Certified FrameGrabber Associate

FGC-101

Course Objectives

1. Identify the typical use cases for FrameGrabber camera (FGC) systems
2. Describe how the components of the FGC system are connected to each other and how they work
3. Describe how the Camera Link protocol is used for image acquisition by the FrameGrabber system

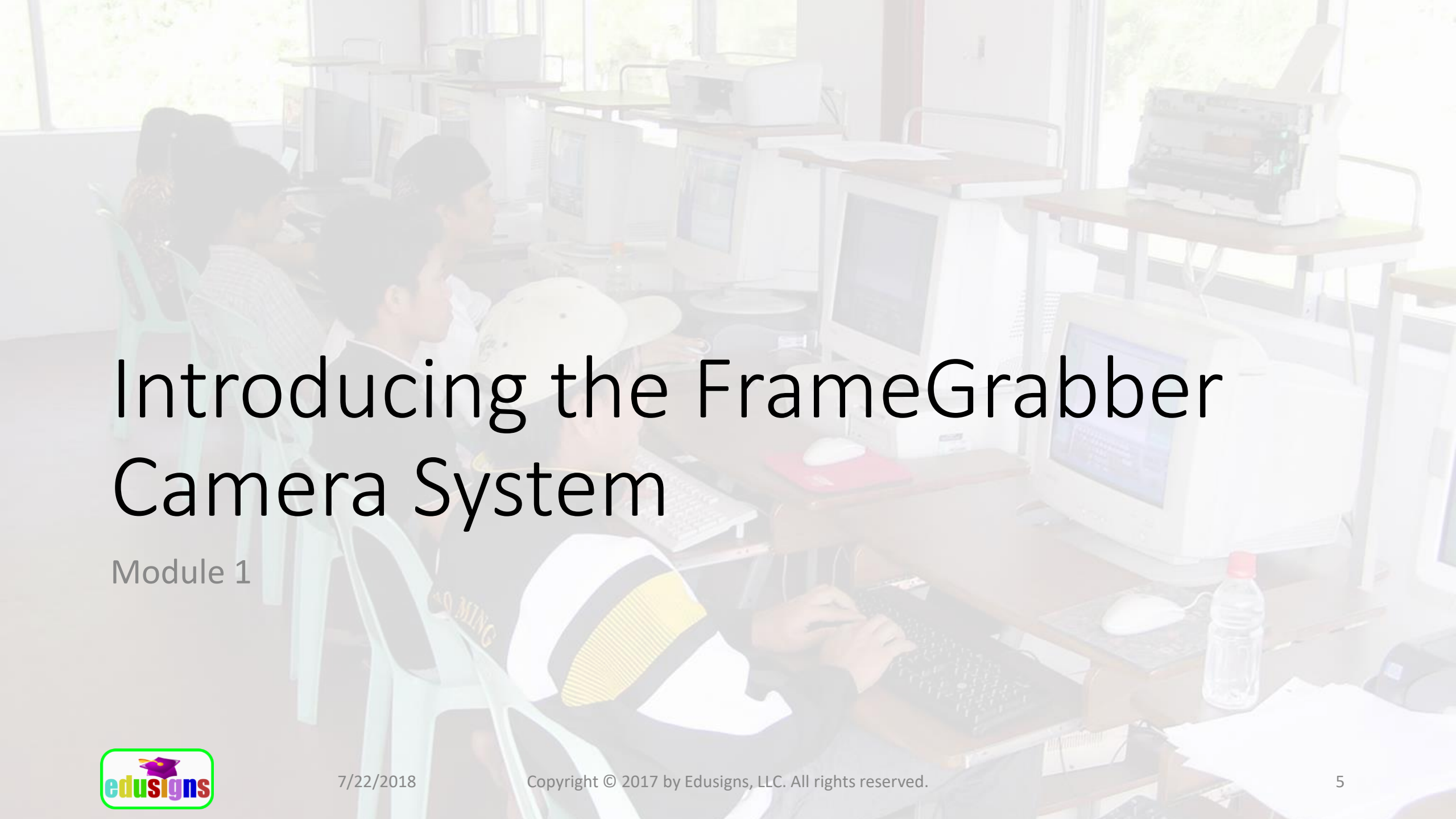
Intended Audiences

This course has no pre-requisite course requirements and is intended for:

- Photographers who will use the FGC system during events
- FrameGrabber installation and maintenance technicians

Agenda

9:00 – 9:15 a.m.	Participant introductions
9:15 – 9:30 a.m.	Module 1: Introduction
9:30 – 10:15 a.m.	Module 2: The Camera Subsystem
10:30 – 10:45 a.m.	BREAK
10:45 – 11:00 a.m.	Module 3: The Fiber Optic Subsystem
11:00 – 11:30 a.m.	Module 4: The Server-Side Subsystem
11:30 – 11:55 a.m.	Module 5: Camera Link Protocol & Wrap-Up



Introducing the FrameGrabber Camera System

Module 1

Module Objectives

- Identify and describe the typical FGS use cases
- Identify the three FGS subsystems

Typical Use Cases

- Filming games and other events at stadiums and arenas
- Security Surveillance

Filming Events

- This is the most common use case
- Cameras are placed on pillars or the roofs of buildings in stadium
  - Number and placement of cameras and server room set up are discussed in the course FGC-102 FrameGrabber Certified Technician
- Photographers have complete control of the FGC system for composition and filming activities
  - Can easily combine and sync video streams from multiple cameras
  - Sophisticated broadcast-quality slo-mo, fast-mo, and dissolves are quickly made in real-time

Security Surveillance

- The FGC system can provide security surveillance for large areas
  - Used for surveillance of outdoor areas of large campus
  - School market is a new rapidly growing market
- Multiple security officers can control cameras for different sections of campus
  - Easily create composite legally admissible evidence of criminal incidents from multiple cameras

FGC System Subsystems

- The FGC System consists of the following subsystems:
  - Camera Subsystem
  - Fiber Optic Subsystem
  - Server-Side Subsystem

