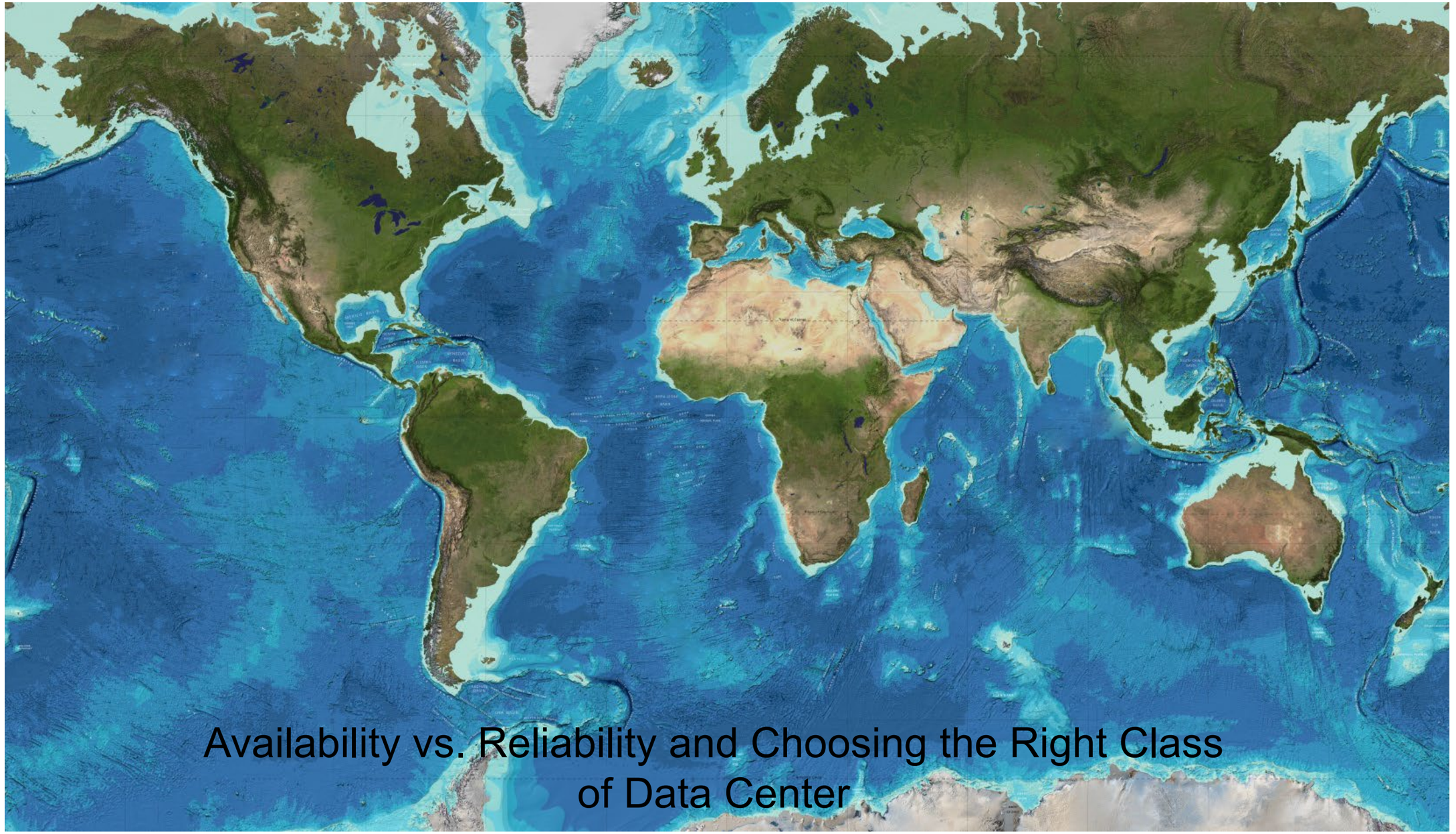


Availability vs. Reliability and Choosing the Right Class of Data Center

Course Description

- With the increased reliance on 24/7 availability of information and data processing support, the reliance on mission critical data processing facilities has also increased. Mission-critical data centers have not traditionally been high-profile projects, yet their design issues are increasingly complex and critical. With an emerging design terminology and vocabulary, their rapid evolution calls for an exceptional degree of building and IT systems coordination and integration. These data centers are not merely warehouses for servers; instead, they rival medical operating rooms or semiconductor plants, with their precise environmental controls and power requirements.

- To increase the likelihood of success of a mission-critical facility, required performance levels of availability and reliability should be defined, prior to the start or formalization of the design, procurement, and maintenance requirements and processes. Failure to define performance and availability levels prior to the project start often yields higher construction, implementation, and operational costs as well as inconsistent and unpredictable performance.

Learning Objectives

At the completion of the course and in accordance with the best practices outlined in *ANSI/BICSI 002-2014 Data Center Design and Implementation Best Practices*, students will be able to:

- Define availability and reliability of a system or component.
- Distinguish between availability and reliability of data centers.
- Calculate availability using the three standard calculation methods.
- Describe commonly scheduled and unscheduled downtime events.
- Describe the key factors necessary to provide optimal design solutions for a mission-critical data center as defined by NFPA 75.
- Describe the five Availability Class levels in a data center.
- Identify the primary areas of concern for each Availability Class.
- Determine the Data Center Availability Class given sample customer requirements and a Reliability Planning Worksheet.
- Evaluate how to use lower Availability Classes to achieve higher availability.

AGENDA

- Understand how the ANSI/BICSI-002-2104 can be used to design redundant data centers
- Understand the ANSI/BICSI-002-2104 Classification of data centers
- Conduct an assessment using the ANSI/BICSI-002-2104 method of Class Determination

Introductions

Proper Data Center Design

Handout: Page 2

AVAILABILITY

BICSI 002-214 4.1

Availability	Reliability
• The probability that a **component** or **system** is in a condition to **perform** its **intended function**.	The probability that a **component** or **system** will **perform as intended** over a given time period.
• Considers scheduled **AND** unscheduled downtime	Considers **ONLY** unscheduled downtime

Simplest Availability Formula

Handout: Page 3

- $$Availability = \frac{Uptime\ within\ Observation\ Interval}{Total\ Time\ of\ Observation\ Interval}$$

Example

$Uptime\ within\ Observation\ Interval = 8{,}420$ hours

$Total\ Time\ of\ Obersvation\ Interval = 8{,}760$ hours

$$Availability = \frac{Uptime\ within\ Observation\ Interval}{Total\ Time\ of\ Observation\ Interval}$$

$$Availability = \frac{8{,}420\ Hours}{8{,}760\ Hours}$$

$$Availability = .96118721$$

OR

96% Availability

Uptime Availability Formula

Handout: Page 3

- $Availability = \frac{Uptime}{Uptime+Downtime}$

Example

$$Uptime = 8{,}420\ Hours \qquad Downtime = 340\ Hours$$

$$Availability = \frac{Uptime}{Uptime + Downtime}$$

$$Availability = \frac{8{,}420\ Hours}{8{,}420\ Hours + 340\ Hours}$$

$$Availability = \frac{8{,}420\ Hours}{8{,}760\ Hours}$$

$$Availability = .96118721$$

OR

96% Availability

Uptime with Downtime Availability Formula

Handout: Page 3

- $$Availability = \frac{Uptime}{Uptime + Scheduled\ Downtime + Unscheduled\ Downtime}$$

Example

$$Uptime = 8{,}420\ Hours$$

$$Scheduled\ Downtime = 40\ Hours$$

$$Unscheduled\ Downtime = 300\ Hours$$

- $$Availability = \frac{Uptime}{Uptime + Scheduled\ Downtime + Unscheduled\ Downtime}$$

$$Availability = \frac{8{,}420\ Hours}{8{,}420\ Hours + 40\ Hours + 300\ Hours}$$

$$Availability = \frac{8{,}420\ Hours}{8{,}760\ Hours}$$

$$Availability = .96118721$$

OR

96% Availability

Scheduled Downtime Events

Handout: Page 4

- **Scheduled Downtime**

- Preventative maintenance
- System and equipment setup and upgrades
- Scheduled facility related events
- Remedial maintenance

Unscheduled Downtime

- Repairs due to failure
- Maintenance delay
- Facility-related failures/outages

Increase Availability Through Reduction of Downtime

Scheduled Downtime

- Redundant Systems
- Scheduling
- CMMS

Unscheduled Downtime

- Preventative Maintenance
- Proper Equipment Sizing
- Training
- Spare Parts/Equipment
- Service Level Agreements with Vendors

Downtime Reduction

$$\boldsymbol{Unscheduled\ Downtime = 300\ Hours}$$

- Preventative maintenance schedule not followed
- Equipment under utilized
- Technicians/Service personnel not trained
- Spare parts not on hand
- No service level agreement with vendors

Example - Revised

$$Uptime = 8{,}580\ Hours$$

$$Scheduled\ Downtime = 80\ Hours$$

$$Unscheduled\ Downtime = 100\ Hours$$

- $$Availability = \frac{Uptime}{Uptime + Scheduled\ Downtime + Unscheduled\ Downtime}$$

$$Availability = \frac{8{,}580\ Hours}{8{,}580\ Hours + 80\ Hours + 100\ Hours}$$

$$Availability = \frac{8{,}743\ Hours}{8{,}760\ Hours}$$

$$Availability = .97945205$$

OR

98% Availability; 2% increase over previous example with a 120 hour reduction

Risk Analysis

Handout: Page 4

Criticality

Operational profile

Risk Analysis

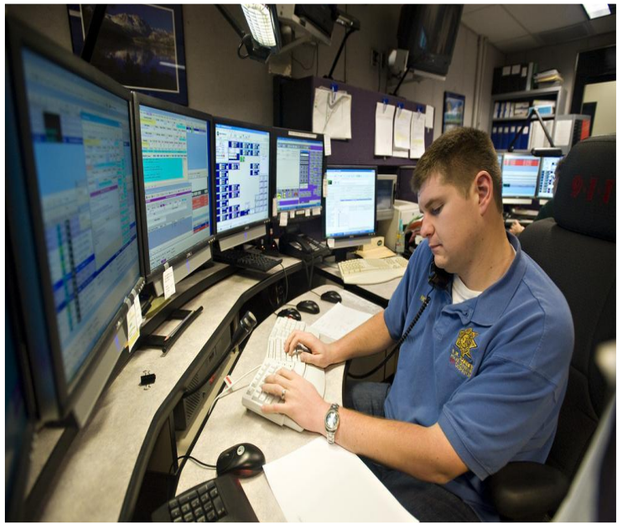
Handout: Page 4

Life Safety

Handout: Page 4

Traffic Control

Air Traffic Control



Emergency Call Center

Catastrophic Events

Handout: Page 4

Natural

Man-Made

Technological

Economic Loss

Handout: Page 4

Loss of Function or Records

Access to off-site systems

Reference

Equipment Loss

Handout: Page 4

Reputation

Handout: Page 4

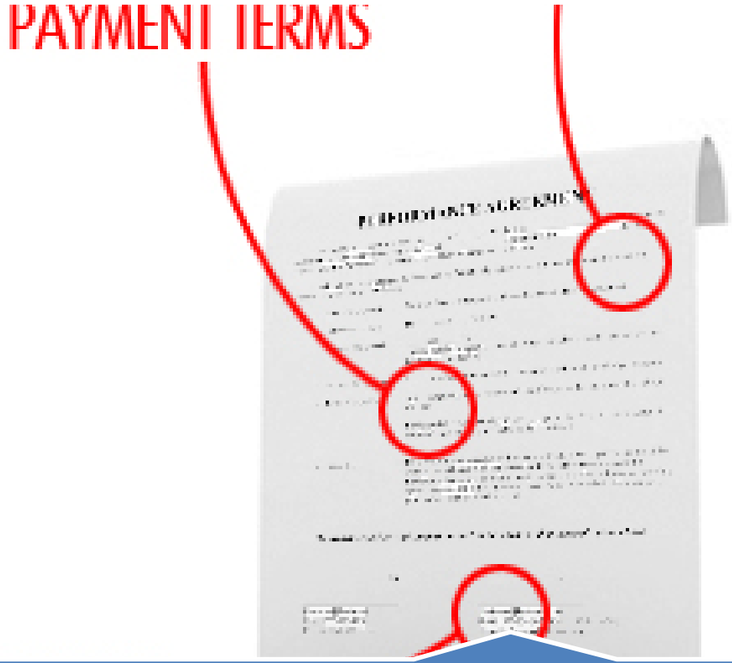
- “It takes 20 years to build a reputation and five minutes to ruin it. If you think about that you’ll do things differently.”

- -Warren Buffett

Regulatory/Contractual Impact

Handout: Page 4

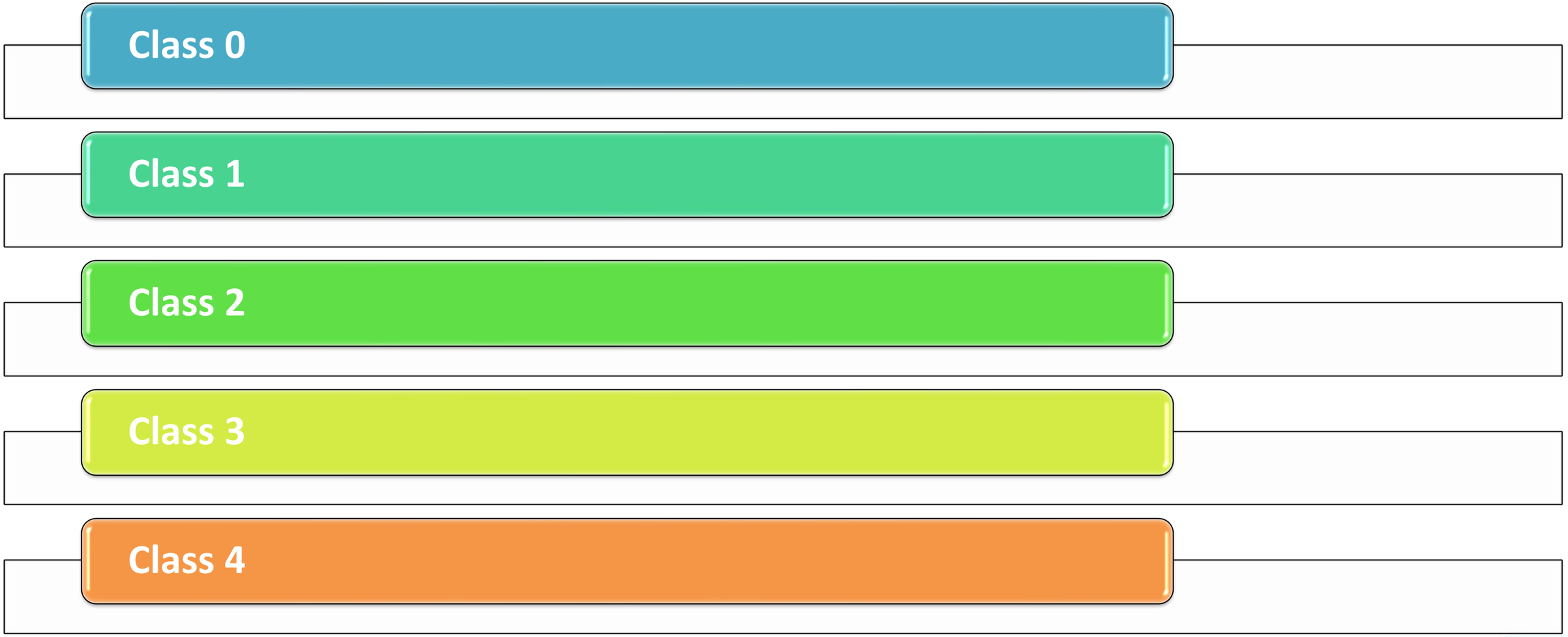
Regulatory



Contractual

Availability Classes

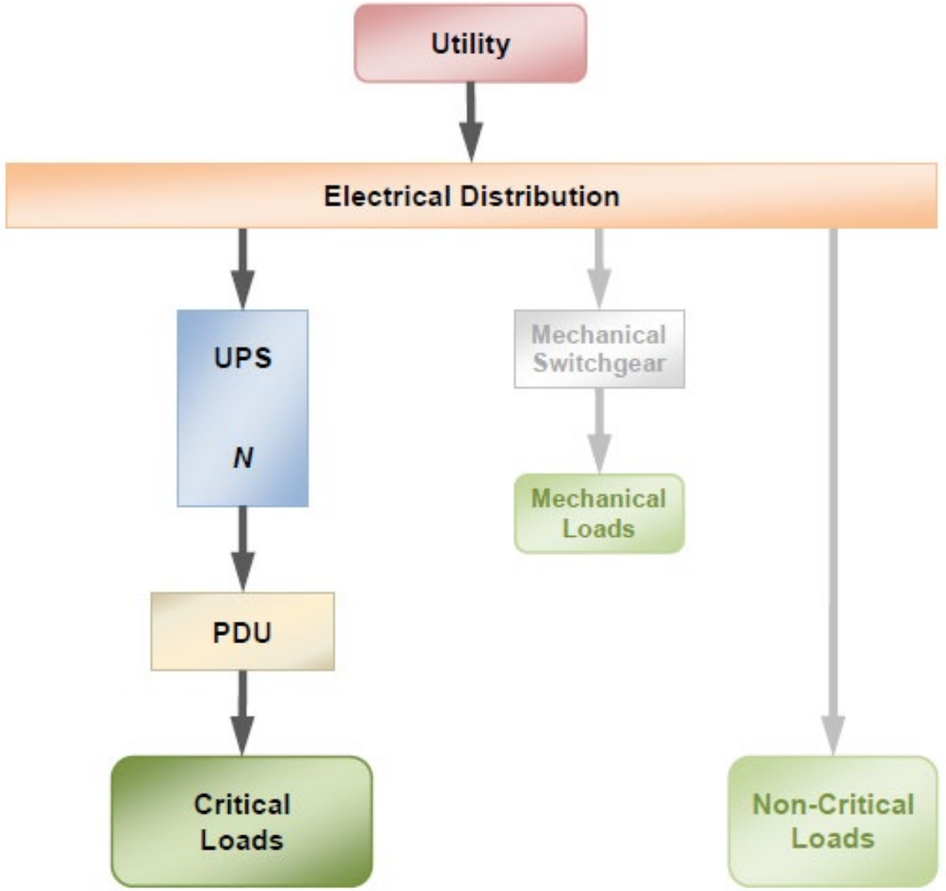
Handout: Page 4 & 5



Class 0

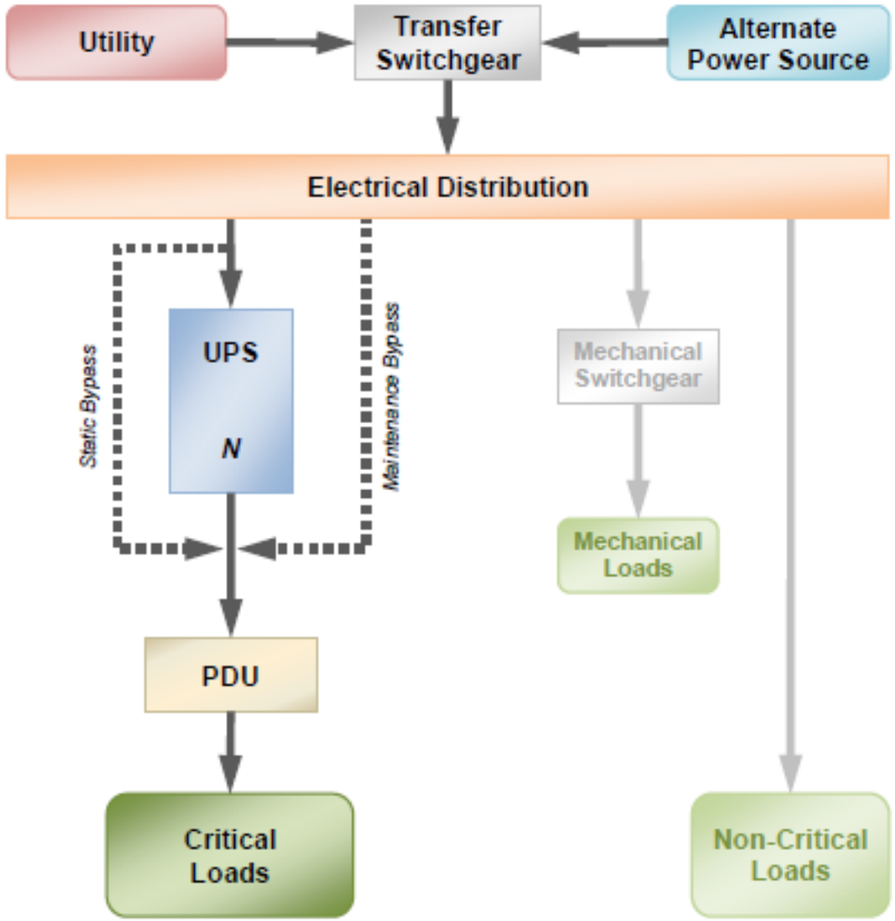
BICSI 002-2014 9.1.6.2

- Support basic IT requirements
- No supplementary equipment
- Capital cost major driver
- High risk of downtime



