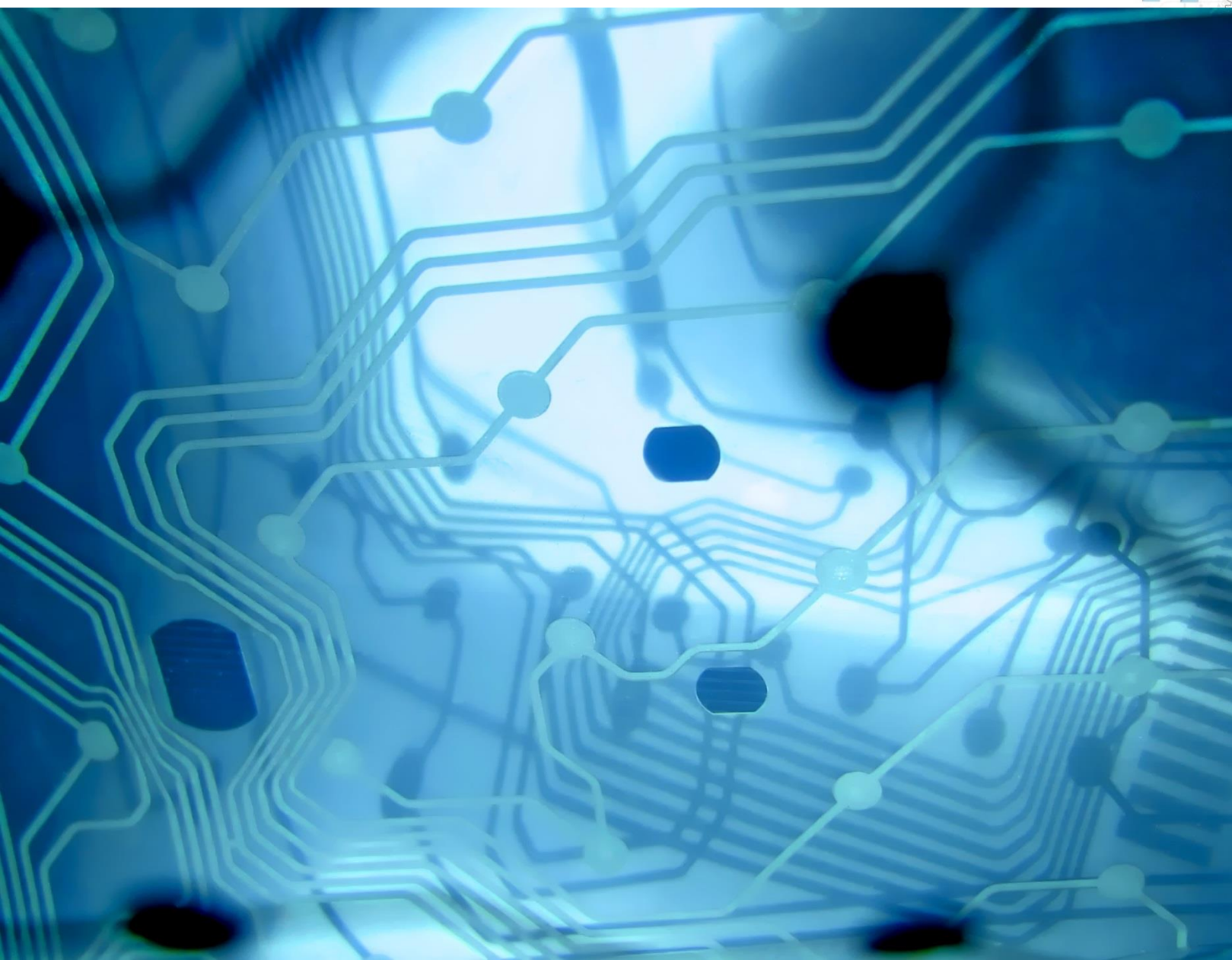
SCADA AUSTRALIA 2016
24 – 25 May 2016 | The Royce Hotel, Melbourne, VIC

SCADA innovation

How to test relays without blacking out the zone substation



The utilities sector is moving towards smart grid technology – a shift that reflects the rapid advances in technical capacity for SCADA systems. Victoria University (VU) in Melbourne will become a cornerstone for integrating smart grid technology into Australia's electricity supply market, with the development of one of the world's few (if not first) *Zone Substation Simulator Centre (VZSSC)*.

At the last SCADA event, two of the project's lead specialists shared exclusive insight into the technical specifications, research and development, and what it means for the electricity supply industry. The specialists include:

- **Dr Akhtar Kalam**, Discipline Leader – Electrical & Electronic Engineering at VU; and
- **Graeme McClure**, Principal Engineer – Protection, Control & Automation, AusNet Services

Simulator specifications

The Centre will simulate 66 to 22 KV substation environments (specifically a two-transformer zone substation with dual MV buses), control and protection schemes using the IEC 61850 technology standard for the automation and control designs.

