

Making Stuff *Work Together*

Making Stuff Work Together

Dan Fogel
Chief Technology Officer
DNF Controls

Delivering Trusted Control Solutions for 28 years



Making Stuff Work Together

The Daily Challenge

Spent \$\$\$\$\$\$ To Get Here

- It works
- Operators are comfortable with it
- We can maintain it
- Its paying for itself



Making Stuff Work Together

The Daily Challenge

**Some of the equipment
is fully depreciated
But works great
And is easy to maintain**



Delivering Trusted Control Solutions for 28 years

DMF
CONTROLS

Making Stuff Work Together

The Daily Challenge

**Some of the equipment
is somewhat new.**

**Need to keep it working
for a couple more years**



Delivering Trusted Control Solutions for 28 years

DMF
CONTROLS

Making Stuff Work Together

The Daily Challenge

**Management just
purchased some
shiny new stuff
Issued mandate
“Make it Work!”**



Delivering Trusted Control Solutions for 28 years

DMF
CONTROLS

Making Stuff Work Together

Starting Point:

1. What do we mean by “Work TOGETHER” ?
2. What is really being CONTROLLED ?
3. How do we INTERCONNECT them ?

Making Stuff Work Together

1. What do we mean by “Work TOGETHER” ?

Typically, one device is in charge

It tells the other what to do and when to do it

ROLL!!



Delivering Trusted Control Solutions for 28 years

DMF
CONTROLS

Making Stuff Work Together

1. What do we mean by “Work TOGETHER” ?

Which one is the Controller (Master) ?

Which one is the Controllee (Slave) ?

Master



ROLL!!



Slave



Making Stuff Work Together

1. What do we mean by “Work TOGETHER” ?

Does this relationship work?

Slave



ROLL!!



Master



Delivering Trusted Control Solutions for 28 years

DMF
CONTROLS

Making Stuff Work Together

1. What do we mean by “Work TOGETHER” ?

Master



How Does it Communicate ?

GPI Input / Output

Serial: RS232, RS422

IP Control

What Languages Does it Speak ?

Making Stuff Work Together

1. What do we mean by “Work TOGETHER” ?

How Does it Communicate ?

GPI Input / Output

Serial: RS232, RS422

IP Control

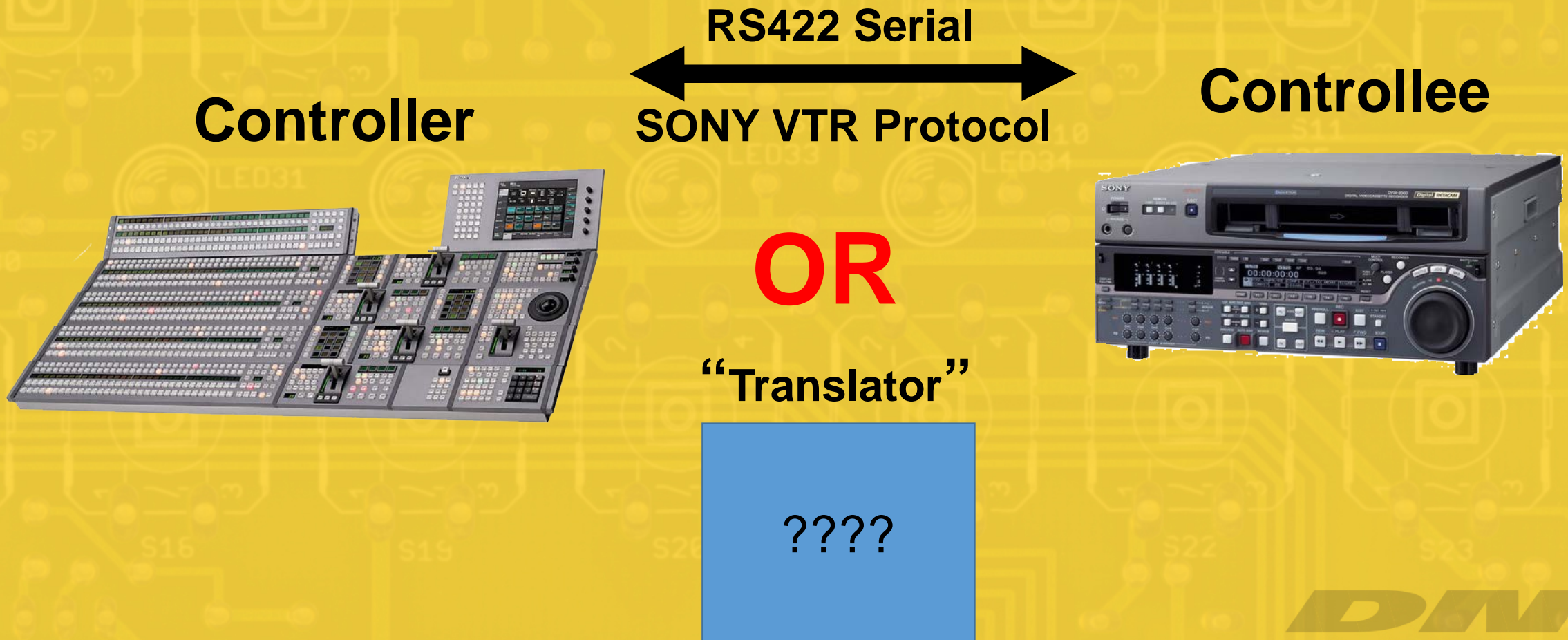
Slave

What Languages Does it Speak ?



