D8021 STRUCTURED CABLING SYSTEMS

1.1 Goals and Objectives

A. The Structured Cabling System shall provide standardized network availability to all school locations utilizing TIA/EIA accepted standards for fiber-optic backbone cabling and copper horizontal cabling. This guide is an outline for new construction and modernization projects.

B. The following guidelines are not intended to be universally applied, "as-is" to all projects. It remains the responsibility of the architect to use professional judgment to develop appropriate contract documents for the execution of the project specific work.

C. The Structured Cabling System is based on the design assumption that school and administrative buildings upon completion of Technology upgrade shall contain structured cabling plants, local-area-network (LAN) equipment, wide-area-network (WAN) equipment, wireless networking equipment (WIFI), voice-over internet-protocol (VoIP) equipment, and energy management systems.

D. The i21 Classroom initiative calls for new technology systems and significant increases in the number of mobile devices that shall require the highest possible performance and provision for growth in all school communications systems.

E. Network drops for classrooms shall be identified by locations relative to the "front" of the classroom. The front of the classroom (FOC) will be determined by the architect through interviews and site surveys with site staff.

1.2 Related Specifications and Design Guides

NOTE: Specifications highlighted in YELLOW in this document need to be updated by the architect, design team or consultant.

A. 260519 Low-Voltage Electrical Power Conductors and Cables Rev. 8.1.11

B. 262416 Panel Boards Rev. 8.1.11

C. 271116 Communications Cabling, Racks, Frames and Enclosures Rev. 8.1.11

D. 271300 Communications Optical Fiber Backbone Cabling Rev. 8.1.11

E. 271523 Communications Copper Horizontal Cabling - Interior Rev. 8.1.11

F. D8022 Main Distribution Frame Systems

G. D8023 Wireless Local Area Network (WIFI) Design Guide.

1.3 Summary

A. The following guidelines are not intended to be universally applied "as-is" to all projects. It remains the responsibility of the Architect to use professional judgment to develop appropriate design and contract documents for the execution of the project specific work.

B. The i21 Classroom initiative calls for new technology systems and significant increases in the number of mobile devices that will require the highest possible performance standards and provision for growth in all school communications systems.

C. Structured Cabling Systems consist of the fiber optic backbone and copper horizontal cabling connecting networking equipment from MDF to BDF and CDF/IDF closets. District standards for structured cabling are described herein.

1.4 Codes and Regulations

A. TIA/EIA-568-B Copper Horizontal Cabling Wiring Standard

B. TIA/EIA-568-C Requirements for Balanced Twisted Pair, Optical Fiber & Coaxial Cabling

C. TIA/EIA-569-C (includes A and B) Communications Pathways & Spaces

D. TIA/EIA-607-B September 2011 – Telecommunications Grounding and Bonding

E. ANSI/NFPA 70: National Electrical Code (NEC), with 2014 California Amendments (CEC)

F. ITU G-652 Characteristics of Single-Mode fiber-optic cable

G. ITU G-651.1 Characteristics of a 50/125µm Multimode fiber-optic cable

H. ISO/IEC 11801 2.0A2 OM4 Generic Cabling for Customer Premises: Office

I. NEMA WC66/ICEA S-116-732-2013 Standard for Category 6 and 6A.

1.5 Definitions

A. LAN – Local Area Network – Each site shall have a 10Gbps LAN.

B. WIFI – Wireless Fidelity –Each site shall have WIFI saturation.

C. VoIP – Voice-over Internet Protocol – Each site shall have an IP Telephony system.

D. MDF - Main Distribution Frame – Central dedicated facility for communications and other low-voltage distribution systems. Hosting facility for fiber-optic backbone panels, copper-horizontal cable panels, core switches, edge switches and UPS systems.

E. IDF - Intermediate Distribution Frame – Distribution facility for communications and other low-voltage systems downstream from the MDF. Hosting facility for fiber-optic backbone panels, copper-horizontal cable panels and edges switches.

