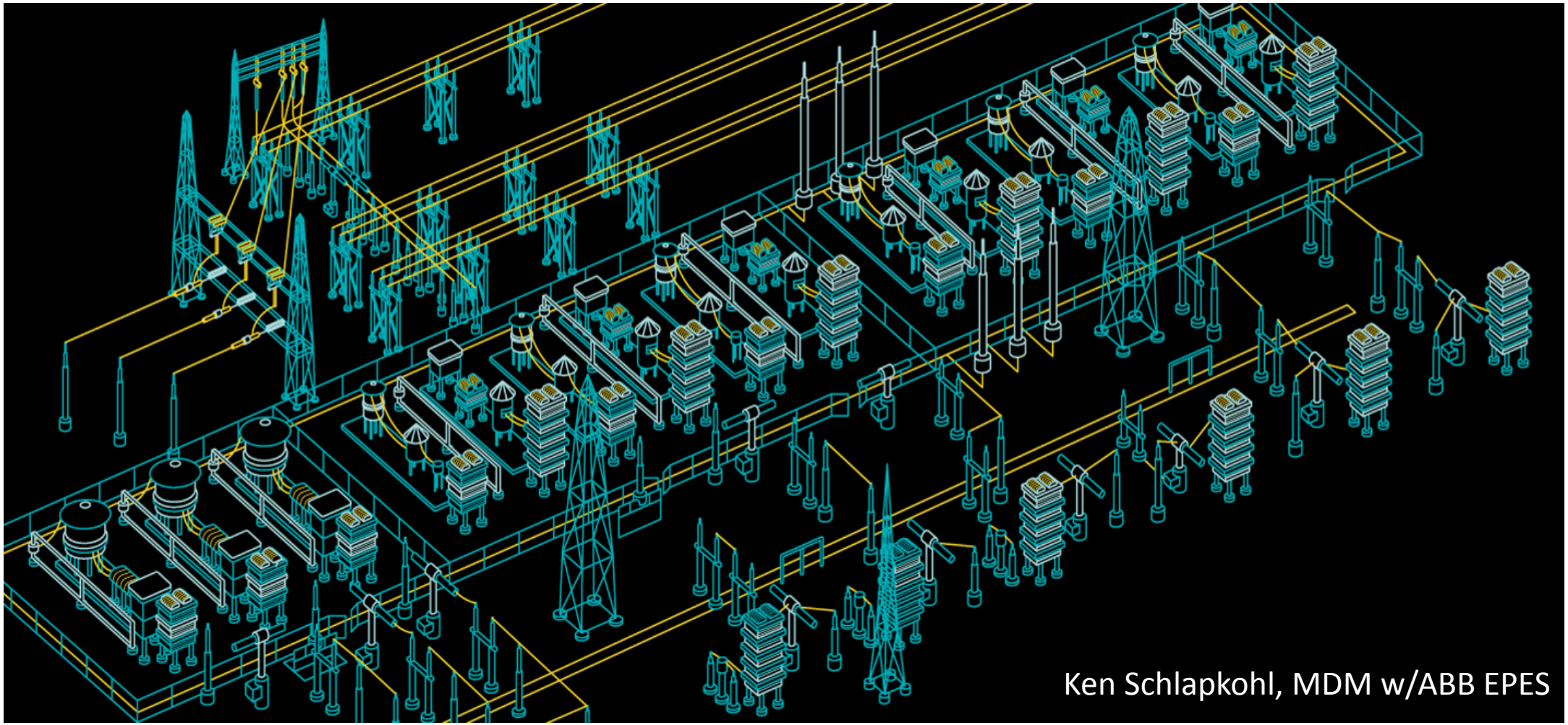
Application for IEC 61850 Parallel Redundant Protocol on a University Campus Micro Grid Power Distribution and Generating System