Camera Subsystem

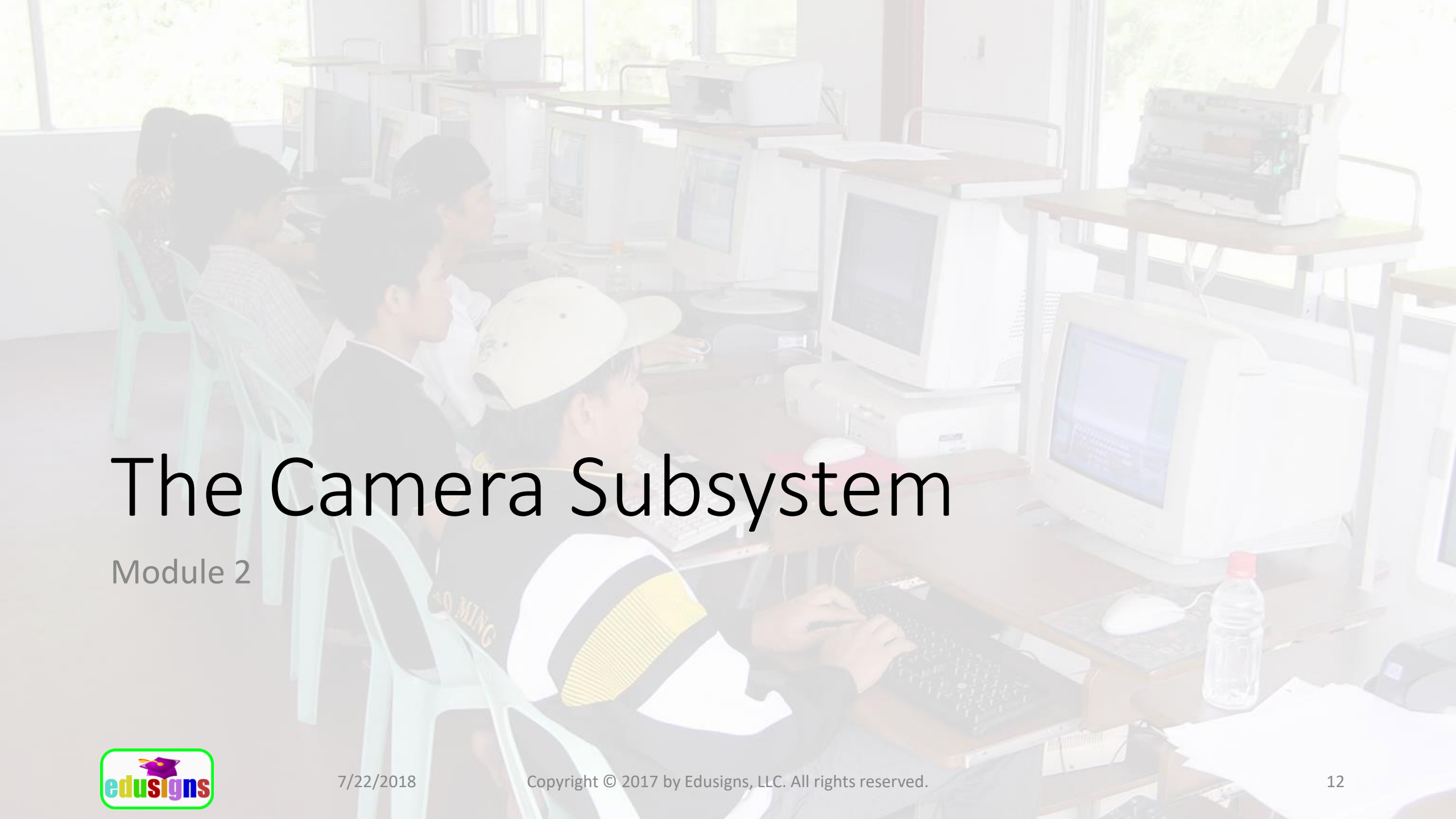
Patch Panel

Fiber Optic Subsystem

Server side Subsystem

Module Summary

- FrameGrabber Camera Systems are most commonly used for filming stadium events
- They are also used for security surveillance applications
- The FGC System consists of the following three subsystems
  - Camera Subsystem
  - Fiber Optic Subsystem
  - Server-Side Subsystem

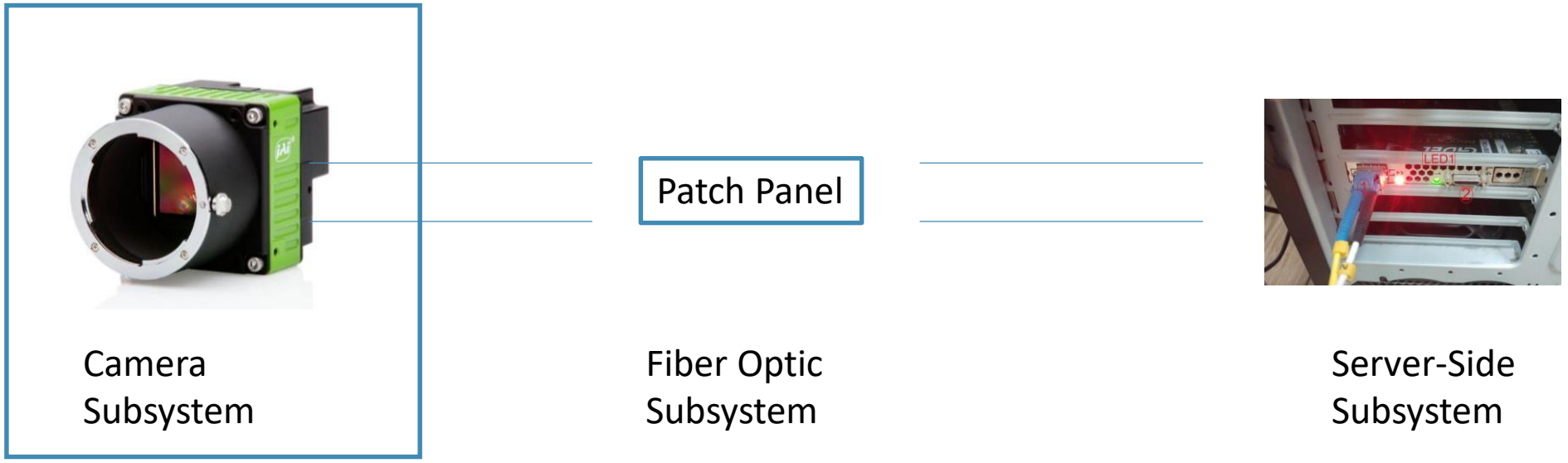


The Camera Subsystem

Module 2

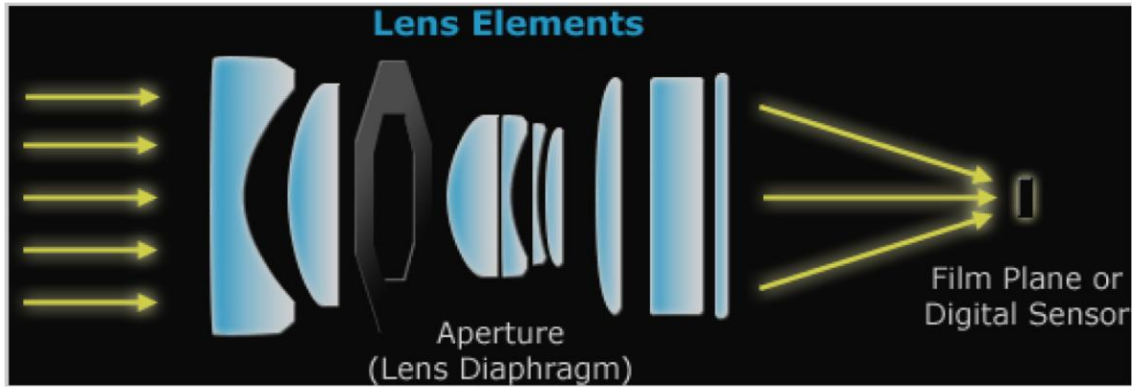
Module Objectives

- Describe how the Camera Subsystem works
- Identify the connections that must be made to connect the camera to the Fiber Optic and Server-Side Subsystems



Digital Image Acquisition Basics

- Light enters the lens assembly
- Amount of light entering lens assembly controlled by aperture (lens diaphragm)
- Image is captured by Digital Sensor
- Image can be further processed by video editing