Class 1

BICSI 002-2014 9.1.6.3

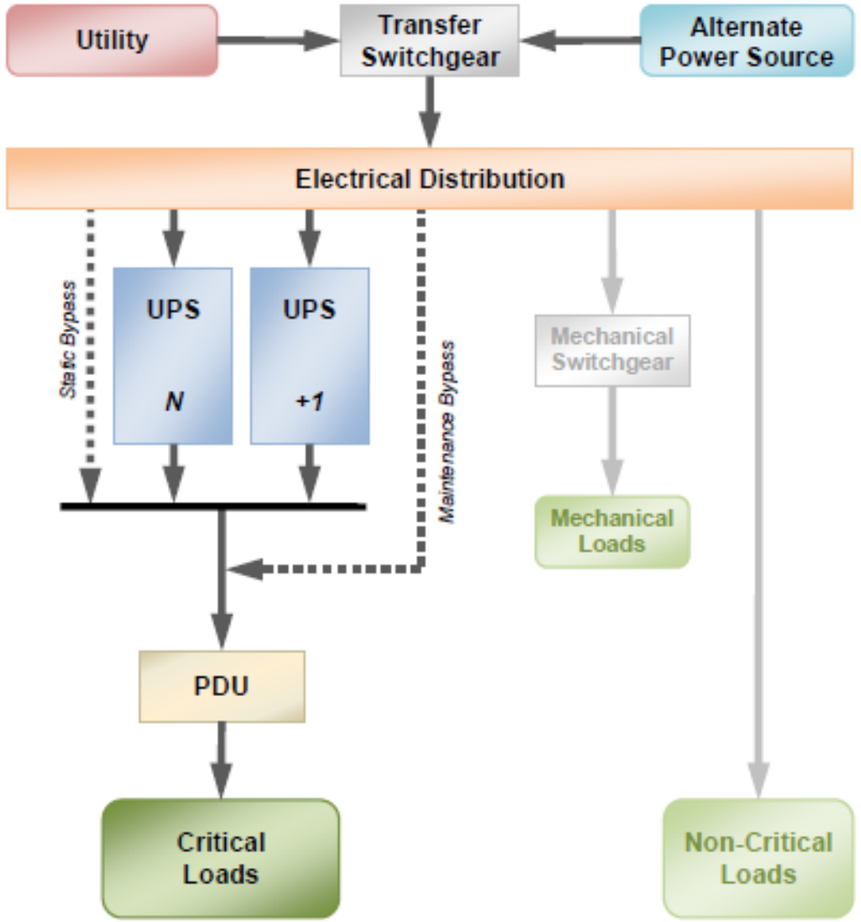


- Support basic IT requirements
- Very little supplementary equipment (UPS, Generator for IT load only)
- Remedial maintenance can be performed

Class 2

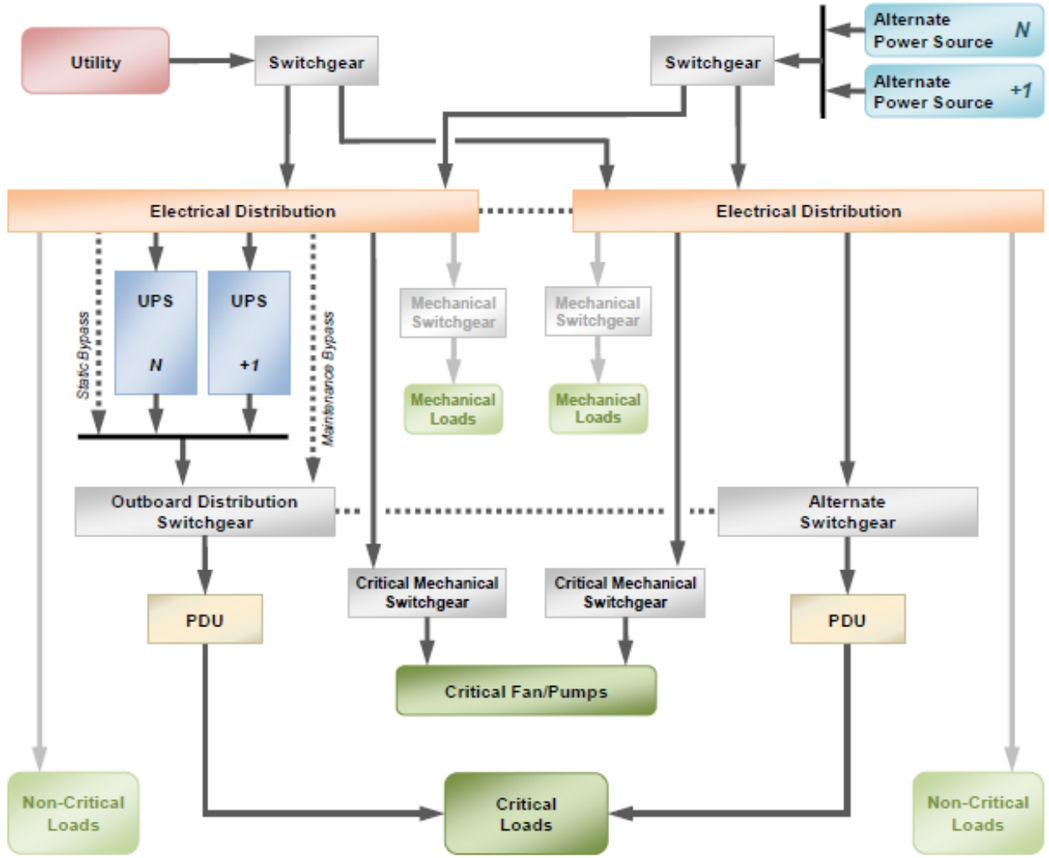
BICSI 002-2014 9.1.6.4

- Reliability higher than Class 1
- Redundant components for critical systems
- Moderate risk of downtime



Class 3

BICSI 002-2014 9.1.6.5

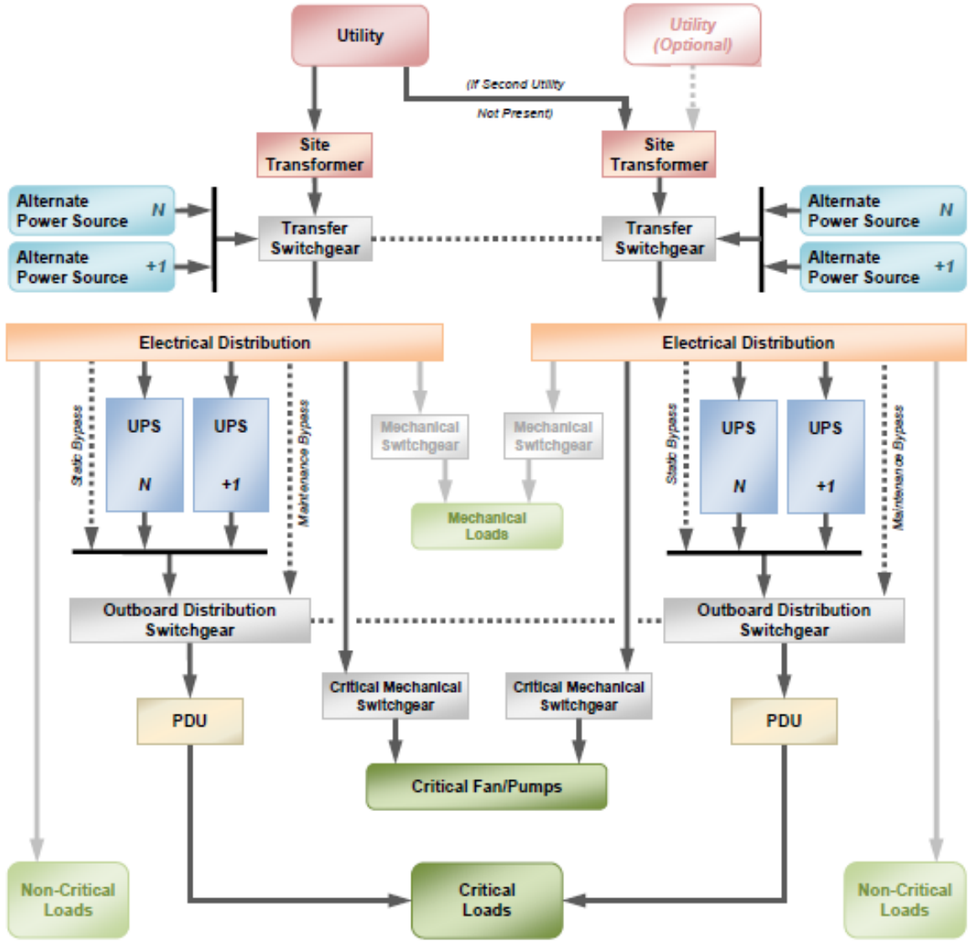


- Additional reliability and maintainability
- Maintenance can be performed during operational hours
- Redundancy is lost during maintenance

Class 4

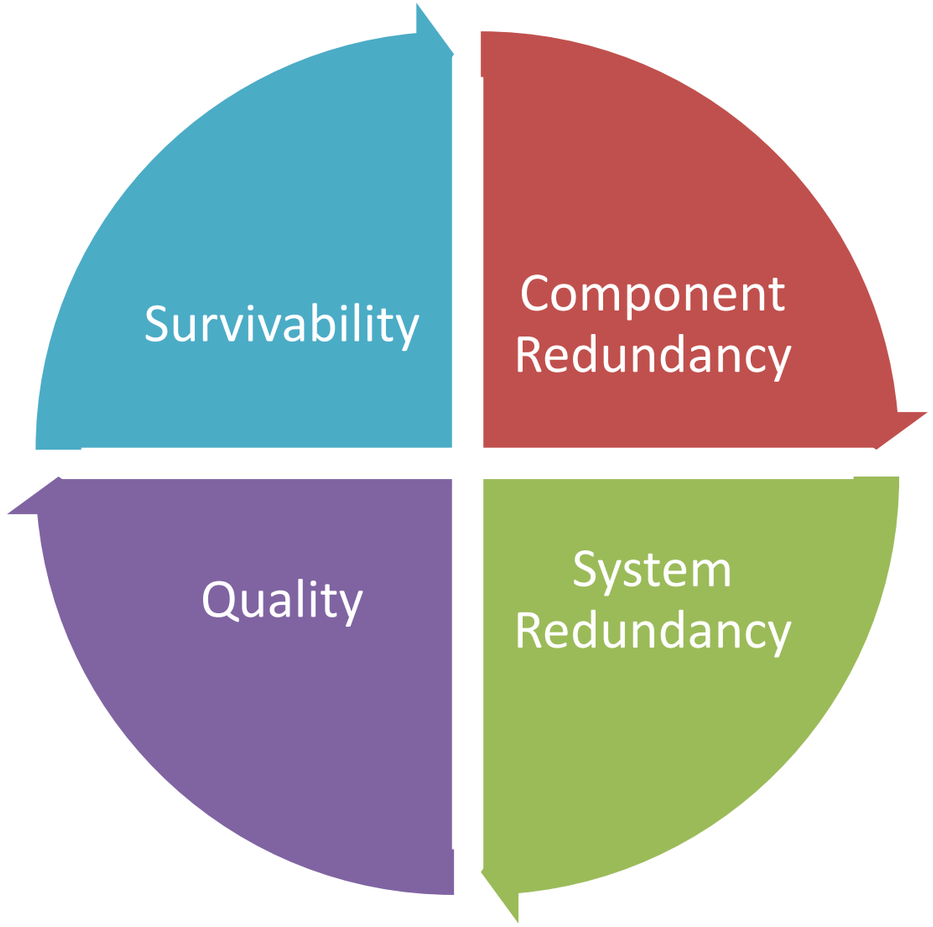
BICSI 002-2014 9.1.6.6

- Designed to eliminate downtime
- No single point of failure
- Redundancy during maintenance



Primary Concerns

Handout: Page 5



Component Redundancy

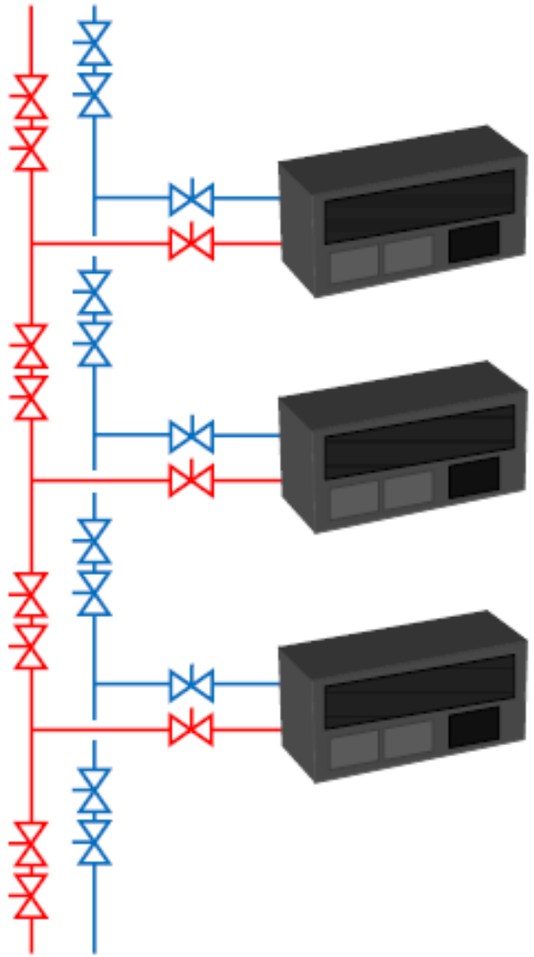
Handout: Page 5

- Increase reliability by providing redundancy for critical high risk, low-reliability components within systems

System Redundancy

Handout: Page 5

- Increase reliability by providing redundancy at the system level



Quality

Handout: Page 5

- Ensure that high quality is design and implemented in the data center

Survivability

Handout: Page 5

- Reduce the risk of downtime due to external events

How Primary Concerns are addressed Class 0/1/2

Handout: Page 5

Class	Component Redundancy	System Redundancy	Quality Control	Survivability
Class 0/1	None	None	Standard commercial quality	None
Class 2	Redundancy is provided for critical components	None	Premium quality for critical components	Moderate hardening for physical security and structural integrity

How Primary Concerns are addressed Class 3

Handout: Page 5

Class	Component Redundancy	System Redundancy	Quality Control	Survivability
Class 3	Redundancy is required for critical and noncritical components, except where the component is part of a redundant system	System redundancy is required where component redundancy does not exist	Premium quality for all components	Significant hardening for physical security and structural integrity

How Primary Concerns are addressed Class 4

Handout: Page 5

Class	Component Redundancy	System Redundancy	Quality Control	Survivability
Class 4	Redundancy is provided for all critical components and to increase maintainability; also provided for noncritical components	System redundancy is provided with component redundancy so that overall reliability is maintained even during maintenance activities	Premium quality for all components. Recommended to use different lots, model, and manufacturer to avoid common fault or recall	All systems are self-supporting in any event and are protected against the highest levels of natural forces

