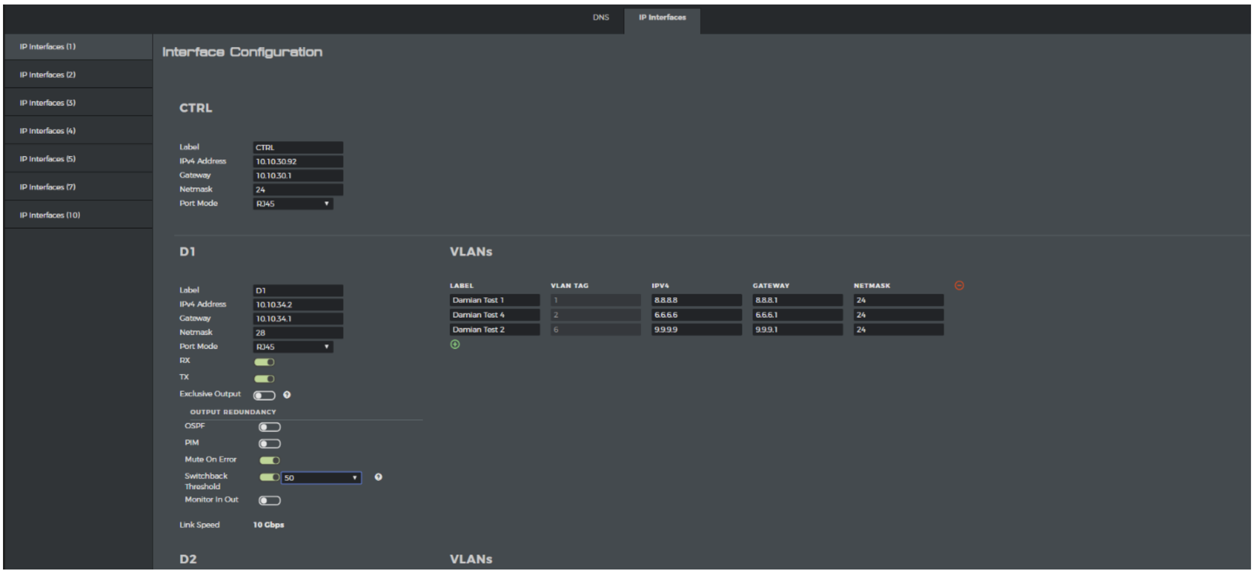


Mute on error will trigger when a service or services go missing from the MPTS with an aggregated priority of 100 or more. In the example above, the loss of just one high priority service will trigger MOE where as four or more low priority services would have to go missing to reach the threshold point of 100 and trigger redundancy protection.
The threshold concept has been illustrated below;



- When a service fails, then it adds the priority points, when the total reaches the «Set Threshold» the output redundancy will take action.
- When a service recovers, the priority point is removed, when the points **drops below** the «Clear Threshold» the output is re-activated

