

Substation Protective Relay Conversion from Analog to Digital Technology



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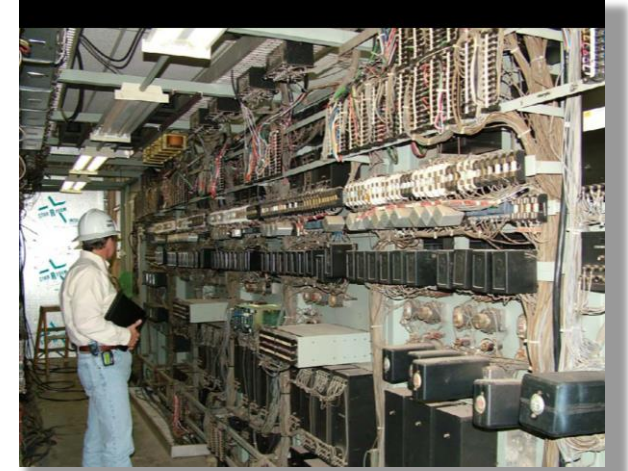
Objectives

- 1** Discuss benefits of digital technology
 - 2** Resources available in modern digital devices
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- 3** How to reduce copper cables in the substation
 - 4** Accurate fault-locating
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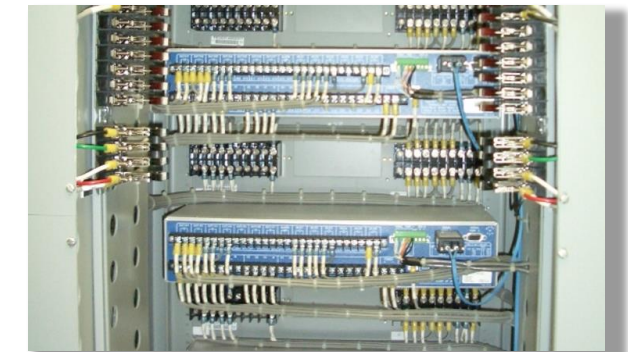
Electromechanical vs. Digital Relays



- Single function devices
- Protection only
- Complex wiring
- Expensive maintenance



- Multifunction – protection, control, automation, and monitoring
- Automated tests and self-diagnostics



Benefits of system protection, control, and automation with digital relays

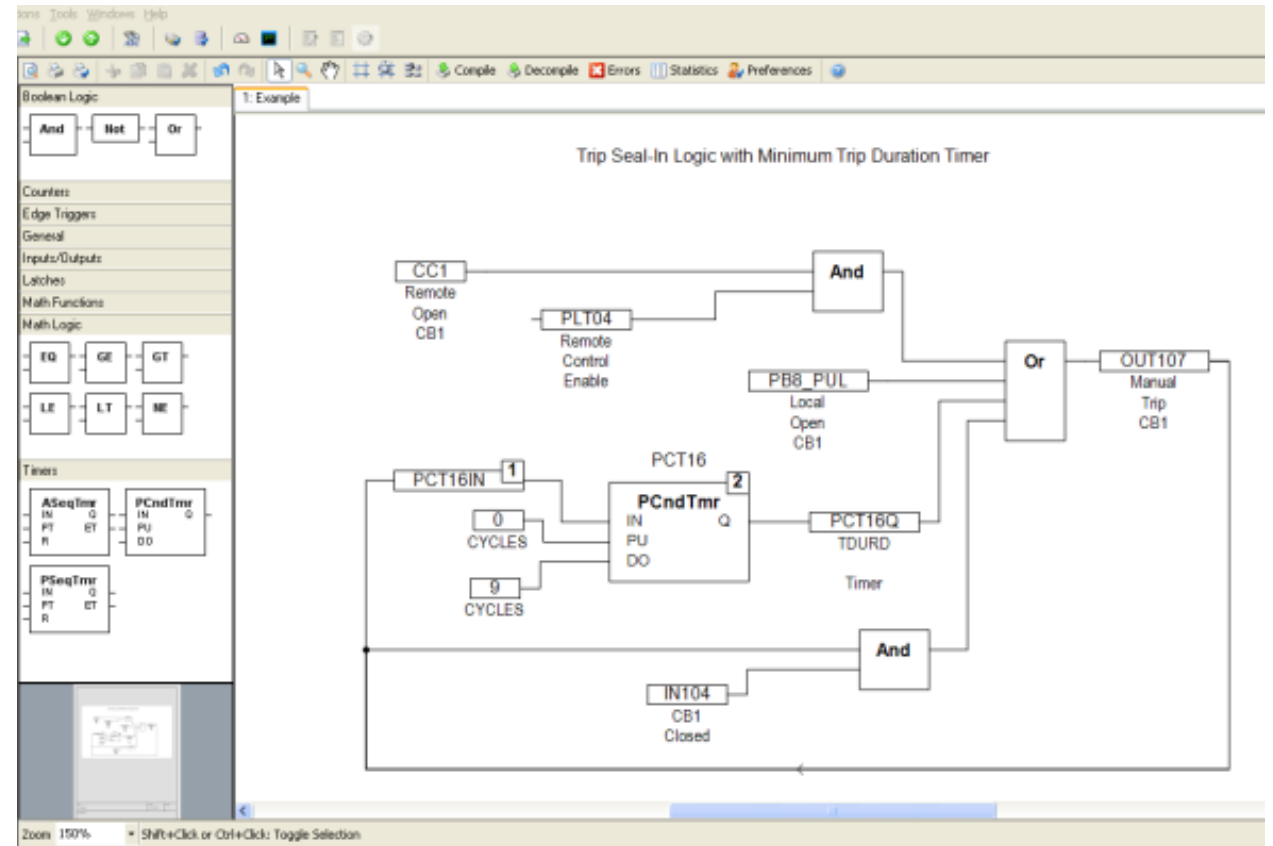
- Multifunction
 - Protection, metering, control, automation, integration, monitoring
- Special protection schemes
 - Arcflash, fast-bus tripping, load-shedding, etc.
- Accurate fault location
 - Travelling wave, double-ended impedance-based, etc.
- Oscillography
 - High-resolution, 1 MHz
- Sequential event reporting
- Remote engineering access
- Time synchronization
- Control HMI
 - Dedicated pushbuttons, bay mimic screens, metering, phasors, alarms, etc.
- Self-diagnostics
 - Extended maintenance interval
 - Automated test equipment