Availability Class Groups

Handout: Page 6

Facility

- F0
- F1
- F2
- F3
- F4

Cable Plant

- C0
- C1
- C2
- C3
- C4

Network

- N0
- N1
- N2
- N3
- N4

Data Processing/Storage

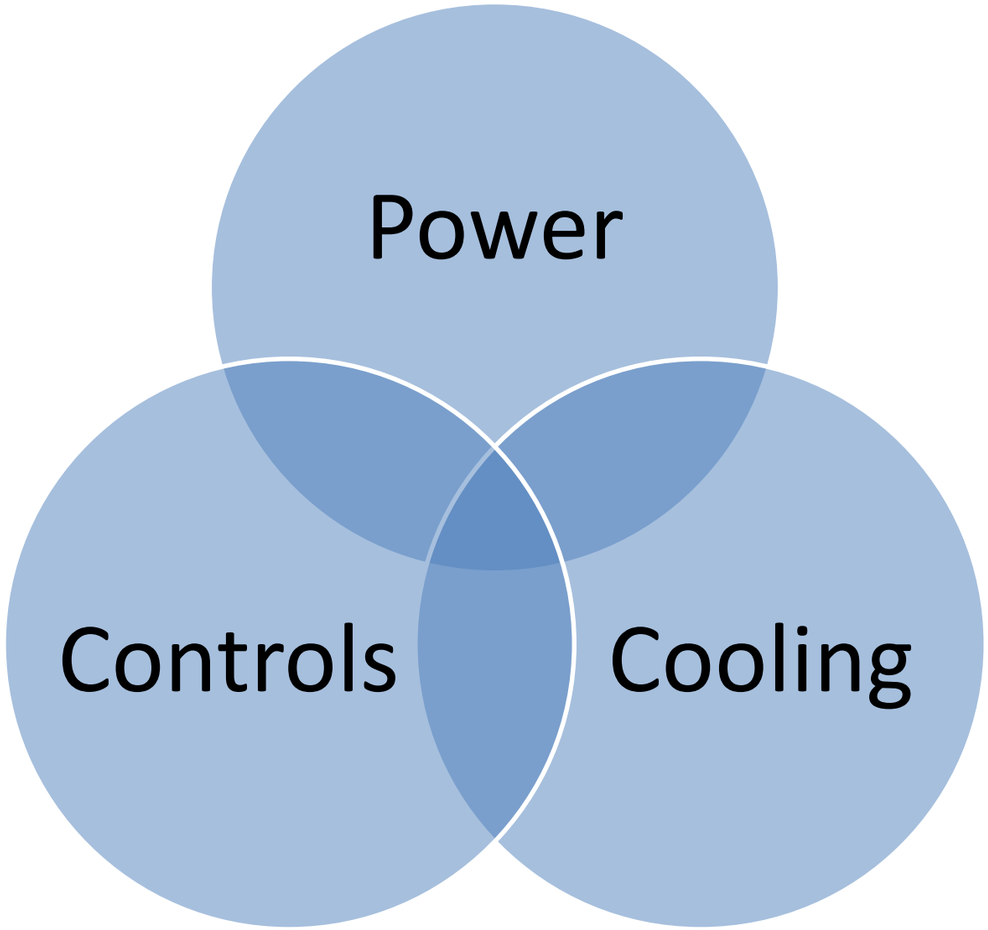
- S0
- S1
- S2
- S3
- S4

Applications

- A0
- A1
- A2
- A3
- A4

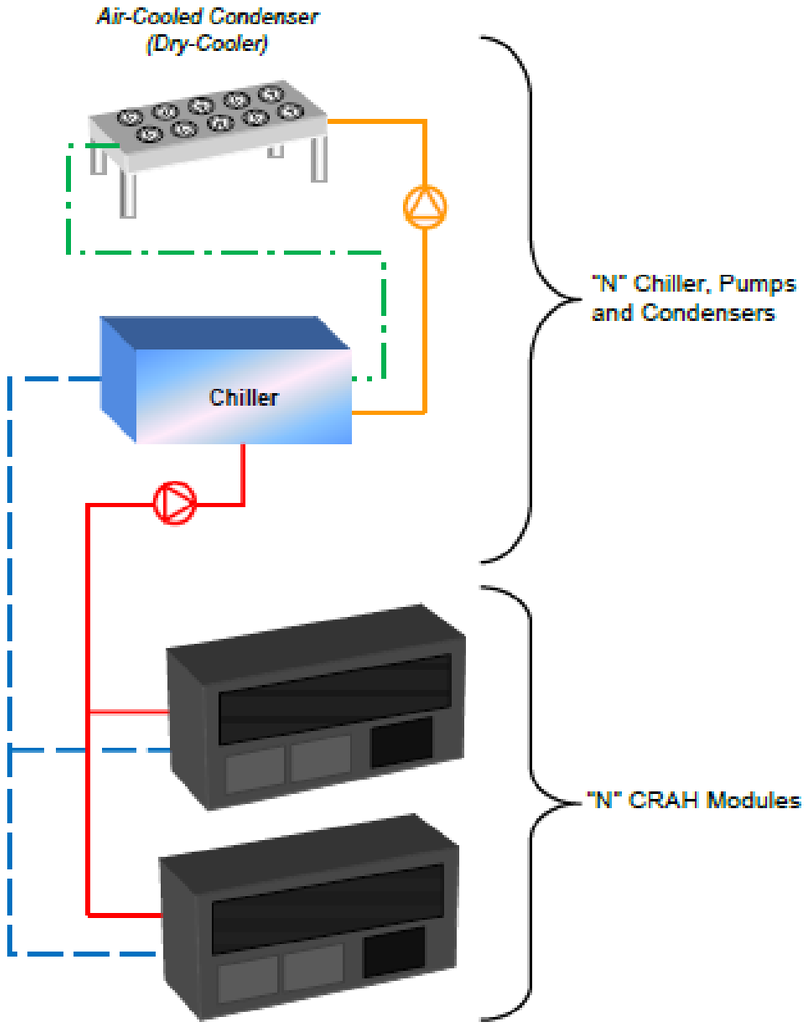
Facility

Handout: Page 6



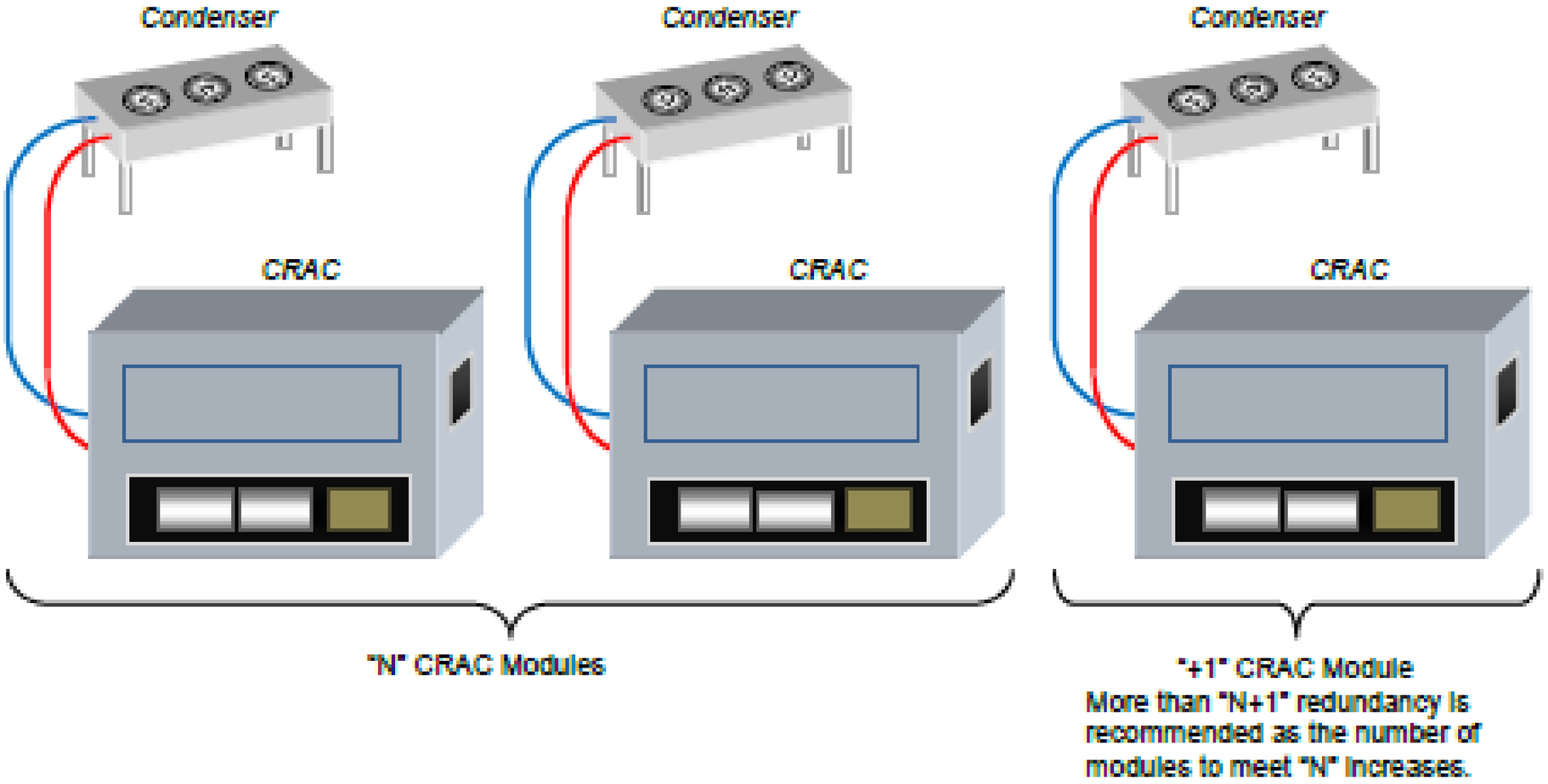
Mechanical Class F0/F1

BICSI 002-2014 10.3.2



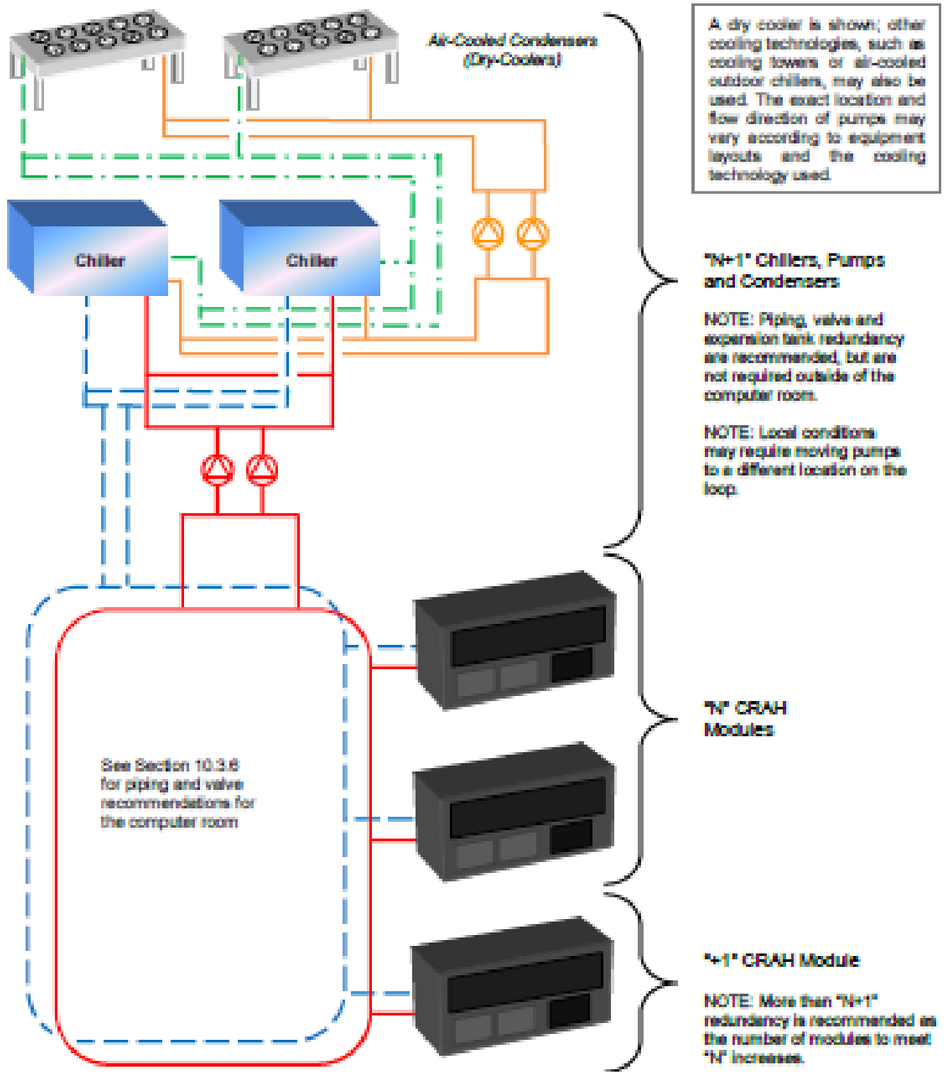
Mechanical Class F2

BICSI 002-2014 10.3.3



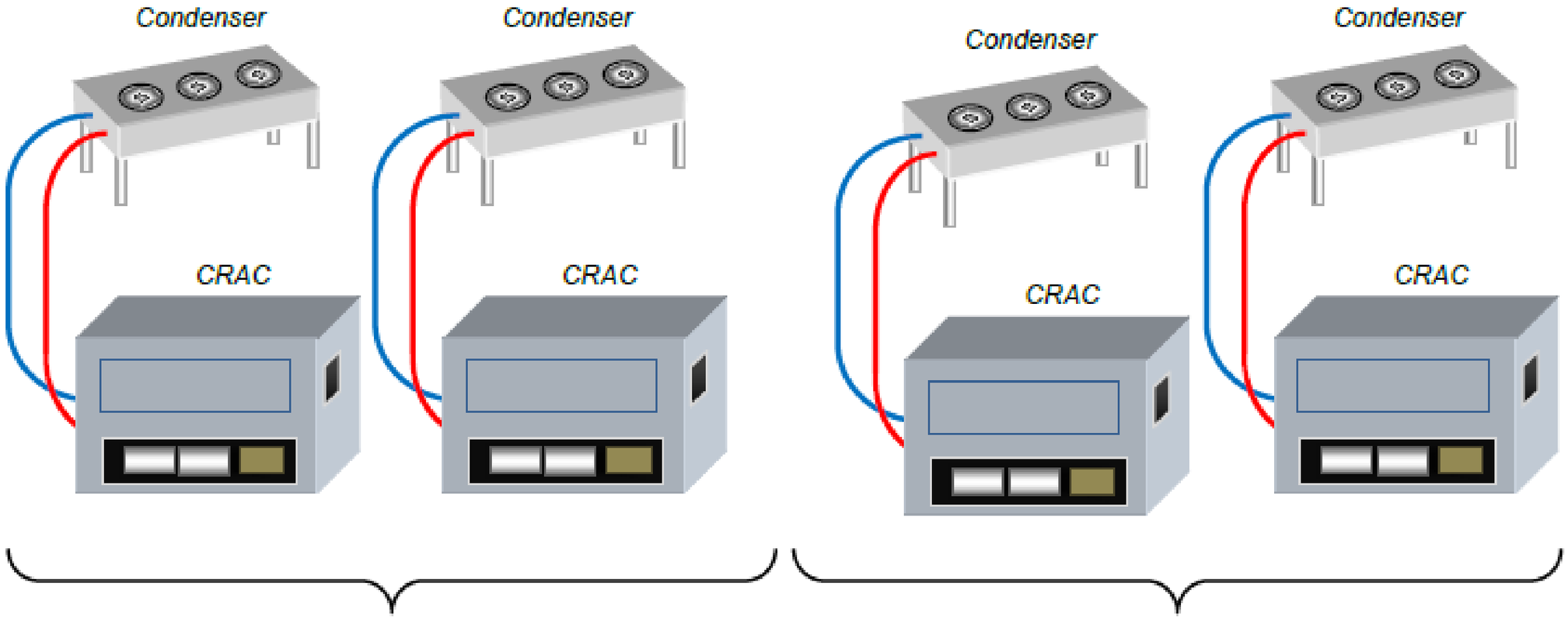
Mechanical Class F3

BICSI 002-2014 10.3.4



Mechanical Class F4

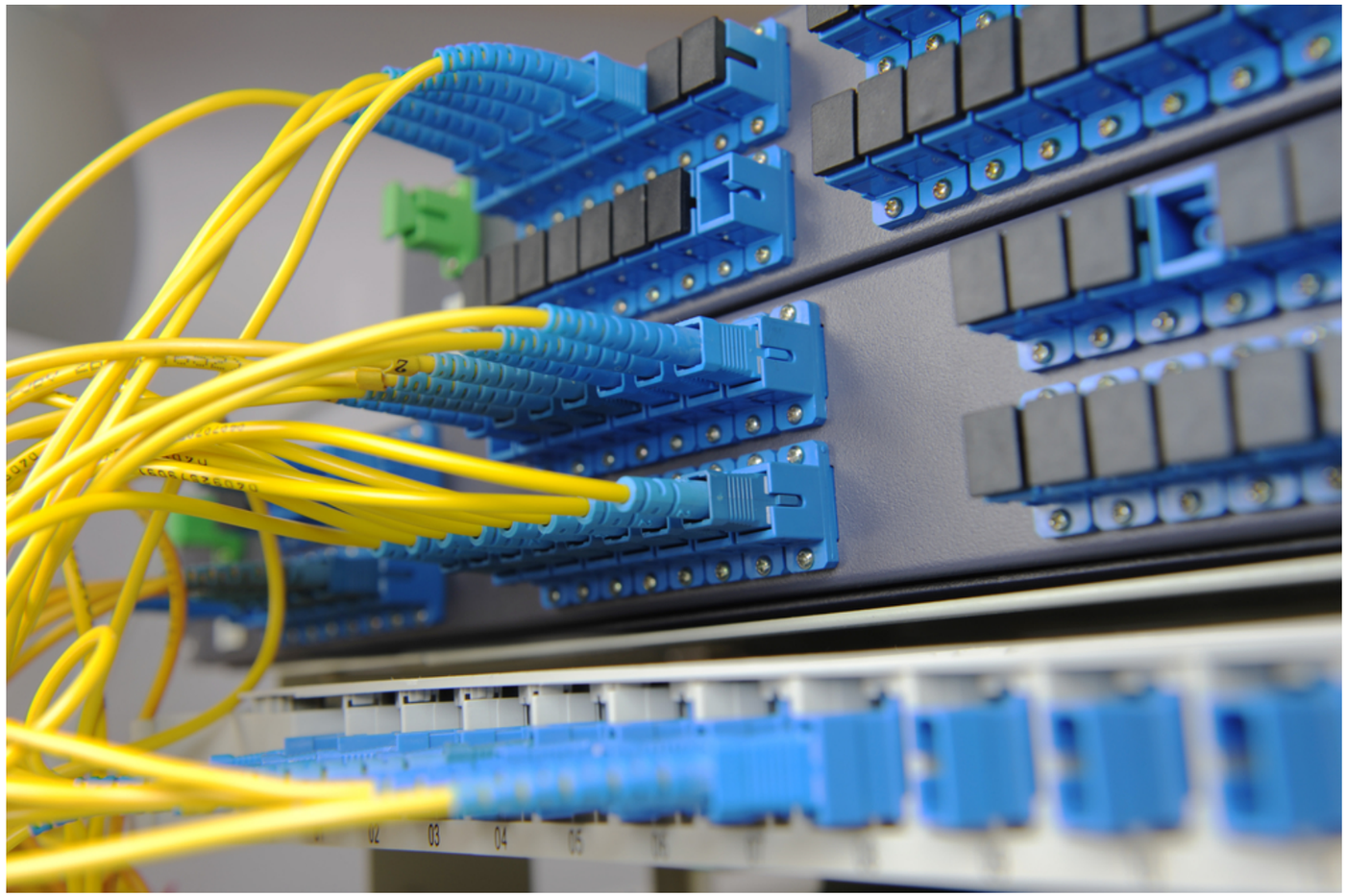
BICSI 002-2014 10.3.5



More than "N+2" redundancy is recommended as the number of modules to meet "N" increases.

