COMNET APPLICATION NOTE:

CNGE2+2SMS[POE][HO]

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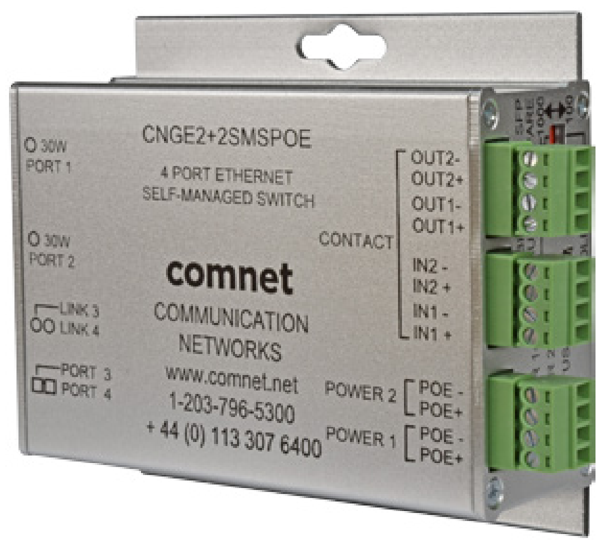

CNGE2+2SMS[POE][HO] Application Note

Preface

Traditionally, to create networks that can correctly support complex topologies with built-in redundancy to prevent against network failure; such as Redundant Point-to-Point and Ring topologies, as well as handling large volumes of multicast traffic has long been the reserve of managed layer 2 switches. Implementing such networks involves time consuming and sometimes complex configuration of each individual network switch and requires the user to have a good understanding of the protocols required to handle such a configuration and more importantly how to correctly implement them. As the demand for IP-based security systems increases it is adding an additional burden to users who must now ensure that they have network trained personnel capable of such configuration work not only for the larger head end switches but also for the field or edge switches where individual devices are connected.

The ComNet CNGE2+2SMS[POE][HO] is a unique 4 port Gigabit Ethernet switch platform that throws out the traditional rule book and provides users with a feature rich product that provides the traditional web based GUI configuration, yet also provides a much simpler means of configuring the key networking features by using simple DIP switches that do not require time consuming and complex configuration by specially trained personnel. This built-in self-management functionality enables several key network features to be enabled and implemented without the requirement for any programming or expert configuration knowledge as would normally be expected with a typical managed layer 2 Ethernet switch. The product can be used on its own or combined with more sophisticated managed switches (even those from third parties) such as at the network core. This offers the user the ultimate in flexibility vs cost and complexity.

This document will describe these unique self-managed modes of operation featured within the CNGE2+2SMS[POE][HO] and give examples of possible topologies as well as explaining recommended settings and the limitations of each operating mode. The self-managed modes are those that can be operated by using the device's DIP switches without any computer or complex configuration. The CNGE2+2SMS[POE][HO] series also features a comprehensive web GUI where all of the functions described in this document can be enabled and configured as well as many others. The web GUI configuration aspect will not be covered in this document. For details on the web GUI configuration please refer to the product's installation manual where these settings are covered in detail.

The information contained in this document is applicable to the following ComNet model numbers:

CNGE2+2SMS

CNGE2+2SMSPOE

CNGE2+2SMSPOEHO

Throughout this document the reference CNGE2+2SMS will be used but where this reference is used it can be interchanged with any of the above part codes as all of the features discussed are common across the entire range.

This application note should be read in conjunction with the CNGE2+2SMS installation manual and product data sheet to fully understand the features available and the implementation of each.

SMS MUX Mode (DIP Switch 2)

The exclusive ComNet SMS MUX mode is designed for applications where the connected devices are using multicast transmission as can typically be the case for IP cameras especially in larger networks.

When using a typical unmanaged Ethernet switch if multicast traffic is present, the switch does not know where to send the traffic to as there is no single destination MAC address that would be found with a typical Ethernet frame.

An example of how an unmanaged switch operates with multicast traffic can be seen below in Figure 1. This would also be the case for how the CNGE2+2SMS switch would operate if the SMS MUX mode is not enabled (DIP Switch 2 OFF).

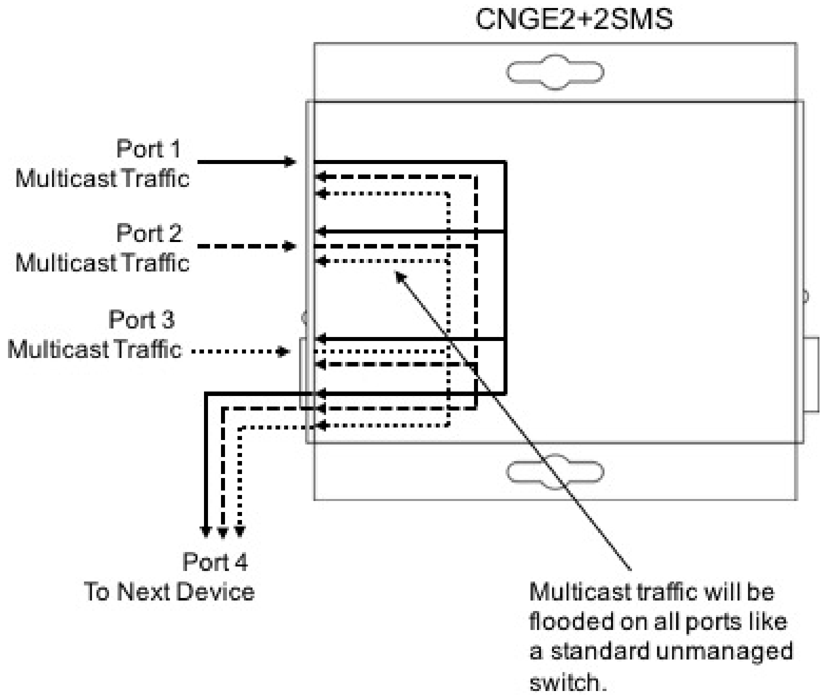

Figure 1

In this example, the traffic from port 1 is flooded to ports 2, 3 and 4. The net result of this is that ports 2 & 3 have to deal with traffic not intended for them. This can result in traffic from the connected devices on these ports not being allowed through or being severely restricted. In applications where these devices are IP-cameras this results in poor video performance such as missing video or blocking/stuttering video images and can also potentially bring down the whole network.

Traditionally to avoid this problem the user would be required to install expensive, and complex to configure, fully managed layer 2 switches which support IGMP at all locations to correctly handle the multicast streams and prevent network flooding.

