



State of South Carolina

Data Center Assessment Report

And

Transformation Plan



World class. Local knowledge.

Table of Contents

1	DOCUMENT CONTROL PAGE	5
1.1	DOCUMENT AUTHORITY	5
1.2	DOCUMENT INFORMATION	5
1.3	CLIENT DISTRIBUTION	5
1.4	CLIENT APPROVAL	5
1.5	DOCUMENT HISTORY	6
2	EXECUTIVE SUMMARY	7
2.1	LEGISLATIVE MANDATE	7
2.2	PROJECT MISSION	7
2.3	PROJECT OVERVIEW	7
2.4	PROJECT APPROACH	8
2.5	FINDINGS SUMMARY	8
2.6	STRATEGIC REMEDIATION RECOMMENDATION	8
3	ASSESSMENT	9
3.1	ASSESSMENT SUMMARY	9
3.2	URGENT REMEDIATION RECOMMENDATIONS	9
3.3	STARS ASSESSMENT	10
3.4	PUE (POWER USE EFFICIENCY)	17
3.5	EQUIPMENT AREA LAYOUT AND CFD (COMPUTATIONAL FLUID DYNAMICS ANALYSIS)	17
3.6	DATA CENTER LIGHTING	20
3.7	DATA CENTER INVENTORY	21
3.8	PLATFORM RISK	21
4	DATA CENTER STRATEGY	23
4.1	STRATEGY SUMMARY	23
4.2	BENCHMARKING	23
4.3	FUNCTIONAL END STATE	24
4.4	KEY COMPONENTS AND JUSTIFICATIONS	26
4.5	SUCCESS CRITERIA	26
4.6	TRANSFORMATION	27
5	SERVICE DELIVERY MANAGEMENT	28
5.1	SUMMARY	28
5.2	ENGAGEMENT MODEL	28
5.3	STRUCTURED FEES	29
5.4	SERVICE CATALOG	30
5.5	SERVICE LEVELS	31
5.6	COST MANAGEMENT AND FINANCIAL MODELS	33
6	DATA CENTER PLATFORM OPTIONS	36

6.1	SECTION SUMMARY	36
6.2	OPTION SCORING AND WEIGHTING	36
6.3	DESIGN AND COST ASSUMPTIONS AND NOTES	37
6.5	SUMMARY OF OPTION SCORES AND COSTS.....	38
6.6	OPTION 1 – OUTSOURCE TO SINGLE LEVEL 3	39
6.7	OPTION 2 COLOCATION AT TWO NEW STARS L2 FACILITIES	40
6.8	OPTION 3 – NEW CONSTRUCTION (SINGLE FACILITY)	41
6.9	OPTION 4 CONSTRUCT ONE STARS L2, COLOCATE AT ONE STARS L2	43
6.10	OPTION 5 CONSTRUCT TWO NEW STARS L2	44
6.11	OPTION 6A UPGRADE DCB TO STARS L2 & COLOCATE AT A STARS L2 FACILITY	45
6.12	OPTION 6B UPGRADE DCB TO STARS L2 & CONSTRUCT STARS L2	46
6.13	OPTION 7 - MODIFY EXISTING FACILITY	48
6.14	SCORE-BASED RECOMMENDATION.....	51
6.15	HYBRID OPTION COMPONENTS.....	51
7	TABLE 11 - HYBRID REMEDIATION COMPONENTS: LEVEL 2 COLOCATION OPERATING MODEL	55
7.1	OPERATING STANDARDS	56
7.2	OPERATIONAL PROCESS AND PROCEDURES.....	57
7.3	INTERNAL SERVICE LEVEL AGREEMENTS	58
8	TRANSFORMATION PLAN	60
8.1	SECTION SUMMARY	60
8.3	PHASE 1: MONTHS 0-6.....	61
8.4	PHASE 2: MONTHS 7-12 OR 7-24	63
8.5	PHASE 3: MONTHS 12-18 OR 25-30	64
9	GLOSSARY OF KEY TERMS	67
APPENDIX 1	SAMPLE OPERATING MANUAL TABLE OF CONTENTS.....	72
APPENDIX 2	DATA CENTER OPTIONS – DIRECTIONAL COST COMPONENTS.....	73
APPENDIX 3	COMPUTATIONAL FLUID DYNAMICS REPORT	76

Table of Figures

Figure 1 - Area Summary Site Chart	11
Figure 2 – STARS Component Scores – SSC DSIT DCB	12
Figure 3 - CFD: Immediate Remediation Areas	17
Figure 4 - CFD: Air Recirculation	18
Figure 5 - CFD: Air Volume Diagram	18
Figure 6 - CFD: Airflow Temperature.....	18
Figure 7 - DCB Server Area Layout (June Snapshot)	19
Figure 8 - Server Area Optimized Layout.....	20

Figure 9 - Transformation Plan Block Diagram	27
Figure 10- Relative Category Weights	37
Figure 11 – Weighted and Un-weighted Option Scores	38
Figure 12 - DSIT Operational Requirements and Procedures Model	55
Figure 13 - Transformation Plan Roadmap.....	60
Figure 14 - Remediation Phase 1 Timeline	61
Figure 15 - Remediation Phase 2 Timeline	63
Figure 16 - Remediation Phase 3 Timeline	64

Table of Tables

Table 1 - Strategic Remediation Options.....	8
Table 2 - DCB Site Summary	10
Table 3 - DCB Power Capacity vs. Utilization	11
Table 4 - DCB Single Point of Failure Summary	13
Table 5 – Weighted and Un-weighted Option Scores	38
Table 6 - Remediation Option 1 Components	39
Table 7 - Remediation Option 3 Components	42
Table 8 - Remediation Option 7 Components	50
Table 10 - Hybrid Remediation Components: Construct New Level 2	53
Table 11 - Hybrid Remediation Components: Level 2 Colocation	55

1 DOCUMENT CONTROL PAGE

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1.5 DOCUMENT HISTORY

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3	2012/06/11	Draft	Client preliminary draft
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2 EXECUTIVE SUMMARY

Data centers have the unique characteristic of being the repository for an organization's critical information. One key responsibility of any Chief Information Officer is to ensure those assets are protected, available, and accessible as required; and processed and managed in a quality, structured, auditable way.

2.1 LEGISLATIVE MANDATE

[SC ST SEC 1-11-435]

Protection of critical information technology infrastructure and data systems.

To protect the state's critical information technology infrastructure and associated data systems in the event of a major disaster, whether natural or otherwise, and to allow the services to the citizens of this State to continue in such an event, the Office of the State Chief Information Officer (CIO) should develop a Critical Information Technology Infrastructure Protection Plan devising policies and procedures to provide for the confidentiality, integrity, and availability of, and to allow for alternative and immediate on-line access to critical data and information systems including, but not limited to, health and human services, law enforcement, and related agency data necessary to provide critical information to citizens and ensure the protection of state employees as they carry out their disaster-related duties. All state agencies and political subdivisions of this State are directed to assist the Office of the State CIO in the collection of data required for this plan.

2.2 PROJECT MISSION

The Chief Information Officer of the State of South Carolina has defined long-term goal for DSIT's data center platform as follows:

Establish a first class data center that will enable DSIT to provide consolidated, cost-effective IT services to government entities throughout South Carolina.

2.3 PROJECT OVERVIEW

In order to achieve the mandate and mission listed above, the State of South Carolina's Department of State Information Technology (DSIT) engaged PTS Consulting to assist in the evaluation of the existing Broad River Road data center facility and measure it against industry standards and DSIT's strategic goal.

Addressing the project mission requires that the state accept a clearly defined technology vision and strategy. This report presents the existing state of the facility and recommendations on achieving that goal.

2.4 PROJECT APPROACH

PTS engaged in a four-phased approach to developing recommendations to achieve the goal stated in the mission. Beginning with a governance model, we entered a discovery phase, which included interviews, targeted reviews of the operation, and in-depth surveys of the facility. Working with DSIT management, PTS built the required and recommended remediation options.

2.5 FINDINGS SUMMARY

Building upon industry best practices, PTS's proprietary rating system assesses components of a data center facility on a scoring scale of 0 to 4.2. **The Broad River Road facility scored a 1.4 on that scale**, highlighting multiple gaps when compared to typical facilities with similar services, which generally score between 2.6 and 3.2. The category with the widest gap to the industry is facility operations and maintenance. Due to limited staffing, inadequate and insufficient procedures, and multiple location-based risk exposures, this area scored 0.7 out of 4.2.

2.6 STRATEGIC REMEDIATION RECOMMENDATION

This report considers the following options to remedy the DSIT data center offering. Please refer to Section 6 for a detailed discussion of these options.

	Option 1 Colocate Level 3	Option 2 2x Colocate Level 2	Option 3 New Level 3	Option 4 New Level 2 + Colocate Level 2	Option 5 2x New Level 2	Option 6A DCB to Level 2 Colocate Level 2	Option 6B DCB to Level 2 New Level 2	Option 7 DCB to Level 3
Two Year Capital	\$2.23M	\$2.9M	\$13.03M	\$10.81M	\$18.71M	\$6.9M	\$14.8M	\$11.22M
Two Year Op. + Energy (not scored)	\$5.7M	\$6.08M	\$7.26M	\$7.69M	\$9.29M	\$7.8M	\$9.41M	\$7.09M
Ten Year Capital, Op, Energy	\$78.46M	\$76.38M	\$82.16M	\$89.28M	\$102.18M	\$96.44M	\$109.34M	\$90.32M
Total Weighted Score	534	495	453	413	381	377	334	302

Table 1 - Strategic Remediation Options

Based on our observations and the independent scoring contained in this report, PTS recommends a transformation of the DSIT operation including new procedures and service delivery management procedures, culminating in relocation to an outsourced STARS L3 facility.

Cost is one component of determining the strategic end point. PTS recommends that DSIT study these parameters further with the goal of making a decision by December 31, 2012.

3 ASSESSMENT

3.1 ASSESSMENT SUMMARY

Using our proprietary facility analysis method, PTS scored the infrastructure and operation of the facility against industry best practices for data center facilities that offer similar services. PTS performed assessments of the following facility components:

- STARS assessment (data center rating)
 - Single points of failure
 - Site-based risks
- Operational maturity
- Power usage effectiveness (PUE)
- Facility layout thermal efficiency, including a computational fluid dynamics (CFD) study
- Facility lighting efficiency

3.2 URGENT REMEDIATION RECOMMENDATIONS

In order to meet anticipated customer demand while implementing the recommended remediation option, the State must reduce operational risk significantly at a minimal cost impact to the longer-term implementation. **PTS recommends that DSIT undertake the following initiatives immediately.**

- Make tactical operational improvements (estimated \$750k)
 - Refine as-built documents and update run books (\$100K)
 - Dedicated operational staff - salaries through year 1 (\$500k)
 - Staff training (\$100K)
 - Procure maintenance equipment (\$50k)
- Inspect and repair maintenance deficiencies in all critical and essential infrastructure equipment (estimated \$200K)
- Engage in maintenance contracts for all installed critical equipment (estimated \$200K)
- Improve data center access control (estimated \$200K)
 - Install man traps at two data center entrance doors
 - Improve security control station, including additional monitoring points and equipment
 - Install cameras in critical spaces
- Upgrade infrastructure to support known immediate growth properly (estimated \$1.4MM)
 - (Assumes UPS procurement under separate budget)
 - Install second generator to match new UPS capacity (\$1MM)
 - Install third chiller to maintain cooling redundancy (\$400K)

3.2.1 Remediation Recommendation Urgency

Making the improvements outlined above is critical to the successful operation of DCB in the immediate term. PTS is aware of plans to install very high-demand equipment; and staff at DSIT based those plans on the assumption that vacating the print spaces would allow for more server equipment growth than field conditions will allow.

Maintenance and operational improvements are equally critical to data center operations. The past 12 months have seen multiple systems failures and other unplanned outages, all of which were preventable. Improving the operation of the organization will ensure that new gear is in a state to be re-sold.

3.2.2 Remediation Recommendation Notes

- This remediation work is required to meet known and anticipated customer demand.
- Costs above are excluded from the values discussed in Section 6.
- PTS estimates that new UPS, and generator equipment may be re-sold on the secondary market after the State has vacated DCB. This will recover approximately \$500k.

3.3 STARS ASSESSMENT

3.3.1 Broad River Road Facility Summary

Metric	SSC DSIT DCB
MSP	SSC DSIT
DC Location	Columbia, SC
DC Area (SF)	20,500
Rack Capacity	~165-175 (current layout) 425 (fully optimized)
UPS Capacity (kVA)	500 kVA
UPS Resilience	N+1
Generator Capacity (kVA)	1,875 kVA
Generator Resilience	N
SPOF	Multiple major & minor

Table 2 DCB Site Summary

Facility	Available Power (UPS)	Installed Equipment Nameplate Maximum Draw	Startup Draw (70%)	Steady State Draw (UPS Reading)
SSC DSIT DCB	~65 kW	~1,000kW	~560kW	335 kW

Table 3 - DCB Power Capacity vs. Utilization

3.3.2 Assessment Summary

The STARS assessment uses a thorough on-site inspection of the facility. The STARS score of the facility classifies it against various reliability metrics. It goes on to highlight deficiencies between the facility and a typical commercial colocation data center. STARS scores range from 0 to L4 ☆ (4.2). **The Broad River Road facility scored a STARS L1☆☆ (1.4)**

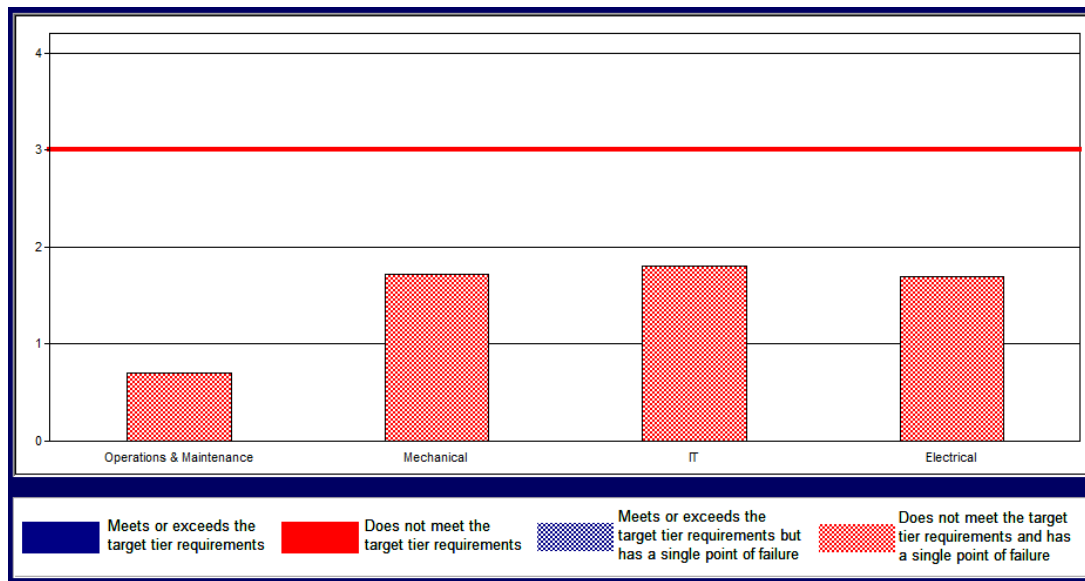


Figure 1 - Area Summary Site Chart

Multiple ratings within each subsystem form the major scores. The graph below includes a details the subsystem scores. Hashed bars indicate areas subject to single points of failure.

