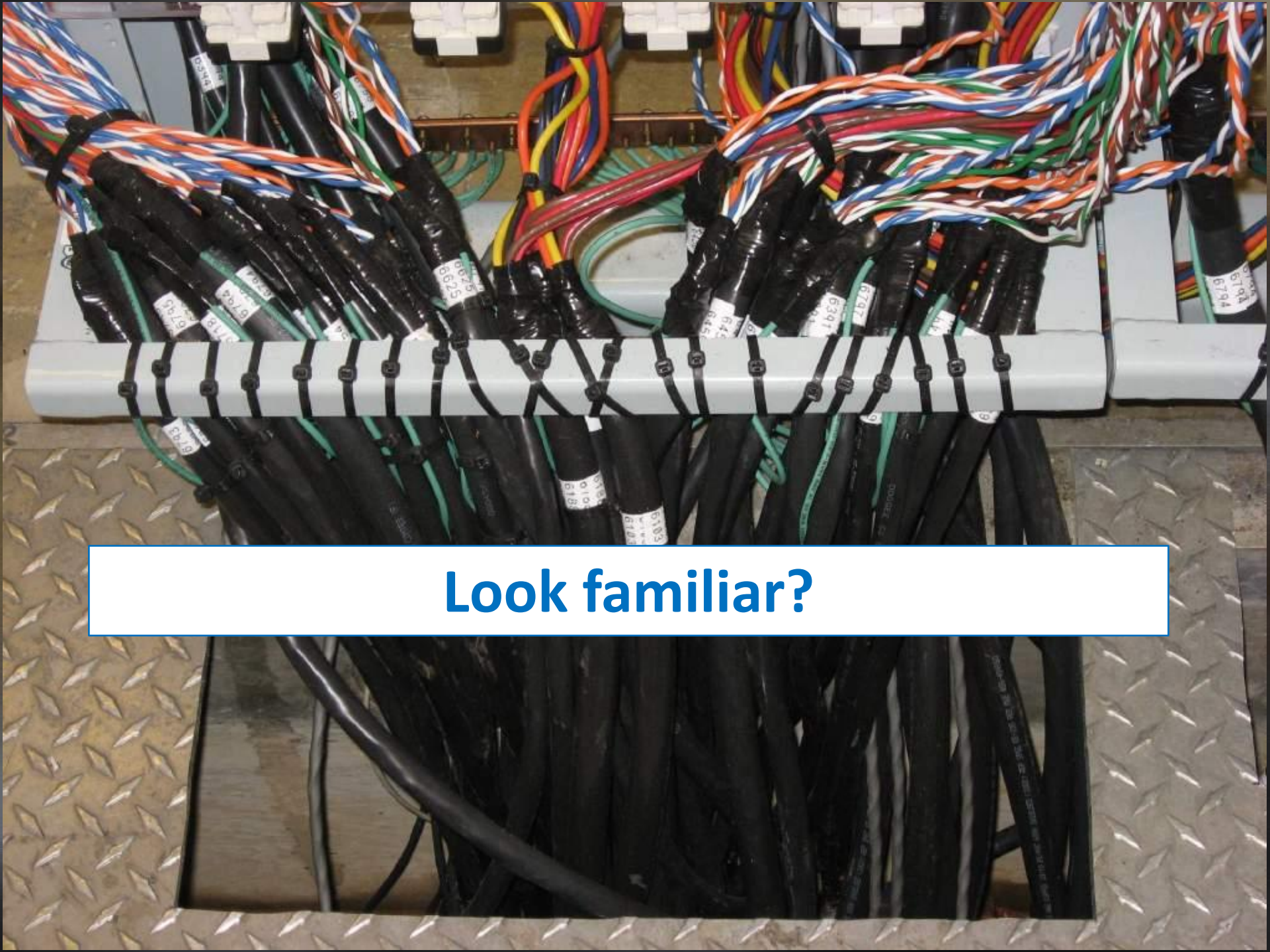
Manufactured Protection and Control:
A Modular Approach to Installing Protection and Control

Rich Hunt

GE Digital Energy

Texas A&M Relay Conference 2014


Look familiar?

The Problem

- A protection and control system is designed as a whole entity from the primary equipment all the way to the protective relay
  - From wiring terminations at the primary equipment, to wiring terminations at the relay

Protection System Reality

- Microprocessor relaying hasn't changed the execution of relay projects
  - Field wiring still the dominant cost and time sink
  - Up to 80% of project effort / cost
- Relays don't last forever
  - Requires a design for replacement strategy

A Reality of the Traditional Way

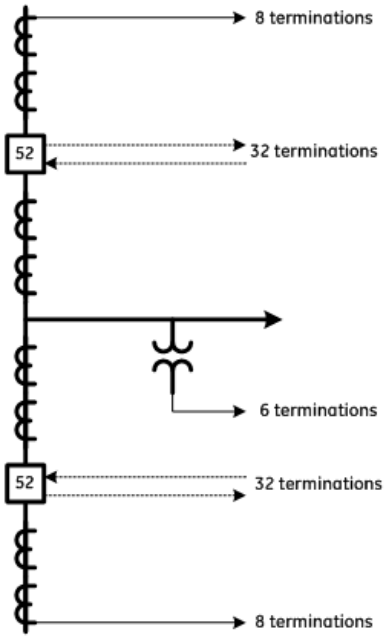
- MTTR = Mean Time To Repair (or Restore)
- "MTTI" = Mean Time To Install