Whilst a breaker and a half configuration will define the sub-transmission side, the protection and control setup will encompass a specific X & Y protection scheme.

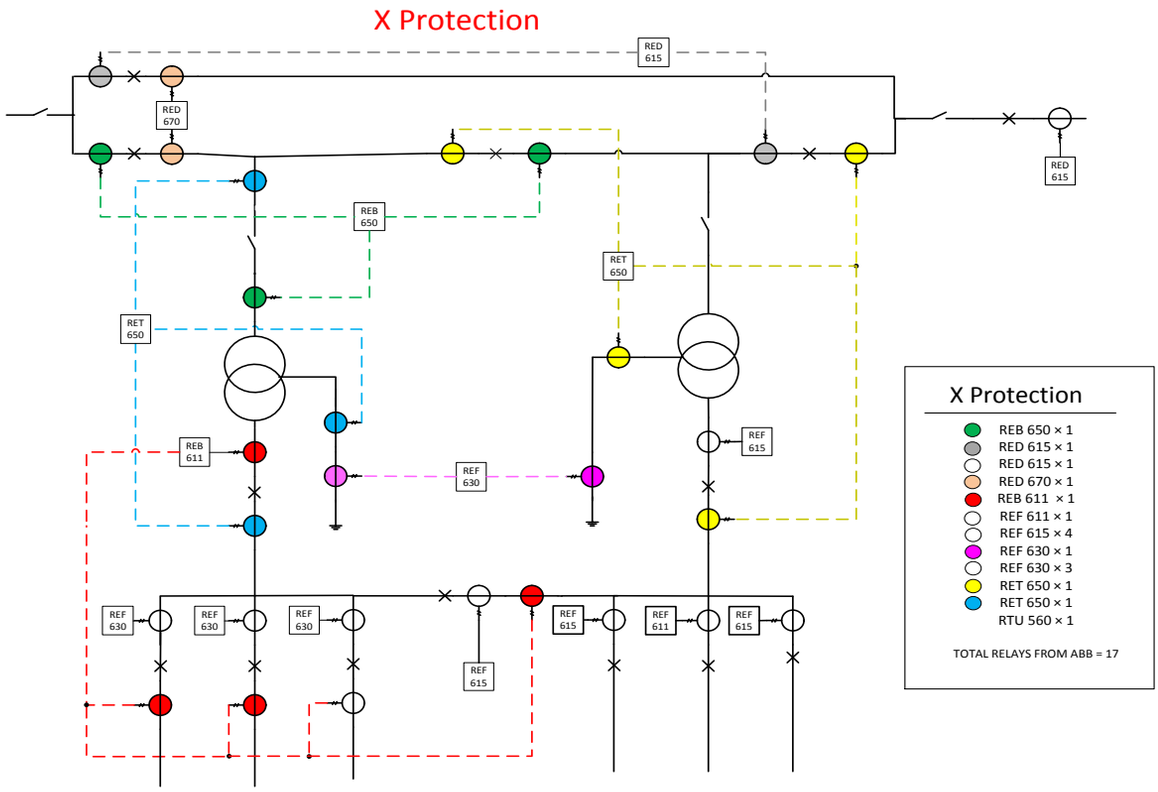
And to ensure automation is fully embedded with the Centre as one facility, MicroSCADA PRO synchronised with a Remote Terminal Unit (RTU) system will be integrated. As it is designed in line with IEC 61850 requirements, it will work in harmony with compliant intelligent electronic devices (IEDs).

The VZSSC can then provide practical knowledge on the concept and application of IEC 61850, marking an important move to greater interoperability. With completion of the Centre due in just a few months, Victoria University will house a world class, state-of-the-art training facility.

Several of the Centre's key features include:

- Unit protection
- Distance protection
- End-differential form
- Distribution and sub-transmission bus protection
- Joggle protection
- Feeder relays
- Capacitor banks & capacitor step controllers
- Backup protection

All of these features are integrated with the Ethernet infrastructure, RTU systems, SCADA backend and the actual remote SCADA control centre (a dedicated room set up next to the main Simulator).



Schematic diagram of X-protection for VZSSC using ABB equipment, courtesy of Dr Akhtar Kalam

Part of the Centre, courtesy of Dr Akhtar Kalam

"Relays were provided by GE and ABB; whilst Siemens supplied the Ethernet equipment and Doble Engineering donated the testing facilities. Weidmuler provided the hook-up equipment and ASC delivered the fibre optic technology," Graeme from AusNet explains.

Many vendors have customised their own packages without IEC 61850 compatibility, which is why the Centre is a crucial step forward for interoperability.