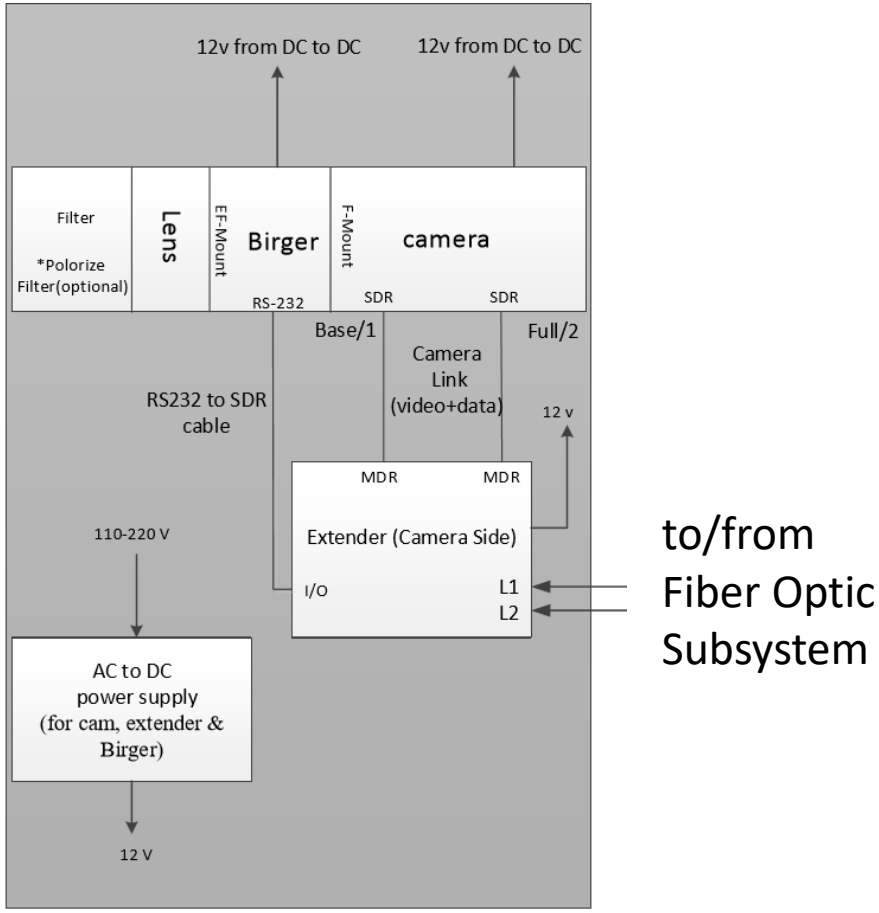
Camera Subsystem

The Camera Subsystem is installed in a weatherproof enclosure and consists of:

- One (1) JAI SPRP-2000C-PMCL camera
- Choice of Canon electronically controlled lenses
- Birger Adapter
- Gidel Extender
- Power Supply

How the Camera Subsystem Works

- Images captured by camera are transported through the Extender to the Fiber Optic Subsystem using Camera Link Protocol
- Fiber Optic Subsystem terminates in the Server side Subsystem
- Camera Subsystem controlled by photographer / security officer using Server-Side Subsystem components



Camera

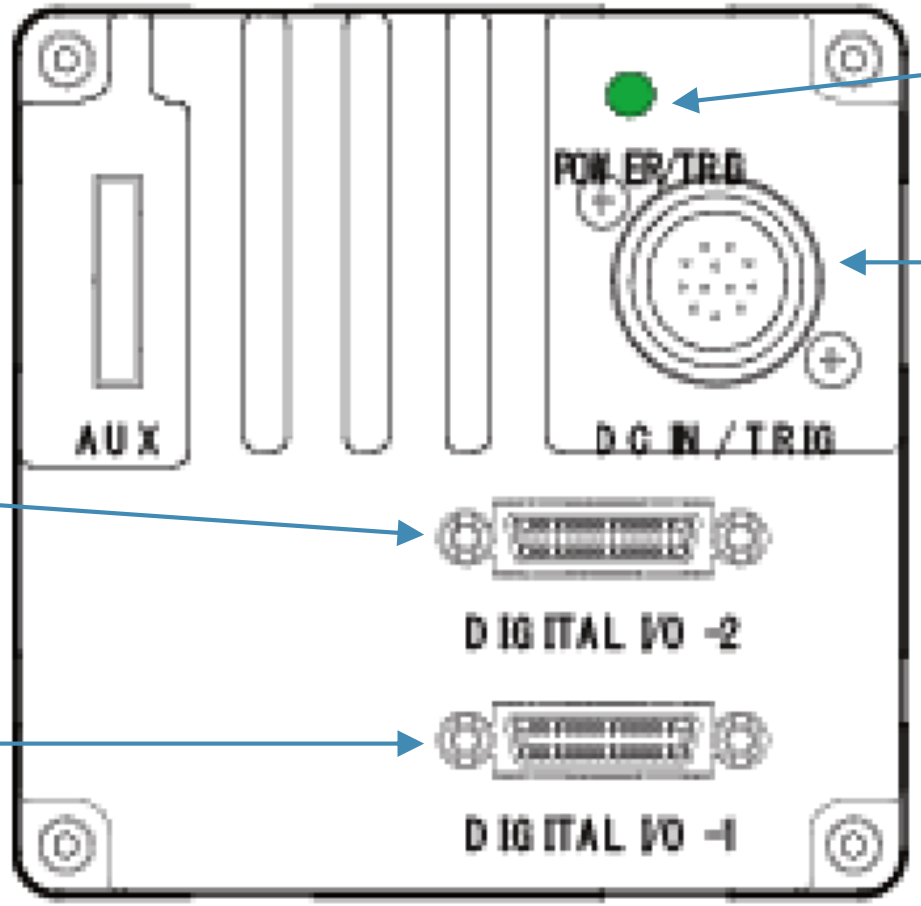
- JAI SPRP-2000C-PMCL manufactured by JAI Company
- Dimensions (HxWxL)
  - 62 x 62 x 84.5 mm
- 20 megapixel CMOS sensor
  - Active area of sensor 32.77 (h) and 24.58 (v) and 42 mm diagonal
  - Full 35 mm full size image format
- Full frame resolution of 5120 (H) x 3840 (V) pixels at 30 fps
- Gamma correction from 0.45 to 1.0 in in eight (8) steps
- F-mount for lens mount

Camera

- Dual Mini Camera Link connections in two-cable “full” configuration
  - provides maximum bandwidth needed for high-speed, high-resolution output

- Connections provided for
  - DC IN/TRIG Power
  - DIGITAL I/O 1 – Camera Link cable from BASE connector on extender
  - DIGITAL I/O 2 – Camera Link cable from MEDIUM/FULL connector on extender

Camera Connections



Status LED

DC IN / TRIG
Power Connector

DIGITAL I/O 2
Connect CL Cable to **MEDIUM/FULL** connector on Extender

DIGITAL I/O 1
Connect CL Cable to **BASE** connector on Extender

Lenses

- Choose from fixed focal length Prime lenses or Zoom lenses
- Zoom lenses are more versatile since you can change focal length
- Our systems have been tested for compatibility with Canon electronically controllable lenses

Prime Lenses

Focal Length	Brand	Minimum Aperture	Maximum Aperture
20	Canon	f/2.8	f/22
24	Canon	f/2.8	f/22
28	Canon	f/1.8	f/22
35	Canon	f/2	f/22
40	Canon	f/2.8	f/22
50	Canon	f/1.8	f/22
85	Canon	f/1.8	f/22
100	Canon	f/2	f/22
135	Canon	f/2	f/32
200	Canon	f/2	f/32
300	Canon	f/4	f/32

Zoom Lenses

Focal Length	Brand	Minimum Aperture	Maximum Aperture
24-70	Canon	f/2.8	f/22
70-200	Canon	f/2.8	f/22
70-300	Canon	f/1.8	f/22

Birger Adapter

- Device connected between the camera and lens
  - Allows remote control of lens aperture, focus, and focal length
  - Eliminates need to run around stadium before events to manually adjust settings on each camera
  - Recognizes lens type, and current focal length
  - Transmits lens parameters to Birger application on host PC

Birger Interface

1. Connect desired lens (4) to the EF mount side of Birger adapter
2. Connect F mount side of Birger (5) to camera
3. Connect power cable (3) to 12 VDC Birger connector on Power Supply
4. Connect RS-232 cable (2) to SDR cable