Making Stuff Work Together

1. What do we mean by “Work TOGETHER” ?



Making Stuff Work Together

2. What is really being CONTROLLED?



Play
Stop
Record
Cue to Time
Load Clip



CUT Source on PGM
Select Source on PRESET
Do Transition
Keyer 1 ON



On-Air Tally
Goto Preset Position
Goto Preset Shot



Turn ON
Turn OFF
Flash

Making Stuff Work Together

2. What is really being CONTROLLED ?

How will they interact:

Control Only: Tell slave device what to do

Monitor Only: Ask slave device what it is doing

**Control & Monitor: Do something !
Did you do it ?**

Making Stuff Work Together

2. What is really being CONTROLLED ?

Command Only

Do Something!!



Command - Response

Do Something!!



Got it



Did You Do it ??



Yup!



Unsolicited Response

I Did Something!!



DMF
CONTROLS

Making Stuff Work Together

3. How do we INTERCONNECT them ?

Let's look at some common interfaces:

Parallel Control

Serial Control

IP Control

Making Stuff Work Together

3. How do we INTERCONNECT them ?

Parallel:

(a.k.a. GPI Input / GPI Output)

- ✓ **One pin for each supported function**
Pull to ground or voltage to activate
Release to de-activate
- ✓ **One pin for each supported status tally**
ON: Pulled to ground or voltage by device
OFF: Do the opposite

Making Stuff Work Together

3. How do we INTERCONNECT them ?

Parallel:

Inputs and Outputs can be configured as

- Active High or Active Low
- Latching or Momentary

Making Stuff Work Together

3. How do we INTERCONNECT them ?

Parallel:

Active High

ON: apply a voltage to pin

OFF: remove voltage



Active Low

ON: apply ground to pin

OFF: remove ground



DRY

WET

Making Stuff Work Together

3. How do we INTERCONNECT them ?

Parallel:

Latching

Turn ON & stay ON

Turn OFF & stay OFF

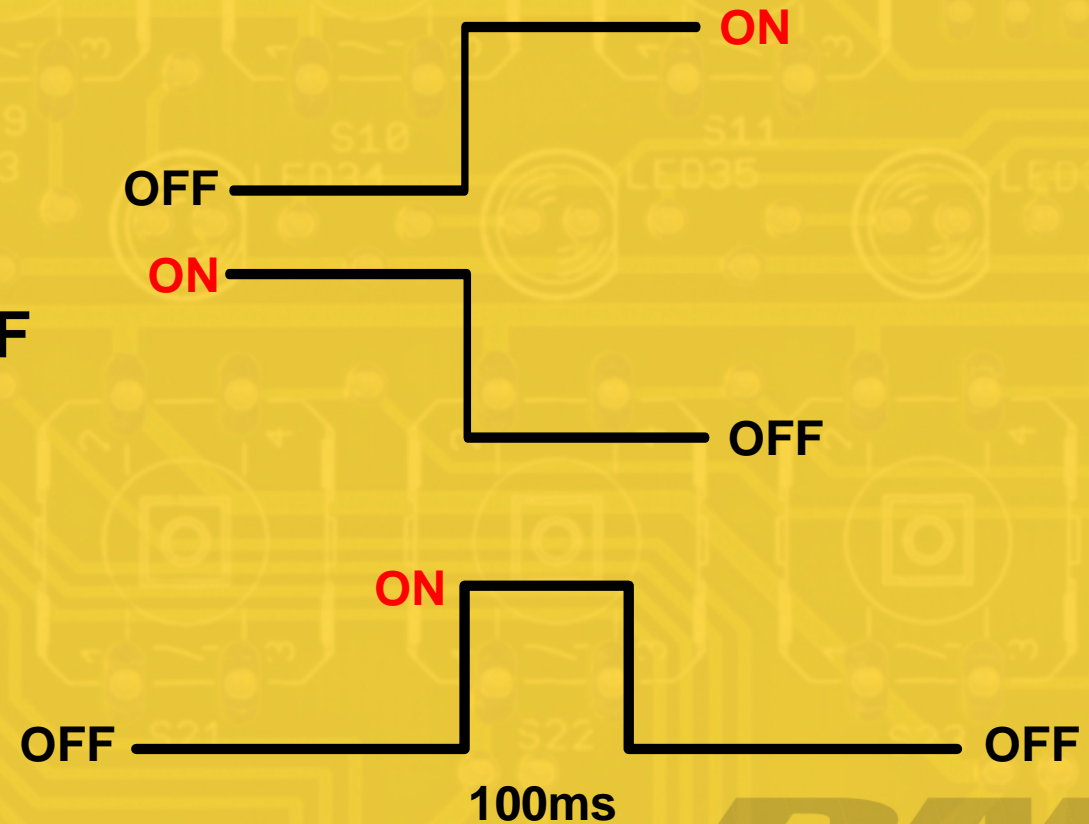
Typically responds to ON & OFF

Momentary

Turn ON for minimum time

Typically responds to ON only

Don't care when OFF



Making Stuff Work Together

3. How do we INTERCONNECT them ?

Serial:

One or two pins for ALL supported functions

One or two pins for ALL supported status tallies

Common: RS232 & RS422

RS485 more industrial

Making Stuff Work Together

3. How do we INTERCONNECT them ?

Serial: RS232

DTE

Pin 2: Receive Data

Pin 3: Transmit Data

Pin 5: Gnd

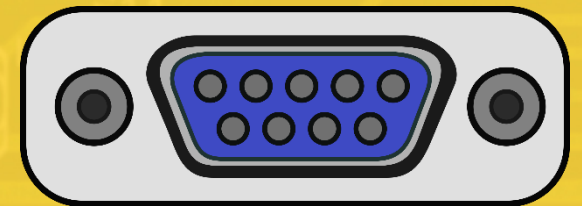
DCE

Transmit Data: Pin 2

Receive Data: Pin 3

Gnd: Pin 5

DB9 Common



Used to Enable/Disable Communication

RTS: Request to Send

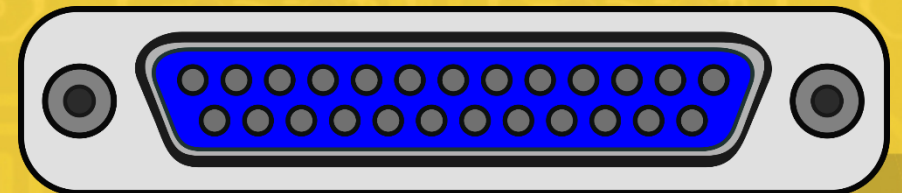
CTS: Clear to Send

DTR: Data Terminal Ready

DSR: Data Set Ready



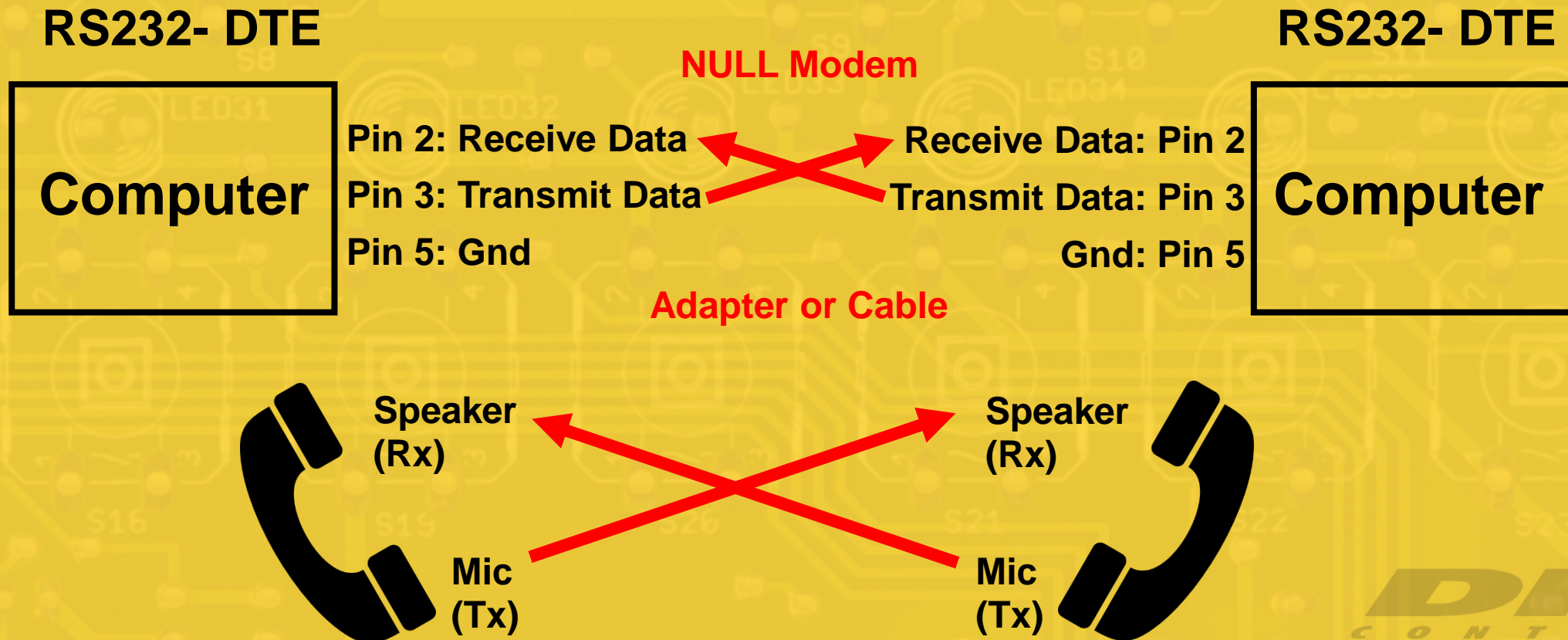
DB25 Not so common



Making Stuff Work Together

3. How do we INTERCONNECT them ?

Serial: RS232 BEWARE!



Making Stuff Work Together

3. How do we INTERCONNECT them ?

Serial: RS422

Controller / Master

Device / Slave

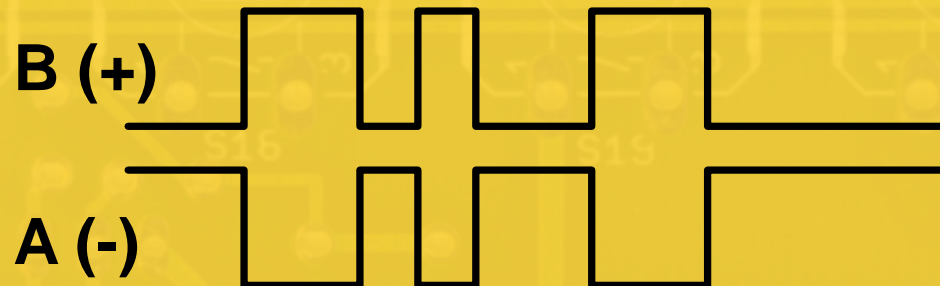
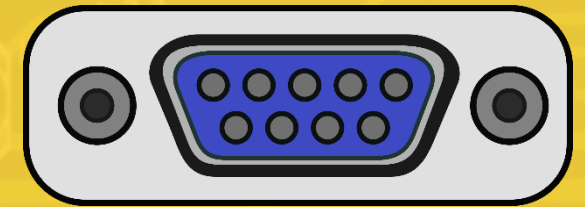
Pin 3: Transmit B (+) → Receive B (+) : Pin 3

Pin 8: Transmit A (-) → Receive A (-): Pin 8

Pin 7: Receive B (+) ← Transmit B (+): Pin 7

Pin 2: Receive A (-) ← Transmit A (-): Pin 2

DB9



“Differential Pair”