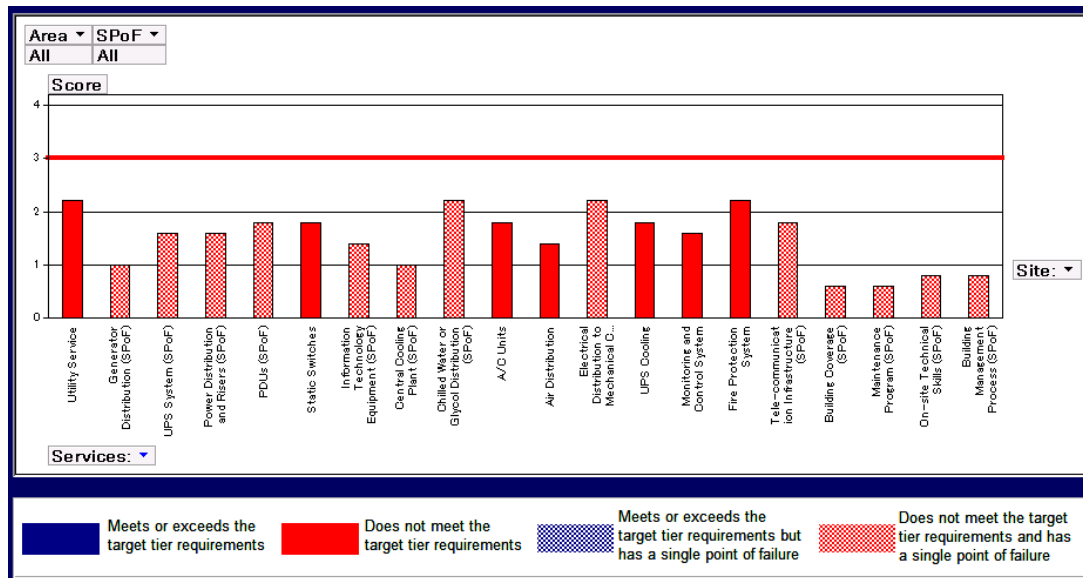


Figure 2 – STARS Component Scores – SSC DSIT DCB

3.3.3 Resilience and Single Point of Failure Summary

The table below summarizes the facility infrastructure present at DSIT DCB (“*” indicates SPOF):

Infrastructure Item	Description	Redundancy
Incoming Electrical	Single SCE&G Grid feed, dual TXs (util. owned)	2N
Incoming Mechanical	One water feed, not critical to operation	N
Incoming Telco	2 separate, carrier feeds with 1 POE, 1 MDF	2N / N*
Electrical Distribution	Largely single riser paths, some redundancies	N+1 / N*
Generators	1 generator - Generator shared w/ building, single control and sync boards	N*
UPS	2 500kVA units, single input, output boards	N+1*
Static Switches	No STS units protecting floor (only system SS)	N/A
PDU's / RPP's	6 PDU's, all from same source (UPS DB), 4 RPP's fed from PDU's	N+1
Central Mech. Plant	Single plant. During warmer weather, chillers lack sufficient redundant capacity, leading to SPOFs	N*
Heat Rejection	2x 150 Ton Air-Cooled Trane Chillers provide CHW to DC. Currently at N due to building load.	N*
Coolant Distribution	Single riser, loop distribution in DC	N+*

Infrastructure Item	Description	Redundancy
AC	N+1 CRAHs near capacity, 18" raised floor	N+1
Fire	Single-interlock pre-action per zone. VESDA installed but not maintained, in state of alarm	Zoned
Monitoring / Controls	JCI Metasys Systems	Centralized
Security	Facility not fenced, No security at gate and only 1 point of authentication	Deficient
O&M	SOPs, MOPs, EOPs not well defined, not followed. Insufficient facility maintenance practices. Equipment failures increasing risk to uptime.	Deficient

Table 4 - DCB Single Point of Failure Summary

3.3.4 Electrical Systems

Two utility sources each feed dedicated utility-owned transformers, which collapse at a switchgear and single generator. Dedicated ATs switch specific elements of the electrical infrastructure between utility power and emergency standby power. A single two-unit UPS system, feeds data center power through a common PDU distribution board. Six PDUs and four downstream RPPs provide branch circuit distribution on the raised floor.

The electrical infrastructure scored a STARS L1☆☆☆ (1.7), with the single generator system being the single most critical deficiency. Key deficiencies are below"

- Utility Service
 - While two utility-owned transformers serve the site, at the ultimate build-out design involving 3 UPS units and 3 chillers, the facility will require both transformers to operate at N+0. *This is not a SPOF due to generator infrastructure.*
- Generator System
 - The site features a single, highly loaded shared generator, its most critical SPOF
 - Separate fuel systems with redundant pumps for each (or shared between all) are also required
- UPS Systems
 - Currently a single N+1 (nearly N+0) system protects the raised floor, with multiple SPOFs
- Power Distribution
 - A single distribution pathway between the UPS system and the PDUs is an important SPOF
 - At least two UPS distribution power boards should be able to feed each PDU
- PDUs & Static Switches

- In order to properly protect the PDUs, Static Switches should be placed upstream between the PDUs and the UPS distribution board
- Electrical Supply to Mechanical Systems
 - Unless the design of mechanical systems is improved to 2N levels (see below), power feeds to the pumps, chillers, and CRUs needs to be split among multiple sources to eliminate any SPOFs
 - Alternatively for the CRUs, independent ATS units can exist at each CRU; this means that two or three panels can remain as the power sources, as the SPOFs have been removed via the ATS units
 - One of two electrical components to score above a Level 2 (the other being the utility feed)

3.3.5 Mechanical Systems

A single central plant with two air-cooled chillers feed a single vertical water riser to the raised floor. Once in the data center, a loop splits to provide a level of added resiliency under the data center floor, which feeds eight data center CRUs and two UPS CRUs. The legacy design and inconsistent application of hot / cold aisle designs is a significant impediment to air distribution.

The mechanical systems scored a STARS L1☆☆☆ (1.7). Only two components met Level 2 requirements, with the central plant being the weakest link to the mechanical infrastructure due to current load levels.

- Central Plant & Chillers
 - Due to current load levels, the central plant design fails to exceed Level 1 standards
 - Four chillers may be needed at ultimate design load levels; five would be needed to achieve N+2 levels
- Water Distribution Loop
 - At a STARS L2☆ (2.2), the distribution loop scored highest of all mechanical components.
 - A second vertical riser to the rooftop central plant and additional redundancy in the secondary water pump infrastructure would eliminate the SPOF.
 - Sufficient water detection and leak aversion dams under the raised floor of the data center are required, especially in areas where piping intersects with critical data and, more importantly, power cabling infrastructure
- Computer Room Units
 - Current resiliency is effectively at N. **The computer room cooling demand will exceed N capacity with known planned equipment installations.**
 - In order to meet N+1 resilience throughout the floor, CRU density must increase by 50% - 100%. Placement must be planned strategically, based on the results of the CFD analysis.
- Air Distribution

- Proper airflow and distribution in the space is a major concern, especially with increasing equipment densities resulting from increased blade deployments
- All rows will need to be re-aligned to proper hot/cold aisle patterns
- Perforated tiles will need to be redistributed to be largely cold-aisle centric based on high-level results from the CFD analysis
- Due to the non-ideal CRU layout for standard hot/cold aisle design, proper methods to eliminating air-mixing will need to be considered
- Uniform usage of blanking panels and elimination of floor air leakage will be essential
- UPS Cooling
 - Installing a second riser from the central plant and feeding each via a separate riser will be one of two improvements necessary to the UPS cooling infrastructure
 - Also important will be providing truly diverse sources of power for each CRU
- Monitoring and Controls
 - Increased monitoring visibility and more widespread staff knowledge of control systems is essential to reliable operation of the data center
 - A centralized NOC infrastructure should be developed to monitor not only IT infrastructure, but also physical M&E infrastructure on a real-time and fully-staffed basis
- Fire System
 - One of only two mechanical components to meet Level 2 standards, a re-installation and calibration of the VESDA system would be required to achieve a higher standard

3.3.6 Technology and Telecommunications Systems

The telecommunications infrastructure was largely consistent with Level 2 standards. Independent carrier feeds enter the facility via diverse routes into a common entry closet and via a common MDF.

- In order to improve resiliency levels, a second, diverse entrance, constructed in a separate area of the facility, with carrier equipment duplicated in the newly created POE is required.

Technology systems and management of those systems is largely client-dependent. PTS noted some systems, critical to statewide safety, which operate without redundant equipment and incur a weekly maintenance outage.

3.3.7 Operations & Maintenance

There are multiple gaps between DSIT's data center operation and the practices generally accepted by data center facilities with similar customer makeup and criticality.

- Procedures and Documentation

- There are no site-specific operating procedures for any element of the infrastructure or client interaction.
- As-built documentation is not up to date and PTS found multiple inaccuracies.
- There are no enforced data center tenant rules, including planning and procedures for the installation of new equipment.
- Equipment Maintenance
 - DSIT does not perform maintenance on critical systems in accordance with manufacturer's requirements.
 - DSIT maintains selected emergency service contracts for key equipment.
 - DSIT does not update or replace equipment according to manufacturer specifications
 - During the term of the PTS engagement, the battery string for UPS #1 failed. This string had been in service since the site went online in 1996. Manufacturer requirements and industry standards set a useable life expectancy of less than ten years.
- Site-wide procedures
 - The DCB is not under the control of a single body. Some portions fall to GSA, while others are under the purview of DSIT. This leads to confusion and delays during emergencies.
 - DCB and GSA enact infrastructure in a largely reactionary mode, with inadequate consideration of second- and third-order impacts and requirements.
 - The data center floor includes work area cubicles and access to high volume printing services. Supplies for staff and printing are on the data center floor.
 - *PTS understands that during the completion of this report--and due in part to our informal recommendation—DSIT and GSA relocated printing services to another facility and shifted staff into the former print areas. These areas are accessible through the data center, garnering a partial remediation of the associated risks.*
- Security policy and enforcement
 - Data center visitor policy, while written, is largely unenforced.
 - DCB culture includes common manners, which lead to “tailgating” a substantial risk to site security.
 - Delivery / loading dock security is minimal.

3.3.8 Site Risk Analysis

The Broad River Road facility is subject to multiple site risks.

- Natural risks
 - Saluda River flood stage crests impact potential access to the site
 - 17 since site opened
 - 4 in past five years
 - Hail storms
 - 94th percentile nationally

- Wildfire
 - Facility near Harbison State Forest
 - Medium risk
- Seismic risks
 - Minimal landslide risk
 - No localized earthquake risk

3.4 PUE (POWER USE EFFICIENCY)

Due to a risk of facility outage, PTS aborted installation of PUE data gathering equipment. Efforts to mitigate that risk are scheduled for August of 2012. PTS will gather the data after that point and update this section.

3.4.1 Present State

3.4.2 Areas for Improvement

3.5 EQUIPMENT AREA LAYOUT AND CFD (COMPUTATIONAL FLUID DYNAMICS ANALYSIS)

3.5.1 CFD Interpretation

PTS has reviewed the report presented by an independent CFD analysis company. The report is attached as Appendix (); and a summary of the findings is below.

- Air conditioning units are not located in a manner conducive to cooling the equipment as deployed.
 - There is a real risk of overheating the room as load grows.
 - Certain areas of the space are far more loaded. There are five specific areas with an immediate need of remediation.

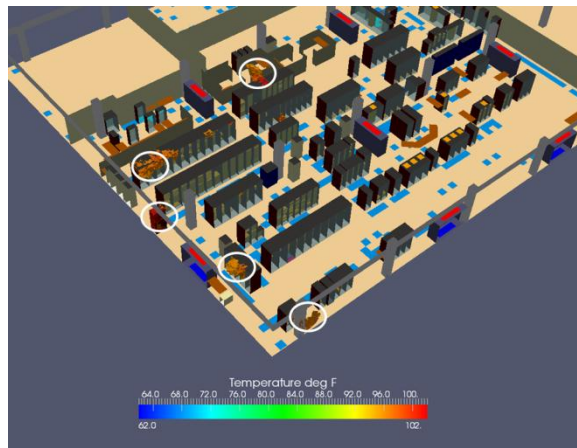


Figure 3 - CFD: Immediate Remediation Areas

- Due to the lack of a return path, there is widespread air recirculation within the facility, contributing to the risk of local hot spots.

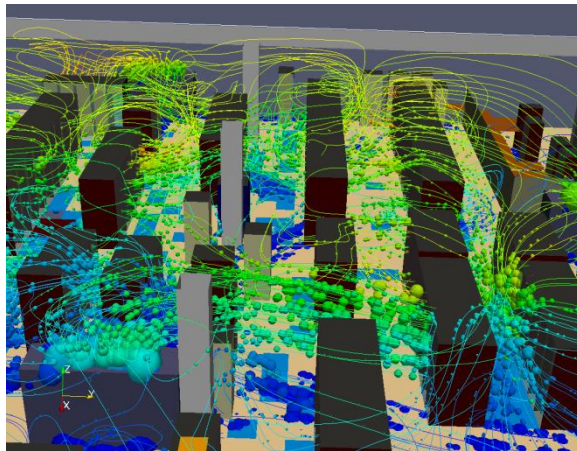


Figure 4 - CFD: Air Recirculation

- There is further evidence that improper airflow under the raised floor leads to vortex patterns, where cold air is drawn back through tiles and into the floor void.

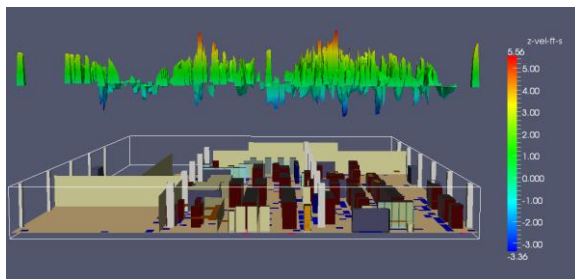


Figure 5 - CFD: Air Volume Diagram

- CRUs 3, 5, and 7 are of particularly high risk of causing a thermal overload condition.

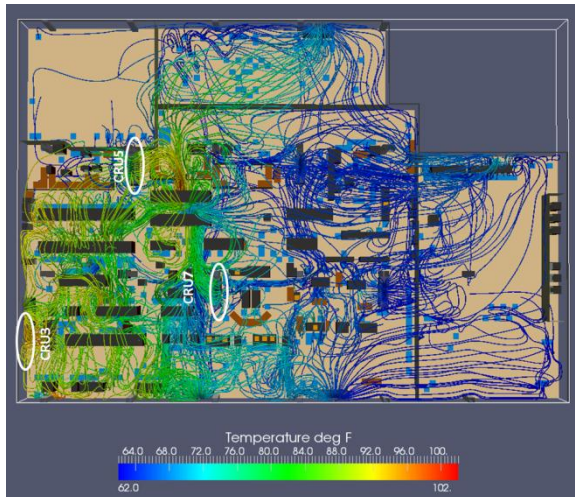


Figure 6 - CFD: Airflow Temperature

- The room does not have any cooling resilience; if one CRU fails, DCB will be unable to support all equipment.

- The total load in the space after installation of the new Child Protection servers will be over 430 kW. A standard margin of 15% - 25% accounts for losses in a typical design, yielding a total load of 490-530kW against a total installed capacity of 504kW

In order to use this facility in a modern way, and grow to meet anticipated client demand, the following actions are required:

- Increase CRU capacity and resilience by adding units.
- Ensure adequate air flow by re-locating all CRUs in a common fashion
 - This will require multiple client equipment moves, resulting in service disruptions and risk of unplanned outages.
- Improve floor tile layout by removing unnecessary perforated tiles and developing real cold aisles.
- Improve airflow by rotating some cabinets to achieve uniform hot and cold aisles.

3.5.2 Equipment Area Layout

The equipment area at the Broad River Road facility is not adequate to meet the demands of a high density computing environment. Having undergone significant organic, unplanned growth during its lifespan, the facility is subject to an uneven distribution of electronic and infrastructure equipment. Rows within the equipment area are inconsistent and do not segregate the supply (cold) and return (hot) air in a uniform manner. This condition is exacerbated by the perpendicular placement of electronic and air handling equipment.