For Utilities, MTTI = MTTR

Another Reality

- Pressure on costs
- Workforce issues:
  - Age (Experienced vs. inexperienced)
  - Skills / experienced
  - Count

Relay Replacement



- New relay / panel
- 80-90 wiring terminations
- Completely commissioned in the field
- ~16 man-hours relay
- ~24 man-hours wiring design
- ~ 80 man-hours field install

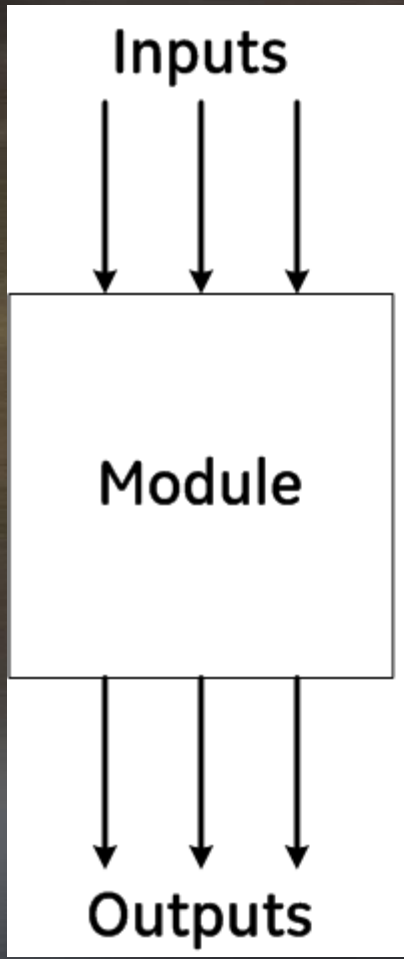
Engineering	Field
Relay Configuration	Wiring
Calculations, relay settings, scheme design, device configuration	Panel removal, panel installation, terminations to new panel
Wiring Design	Commissioning
Panel design, wiring design verification, wiring interface to panel	Wiring and device commissioning

Maths

- A utility needs to upgrade 2000 distribution substations
  - 3,000 transformer relays
    - 2 man-weeks field work per relay
  - 1,000 bus relays
    - 2 man-weeks field work per relay
  - 13,000 feeder relays
    - 3 man-days field work per relay
  - 11,900 man-weeks

(20) 2-man crews – 5.9 years

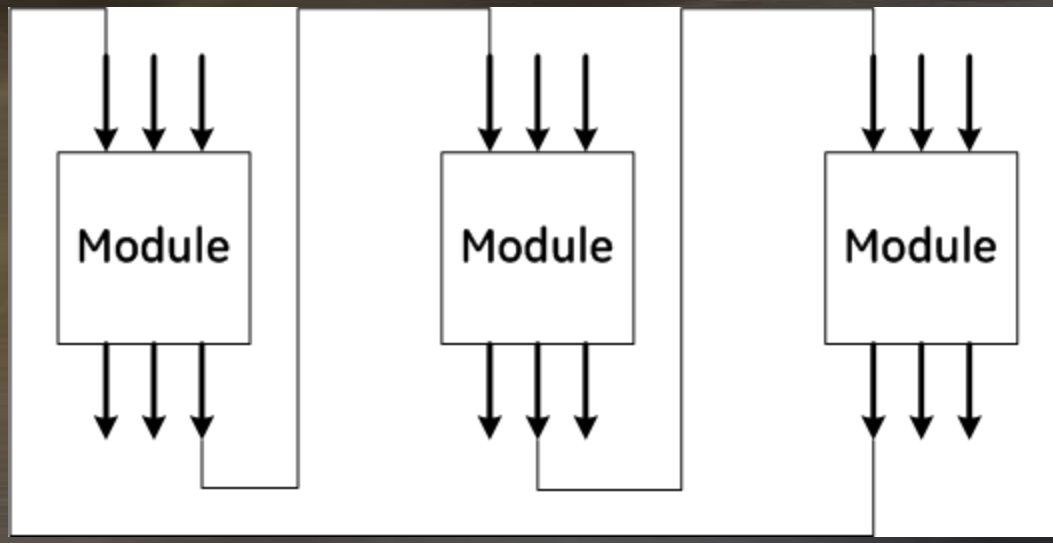
The Answer: Modular Design



Module Definition

A module is a black box solution. The module accepts inputs of a specific type at a specific location, makes operating decisions, and provides outputs of a specific type at a specific location.

Modular Systems



System Definition

Specific modules connected to make an entire system.