Benefits of system protection, control, and automation with digital relays

- Multifunction
 - Protection, metering, control, automation, interlocking
- Sequential event reporting
- Remote engineering access
- Synchronization
- Special protection
 - Reduce initial and operating costs
 - Improve continuity of service
 - Improve reliability
 - Reduce maintenance
- Arcflash fault clearing
 - Arcflash fault clearing, shedding, etc.
- Accurate fault location
 - Travelling wave impedance-based fault location
- Improved pushbuttons, bay screens, metering, alarms, etc.
- Diagnostics
- Extended maintenance interval
- Oscillography
 - High-resolution, 1 MHz
 - Automated test equipment

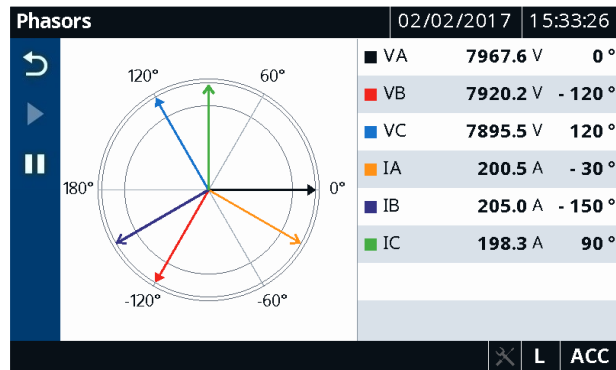
Digital relays programmable logic

- Reduces panel wiring
- Reduces installation time and costs
- Can be easily tested in laboratory
- Provides flexibility
- Facilitates troubleshooting with relay event reports and SER logs