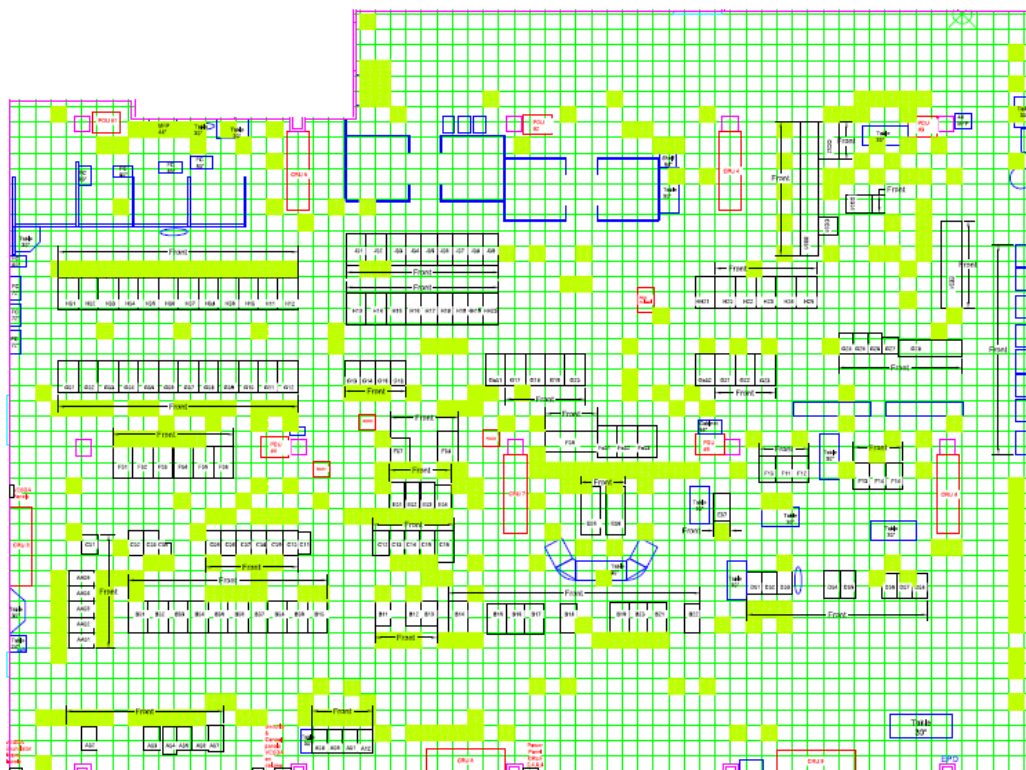


Figure 7 - DCB Server Area Layout (June Snapshot)

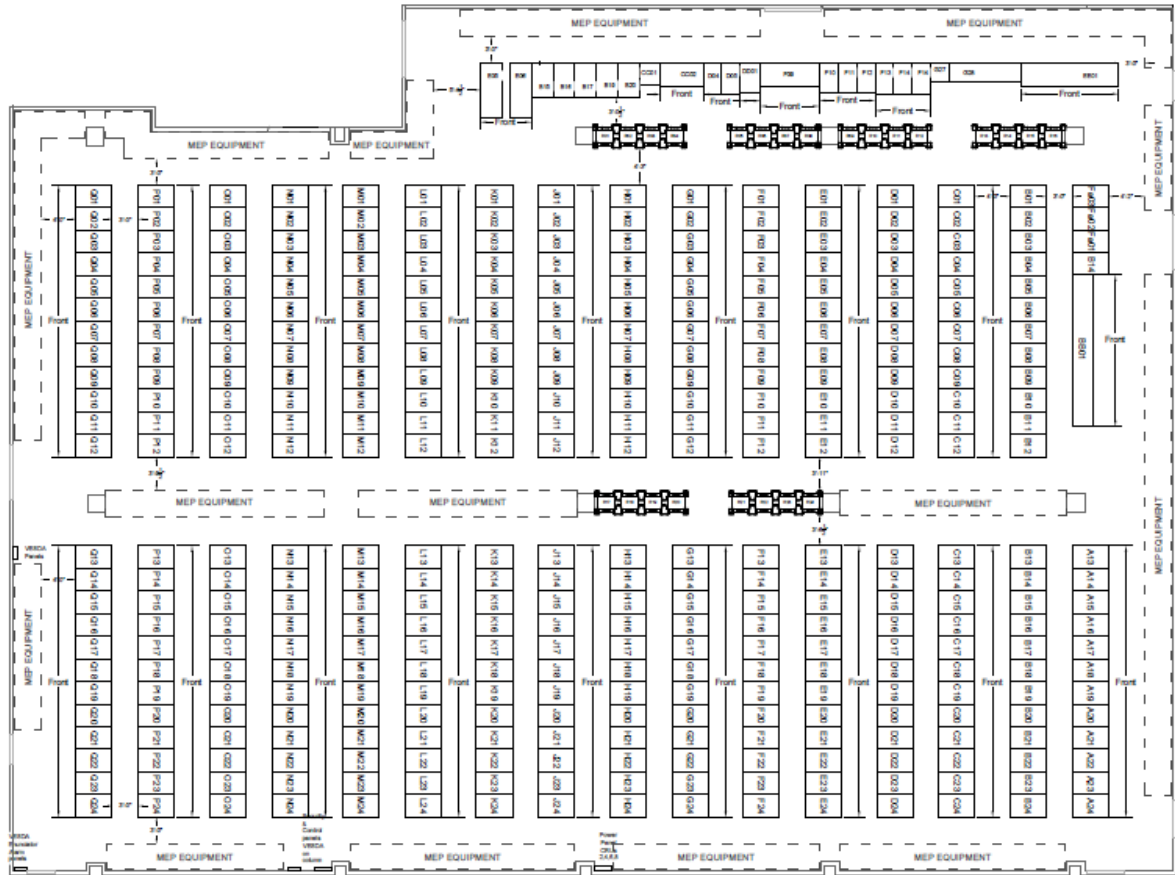


Figure 8 - Server Area Optimized Layout

3.6 DATA CENTER LIGHTING

Existing data center lighting levels are at or near the ANSI and TIA standards for lighting in equipment spaces (50cd @ 3'0" A.F.F.). In planning a re-alignment of the equipment on the data center floor, there are many options for improving the efficiency of lighting within the space. The number of fixtures required to light the space in a uniform configuration may be lower than the current installation, yielding a nominal operational savings.

Given the number of options available and the relatively low impact to capital and operating expense, these options are not included in the high level budgets discussed in Section 6 (Data Center Platform Options) and are relative to each other rather than to the total operating budget.

- Retain existing lighting strategy
 - Re-use existing fixtures and supplement
 - Minimal cost to implement; minimal cost savings

- “Lights Out” styles using existing strategy
 - Re-use existing fixtures and supplement
 - Enable selective lighting by modify electrical distribution to lighting grid
 - Use motion-controlled lighting to determine row occupancy
 - Use manually-controlled lighting based on required effort
 - Moderate cost to implement, reduced operating cost
- Low-voltage lighting
 - Install new fixtures
 - Install new control system
 - Use motion-controlled lighting to determine occupancy at a granular (cabinet) level.
 - Use manually-controlled lighting based on larger efforts
 - High implementation cost, significantly reduced operating cost (2-3 year ROI)

3.7 DATA CENTER INVENTORY

3.7.1 Present State

The data center currently houses approximately 1,800 devices in 175 cabinets. These devices, when operating at the maximum load specified by the manufacturer, would draw over 1MW of power. The divergence between nameplate load and demand load accounts for less equipment efficiency than is common in a Level 3 facility, and is a cause for concern.

3.7.2 Future State

The future state of the facility is difficult to assess. The trend during the PTS engagement has favored equipment additions at a far greater rate than deletions. When coupled with the issues in cold air and electrical delivery, the wide gap between nameplate load and system capacity yields a significant risk to facility operations. As clients improve their equipment use efficiency, power consumption and heat exhaustion will grow within the same space. Given the present state of communications between client IT and DSIT, DSIT will have difficulty in planning for this growth.

The relatively low equipment use efficiency also indicates an area for improved space efficiency in the new environment. By improving equipment compute density, DSIT may reduce the overall operational cost of the new facility.

3.8 PLATFORM RISK

Sections 3.3.4 through 3.3.8 discuss key elements of the infrastructure which fall below the

levels required to meet the legislature or the CIO's mission. Subsections here describe some of the most serious risks associated with those gaps.

3.8.1 **Security Risks**

- Risk to personnel or property during an isolated event (individual or small group breakout) at one of the adjacent correctional facilities
- Risk to building perimeter and exterior infrastructure during a large-scale event at one of the adjacent correctional facilities
- Risk to data or property during a breach of the security platform

3.8.2 **Operational Risks**

- Known inability to meet customer need for equipment installation, leading to isolated customer platform and relationship damage
- Unknown inability to meet customer need for equipment installation, leading to a partial or full outage at the facility, impacting multiple customer platforms and relationships

3.8.3 **MEP Plant Risks**

- Risks to delivery of electrical power during a maintenance period
- Risks to continued electrical redundancy above N+0
- Risks to distribution of cold air across the facility floor
- Risks to chilled water production redundancy

3.8.4 **Technology Platform Risks**

- Risk to delivery of telecommunications service due to accidental or malicious damage (MDF failure)
- Risk to existing systems during upgrade condition

4 DATA CENTER STRATEGY

4.1 STRATEGY SUMMARY

The long-term vision, consistent with the project mission, is to provide state agencies and customers with a highly resilient, highly secure data center environment and service catalog.

The data center environment must provide the following infrastructure and IT related services:

- Support for existing technology platforms
- Advice on and support of new technology platforms to address leading edge technology solutions required by agencies
- Cost competitive environment

Implementing this strategy requires the following components:

- Service Delivery Management
 - IT hardware management services
 - Subject matter expertise and thought leadership
 - Multiple service level agreement offerings
 - Cost and plan transparency
- Data Center Portfolio
 - Highly resilient physical plant
 - Managed real estate and infrastructure
 - Long-term growth planning
- Platform Operating Model
 - Active management and maintenance
 - Technical staffing
 - Physical access control
 - Logical access control

4.2 BENCHMARKING

4.2.1 Industry Standards

The data center industry, as represented by both the Uptime Institute (a private company) and the Telecommunications Industry Association (an international trade organization) apply four categories, or tiers, to data center infrastructure resiliency. A facility with a higher tier rating carries a higher level of resiliency, with a Tier 4 facility theoretically offering less than one minute of unscheduled downtime per year. The PTS STARS method provides additional granularity in data center ratings, with four intermediate scores within each infrastructure

category; and an overall facility rating as a blend of those infrastructure categories. STARS also allows classifications to span physical facilities or campuses, providing an overall IT resiliency rating.

In practical terms, constructing a Tier 4 (or a facility above a STARS L3 **) is cost prohibitive with minimal improvement to the risk profile.

4.2.2 Industry Validation

The majority of critical service data centers in the United States claim to meet the TIA classification of Tier 3, with no third party verification of those claims. PTS's independent review of several of these facilities has led us to conclude that they generally fall within the range of STARS L2** to STARS L3*. Facilities within that range provide resiliency sufficient for most data customers. In addition, industry studies of late point to the notion that a data center portfolio consisting of applications capable of site-level failover, operating across two or more independent facilities within the STARS L1*** to STARS L2* rating range, provides greater resilience than most "Tier 3" facilities, with relatively minor increases in capital and operating budgets.

Identifying the best data center portfolio for the state requires an in-depth understanding of the level of maturity of the component applications as well as the level of influence that DSIT will be empowered to exert over those decisions.

4.3 FUNCTIONAL END STATE

The State of South Carolina data center end state should be consistent with the design principles and aligned to the industry in a requirement for concurrent maintainability. To that end the data center service requires a facility or portfolio of facilities which as a unit allows for maintenance at most levels without the risk of service interruption.

4.3.1 Physical Security

Data center security is central to data center and electronic asset protection. Ensuring operational excellence and reducing risk of outages requires that a platform prevent unauthorized personnel accessing critical equipment and MEP service areas. Securing the assets is equally important as ensuring the continued operation of the facility.

PTS recommends the implementation of a more robust monitoring system including:

- Surveillance monitoring with increased camera coverage in the data center and all IT and facilities access points.
- Access monitoring with card reader controlled entrance and exits to all IT and facilities access points.
- Development of security procedures including, but not limited to:
 - Physical access permission and scheduling associated with maintenance or installations
 - Manned guard stations with procedures for granting access
 - Notification lists for guards or operations personnel
 - Equipment removal

4.3.2 IT Security

Based on our interviews, the state of electronic security with respect to access prevention and control is in good and well-funded.

PTS recommends a more formalized set of procedures associated with, but not limited to:

- Security/Syslog log management and analysis
- Data migration
- Intrusion detection and analysis

4.3.3 Resiliency

This primary concept means that mechanical and electrical systems should have a level of redundancy that ensures critical systems components can be maintained, or potentially fail without risk to the operation of the facility.

PTS recommends an N+2 design for critical components. This will allow the facility to continue operating if a system component fails while another component of the same system is offline for maintenance. PTS further recommends that the N+2 design be extended to a second data center facility. Technology platforms would be implemented in a redundant design between data centers. Specifics will require a detailed review of systems platforms and application requirements to develop a plan for technology design

4.3.4 Service Stratification

In order to deliver adequate service at the correct cost levels, PTS recommends that the State's service offering account for varying recovery point and recovery time objectives. This approach will allow the state to develop detailed transformation strategy with a set of technical targets, aligning the capital and operational expenses with various client needs.

4.3.5 Fee Structure

As a strategic end state, DSIT's fee structure must accurately reflect the underlying cost of each service; and they must be consistent between services and customers. Fees should follow a similar stratification discussed as a strategic goal in Section 4.3.4 and defined through customer engagement as discussed in sections 5.4 (Service catalog) and 5.5 (Service levels).

Section 5.6, Cost Management and Financial Models, discusses the methods which DSIT will use to develop rates as they relate to the existing data services and any new thought leadership services which may be included in the new catalog.

4.4 KEY COMPONENTS AND JUSTIFICATIONS

To enable the CIO's mission and the recommendations included throughout this report, the State of South Carolina must define the design pillars for excellence in their data centers. Recommended design pillars are defined conceptually below.

- Security
 - Restricted physical access to the data center
 - Restricted system access from internal and external vectors
 - Intrusion detection and protection mechanisms
 - Monitoring and audit capability
- Resiliency
 - High availability for all systems and operations
 - Concurrent maintainability
 - Alternate path communications
- Technology Flexibility
 - Accommodate any foreseeable technology platform
 - Scale current and future platforms
 - Employ a robust change management process
 - Support all systems and services through thorough operational procedures

4.5 SUCCESS CRITERIA

PTS recommends measuring the success of the implementation using the following parameters.