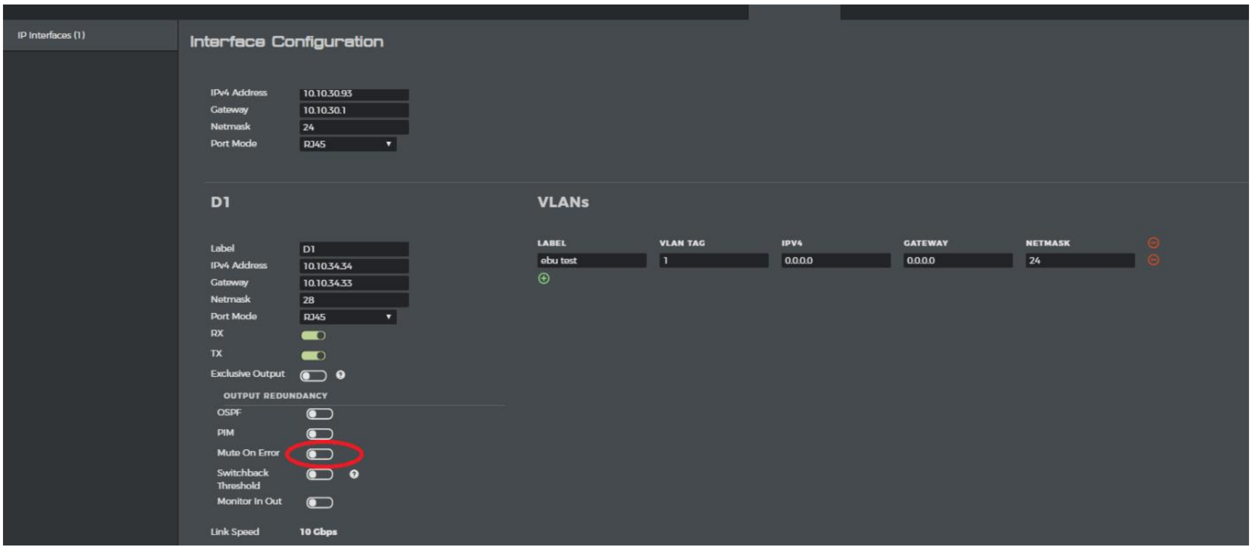
Note that the restoration of normal service (or SWITCHBACK from redundancy) is also based on the priority threshold mechanism and is user definable. The GUI screenshot below shows the master switch for MOE with the ability to set a user defined SWITCHBACK threshold.



So the mute on error feature is about muting output flows that have issues, such as having missing services because they have failed to be delivered on input. The reason for wishing to mute defective outputs in this way is to enable simple but fast acting downstream redundancy protection mechanisms to act, placing the intelligence to drive them within the Appear TV chassis domain. For example, consider an IP output flow containing an MPTS in which one of the services has become unavailable. Without MOE, an external device would be needed to independently analyze and perform an ETR290 assessment of the MPEG_TS layer. This requires expensive monitoring probes and will likely be slow. However, MOE uses the comprehensive Appear TV monitoring and alarms infrastructure within the chassis to identify issues. When these occur, stopping the output enables simple IP packet detection systems to act and cause a fast redundancy changeover.

The intention is to support MOE on satellite modulator, ASI and other outputs also which will bring the same benefits of MOE for outputs other than IP. For example, ASI switches only need respond to sync detection to cater for a very wide range of faults, and satellite RF switches only need switch on RF level detection.

On X platform, MOE is set per port



With MOE set on the port, all IP output flows will be monitored and muted individually should a problem be detected.

In the future, it will be possible to have greater control over parameters such as switch and switchback times etc. but currently these are preset.