Overview

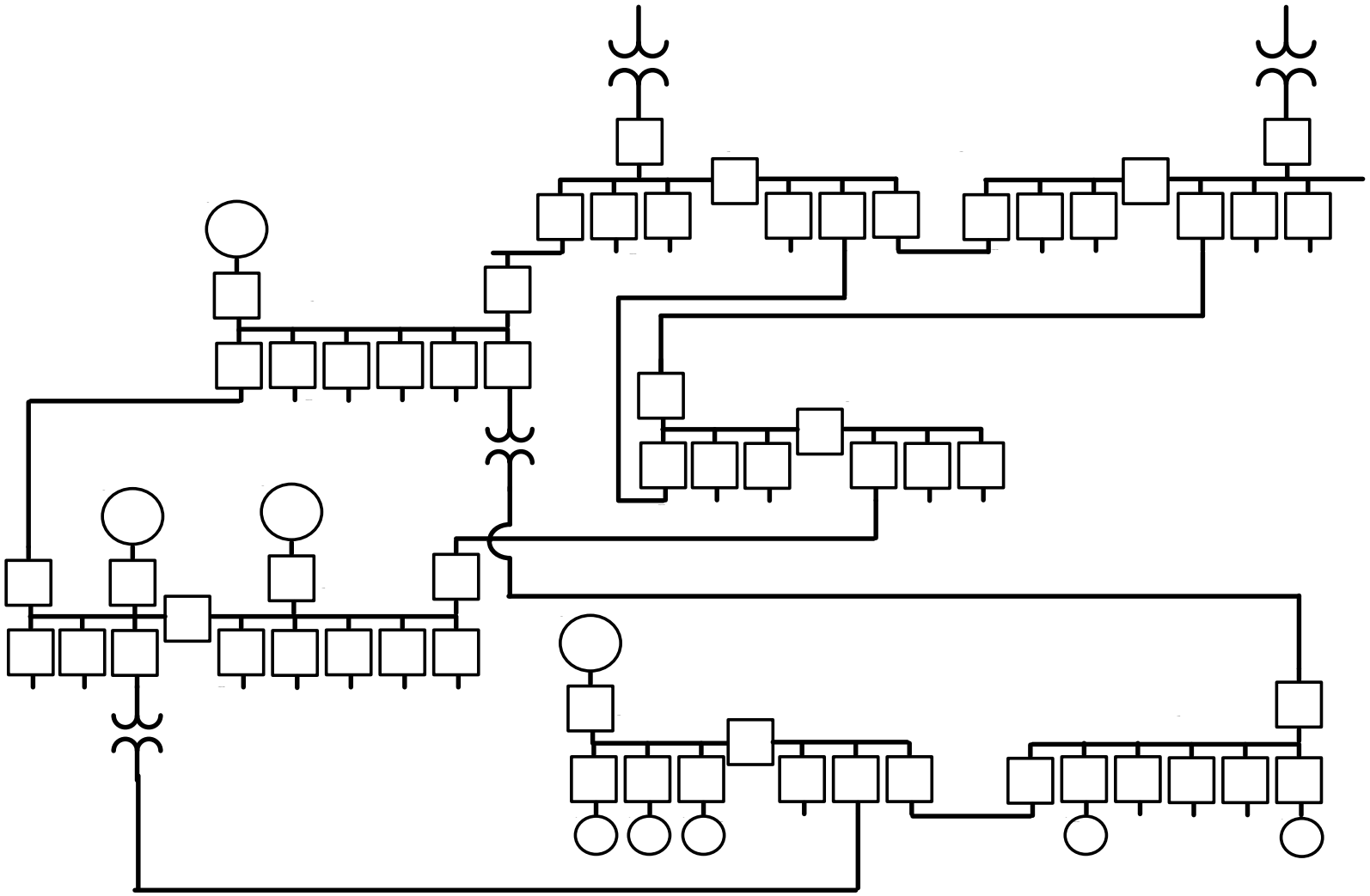
- Background/History
- Application Requirements
- Brief Overview of IEC 61850
- Network Design/Options
- Network Design/Options w/IEC 61850 Parallel Redundant Protocol (PRP)
- Additional Challenges During Implementation
- Conclusions

Background/History

- **Iowa State University, Ames Iowa**
  - **Research and Teaching Institution with over 42,000 students and faculty**
- **Long History for Generating Electricity**
  - **1884 Edison Isolated Electric Plant**
  - **1st Campus Light Bulbs Provided by T. Edison for the Physics Lab**
  - **By 1890 All Major Buildings Illuminated by Electric Lights**
- **Campus Power is distributed at 13.8 & 4.16 kV**
  - **46MW of Generated Power w/Connections to City of Ames through two 20 MVA Transformers**
  - **50-60% of the Power from on Campus Generation**