- Service Delivery Management
 - Client communications
 - Adherence to service level agreements
 - Customer policies and procedures
 - Cost transparency

- IT service catalog
- Data Center Platform
 - Infrastructure resilience
 - Management practices and operational procedures
 - Scalability and flexibility
 - Platform operations and maintenance
- Fiscal Considerations
 - Capital expenses
 - Operational expenses
 - Facility amortization

4.6 TRANSFORMATION

The remaining sections in this document describe the strategy for determining and implementing the optimal transformation for the DSIT data center platform. The transformation plan includes the following steps:

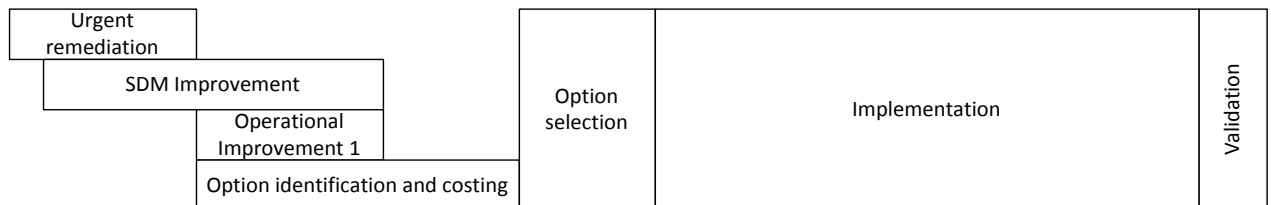


Figure 9 - Transformation Plan Block Diagram

Please refer to Section 8, Transformation Plan, for a detailed breakdown of this plan.

5 SERVICE DELIVERY MANAGEMENT

5.1 SUMMARY

The most important element of the strategy for building a world-class engagement model is understanding the utility of the facility over a period of time.

The strategy serves as end state goal. From the client perspective they need to know that DSIT understands the needs of the agencies potentially occupying the space. DSIT must prove to the agencies there is a real, quantitative understanding of their day-to-day challenges.

5.2 ENGAGEMENT MODEL

In order to determine the best data center portfolio for the State of South Carolina, DSIT must engage in a detailed discovery of the needs of their customers. As part of the improvement in customer relationships, gathering this information will both assure customers that DSIT is thinking about providing the services in a good way and ensure that the system implemented by DSIT will meet customers' short- and long-term requirements.

Options discussed in Section 6, Data Center Platform Options may carry a lower TCO of the DSIT budget while requiring a much greater investment by customers. For example, while engaging with a colocation provider at the STARS L3 range carries the lowest TCO for DSIT it may incur unacceptable risk to client operation.

5.2.1 Assessment (Needs Analysis)

DSIT must completely understand the requirements of the IT consumers in the agencies by engaging with the appropriate technical managers in each organization. This is not a "done once and finished" engagement. Client requirements are continually changing. Data centers must be dynamic.

5.2.2 Account Liaison Office

The ongoing assessment of customer requirements will necessitate account liaisons be involved on a regular basis. One or more dedicated employees must function as Account Liaisons. The Account Liaison must understand client requirements including the following:

- Growth Projections

- Migration planning
- Security
- Reporting and analytic requirements (state and federal requirements, environment certifications, auditability, etc.)
- Operational responsibilities
- Budget and cost considerations

The Account Liaisons must have sufficient technical knowledge to understand these goals and align them to the appropriate levels within the DSIT offering. One of the key functions will be to work within the existing framework, guiding clients to select a portfolio of services at varying resilience levels. This will optimize the client's spend rate while improving their trust of DSIT.

Our expectation is that agencies will have many common requirements and constraints and a very small account liaison effort will dramatically increase the understanding of requirements associated with the above. A wider benefit of the Account Liaison Office will be communications with the agencies as a community of users. This office will be responsible for identifying the great things going on at DSIT. This will also provide an opportunity for the DSIT organization to market not only the data center capabilities, but other ancillary services associated with thought leadership, cost transparency, and optional levels of service.

- Data Center User Group
- User Feedback and Statistical Evaluation of Performance
- Definition of Data Center Road Map
- Consulting and Thought Leadership (Center of Excellence)

As the individual account liaisons complete their assessments of client needs, DSIT will use this information to develop the standardized service levels for inclusion in the service catalog, socializing those levels with the clients before completing the process. Items to be standardized are discussed in Sections 5.5, Service levels.

5.3 STRUCTURED FEES

DSIT must establish a baseline cost for the provision of services and provide insight as to the components of that cost. Components of this cost will include:

- Operating expenses and escalation guideline for subscribers
 - Salaries
 - Security
 - Monitoring, Analysis and Deployment Tools
 - Licensing renewals
 - Service contracts

- Taxes
 - Utilities
- Sinking funds for infrastructure upgrade
 - Facilities
 - Technology
- Reconfiguration
 - Infrastructure deployment
 - Patching
 - Dynamic processing and hosting

5.4 SERVICE CATALOG

The service catalog is meant to inform users of the breadth of data center related services and costs for delivering those services. The Service Catalog should convey DSIT's ability to meet various client service needs.

The intent is to identify the areas where DSIT can provide value added services at competitive prices. The service catalog should provide an understanding of the value to the business.

- What goals does the business need to achieve?
- Have we engaged the correct audience?
- What's the (quantitative/qualitative) value?

5.4.1 Service Definitions

The least important element of a service catalog is the detailed service definition. A service definition document should be part of the portal that informs customers. The portal will also include the service level agreements and the metrics and parameters against which DSIT and customers will evaluate performance.

5.4.2 Service Management Policy

More than the definition of what the service is, the defining factor is how your customers will know that you are capable of delivering on the services for which they are paying. There must be a service management policy to address the services offered in the service catalog.

The service management policy is the definition of how DSIT will accomplish the goals of each agency. These should be proven in the Operation Procedures documents.

The service catalog must include the units of measure for the service adherence. The agencies will be focused on evaluating how DSIT's offer compares to industry alternatives and their

internal cost base.

Service catalog components should include but not be limited to:

- Real Estate (metrics and units below)
 - Square footage
 - Cabinet
 - Power consumption
- Hosting
 - Processing equipment (processor, memory, interface, etc.)
 - Storage
 - Access (internet bandwidth, communications, etc.)
- Managed services
 - Hardware
 - OS and Patching
 - Application support
- Thought Leadership and Consulting services

5.5 SERVICE LEVELS

The Service Level Agreement is the basis for delivery and measurement of success of the client experience.

5.5.1 Agreement Components

The DSIT data center customers have the specific responsibility to ensure the understanding of things like DSIT resolution processes, management escalation, and cost for expedited services. These are important criteria as their invocation must be at pre-determined points with both parties having a complete understanding of the penalties and obligations. These must be agreed before the services are in production. The next discussion of these terms will be in a “downtime” situation.

Typical agreements include the following elements to reduce the possibility of conflicting expectation and/or ambiguity. In order to ensure DSIT’s ability to deliver on the terms of the agreement it is critical the service level agreement be tied to internal process and procedures.

The Account Liaison Office will work with the customers to determine the available service levels in each of the following categories:

- Available services
- Resilience options

- Recovery objectives

Once DSIT has aligned the service catalog with the requirements of the community, individual account liaisons will instill in each client an understanding of the options and their associated benefits, costs, and enforcement. Liaisons will have completed the second stage of the Office's objective when clients have selected a set of services and options.

5.5.2 **Recovery Point Objective**

Recovery point objective defines the maximum amount of data that can be lost following an unplanned outage. This is measured in time rather than quantity of data. In setting the standard service levels, customers will need assistance in assessing the frequency of backup required. There will also be questions of what data needs to be recovered and how quickly.

In addition to the objective itself, DSIT must lead customers to completely document what's necessary to achieve recovery. These procedures will include both manual and automated processes involved in the effort, and will allow for a realistic lens in determining an adequate RPO.

5.5.3 **Recovery Time Objective**

Business continuity standards define RTO as the target time set for resumption of product, service, or activity delivery after an incident. Account Liaisons will lead customers in defining the following service-related requirements for operations:

- What constitutes a disaster scenario?
- Who will address which aspects of each scenario?
- What are the recovery requirements for each unit's operation?
- What needs to recover today? At the end of the week? End of month? Who identifies that situation?

Similarly to the approach to recovery point objective, having realistic answers to those questions will allow DSIT and the client to identify the services and strata which will meet functional needs at an adequate price point.

5.5.4 **Service Level Agreement (SLA)**

The service level agreements will define what services the customers subscribe to and the expected outcomes associated with failure to deliver those services. The Account Liaison Office must manage the relationships with the agencies employing DSIT for data center services. The service level agreement should be the tool by which the service/equipment/application is

managed.

Service level agreements require attention from DSIT to ensure the agreements are up to date, well understood by both the customer agency, the service provider, and the operations staff responsible for maintaining the service identified in the agreement.

SLAs should include the following definitions:

- Ownership, responsibility and roles of the agreeing parties
- The metrics by which compliance will be evaluated
- Review period (annual expected but can be defined and adjusted on any basis)
- Detailed responsibilities of the service providers
- Customer responsibilities
- Service Management
 - Support (Help desk, telephone, tech support, onsite assistance)
 - Requests (time frame to complete, windows of opportunity, emergency procedures)
 - Change Management

Through the Account Liaison office, DSIT will responsible for effectively communicating SLA content and addressing any changes necessary to those agreements. Without this level of continued interaction, DSIT will not meet the deliverables in a quality way and the relationship will fail.

5.6 COST MANAGEMENT AND FINANCIAL MODELS

A key component of the strategic end state is a revised financial model that accounts for the requirements of a first class data center portfolio. Financial models included in this document consider the following elements.

- Capital cost to achieve goals in various scenarios
- Operating costs associated with client satisfaction and service level agreement compliance
- Cost model for data center services

Other cost components will include service level requirements identified by customer need. DSIT will define and price these services based on specifics.

5.6.1 Revenue Neutrality

The notion of a “revenue neutral” model requires a very detailed cost management process that ensures capital and operational costs are understood and captured. These costs include the

initial cost of DSIT platform remediation and project work as it is required or requested. These costs must also include a distribution of capital to “sinking funds” associated with future upgrade plans.

Interviews with several agencies indicated a very strong dissatisfaction with the rates DSIT levies for telephone, and other services. They claim the billing is wrong, the prices are very high and finally, the invoices cannot be easily understood.

The model for the DSIT facility must be neutral and account for all capital and operations costs expected to be incurred over the term of the engagement. Those cost estimates can be adjusted annually to reflect changes to DSIT operating costs:

5.6.2 Cost Control and Transparency

The dissatisfaction of the agencies regarding the costs associated with using DSIT provided services and infrastructure is, based on our interviews, two fold. The first issue is the understanding of costs based on the invoices. The second is the perception that DSIT is overcharging for services with the “profit” associated with those overcharges being applied to other shortfalls.

Revenue neutrality requires a very close eye on cost control. Financial management of data center environments and all of the moving parts is critical to long-term success. Financial management means planning tactical elements of a well-developed strategic vision through capital and operations budgeting and audit.

PTS recommends a structured and detailed accounting of all services associated with the data center facility. Specifically:

- Provide a detailed budget of all project and committed capital costs
 - Infrastructure (facilities and technology)
 - Equipment (hardware and software)
 - Licensing
 - OS
 - Tools
 - Applications
 - Security
- Services
 - Consulting
 - Training and education
 - Vendor and technical support

- Financial Reporting
 - Budget development, submission and approval
 - Spend authorization
 - Order processing
 - Reporting
 - Audit
- Customer Invoicing
 - Service level
 - Pricing stratification (Platinum/Gold/Silver/Bronze)
 - Detailed description of add on services
 - Training
 - Emergency requests

All of the above will provide the highest level of transparency to the DSIT customer base. The invoicing will be consistent across services and most importantly between agencies. The inevitable invoice comparison will result in an agreement that all services are equally represented and charged.

Consistency is important to the data center environment in every way. Operational procedures that are reflected in a consistent financial format and understanding will lead to a high level of satisfied customers as expectations are understood by both parties, managed consistently by liaisons and billed with consistency.

6 DATA CENTER PLATFORM OPTIONS

6.1 SECTION SUMMARY

The sections below describe the high-level options for providing a highly resilient system to customers. Items include order of magnitude pricing and schedule elements based on the best available information.

The items as discussed are the industry-accepted options for deploying new data center facilities: purpose-built or hosted facilities, as well as improving the existing DCB. In general, data center operations of this size are better suited to an outsourced, colocation model than to a new facility.

6.2 OPTION SCORING AND WEIGHTING

Options are scored on a set of criteria, each using a ten point scale in which 0 is the least favorable and 10 is the most favorable. Criteria are weighted relative to each other. An element with a weight of 2 is twice as important to the total score as an element with a weight of 1.

- **Initial Capital Cost** is the total initial capital spend requirement, or the capital requirement prior to initiating a phase of work. Since operational expenses will be spread across multiple concurrent initiatives, they are excluded from initial cost.
 - Client-provided weight: 8/10
- **Ten year Total Cost of Ownership** is the total cost to construct and operate the platform option over ten years. It does not consider revenue.
 - Client-provided weight: 7/10
- **Client Attractiveness** is the level at which this platform option will attract new or expanded business, and ensure that customers do not leave DCB.
 - Client-provided weight: 9/10
- **Short-Term Platform Exposure** is the combination of known planned outages to client service, coupled with the likelihood of unknown outages to the environment
 - Client-provided weight: 8.5/10
- **Long-Term Platform Exposure** is the likelihood of unplanned outage to client services after the option is in operation
 - Client-provided weight: 8.5/10
- **Physical Feasibility** is a measure of the known and unknown difficulties inherent in option implementation
 - Client-provided weight: 9.5/10
- **Operational Feasibility** is a measure of DSIT's ability to operate such an environment, coupled with the ability of clients to work within that environment.
 - Client-provided weight: 10/10

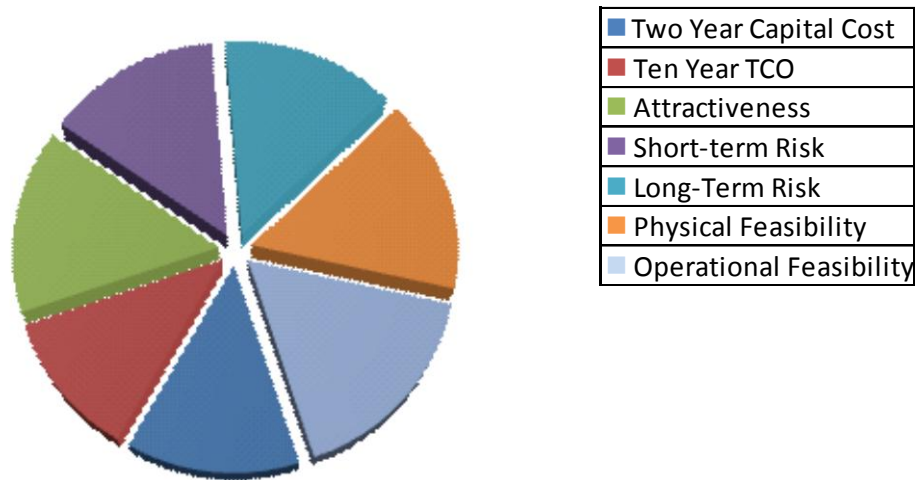


Figure 10- Relative Category Weights

6.3 DESIGN AND COST ASSUMPTIONS AND NOTES

The options below include the following assumptions:

- Platform ratings below STARS L3 are not considered. A L3 rating includes set levels of physical and logical resilience as well as robust security offerings, which will meet most government- and industry-defined requirements.
- Single facilities begin with an electrical footprint of 500kW, ramping to ~1.1MW within the first two years and to 2MW within the ten year term.
- Paired facilities begin with an electrical footprint of 350kW each, ramping to ~700kW within the first two years and to 1.2MW within the ten year term.
- Purpose-built facilities use smaller unitized energy devices than colocation facilities.
- This section does not discuss the overall cost of the DSIT operating model, including additional resources required to manage costs and clients.
- Colocation options do not include any additional overhead for vendor management or other tasks.
- Given the complexity of the environments within DCB, migration cost estimates are not included.
- Cost items are indicative and are not suitable for submission in budgetary planning sessions.
- Hybrid options consist of a combination of lower-resilience solutions. Refer to Section 6.14 for a detailed description of the components required by each solution.
- **Costs for all options are in addition to those discussed in Section 3.2, Urgent Remediation Recommendations.**