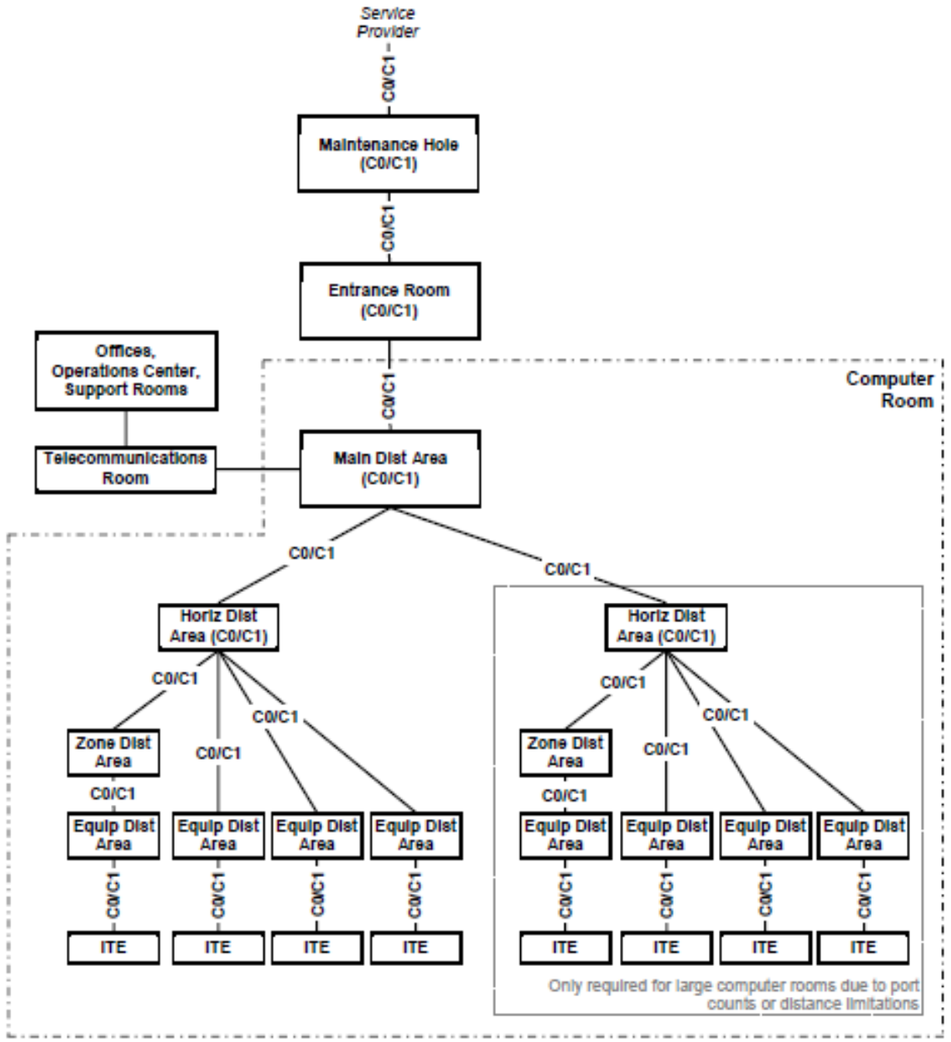
Cable Plant

Handout: Page 6



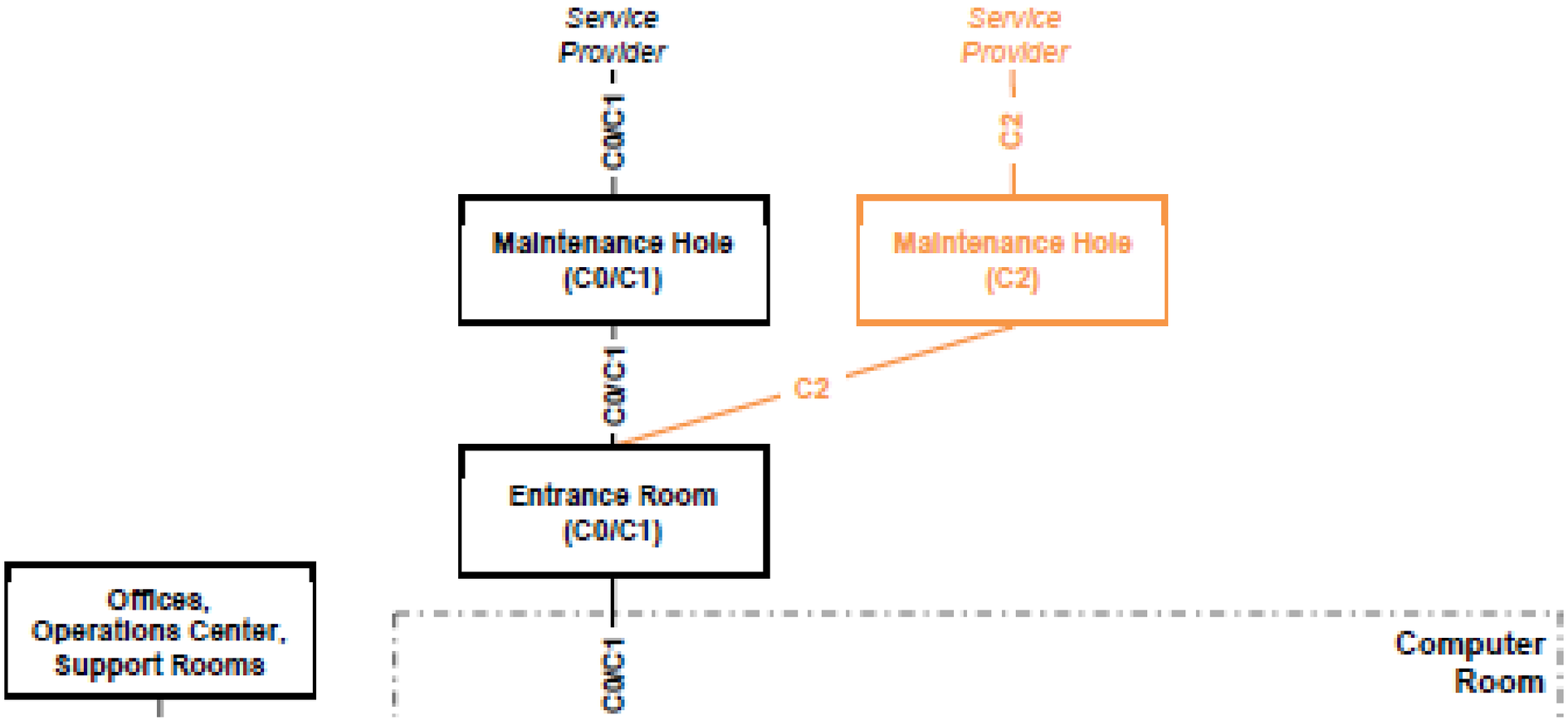
Communications Class C0/C1

BICSI 002-2014 14.2.2



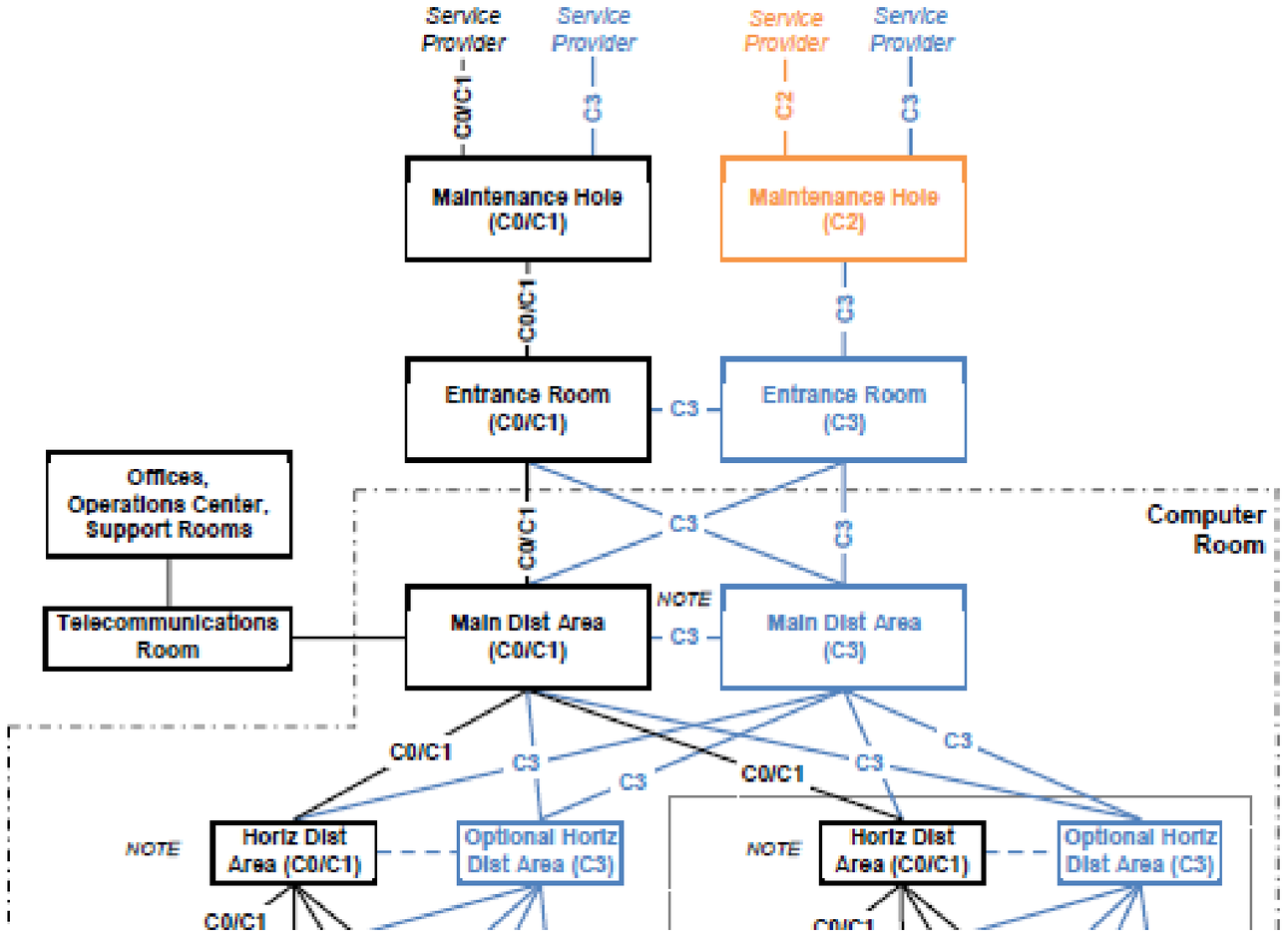
Communications Class C2

BICSI 002-2014 14.2.3



Communications Class C3

BICSI 002-2014 14.2.4



Communications Class C4

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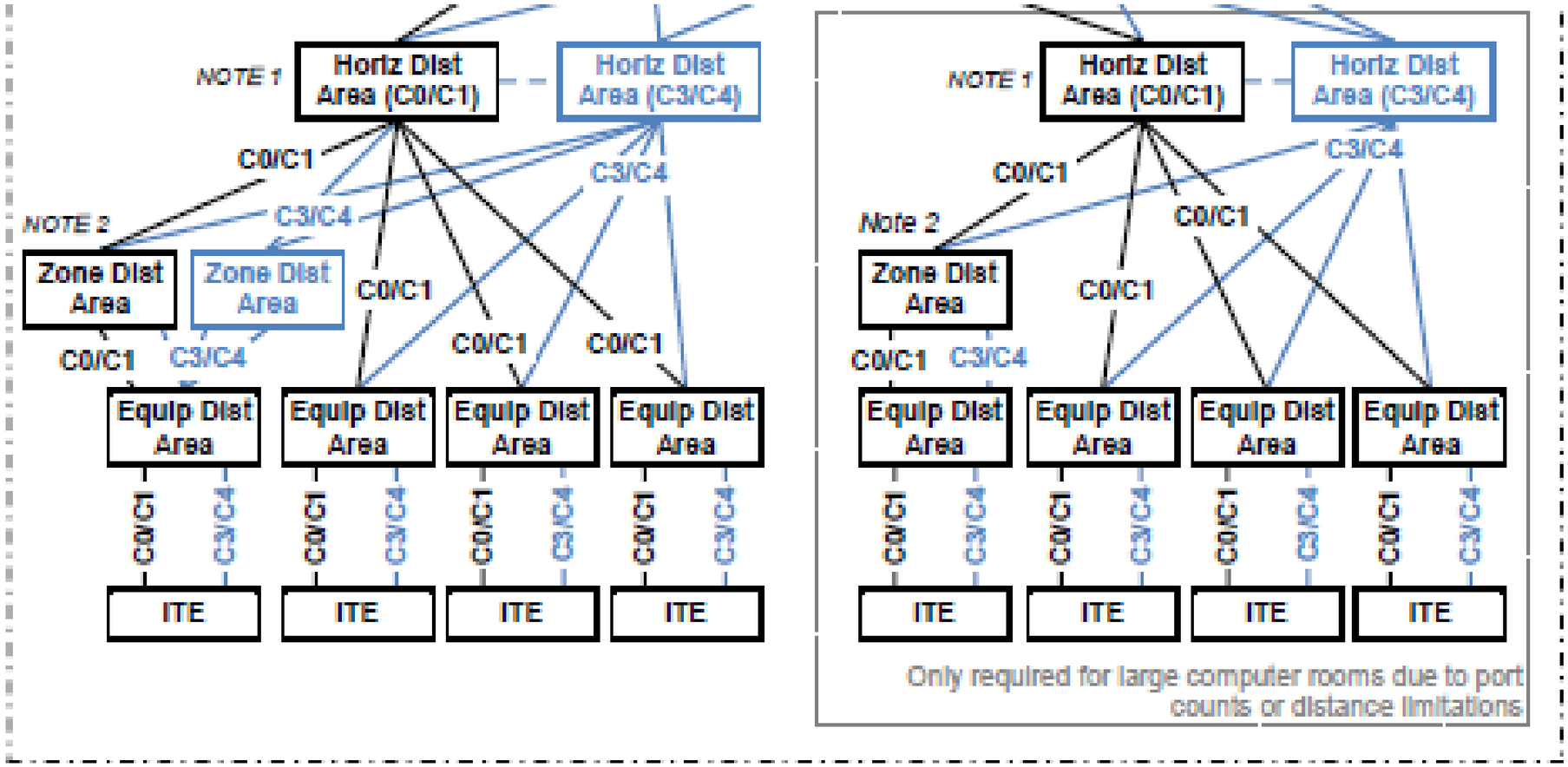
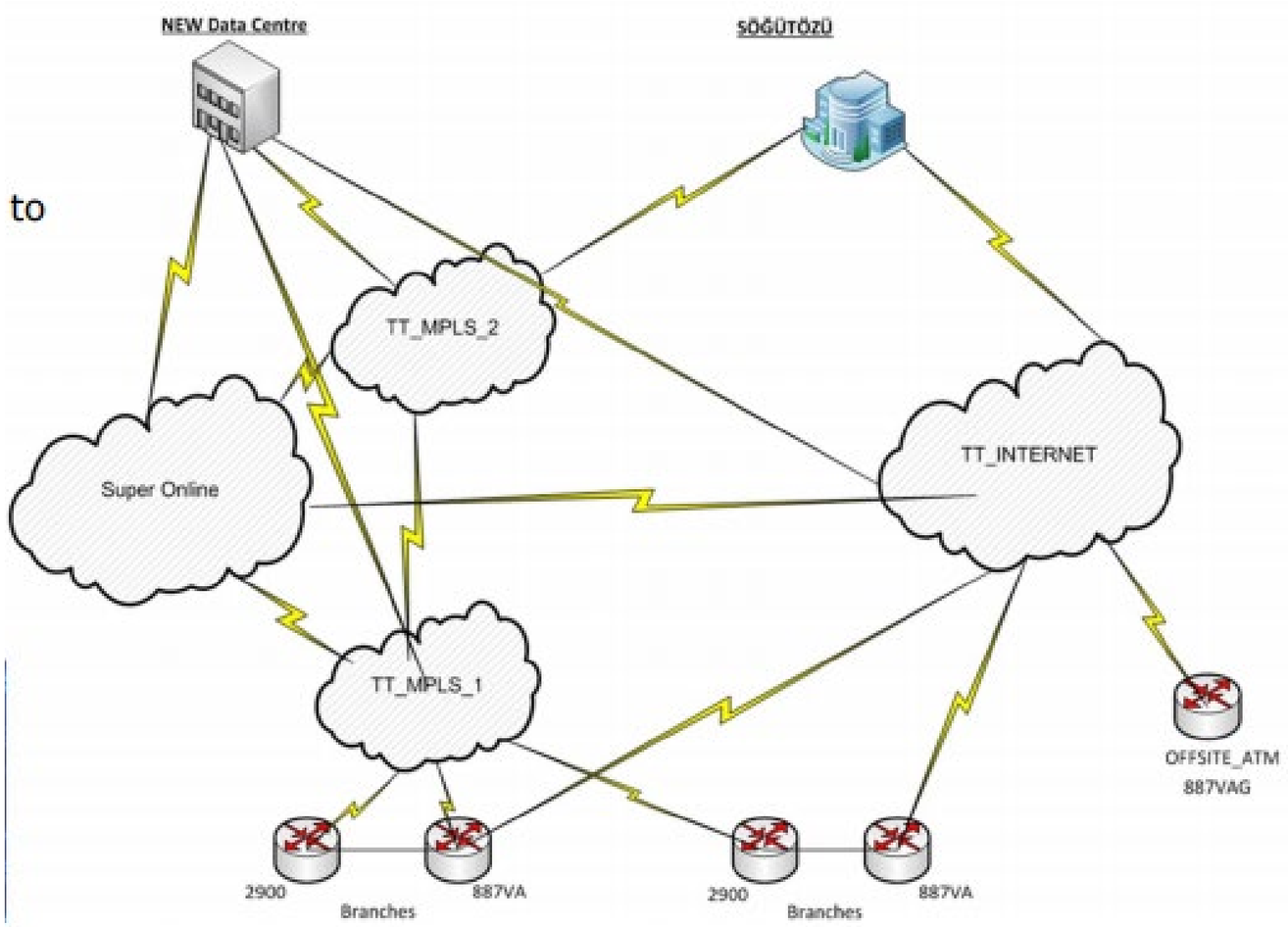


Network

Handout: Page 6



Network Class N0/N1

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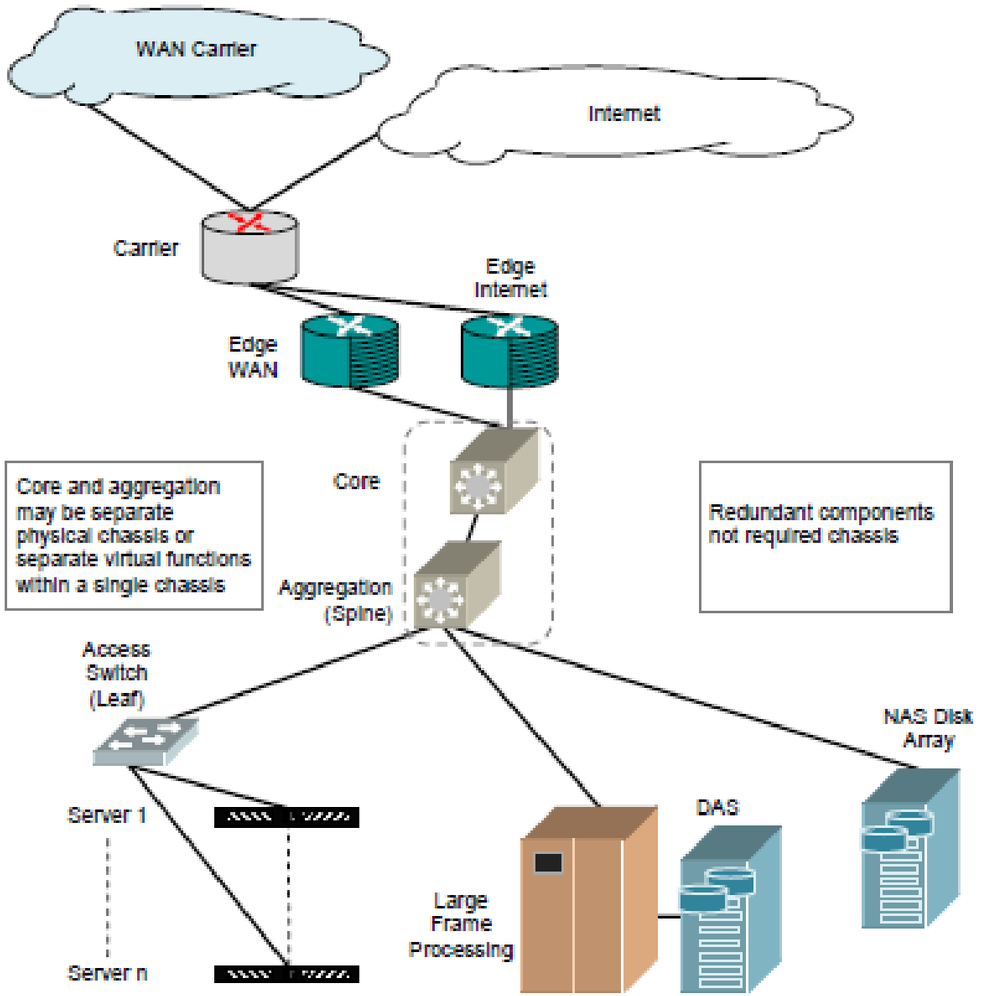
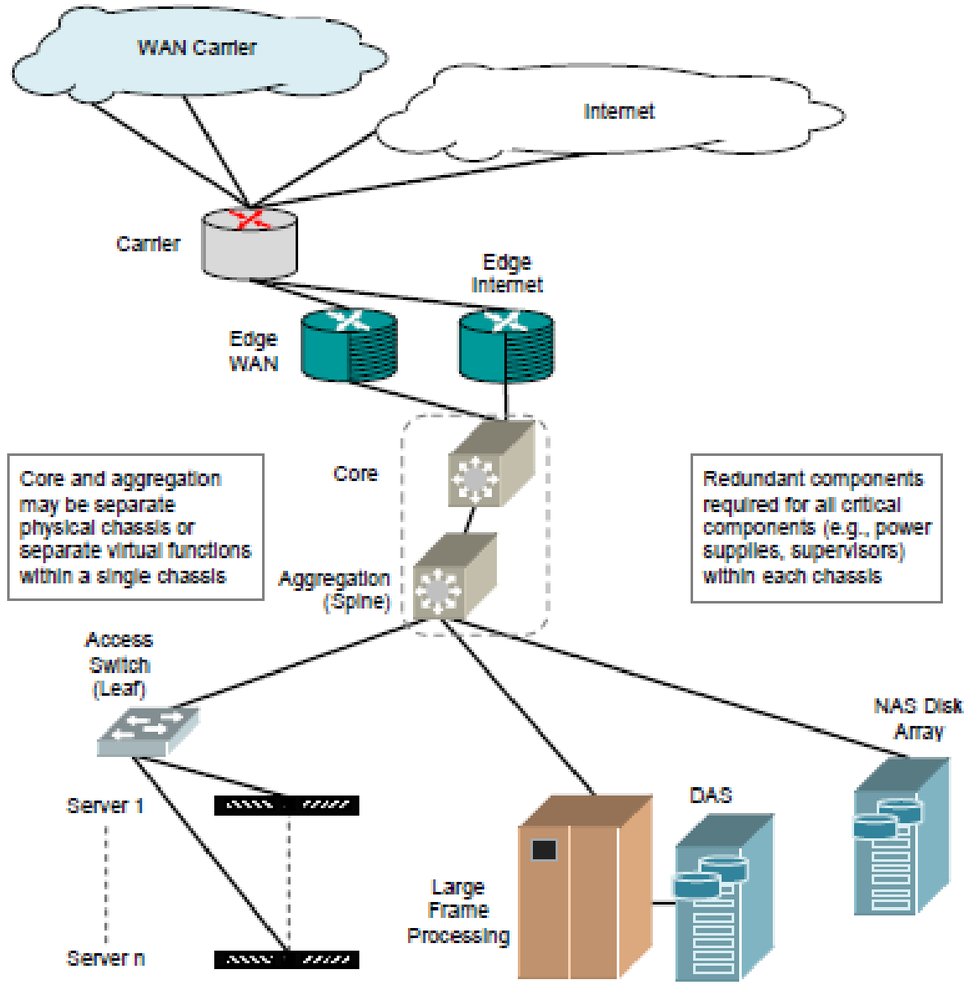