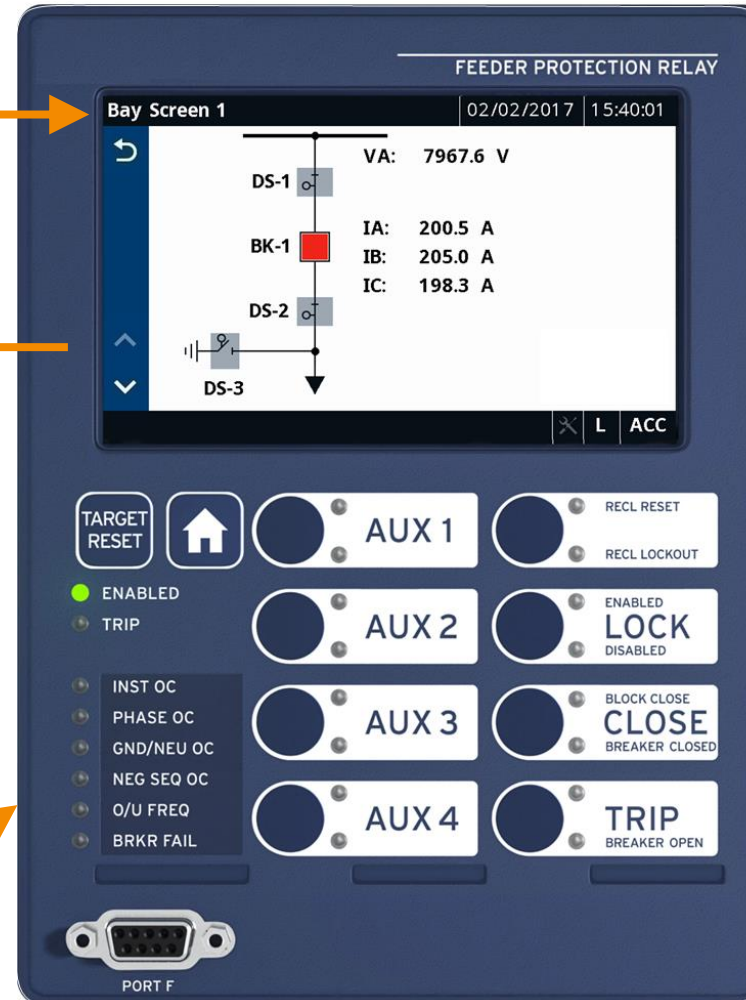


Digital relay front-panel HMI enables control and monitoring

Rotating
Touchscreen Display



Programmable
Target LEDs



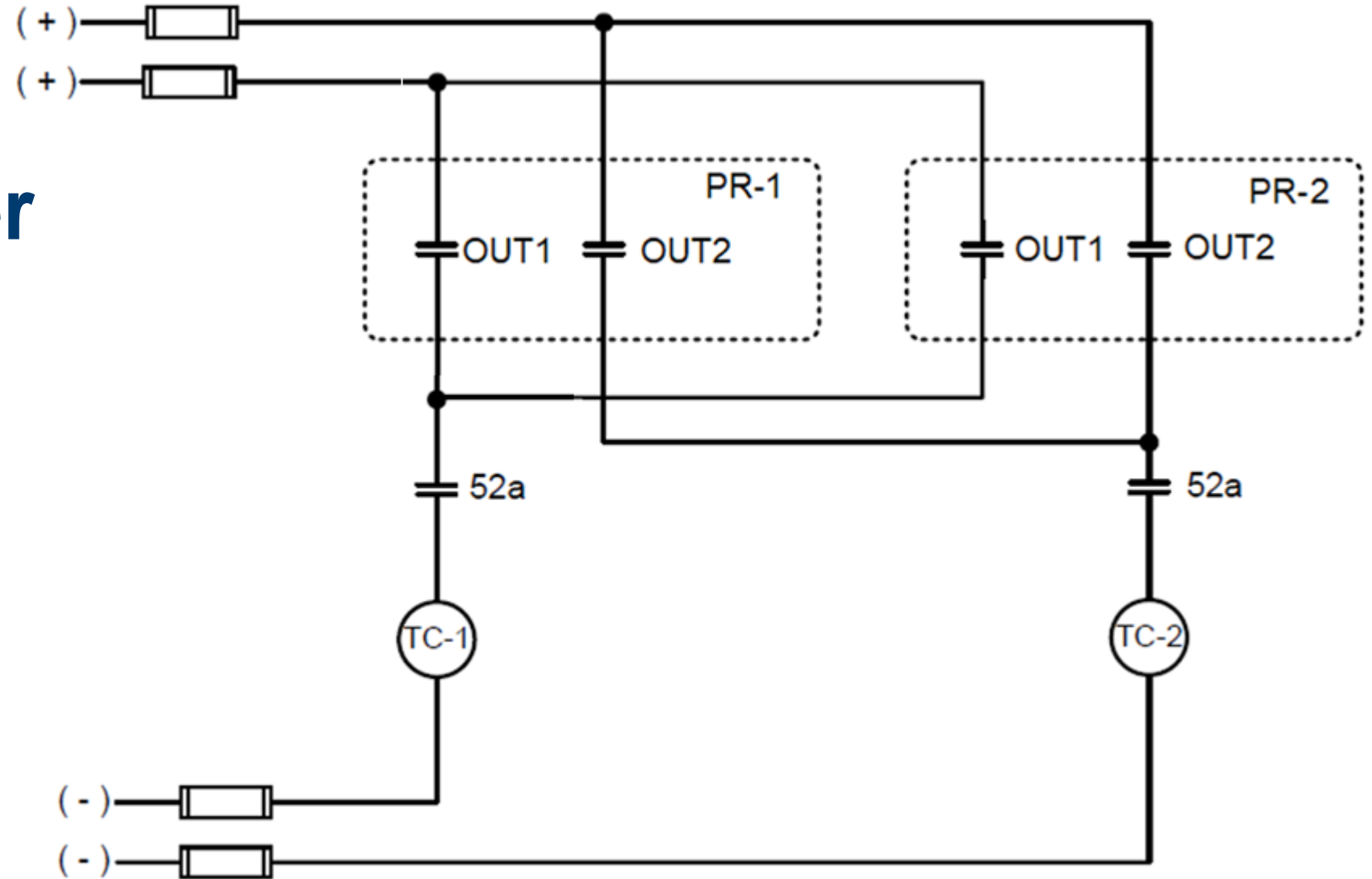
Operator
Pushbuttons

Advantages of digital relay output contacts

- Digital relays provide many programmable output contacts
 - Allow eliminating auxiliary relays
 - Simplify dc wiring, increase reliability and speed, and reduce cost
- Digital relays provide high-interrupting and high-speed contacts