Or a module can be a system of modules

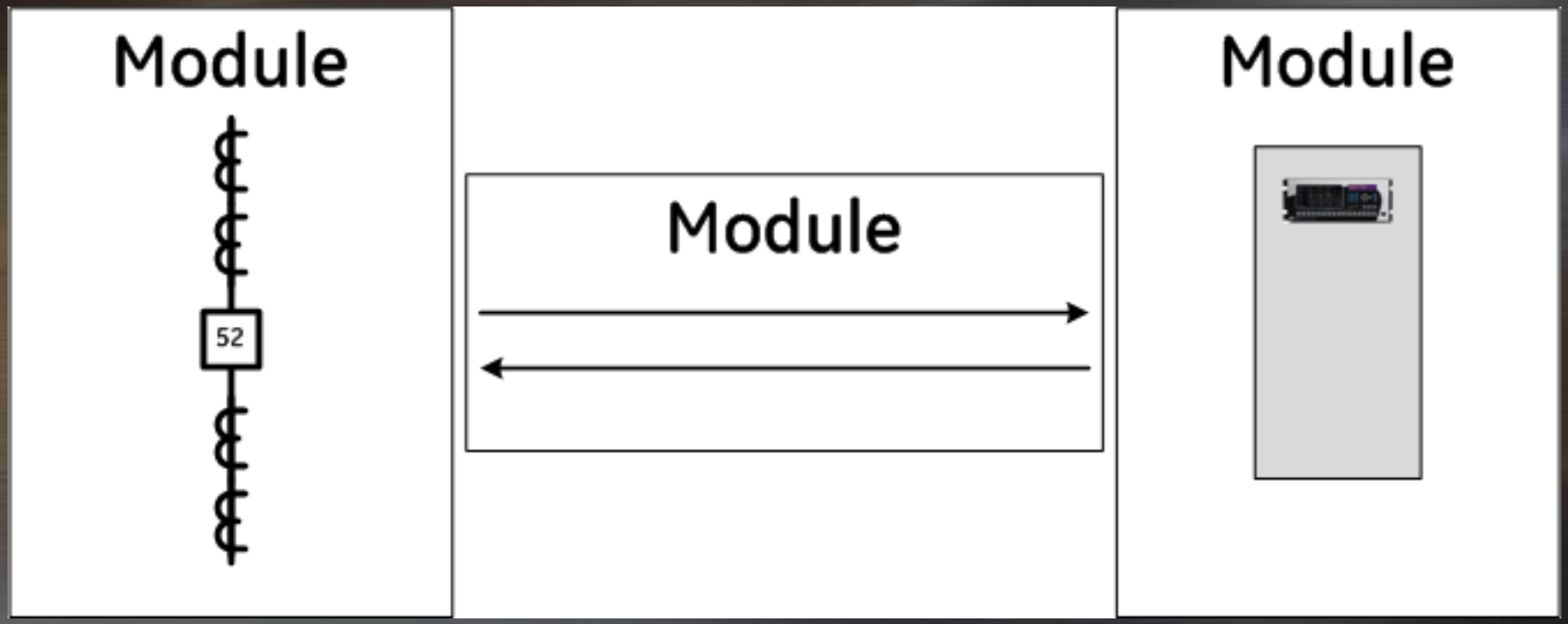
Why Modular Design?

- Modules broken down into logical functions
- Modules pre-designed
- Modules pre-manufactured and pre-tested
- Modules operate independently from each other
  - One module can be changed without impacting the rest of the system – or other modules.
- Modules quickly connect together for installation