Background/History

Abbreviated Campus Power Grid Over View



Application Requirements

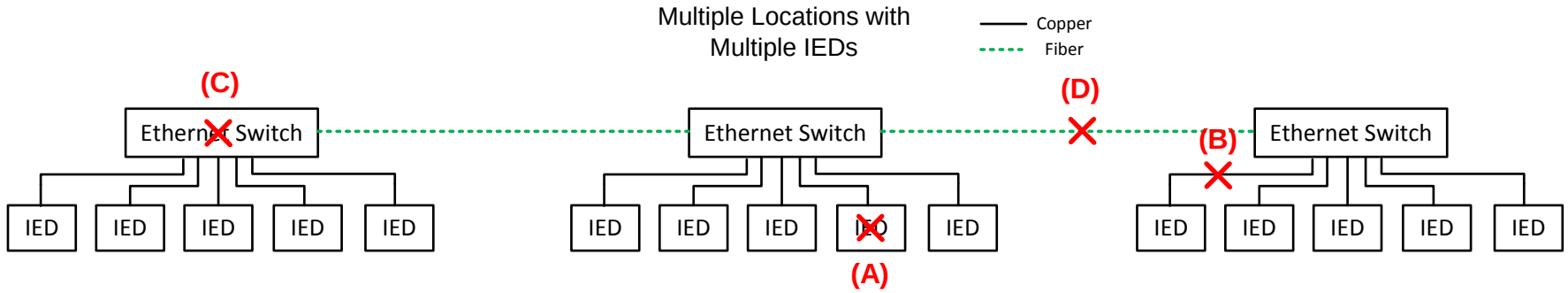
- Campus Grid Expansion Prompted Evaluation for a Change Out of the Existing Electro-mechanical Relays to Solid State Intelligent Electronic Devices (IED's)
- Multifaceted Evaluation Process
  - Function Set, Flexibility, Scalability, Ease of Use, Total Integration
- Existing Relays Interconnects Required a hard wire system Making Some Connections Difficult or Impossible based on Distance
- Segregating Power Sources required to minimize fault levels
- Arc Flash Detection to Lower Incident Energy
- Campus Distribution System Creates a Micro Grid that Permits Power to route in a Number of Different Combinations
- Monitoring & Control of Power Factor
- Communications Link required to the City of Ames
- Redundant Communications Path

Brief Overview of IEC 61850

- **A Global Standard Evolving out of ANSI UCA 2.0 and IEC 60870-5-103**
  - **Collaborative Effort from Both Standards Groups for issue resolution and device level**
  - **Creates long term Stability for Communications Between Intellegent Electronic Devices (IED's)**
  - **Allows interoperability between different protective relay manufactures**
- **Common Platform for Data Exchange via Generic Object Orientated Substation Event (GOOSE)**
  - **Transmission Rated Devices rated for 4 ms and Distribution Rated Devises rated for 8 ms.**
- **Utilizes Ethernet as Communications Backbone to Guarantee the Data Exchange Rate**
- **Error Checking as part of the Standard**