- Output contacts connected directly to the CB coils

Single breaker tripping

Breaker with two trip coils



Use Fiber Optics Instead of Replacing Old Copper Control Cables

Is Less
Expensive

Fits in
Crowded
Trenches

Performs
Over Long
Distances

Is Resilient
to Moisture



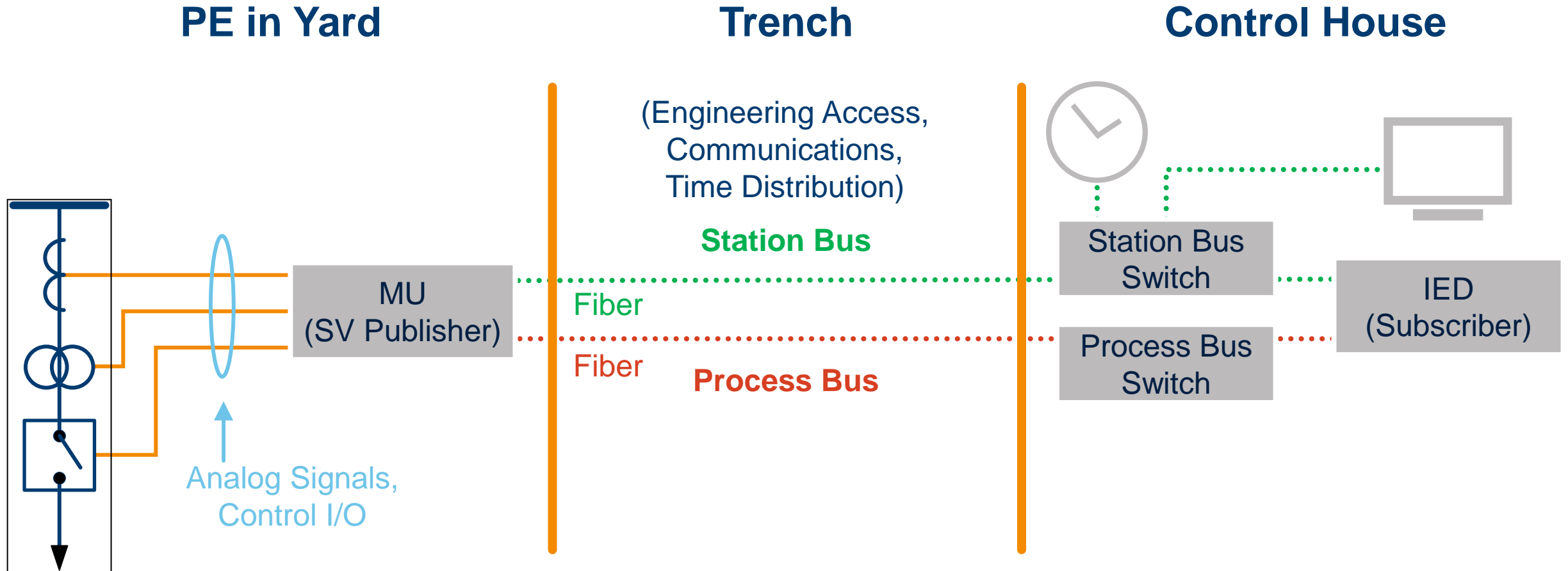
Cost Savings and Safety Motivate Adoption

Other Applications Emerge

- Modernizing substations with full trenches
- Minimize CT saturation
- Avoid control cable failures
- Personnel safety
- Optical CTs