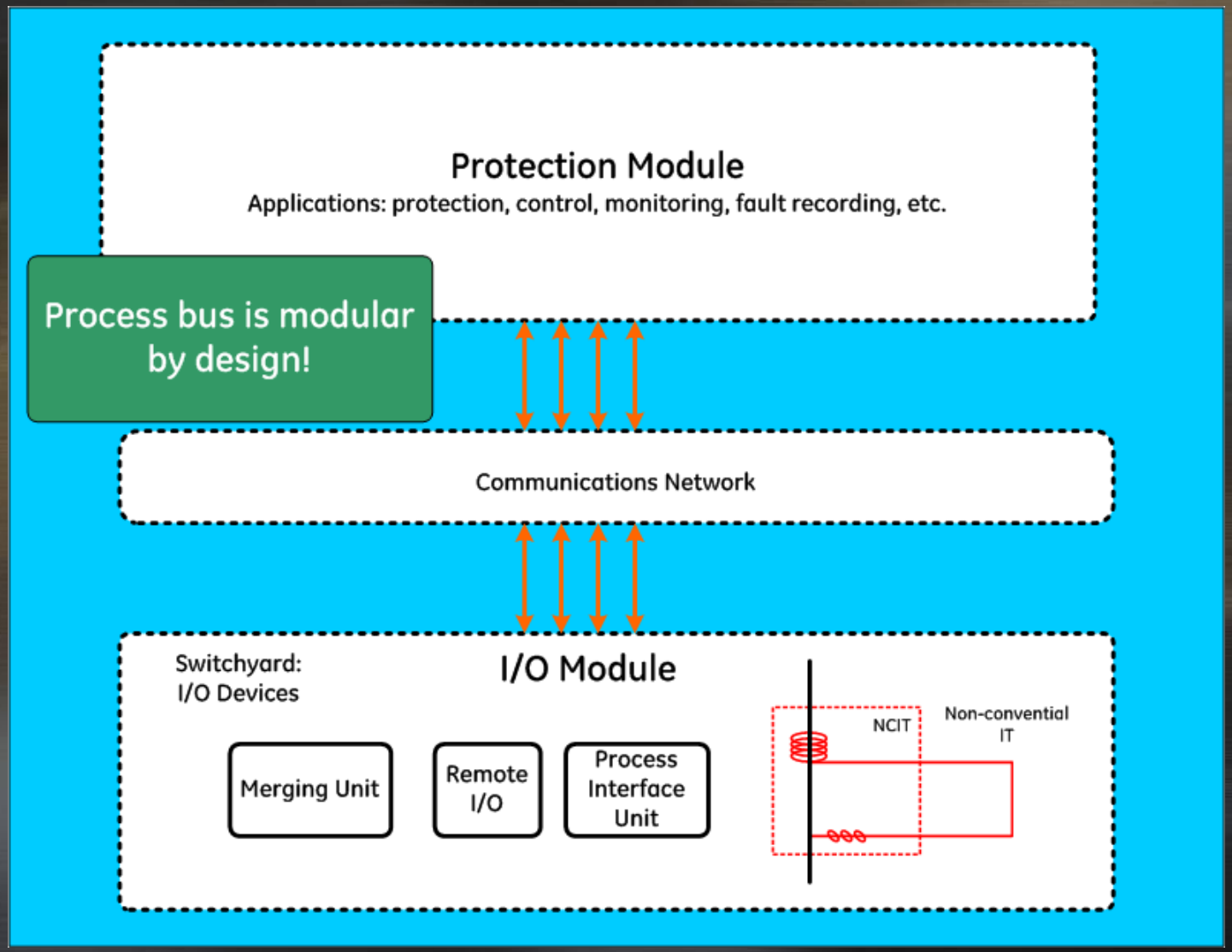
Advantages of Modular Design

- Focus on value-add design activities
- Designs become consistent
  - Accuracy, reliability, training, maintenance all get better
- Become parts installers / replacers
- Design for replacement by the very nature of modular design
- Allows for simple technology upgrades / application changes

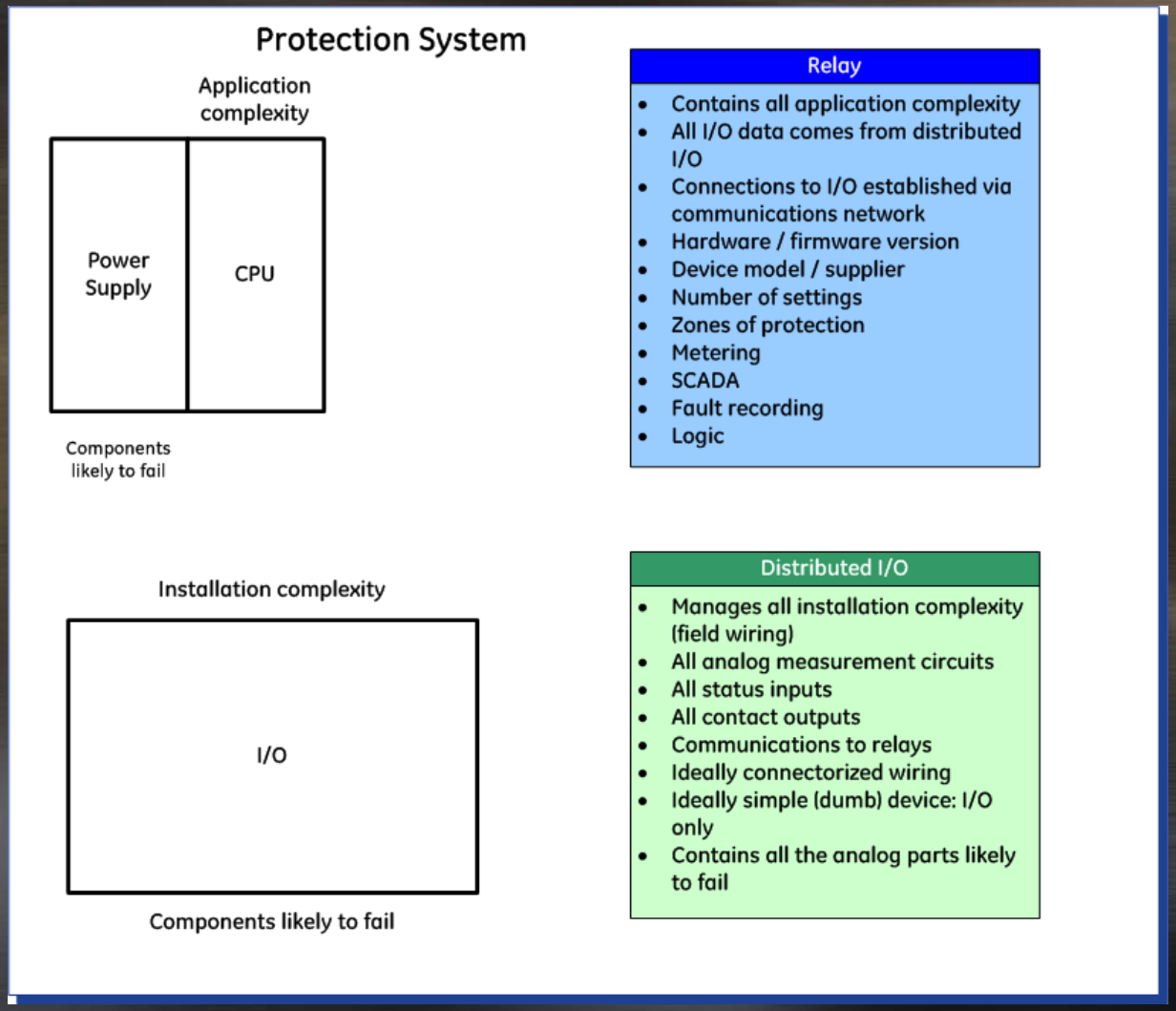
Modular Protection and Control System



Process Bus


Protection Module
Applications: protection, control, monitoring, fault recording, etc.
Process bus is modular by design!
Communications Network
Switchyard: I/O Devices
I/O Module
Merging Unit
Remote I/O
Process Interface Unit
NCIT
Non-convential IT