FYI:

Broadcast: B +, A -

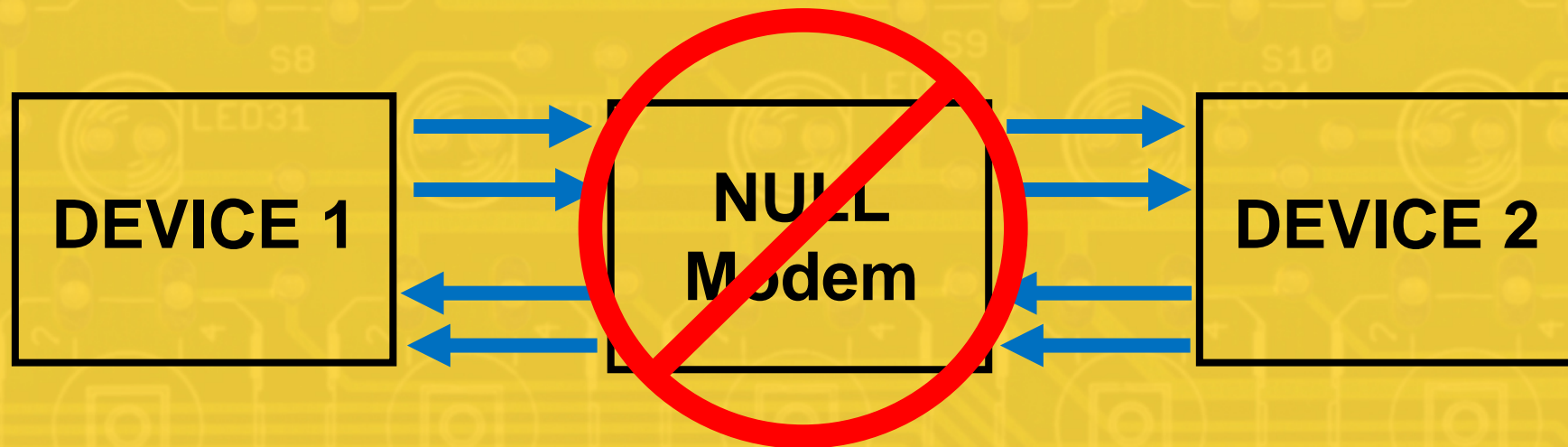
Industrial: B -, A +

DMF
CONTROLS

Making Stuff Work Together

3. How do we INTERCONNECT them ?

Serial: RS422 BEWARE !



Very Very Very Unusual

More likely wiring problem!

Making Stuff Work Together

3. How do we INTERCONNECT them ?

Serial: Typical Configuration Items

Baud Rate (Bits per second): 300, 1200, 9600, 38.4K, 115.2K

Parity (Number of bits): Odd Number, Even Number, No Parity

Data Bits (Data Byte Length): 7 or 8 8 most common

Stop Bits (Number of bits): 1 or 2 1 most common

Both Devices Set to SAME! No Negotiation

Making Stuff Work Together

3. How do we INTERCONNECT them ?

Serial: CAVEATS

1. **Control works, but no status- check wiring**
2. **Intermittent communication- check Parity & Data Bits**
3. **An RS232 cable connected to RS422 device can sometimes work (dependent upon device)**
4. **There are serial tools available to monitor and capture data for troubleshooting**

Making Stuff Work Together

3. How do we INTERCONNECT them ?

Ethernet / IP:

Very high speed serial connection: 100Mb, 1Gb, 10Gb

Wired vs. Wireless: End result the same
Very different mechanics

ALL supported functions pass over common cable

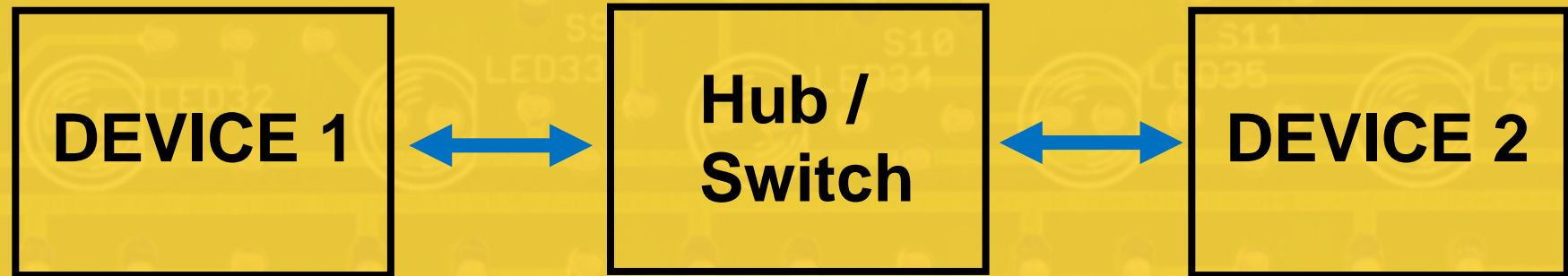
ALL supported status tallies pass over same cable

Making Stuff Work Together

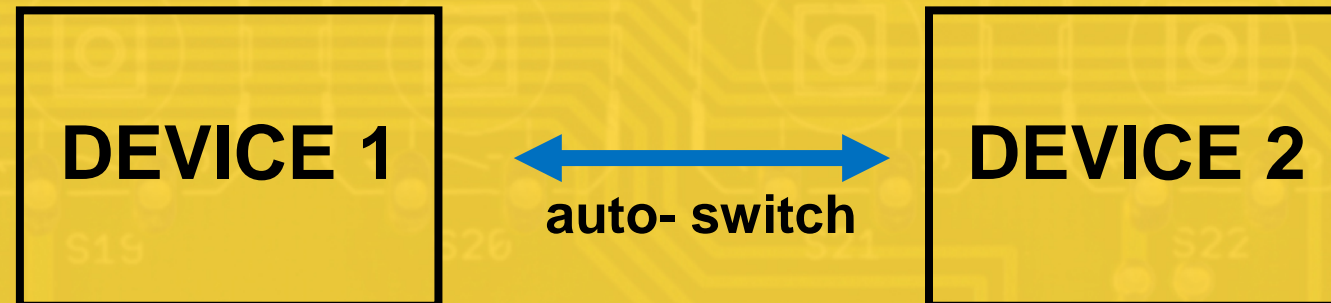
3. How do we INTERCONNECT them ?