Protection scheme with process bus



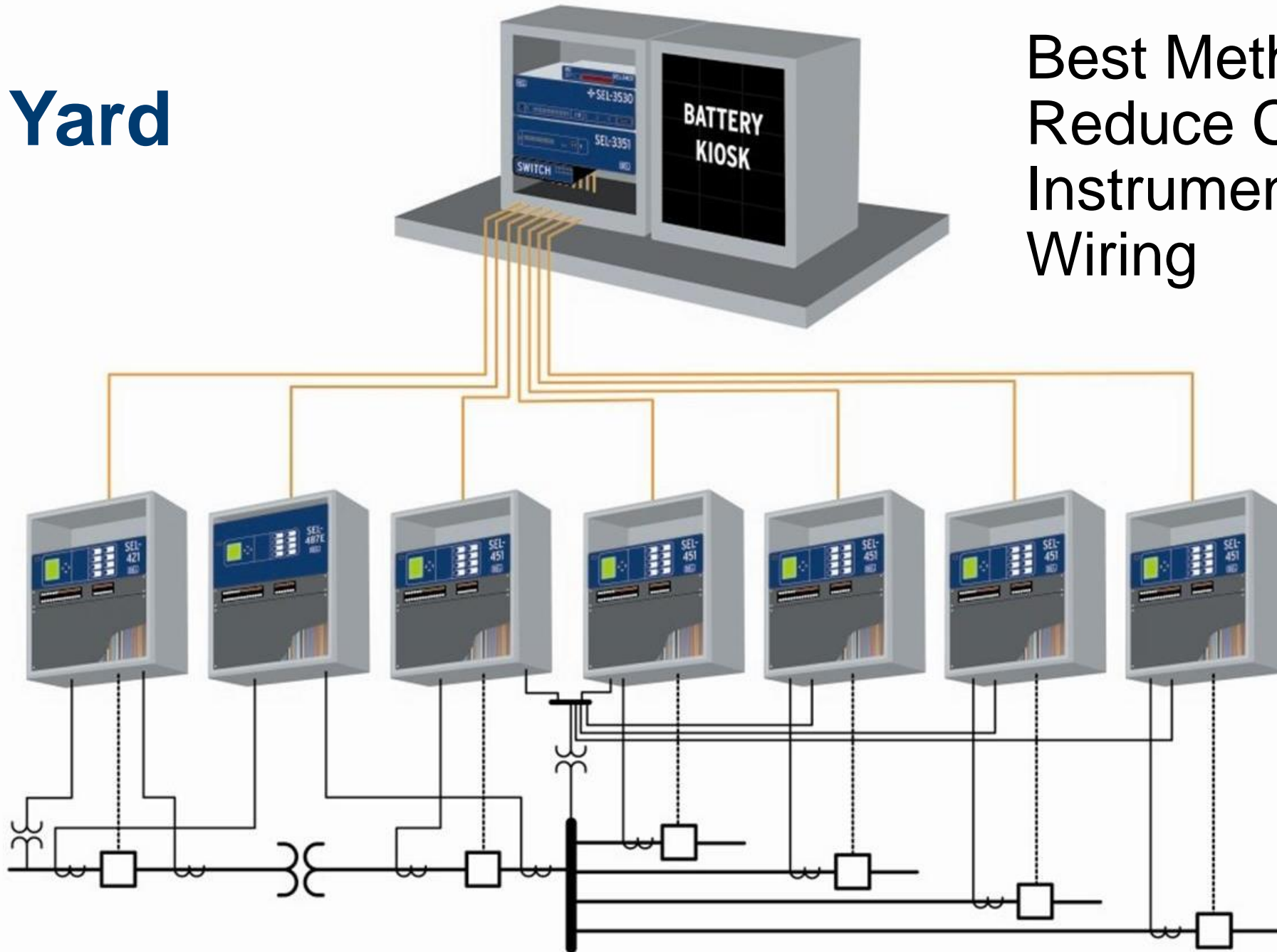
Move Relays to the Yard

- Locate relays closer to equipment
- Run CT, PT, and control wiring to relay
- Digital relays for harsh environments