Process Bus Devices



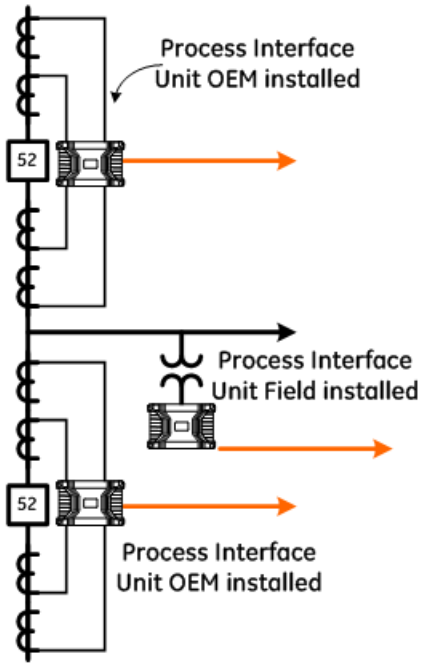
Process Bus Modules

- Relay panels (panels can be modular too)
- PIUs
- Fiber optic cables / communications

Relay Project Activities

- New installation
- Replacement of aging components
- Application change / upgrade (this project)

New Installation w/ Process Bus

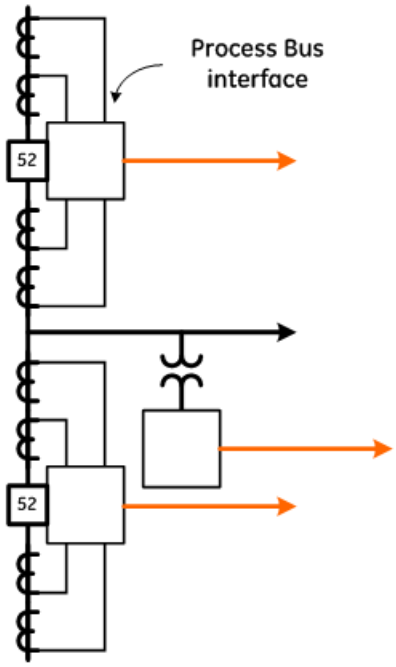


- Relay / panel
- PIUs, cables
- 6 wiring terminations
- Commissioned in lab and field
- ~16 man-hours relay
- ~24 man-hours wiring design
- ~ 8 hours lab commissioning
- ~ 47 man-hours field install

Engineering	Field
Relay Configuration Calculations, relay settings, scheme design, device configuration	Wiring Panel removal, panel installation, terminations to new panel, PIU installation and terminations
Wiring Design Panel design, wiring design verification, wiring interface to panel	Commissioning PIU commissioning Checkout commissioning
Commissioning Commission relays in lab before sending to site	