6.5 SUMMARY OF OPTION SCORES AND COSTS

	Option 1 Colocate Level 3	Option 2 2x Colocate Level 2	Option 3 New Level 3	Option 4 New Level 2 + Colocate Level 2	Option 5 2x New Level 2	Option 6A DCB to Level 2 Colocate Level 2	Option 6B DCB to Level 2 New Level 2	Option 7 DCB to Level 3
Two Year Capital	\$2.23M	\$2.9M	\$13.03M	\$10.81M	\$18.71M	\$6.9M	\$14.8M	\$11.22M
Two Year Op. + Energy (not scored)	\$5.7M	\$6.08M	\$7.26M	\$7.69M	\$9.29M	\$7.8M	\$9.41M	\$7.09M
Ten Year Capital, Op, Energy	\$78.46M	\$76.38M	\$82.16M	\$89.28M	\$102.18M	\$96.44M	\$109.34M	\$90.32M
Total Weighted Score	534	495	453	413	381	377	334	302

Weight																	
Two Year Capital Cost	8	10	80	9	72	5	40	7	56	3	24	8	64	4	32	6	48
Ten Year TCO	7	9	63	10	70	8	56	7	49	4	28	5	35	3	21	6	42
Attractiveness	9	9	81	5	45	8	72	4	36	4	36	5	45	5	45	4	36
Short-term Risk	8.5	9	76.5	9	76.5	6	51	8	68	7	59.5	7	59.5	5	42.5	2	17
Long-Term Risk	8.5	8	68	9	76.5	8	68	8	68	8	68	9	76.5	9	76.5	6	51
Physical Feasibility	9.5	10	95	10	95	9	85.5	9	85.5	10	95	7	66.5	6	57	4	38
Operational Feasibility	10	7	70	6	60	8	80	5	50	7	70	3	30	6	60	7	70

Table 5 – Weighted and Un-Weighted Option Scores

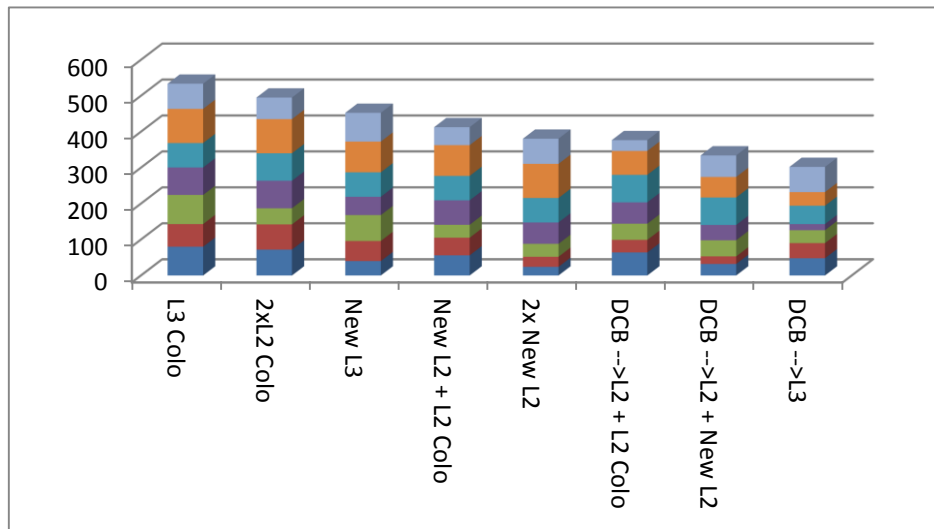


Figure 11 – Weighted and Un-weighted Option Scores

6.6 OPTION 1 – OUTSOURCE TO SINGLE LEVEL 3

In general, facilities of the size under discussion in this document are less expensive at an outsourced provider's facility. Multiple tenants share the provider's capital and operating costs, yielding a lower TCO. **Selecting and occupying a STARS Level 3 colocation facility will occupy a timeframe of 9-12 months at a capital cost of \$2.2M, excluding the cost to migrate services.**

Item	Cost	Outages Required
Site Selection <ul style="list-style-type: none"> Identify a field of candidate providers Engage in a detailed RFP process to select a provider 	\$100K	
Vendor Fit-Out (Year 1 / 2 Capex) <ul style="list-style-type: none"> Construct a cage or cages to DSIT's specifications Install cabinets and ancillary equipment to vendor's specifications. 	\$2.2M	
Commissioning <ul style="list-style-type: none"> Ensure that the system operates as required and is fully documented 	Included Above	
Migration <ul style="list-style-type: none"> Plan and implement the migration of customer services to the new facility 	*	Multiple, planned
Year 1 / 2 Rent + Power <i>not included in two year capital expense</i> <ul style="list-style-type: none"> Recurring fees for rent at provider Energy costs charged back at a moderate fee 	\$5.7M	

Table 6 - Remediation Option 1 Components

6.6.1 **Total Score** **534/605**

6.6.2 **Initial Capital Cost** **10 of 10**

- Two-year capex of \$2.2M is the lowest in the field.
- Given the revenue neutral model, a lower initial cost will likely be more attractive to DSIT and the State.

6.6.3 **Ten Year TCO** **9 of 10**

- Ten-year total cost of \$78.5M is the second in the field.

6.6.4 Client Attractiveness 9 of 10

- Sourcing data center services from a known provider with a high level of quality will provide most customers with an enhanced level of comfort.
- Requiring a physical migration and the logistical implications thereof is the significant “unpalatable” factor.

6.6.5 Short-Term Exposure 9 of 10

- Exposure to client operation consists of remaining at the existing facility for the period of implementation, as well as the risks inherent any data center migration.
- This option carries the lowest interval during which clients will remain at DCB.

6.6.6 Long-Term Exposure 8 of 10

- As a STARS Level 3 facility, the likelihood of unplanned outage due to physical component failure is low.

6.6.7 Physical Feasibility 10 of 10

- Working an operational facility eliminates any risk associated with the feasibility of construction.

6.6.8 Operational Feasibility 7 of 10

- Clients would continue to operate in a single-site facility, requiring little change to their operational methods.
- Operating as a reseller of colocation services and acting as the primary interface between the provider and clients will be a new model for DSIT.

6.7 OPTION 2 COLOCATION AT TWO NEW STARS L2 FACILITIES

(Refer to Section 0 for a description of the Level 2 colocation requirements.)

6.7.1 Total Score 495/605 2nd in a field of 7

6.7.2 Initial Capital Cost 9 of 10

- Two-year capex of \$2.9M is the second lowest in the field.
- Given the revenue neutral model, a lower initial cost will likely be more attractive to DSIT and the State.

6.7.3 Ten Year TCO 10 of 10

- Ten year TCO, including energy and operation, of \$76.8M the lowest in the field
 - Note that this figure may be misleading, as it does not consider additional DSIT overhead in working with two facilities.

6.7.4 Client Attractiveness 5 of 10

- **Requiring that clients split their operation to gain maximum resilience will be costly and unattractive.**
- Sourcing data center services from a known provider with a high level of quality will provide most customers with an enhanced level of comfort.
- Requiring a physical migration and the logistical implications thereof is another “unpalatable” factor.

6.7.5 Short-Term Exposure 9 of 10

- Exposure to client operation consists of remaining at the existing facility for the period of implementation, as well as the risks inherent any data center migration.
- This option carries the lowest interval during which clients will remain at DCB.

6.7.6 Long-Term Exposure 9 of 10

- Two Level 2 facilities provide a very high level of resilience.
- This resilience is further improved through the employment of an experienced organization.

6.7.7 Physical Feasibility 10 of 10

- Working with a facility that is already operational eliminates any risk associated with the feasibility of construction.

6.7.8 Operational Feasibility 6 of 10

- In order to reach the maximum level of resilience, client systems must be split between two locations. This requires investment in those systems for new equipment, training, procedures, and documentation.
- Operating as a reseller of colocation services and acting as the primary interface between the provider and clients will be a new model for DSIT.

6.8 OPTION 3 – NEW CONSTRUCTION (SINGLE FACILITY)

Depending on many factors and constraints outside the scope of this document, constructing a new facility or updating an existing/new property to acceptable levels of resilience may be an attractive option to DSIT and the State. **Constructing a new STARS Level 3 facility will occupy an approximate timeframe of 15 months at a cost estimate of \$17M.**

The table below describes the tasks required to complete such an initiative.

Item	Cost	Outages Required
Site Selection <ul style="list-style-type: none"> Identify a field of candidate sites, including both “green field” (unconstructed land) and “brown field” (existing buildings, typically warehouses or industrial sites) Choose the best site based on the known constraints and requirements 	\$250K	None
Facility Design & Construction <ul style="list-style-type: none"> Develop a site-specific design which is also tailored to the current and future needs of the current and potential clients 	\$13M	None
Commissioning <ul style="list-style-type: none"> Ensure that the system operates as required and is fully documented Develop site-specific operational manuals 	Included in Above	None
Migration <ul style="list-style-type: none"> Plan and implement the migration of customer services to the new facility 	*	Multiple, planned
Year 1 / 2 Opex & Power <i>not included in two year capital expense</i> <ul style="list-style-type: none"> Multiple shifts of staff at varying levels Maintenance contracts and other considerations Power increasing through term (assumes land is owned with no property tax liability) 	\$7.3M	None

Table 7 - Remediation Option 3 Components

6.8.1 **Total Score** **453/605** **3rd in field of 7**

6.8.2 **Initial Capital Cost** **5 of 10**

- Two-year capex of \$13M is 6th in the field.
- Given the revenue neutral model, a lower initial cost will likely be more attractive to DSIT and the State.
- Note that client migration cost estimates are not feasible at the current level of detail.**

6.8.3 **Ten Year TCO** **8 of 10**

- Ten year TCO, including energy and operation of \$82.1M is 3rd in the field

6.8.4 Client Attractiveness 8 of 10

- Building a single, highly resilient facility eliminates the existing impressions of the existing DCB without requiring any operational transformation within the clients' organizations.
- Requiring a physical migration and the logistical implications thereof is the significant "unpalatable" factor.

6.8.5 Short-Term Exposure 6 of 10

- Exposure to client operation consists of remaining at the existing facility for the period of construction
- Physical relocation of devices or services is inherently risky, exacerbated by the probably lack of documentation in client systems.

6.8.6 Long-Term Exposure 8 of 10

- As a STARS Level 3 facility, the likelihood of unplanned outage due to physical component failure is low.

6.8.7 Physical Feasibility 9 of 10

- Beginning with a rigorous site selection process, a "green field" for data center construction would incur minimal risk to long-term feasibility.

6.8.8 Operational Feasibility 8 of 10

- Clients would continue to operate in a single-site facility, requiring little change to their operational methods.
- Employing largely new staff in a new facility reduces the risks associated with platform operation.
- Acting as a business in which "colocation provider" is only one function has the potential to reduce DSIT's effectiveness in this arena.

6.9 OPTION 4 CONSTRUCT ONE STARS L2, COLOCATE AT ONE STARS L2

(Refer to Section 0 for a description of L2 construction components, and Section 0 for a description of L2 colocation components.)

6.9.1 Total Score 413/605

6.9.2 Initial Capital Expense 7 of 10

- Two-year capex of \$7.7 is fourth lowest in the field.

6.9.3 Ten Year TCO 7 of 10

- Ten year TCO, including energy and operation of \$89.3M is fourth lowest in the field.

6.9.4 Client Attractiveness 4 of 10

- **Requiring that clients split their operation to gain maximum resilience will be costly and unattractive.**
- Retaining control of at least half of all services may improve some clients' opinions of the offering.

6.9.5 Short-Term Exposure 8 of 10

- Exposure to client operation consists of remaining at the existing facility for the period of implementation, as well as the risks inherent any data center migration.

6.9.6 Long-Term Exposure 8 of 10

- Two Level 2 facilities provide a very high level of resilience.
- Locating one at a facility that has been in operation and is run by a dedicated firm further improves the risk profile.

6.9.7 Physical Feasibility 9 of 10

- Beginning with a rigorous site selection process, a "green field" for data center construction would incur minimal risk to long-term feasibility.
- Working with a facility which is already operational eliminates any risk associated with the feasibility of construction.

6.9.8 Operational Feasibility 5 of 10

- In order to reach the maximum level of resilience, client systems must be split between two locations. This requires investment in those systems for new equipment, training, procedures, and documentation.
- Operating a split data center platform between owned and managed facilities is the most complicated scenario.

6.10 OPTION 5 CONSTRUCT TWO NEW STARS L2

(Refer to Section 0 for a description of L2 construction components.)

6.10.1 Total Score 381/605

6.10.2 Initial Capital Cost 3 of 10

- Two-year capex of \$18.7M is the highest in the field.

6.10.3 Ten Year TCO 4 of 10

- Ten year TCO, including energy and operation of \$102.2M is the second highest in the field

6.10.4 Client Attractiveness 4 of 10

- **Requiring that clients split their operation to gain maximum resilience will be costly and unattractive.**
- Building a highly resilient platform eliminates the existing impressions of the existing DCB.
- Requiring a physical migration and the logistical implications thereof is another “unpalatable” factor.

6.10.5 Short-Term Exposure 7 of 10

- Exposure to client operation consists of remaining at the existing facility for the period of construction, as well as the risks inherent any data center migration.

6.10.6 Long-Term Exposure 8 of 10

- Two Level 2 facilities provide a very high level of resilience.

6.10.7 Physical Feasibility 10 of 10

- Beginning with a rigorous site selection process, a “green field” for data center construction would incur minimal risk to long-term feasibility.
- Risk is further reduced by building on two physically diverse plots of land.

6.10.8 Operational Feasibility 7 of 10

- In order to reach the maximum level of resilience, client systems must be split between two locations. This requires investment in those systems for new equipment, training, procedures, and documentation.
- Operating a split data center platform is more complex than a single facility, which will cause some “growing pains” in the first 2-3 years.

6.11 OPTION 6A UPGRADE DCB TO STARS L2 & COLOCATE AT A STARS L2 FACILITY

(Refer to Section 6.15.1 for a description of the requirements for upgrading DCB to Level 2. Refer to Section 0 for a description of L2 colocation requirements.)

6.11.1 Total Score 377 / 700

6.11.2 Initial Capital Cost 8 of 10

- Two-year capex of \$6.9M is the third lowest in the field.

6.11.3 Ten Year TCO 5 of 10

- Ten year TCO, including energy and operation of \$96M is third highest in the field

6.11.4 Client Attractiveness 5 of 10

- **Requiring that clients split their operation to gain maximum resilience will be costly and unattractive.**
- Retaining control of at least half of all services may improve some clients' opinions of the offering.
- Providing a very high level of availability while allowing at least some equipment to remain in its present location is an attractive proposition.

6.11.5 Short-Term Exposure 7 of 10

- This plan requires multiple systems outages, which include risks in simple shutdown and startup of older or un-documented systems.
- The existing conditions and unknown factors at the facility add a level of risk which is difficult to predict.
- Exposure to client operation consists of remaining at the existing facility for the period of implementation, as well as the risks inherent any data center migration.
- The factors above may be mitigated by bringing the new facility online prior to engaging in substantial construction at DCB. This option carries a shorter interval before work at DCB could begin than in Option 4A.

6.11.6 Long-Term Exposure 9 of 10

- Two Level 2 facilities provide a very high level of resilience.

6.11.7 Physical Feasibility 7 of 10

- There are a large number of "unknown unknowns" at DCB, making detailed planning difficult and inaccurate.
- Working with a facility which is already operational eliminates any risk associated with the feasibility of construction.

6.11.8 Operational Feasibility 3 of 10

- In order to reach the maximum level of resilience, client systems must be split between two locations. This requires investment in those systems for new equipment, training, procedures, and documentation.
- Operating a split data center platform between owned and managed facilities is the most complicated scenario.