Relay in the Yard

Best Method to Reduce Copper Instrumentation Wiring

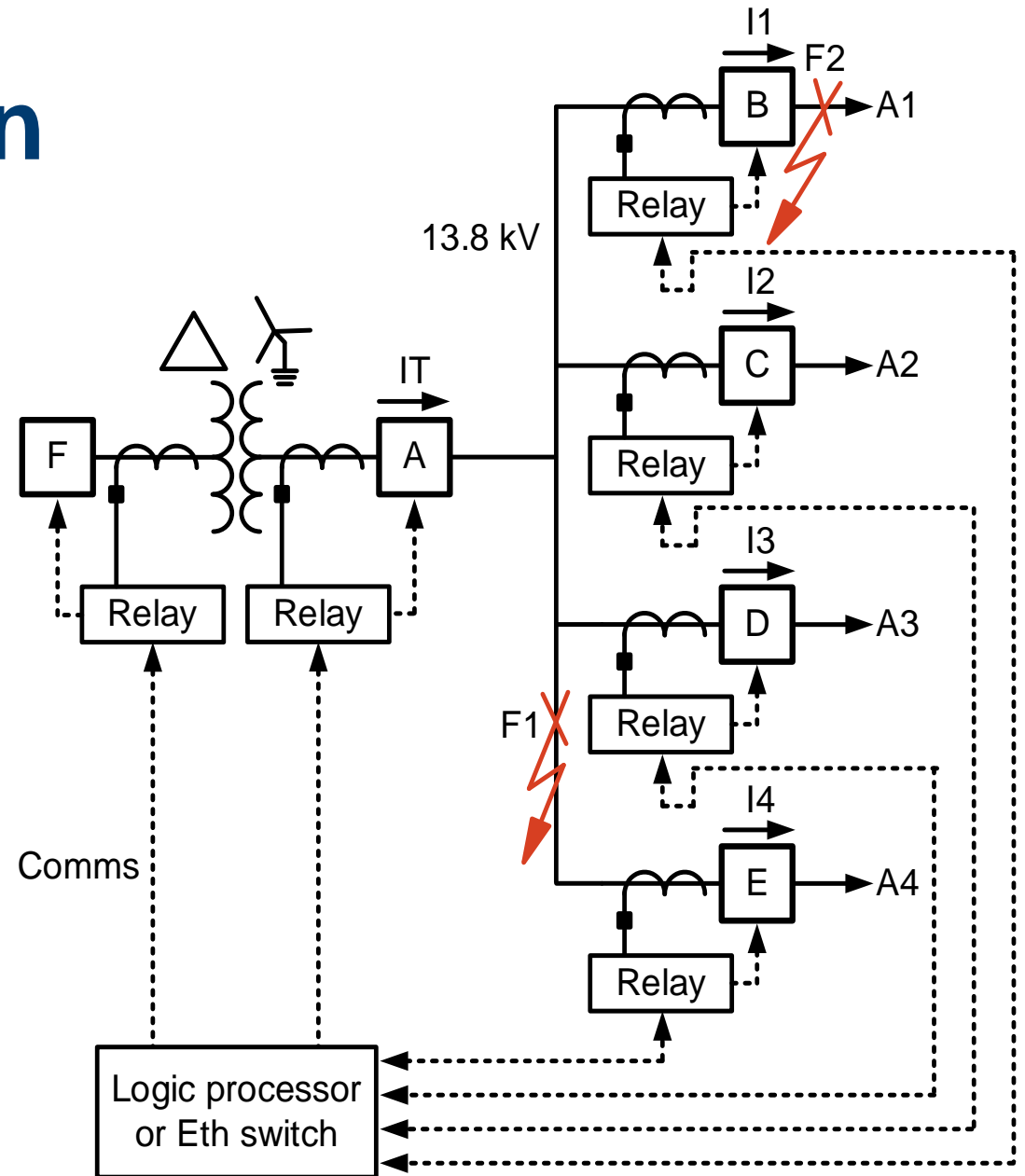
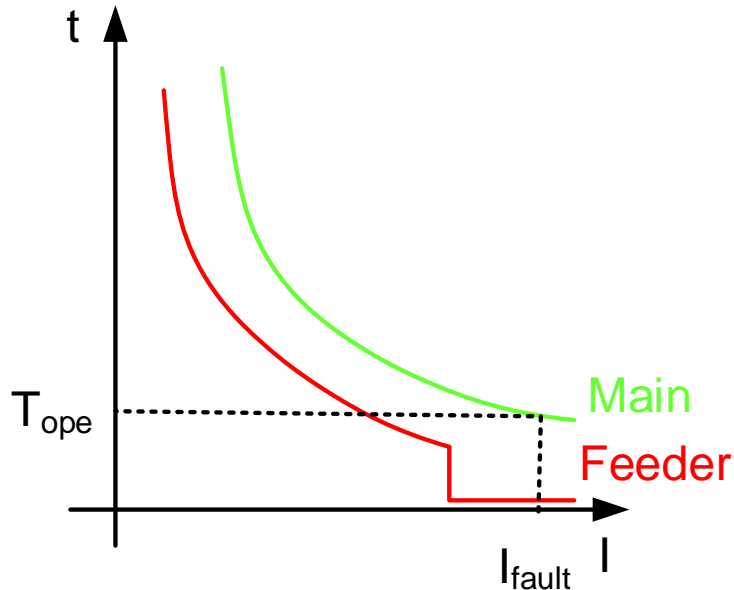


Click on the link below to watch the case study video “IEC 61850 Substation Modernization and Wire Reduction”.