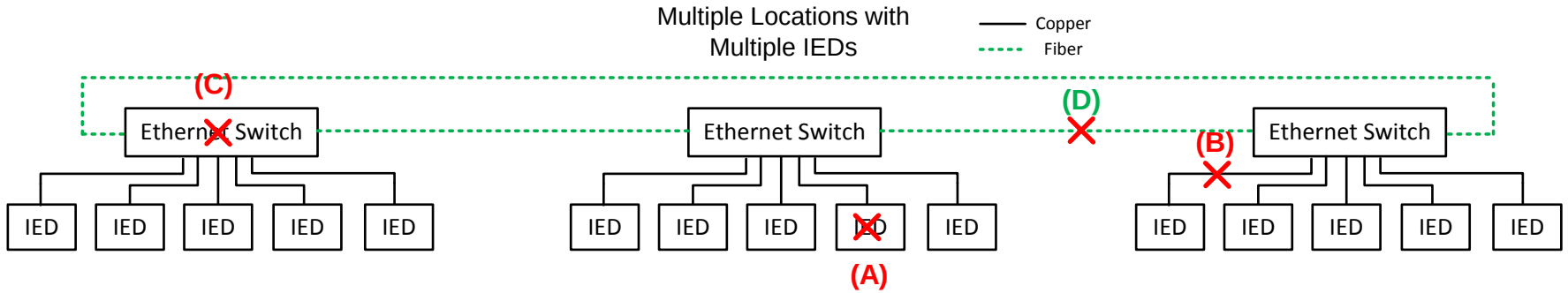
Network Design/Options

- **Network Communication Failure Points**
  - **IED (A)**
  - **Cable from IED to Ethernet Switch (B)**
  - **Ethernet Switch (C)**
  - **Cable from Ethernet Switch to Ethernet Switch (D)**



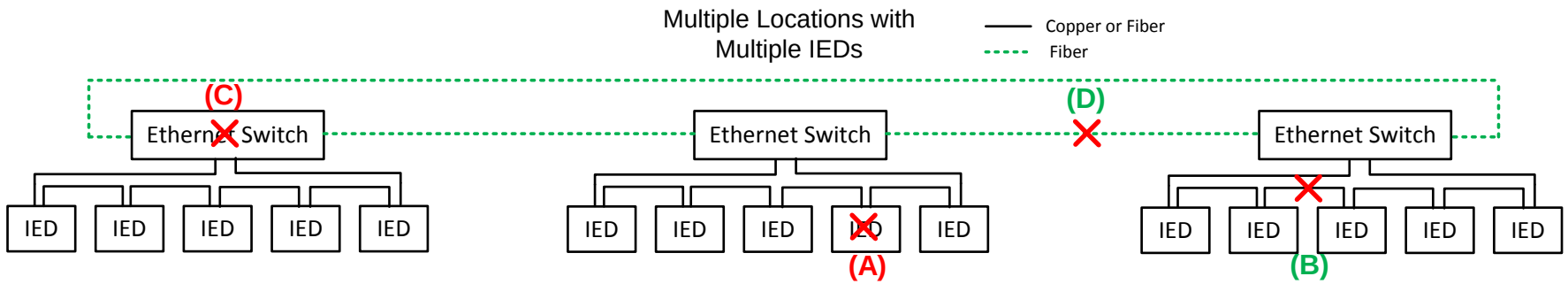
Network Design/Options

- **Network Communication Failure Points**
  - **IED (A)**
  - **Cable from IED to Ethernet Switch (B)**
  - **Ethernet Switch (C)**
- **Ethernet Switch Location to Ethernet Switch Location Still Capable (D)**