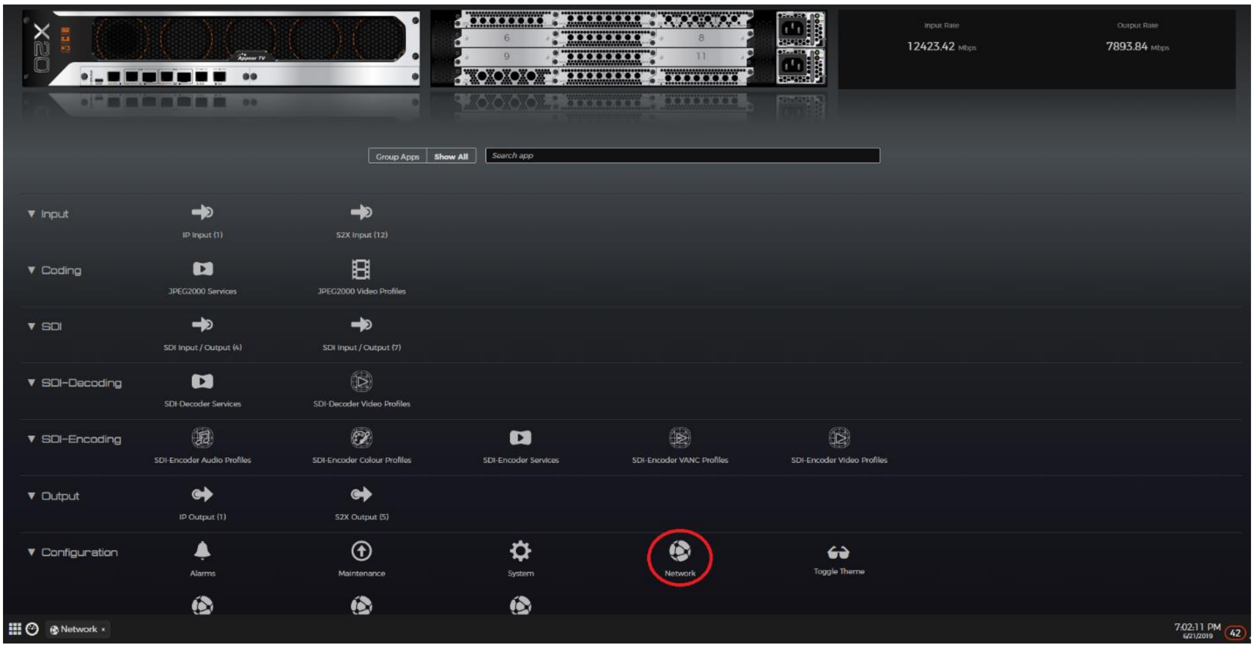
The MOE feature is triggered by the chassis alarms system which is aware of the status of each service.
If a critical alarm is raised against a service or its components, or the services is not received into the output module from the backplane (detected by monitoring the incoming bitrate and CC error status for each PID within the service) then MOE will stop the affected flow so that o packets are output for it. An alarm will be raise to identify that this has happened.
In future, it should be possible to detect even more fault conditions (such as service scrambling status) as new alarm criteria become implemented and control of the functionality offered becomes more granular.
Although switch times vary depending on the state of the chassis and the nature of the alarm causing triggering, MOE can be expected to act within 500ms. In many cases, the actual time experienced is between 200 and 400ms.

When using MOE, extra care should be taken in cloned output mode to ensure that both ports have MOE set (if required). Although it is permitted to have a different MOE setting on a cloned output port pair, it is unusual to require this and so a WARNING alarm will be raised whenever this combination is set.

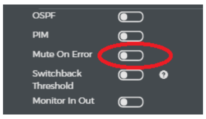
6.1 Functional testing of MOE

The following instructions can be used to ensure MOE is correctly enabled, and can also be used for instruction purposes to understand how MOE works. The instructions are based on X platform running software 3.2 or greater.

1) From the dashboard, open NETWORK and find the output port you wish to enable MOE.



2) Enable MOE for this port (plus the adjacent port if using cloned output mode)



3) Add an output stream (as normal) from this port. Ensure the output flow is present.
4) Remove the service that is being output, or one or more services if an MTPS. You could kill the IP input feed for example, if the input is over IP (the type of source that is delivering the service does not matter). Critical alarms will be raised in response to the service no longer being available and the associated IP output flows will be muted. A mute on error alarm will be raised to indicate what has happened.
5) Re-insert the Input source and observe that automatic switchback occurs.
6) Disable the Mute-On-Error feature on the interface. Observe that the output is present.
7) Remove the input and observe that Mute-On-Error is not active and the flow is not stopped.
8) Restart the input and restore the system to your preferred mode of operation.

6.2 Example alarm triggers

The following alarms can trigger MOE:

- A card missing alarm does not trigger MoE. However, MoE can be triggered in two different ways:
  -Critical Alarms upstream
  -Loss of bitrate over the backplane
- Note that if a card is missing, bitrate over the backplane will be lost so MoE will trigger via this route.
- For the IP Gateway module, all of the following critical alarms will trigger mute on Error.
  -no_link,
  -no_bitrate
  -pmt_missing
  -input_dropping_packets
  -pat_missing