<https://video.selinc.com/detail/videos/case-studies/video/700809017001/iec-61850-substation-modernization-and-wire-reduction?autoStart=true&page=1>

Fast-bus tripping and breaker failure protection

- High-speed communication protocols
- Supervision of comms enables or disables schemes

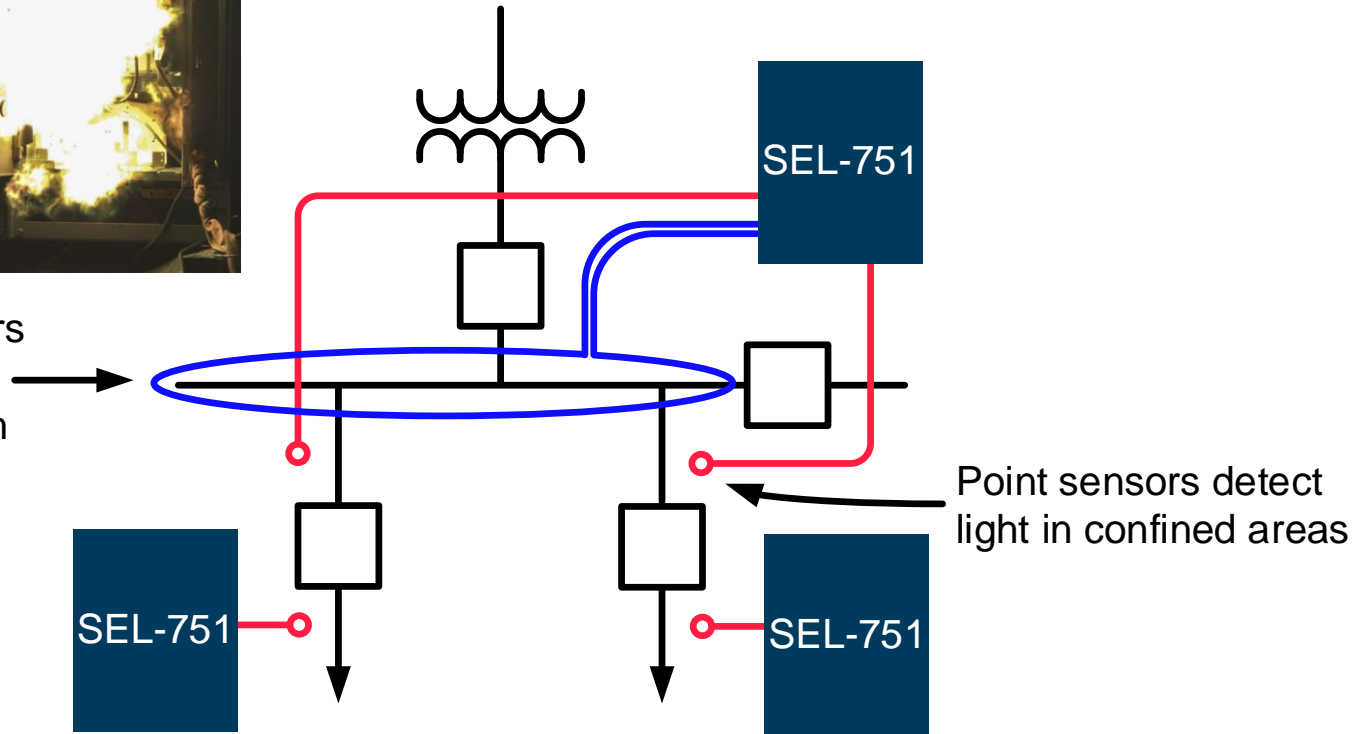


Arc-flash protection with digital relays

Saving lives

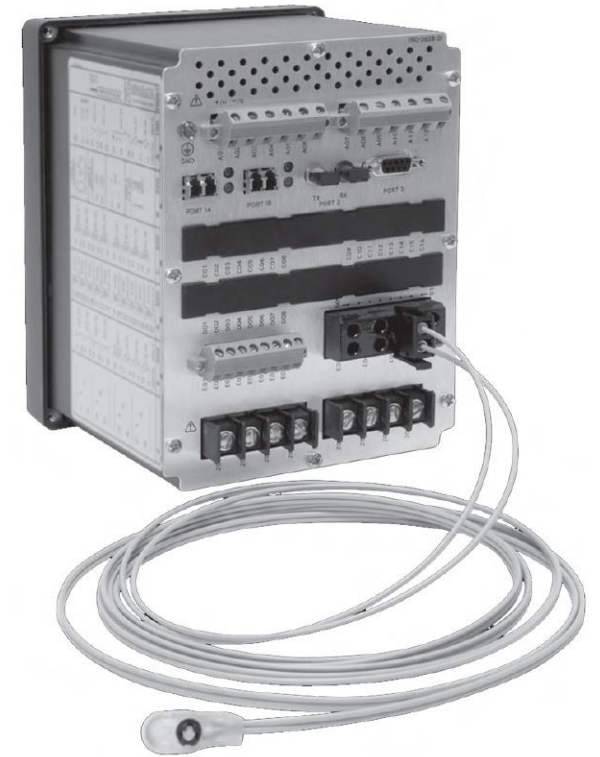


Bare-fiber sensors
detect light over
their entire length



Point sensors detect
light in confined areas

Combination of light sensors and overcurrent protection provides trip security