By contrast the ComNet SMS MUX mode by contrast provides a very easy to implement solution to this multicast flooding problem by enabling a single DIP switch on the side of the CNGE2+2SMS module. There is no special knowledge or computer required for the configuration of this feature.

An example of how the CNGE2+2SMS operates with multicast traffic once the SMS MUX mode has been enabled (DIP Switch 2 ON) can be seen in Figure 2.

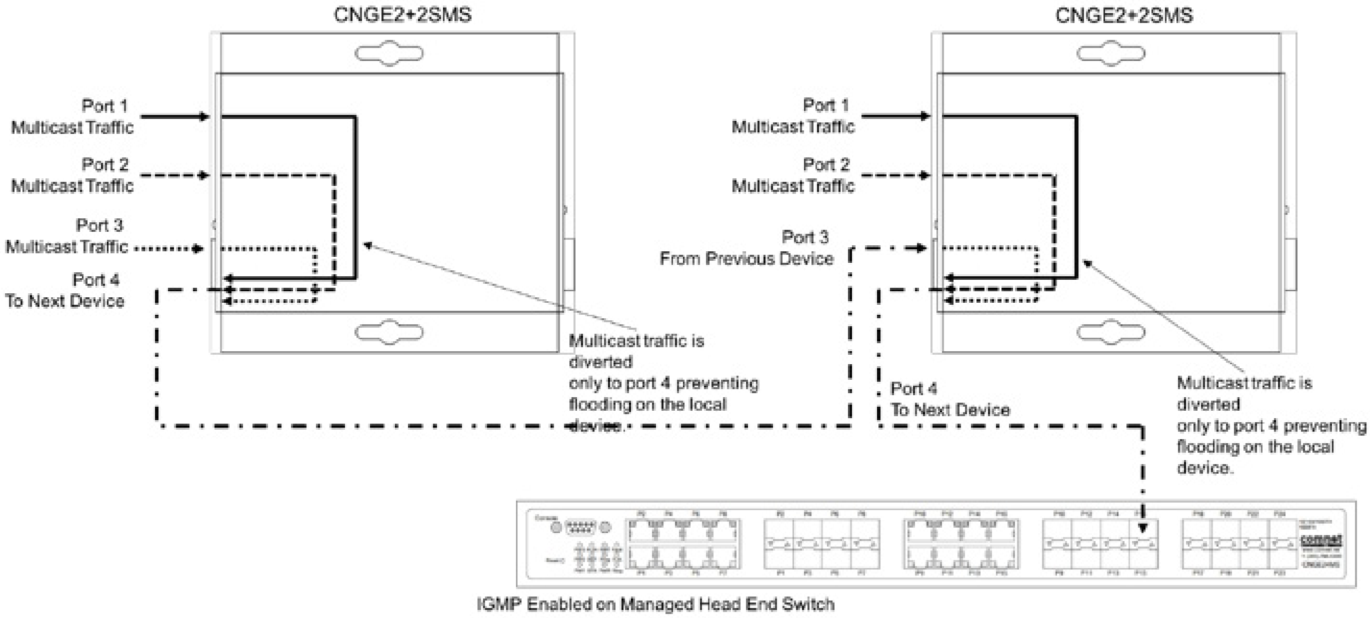

Figure 2

In contrast to Figure 1 where the traffic is flooded to all ports, in the above diagram with the same configuration of multicast devices, it can be noted that instead of flooding the traffic from port 1 to ports 2 & 3, the traffic from port 1 is now only sent to port 4. The result of this is that now devices on ports 1, 2 & 3 can operate normally without being flooded with unwanted multicast traffic from other ports and they effectively become isolated from each other. While this feature does not use IGMP to achieve its operation it can be considered to perform in a similar way by preventing multicast flooding within each device.

The mode of operation for the SMS Mux feature is that all traffic will be sent out of port 4 which is treated as a dedicated uplink port. Where multiple CNGE2+2SMS units are connected in a linear/drop & insert topology they should always be connected from Port 4 of one device to Port 3 of the next device to ensure correct operation of the SMS Mux feature. (Seen in Figure 2.)

In the diagram above, the head end device is a ComNet or similar managed layer 2 or layer 3 switch. As this device will not have the ComNet SMS MUX function that switch would be required to have IGMP correctly configured and enabled to handle the multicast traffic at that point in the network.

Important Usage Limitations: It is important to understand that the ComNet SMS Mux mode can only be used in point-to-point or liner/drop & insert topologies. It cannot be implemented when using the CNGE2+2SMS products in a ring topology. If this feature is enabled in a ring topology it will prevent correct recovery at certain points of the ring topology.

When using the SMS Mux feature there is no theoretical limit to the number of CNGE2+2SMS devices that could be used in a linear/drop & insert topology. The limiting factor will be the backbone speed of 100Mb or 1Gb (depending on which SFP modules are used). The user should also take into consideration that when implementing a linear/drop & insert topology, should a link fail between two devices or a single CNGE2+2SMS device fails or loses power then communication will be lost to all devices beyond that point in the chain.

The CNGE2+2SMS product is fully compatible in SMS Mux mode with other ComNet Self-Managed switches that support the exclusive ComNet SMS operating mode and can be used alongside other models in the same system or chain allowing the user to select models that best meet their operational requirements in terms of number of ports and other features. The SMS feature is proprietary to ComNet and when enabled all devices in the chain should be from ComNet and support the SMS feature.

Redundant SFP (RSFP) Mode (DIP Switch 4)

The exclusive ComNet Redundant SFP mode is designed for applications that require a redundant connection between two points for ultra-high reliability and protection against a single point of transmission failure.

If you make a redundant connection between two points a loop is created using a standard unmanaged switch or managed switch that has not been configured, serious issues may be caused for the network and this could lead to complete network failure. The Redundant SFP mode allows for a redundant connection to be implemented and prevents any loops from forming, ensuring correct operation of the network.

An example of how the Redundant SFP feature operates between two CNGE2+2SMS devices can be seen in Figure 3 below.