IP:

Typical



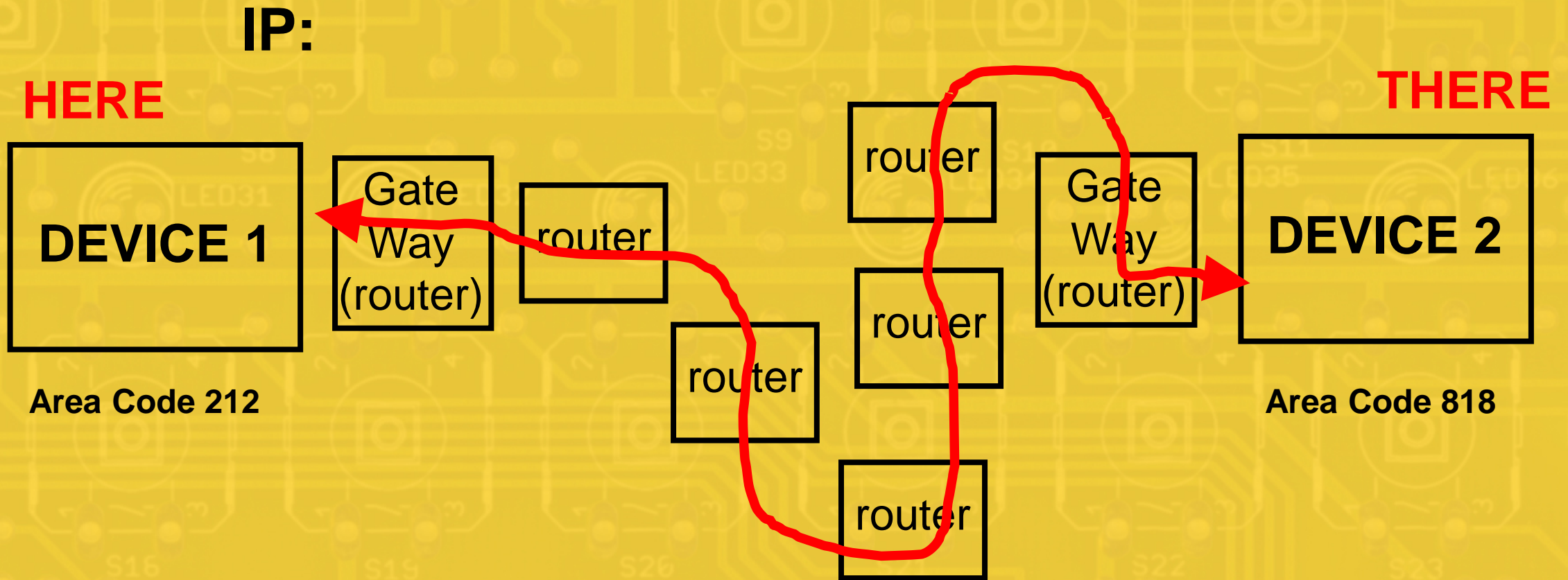
**Becoming
More
Common**



**To be safe:
Use switch
until prove its
not needed**

Making Stuff Work Together

3. How do we INTERCONNECT them ?



Over hill, over dale, through LAN, WAN, & Internet

Making Stuff Work Together

3. How do we INTERCONNECT them ?

IP:

HERE



Area Code 212

We are more interested in:

- ✓ **What they have to say**
Control Language
- ✓ **How they exchange it**
TCP, UDP
HTTP, SNMP....

THERE



Area Code 818

Making Stuff Work Together

3. How do we INTERCONNECT them ?

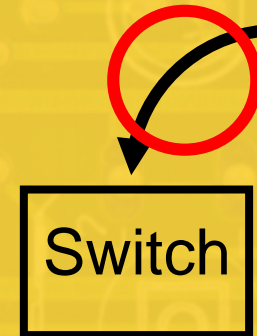
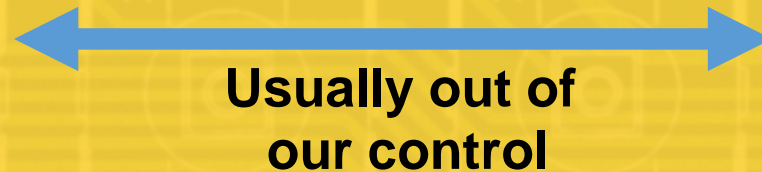
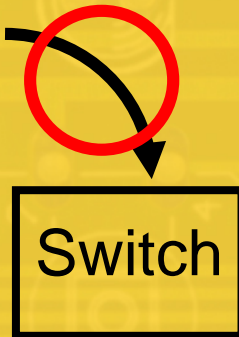
IP:

HERE

THERE



TCP and UDP most common means
to exchange data
(from our point of view)



Making Stuff Work Together

3. How do we INTERCONNECT them ?

IP:

TCP- Client / Server Relationship

Client wants something the Server has-- DATA ie: website

Client is responsible for connecting to server

Needs to know server's IP address & TCP Port Number

Client is responsible for maintaining connection

If connection dropped, client must re-establish it, if it wants to communicate

Server drinks its coffee & waits.... and waits

Is not concerned if Clients connect or not

Making Stuff Work Together

3. How do we INTERCONNECT them ?

IP:

TCP-

- **Formal relationship between Client and Server**
- **Defined rules for communicating**
- **Define rules for communication failures**
- **“Guaranteed” delivery of messages**
- **Delivery of messages in order sent**

Making Stuff Work Together

3. How do we INTERCONNECT them ?

IP:

UDP- Informal Relationship, No Formal Connection

Used for SNMP, transmitting audio and video through LAN, WAN, internet

Device 1 sends message to Device 2

Device 2 may not be expecting it

Device 2 may not receive it

Device 1 may not know if Device 2 received it

Device 1 decides how important it is that Device 2 receives its message

Making Stuff Work Together

3. How do we INTERCONNECT them ?

Ethernet / IP:

What they have to say-- Control Language

Control Language / Protocol can be

- **ASCII text**
- **Binary values**
- **Hybrid of text and binary**
- **User Manual / Addendum source for commands & format**
- **Wireshark communication with app / GUI**

Making Stuff Work Together

Starting Point:

1. What do we mean by “Work TOGETHER” ?
2. What is really being CONTROLLED ?
3. How do we INTERCONNECT them ?

Making Stuff Work Together

Decisions:

1. Which device is the **Controller**
2. Which device is the **Controllee**
3. What interface will be used to connect them
GPIO, Serial, or IP **OR** a combination
4. What functions will be controlled on the **Controllee**

Making Stuff Work Together

Decisions:

- 5. Will the Controller simply tell the Controllee what to do**
- 6. Will the Controller require status from the Controllee**
- 7. Does the Controller ask nicely for each status or does the Controllee send it without being asked**

Making Stuff Work Together

Let's do something:

Operations has just notified you that the reliable VTR has died ☹

Management wants to replace it with a Blackmagic Design HyperDeck

And.... they want to be able to load specific clips from the production switcher

Making Stuff Work Together

Controller



Known:

1. Does support GPI/O
2. Does support Sony serial VTR protocol
3. Does not support HyperDeck IP control
4. Does not support IP control

Controllee



Known:

1. Does not support GPI/O
2. Supports Sony serial VTR protocol, can't load clips
3. Requires IP Control to load clips
4. User Manual has IP control details & list of commands

Making Stuff Work Together

Decisions:

1. Operations needs to access 10 clips in HyperDeck
2. Production switcher supports at least 10 GPIs
3. Use GPIs to control HyperDeck
4. Call DNF Controls for an interface solution ☺

Making Stuff Work Together

Controller



- 10 GPIs
- Active Low
- Momentary

Controllee



- TCP connection
- AIB-3 Client, HyperDeck Server
- Send 1 command for each clip to load & play
- Loop clip



Making Stuff Work Together

AIB-3 Configuration Web Pages

1. Configure AIB-3 as a TCP client
2. Enter HyperDeck's IP Address: 192.168.10.203
3. Enter HyperDeck's TCP Port Number: 9993 (from manual)

| REMOTE DEVICE LIST | | | | | | | | | |
|--------------------|---------------------|-------------|----------------------|-----------------|---------------------------|--------------|----------------|-------------|--------------------------|
| Device # | Remote Device Label | Device Type | Primary /Backup Pair | Connection Type | Connection Mode | UDP Attempts | IP Addresss | Port Number | Heartbeat Rate (seconds) |
| 1 | Black Magic | Other ▼ | | TCP/IP ▼ | Client Transmit/Receive ▼ | | 192.168.10.203 | 9993 | |
| 2 | Remote Device 2 | USP ▼ | | | | | 0.0.0.0 | 161 | 5 ▼ |
| 3 | Remote Device 3 | USP ▼ | | | | | 0.0.0.0 | 161 | 5 ▼ |
| 4 | Remote Device 4 | USP ▼ | | | | | 0.0.0.0 | 161 | 5 ▼ |
| 5 | Remote Device 5 | USP ▼ | | | | | 0.0.0.0 | 161 | 5 ▼ |
| 6 | Remote Device 6 | USP ▼ | | | | | 0.0.0.0 | 161 | 5 ▼ |
| 7 | Remote Device 7 | USP ▼ | | | | | 0.0.0.0 | 161 | 5 ▼ |
| 8 | Remote Device 8 | USP ▼ | | | | | 0.0.0.0 | 161 | 5 ▼ |

Making Stuff Work Together

Configure Input Events

| GPI CONFIGURATION | | | | | |
|-------------------|-----------|-------------------------|------------------------|-------------------|-----------|
| GPI# | GPI Label | User Defined "ON" State | User Defined "ON" Mode | Debounce (*10 ms) | Currently |
| 1 | GPI_1 | OPTO ON ▾ | Momentary ▾ | 10 ▾ | OFF |
| 2 | GPI_2 | OPTO ON ▾ | Momentary ▾ | 10 ▾ | OFF |
| 3 | GPI_3 | OPTO ON ▾ | Momentary ▾ | 10 ▾ | OFF |
| 4 | GPI_4 | OPTO ON ▾ | Momentary ▾ | 10 ▾ | OFF |
| 5 | GPI_5 | OPTO ON ▾ | Momentary ▾ | 10 ▾ | OFF |
| 6 | GPI_6 | OPTO ON ▾ | Momentary ▾ | 10 ▾ | OFF |
| 7 | GPI_7 | OPTO ON ▾ | Momentary ▾ | 10 ▾ | OFF |
| 8 | GPI_8 | OPTO ON ▾ | Momentary ▾ | 10 ▾ | OFF |