F. CDF – Classroom Distribution Frame – Typically a 2'x2'x2' wall-mounted steel enclosure housing classroom fiber and copper terminations, edge switch and UPS.

G. CDF2 – Classroom Distribution Frame Type 2 – CDF shared between two adjacent classrooms.

H. BDF – Building Distribution Frame – Typically a 2'x3'x7' steel enclosure housing fiber-optic backbone passive interconnection points between the MDF and CDFs.

I. Prop O-type – Legacy MDF/IDF topology installation-type from Proposition O. These installations shall be modernized.

J. OSP – Outside Plant – Communications cabling rated for underground, direct burial, aerial or submarine installations.

K. WAP – Wireless Access Point – Antennae for WIFI.

L. LIU – Light Interface Unit – Termination panel for fiber-optic cable

M. UPS – Uninterruptible Power Supply – MDF and Administration areas only.

1.6 System Description

The structured cabling system shall be designed in a hub-and-spoke topology utilizing a main distribution frame (MDF) facility, and downstream intermediate distribution frames (IDF), communications facilities within each floor of each building within a campus.

A. Main Distribution Frames (MDF)

1. The MDF is a dedicated, secured and environmentally controlled location designed for low-voltage electronic systems. The MDFs shall provide four-post, open-frame, telecommunications racks and enclosures commensurate with the low voltage equipment requirements.

2. Fiber-optic backbone cable shall be terminated in LIUs in main

distribution rack.

3. Copper horizontal cable shall be terminated in Category 6 copper patch panels on distribution rack.
4. Core switches shall be permanently mounted in MDF racks.
5. UPS shall be permanently mounted in close proximity to the core switch.

B. Intermediate Distribution Frames

1. In each outlying building, an intermediate distribution frame (IDF) shall house the termination of the fiber-optic backbone and provide the distribution point for the copper horizontal cabling.
2. Fiber-optic backbone cable shall be terminated in LIUs in main distribution rack.
3. Copper horizontal cable shall be terminated in Category 6 copper patch panels for distribution to wall-plates or ceiling-mounted termination points.
4. Edge switches shall be permanently mounted in IDF racks.