6.12 OPTION 6B UPGRADE DCB TO STARS L2 & CONSTRUCT STARS L2

(Refer to Section 6.15.1 for a description of the requirements for upgrading DCB to Level 2. Refer to Section 0 for a description of L2 construction requirements.)

6.12.1 **Total Score** **334/605**

6.12.2 **Initial Capital Cost** **4 of 10**

- Two-year capex of \$14.8M is the second highest in the field.

6.12.3 **Ten Year TCO** **3 of 10**

- Ten year TCO, including energy and operation of \$109M is the highest in the field

6.12.4 **Client Attractiveness** **5 of 10**

- **Requiring that clients split their operation to gain maximum resilience will be costly and unattractive.**
- Retaining control of all services may improve some clients' opinions of the offering.
- Providing a very high level of availability while allowing at least some equipment to remain in its present location is an attractive proposition.

6.12.5 **Short-Term Exposure** **5 of 10**

- This plan requires multiple systems outages, which include risks in simple shutdown and startup of older or un-documented systems.
- The existing conditions and unknown factors at the facility add a level of risk which is difficult to predict.
- The factors above may be mitigated by bringing the new facility online prior to engaging in substantial construction at DCB.

6.12.6 **Long-Term Exposure** **9 of 10**

- Two Level 2 facilities provide a very high level of resilience.

6.12.7 **Physical Feasibility** **6 of 10**

- There are a large number of "unknown unknowns" at DCB, making detailed planning difficult and inaccurate.
- Beginning with a rigorous site selection process, a "green field" for data center construction would incur minimal risk to long-term feasibility.

6.12.8 **Operational Feasibility** **6 of 10**

- In order to reach the maximum level of resilience, client systems must be split between two locations. This requires investment in those systems for new equipment, training, procedures, and documentation.
- Operating a split data center platform is more complex than a single facility, which will cause some "growing pains" in the first 2-3 years.

6.13 OPTION 7 - MODIFY EXISTING FACILITY

The original intent of the PTS engagement was to assess the existing DCB facility with a view on initiating remediation efforts to bring that facility in line with industry standards and customer expectations. In performing our assessment of that facility, we have determined that to upgrade the existing DCB to meet the standards at or near a **STARS Level 3 facility will occupy an approximate timeframe of 18 months with a capital cost estimate of at least \$11M, and at very high levels of risk to service delivery during the upgrade process.**

In addition to the operational improvements described in Section 7, Operating Model, this option requires the following tasks.

Item	Cost	Outages Required
Physical Access Control <ul style="list-style-type: none"> Construct dedicated data center guard station at main entrance Construct separate security control center Secure loading dock Construct man traps at all data center entry points Install bollards/berms around exterior equipment Install surveillance cameras throughout the interior and exterior of the facility 	\$700K	None
Cabinet Layout <ul style="list-style-type: none"> Remove all non-essential equipment and material from the data center Align all cabinets in uniform rows (multi-phased approach) Align CRAC and RPP elements within same plan Note that data center optimization will increase the demand load on the facility by more than 100%.	\$200K	Multiple, groups of cabinets/clients

Item	Cost	Outages Required
Electrical Plant <ul style="list-style-type: none"> Fully segregate data center and office space electrical systems by splitting and improving utility, generator designs Increase resilience in UPS control, distribution systems Install transfer switches between critical load elements Increase PDU/RPP redundancy to 2N Improve / enforce electrical distribution within data center floor & to mechanical components Improve CRU resiliency in UPS room 	\$5.3M	Multiple, entire facility
Mechanical Plant <ul style="list-style-type: none"> Fully segregate data center and office building systems Increase chiller redundancy to N+1 or ideally N+2 Improve expansion capability within chiller plant Relocate chilled water valves as necessary Install second vertical water riser to 1st floor loop Install sufficient water detection systems and water leak protection mechanisms Improve air distribution and cooling capacity 	\$3M	Multiple, entire facility (some overlap with above)
Fire Protection <ul style="list-style-type: none"> Properly reinstall and re-commission VESDA system 	\$450K	At-risk operation
Monitoring and Control Systems <ul style="list-style-type: none"> Upgrade monitoring systems to industry standards 	\$330K	Riskier works coupled with outages above
Telecommunications <ul style="list-style-type: none"> Improve redundancy to the carrier entrance facility and MDF design 	\$630K	At-risk operation

Item	Cost	Outages Required
Operational Investment <i>not included in capital estimate</i> <ul style="list-style-type: none"> Invest in facility maintenance equipment Enroll necessary and key staff in relevant data center training programs Hire additional staff at the right levels and skill sets 	\$630K	
Two Year Operation and Energy <i>not included in capital estimate</i> <ul style="list-style-type: none"> Maintain staffing levels as appropriate Perform all equipment maintenance Recurring energy costs <i>Does not include any rent paid to GSA</i> 	\$7.09M	

Table 8 - Remediation Option 7 Components

6.13.1 **Total score** **302/605**

6.13.2 **Initial Capital Cost** **6 of 10**

- Two-year capex of \$11.2M is 6th in the field of 7.
- Given the revenue neutral model, a lower initial cost will likely be more attractive to DSIT and the State.

6.13.3 **Ten Year TCO** **6 of 10**

- Ten year TCO, including energy and operation of \$90M is 6th in the field of 7.

6.13.4 **Client Attractiveness** **4 of 10**

- Recent unplanned outages at DCB will impede client confidence.
- The number of planned outages and the likelihood of unplanned outages will reduce client confidence.

6.13.5 **Short-Term Exposure** **2 of 10**

- This plan requires multiple systems outages, which include risks in simple shutdown and start-up of older or un-documented systems.
- The existing conditions and unknown factors at the facility add a level of risk that is difficult to predict.

6.13.6 **Long-Term Exposure** **6 of 10**

- As a STARS Level 3 facility, the likelihood of unplanned outage due to physical component failure is low.

- This option scored two points lower single Level 3 solutions due to the location-based risks specific to the location.

6.13.7 **Physical Feasibility** **4 of 10**

- There are a large number of “unknown unknowns” at DCB, making detailed planning difficult and inaccurate.

6.13.8 **Operational Feasibility** **7 of 10**

- Clients would continue to operate in a single-site facility, requiring little change to their operational methods.
- Familiarity with the existing facility will allow for a comfort level within DSIT, which may be accompanied by a high-risk level of complacency.

6.14 **SCORE-BASED RECOMMENDATION**

Based on the scores of each option above, **PTS recommends that DSIT engage with a single colocation vendor for data center services and become a reseller of those services.** While this option includes the discontinuation of DCB as a data center facility, it carries considerably less risk at lower two year and ten year cost profiles.

6.15 **HYBRID OPTION COMPONENTS**

As discussed in Section 4.2, Benchmarking, many industry leaders, and organizations with similar portfolios to DSIT are trending toward operating a platform of multiple facilities with lower site-level resilience. This approach carries the requirement that the services operating within the data center platform that require a high level of resilience and a low RPO/RTO requirement have the capability to fail between physical locations.

Based on the results of the customer discovery phase, DSIT may choose to consider one of the following hybrid options, based on the three base concepts of Upgrade, Build, or Colocate in a Level 2 facility:

- Lower cost upgrades to DCB coupled with either
 - **Option 6A** A lower-resilience colocation facility (Section 6.11)
 - **Option 6B** A newly-constructed lower-resilience (STARS L2) facility (Section 6.12)
- **Option 5** Construction of two new STARS L2 facilities (Section 6.10)
- **Option 2** Colocation at two new STARS L2 facilities (Section 6.7)
- **Option 4** Construction of one STARS L2 facility coupled with colocation at one STARS L2 facility. (Section 6.9)

6.15.1 Upgrade to Level 2

Item	Cost	Outages Required
Physical Access Control <ul style="list-style-type: none"> Construct dedicated data center guard station at main entrance Construct man traps at all data center entry points Install bollards/berms around exterior equipment Install surveillance cameras throughout the interior and exterior of the facility 	\$460K	None
Cabinet Layout <ul style="list-style-type: none"> Remove all non-essential equipment and material from the data center Align all cabinets in uniform rows Align CRAC and RPP elements within same plan Note that data center optimization will increase the demand load on the facility by more than 100%.	\$140K	Multiple, groups of cabinets/clients
Electrical Plant <ul style="list-style-type: none"> Improve capacity of generator plant to ensure N+1 capability. If facility or DC power needs rise, a third generator may be required to maintain this level Increase resilience in UPS maintenance capability Increase PDU/RPP redundancy to 2N Improve CRU power resiliency in UPS room 	\$2M	Multiple, entire facility
Mechanical Plant <ul style="list-style-type: none"> Increase chiller redundancy to N+1 Improve expansion capability within chiller plant to allow for fourth chiller when load requires it Relocate chilled water valves as necessary Install sufficient water detection systems and water leak protection mechanisms Improve air distribution and cooling capacity 	\$1.7M	Multiple, entire facility (some may overlap with above)
Fire Protection <ul style="list-style-type: none"> Remove VESDA System, Re-Commission Existing 	\$230K	At risk operation
Monitoring and Control Systems <ul style="list-style-type: none"> Improve existing monitoring capabilities 	\$210K	None
Telecommunications <ul style="list-style-type: none"> Improve redundancy to the carrier entrance facility and MDF design 	\$370K	At risk operation

Item	Cost	Outages Required
Operational Investment <ul style="list-style-type: none"> Invest in adequate facility equipment Enroll necessary staff in relevant data center training programs 	\$360K	

Table 9 - Hybrid Remediation Components: Upgrade DCB to Level 2

6.15.2 Build New Level 2

Item	Cost	Outages Required
Site Selection <ul style="list-style-type: none"> Identify a field of candidate sites, including both “green field” (unconstructed land) and “brown field” (existing buildings, typically warehouses or industrial sites) Choose the best site based on the known constraints and requirements 	\$250K	None
Facility Design & Construction <ul style="list-style-type: none"> Develop a site-specific design which is also tailored to the current and future needs of the current and potential clients 	\$10M	None
Commissioning <ul style="list-style-type: none"> Ensure that the system operates as required and is fully documented Develop site-specific operational manuals 	Included in Above	None
Migration <ul style="list-style-type: none"> Plan and implement the migration of customer services to the new facility 	*	Multiple, planned

Table 10 - Hybrid Remediation Components: Construct New Level 2

6.15.4 Colocate in Level 2

Item	Cost	Outages Required
Site Selection <ul style="list-style-type: none"> Identify a field of candidate providers Engage in a detailed RFP process to select a provider 	\$100K	None
Vendor Fit-Out (Year 1 / 2 Capex) <ul style="list-style-type: none"> Construct a cage or cages to DSIT's specifications Install cabinets and ancillary equipment to vendor's specifications. 	\$1.5M	None
Commissioning <ul style="list-style-type: none"> Ensure that the system operates as required and is fully documented 	Included Above	
Migration <ul style="list-style-type: none"> Plan and implement the migration of customer services to the new facility 	*	Multiple, planned
Year 1 / 2 Rent + Power <ul style="list-style-type: none"> Space Rent and Power estimate costs 	\$3.8M	

7 **TABLE 11 - HYBRID REMEDIATION COMPONENTS: LEVEL 2 COLOCATION OPERATING MODEL**

DSIT Operational Requirements and Procedures Model			
Customer Support/Operational Success/Best Practices/Service and Support Evolution	Service Delivery Management	Service Level Agreements	Operational Requirements
	Customer Requirements	Develop SLA's	Supporting Operations Requirements for SLA's
	What does the customer want?	Define what the customer requirements mean	What does this mean in terms of data center function?
	Who finds out?	Develop SLA	Review Operational Procedures for Compliance with SLA
		Determine metrics	Gap Analysis
			Revise Operational Procedures

Figure 12 - DSIT Operational Requirements and Procedures Model

The first order of operational improvement is to define and implement data center standards. These standards and operational procedures govern all aspects of the data center. These definitions will lead to other tactical improvements.

7.1 OPERATING STANDARDS

Customers must have access to data center standards, and accept that their tenancy includes adherence to these standards. This will also allow customers to understand the embedded infrastructure and the operational, support, and cost impact of decisions to employ non-standard infrastructure.

Data center standards should incorporate the standard set of products that are allowed and supported in the data center. As the organization matures, so will the standards. Standards will evolve to keep pace with customer requirements and technology advances.

Standards will control the physical data center environment with respect to equipment proliferation and the logical environment with respect to software and systems configuration.

Typical data center standards include (but are not limited to) the following:

Security – Access Control

- Vendor/Client/Operations personnel access
 - Who can access the space
 - Authorization and approval process
 - Window of work effort – when can the work take place
 - Client ownership, data center supervisor, escalation path
 - Completion documentation

Infrastructure - Hardware and Equipment

- Infrastructure
 - Data cabinet, rack, and distribution infrastructure
 - Cable – Layer 1 components
 - Mechanical/Electrical environment
- IT Equipment
 - Allowed manufacturers and models
 - Procurement process and timing for acquisition and delivery
 - Installation procedures and notification
 - Equipment startup and burn-in
 - Security controls

Software Applications

- Supported software
- Supported applications
- Security configurations

- Processing zones

7.2 OPERATIONAL PROCESS AND PROCEDURES

Effectively operating a data center platform requires complete documentation and accurate adherence to operational procedures. Comprehensive procedures ensure the appropriate personnel react to situations in the right way. This dramatically reduces the possibility of errors associated with reacting to events, normal maintenance, project related efforts and emergencies.

The relevant personnel must have a thorough understanding of pertinent operations manuals. Functions covered by such manuals will include technical (repair) as well as non-technical (client notification) tasks. Operating manuals are reference manuals for the staff and must be accessible in multiple forms.

Operating manuals should include:

- Detailed description of the systems “as built”
- Upgrade and changes – description of changes and dates of implementation
- Specific operating instructions
 - Notification requirements
 - How to stop and re-start equipment and process
 - Specific commands/controls for operation
 - Production requirements
 - Production bypass for offline servicing
 - Maintenance procedures
 - Support contacts
 - Vendor service agreements

Operating manuals are required for the following areas and should include (but not be limited to) the following items:

- Security
 - Protocol for access
 - Authorization process
 - Notification and escalation
- IT
 - Ownership records, notification and approval requirements checklist
 - Equipment delivery and installation instructions and acceptance procedures
 - Inventory management
 - Connectivity requirements and activation

- Hardware maintenance – authorized vendors
- OS and application installation and patching/upgrade procedures
- Notification and escalation
- Facilities
 - Ownership records, notification and approval requirements checklist
 - Vendor authorizations and contact information – maintenance and repair
 - Real estate related information
 - Landlord information
 - Municipal contacts
 - Police and Fire
 - Cleaning and building maintenance
 - Building repair (roofing, external leaks, landscaping)

Operating Procedures are applied to three conditions in the data center. Mechanical/electrical/plumbing operating procedures are of paramount importance in data center environments. They are critical systems without which the primary operations related to processing cannot occur. The mechanical electrical systems are the very definition of mission critical.

Operating procedures for mechanical/electrical/plumbing systems have to be more detailed and specific in nature than any other systems as the effect of outage may be all encompassing. Please refer to Appendix () for a sample table of contents.

7.2.1 Maintenance and Emergency Procedures

In addition to the standard procedures outlined above, a data center facility must have comprehensive procedures for the maintenance of each piece of equipment as well as complete documentation of the steps to take during an emergency. These procedures will be written specifically for the operating platform as implemented.

7.3 INTERNAL SERVICE LEVEL AGREEMENTS

Similar to the client-facing service level agreements discussed in Section 5.5, internal SLAs provide a clear list of services included in the operation of the facility. Each of these individual services is an element of a flow chart, and a failure within that “black box” will impact the ability of the overall platform to support clients at an acceptable level.