Configure Output Actions

| AHSC TRANSMIT ACTIONS | | |
|-----------------------|--------------------------|------------------------|
| Line# | Action Label | ASCII/HEX Command |
| 1 | Play command | play %0A |
| 2 | Stop command | stop %0A |
| 3 | Record command | record %0A |
| 4 | Transport Status Request | transport %20 info %0A |
| 5 | AHSC Transmit 5 | |
| 6 | AHSC Transmit 6 | |
| 7 | AHSC Transmit 7 | |

Assign Input EVENT to Output ACTION

| EVENT IN -> ACTION OUT TABLE | | | | | | | | | |
|------------------------------|---------------|-----------------|---------------|----------------------|-----------------|----------------------------|----------------------|--------------|--------------|
| Line# | EVENT IN | | | ON ACTION | | | OFF ACTION | | |
| | Source | Event Type | Event | Local/ Remote Device | Type | Action Label | Local/ Remote Device | Type | Action Label |
| 1 | Local ▾ | Cont. Timer-1 ▾ | 1 sec ▾ | Black Magic ▾ | AHSC Transmit ▾ | Transport Status Request ▾ | | | |
| 2 | None ▾ | | | | | | | | |
| 3 | Local ▾ | GPI ▾ | 1 ▾ | Black Magic ▾ | AHSC Transmit ▾ | Play command ▾ | Local ▾ | Do Nothing ▾ | |
| 4 | Local ▾ | GPI ▾ | 2 ▾ | Black Magic ▾ | AHSC Transmit ▾ | Stop command ▾ | Local ▾ | Do Nothing ▾ | |
| 5 | Local ▾ | GPI ▾ | 3 ▾ | Black Magic ▾ | AHSC Transmit ▾ | Record command ▾ | Local ▾ | Do Nothing ▾ | |
| 6 | Black Magic ▾ | AHSC Receive ▾ | Play Status ▾ | Local ▾ | GPO ON ▾ | GPO_1 ▾ | Local ▾ | Do Nothing ▾ | |
| 7 | Black Magic ▾ | AHSC Receive ▾ | Stop Status ▾ | Local ▾ | GPO ON ▾ | GPO_2 ▾ | Local ▾ | Do Nothing ▾ | |

Making Stuff Work Together

Let's do something:

The video processing / encoding system has been replaced with a unit that provides more functionality.

Unfortunately, it does not support Alarm Outputs like the old one. It does support SNMP traps.

We need to generate Alarm GPOs for specific faults

Making Stuff Work Together

Controller

**Video Processor /
Encoder**

Known:

1. Does not support GPI/O
2. Does support SNMP Traps
3. Ethernet interface using UDP
4. Manufacturer provides MIB documentation

Controllee

???

Known:

1. Must receive and decode SNMP Traps
2. Must support at least 12 GPOs
3. Half of the GPOs are Latching, the other half are momentary
4. Need Active Low GPOs

Making Stuff Work Together

Decisions:

1. **Require IP connection from Controller to Controllee to receive SNMP traps (UDP)**
2. **Solution processes traps and generates GPOs**
3. **Need means to enter required SNMP Traps**
4. **Need means to configure individual GPOs**
5. **Call DNF Controls for an interface solution 😊**

Making Stuff Work Together

Controller

Video Processor /
Encoder

- IP connection
- SNMP (UDP)
- SNMP Traps sent when fault occurs
- SNMP Traps sent when fault corrected

Controllee



- Listen for SNMP Traps
- Process received traps
- Generate 6 Latching GPOs
- Generate 5 Momentary GPOs with 1 second ON Time

Making Stuff Work Together

AIB-3 Configuration Web Pages

1. Configure AIB-3 Remote Device #2 to receive SNMP Traps
2. Enter Controllers IP Address: 192.168.10.190
3. AIB automatically sets Port Number to 162

| REMOTE DEVICE LIST | | | | | | | |
|--------------------|---------------------|-------------|----------------------|-----------------|------------------------|--------------|--|
| Device # | Remote Device Label | Device Type | Primary /Backup Pair | Connection Type | Connection Mode | UDP Attempts | IP Address Add single forward Do not add http:// |
| 1 | SNMP Device | Other | None | SNMP | Client Forward | 1 | 0.0.0.0 |
| 2 | SNMP TRAP | Other | None | SNMP TRAP | Unit Transmit/Receive | | 192.168.10.190 |
| 3 | Remote Device 3 | Other | None | UDP | Client Forward/Receive | 3 | 0.0.0.0 |
| 4 | Remote Device 4 | USP | None | UDP | Unit Transmit/Receive | | 0.0.0.0 |
| 5 | Remote Device 5 | USP | None | UDP | Client Forward/Receive | | 0.0.0.0 |