1 PIU installed in field – the rest are OEMed

Relay Replacement w/ Process Bus

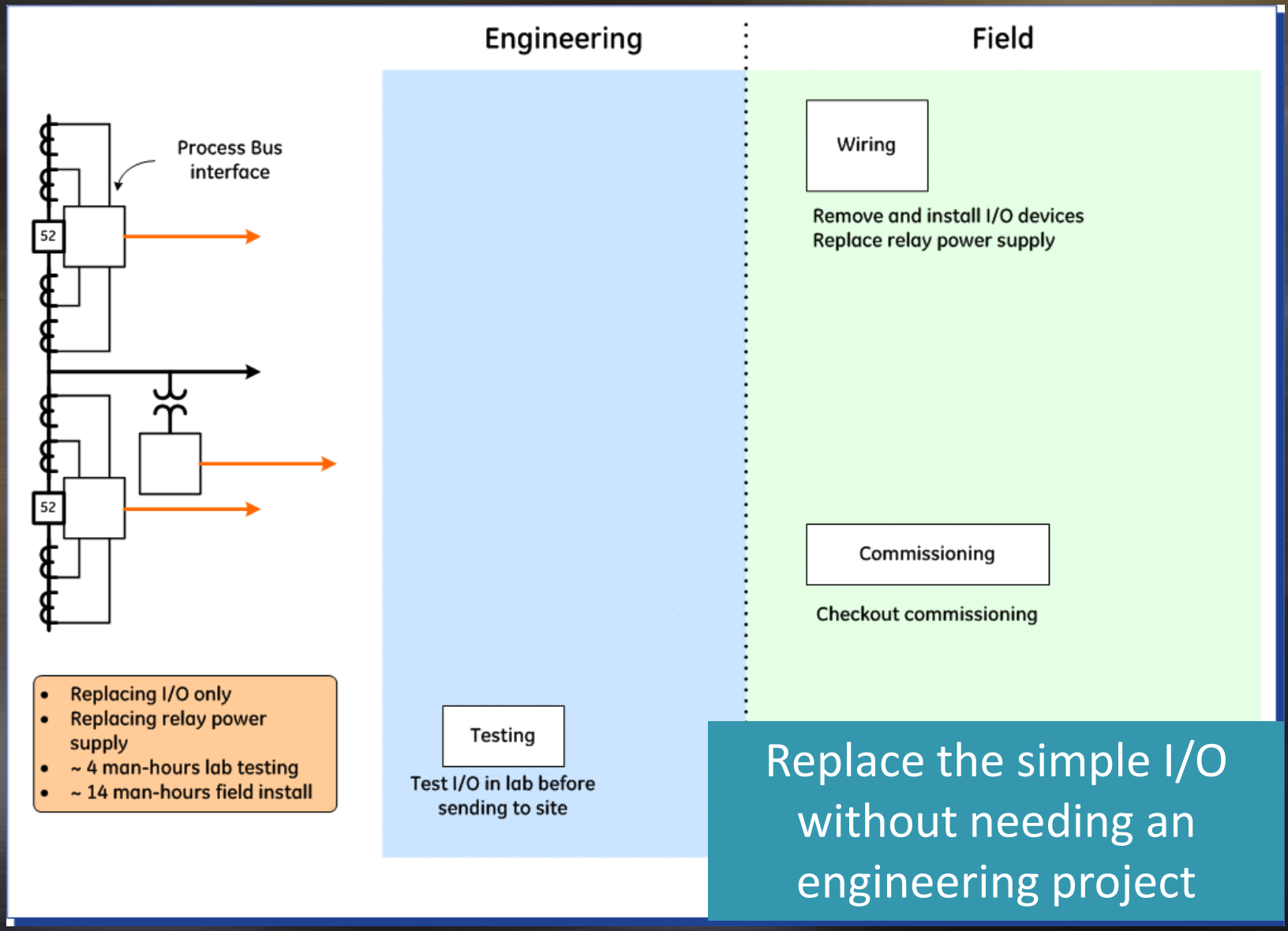


- New relay / panel
- New PIUs, cables
- 80-90 wiring terminations
- Commissioned in lab and field
- ~16 man-hours relay
- ~24 man-hours wiring design
- ~ 8 hours lab commissioning
- ~ 61 man-hours field install

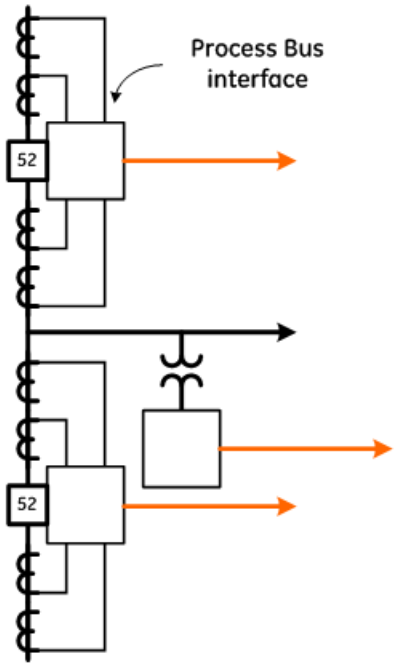
Engineering	Field
Relay Configuration Calculations, relay settings, scheme design, device configuration	Wiring Panel removal, panel installation, terminations to new panel, PIU installation and terminations
Wiring Design Panel design, wiring design verification, wiring interface to panel	Commissioning PIU commissioning Checkout commissioning
Commissioning Commission relays in lab before sending to site	