As the functional descriptions of the elements within the new data center platform take shape, DSIT will be in a position to understand how they interact, what failure types and intervals to expect, and the feasible levels of service available from each individual system. Internal SLAs

will incorporate that information and connect to the standard, maintenance, and emergency operating manuals at multiple points.

8 TRANSFORMATION PLAN

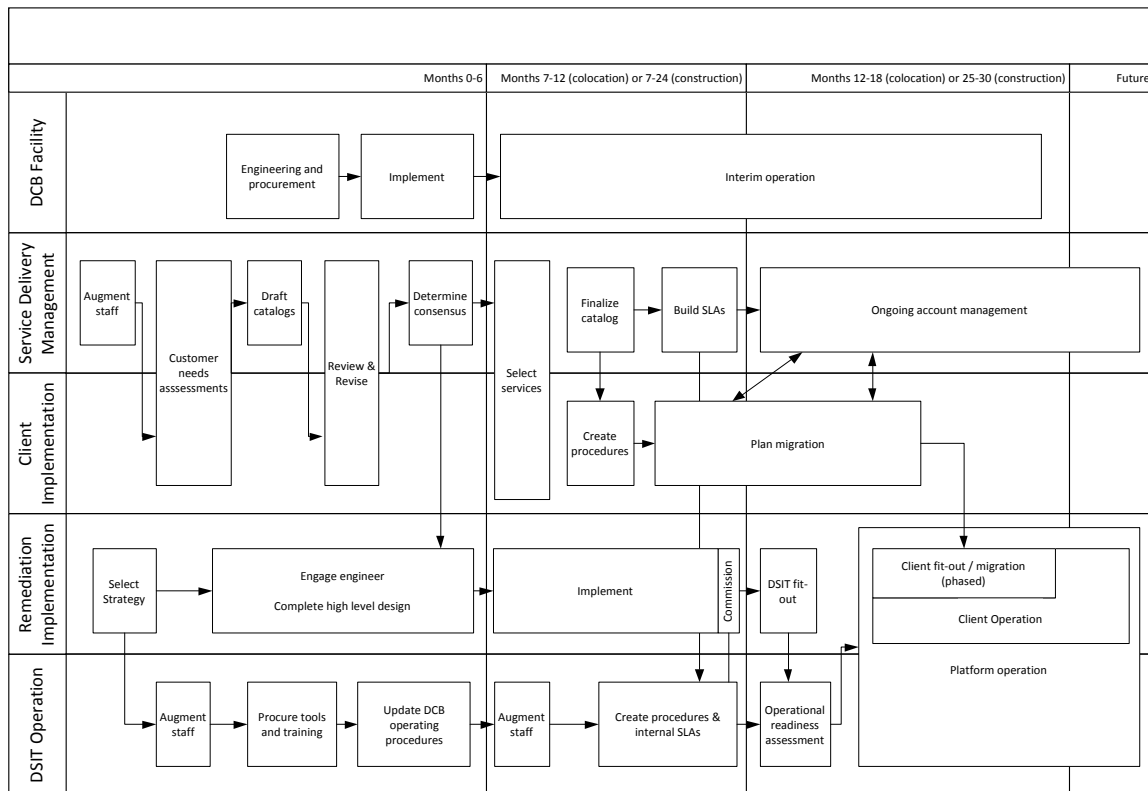


Figure 13 - Transformation Plan Roadmap

8.1 SECTION SUMMARY

The transformation plan included here is a block-level strategic outline. The plan includes phases of work, with various stakeholders having responsibilities in various phases. At the strategic level, this plan is independent of the DCB remediation option (discussed in Section 6, recommendation in Section 6.14). Timing on a newly constructed or repaired facility is longer than that of a colocation solution.

DSIT must vet and expand each element of this strategy, developing an integrated program plan.

8.3 PHASE 1: MONTHS 0-6

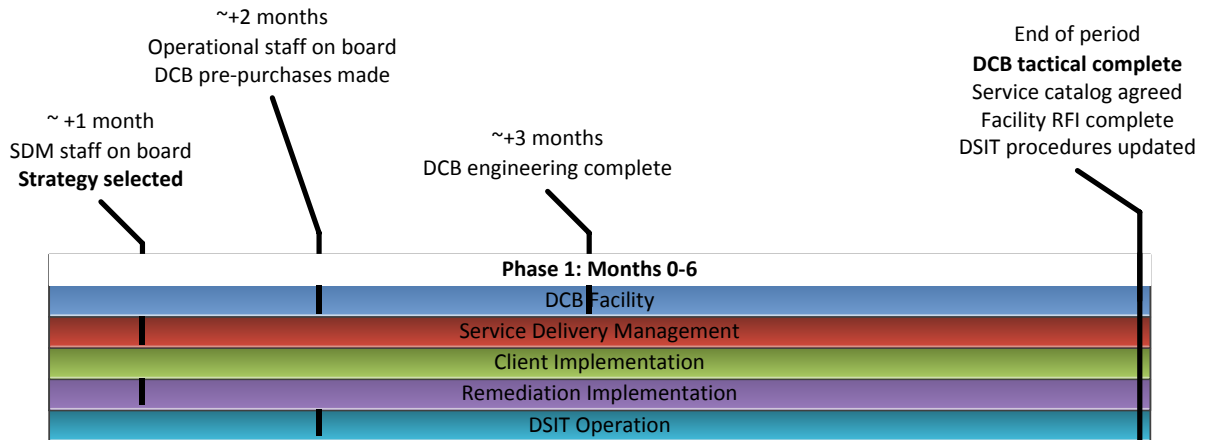


Figure 14 - Remediation Phase 1 Timeline

The first phase of the remediation plan includes the urgent remediation items for DCB, which are critical to continued delivery of services to existing customers. In this phase, DSIT must also begin the larger operational transformations as described in sections 5 and 7. The final key output of this phase is the selection of a long-term remediation path.

8.3.1 DCB Facility Improvements

Perform the DCB improvements described in Section 3.2.

- Augment DCB staff and train accordingly
- Procure tools, services, and maintenance contracts
- Audit existing documentation
- Install new UPS, generator, and chiller
 - **It is critical that all three devices, as key components of a single system, be installed simultaneously.**

8.3.1.1 Schedule Impact

Depending on lead-time for heavy infrastructure, this work will complete in no less than six months. Considering that lead-time, many tasks within this subsection must be executed in parallel.

8.3.2 Service Delivery Management

This phase involves the “spin up” of the new SDM arm of DSIT. Once the CIO and Director of Operations have determined the appropriate staffing levels, hiring must begin in earnest. As each Liaison is prepared to discuss the offerings with customers, outputs from those meetings

will be compiled in a single repository and a full service catalog will emerge.

At the end of this phase of work, DSIT will have an itemized service catalog, and will be prepared to discuss with individual customers the services that they require. Costs of services will not be final at this point.

8.3.3 Remediation Implementation

Prior to the inception of the long-term remediation, the State must select of a strategic direction. This direction consists of three key decisions:

- Disposition of DCB
 - Independent score: abandon DCB as part of the platform
- New construction or hosting
 - Independent score: hosted solution
- Single or dual facility
 - Independent score: Single facility, possibly expanding to a second location in the 5-7 year timeframe.

The score-based recommendations above are based on technical, operational, and apparent financial factors. There are many other elements in making such a decision, which are outside the scope of this report. **DSIT must make a strategic decision within the first three months of this phase.**

Upon selection of a strategic direction, DSIT must immediately proceed with the implementation of the target solution. Additional project management and technical consulting will augment DSIT staff; and depending on the direction chosen construction sites must be evaluated (new construction); or preliminary requests for information must be prepared for issuance to vendors.

8.3.4 DSIT Operation

In concert with the account and site works described above, DSIT must improve internal operation and procedures. Based on the strategic direction decision described above, operational resources may be retained for short-term engagements only; if DCB is to be re-purposed, site engineers will be required for as little as 18 months. Similarly, if the State chooses to engage with colocation vendors, staffing overhead will consist of additional resources to manage the relationship with the vendor(s) and act as the gateway between clients and vendors.

The state of the infrastructure at DCB even after the updates are complete requires that the environment be managed holistically, in a hands-on fashion. During the implementation of the

urgent updates to DCB, DSIT must improve the operational procedures at that site (Section 7). This includes a more robust set of documents and manuals for use by new and existing staff.

8.4 PHASE 2: MONTHS 7-12 OR 7-24

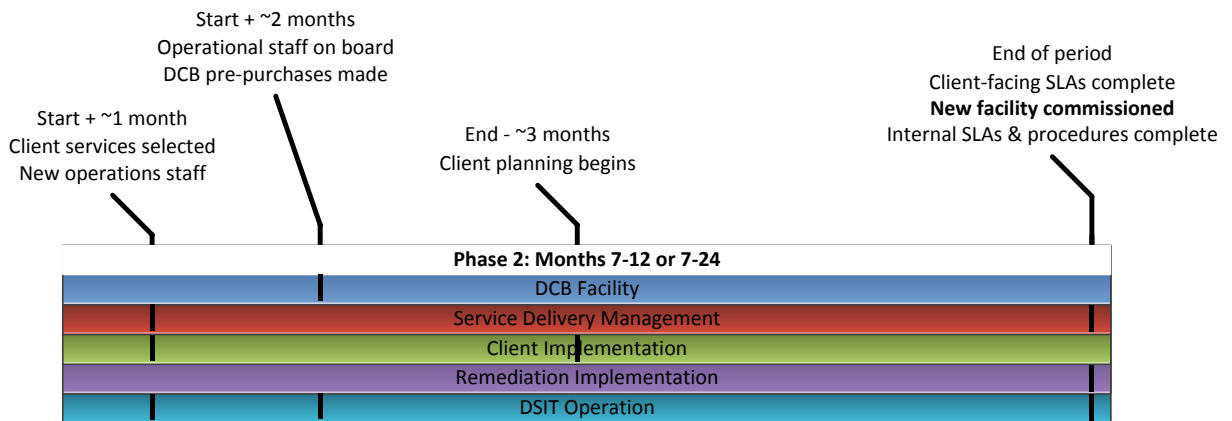


Figure 15 - Remediation Phase 2 Timeline

As operations transition from Phase 1 to Phase 2, users will begin to see the benefits of Phase 1. DCB will have expanded capacity and will offer a better environment to existing customers. Account Liaisons will have engaged with customers and improved their opinion of customer service. Transparency policies will further enable users to see the future offering; and a well-engineered plan will encourage more improvements customer confidence.

This phase includes the implementation of the new data center portfolio, as well as additional planning by DSIT and clients. At the end of the phase, the new facility or facilities will be ready for occupancy by DSIT

8.4.1 DCB Facility Operation

The DCB will operate in an as-is state during this phase. With the Phase 1 improvements to infrastructure and operations complete, DCB will operate largely as an independent unit; and will require minimal strategic oversight.

8.4.2 Service Delivery Management

Continuing the relationships built in Phase 1, Account Liaisons will work with clients to determine the services which meet their needs. They will continue to develop this information as the final service catalog, and document the necessary SLAs. Clients will be prepared to move their equipment, and confident in the outcome.

If the Liaisons determine that clients need such a service, DSIT may also offer project management consulting to assist in migration planning.

8.4.3 **Client Implementation**

In this phase of the transformation, clients will work independently and with DSIT to develop the best solution for their needs and align that solution to the DSIT services that will be available. Many clients will use this as an opportunity to review their internal technology road maps. In working in a new environment with new rules, clients will update existing operational procedures and create new ones where necessary. Once the clients' end states are in hand, they will begin to plan their own migrations to the new environment.

8.4.4 **Remediation Implementation**

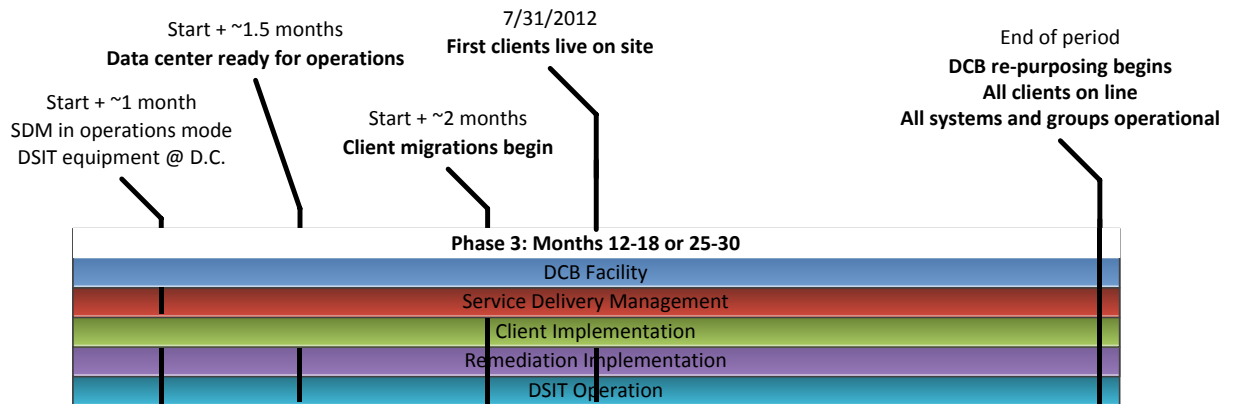
During this phase, DSIT and the necessary consultants, contractors, and vendors will implement the strategy as defined in Phase 1. The phase will begin with an RFP for construction or hosting services. In a new construction environment, selected construction managers will engage with their subcontractors and begin work on the new facility. In a hosted environment, the vendor will complete any works necessary to meet DSIT's technical and security needs. If the state elects to remain in DCB, in-depth discovery and project management will lead to a multi-phase plan for implementation and migration, which will be a key component of construction manager and contractor pricing.

In order to ensure that the facility is fully ready for occupancy, DSIT must engage with an independent commissioning agent upon completion of the vendor implementation. The results of both the construction and commissioning efforts include site-specific inputs to the operational manuals.

8.4.5 **DSIT Operations**

In this phase of works, DSIT will complete its operational transformation. Based on the decisions made to this point, additional staffing decisions will be finalized and implemented; and the new staff will work to develop the operating manuals and internal SLAs which will enable DSIT to service its customers in a quality way.

8.5 **PHASE 3: MONTHS 12-18 OR 25-30**



8.5.1 DCB Facility

Should the State elect to remain at DCB, this phase will include a period of instability to client operations. PTS anticipates that each client's equipment will be moved at least once; and during the period of major resilience improvements there is a very high risk of outage to customer services. The operating staff at DCB must be on hand and prepared to deal with a wide array of potential failures.

In the scenarios that do not include DCB as part of the end state, the facility will operate in a "business as usual" fashion for the majority of this period. Maintaining facility operation will require continued quality oversight of the systems and their operation. Near the end of this phase, DCB will see a reduction in customers as they move to the new facility. It will end with the decommissioning of DCB as a primary data center environment.

8.5.2 Service Delivery Management

The Account Liaison Office will enter an "operational mode" during this phase of the program. Liaisons will continue to interact with existing and potential clients, ensuring that their needs are met and their migrations are running smoothly.

At the end of this phase, there will be little change in the workings of the client management organization.

8.5.3 Client Implementation

As clients move their services to the new facility, this phase will see a large amount of client work. Phased migrations must account for internal dependencies as well as the works of other clients in close schedule or location proximity.

At the end of this phase, clients will be operating in the new facility, with minimal issues during migration.

8.5.4 Remediation Implementation and DSIT Operation

After the completion of construction commissioning in Phase 2, DSIT will be ready to engage in their fit-out. This will include cabinets, racks, cabling, and a limited amount of network and server equipment.

After technology support infrastructure has been deployed, DSIT will engage in test migrations to the new location. As a part of these tests, a set of operational readiness assessments and drills will ensure that DSIT is ready for client equipment. These will be structured to capture the most likely customer service and equipment failure scenarios. Publication of these test results will solidify client confidence in both the solution and DSIT's transparency.