SDR Cable

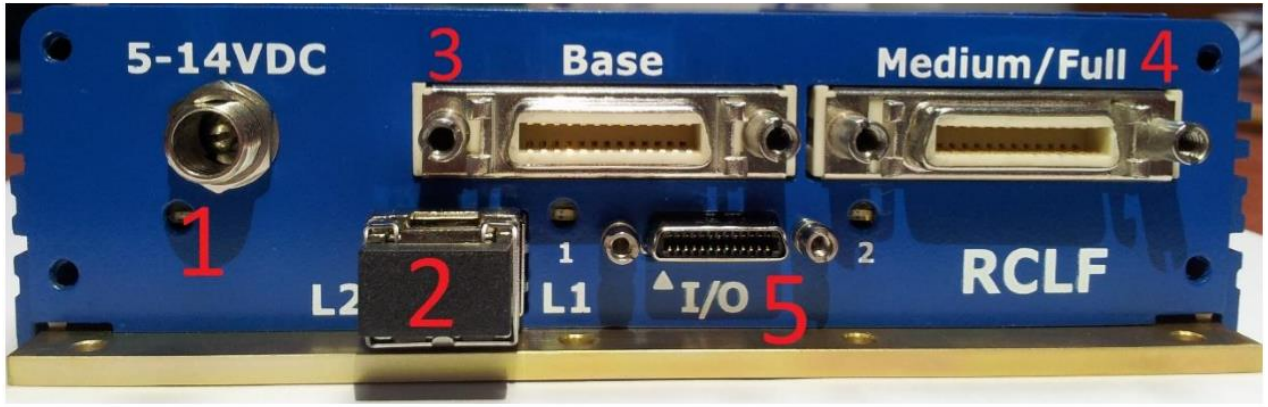
- Connects Birger interface to Extender
- Control signals are sent to and from lens through the Birger interface via this adapter to the Extender

Extender

- The Gidel Extender model RCLF is the hub of the Camera Subsystem
- Extender is necessary since JAI Camera and Birger do not work with fiber optic communication
- Camera Link protocol compliant high-speed fiber optic connections for Camera, host PC

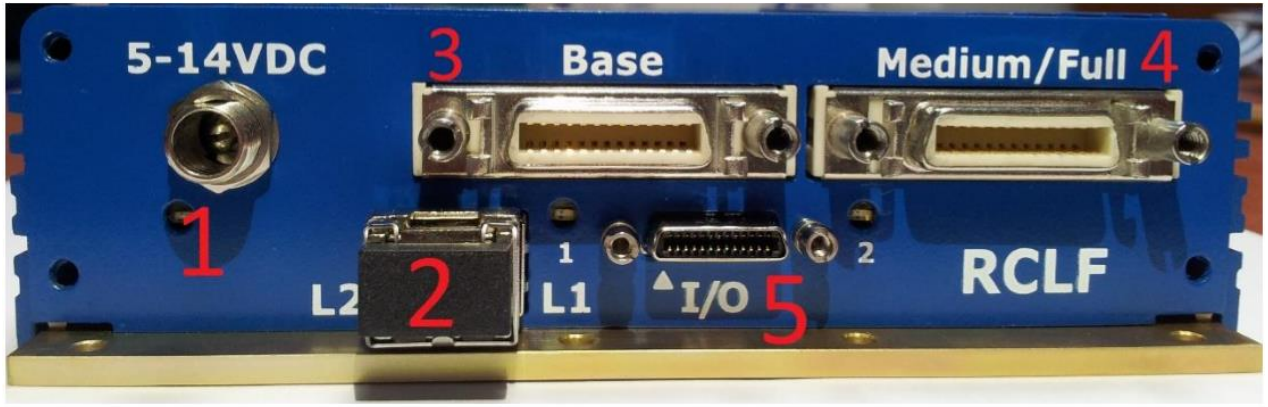
Extender Connections

1. Power connection – connect a 12 VDC connector from Power Supply -- LED1 will be solid green.
2. Fiber Optic cable from Patch Panel



Extender Connections

3. Connection from Digital I/O 1 connector on camera
4. Connection from Digital I/O 2 connector on camera
5. Birger connection with RS232 SDR Cable

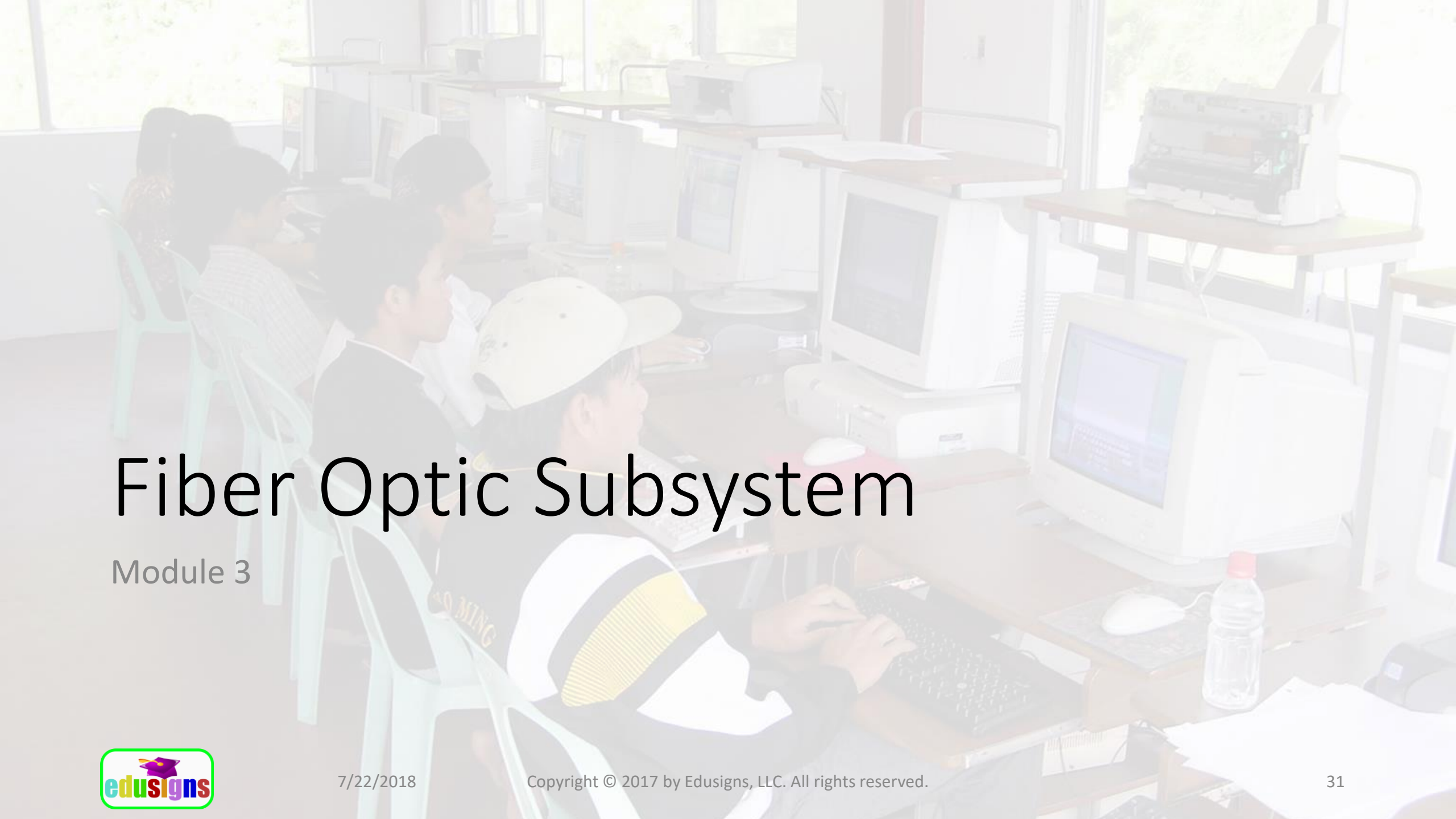


Power Supply

- Connections for Camera, Birger, and Extender
- Connections for 110-240 VAC from electrical outlet
- All components in the Camera Subsystem receive their power from the Power Supply