First process bus installation (retrofit) requires some field wiring

Process Bus I/O Replacement



Relay Design Change w/Process Bus

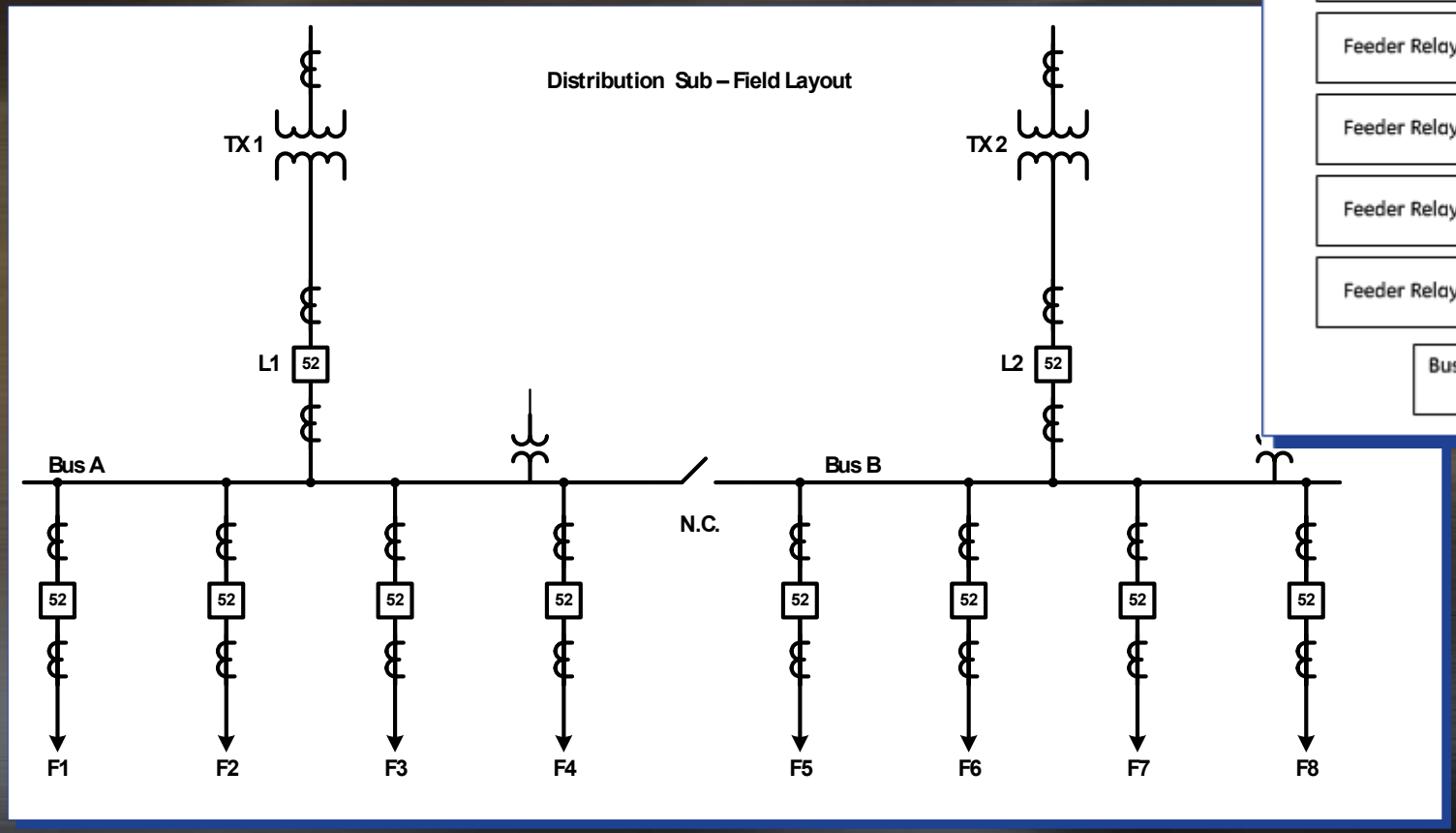


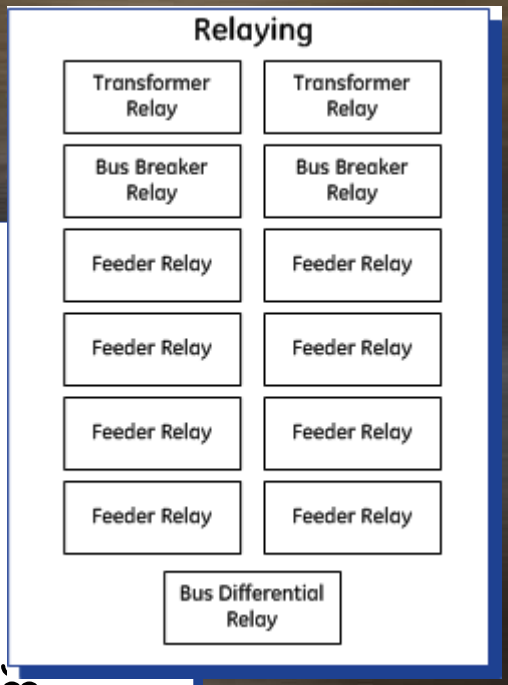
- Replacing relay, not I/O
- ~16 man-hours relay
- ~ 8 man-hours lab testing
- ~ 20 man-hours field install

Engineering	Field
Relay Configuration Calculations, relay settings, scheme design, device configuration	Wiring Relay installation
	Commissioning Checkout commissioning
Commissioning Commission relays in lab before sending to site	

Replace the complex relay without touching field wiring

Substation Project





This Project

- Application design
- Relay configuration
- Panel Design, manufacture, and test
- PIU mounting cabinet design, manufacture, and test
- Cable layout
- System FAT
- Install
- Commission