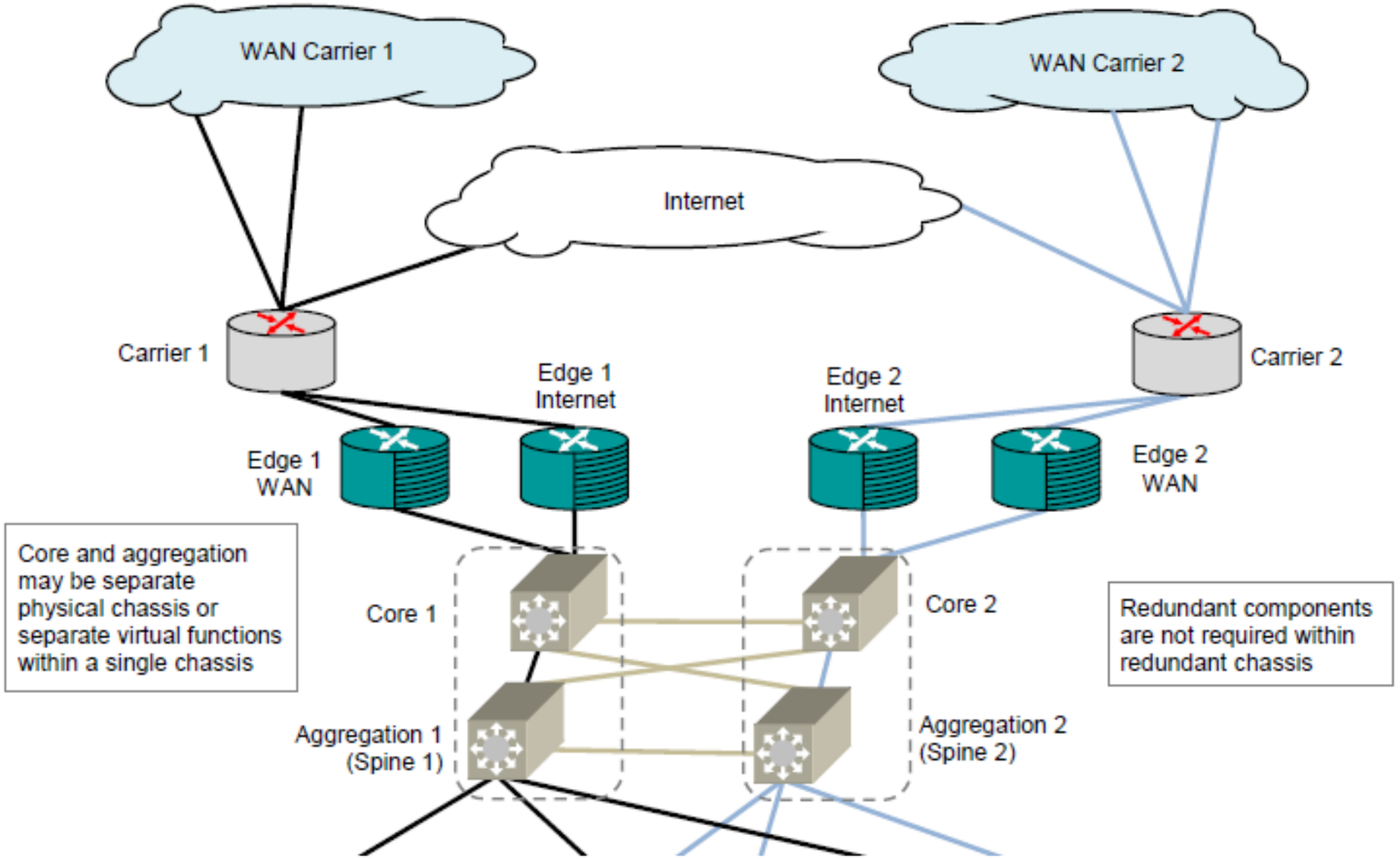
Network Class N2

BICSI 002-2014 15.6.2.3



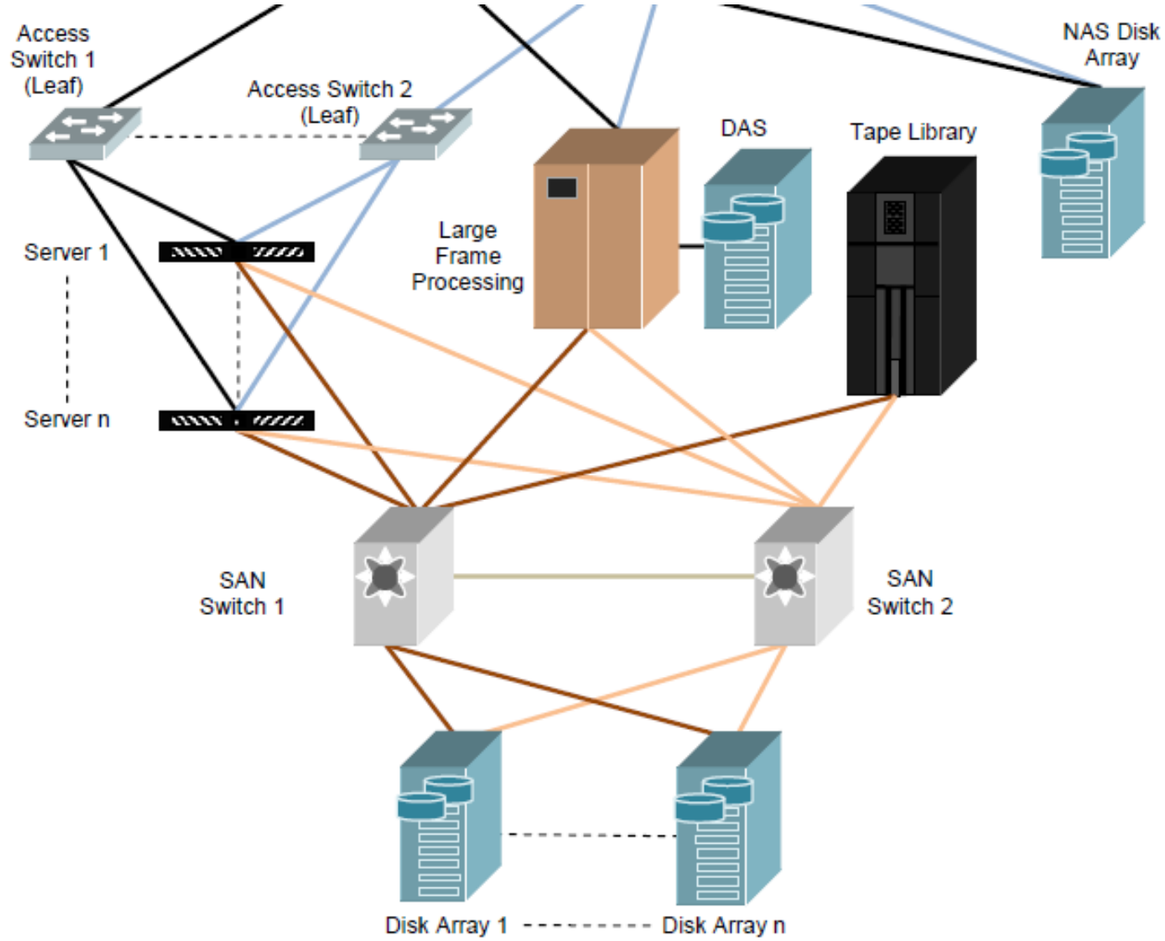
Network Class N3 WAN/Core

BICSI 002-2014 15.6.2.4



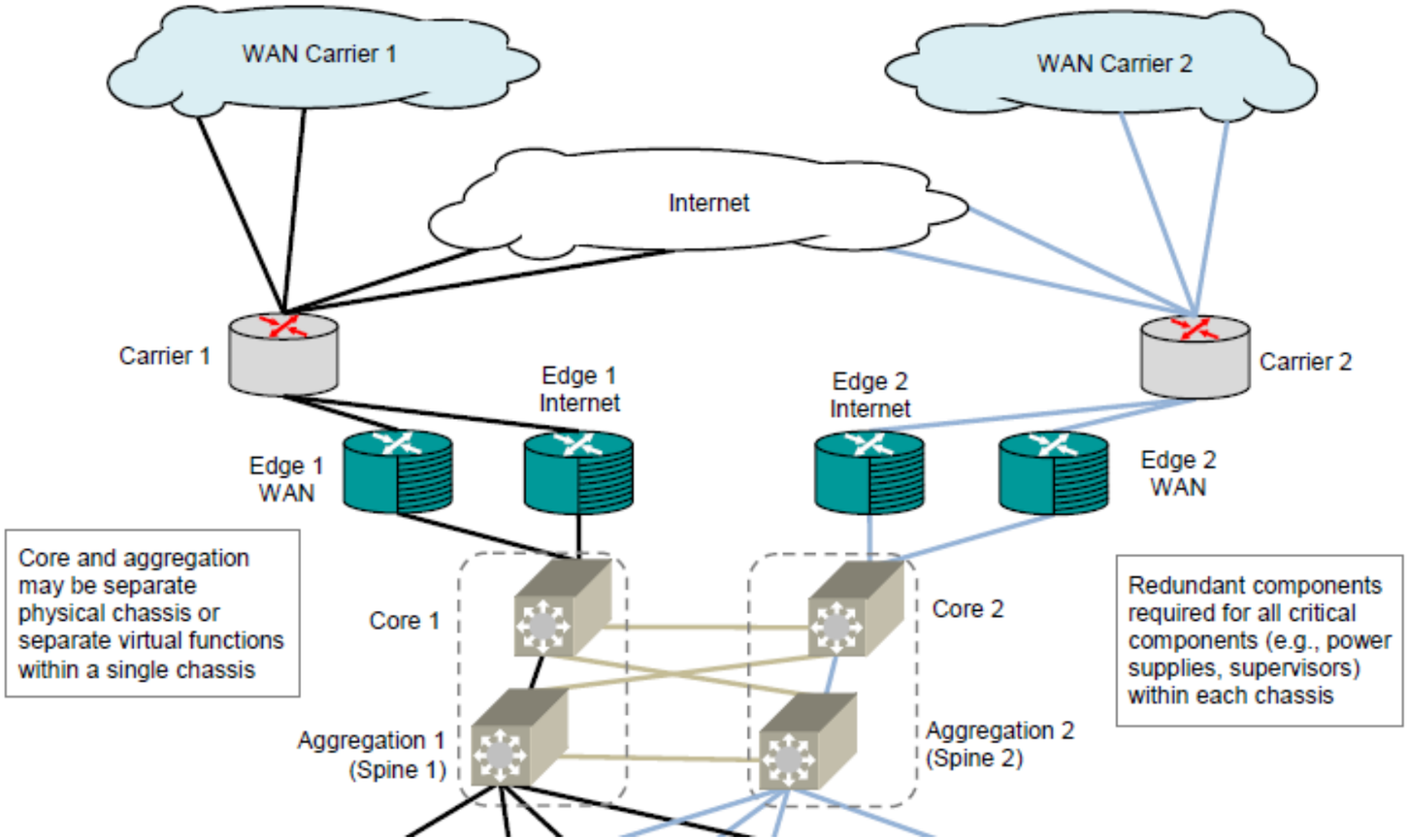
Network Class N3 Access/SAN

BICSI 002-2014 15.6.2.4



Network Class N4 WAN/Core

BICSI 002-2014 15.6.2.5



Network Class N4 Access/SAN

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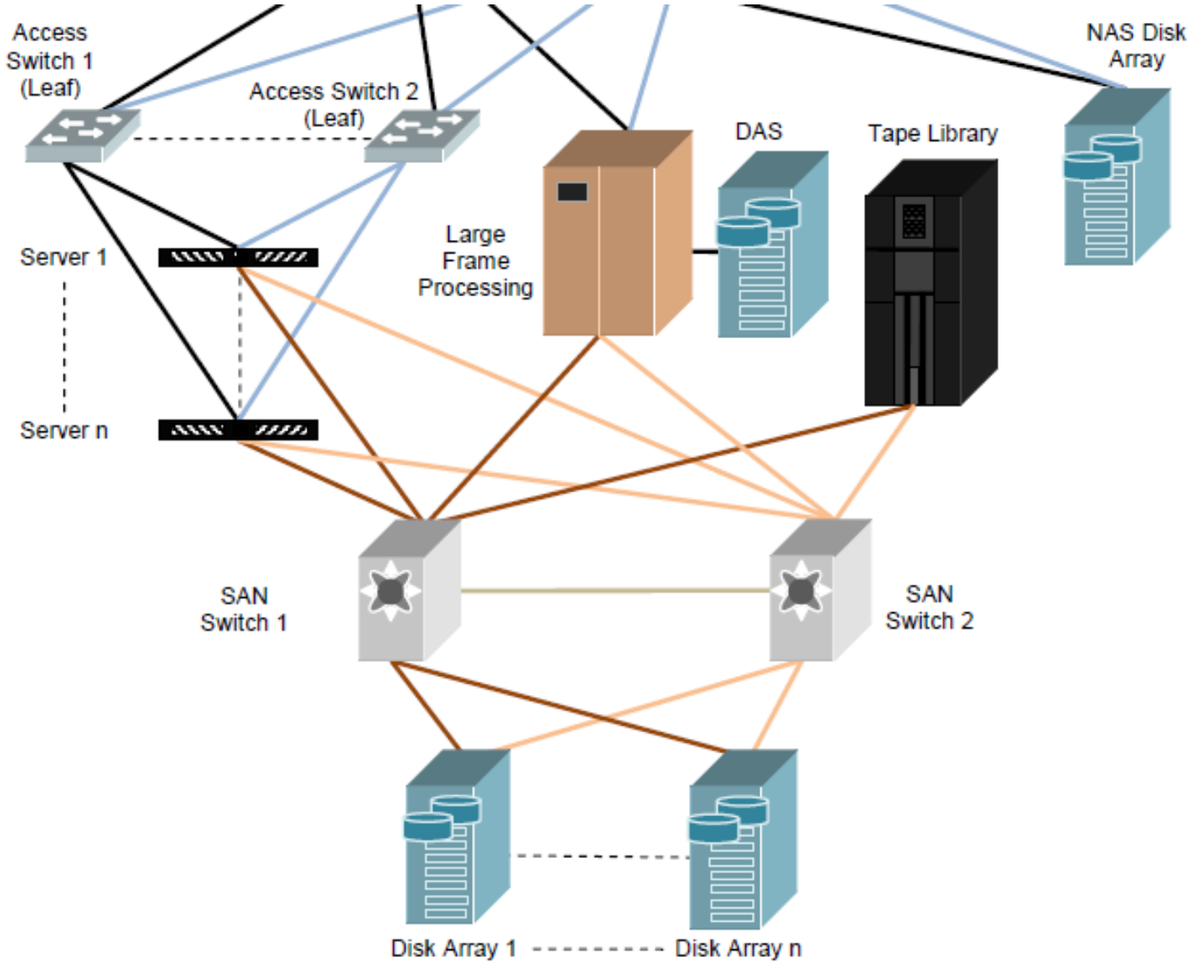
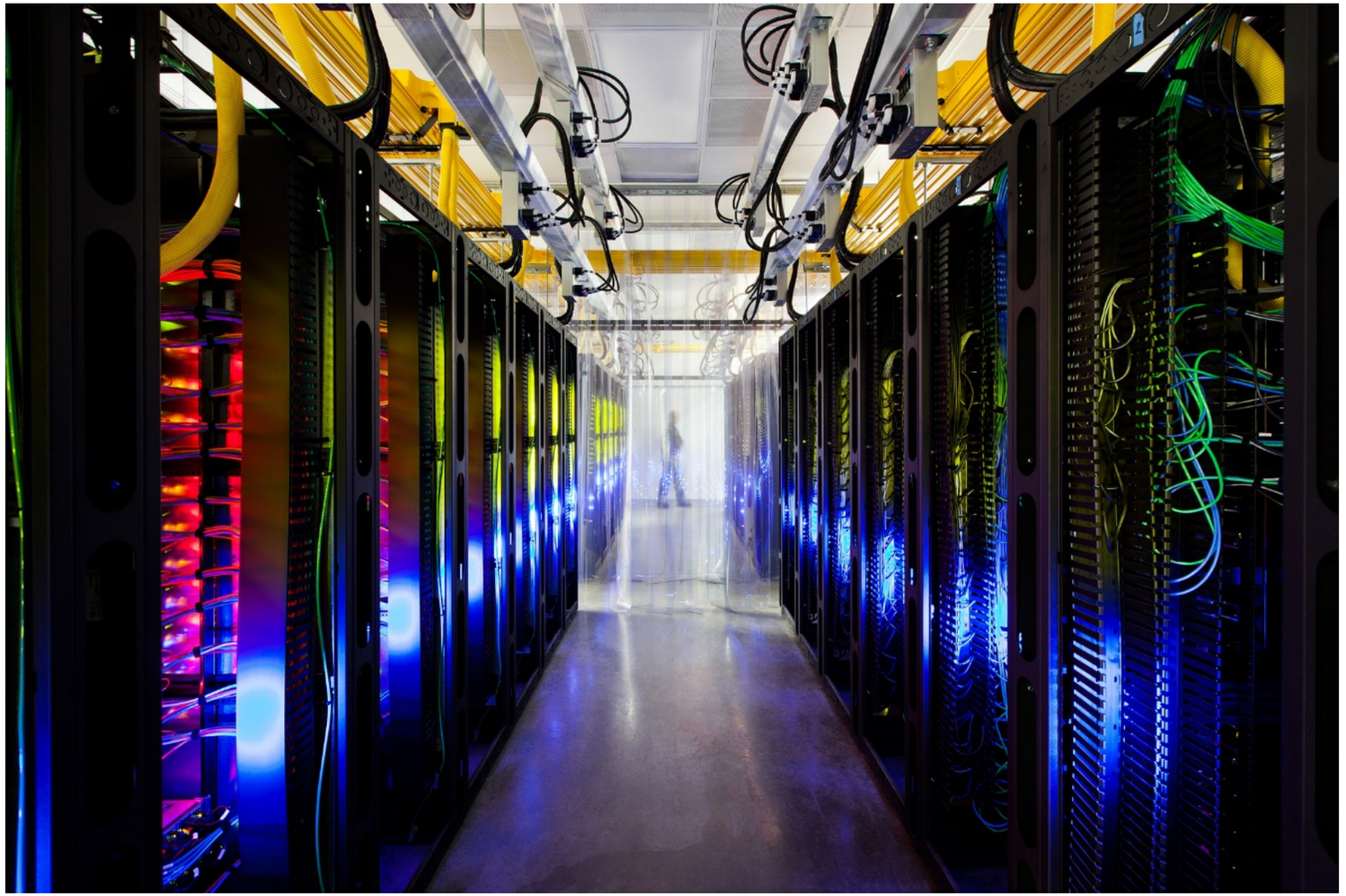