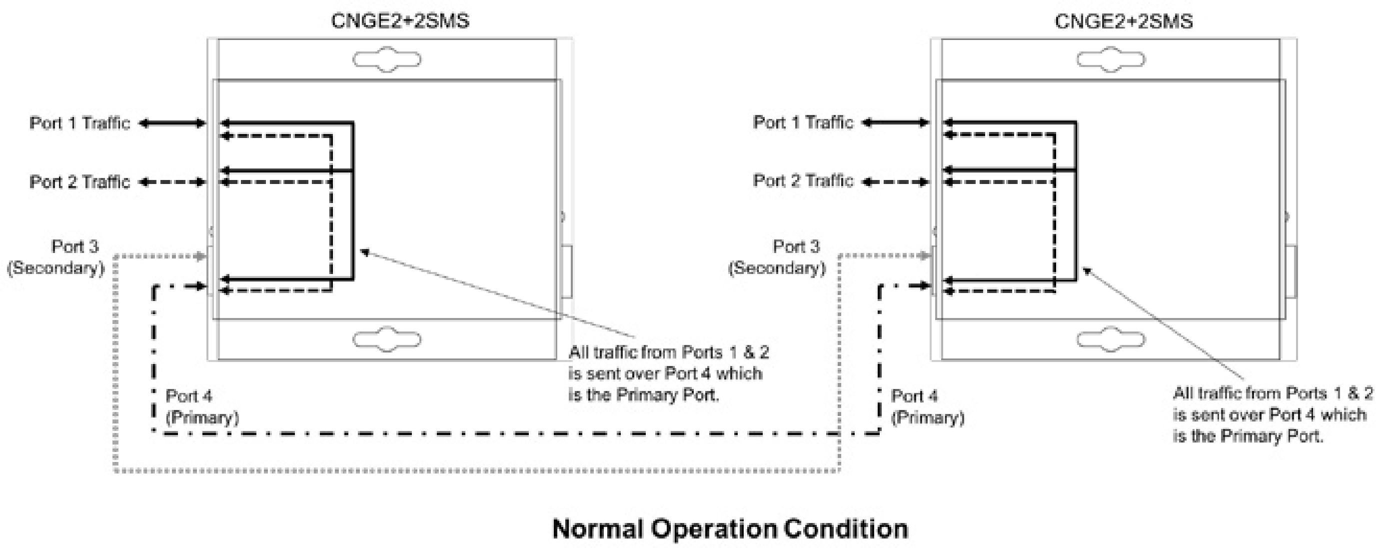

Figure 3

From the above diagram all traffic from ports 1 & 2 is sent to port 4 by default with port 3 held in a standby configuration (but no traffic passing across it).

In the event that a failure occurs on port 4 such as a break in the fiber cable etc. the units will immediately switch over to use port 3 instead and all traffic is diverted to this port. This switchover will take place in less than 1 second (switchover times of <300ms are typical and can be as fast as <50ms in many cases). This switchover is detailed in Figure 4 below.

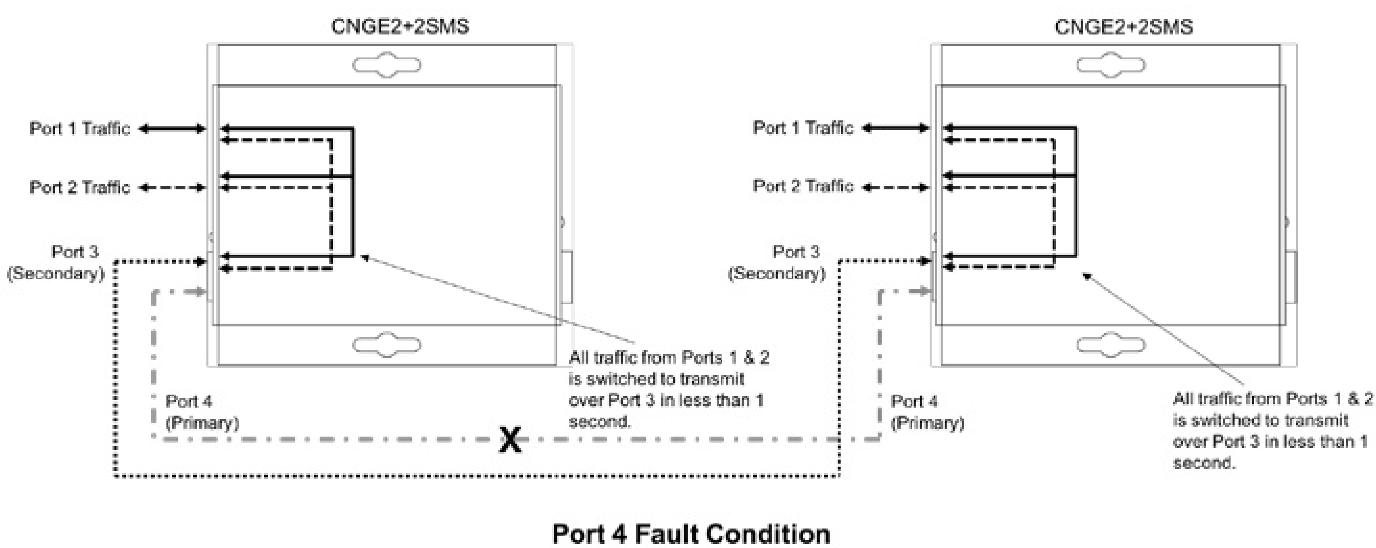

Figure 4

Detailed in the diagrams above ports 1 & 2 are free to communicate with each other just as in a standard Ethernet switch. If multicast traffic was present on ports 1 & 2 then this would be flooded to all ports and would present a similar issue as that described in the SMS Mux part of this application note. (To prevent multicast flooding while using the Redundant SFP mode please refer to the next section of this application note that covers using Redundant SFP and SMS Mux modes together.)

Important Note: When using Redundant SFP mode port 4 is considered the primary port and as such the unit will always communicate using port 4 if possible. In the event that the unit has switched over to using port 3 due to a failure on port 4 and the fault on port 4 is subsequently rectified, then the unit will then immediately switch to using port 4 again, even if port 3 is still operational. This mode of operation can be very useful for creating backup links for example when using the ComNet Sky Laser free space optic units as the primary path (port 4) with a 5GHz Netwave wireless link as a backup (port 3). In these type of scenarios the preference would always be to use the higher capacity and lower latency free space optic link rather than the 5GHz Netwave link.

The Redundant SFP mode uses port link to make decisions based on which port should be used. The decision to change from port 4 to port 3, or port 3 to port 4, will only happen if there is a loss of port link. It is still a valid condition for there to be no traffic on a port and a lack of traffic would not cause the unit to switch ports if there was still a valid link present for that port.

The Redundant SFP feature is a ComNet proprietary feature in its operation however it has been designed to also inter-operate with any other ComNet Ethernet product or non-ComNet Ethernet product. An example of such a scenario can be seen below in Figure 5 & 6 where the CNGE2+2SMS is connected in Redundant SFP mode to another ComNet or non-ComNet switch.

