To Kill-A-Watt-Hour, We Recommend to Hot Standby

A Technical Paper prepared for SCTE by

Richard Grivalsky
Principal Engineer
Comcast Cable
Vermont, USA
+1 (802) 316-6553
Richard_Grivalsky@cable.comcast.com

Brian Allen
Engineer III
Comcast Cable
Tennessee, USA
+1 (865) 437-0259
Brian_Allen@comcast.com

Budd Batchelder, Comcast Cable

Table of Contents

List of Figures

List of Tables

1. Introduction

Operational practices have long been to rely on both power supplies, in network equipment, to prevent service interruption in the event of a single power supply unit (PSU) or input failure. Leveraging platform-level controls, such as hot standby, allows for fully redundant powering schemas while reducing energy consumption.

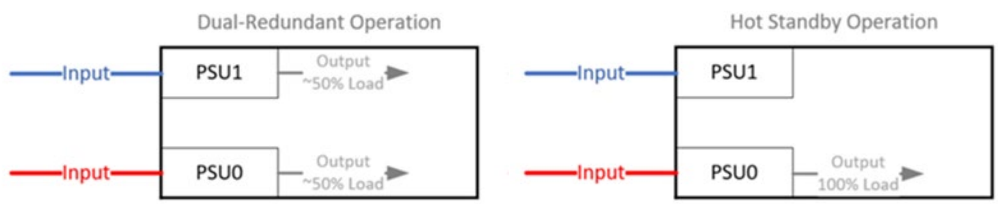

Figure 1 - Dual-Redundant and Hot Standby Platform Operation

With an eye to a greener future, Comcast has set goals to double network energy efficiency by 2030 and to be carbon neutral (Scope 1 and Scope 2 emissions) by 2035. Hot standby presented an opportunity to apply platform-level configuration changes to save power while maintaining reliability. While cable operators can benefit from hot standby at a platform level, when it comes to full-scale solutions some elements in the hardware stack need to be addressed as they do not support hot standby today.

The use of hot standby has the potential to impact 34-50% of the energy pyramid (critical facilities & data centers) by reducing platform consumption by ~6%, which could potentially reduce a cable operator's total consumed electricity by 1.4-3% as more manufacturers integrate the option in additional hardware platforms.

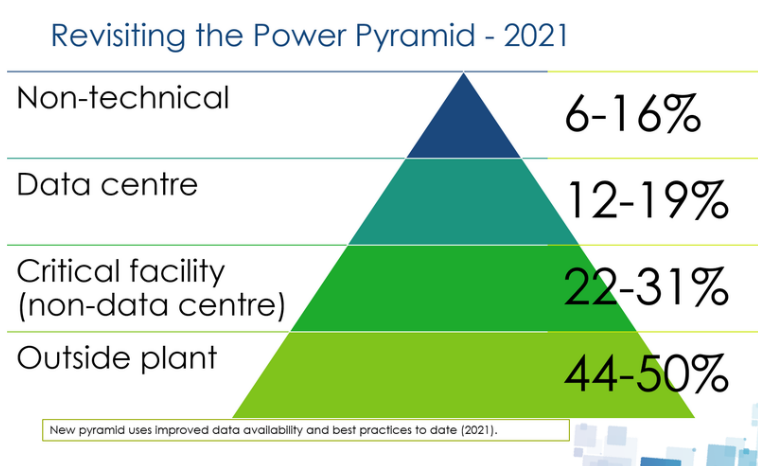

Figure 2 - SCTE Power Pyramid

Comcast began evaluating energy savings, with hot standby enabled, on several platforms in 2021. Identifying platforms in our next-generation hardware stack and then quantifying the power savings allowed the next phase of conversations to be had, specifically around piloting the energy-saving setting in production equipment.

Our current generation of distributed access architecture (DAA) is put into production with hot standby enabled, reducing power consumption for the hardware stack by ~2%. Today, not all platforms in the stack have the required BIOS or configuration settings that allow for hot standby implementation.

2. Measurement and Validation

Comcast performed rigorous trials of our DAA solution that consisted of a mix of hot standby capable devices as well as network gear that currently does not support hot standby mode in the platform(s).

During these trials, individual circuit-level measurements, as well as combined platform measurements, were captured for 26 network devices in the trial hardware stack. Measurements produced an average energy savings of ~1.7% under maximum central processing unit (CPU) utilization and up to ~6% savings under idle CPU load. Circuit level monitoring was performed for seven days prior to and after initializing hot standby configuration, to compare baseline data in and out of dual-redundant modes. Hot standby was tested under varying loads of simulated traffic.