Making Stuff Work Together

Configure Output Actions

| GPO CONFIGURATION | | | | | | |
|-------------------|-----------|-----------------------|----------------|---------------------------|--------|-----------|
| GPO# | GPO Label | User Defined ON State | Operating Mode | Momentary On Time (*10ms) | Group | Currently |
| 1 | GPO_1 | Relay Closed ▾ | Latch ▾ | | RG1 ▾ | OFF |
| 2 | GPO_2 | Relay Closed ▾ | Latch ▾ | | RG1 ▾ | OFF |
| 3 | GPO_3 | Relay Closed ▾ | Latch ▾ | | RG1 ▾ | OFF |
| 4 | GPO_4 | Relay Closed ▾ | Latch ▾ | | None ▾ | OFF |
| 5 | GPO_5 | Relay Closed ▾ | Latch ▾ | | None ▾ | OFF |
| 6 | GPO_6 | Relay Closed ▾ | Latch ▾ | | None ▾ | OFF |
| 7 | GPO_7 | Relay Closed ▾ | Momentary ▾ | 100 ▾ | | OFF |
| 8 | GPO_8 | Relay Closed ▾ | Momentary ▾ | 100 ▾ | | OFF |
| 9 | GPO_9 | Relay Closed ▾ | Momentary ▾ | 100 ▾ | | OFF |
| 10 | GPO_10 | Relay Closed ▾ | Momentary ▾ | 100 ▾ | | OFF |
| 11 | GPO_11 | Relay Closed ▾ | Momentary ▾ | 100 ▾ | | OFF |
| 12 | GPO_12 | Relay Closed ▾ | Latch ▾ | | None ▾ | OFF |
| 13 | GPO_13 | Relay Closed ▾ | Latch ▾ | | None ▾ | OFF |
| 14 | GPO_14 | Relay Closed ▾ | Latch ▾ | | None ▾ | OFF |
| 15 | GPO_15 | Relay Closed ▾ | Latch ▾ | | None ▾ | OFF |
| 16 | GPO_16 | Relay Closed ▾ | Latch ▾ | | None ▾ | OFF |

Making Stuff Work Together

Configure Input Events- SNMP Traps

| SNMP TRANSMIT ACTIONS | | | | |
|-----------------------|---|------------------------------------|------------------|---|
| Line# | Event/Action Label 32 characters maximum | Community 16 characters maximum | Command | OID 100 characters maximum Use dot notation with |
| 1 | Aux System Fault #1 | public | TRAP (Rx Only) ▾ | 1.3.6.1.4.1.21541.8.1.0 |
| 2 | Main System Fault 1 | private | TRAP (Rx Only) ▾ | 1.3.6.1.4.1.1166.7.3.1.9.1.0 |
| 3 | Main System Fault 2 | public | TRAP (Rx Only) ▾ | 1.3.6.1.4.1.1166.7.3.1.9.2.0 |
| 4 | Main System Fault 3 | public | TRAP (Rx Only) ▾ | 1.3.6.1.4.1.1166.7.3.1.9.3.0 |
| 5 | Main System Fault 4 | public | TRAP (Rx Only) ▾ | 1.3.6.1.4.1.1166.7.3.1.9.4.0 |
| 6 | Primary Encoder Offline | trap community | TRAP (Rx Only) ▾ | 1.3.6.1.4.1.1166.7.3.1.231.0.x |
| 7 | Primary Encoder Online | trap community | TRAP (Rx Only) ▾ | 1.3.6.1.4.1.1166.7.3.1.247.1.x |
| 8 | Secondary Encoder Offline | trap community | TRAP (Rx Only) ▾ | 1.3.6.1.4.1.1166.7.3.1.22.0.x |
| 9 | Secondary Encoder Online | trap community | TRAP (Rx Only) ▾ | 1.3.6.1.4.1.1166.7.3.1.22.1.52.9 |

Assign Input EVENT to Output ACTION

| EVENT IN -> ACTION OUT TABLE | | | | | | | |
|------------------------------|-----------|--------------|-------------------------|-------------------------|--------|--------------|-------------------------|
| Line# | EVENT IN | | | ON ACTION | | | Local/ Remote Device |
| | Source | Event Type | Event | Local/ Remote Device | Type | Action Label | |
| 1 | SNMP TRAP | SNMP Receive | Aux System Fault #1 | Local | GPO ON | GPO_9 | Local |
| 2 | SNMP TRAP | SNMP Receive | Main System Fault #1 | Local | GPO ON | GPO_1 | Local |
| 3 | SNMP TRAP | SNMP Receive | Main System Fault #2 | Local | GPO ON | GPO_2 | Local |
| 4 | SNMP TRAP | SNMP Receive | Main System Fault #3 | Local | GPO ON | GPO_3 | Local |
| 5 | SNMP TRAP | SNMP Receive | Main System Fault #4 | Local | GPO ON | GPO_4 | Local |
| 6 | SNMP TRAP | SNMP Receive | Primary Encoder Offline | Local | GPO ON | GPO_7 | Local |
| 7 | None | | | | | | |

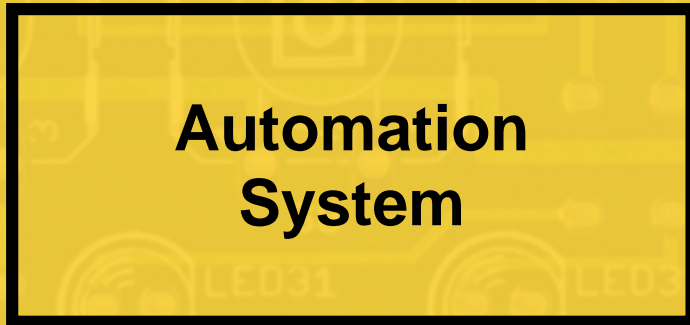
Making Stuff Work Together

Let's do something:

For the streaming feed, Operations wants to replace video server playout with cloud based play out.

Making Stuff Work Together

Controller



Known:

1. Supports GPI Outputs for secondary events
2. Supports serial VDCP control of video server
3. Does not support cloud vendor control protocol

Controllee



Known:

1. Does not support GPI/O
2. Does not support serial (maybe with really long cable?)
3. Does not support VDCP
4. Has its own proprietary control protocol

Making Stuff Work Together

Decisions:

1. Get help!
2. Call DNF Controls 😊

Making Stuff Work Together

Controller

Automation
System

- Emulates a VDCP video server
- Serial interface



Controllee



- TCP connection to cloud
- Supports cloud control protocol
- Supports Load, Play, Stop, Recue
- Support manual over-ride
- Weather control not yet supported



Making Stuff Work Together

QUESTIONS ?

Delivering Trusted Control Solutions for 28 years

DMF
CONTROLS