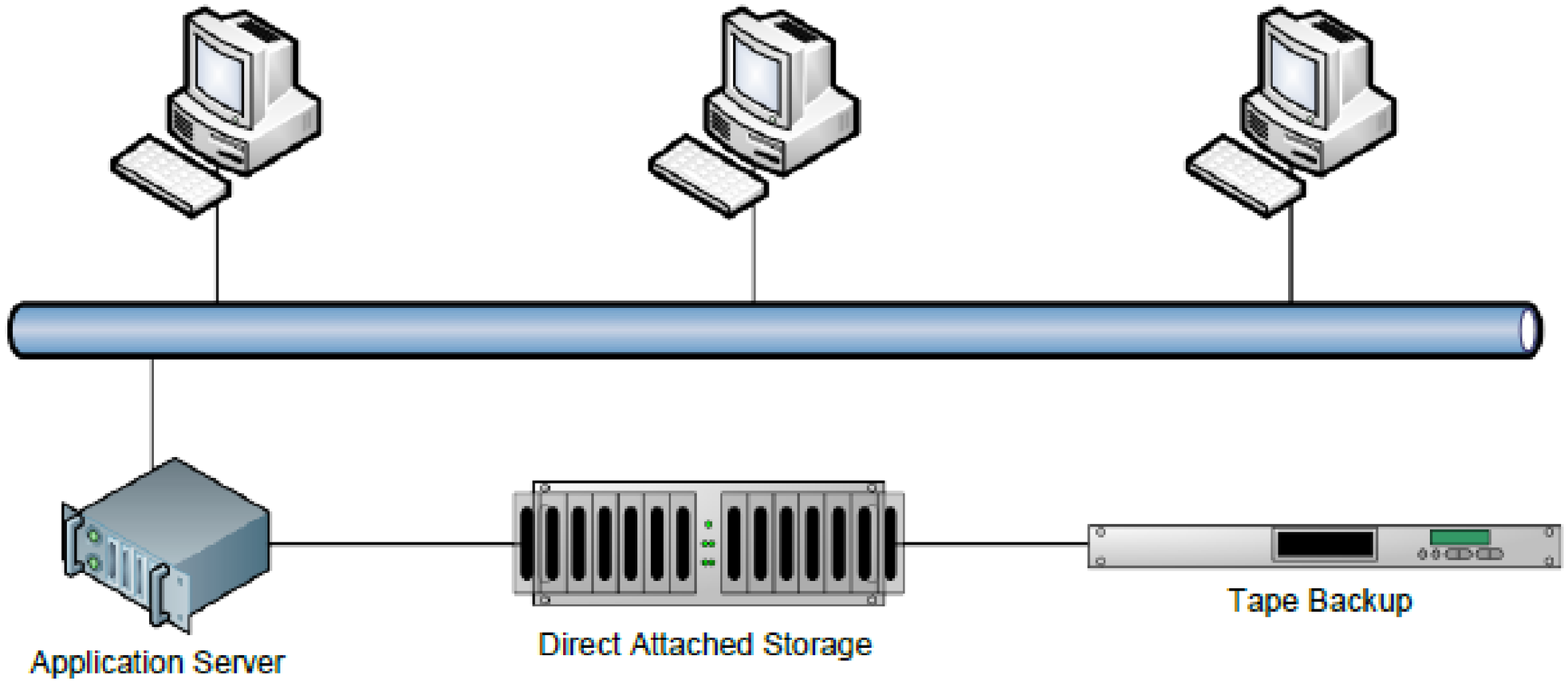
Data Processing/Storage

Handout: Page 6



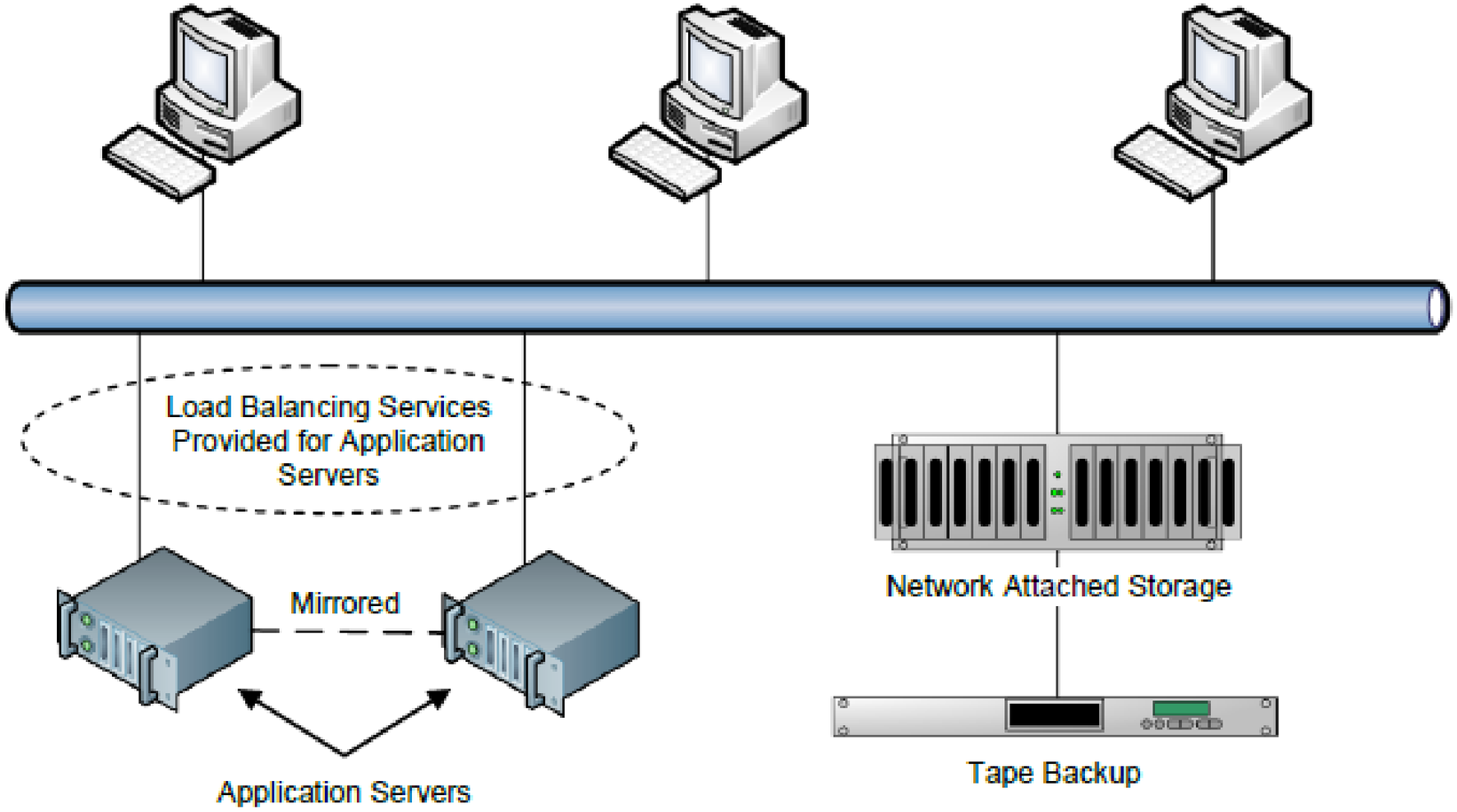
Data Processing/Storage Class S0/S1

BICSI 002-2014 C.3.2



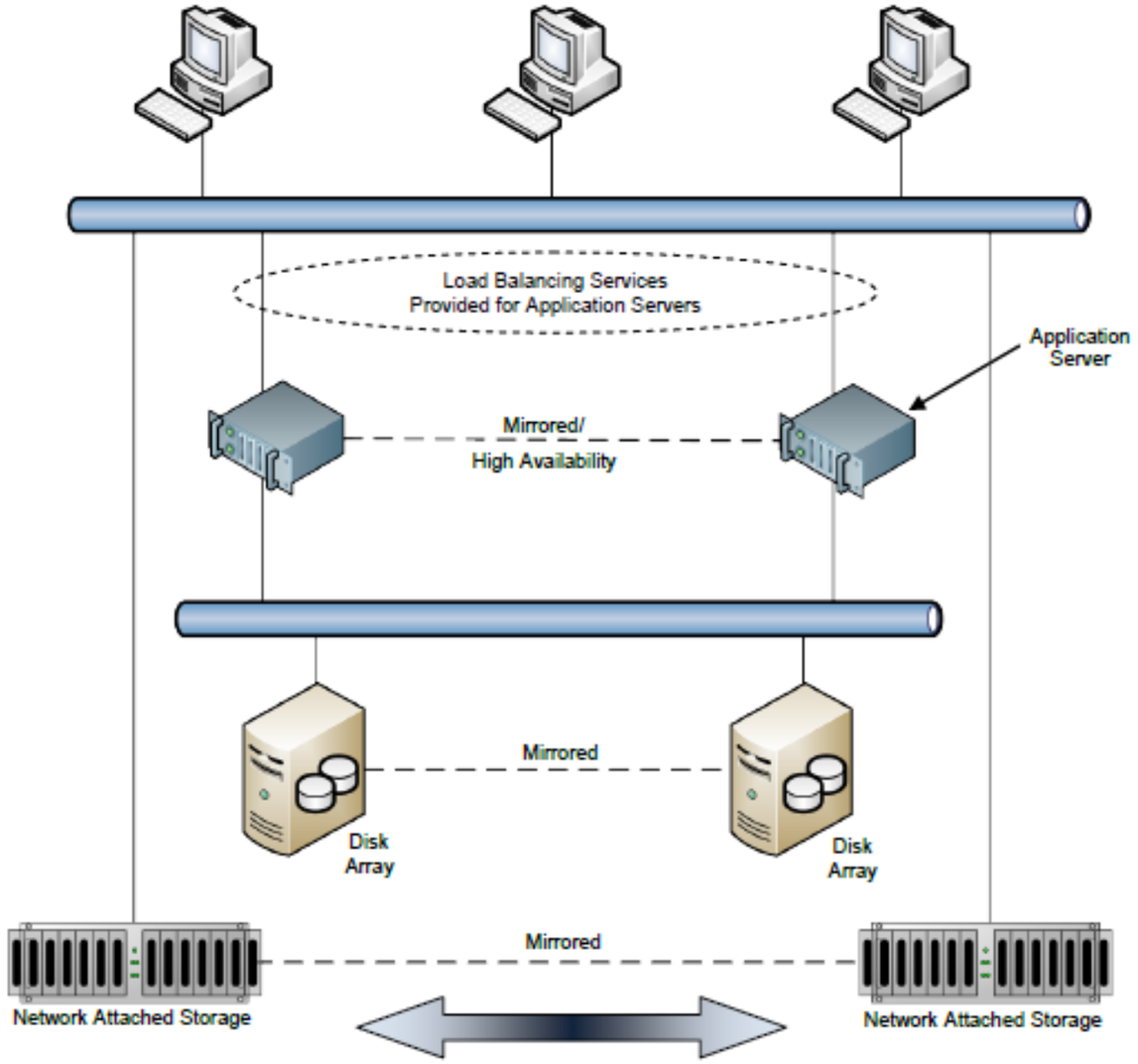
Data Processing/Storage Class S2

BICSI 002-2014 C.3.3



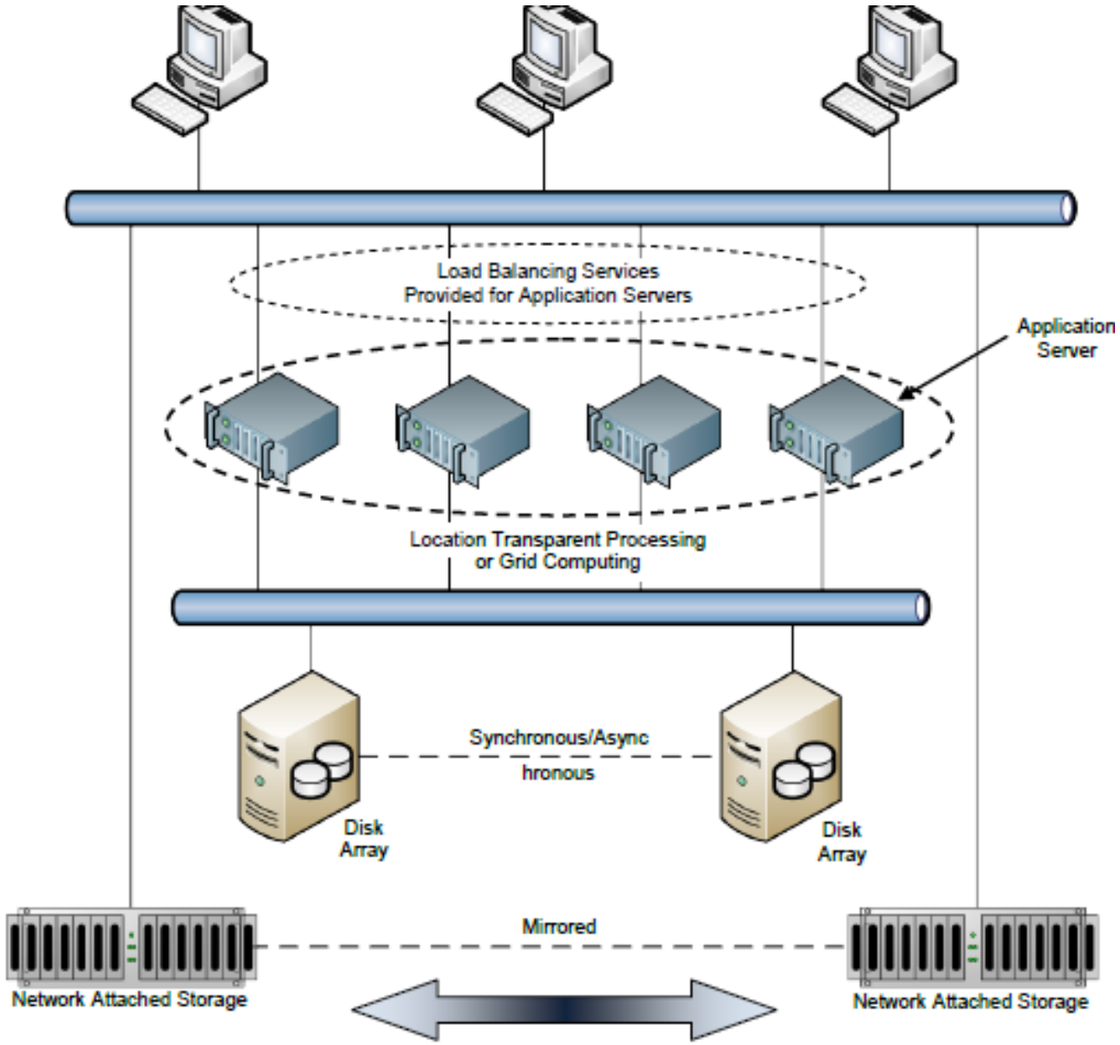
Data Processing/Storage Class S3

BICSI 002-2014 C.3.4



Data Processing/Storage Class S4

BICSI 002-2014 C.3.5

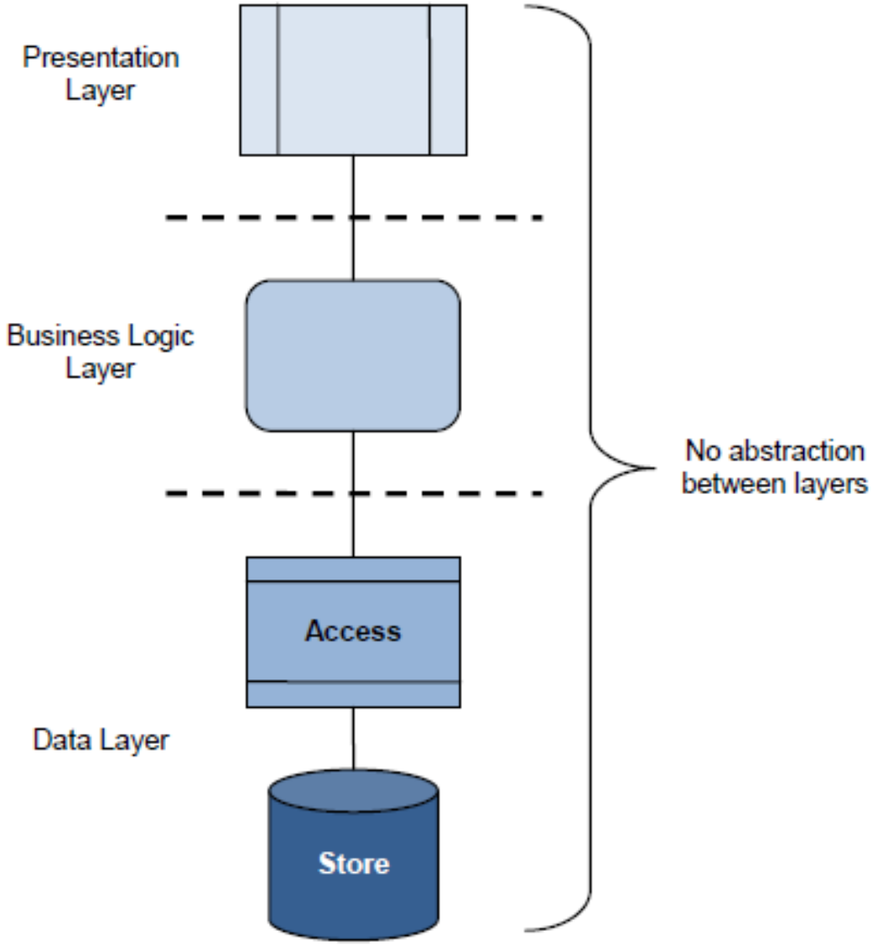


Applications

Handout: Page 6

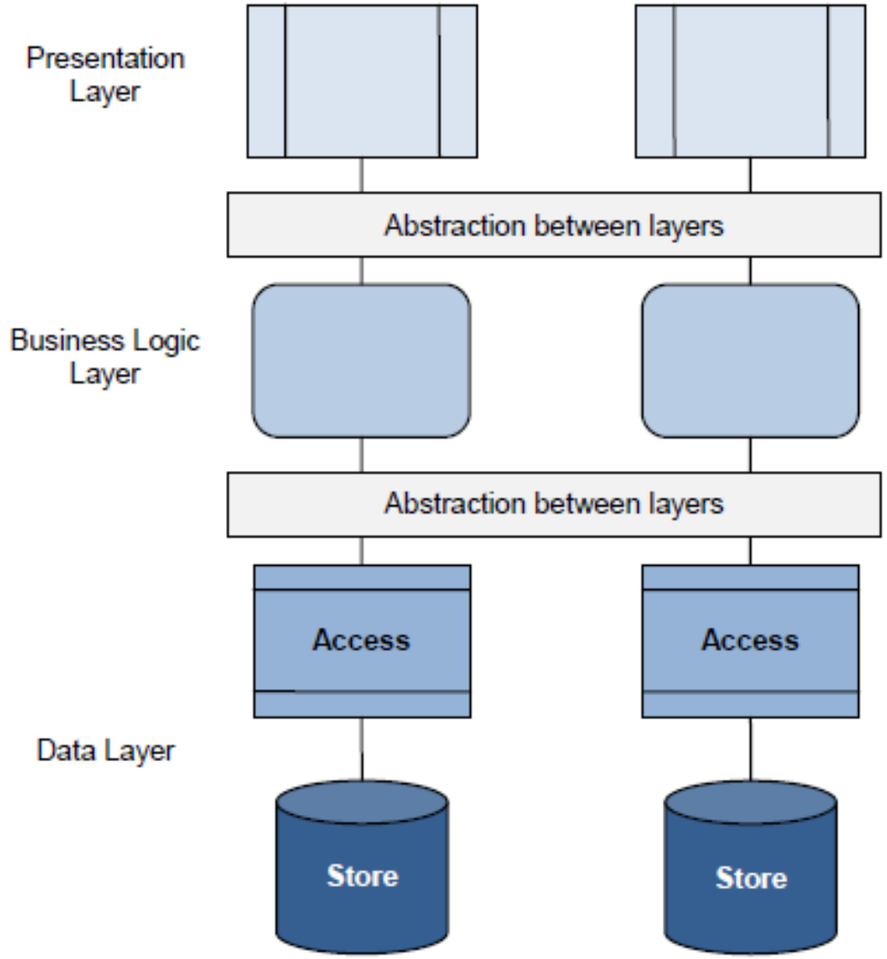
Applications Class A0/A1

BICSI 002-2014 C.2.2



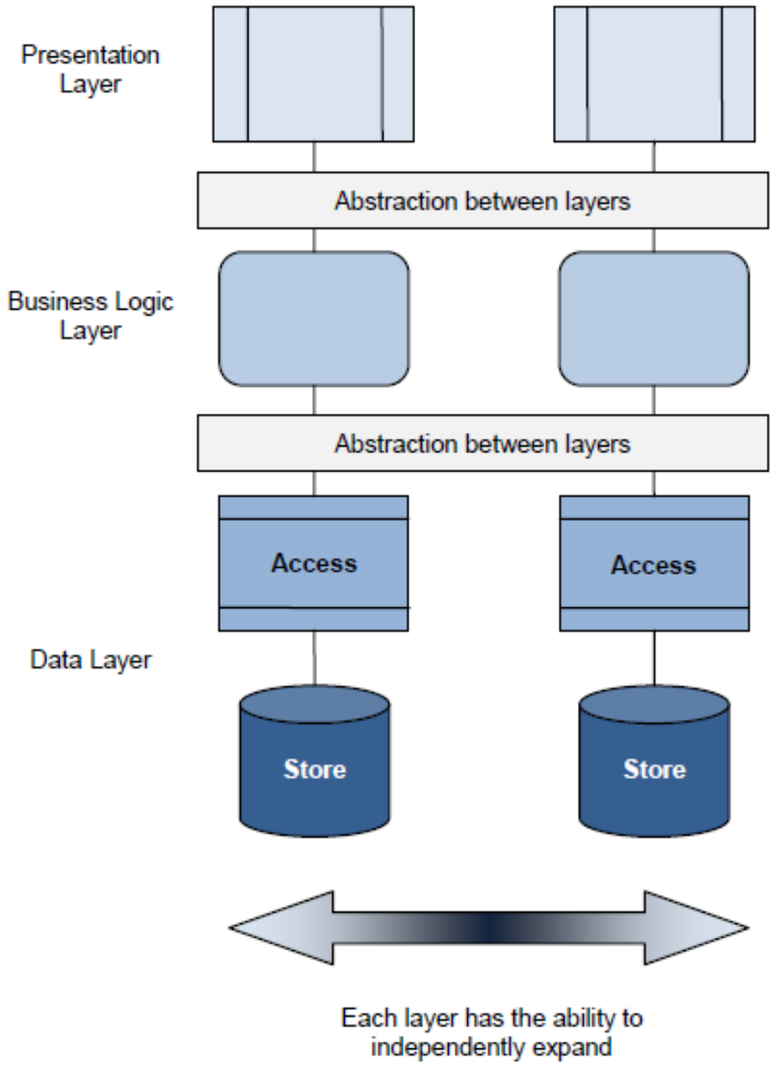
Applications Class A2

BICSI 002-2014 C.2.3



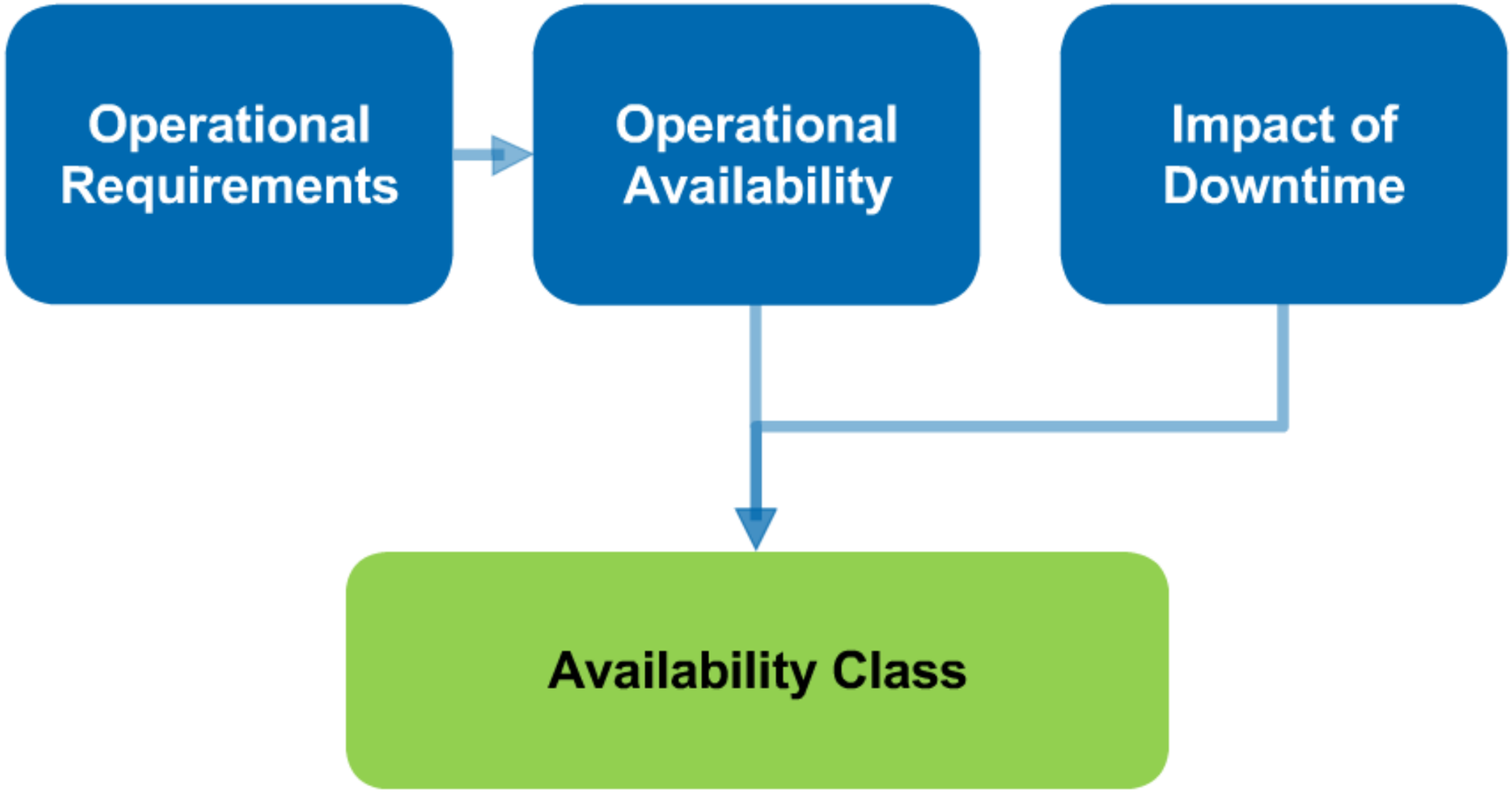
Applications Class A3/A4

BICSI 002-2014 C.2.4



Determining Availability Class

Handout: Page 6



Operational Requirements

Handout: Page 7

- Primary factor is **planned downtime** for planned testing and maintenance activities that disrupt normal operations

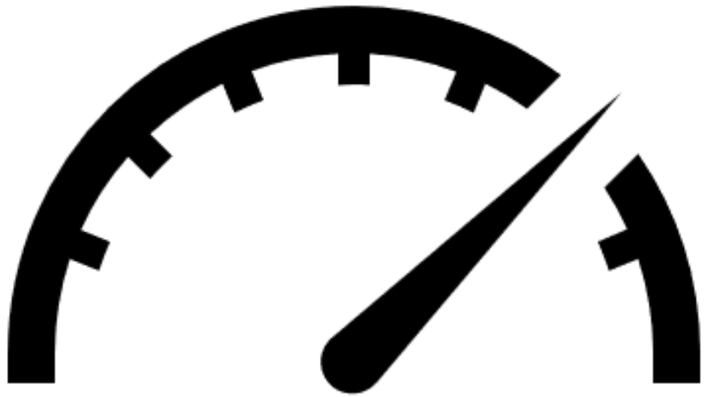
Operational Requirements Table 3

Handout: Page 7

Operational Level	*Annual Hours Available for Planned Maintenance Shutdown*	*Description*
0	> 400	Functions are operational less than 24 hours a day and less than 7 days a week. Scheduled maintenance down time is available during working hours and off-hours.
1	100-400	Functions are operational less than 24 hours a day and less than 7 days a week. Scheduled maintenance down time is available during working hours and off-hours.
2	50-99	Functions are operational up to 24 hours a day, up to 7 days a week, and up to 50 weeks per year; scheduled maintenance down time is available during working hours and off hours.
3	0-49	Functions are operational 24 hours a day, 7 days a week for 50 weeks or more. No scheduled maintenance down time is available during working hours.
4	0	Functions are operational 24 hours a day, 7 days a week for 52 weeks each year. No scheduled maintenance down time is available.

Operational Availability

Handout: Page 7



Operational availability refers only to **scheduled uptime**—that is, the time during which the IT functions are actually expected to run.

OR

Unplanned downtime allowed

Operational Availability Table

Handout: Page 8

Operational Level (from Table 3)	*Allowable Maximum Annual Downtime (minutes) (Availability as %)*				
	>5000 (> 99%)	*500 – 5000 (99% > 99.9%)*	*50 – 500 (99.9% > 99.99%)*	*5 – 50 (99.99% > 99.999%)*	*0.5 – 5.0 (99.999% > 99.9999%)*
Level 0	0	0	1	2	2
Level 1	0	1	2	2	2
Level 2	1	2	2	2	3
Level 3	2	2	2	3	4
Level 4	3	3	3	4	4

Impact of Downtime

Handout: Page 8

- Identifying the impact of downtime on mission-critical functions helps determine the tactics that will be deployed to mitigate downtime risk.

SYSTEM FAILURE

Impact of Downtime Table

Handout: Page 8

Classification	*Description – Impact of Downtime*
Isolated	Local in scope, affecting only a single function or operation, resulting in a minor disruption or delay in achieving non-critical organizational objectives.
Minor	Local in scope, affecting only a single site, or resulting in a minor disruption or delay in achieving key organizational objectives.
Major	Regional in scope, affecting a portion of the enterprise (although not in its entirety) or resulting in a moderate disruption or delay in achieving key organizational objectives.
Severe	Multiregional in scope, affecting a major portion of the enterprise (although not in its entirety) or resulting in a major disruption or delay in achieving key organizational objectives.
Catastrophic	Affecting the quality of service delivery across the entire enterprise or resulting in a significant disruption or delay in achieving key organizational objectives.

Identify the Data Center Class

Handout: Page 8

- Combine the previously identified factors to arrive at a usable expression of availability.

Identify the Data Center Class Table

Handout: Page 9

Impact of Downtime (from Table 5)	*Operational Availability Rating (from Table 4)*				
	0	*1*	*2*	*3*	*4*
Isolated	**Class 0**	**Class 0**	**Class 1**	**Class 3**	**Class 3**
Minor	**Class 0**	**Class 1**	**Class 2**	**Class 3**	**Class 3**
Major	**Class 1**	**Class 2**	**Class 2**	**Class 3**	**Class 3**
Severe	**Class 1**	**Class 2**	**Class 3**	**Class 3**	**Class 4**
Catastrophic	**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 4**

Example

Description	Value
Planned Downtime	60 Hours
Unplanned Downtime	30 Minutes
Impact of Downtime	Regional Data Center only supporting one application

Step 1: Identify Operation Requirements

Handout: Page 7

Operational Level	*Annual Hours Available for Planned Maintenance Shutdown*	*Description*
0	> 400	Functions are operational less than 24 hours a day and less than 7 days a week. Scheduled maintenance down time is available during working hours and off-hours.
1	100-400	Functions are operational less than 24 hours a day and less than 7 days a week. Scheduled maintenance down time is available during working hours and off-hours.
2	50-99	Functions are operational up to 24 hours a day, up to 7 days a week, and up to 50 weeks per year; scheduled maintenance down time is available during working hours and off hours.
3	0-49	Functions are operational 24 hours a day, 7 days a week for 50 weeks or more. No scheduled maintenance down time is available during working hours.
4	0	Functions are operational 24 hours a day, 7 days a week for 52 weeks each year. No scheduled maintenance down time is available.

