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SEL ICON® System Availability Calculations

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INTRODUCTION

The SEL ICON® Integrated Communications Optical Network is designed to provide Dependable Communications for Critical Infrastructure®. An ICON network must provide the highest level of availability possible for critical communications, such as power system protection and automation. To achieve this goal, several levels of redundancy are incorporated in its design.

An ICON node equipped with protected line modules provides hardware redundancy on the synchronous optical network (SONET) transport, cross-connect, and backplane connections. Additionally, redundant power modules are standard and provide redundancy for shelf power and the ability to connect to redundant power sources as well. The ICON will continue to operate even with a failure of either of these modules.

The add/drop modules provide the physical interface for the voice and data circuits. Redundancy at this level is typically provided by using two interfaces and redundant interconnected devices as required, such as a primary and backup protective relay. When this level of redundancy is applied, node availability is 100 percent or 1 because a single failure of the line module, power module, or drop module will not cause an interruption of communications.

This application note provides the method of calculating ICON availability.

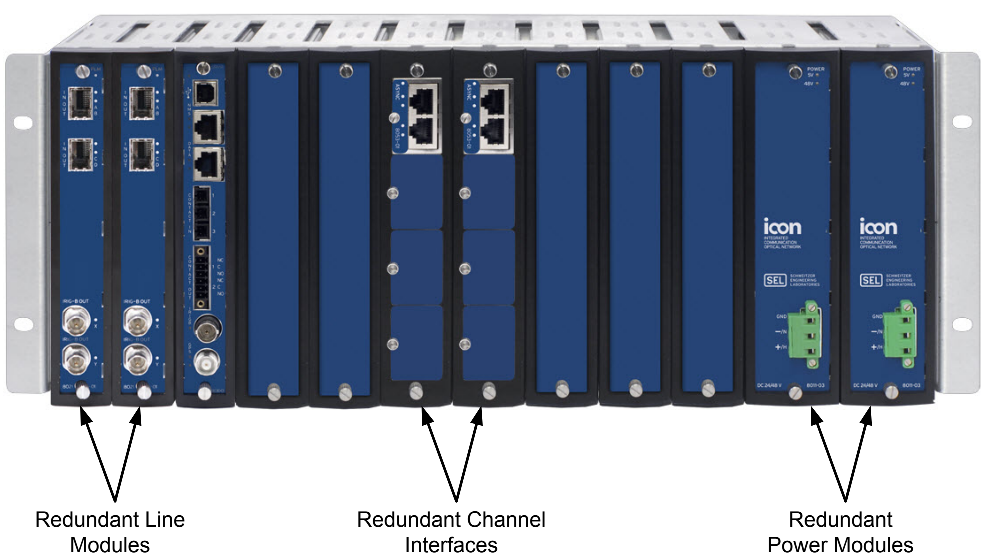

Figure 1 ICON System Module Redundancy

Calculating Availability

Availability indicates how infrequently the functionality of a product is impacted by a fault or defect. It is calculated by dividing the mean time between failure (MTBF) by the sum of the MTBF and the mean time to repair (MTTR). The formula used to determine system availability is as follows:

$$\text{Availability} = \frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}}$$

SEL uses a measured MTBF based on the number of ICON nodes installed and the total number of ICON modules returned for repair.

$$\text{MTBF} = \frac{\text{Number of products in service in past 5 years}}{\text{Number of confirmed hardware or manufacturing-related failures in the past 12 months}}$$

For example, a 5-year MTBF of 500 means that an end user might experience one failure per year per 500 installed nodes.

$$\text{Annual failure rate} = \frac{1}{\text{MTBF}} \bullet 100$$

The MTTR is the average time required to perform corrective maintenance on a unit. The following calculation is based on an MTTR of one hour. This assumes that spare modules are available. For this calculation, MTBF must be converted into hours, so it must be multiplied by the number of hours in one year (8,760 hours).

$$\text{Where MTBF is 500, ICON availability} = \frac{500 \bullet 8,760}{\left(\left(500 \bullet 8,760\right) + 1\right)} = 0.99999977\ldots \text{ (or six nines).}$$

The following calculation is based on an MTTR of 24 hours. This assumes spare modules are not available onsite and need to be shipped from a central warehouse.

$$\text{Where MTBF is 500, ICON availability} = \frac{500 \bullet 8,760}{\left(\left(500 \bullet 8,760\right) + 24\right)} = 0.99999457\ldots \text{ (or five nines).}$$

Conclusion

The overall node availability for an ICON system equipped with redundant line modules is six nines (0.999999) with the availability of spare modules, which equates to a system downtime of 31.5 seconds per year.

When replacement components are available from a central facility, the availability is reduced to five nines (0.99999), which equates to a downtime of 5.26 minutes per year.

The availability numbers demonstrated in this application note meet or exceed the performance requirements for critical communications transport networks. It is important to note that the ICON system remains in service and provides communications during any combination of single redundant module failures.

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