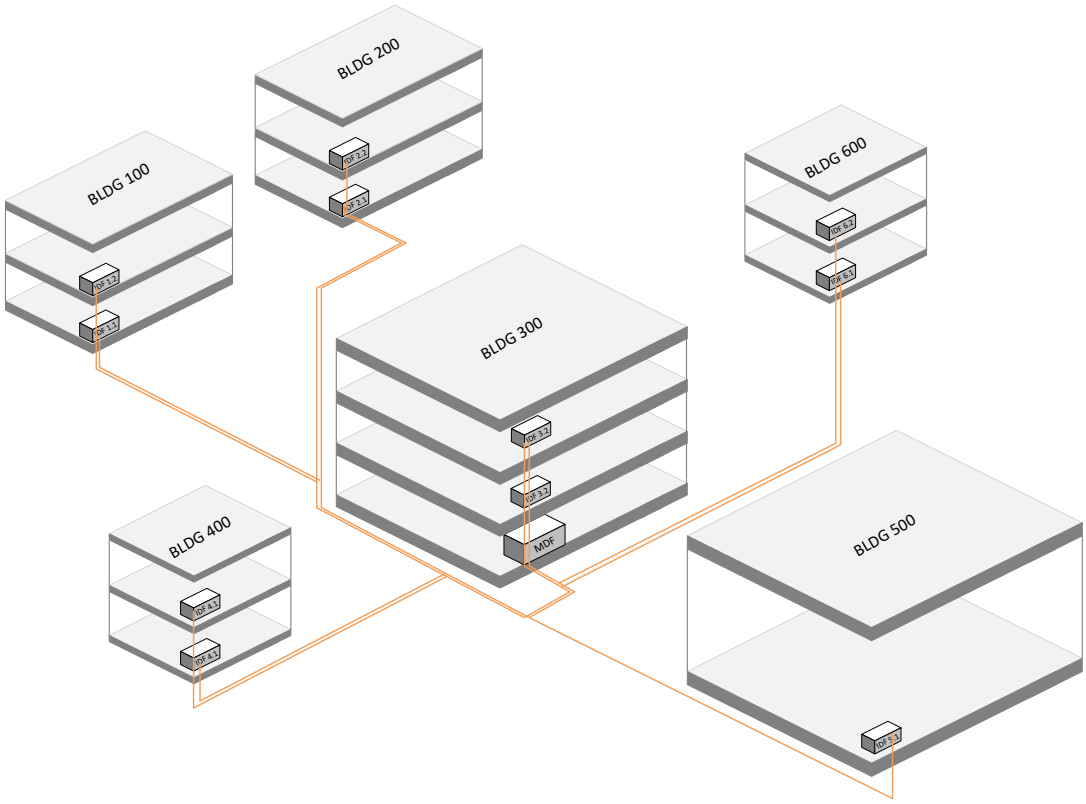
C. Pathways and Spaces

- Refer to specification section 271300 Communications Optical Fiber Backbone Cabling Rev. 8.1.11 for the following specifications related to Pathways and Spaces, including:
- Cable Protection
- Duct Utilization
- Building and Fire Codes
- Optical Fiber Termination Spaces

D. Fiber-Optic Backbone

1. All fiber-optic cabling shall comply with the following industry standards:
   - TIA/EIA-568-C Requirements for Balanced Twisted Pair, Optical Fiber & Coaxial Cabling
   - ITU G-652 Characteristics of Single-Mode fiber-optic cable
   - ITU G-651.1 Characteristics of a 50/125µm Multimode fiber-optic cable
   - ISO/IEC 11801 2.0A2 OM4.

2. Fiber-optic cable shall be used for the backbone of the structured cabling system. Design characteristics of fiber-optic backbones shall support applications of at least 10Gbps @ 850nm.



3. The architect shall determine the fiber-optic cabling type based on specific applications.
   - For backbone distances up to 400 meters, use multimode OM4 fiber-optic cable.
   - For backbone distances in excess of 400 meters, use single-mode OS1 fiber-optic cable.
   - OSP Cable shall be used for all inter-building structured cabling connections.
4. Architect shall determine the number of fiber-optic cables to be installed between the MDF and each IDF based on the number of edge switches required in each IDF.
   - Each classroom shall receive eight (8) new drops.
   - Each edge switch shall support twenty-four (24) LAN

connections, supporting three (3) classrooms.

- Each non-instructional area shall include two (2) drops per workstation location and two (2) ceiling-mounted drops per each 3,000 square feet.
- Install two pairs (4 strands) of fiber- optic cable per edge device – one for immediate use, and one for spare, with a minimum of six-pairs (12 strands).
- Add additional capacity in groups of three- or six-pairs (6 or 12 strands).