Step 2: Operational Availability Requirements

Handout: Page 7

Operational Level (from Table 3)	*Allowable Maximum Annual Downtime (minutes) (Availability as %)*				
	>5000 (> 99%)	*500 – 5000 (99% > 99.9%)*	*50 – 500 (99.9% > 99.99%)*	*5 – 50 (99.99% > 99.999%)*	*0.5 – 5.0 (99.999% > 99.9999%)*
Level 0	0	0	1		2
Level 1	0	1	2		2
Level 2				2	3
Level 3	2	2	2	3	4
Level 4	3	3	3	4	4

Step 3: Determine the Impact of Downtime

Handout: Page 7

Classification	*Description – Impact of Downtime*
Isolated	Local in scope, affecting only a single function or operation, resulting in a minor disruption or delay in achieving non-critical organizational objectives.
Minor	Local in scope, affecting only a single site, or resulting in a minor disruption or delay in achieving key organizational objectives.
Major	Regional in scope, affecting a portion of the enterprise (although not in its entirety) or resulting in a moderate disruption or delay in achieving key organizational objectives.
Severe	Multiregional in scope, affecting a major portion of the enterprise (although not in its entirety) or resulting in a major disruption or delay in achieving key organizational objectives.
Catastrophic	Affecting the quality of service delivery across the entire enterprise or resulting in a significant disruption or delay in achieving key organizational objectives.

Step 4: Identify the Data Center Availability Class

Handout: Page 7

Impact of Downtime (from Table 5)	*Operational Availability Rating (from Table 4)*				
	0	*1*	*2*	*3*	*4*
Isolated	Class 0	Class 0	Class 1	Class 3	Class 3
Minor	Class 0	Class 1	Class 2	Class 3	Class 3
Major			Class 2	Class 3	Class 3
Severe	Class 1	Class 2	Class 3	Class 3	Class 4
Catastrophic	Class 1	Class 2	Class 3	Class 4	Class 4

Hands-on Activity

Case Study One

Example

Description	Value
Planned Downtime	150 Hours
Unplanned Downtime	10 Minutes
Impact of Downtime	Major disruption in key organizational objectives

Hands-on Activity Solution

Step 1: Identify Operation Requirements

Handout: Page 7

Operational Level	*Annual Hours Available for Planned Maintenance Shutdown*	*Description*
0	> 400	Functions are operational less than 24 hours a day and less than 7 days a week. Scheduled maintenance down time is available during working hours and off-hours.
1	100-400	Functions are operational less than 24 hours a day and less than 7 days a week. Scheduled maintenance down time is available during working hours and off-hours.
2	50-99	Functions are operational up to 24 hours a day, up to 7 days a week, and up to 50 weeks per year; scheduled maintenance down time is available during working hours and off hours.
3	0-49	Functions are operational 24 hours a day, 7 days a week for 50 weeks or more. No scheduled maintenance down time is available during working hours.
4	0	Functions are operational 24 hours a day, 7 days a week for 52 weeks each year. No scheduled maintenance down time is available.

Step 2: Operational Availability Requirements

Handout: Page 7

Operational Level (from Table 3)	*Allowable Maximum Annual Downtime (minutes) (Availability as %)*				
	>5000 (> 99%)	*500 – 5000 (99% > 99.9%)*	*50 – 500 (99.9% > 99.99%)*	*5 – 50 (99.99% > 99.999%)*	*0.5 – 5.0 (99.999% > 99.9999%)*
Level 0	0	0	1		2
Level 1				2	2
Level 2	1	2	2	2	3
Level 3	2	2	2	3	4
Level 4	3	3	3	4	4

Step 3: Determine the Impact of Downtime

Handout: Page 7

Classification	*Description – Impact of Downtime*
Isolated	Local in scope, affecting only a single function or operation, resulting in a minor disruption or delay in achieving non-critical organizational objectives.
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Catastrophic	Affecting the quality of service delivery across the entire enterprise or resulting in a significant disruption or delay in achieving key organizational objectives.

Step 4: Identify the Data Center Availability Class

Handout: Page 7

Impact of Downtime (from Table 5)	*Operational Availability Rating (from Table 4)*				
	0	*1*	*2*	*3*	*4*
Isolated	Class 0	Class 0	Class 1	Class 3	Class 3
Minor	Class 0	Class 1	Class 2	Class 3	Class 3
Major	Class 1	Class 2	Class 2	Class 3	Class 3
Severe			Class 3	Class 3	Class 4
Catastrophic	Class 1	Class 2	Class 3	Class 4	Class 4

Hands-on Activity

Case Study Two

Example

Description	Value
Planned Downtime	20 Hours
Unplanned Downtime	10 Minutes
Impact of Downtime	Significant disruption in key organizational objectives

Hands-on Activity Solution

Step 1: Identify Operation Requirements

Handout: Page 7

Operational Level	*Annual Hours Available for Planned Maintenance Shutdown*	*Description*
0	> 400	Functions are operational less than 24 hours a day and less than 7 days a week. Scheduled maintenance down time is available during working hours and off-hours.
1	100-400	Functions are operational less than 24 hours a day and less than 7 days a week. Scheduled maintenance down time is available during working hours and off-hours.
2	50-99	Functions are operational up to 24 hours a day, up to 7 days a week, and up to 50 weeks per year; scheduled maintenance down time is available during working hours and off hours.
3	0-49	Functions are operational 24 hours a day, 7 days a week for 50 weeks or more. No scheduled maintenance down time is available during working hours.
4	0	Functions are operational 24 hours a day, 7 days a week for 52 weeks each year. No scheduled maintenance down time is available.