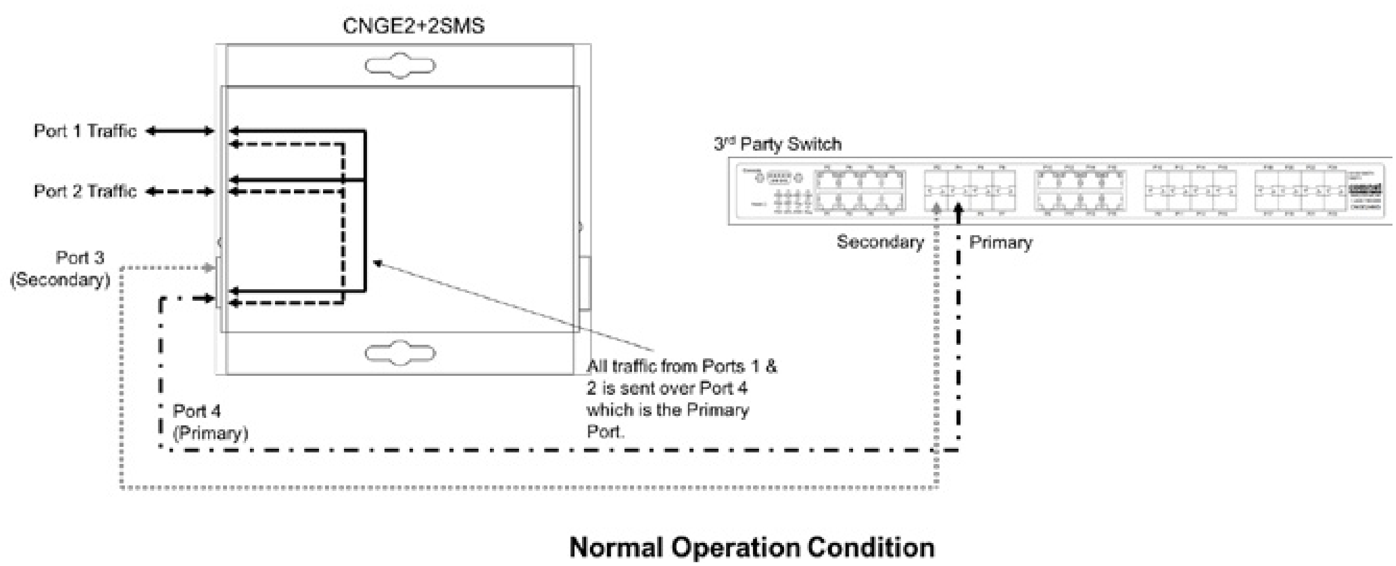

Figure 5

In the above diagram all traffic from ports 1 & 2 is sent over port 4 to the managed switch. There is no special configuration required on the managed switch to achieve this configuration.

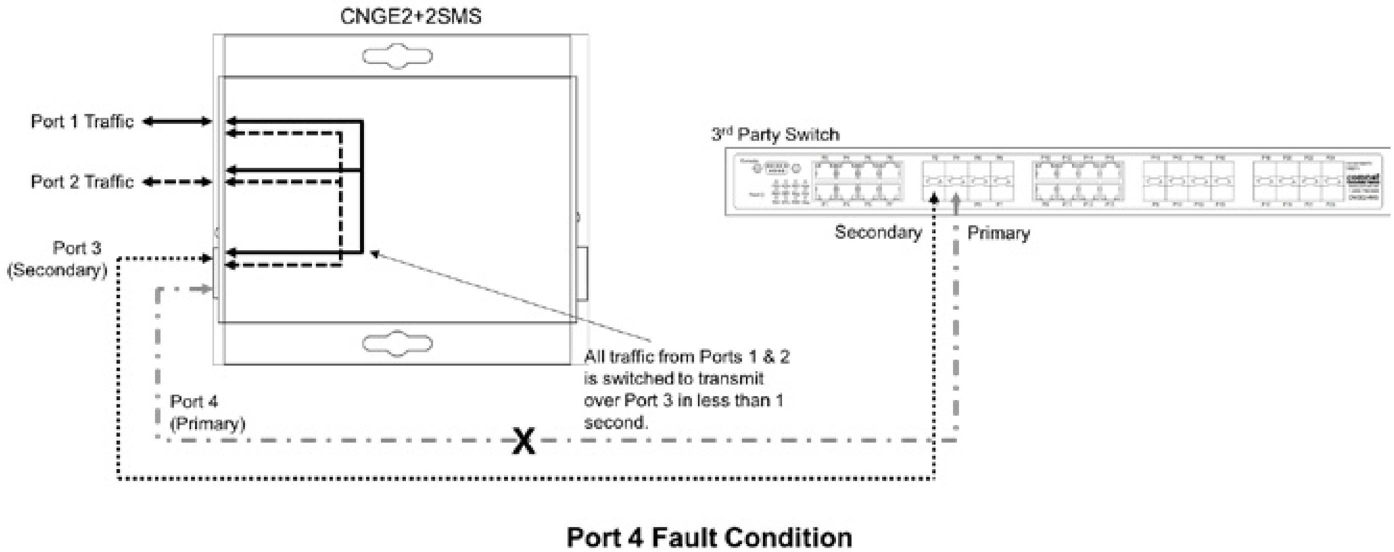

Figure 6

In the above diagram, port 4 has suffered a link failure and within 1 second all traffic has been transferred to port 3.

As in the previous ComNet example, ports 1 & 2 are free to communicate with each other. This setup should not be implemented if the devices connected to ports 1 & 2 are using multicast. For multicast operation please refer to the next section of the application note which discusses implementing Redundant SFP and SMS Mux modes together.

Although no special configuration is required on the managed switch shown in this application the user may find that they achieve the fastest recovery switchover times if they disable MAC learning on the two ports that are used on the managed switch. This feature is not always present on all non-ComNet switches and it is not a mandatory configuration step needed to achieve the redundant configuration.

Currently the above operation example has been tested with ComNet switches as well as Cisco layer 2 managed switches and found to operate correctly. While this feature should operate with any managed switch it is highly recommended that the user tests this feature with their chosen non-ComNet switch prior to implementing the feature in a live network environment.

Redundant SFP (RSFP) & SMS MUX Mode (DIP Switch 2 & 4)

For applications where multicast traffic is being used and there is also a need for a redundant point-to-point connection it is possible to implement the SMS Mux and Redundant SFP modes together at the same time. This is achieved by switching both DIP switches 2 & 4 to the ON position. In this mode it is possible to correctly handle multicast traffic while maintaining the redundant switchover capability.