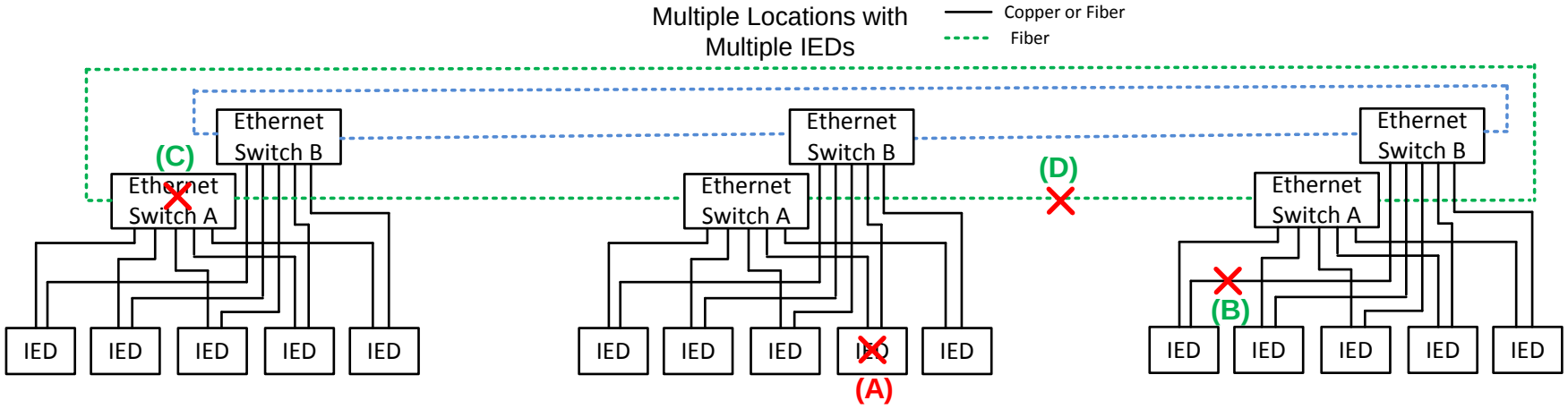
Network Design/Options

- **Network Communication Failure Points**
  - **IED (A)**
  - **Ethernet Switch (C)**
- **Ethernet Switch Location to Ethernet Switch Location Still Capable (D)**
- **IED Location to Ethernet Switch Same Location Still Capable via Ring Bus (B)**



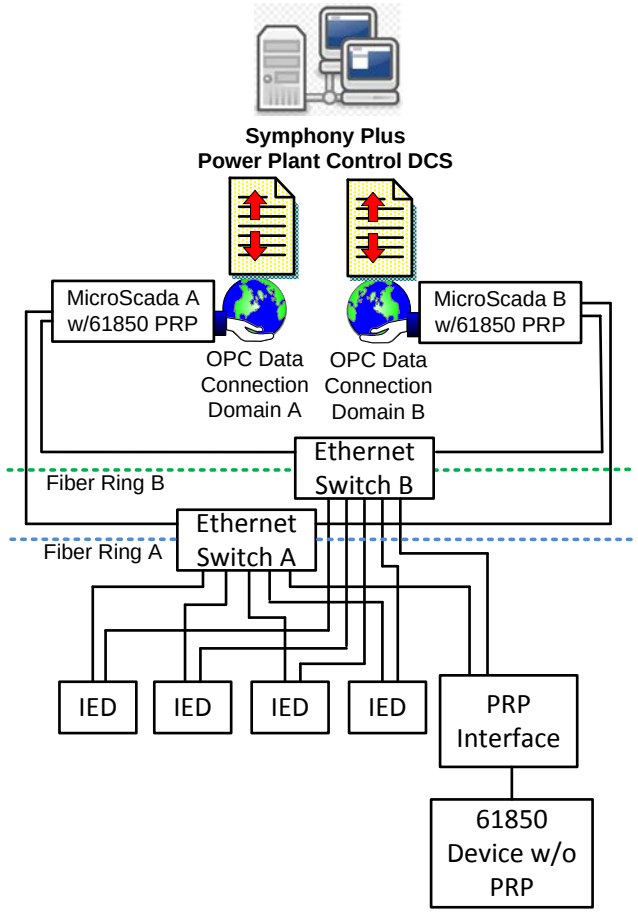
Network Design/Options w/IEC 61850 Parallel Redundant Protocol (PRP)

- **Network Communication Failure Points**
  - **IED (A)**
- **Ethernet Switch Location to Ethernet Switch Location Still Capable (D)**
- **IED Location to Ethernet Switch at Same Location Still Capable via Connection to Alternate Network Ethernet Switch (B)**
- **IED to Ethernet Switch Still Capable by Alternate Switch Connection (C)**



Additional Challenges During Implementation

- **Some IEC 61850 Devices did not support PRP**
  - **Required Special Network Interface Module**
- **Campus DCS System Accessed Data thru Redundant MicroScada Devices via OPC Link**
  - **Redundant MicroScada Served as Back Up for Campus Distributed Control System**



Conclusions

- **IEC 61850 Parallel Redundant Protocol allowed ISU the greatest amount of Flexibility and Scalability for their Networking Application**
- **The speed of the GOOSE message permitted ISU to interface protective Relays Across Campus with Control Schemes that were not possible before with hard wired systems**
  - **Cable Compartment Arc Flash Detection in Remote Switchgear Lowering Incident Energy Levels**
  - **Maintain Power by closing or opening Tie Connections on loss of a source or reverse power flow**
  - **Validate Remote Synchronization of Sources**
- **Network Security – Secure locations with open ports and no wireless connections**
- **Redundant Network Connections with Error Checking/Alarming for any network segment or component loss**

Questions?