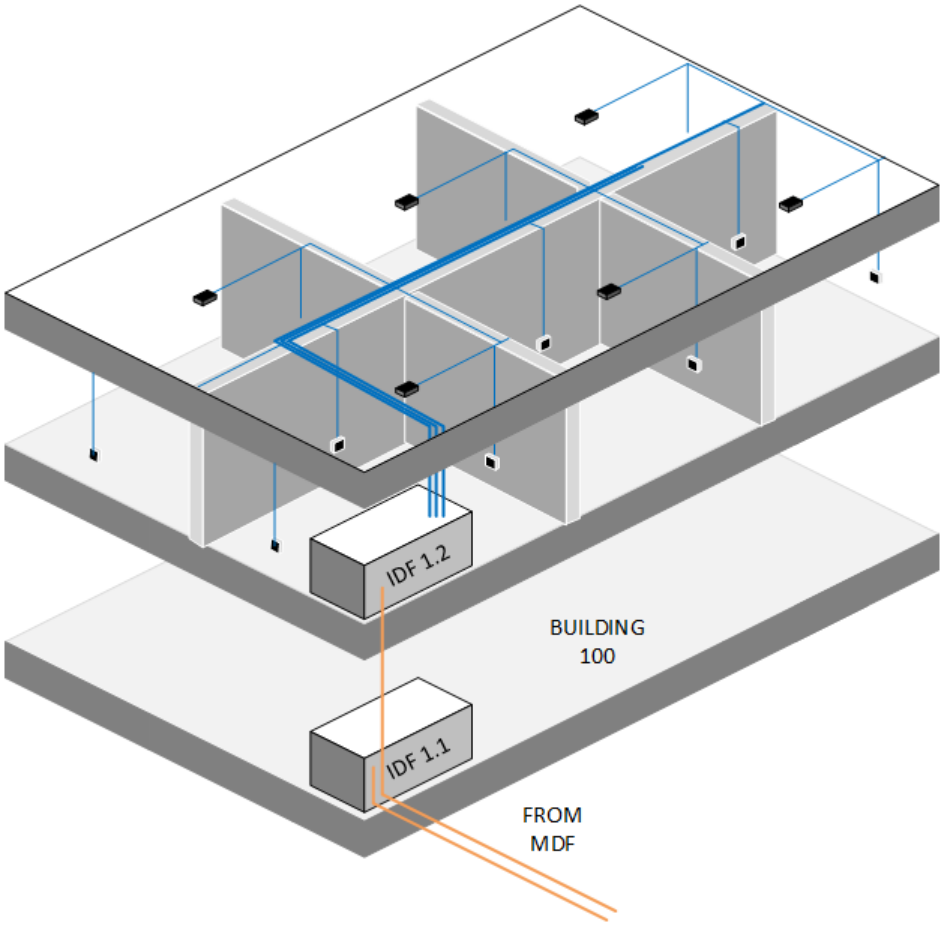
5. Fiber-optic backbone cabling may include a maximum of one (1) passive interconnection point between the MDF and the IDF. This type of interconnect may be used to support multi-floor buildings where fiber-optic cables are used as risers to a main distribution IDF in the building.
   - Fiber-optic backbone links with passive interconnections must pass the same level of 10Gbps validation testing as defined in 271300 Communications Optical Fiber Backbone Cabling Rev 8.1.11.
   - The fiber-optic backbone cabling with passive interconnections between the MDF and the distribution IDF must support the maximum number of fiber strands interconnecting back to the MDF to each downstream IDF. For example, if a four-story building requires each IDF to support six pairs (12 strands), then the cable between the MDF and the distribution IDF must support twenty-four pairs (48 strands).
6. All exposed fiber-optic cabling shall be installed within inner-duct except for the last section of cable to include service loops, dressing and termination.
7. All fiber-optic cable termination locations shall include a service loop with a minimum of four (4) meters of additional cable (slack).
8. Minimum Bend Radius
   - The minimum bend radius shall not exceed ten (10) times the outside diameter of the cable jacket when under no-load conditions
   - The minimum bend radius shall not exceed fifteen (15) times the outside diameter of the cable jacket under loaded

conditions.

9. Maximum Tensile Load Rating
    - The maximum tensile load for Long Term loads shall not exceed 800 Newtons.
    - The maximum tensile load for Short Term loads shall not exceed 2,700 Newtons.