Important Usage Limitations: When using these two modes combined it is not possible to use a CNGE2+2SMS switch on each side of the link as in that topology the multicast traffic would not be correctly handled. The only supported configuration when using these two modes together is to have 1 × CNGE2+2SMS switch connected to a ComNet or non-ComNet managed layer 2 switch that supports IGMP and has this correctly configured to handle the multicast traffic at that point.

An example of how these two modes operate can be seen in Figures 7 & 8 shown below.

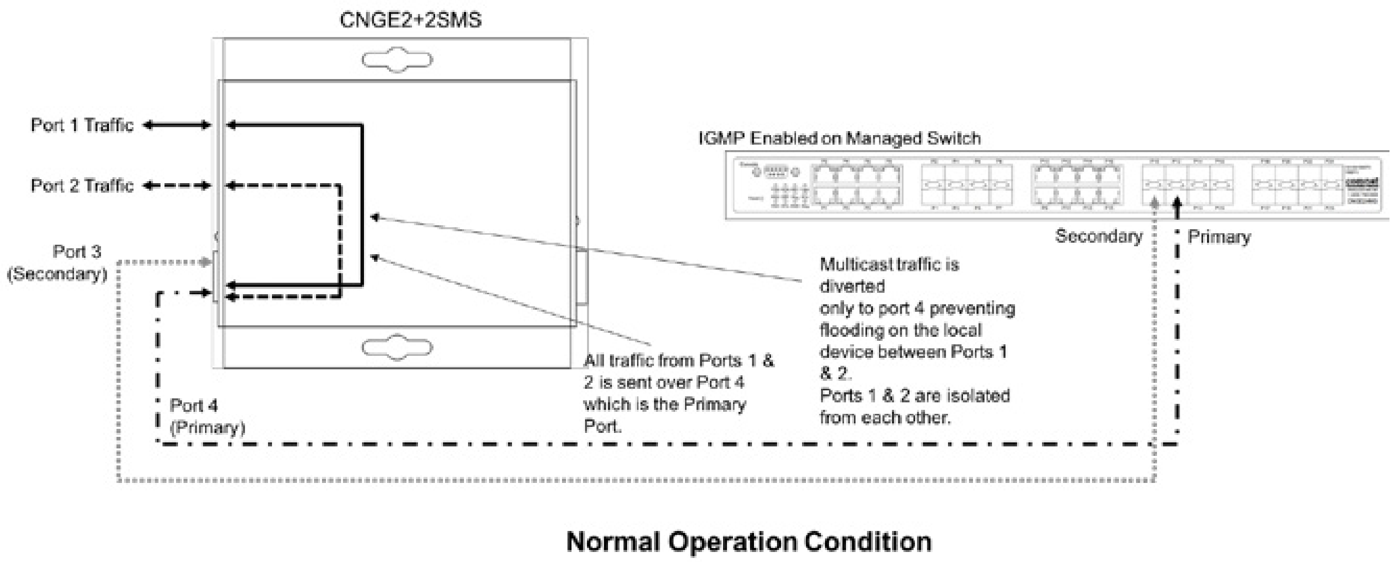

Figure 7

In the above diagram all traffic is sent over port 4 as the primary port. Ports 1 & 2 are isolated from each other so that no multicast flooding can occur between those ports.

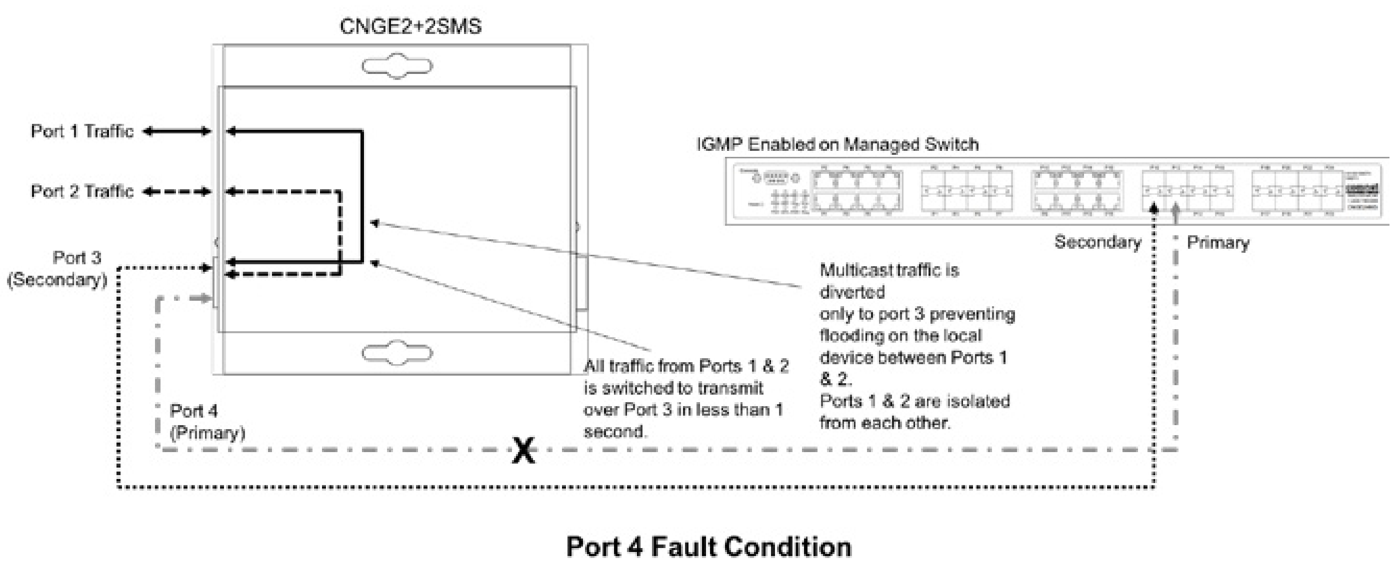

Figure 8

In the diagram above, port 4 has suffered a link failure and all traffic has been transferred within one second to port 3. Ports 1 & 2 remain isolated from each other so that no multicast flooding can occur between those ports.

The Redundant SFP mode uses port-link to make decisions based on which port should be used. The decision to change from port 4 to port 3, or port 3 to port 4, is determined by the port link status of port 4. If port 4 has an Ethernet link then all traffic is sent over port 4. If port 4 has no Ethernet link then all traffic is sent over port 3. It is still a valid condition for there to be no traffic on a port and a lack of traffic would not cause the unit to switch ports if there was still a valid link present for that port.