Module Summary

- Images enter the JAI Camera through the lens assembly and are captured by the digital sensor at the backplane of the camera
- Images are converted to Camera Link Protocol data and fed to the Gidel Extender
- The Gidel Extender converts the Camera Link Protocol data to fiber optic data for transmission through the Fiber Optic Subsystem to the Server-Side Subsystem for further processing and editing
- 12 VDC power is supplied by the Power Supply to the camera, Birger, and Extender
- Two Camera Link cables connect the camera to the extender
- A fiber optic cable connects the extender of each Camera Subsystem to the Patch Panel in the Server-Side Subsystem

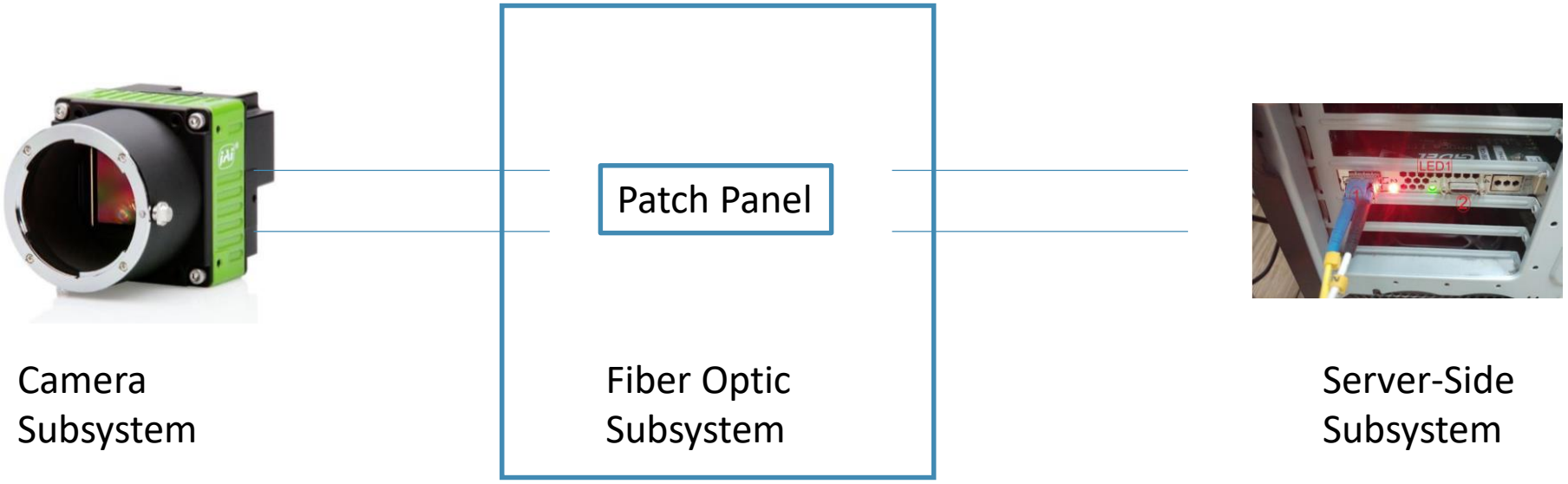


Fiber Optic Subsystem

Module 3

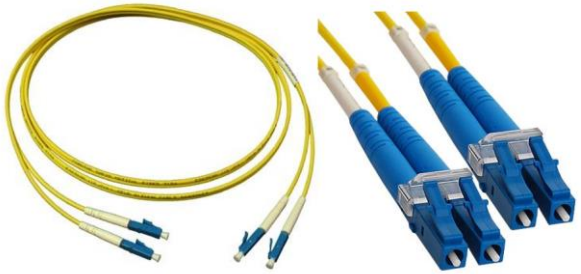
Module Objectives

- Describe how the Fiber Optic Subsystem works
- Identify the connections that must be made to connect the Camera and Server side Subsystems to the Fiber Optic Subsystem



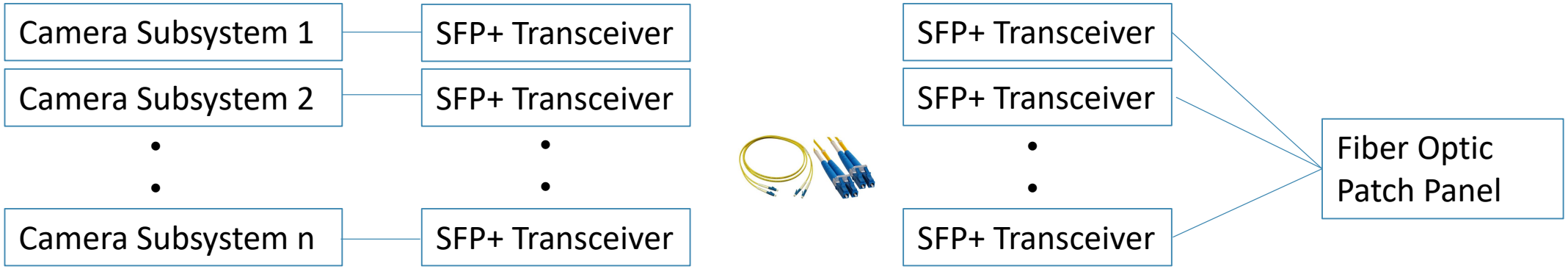
Fiber Optic Subsystem

- The Fiber Optic Subsystem consists of all fiber optic connections from Camera Subsystem(s) and Server-Side Subsystem
- Fiber connections terminate from Server-Side Subsystem and Camera Subsystem(s) terminate at the Patch Panel



How the Fiber Optic Subsystem Works

- An SPF+ transceiver terminates each end of fiber optic cable
- This transceiver is internal in the Patch Panel and Extender
- However, external transceivers may be needed when spanning longer distances to minimize signal attenuation