Step 2: Operational Availability Requirements

Handout: Page 7

Operational Level (from Table 3)	*Allowable Maximum Annual Downtime (minutes) (Availability as %)*				
	>5000 (> 99%)	*500 – 5000 (99% > 99.9%)*	*50 – 500 (99.9% > 99.99%)*	*5 – 50 (99.99% > 99.999%)*	*0.5 – 5.0 (99.999% > 99.9999%)*
Level 0	0	0		2	2
Level 1	0	1		2	2
Level 2	1	2		2	3
Level 3			2	3	4
Level 4	3	3	3	4	4

Step 3: Determine the Impact of Downtime

Handout: Page 7

Classification	*Description – Impact of Downtime*
Isolated	Local in scope, affecting only a single function or operation, resulting in a minor disruption or delay in achieving non-critical organizational objectives.
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Step 4: Identify the Data Center Availability Class

Handout: Page 7

Impact of Downtime (from Table 5)	*Operational Availability Rating (from Table 4)*				
	0	*1*	*2*	*3*	*4*
Isolated	Class 0	Class 0	Class 1	Class 3	Class 3
Minor	Class 0	Class 1	Class 2	Class 3	Class 3
Major	Class 1	Class 2	Class 2	Class 3	Class 3
Severe	Class 1	Class 2	Class 3	Class 3	Class 4
Catastrophic			Class 3	Class 4	Class 4

Higher Availability with Lower Classes

Handout: Page 9

- “It is unlikely that a single data center would have all the applications, data processing, and storage platform systems aligned within a single reliability classification no matter what the targeted base data center reliability classification is.”

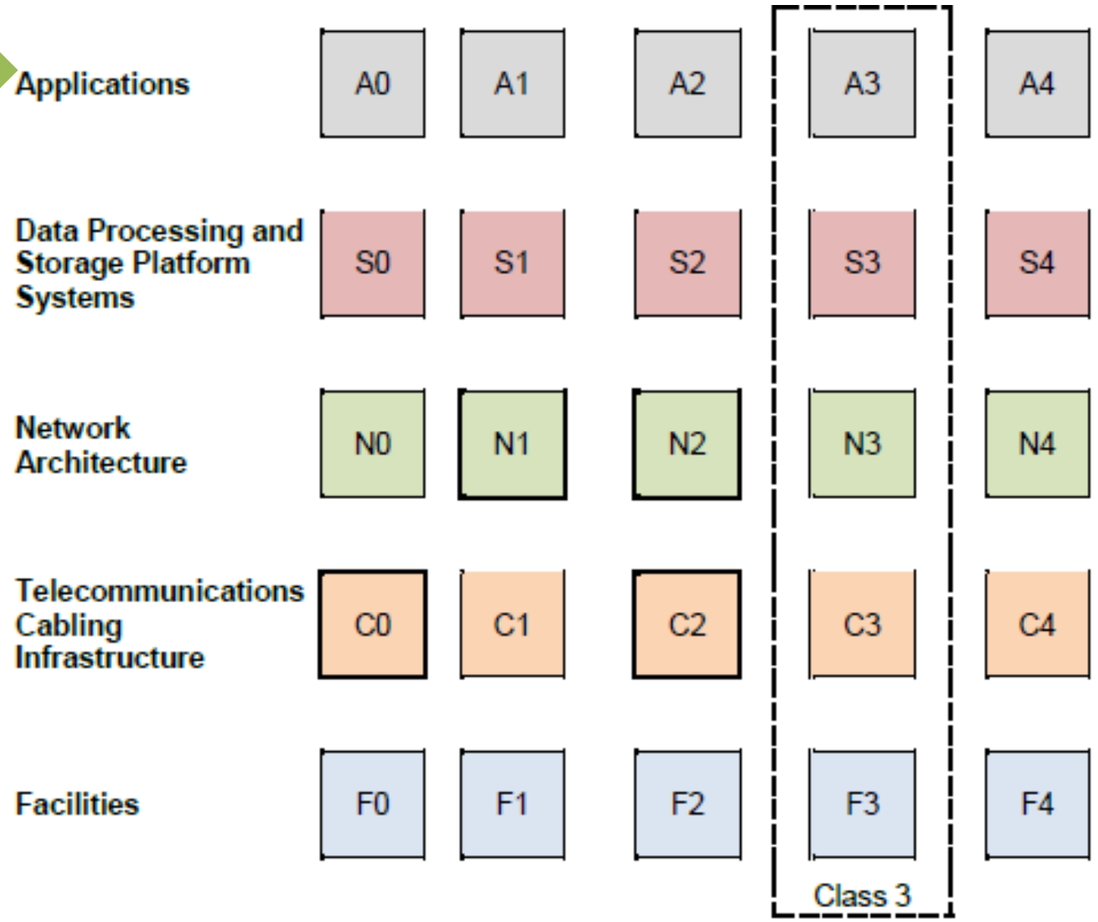
Why the ANSI/BICSI 002 Availability Framework?

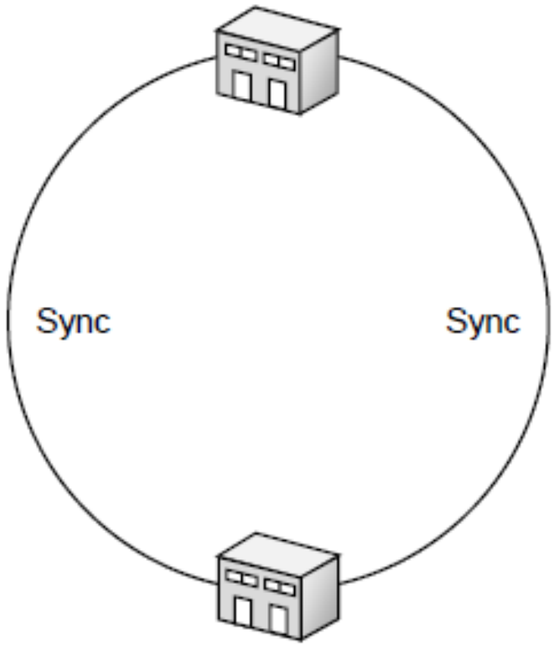
Reference

- Identify the minimum reliability targets.
- Provide a structured methodical approach to guide decisions on how to adjust lower layer services to compensate for higher layer services reliability inadequacies.
- Guide discussions regarding the possible technical and cost benefits of increasing the reliability of the network architecture and higher layers above the targeted reliability class across multiple data centers so that cost savings can be realized by building each of the data centers facilities to a lower Class than the targeted reliability classification

Multi-Data Center Class 3 Example

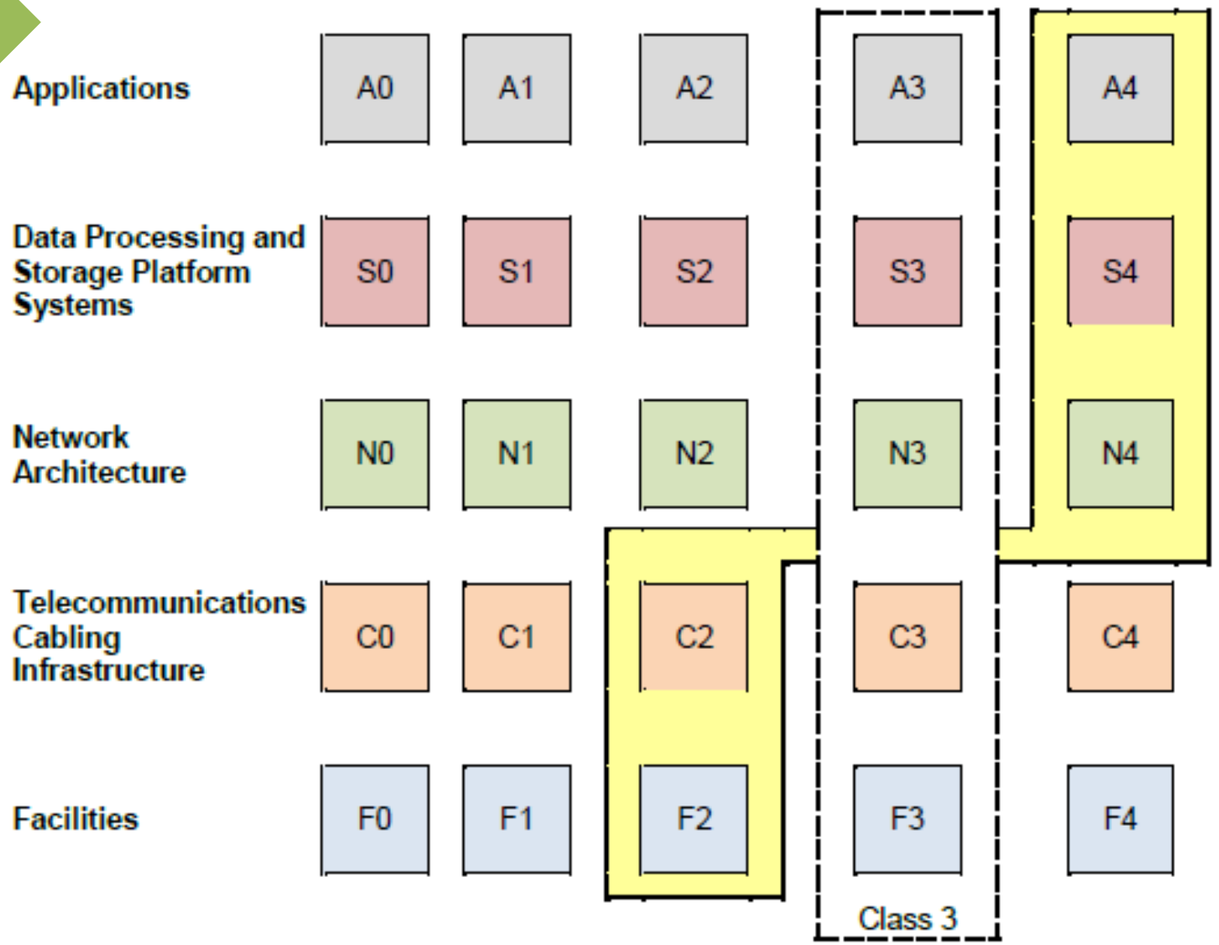
Handout: Page 10

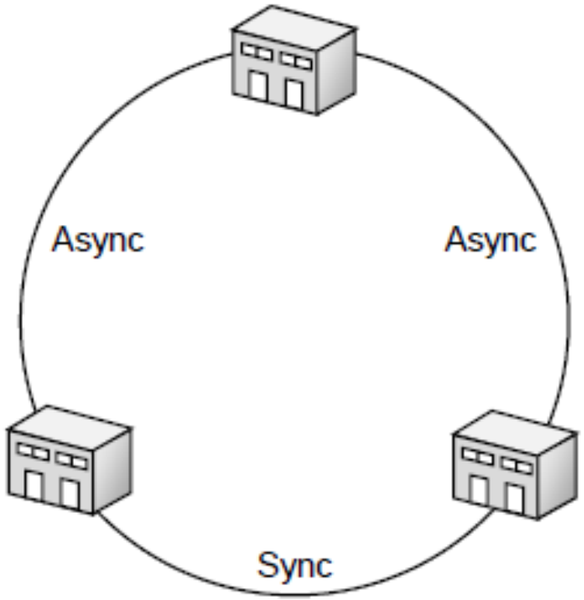




Class 3 Solution/Three Class 2 Facilities

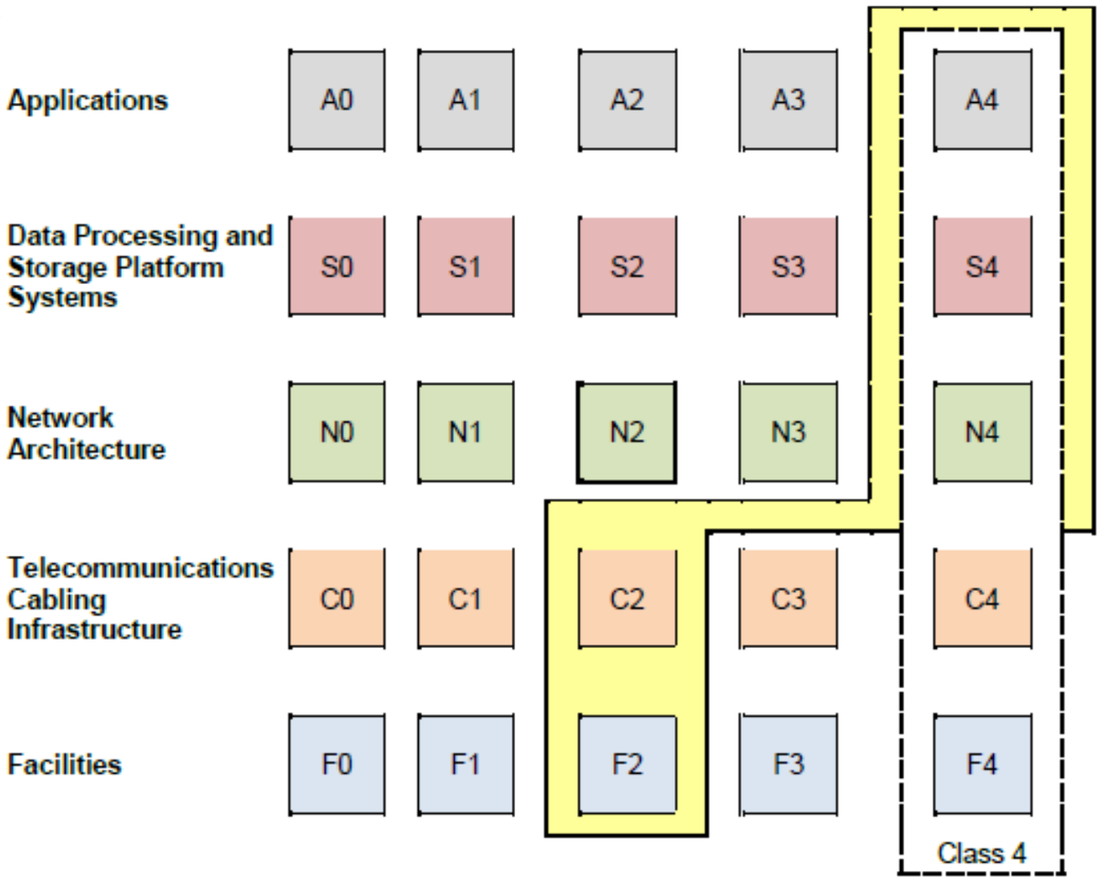
Handout: Page 11

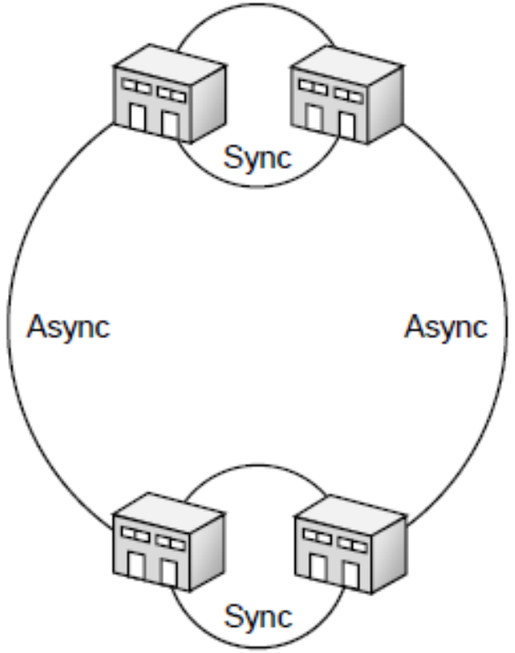




Class 4 Solution/Four Class 2 Facilities

Handout: Page 12





Summary

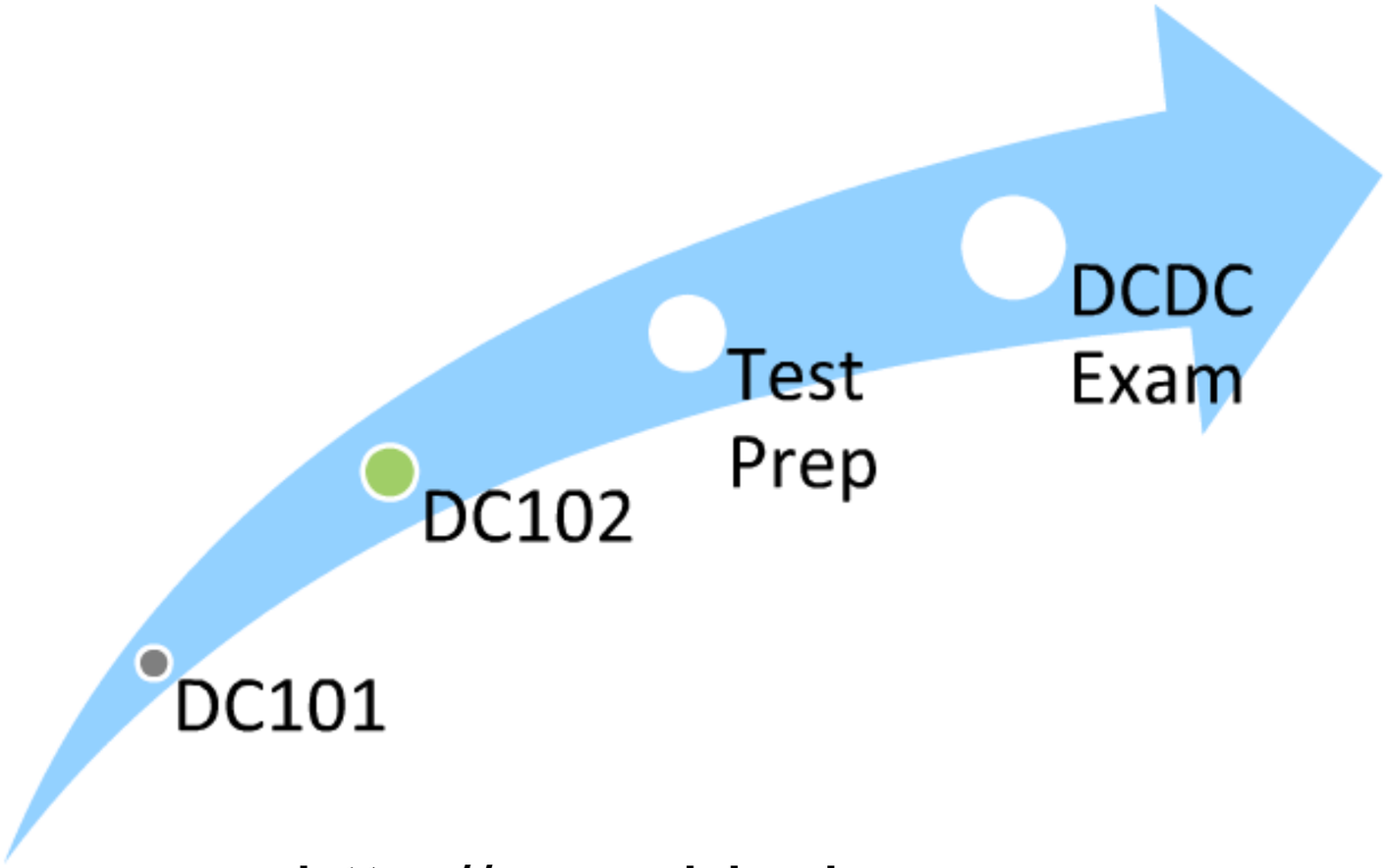
- Understand how the ANSI/BICSI-002-2104 can be used to design redundant data centers
- Understand the ANSI/BICSI-002-2104 Classification of data centers
- Conduct an assessment using the ANSI/BICSI-002-2104 method of Class Determination

Data Center Design Consultant

Handout: Page 15

Data Center Education

Handout: Page 15



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Questions

Thank you!