Important Note: In this configuration the managed switch must support IGMP and it must be correctly configured to handle the multicast traffic coming from ports 1 & 2 of the CNGE2+2SMS switch. If IGMP has not been correctly configured it will cause multicast flooding to occur on the managed switch which will lead to detrimental network performance.

Although the only special configuration required on the managed switch shown in this application is the correct configuration of IGMP the user may find that they achieve the fastest recovery switch over times if they also disable MAC learning on the two ports that are used on the managed switch. This feature is not always present on all managed switches and it is not a mandatory configuration step to achieve the redundant configuration.

Rapid Spanning Tree (RSTP) & ROOT BR Mode (Single Ring) (DIP Switch 1 or 3)

One of the most common topologies for modern IP networks is a redundant ring topology that provides a cost effective, highly reliable network with protection against a single point of transmission failure. The ComNet CNGE2+2SMS product provides support for legacy Spanning Tree Protocol (STP) defined under the IEEE 802.1D standard as well as the more modern Rapid Spanning Tree Protocol (RSTP) defined under the IEEE 802.1w standard. The benefit of implementing these protocols is that they are open standards and are supported by the majority of network switch manufacturers. This allows the user to integrate the CNGE2+2SMS into a redundant topology consisting of just CNGE2+2SMS devices or combine it with other ComNet or non-ComNet switches that support the STP and/or RSTP standard. This provides much greater flexibility than would be achieved if a proprietary ring topology system was implemented.

RSTP mode can be enabled on the CNGE2+2SMS product by simply setting DIP switch 1 to the ON position. This is an exclusive ComNet feature and makes setup of an RSTP redundant network very easy as there is no configuration with a computer required. For the system to operate correctly all units that are part of the ring topology must have this DIP switch set to the ON position.

An example of a ring topology created using RSTP with the CNGE2+2SMS units can be seen in Figure 9 below.

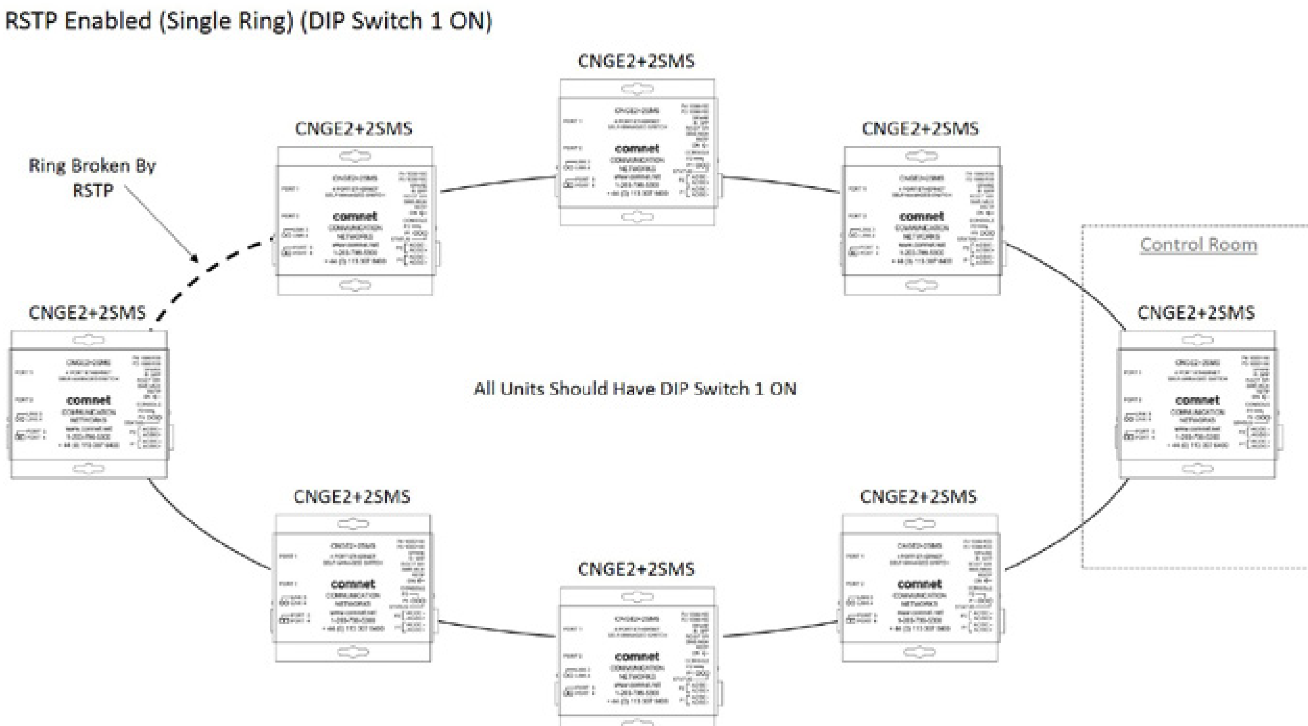

Figure 9

In the above diagram, eight units of CNGE2+2SMS are configured in a standard ring topology with one unit being located at the main control room as is typical with an IP based CCTV perimeter infrastructure.

A ring topology by default is not permitted within an IP network as it would create a loop which would cause undesired effects in the network and would ultimately lead to a network failure if the above system was implemented with unmanaged switches, with the CNGE2+2SMS, or managed switches that had not been correctly configured with a protocol to handle a ring topology such as RSTP in this example.

In the example shown above in Figure 9 one of the links between two CNGE2+2SMS units is shown with a dashed line. This indicates a point in the ring that has been disabled or blocked by the RSTP protocol. This blocked path will be re-enabled should there be a break detected elsewhere in the ring and thus will provide the redundancy. The location of this blocked link is determined by two key factors of the RSTP protocol briefly explained below.

Root Bridge: In an RSTP network there will be one switch thst becomes the root bridge. The root bridge is selected based on the bridge priority value that is set to 32768 by default. (The bridge priority must be a multiple of 4096). The switch with the lowest bridge priority value will become the root bridge. In the event that there are multiple switches with the same bridge priority value then the switch with the lowest MAC address will become the root bridge. The bridge priority can be changed by using DIP switch 3 or by using the web GUI of the CNGE2+2SMS switch. The DIP switch method is discussed later this section however the web GUI configuration is not discussed. For details of the web GUI configuration please refer to the products installation manual.