Table 1 - 26-Server Trial Results

PSU Mode	Aggregated 26-Server Draw (Amperes)	Dual-Redundant to Hot Standby Energy Savings (%)
Dual-Redundant Idle CPU	88.1	--
Hot Standby Idle CPU	82.7	6.5
Dual-Redundant Max CPU	135.3	--
Hot Standby Max CPU	132.9	1.8

Hot standby power supplies were alternated between primary and hot standby, across the power distribution panels, utilizing the odd/even methodology as covered in SCTE 282 2023. This approach offered Comcast additional resiliency while implementing hot standby in production equipment.

DC Distribution Panel 1										
A Side	Platform 1	Platform 3	Platform 5	Platform 7	Platform 9	Platform 11	Platform 13	Platform 15	Platform 17	Platform 19
B Side	Platform 2	Platform 4	Platform 6	Platform 8	Platform 10	Platform 12	Platform 14	Platform 16	Platform 18	Platform 20
Circuit #	1	2	3	4	5	6	7	8	9	10

DC Distribution Panel 2										
A Side	Platform 2	Platform 4	Platform 6	Platform 8	Platform 10	Platform 12	Platform 14	Platform 16	Platform 18	Platform 20
B Side	Platform 1	Platform 3	Platform 5	Platform 7	Platform 9	Platform 11	Platform 13	Platform 15	Platform 17	Platform 19
Circuit #	1	2	3	4	5	6	7	8	9	10

Figure 3 - Dual Panel, Mixed Odd/Even, Distributed A/B Power Schema

Circuit level monitoring was performed via simple network management protocol (SNMP) through a WebView monitoring system, polling the in-rack power distribution panels. This ensured total draw on the DC plant was captured, rather than just that of the platforms themselves. Measurement of the hot standby load savings was recorded at all stages.

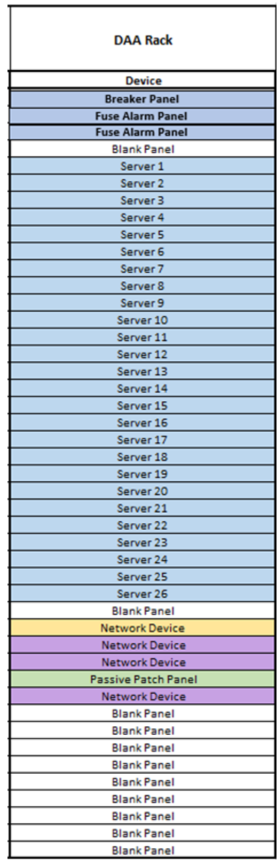

Figure 4 - DAA Test Rack Example

Table 2 - Sample of Dual-Redundant Data from 26-Server Trial

Server	PSU0 (Amperes)	PSU1 (Amperes)	Total (Amperes)
Server1	1.75	1.75	3.50
Server7	1.57	1.68	3.25
Server14	1.86	1.74	3.60
Server25	1.89	1.74	3.63

Table 3 - Sample of Hot Standby Data from 26-Server Trial

Server	PSU0 (Amperes)	PSU1 (Amperes)	Total (Amperes)
Server1	0.00	3.32	3.32
Server7	3.04	0.00	3.04
Server14	0.12	2.78	2.90
Server25	0.00	3.03	3.03

Note: panel monitoring sensitivity thresholds resulted in occasional zero-ampere readings for the PSU in hot standby.

3. Implementing Hot Standby

Leveraging SCTE 282 2023, a piloted, data-driven approach was required to implement a successful change management strategy.

3.1. Stakeholder Alignment

Stakeholder identification is critical during the hot standby pilot phase. Impacted teams during the pilot phase include on-site engineering, network operations center (NOC), and engineering leadership. If the pilot is successful and wide-scale adoption is recommended, additional stakeholders including platform teams, procurement, finance, and sustainability reporting should be included.

3.2. Pilot Deployment

The goal of a hot standby pilot deployment should be to collect data to demonstrate energy avoidance while maintaining, or potentially improving, customer reliability. A pilot project plan with scope, milestones, schedule, and measures of success should be documented prior to implementing a hot standby pilot. The plan should be agreed upon by all stakeholders in the pilot phase of the project. Key considerations for the scope of the project include the number of devices to be activated in hot standby, pre- and post-measurements, alarming configuration to eliminate false alarms, and equipment monitoring to verify no-impact implementation.

3.3. Change Management Program

A comprehensive change management program should be rolled out prior to a scaled deployment of hot standby. The stakeholders identified above should be notified of the intent to deploy a hot standby program and given the opportunity to ask questions and/or contribute to the deployment. The Prosci ADKAR® model prescribes five key elements of change management:

- Awareness- of the need for change,
- Desire- to participate and support the change,
- Knowledge- on how to change,
- Ability- to implement desired skills and behaviors, and
- Reinforcement- to support the change.