External SFP+ Transceiver

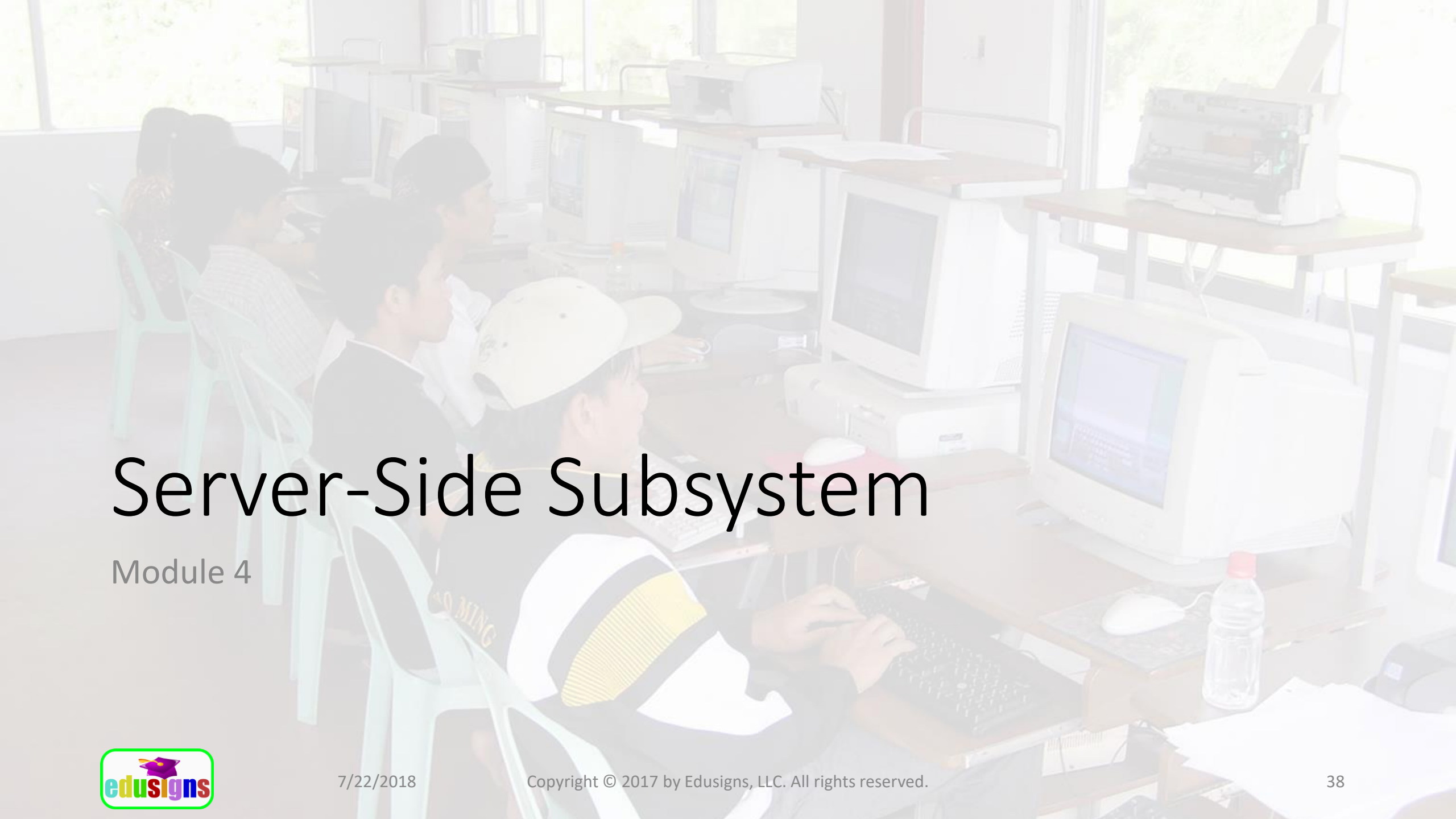
- Use an external SFP+ transceiver when
  - Connected device does not include built-in transceiver
  - Distance between Camera and Server-Side Subsystems exceeds one (1) mile to reduce risk of signal attenuation

Patch Panel

- Camera Subsystems and FrameGrabber Servers terminate at the Patch Panel
- The Patch Panel is analogous to the switches found on Ethernet Local Area Networks (LANs)

Module Summary

- The Fiber Optic Subsystem connects the Camera Subsystems located throughout the stadium to the Server-Side Subsystem via the Patch Panel
- The FrameGrabber Servers are also connected to the Fiber Optic Subsystem via the Patch Panel using an external SFP+ transceiver on the server end of the connection
- Each end of the Fiber optic cable requires an SFP+ transceiver, which is either external or built into the device being connected
- Extenders and Patch Panels usually have built-in extenders, while the FrameGrabber cards require an external transceiver at the PC end



Server-Side Subsystem

Module 4

Module Objectives

- Describe how the Server-Side Subsystem works
- Identify the connections that must be made to connect the Server-Side components used in synchronizing video streams

Camera Subsystem

Patch Panel

Fiber Optic Subsystem

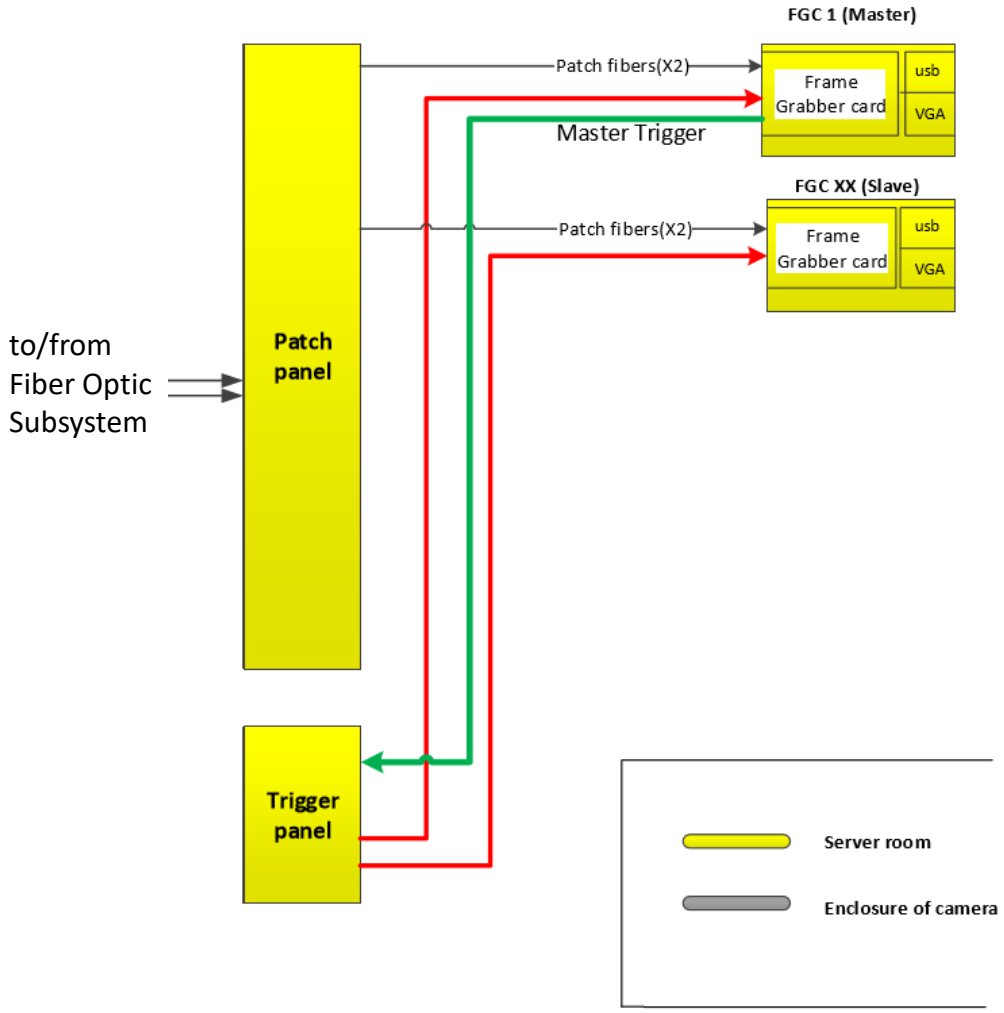
Server-Side Subsystem

Server-Side Subsystem

- The Server-Side Subsystem is installed in a room and consists of:
  - Patch Panel
  - Master FrameGrabber Server
  - One or more Slave FrameGrabber Servers
  - Trigger Panel

How the Server-Side Subsystem Works

- Images coming in from Camera Subsystems throughout stadium are transported by the Fiber Optic Subsystem through the Patch Panel to one or more FrameGrabber Servers
- Photographers use the FrameGrabber application on the servers to synchronize video streams and blend them together as required for their event filming
- The Trigger Panel allows photographers to control Camera Subsystems remotely



Patch Panel

- All fiber from the Camera Subsystems and FrameGrabber Servers (including spare fiber) are connected to the Patch Panel
- Enables ease of connection management between cameras and FrameGrabber Servers