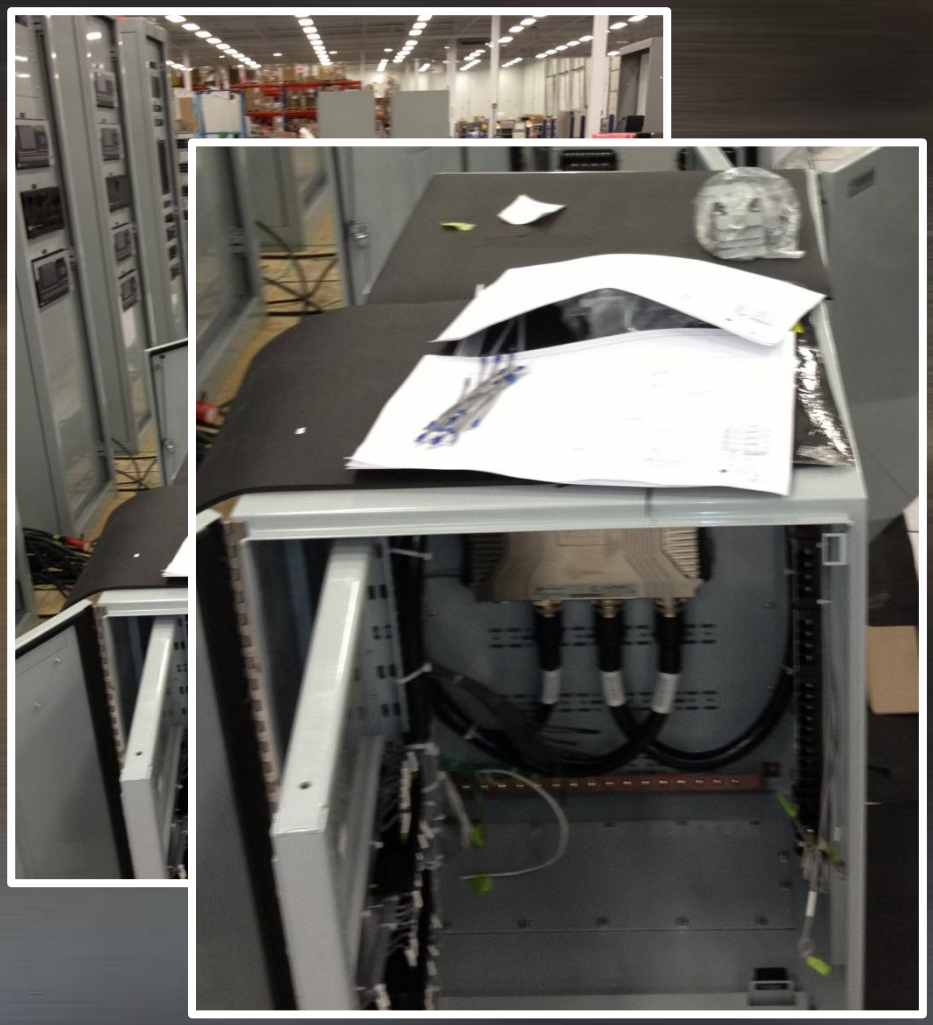
Manufacturer Scope of Supply

- Configured and tested relay panels
- PIUs mounted in cabinets
- Fiber optic cables
- Entire protection and control system tested as part of FAT

Relay Panels

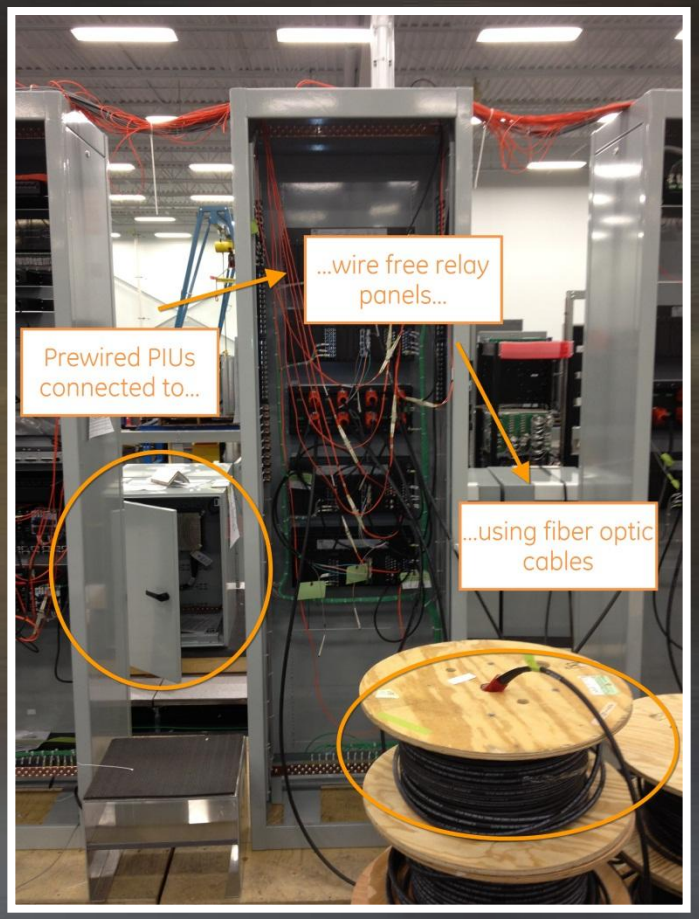
- Relay Panels designed and manufactured
- Relays configured
- Relays commissioned during FAT

PIU Cabinets



- Decided to use cabinets to simplify mounting to breaker cabinets
- PIUs wired to terminal blocks / test switches
- Cabinets bolt onto breaker control cabinets for easy field retrofit
- All cabinets designed / wired identically
- All cabinets pre-tested before shipping

Factory Acceptance Tests



- Tested, configured relay panels connected to...
- ....tested PIU cabinets using...
- ...fiber optic cables

Entire protection and control system tested end-to-end before shipping to site

Project

- 3 months from project start to in-service
- On-site work:
  - Wire in PIU cabinets
  - Install relay panels
  - Install fiber optic cables
  - 3 separate activities done in parallel
  - Checkout commissioning
  - 7 days install / commission

Summary: Why Do This?

- Every project is identical:
  - Order PIU cabinets
  - Order relay panels
  - Order fiber cables
- Project engineering is reduced to:
  - Relay schemes & configuration
  - Ordering materials
- Explicitly supports future replacement / upgrades
- Supports modular design of substations
  - Simple switchgear sections, containerized substations

Thank You

Questions?