Path Cost: In an RSTP network traffic from each connected device must travel over the path of least cost. The cost of a path will equate to the sum of the cost for each part of the link back to the root bridge. By default the path costs are set by the link speed so for the CNGE2+2SMS switch a port operating in 100Mb mode will have a path cost of 200,000 while a port operating in 1Gb mode will have a path cost of 20,000. These path cost values can be altered by the user using the web GUI of the CNGE2+2SMS switch but in most cases there is no need to change them for typical systems.

The above information is only a brief high-level overview of two key aspects that make up the Rapid Spanning Tree Protocol. There are many other details and aspects that affect the RSTP operation that are beyond the scope of this document. Further technical details on all aspects of RSTP can be found by reviewing the IEEE 802.1D-2004 specification (which incorporates the 802.1w RSTP specification). This document can be downloaded from the IEEE website at: http://standards.ieee.org/getieee802/download/802.1D-2004.pdf

In the above example system shown in Figure 9 it is possible just to implement RSTP on all switches (by setting DIP switch 1 to the ON position) and connecting them all together as shown. In this basic configuration the units will calculate the root bridge by themselves and the switch with the lowest MAC address will become the root bridge. While this configuration will work it is not the recommended configuration as it can be difficult to figure out how the system will operate and how the traffic will flow. To overcome this issue and to make configuration as simple as possible for the user the CNGE2+2SMS switches feature a further exclusive ComNet feature which is the ability to set the root bridge in the topology simply by changing a DIP switch. By setting DIP switch 3 to the ON position the user can force that switch to become the root bridge. When DIP switch 3 is in the ON position the bridge priority value of that switch will be lowered to 4096 and thus forcing it to become the root bridge as all the other switches will have a bridge priority that remains at the default value of 32768 (The bridge priority value can also be manually configured by the user through the CNGE2+2SMS web GUI).

An example of using DIP switch 3 to force the root bridge location can be seen in Figure 10 below.

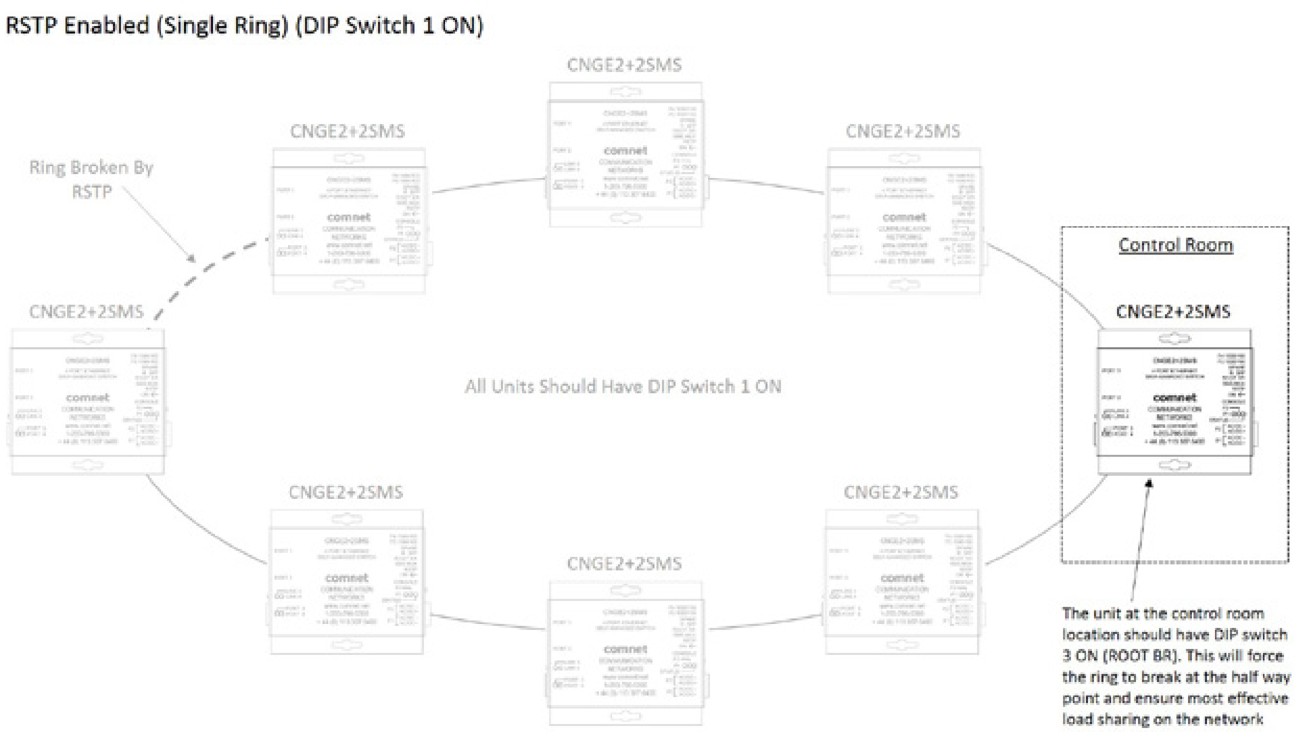

Figure 10

As seen in this diagram, the recommended location for the root bridge in this example would be at the Control Room location. While the root bridge can be located at any point within the ring for the system to function, by forcing it to be at the Control Room location the most effective network can be created as the break point will then be calculated roughly halfway around the ring (assuming the port path costs have not been altered from the default and assuming in this case that all links which form the ring are operating at the same speed). Forcing the ring to be broken at the halfway point ensures that the typical load on the network is roughly split in an even manner and will provide the best performance. The overall network must still be designed to allow for a scenario where all traffic may have to flow back to the Control Room over a single link should there be a failure with one of the links between the Control Room switch and either of its immediate neighbors.

Important Note: Only 1 switch in the network should have DIP switch 3 in the ON position. If more than one switch has this DIP switch set to the ON position then the previously described RSTP root bridge rule will apply and in that case of those devices that have DIP switch 3 in the ON position the switch with the lowest MAC address will be selected as the root bridge.

Important Usage Limitations & Operating Performance: When operating the CNGE2+2SMS switches in RSTP mode ComNet recommends that a maximum of 20 devices be used in a single ring. If more than 20 devices are used, this can cause issues with the recovery time in the event of a failure and can lead to the ring failing to recover completely under certain conditions. Use of more than 20 devices is not supported by ComNet and is done so at the users own risk.