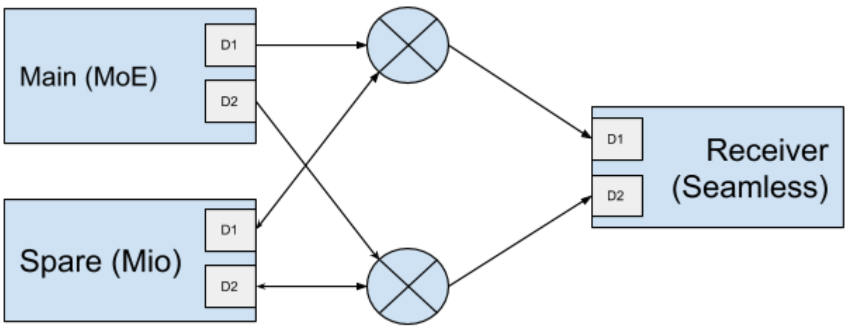
- For the SDI Encoder module, all of the following critical alarms will trigger mute on Error.
  -no_input_lock
  -Bitrate on interface has exceeded limit
  -test_generator_active

-video_encode_error
-unknown_video_input_format
-no_video_input
-no_video_output
-invalid_frame_rate
-invalid_scan_mode
-invalid_vertical_resolution
-Bitrate over_allocation

7 Monitor-In-Out

7.1 Description

Monitor-In-Out (MIO) is a simple and convenient way to implement a 1+1 redundancy configuration between chassis, or even a single chassis fitted with 1+1 redundant management modules.
The concept is easily understood if you firstly understand the MUTE ON ERROR concept. Let us apply this understanding to the following example system to see how it works.



The diagram shows a main and backup chassis providing IP flows over a redundant distribution network.
Let's say the intention is to use the chassis as a 1+1 redundant pair that delivers SMPTE 2022-7 coherent flows to a 2022-7 capable receiver. Adding the 2022-7 dimension highlights some of the behavioral aspects of the redundancy system which is the only reason this has been added.

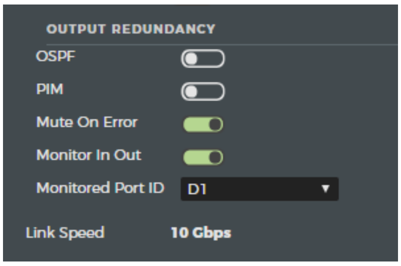
As shown on the diagram, the MAIN chassis is configured in a totally standard way; the only feature it has enabled is MUTE ON ERROR. This means the main chassis will work exactly as described above: In this case it will be configured in cloned output mode to derive two coherent output flows destined to feed the A and B networks. MOE must be enabled on both output ports so any failures cause the affected IP flows to be muted on both ports.

If you just consider the MAIN chassis in isolation, it behaves as a normal stand-alone chassis with mute on error applied, and the two output flows will be coherent and capable of supporting seamless IP reconstruction across both networks in a 2022-7 capable receiver (note that RTP encapsulation must be used to support seamless).

The spare chassis will also be configured in cloned output mode* and have its output ports connected to the distribution network. It will also be configured identically to the main chassis, so it provides an identical and duplicate set of outputs.
If operated in this way, an IP clash would result within the router resulting in a non-viable system. Appear TV offers a solution (called OUTPUT REDUNDANCY) that works in this way, and uses multicast routing in combination with an implementation of the OSPF protocol to resolve IP conflicts but this places requirements on the network configuration and router specification that not all customers wish to support. However, MIO solves the same problem with a greater degree of simplicity and without imposing router pre-requisites by making sure the BACKUP chassis outputs are controlled within the chassis to avoid an IP clash.

This control is implemented by using MOE in reverse. The way this is implemented is as follows;

- The output flows from port A of the main chassis are presented to port A of the backup chassis (for input and monitoring).
- The output flows from port B of the main chassis are presented to port B of the backup chassis (for input and monitoring).
- The monitoring chassis is placed in MIO mode, which is selected by port.



When MIO is set, it monitors the input port (which can be set for X20 MMI modules to specify whether the 10Gb/ or 1Gb/s ports are being used) to see if all of the configured output flows are being sent by the MAIN chassis. If they are, all of the output flows from the BACKUP chassis will be muted. If a flow disappears from main chassis port A, (which will happen if MOE is triggered or the chassis / network fails) it will not be received on the BACKUP chassis port A and will cause the backup chassis to lift the mute for this flow and output it instead.