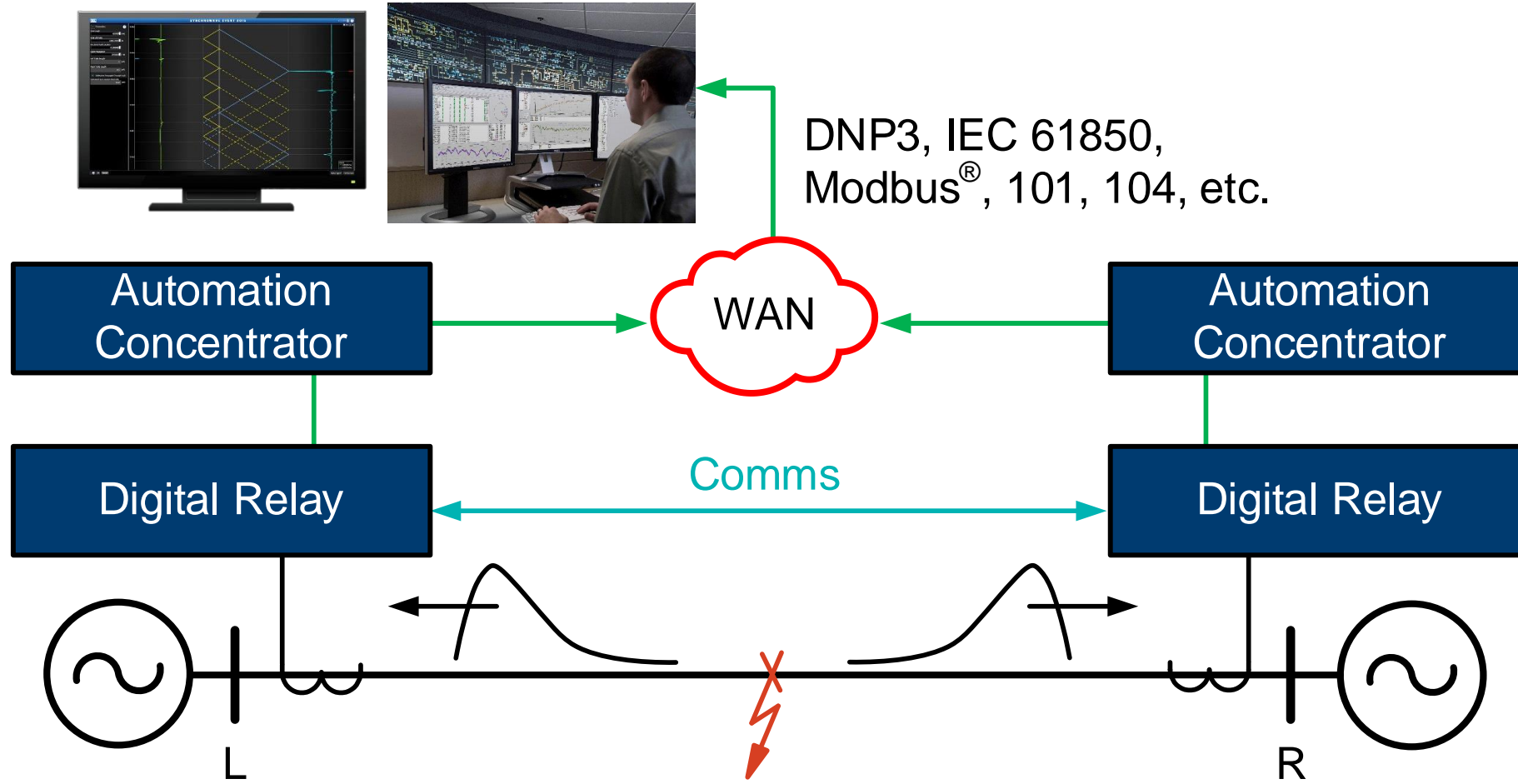
Travelling Wave Fault-locating

- Pinpoint faults/events to the nearest tower
- Expedite service restoration
- Reduce outage time and costs
- Identify insulator problems
- Prevent recurring faults

Fault located by SEL-411L
Photo source: BPA, 2017



TW Fault Location Information Promptly Sent to Control Center



Eliminate patrols, reduce downtime, and make system more reliable

Summary

Going from analog to digital technology

☒ Reduce initial and operating costs

☒ Improve continuity of service

☒ Improve reliability

☒ Reduce maintenance

Thank you