FrameGrabber Servers

- A FrameGrabber Server is a PC outfitted with a FrameGrabber card and has the FrameGrabber software application installed
- FrameGrabber application allows photographers to:
  - Choose which video streams to synchronize/edit
  - Control Camera Subsystems throughout the stadium by sending control pulses through the Trigger Panel to individual Camera Subsystems
- FrameGrabber Servers and Camera Subsystems are Camera Link protocol compliant and support Full mode configurations
- One server serves as the Master Server and controls one or more Slave servers
- Each Slave server is connected by fiber to one Camera Subsystem

FrameGrabber Card

- Stores frames captured by camera
- Uses a cyclic buffer to store the last ~1000 frames in a FIFO manner
- Installs in a PCI slot on PC
- Connected to one Camera Subsystem
- Mirpeset component converts fiber optic data to Camera Link protocol data
- Field-programmable gate array (FPGA) can be configured by customer to special needs

Trigger Panel

- Each FieldGrabber Server is connected to the Trigger Panel
- Usually the first FieldGrabber Server (FGC01) is configured as the Master.
- Master generates trigger pulses for Slave FrameGrabber Servers
- Pulses used to create synchronized video streams
- Each Trigger Panel can support up to 28 Camera Subsystems

How Video Streams are Synced

- Video Streams are sets of images captured sequentially in time
- Two or more streams can be associated by some form of temporal correlation such as
  - Frame number
  - Time stamp
- Trigger pulses are issued by the Master FrameGrabber Server to the Slave FrameGrabber Servers based on photographer input on the FrameGrabber App
  - Photographer uses Trigger Cable connected to master input on the trigger panel and FrameGrabber SDR connection

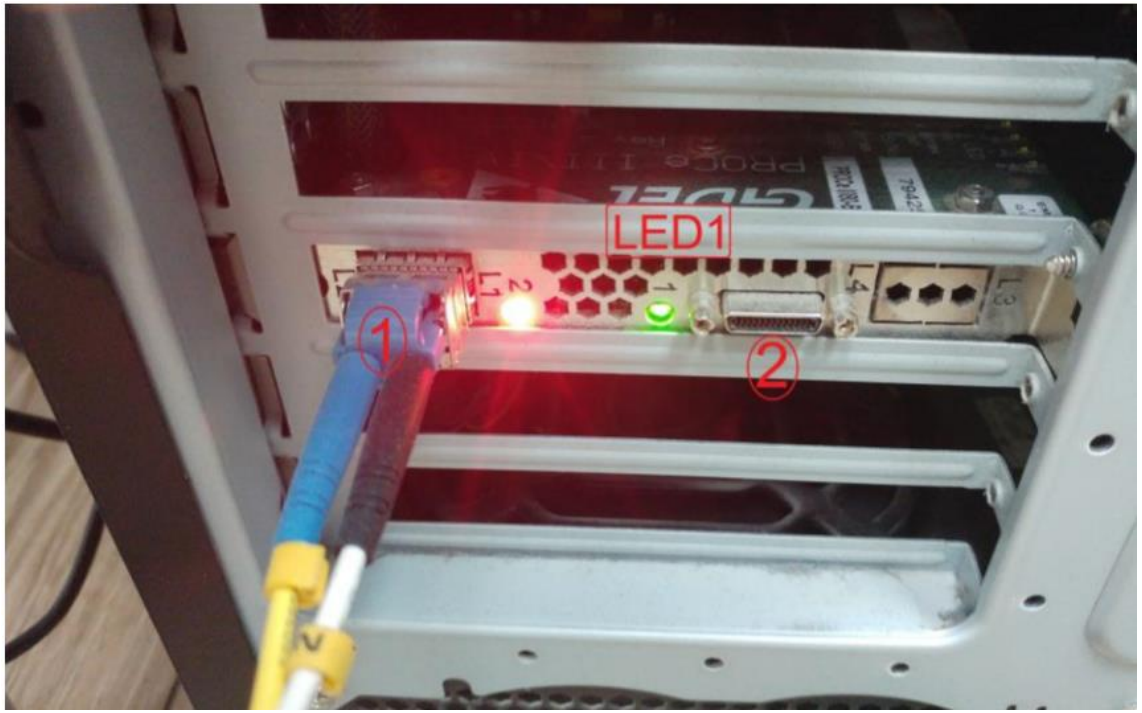
Server-Side Subsystem Connections

- The Server-Side Subsystem connections are comprised of
  - PC connections
  - Trigger Panel connections

PC Connections

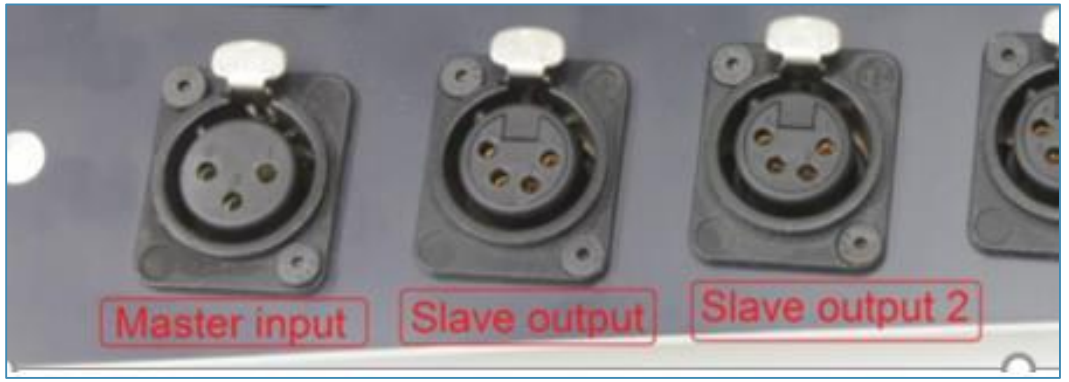
1. Connect one end of L1 and L2 LC-LC Fiber Optic cable to FrameGrabber card

   The other end connects to the SPF+ transceiver connector
2. Connect trigger cable (see next slide for Trigger Panel connection of this cable)



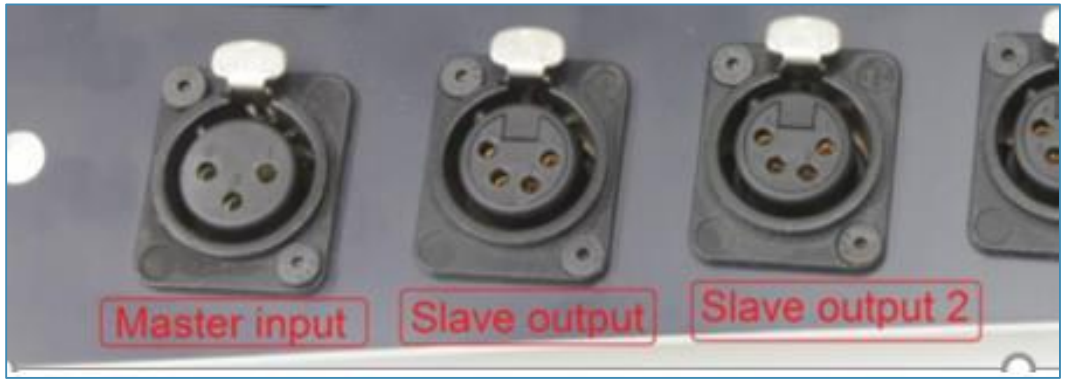
Trigger Panel Connections

- Master Server Connections
  1. Connect SDR connector to FrameGrabber card on Master Server (usually FGC01)
  2. Connect 3-pin XLR connector to Master Input connector on Trigger Panel
  3. Connect 4-pin XLR connector to Slave Output (use the one next to the Master Input connector)