When operating an RSTP ring of up to 20 devices the typical recovery time in the event of a failure is approximately 2-3 seconds. This recovery time assumes a ring of 20 devices maximum with the Root Bridge set to the main unit at the Control Room location as described in the example above.

Rapid Spanning Tree (RSTP) & ROOT BR Mode (Multiple Rings) (DIP Switch 1)

In many cases a single ring of 20 switches may not be enough to accommodate the needs of the system or the devices may be spread over a large or diverse physical area where creating a single ring becomes impractical. In such cases creating multiple rings is the ideal topology and this can be achieved with the CNGE2+2SMS provided the configuration is done as per the below example shown in Figure 11.

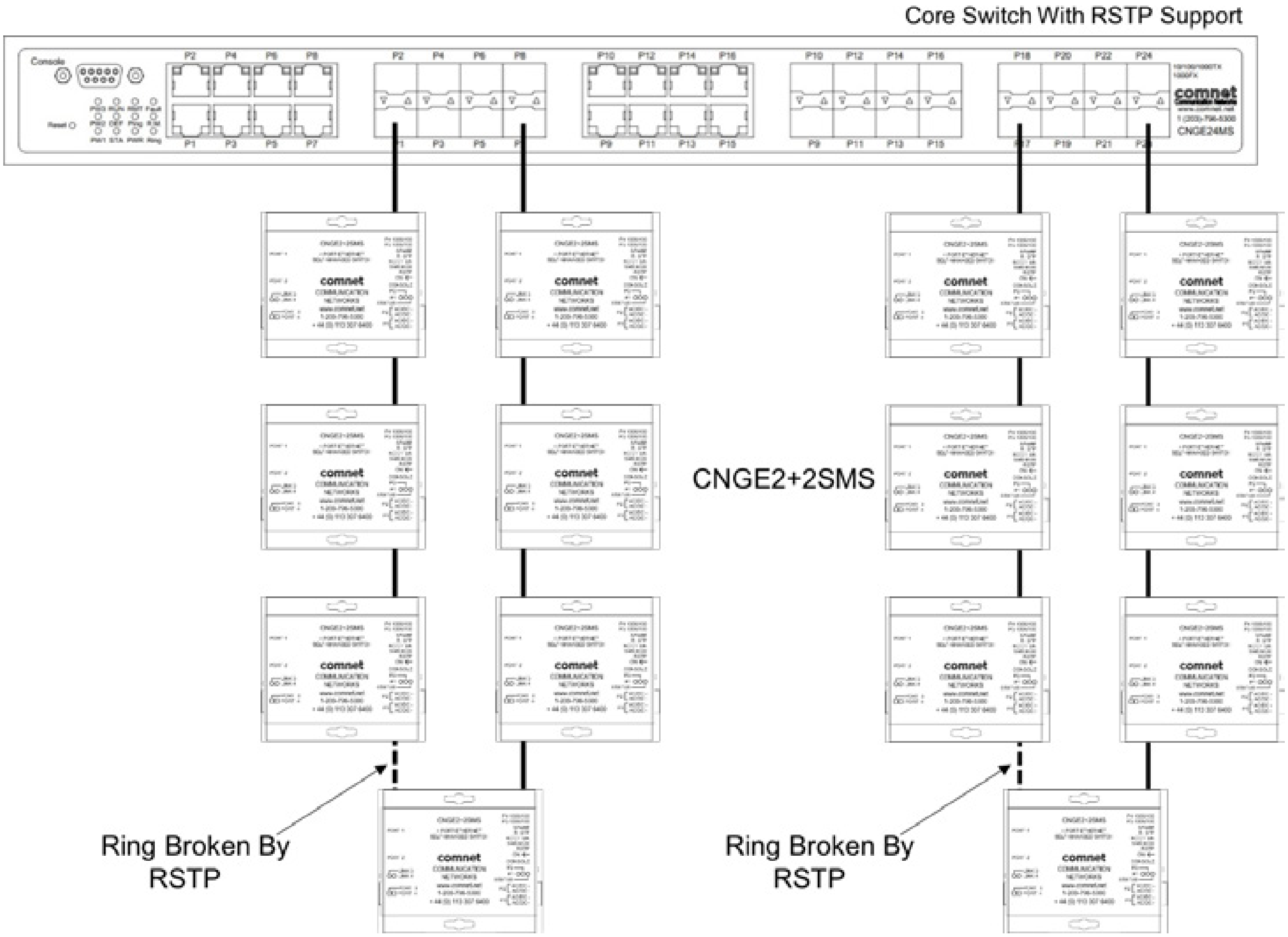

Figure 11

In this example, two separate rings have been created and are terminated into a single core switch. The core switch can be a ComNet switch or a non-ComNet switch, however it must support RSTP to be implemented in this application. The CNGE2+2SMS switches must have DIP switch 1 in the ON position so that they are running in RSTP mode.

When correctly configured these rings will operate independently of each other and a failure in one ring will have no impact on the other ring.

Important Note: For a multiple ring system to operate correctly it must be terminated into a single switch that has RSTP enabled on all ports that are members of the rings. In addition the core switch must also be operating as the root bridge. This can be achieved by manually lowering its bridge priority value so that it is lower than any of the CNGE2+2SMS switches (which have a default bridge priority value of 32768). DIP switch 3 should be set to the OFF position on all CNGE2+2SMS units to ensure that the core switch acts as the root bridge.

Important Usage Limitations & Operating Performance: When operating the CNGE2+2SMS switches in RSTP mode ComNet recommends that a maximum of 20 devices are used in a single ring. If more than 20 devices are used then this can cause issues with the recovery time in the event of a failure and can lead to the ring failing to recover completely under certain conditions. Use of more than 20 devices is not supported by ComNet and is done so at the users own risk.

When operating the CNGE2+2SMS switches in multiple RSTP rings ComNet recommends limiting the total number of separate rings to 3-4 per core switch. The actual number of rings that can be used successfully will be determined by the processing power and capabilities of the core switch along with any other protocols or processes that may be running on the core switch. While larger numbers of rings may be possible this has not been tested or verified by ComNet at this time. For such applications the user should contact the ComNet Technical Support department for specific advice and guidance.

ComNet does not recommend using the following switches for the core switch in such a network due to the limited processing power of these models:

CWGE2FE24MODMS

CWGE24MODMS

CWGE9MS

CNGE8MS

When operating an RSTP ring of up to 20 devices the typical recovery time in the event of a failure is approximately 2-3 seconds. This recovery time assumes a ring of 20 devices maximum with the Root Bridge set to the main core switch as described in the above example.