E. Copper Horizontal Cabling

1. Copper horizontal cabling shall comply with the following Category 6 industry standards:
    - ANSI/TIA/EIA 568-B & C
    - NEMA WC66/ICEA S-116-732-2013
    - ISO 11801.
2. Category 6 copper horizontal cabling shall be used for the channel connection between the device end-point, to the Category 6 termination panel in the IDF, or in the MDF if the device endpoint is in the copper horizontal service area of the MDF.
3. Category 6 copper horizontal cabling shall have no splices, terminations or passive interconnections between the channel endpoints (home run).
4. Link connection: End of patch cord to end of patch cord shall not exceed 100 meters in total length.
5. Channel Connection: Distribution patch panel to wall or ceiling faceplate shall not exceed 90 meters.
6. For new buildings, Category 6 copper horizontal cabling shall be used for two (2) ceiling drops and six (6) walls drops.
7. Category 6 patch cords shall be used in the IDF for connection to LAN equipment in increments of one (1) meter, and two (2) meters to provide nominal additional length to the link connection.
8. Category 6 patch cables for device connectivity (VoIP Phones, Computers or WAPs) shall not exceed five (5) meters.



1.7 Design Assumptions

For modernization, the architect may encounter the following types of existing installations:

A. CDF/BDF/MDF-type

The CDF/BDF/MDF-type is a "fiber to the classroom" topology that delivers a fiber-optic connection in each classroom directly to the MDF for connection to the core switch. Category 5e copper horizontal cabling is used within the classroom to provide Ethernet connectivity.

The CDF/BDF/MDF-type installation represents a majority of the Proposition MM schools.

1. CDF – Classroom Distribution Frame – wall-mounted enclosure and networking equipment with a classroom
2. CDF2 – The CDF2 is a design modification to the CDF that shares the wall-mounted enclosure and networking equipment between two (2) adjacent classrooms.

3. CDF/BDF/MDF-type installations can be identified via the following traits:

   - Wall-mounted 2'x2'x2' CDF Communications cabinet within a classroom
   - Twelve (12) Category 5e network drops run from the CDF enclosure to three (3) wall-plate locations with four (4) drops each
   - A twenty-four (24) port LAN edge switch.
   - Two (2) additional Category 5e drops may be found in some locations as spare capacity.

4. The CDF2 includes twelve (12) fiber strands from a Building Distribution Frame (BDF) terminated within a 2'x2'x2' (minimum) wall mounted enclosure.

   - Twelve (12) Category 5e network drops terminate in the classroom, and twelve (12) Category 5e network drops extend and terminate in the adjacent classroom via interior wall penetration.
   - The network drops are typically distributed within the classroom to three (3) wall-plate locations with four (4) drops each.
   - The CDF2 contains a twenty-four (24) port LAN edge switch.
   - Sites with CDF2 configurations shall also have CDF configurations.

B. Prop O-type Installation. When designing modernizations to a building that currently utilizes an IDF installation from Prop O, refer to Design Guide D8022 Main Distribution Frames for the current district standard of MDF/IDF architecture.

1. The Prop O-type architecture can be identified via the following traits:

   - Prop O-type installations have a designated building IDF, signal or communications closet or cabinet. From this IDF Category 5e – and in some cases Category 5 – network drops extend and terminate in the classroom.
   - The Prop O-type installation may have from eight (8) to twelve (12) wall-mounted, network drops per classroom.
   - Prop MM installations have eleven network drops. Nine (9)

drops distributed to three wall-plates with three (3) network drops each, and two network drops terminated above the drop ceiling designated for wireless networking.

C. For administration buildings, cafeterias, multi-purpose rooms and other non-instructional areas the architect may encounter the following existing cabling instances:

1. Individual Category 5 or 5e network drops at each administrative or other non-instructional work area.
2. No ceiling-mounted network drops designated for WAPs.
3. Individually installed ceiling- or wall-mounted network drops for WAPs.

1.8 IDF Conversion Requirements

A. When designing modernizations to a building that currently utilizes a CDF/BDF/MDF-type installation it is necessary to change the LAN topology to the MDF/IDF architecture.

B. Category 6 copper horizontal cabling shall be installed from a newly designated IDF directly to the workstation wall-plate(s) with no splices or interconnections (home run).