Upon acceptance of the facility's operation, DSIT will work with each client to ensure smooth migrations and support.

9 GLOSSARY OF KEY TERMS

Term	Definition
AC	Air Conditioning
ATC	Automatic Transfer Controller; a PLC –based device used to control two electromechanically operated circuit breakers, normally to automatically switch between two power sources such as utility and generator power
ATS	Automatic Transfer Switch; similar to an ATC, an ATS is a physical piece of equipment that incorporates either a Y-switch or a pair of electromechanically operated circuit breakers. Unlike an ATC, which can be integrated into existing switchgear and in some instances retrofitted to LVPCBs, an ATS is a stand-alone device, typically in its own separate cabinet.
BAS / BMS	Building Automation System / Building Management System; a software solution that allows monitoring (and sometimes control) of building infrastructure, such as electrical distribution equipment, HVAC components, and building security systems
CCTV	Closed-Circuit Television
CER	Central Equipment Room (aka Data Center)
Chiller	A piece of equipment that forms part of a CHW cooling system, chillers remove heat from warmer return water and supply chilled water back out to the closed-loop system
CHW	Chilled Water; one of three types of cooling systems used in buildings and data centers, CHW systems employ either air-cooled or liquid-cooled chillers to produce chilled water (typically below 50 °F) to circulate to CRAHs
Closed-Transition	A transition to backup power that involves paralleling the incoming utility source (typically for less than 100 milliseconds) in order to prevent any loss of downstream power; also known as Make-Before-Break transition

Term	Definition
CMMS	Computerized Maintenance Management System; a software solution that allows digital management of building maintenance operations, including asset management, maintenance procedures, and maintenance schedules. As opposed to BMS, which is used to manage physical operation of the equipment, a CMMS is used to manage documentation.
CRAC	Computer Room Air Conditioner (CW or DX System)
CRAH	Computer Room Air Handler (CHW System)
CW	Condenser Water; one of three types of cooling systems used in buildings and data centers, CW systems utilize rooftop condensers to deliver condenser water (typically below 90 °F) to circulate to CRACs, which then utilize compressors to help cool the building or data center
DC	Data Center
DCB	Data Center Building (DSIT's acronym for their facility)
DSIT	Division of State Information Technology
EOP	Emergency Operating Procedure
HV	High Voltage (50 kV and above); HV is typically used to refer to electrical distribution equipment and cables delivered by a utility company between its substations, and is distributed at higher levels to increase efficiency and reduce cost
HVAC	Heating, Ventilation, & Air Conditioning
kV	Kilovolts
kVA	Kilo Volt-Amps; pure power, excluding Power Factor. This is the typical unit used to measure utility power and power capacity (along with MVA).
kW	Kilowatts; real power, accounting for Power Factor (normally .8 for mechanical loads, to .95+ for IT loads). This is the typical unit used to measure power in a data center.

Term	Definition
LV	Low Voltage (50 to 1000 V); LV is typically used to refer to local building distribution or end-user voltage levels, such as 120V (single-phase) or 208V (three-phase). LV sometimes mistakenly referred to as data or control cabling, which is more correctly termed as eLV (extra-low-voltage) cabling.
Man-trap	A modern physical security protocol involving a space with two sets of interlocking doors, where the first set of doors must close before the second set opens
MDF	Main Distribution Frame; a series of racks or cabinets (or a combination of the two) which houses patch panels and other connecting devices, allowing connectivity between devices or locations which are too far apart to be connected by simple cords.
MEP	Mechanical, Electrical, & Plumbing
MER	Main Equipment Room (for Mechanical or Electrical Equipment)
MMR	Meet-Me Room; a location or room where telecommunications carriers physically connect to one another and exchange data, and where carrier equipment is installed.
MOP	Maintenance Operating Procedure
MSP	Main service provider
MV	Medium Voltage (1000 V to 50 kV); MV is typically used to refer to industrial and building electrical distribution levels, just prior to being transformed down to LV levels for end use. This voltage can be used to distribute electricity throughout a building at greater lengths than is possible at LV levels, and is typically used by a utility company to distribute electricity to customers downstream of local substations.
MVA	Mega Volt-Amps
MW	Megawatt
NOC	Network Operations Center; a location where monitoring and control is conducted for data centers, colocation facilities, or telecommunications infrastructure
O&M	Operations & Maintenance

Term	Definition
OEM	Original Equipment Manufacturer; refers to a company that originally manufactured a product or underlying part, as opposed to the brand or reseller of the equipment
Open-Transition	A transition to backup power that involves disconnecting utility power before switching sources; requires a loss of downstream power, and is also known as Break-Before-Make transition
PDU	Power Distribution Unit; a stand-alone piece of equipment (that normally includes a step-down transformer) in a data center that distributes power to cabinets, RPPs, and CDUs. CDUs are typically confused for PDUs.
PLC	Programmable Logic Controller; a programmable circuit board or computer used to control industrial processes
Plenum	An enclosed space inside a building used for airflow
PM	Preventative Maintenance
POE	Point of Entry
PoP	Point of Presence, also known as Meet-Me-Room (MMR)
RPP	Remote Power Panel; a piece of equipment designed for localized power distribution. This can be either a specialized, stand-alone unit, or a standard distribution board.
SLA	Service-Level Agreement; a service contract where levels of service are formally defined. An SLA will provide measurable metrics and set customer expectations, often including penalties when the vendor fails to meet the expectations.
SLED	State Law Enforcement Division (of South Carolina)
Smart-Hands	Remote Managed Services; also referred to as remote-hands, Smart-Hands services enable remote management of telecommunications and data center equipment. Technicians local to the facility (typically in a colocation facility) troubleshoot issues, instead of sending a technician to the site, saving time.
SOP	Standard Operating Procedure

Term	Definition
SPOF	Single Point of Failure
SS	Static Switch; a switch typically used in a UPS used to transfer quickly and automatically between inverter and bypass power. A SS operates so quickly that IT load downstream of the SS should not be able to detect the transfer in source.
SSC	State of South Carolina
STARS [®]	Site Tier Allocation Rating System (Copyright by PTS Consulting)
STS	Static Transfer Switch; a transfer switch that switches power between automatic and backup power so quickly that IT load downstream should not detect any power fluctuation.
Switchgear	A piece of electrical equipment that can be used to distribute electrical power (of various voltage levels) to a facility or portion of a facility.
TVSS	Transient Voltage Surge Suppression; a device or system installed in electrical distribution systems to help protect against surges and spikes in voltage, typically caused by lightning strikes
UPS	Uninterruptible Power Supply; an electrical device that provides immediate standby power in the event of a power loss, typically via batteries or flywheels. Such a system can also provide power conditioning to downstream load.
V	Volts
VESDA	Very Early Smoke Detection Apparatus; an early-warning fire detection system that actively samples at various places in a facility, and uses a sensitive laser detection unit to analyze the air streams. STRATOS is a competing product of similar functionality.
VFD	Variable Frequency Drive
W	Watts

APPENDIX 1 SAMPLE OPERATING MANUAL TABLE OF CONTENTS

Mechanical Operating Procedures

GENERAL

1. ROUTINE INSPECTIONS
2. NORMAL OPERATION - INITIAL SETTING UP
3. NORMAL OPERATION - ROUTINE INSPECTION
4. COLD WATER SYSTEMS - DRAINING DOWN
5. COLD WATER SYSTEMS - DRAINING DOWN
6. COLD WATER SYSTEMS - REFILLING
7. COLD WATER SYSTEMS - REFILLING
8. COLD WATER SYSTEMS - EMERGENCY PROCEDURES
9. FAILURE OF THE MAINS WATER SUPPLY
10. WATER LEAKS
11. CHLORINATION OF DOMESTIC WATER SERVICES
12. START UP OF AIR HANDLING PLANT
13. REPLACING AND ADJUSTING DRIVE BELTS
14. START UP & SHUT-DOWN OF AIR CONDITIONING SYSTEM
15. AIR SYSTEMS - RENEWING FILTER MEDIA

Electrical Maintenance Procedure

1. RECOMMENDED SPARES
2. SPECIAL TOOLS
3. INTRODUCTION
4. LV SWITCHGEAR
5. DISTRIBUTION BOARDS
6. DISTRIBUTION BOARDS - MAINTENANCE SCHEDULE
7. LIGHTING
8. LIGHTING - MAINTENANCE SCHEDULE
9. CLEANING
10. LAMP BREAKAGE
11. EXTERNAL LIGHTING FITTINGS
12. EXTERNAL LIGHTING FITTINGS - MAINTENANCE SCHEDULE
13. EMERGENCY LIGHTING INSTALLATION
14. EMERGENCY LIGHTING INSTALLATION - MAINTENANCE SCHEDULE
15. ISOLATORS, SWITCH FUSES AND FUSES SWITCHES MAINTENANCE
16. ISOLATORS, SWITCH FUSES AND FUSES SWITCHES - MAINTENANCE SCHEDULE
17. FIRE ALARM SYSTEM
18. FIRE ALARM SYSTEM - MAINTENANCE SCHEDULE
19. LIGHTNING PROTECTION SYSTEM
20. LIGHTNING PROTECTION SYSTEM

APPENDIX 2 DATA CENTER OPTIONS – DIRECTIONAL COST COMPONENTS

	Option 1: Outsource (Colocate) in a STARS L3 Facility	Single L2 Colo
Year 1 / 2 Capex Total	\$2.23M	\$1.45M
Year 1 / 2 En+Op Ex Total	\$5.7M	\$3.04M
Year 3-10 Capex	\$1.12M	\$0.73M
Year 3-10 En+Op Ex Total	\$62.28M	\$29.5M
Contingency 10%	\$7.13M	\$3.47M
10-Year TCO	\$78.46M	\$38.19M

	Option 2: Colocation at 2 STARS L2 Facilities	Single L2 Colo
Year 1 / 2 Capex Total	\$2.9M	\$1.45M
Year 1 / 2 En+Op Ex Total	\$6.08M	\$3.04M
Year 3-10 Capex	\$1.45M	\$0.73M
Year 3-10 En+Op Ex Total	\$59.0M	\$29.5M
Contingency 10%	\$6.94M	\$3.47M
10-Year TCO	\$76.38M	\$38.19M

	Option 3: Build New STARS L3 Facility
Physical AC / Security	\$0.52M
Cabinet Layout / Redesign	\$0.14M
Electrical Plant	\$7.08M
Mechanical Plant	\$3.76M
Fire Protection	\$0.53M
Monitoring & Controls	\$0.26M
Telecommunications	\$0.44M
Operations	\$0.31M
Year 1 / 2 Capex Total	\$13.03M
Year 1 / 2 En+Op Ex Total	\$7.26M
Year 3-10 Capex	\$4.0M
Year 3-10 En+Op Ex Total	\$50.4M
Contingency 10%	\$7.47M
10-Year TCO	\$82.16M

	Option 4: Build STARS L2 + STARS L2 Colocation	Single L2 Build	Single L2 Colo
Physical AC / Security	\$0.4M	\$0.4M	
Cabinet Layout / Redesign	\$0.13M	\$0.13M	
Electrical Plant	\$4.83M	\$4.83M	
Mechanical Plant	\$2.63M	\$2.63M	
Fire Protection	\$0.52M	\$0.52M	
Monitoring & Controls	\$0.2M	\$0.2M	
Telecommunications	\$0.39M	\$0.39M	
Operations	\$0.25M	\$0.25M	
Year 1 / 2 Capex Total	\$10.81M	\$9.36M	\$1.45M
Year 1 / 2 En+Op Ex Total	\$7.69M	\$4.64M	\$3.04M
Year 3-10 Capex	\$3.09M	\$2.36M	\$0.73M
Year 3-10 En+Op Ex Total	\$59.58M	\$30.08M	\$29.5M
Contingency 10%	\$8.12M	\$4.64M	\$3.47M
10-Year TCO	\$89.27M	\$51.08M	\$38.19M

	Option 5: 2 New STARS L2 Facilities	Single L2 Build
Physical AC / Security	\$0.81M	\$0.4M
Cabinet Layout / Redesign	\$0.26M	\$0.13M
Electrical Plant	\$9.65M	\$4.83M
Mechanical Plant	\$5.27M	\$2.63M
Fire Protection	\$1.04M	\$0.52M
Monitoring & Controls	\$0.41M	\$0.2M
Telecommunications	\$0.77M	\$0.39M
Operations	\$0.51M	\$0.25M
Year 1 / 2 Capex Total	\$18.71M	\$9.36M
Year 1 / 2 En+Op Ex Total	\$9.29M	\$4.64M
Year 3-10 Capex	\$4.72M	\$2.36M
Year 3-10 En+Op Ex Total	\$60.15M	\$30.08M
Contingency 10%	\$9.29M	\$4.64M
10-Year TCO	\$102.17M	\$51.08M

	Option 6A: STARS L2 Upgrade + L2 Colocation		L2 Upgrade	Single L2 Colo
Physical AC / Security		\$0.46M	\$0.46M	
Cabinet Layout / Redesign		\$0.14M	\$0.14M	
Electrical Plant		\$1.98M	\$1.98M	
Mechanical Plant		\$1.71M	\$1.71M	
Fire Protection		\$0.23M	\$0.23M	
Monitoring & Controls		\$0.21M	\$0.21M	
Telecommunications		\$0.37M	\$0.37M	
Operations		\$0.36M	\$0.36M	
Year 1 / 2 Capex Total		\$6.9M	\$5.45M	\$1.45M
Year 1 / 2 En+Op Ex Total		\$7.8M	\$4.76M	\$3.04M
Year 3-10 Capex		\$7.48M	\$6.75M	\$0.73M
Year 3-10 En+Op Ex Total		\$65.5M	\$36.0M	\$29.5M
Contingency 10%		\$8.77M	\$5.3M	\$3.47M
10-Year TCO		\$96.44M	\$58.25M	\$38.19M

	Option 6B: STARS L2 Upgrade + L2 New Build		L2 Upgrade	Single L2 Build
Physical AC / Security		\$0.86M	\$0.46M	\$0.4M
Cabinet Layout / Redesign		\$0.27M	\$0.14M	\$0.13M
Electrical Plant		\$6.81M	\$1.98M	\$4.83M
Mechanical Plant		\$4.35M	\$1.71M	\$2.63M
Fire Protection		\$0.75M	\$0.23M	\$0.52M
Monitoring & Controls		\$0.41M	\$0.21M	\$0.2M
Telecommunications		\$0.75M	\$0.37M	\$0.39M
Operations		\$0.61M	\$0.36M	\$0.25M
Year 1 / 2 Capex Total		\$14.8M	\$5.45M	\$9.36M
Year 1 / 2 En+Op Ex Total		\$9.41M	\$4.76M	\$4.64M
Year 3-10 Capex		\$9.11M	\$6.75M	\$2.36M
Year 3-10 En+Op Ex Total		\$66.07M	\$36.0M	\$30.08M
Contingency 10%		\$9.94M	\$5.3M	\$4.64M
10-Year TCO		\$109.34M	\$58.25M	\$51.08M

	Option 7: Remediate DCB to STARS L3 Facility	
Physical AC / Security		\$0.7M
Cabinet Layout / Redesign		\$0.2M
Electrical Plant		\$5.33M
Mechanical Plant		\$2.95M
Fire Protection		\$0.45M
Monitoring & Controls		\$0.33M
Telecommunications		\$0.63M
Operations		\$0.63M
Year 1 / 2 Capex Total		\$11.22M
Year 1 / 2 En+Op Ex Total		\$7.09M
Year 3-10 Capex		\$7.92M
Year 3-10 En+Op Ex Total		\$55.88M
Contingency 10%		\$8.21M
10-Year TCO		\$90.31M

APPENDIX 3 COMPUTATIONAL FLUID DYNAMICS REPORT