For a hot standby scaled deployment, project champions should develop a business case justification to garner executive-level approval to expand the effort from the pilot program. The data collected from the pilot program should be presented and extrapolated to quantify the potential benefit of scaled deployment.

Assumptions should be documented. The business case should generate both awareness of the need for hot standby deployment as well as a desire to scale the effort.

A full-on change management program should be implemented once executive approval is secured. User groups such as engineering and NOC teams can be brought through the change management process, including the reason for the change and a description of why the change is beneficial for operations. End users should also be provided with function-specific change guidance, including training to implement hot standby, expectations for schedule, and performance measurements.

3.4. Scaled Deployment of Hot Standby

Scaled deployment of hot standby should be overseen by a dedicated project team with delegated responsibility to end users. Deployment plans should account for other initiatives being implemented at a site(s), as well as stakeholder notification and post-deployment monitoring.

3.5. Deployment Impacts

As covered in SCTE 282 2023, several user communities are impacted when deploying hot standby instead of dual-redundant powering schemas. Hot Standby changes how PSU utilization is viewed, monitored, and alarmed.

Traditionally, end users expect to see circuit-level monitoring, using dual-redundant mode, wherein the circuit-level current draw is approximately equal for each PSU.

With hot standby, end users will have to be retrained to expect the primary PSU circuit-level current draw to match the full load of the platform and a very small draw, for status monitoring purposes, measurable at the hot standby PSU.

Caring for these changes, polling and reporting platforms will require modification to properly display hot standby configured platform power consumption. Alarming modifications will also be needed to appropriately dispatch resources, if a failure is seen, when hot standby is enabled.

Figure 5 - Dual-Redundant WebView

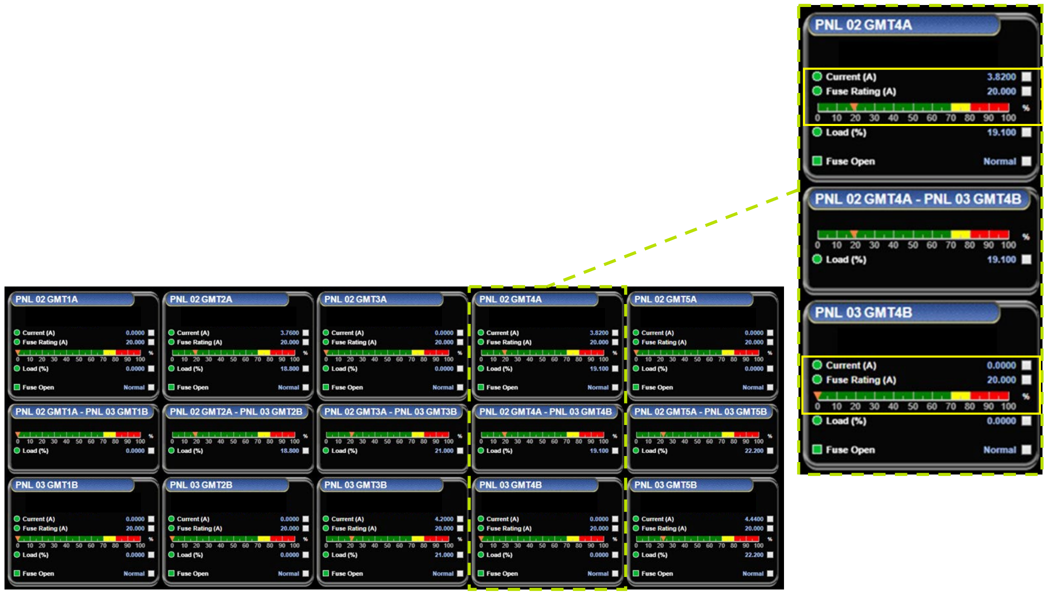

Figure 6 - Hot Standby WebView

4. Conclusion

Our analysis and quantification of energy savings have proven advantageous and impactful toward Comcast's sustainability goals. Operators would benefit from hot standby implementation, whether it drives toward a sustainability goal, or simply to reduce consumed electricity. Our next steps are to continually refresh requests to original equipment manufacturers (OEM) to provide additional platform options for DAA and other network solutions to be deployed with hot standby schemas enabled, striving for the upper limit of the ~3% in consumed energy savings.

Abbreviations

CPU	central processing unit
DAA	distributed access architecture
DC	direct current
NOC	network operations center
OEM	original equipment manufacturer
PSU	power supply unit
SCTE	Society of Cable Telecommunications Engineers
SNMP	simple network management protocol

Bibliography & References

SCTE 282 2023 Implementing Inside Plant Network Platform Hot Standby Powering

Figure 1, SCTE Power Pyramid, https://www.scte.org/standards/development/energy-2020-powering-cables-success/