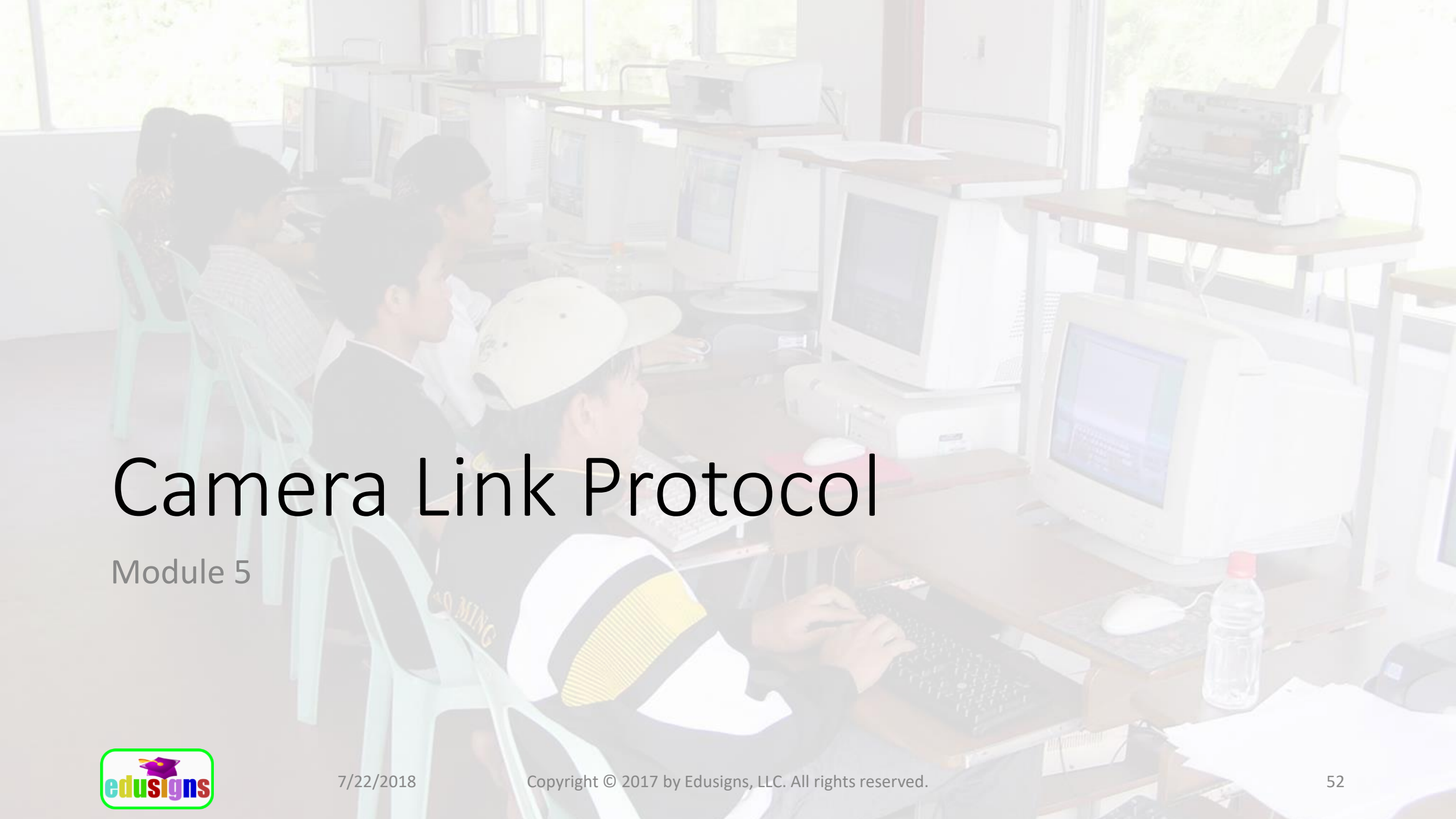
Trigger Panel Connections

- Slave Server Connections
  1. Connect SDR connector to FrameGrabber card on Slave Server
  2. Connect 4-pin XLR connector to Slave Output



Module Summary

- The Server-side Subsystem is housed in a room in the stadium
- FrameGrabber Servers are PCs that have FrameGrabber cards installed and are running FrameGrabber application software
- The FrameGrabber cards use their Mireset component to convert optical data back to Camera Link Data and hold the last 1000 frames captured in a FIFO buffer and can capture 30 frames per second (30 fps)
- The FrameGrabber Servers are connected to the Fiber Optic Subsystem via the Patch Panel and each controls one Camera Subsystem
- The Master FrameGrabber Server has the special role of generating pulses to the Camera Subsystems and to synchronize the video streams coming in from the Slave FrameGrabber Servers
- The servers are connected to the Trigger Panel allowing photographers to control the system using SDR cables connected to their FrameGrabber cards and to the Trigger panel via XLR connectors. Slaves use 4-pin connectors. The Master uses both a 3-pin connector for triggering and a 4-pin connector for camera control



Camera Link Protocol

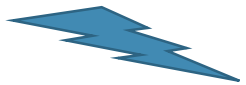
Module 5

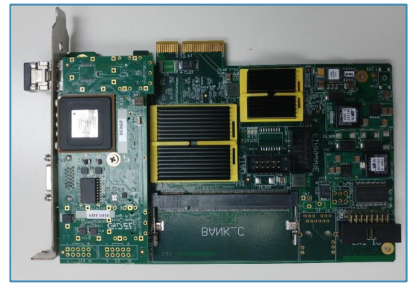
Module Objectives

- Describe the Camera Link Protocol and how it is used to connect cameras, extenders, and frame grabber cards from multiple manufacturers
- Identify the three Camera Link Protocol configurations and which one is used by FrameGrabber systems.

What is Camera Link?

- Camera Link is a robust communications link that uses a dedicated cable connection and standardized serial communications
- The Camera Link Protocol is a hardware specification standard the standardizes camera and frame grabber hardware communications





Camera Link Protocol Features

- Unidirectional video stream from camera to frame grabber card
- Bidirectional communication channel between camera, extender, and frame grabber card
- Camera Link compatible cameras come in several configurations available based on maximum throughput required for image acquisition

Camera Link Configurations

- Base configuration cameras use a single CL cable to connect to extender
- Medium and Full configuration cameras require two cables to connect to the extender

Camera Link Configurations

Configuration	Number of Data Bits	Maximum Possible Throughput (MB/s)	Number of Cables Required
Base	24	255	1
Medium	48	510	2
Full	64	680	2

All FrameGrabber Systems use the Full mode configuration for maximum throughput

Camera Link Cables

- Connects Camera to Extender
- FrameGrabber Systems use Full configuration and requires two (2) cables

Module Summary

- Camera Link is standard protocol that facilitates standardized serial communication between cameras, extenders, and frame grabber cards from many manufacturers
- Uses unidirectional video stream and bidirectional serial communication channel between camera, extender, and frame grabber card
- Camera Link compliant cameras come in three configurations which define the image acquisition capabilities of the camera: Base, Medium, and Full
- Cameras are connected to extenders using one CL cable for Base configurations and two cables for Medium and Full configurations
- FrameGrabber Systems use Full configuration for a maximum throughput of 680 MB/s of data at 64 bits

Congratulations!

- You completed the course FGC-101 Certified FrameGrabber Associate
- Next Steps:
  - Take and pass the FGC-101 FrameGrabber Associate Certification Exam with a score of 80% or better
  - Enroll in the course FGC-102 FrameGrabber Certified Technician