Port B will be monitored in the same way, and it is very important to understand that the A ports and B ports are monitored and controlled independently.

The screenshot also shows how the backup chassis can be set with both MIO and MOE set simultaneously; This can be advantageous if there is downstream switching to select a further backup source since it means neither the main or backup chassis will send flows to the network that are not (as far as the alarms process is concerned) 100% complete.

Appear TV has made MIO easy to configure since when a stream is defined and added to the output of the backup chassis, it will simultaneously join the same IP on the monitoring port (to monitor the expected flow from the main unit). The switching logic is also simple, and is based on the rule “If bitrate is present on the monitoring port, then mute the output, else activate the output”.
When MIO activates a flow, the following alarm syntax is raised to advise the operator;
“Output <output name/label> activated, no bitrate on monitoring source.”

8.1 Functional testing of Monitor-In-Out

The following instructions can be used to ensure MOE is correctly enabled, and can also be used for instruction purposes to understand how MOE works. The instructions are based on X platform running software 3.2 or greater.

Functional test.

9) Navigate from the Dashboard to the NETWORK page (as per MOE)
10) Define the IP interface to be uses as monitor port in Monitor-In-Out mode. Remember X platform interfaces are duplex; the monitoring and output port will usually be the same. In this case select D1
11) Add an output stream; which is also present on the monitoring input (from a MAIN chassis)
=> Observe the output from the BACKUP chassis is muted. No alarm should be raised now: This is the normal state for the MIO chassis to be in.
12) Mute the source on the transmitting (MAIN) chassis. Observe the output is activated from the BACKUP chassis, and that an alarm is raised stating that the switch has occurred.
13) Disable the monitor-In-Out feature on the interface. Observe that output is present and is correctly controlled by the MIO feature.
14) Repeat the tests if necessary in a fully implementable configuration (eg. The diagram shown above with 1+1 chassis and redundant distribution networks) and with a SMPTE 2022-7 configuration and receiver (if required). Observe the behavior is as follows (note: for simplicity, the table considers the status of one output flow. OK = flow present)

Case	Main Chassis port A status	Network A status	Main Chassis port B status	Network B status	Backup chassis status	Receiver status
1	OK	OK	OK	OK	Ports A and B both muted	Full 2022-7 operation
2	FAIL	OK	FAIL	OK	Ports A and B active	Full 2022-7 operation
3	FAIL	OK	OK	OK	Port A active, B muted.	Fallback to near seamless mode
4	OK	OK	FAIL	OK	Port B active, A muted.	Fallback to near seamless mode
5	OK	Fail	OK	OK	Port A active if stream from main (A) lost. B muted.	Fallback to near seamless mode
6	OK	OK	OK	FAIL	Port B active if stream from main (B) lost. A muted.	Fallback to near seamless mode

The table lists most common scenarios;
1 = normal condition
2 = complete failure of the MAIN chassis (eg. De-powered)
3 and 4 = Partial failure of the main chassis or network cable fault (both rare)
5 and 6 = typical result of one router or network failing completely.

Note that when a main chassis or network fault is restored, it is possible for the main chassis to come on line whilst the backup chassis is still transmitting. This causes a brief period where over-subscription of the network is possible. Appear TV is implementing a brief hold-over mechanism to prevent this from happening so the transition from SPARE back to MAIN chassis operation is controlled: To achieve this, the main chassis will send a few small test packets to let the spare chassis know it is about to come back online. This will ensure the spare chassis re-applies its mute before full-rate transmission starts from the main chassis. The entire changeover period will normally take place within a 10 to 20ms interval and so will have very minimal impact on the service.

It is possible that the cable connecting the monitoring chassis port breaks but in this case the transmit packets will go nowhere.

The independent management of both A and B ports, the flow-level specificity and ability to support 2022-7* operation makes MIO a safe and effective solution that is also very easy to implement.

(* requires future FPGA update to support MIO in cloned output mode)