C. The newly designated IDF may be a BDF enclosure.

1.9 Minimum Classroom Facilities for Structured Cabling

A. The architect shall survey each site to determine if each classroom supports the minimum facilities for structured cabling.

B. Existing cable installations shall be replaced or upgraded in a “like for like” manner where applicable. Such instances may include computer lab situations in which a classroom has many network drops installed to support hardwired workstations. These cases should be reviewed with the District and handled accordingly.

C. The architect shall conduct interviews and site surveys with site staff to define Front of Classroom (FOC) in order to determine network drop locations within classrooms for the front, rear and adjacent wall. Adjacent wall may be defined as an interior wall where appropriate. Determination of FOC is subject to approval by District staff.

D. The minimum classroom facilities for structured cabling in modernization schools are:

1. Six (6) wall-mounted Category 6 network drops to support computers, IP telephones, printers or other network devices. These

shall generally be distributed as: one (1) wall-plate with three (3) live ports at the Front of Classroom, one (1) wall-plate with two (2) live ports at the rear of the classroom and one (1) wall-plate with one (1) live port at the adjacent wall of the classroom. The architect will determine feasibility of drop layouts and make final determinations for drop locations such as when adjacent wall location is not available.

2. Two (2) ceiling-mounted Category 6 network drops to support Wireless Access Points (WAPs).

1.10 Administration Offices and Other Non-Instructional Areas

A. For each Administration and non-instructional building, the architect shall perform an RF saturation "heat map" simulation.

1. For areas with no designated drops for WAPs, install two (2) ceiling-mounted network drops for every 3,000 sq. Ft. of interior space.

2. For areas with ceilings higher than 20 feet, network drops for WAPs may be wall-mounted between 8'-12' AFF.

3. Areas with workstations shall have two (2) wall drops per workstation allocated near power sources.

4. Network drops shall be allocated in a "like for like" manner such as multi workstation configurations, computer labs, printing stations or VoIP phone banks.

B. Exterior Building Cabling and Outlying Exterior Locations

1. Subject to the wireless site survey, two (2) Category 6 cables shall be installed to support WAPs for coverage of exterior building locations. These additional cabling installations shall comply with all industry and design standards. See also D8023 WIFI Design Guide.

1.11 Commissioning

1. The architect is responsible for providing a standard for operational testing for each cabling sub-system and operation of the system as a whole. The verification testing and documentation deliverables shall be utilized to acknowledge system and sub-system operational for handoffs between architects and the District.

2. Whereas architects install building infrastructure components, such as: structured cabling, power, mounts, racks, AV cabling. These systems shall be commissioned based on industry standard

diagnostics and deliverable documentation, as well as associated warrantees and certifications.

3. Integrators install equipment using the building infrastructure components. The integrator must acknowledge handoff of architect commissioning documentation before undertaking integration scopes of work.

4. The architect shall define testing suites that include the inter-operation of sub-systems to achieve the operational objectives for commissioning of the entire system. Upon completion of integration work, the integrator shall provide the District with supporting documentation of total system commission.

2.1 Exceptions

E-Rate FY2015 Exhibit 1 projects will establish a permanent centralized IDF location for all instructional and non-instructional areas. Where possible, reuse of existing CAT5e or higher cables is permitted. Where cables do not exist; include the installation of (2) CAT6 copper horizontal cables in the ceiling for WAP locations and (1) CAT6 copper horizontal cable in the wall for VoIP locations from the new IDF location. All IDF locations to have new OM4/OS1 fiber installed from the MDF location. SDUSD Design Guide Standards for design, performance, installation and commissioning apply. The District's intent is to avoid having IDFs in the classrooms. If the architect determines that an IDF should be in the classroom, such determination is subject to review by District staff.

For E-Rate FY2015 Exhibit 2 projects, existing WIFI access points in the classrooms and other instructional areas will be replaced with 802.11ac Wave 2 devices.