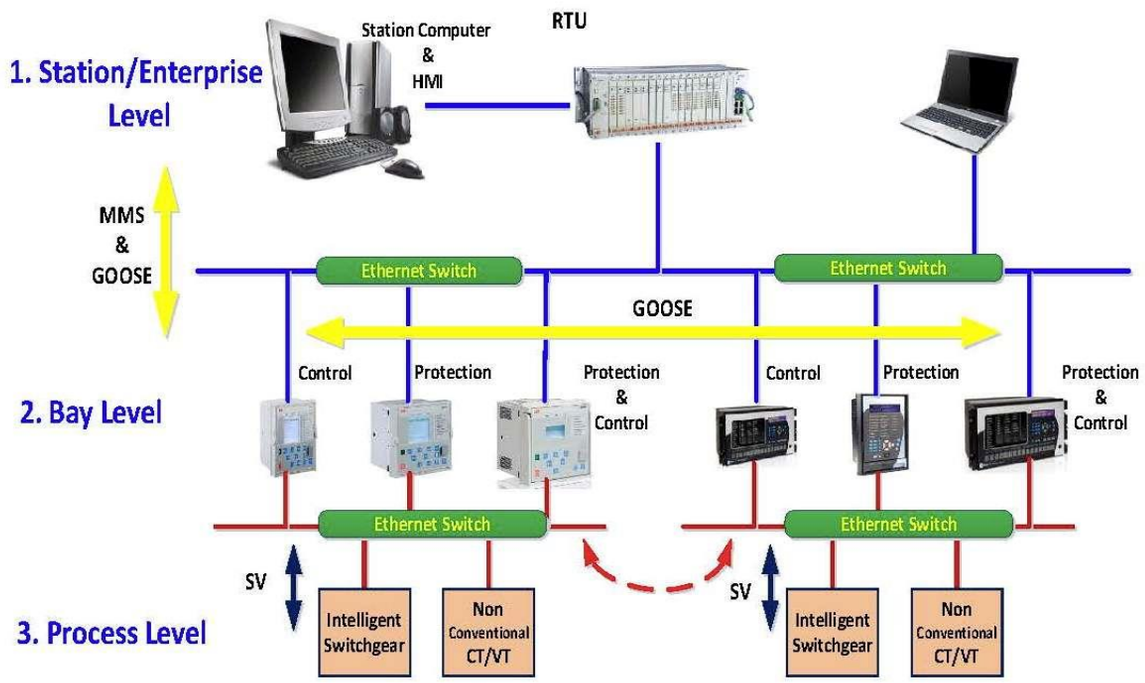


Image courtesy of Dr Akhtar Kalam

Stray signals can easily trigger other relays to operate and cause a system-wide blackout. But technicians will be able to isolate GOOSE signals whilst running the main zone substation system simultaneously.

Research & development

Dr Akhtar Kalam is at the heart of the Centre's design, having directed the research & development from start to finish with a group of PhD students.

One of the vital enablers for this project, Dr Kalam explains, was industry association and support from AusNet Services, GE, ABB, Doble, Weidmuler as well as several other companies.

"Their support and provision of the latest equipment came to an accumulated amount of $1.7 million," he says.

The prototype was a portable demonstration testing unit that took three years to develop. It has already been used throughout Australia for training ESI personnel and students in specialised workshops. Three IEDs from different manufacturers were able to exchange generic object oriented substation event (GOOSE) messages.

Outcomes indicate the Centre will successfully introduce industry-based learning for the next generation of engineers, in a bid to prepare for substation design and automation.

But it wasn't smooth sailing from a business case and funding perspective, which Dr Kalam admits was an eye-opener on how the game has changed.

"With the deregulation and privatisation of the electricity supply industry, major funders like utilities are more reluctant to support new, expensive R&D initiatives – especially for what's perceived as 'ivory tower' research. Traditionally, the sector was more open to funding, but now it's about cash-benefit analysis," he explains.

And the university itself proved a challenge when it was approached to provide the appropriate infrastructure.

"The industry wasn't going to provide the lab or internal resources like computers, work benches, audio visual type equipment and so on. We had to look to the university, which was quite cash-strapped. Every space on campus has a dollar value attached to it, so it took a long time to convince decision makers," he recalls.

The scale of this project was such that he went to all corners of Australia for support. And it has paid off:

"I'm very proud that we have actually provided this state-of-the-art training opportunity to graduates, who in their working life will be required to work in a zone substation environment. Hopefully, the day will come when every student will be told by industry to first spend several months training in the Simulator at Victoria University.

"Smart grid technology is the future, and it's exciting to have one of the world's only substation simulators to enhance its capability."

IEC 61850 and developments at AusNet Services

AusNet Services has developed a framework to integrate the items within IEC 61850 not only for greenfield sites, but brownfield ones as well. One of the key challenges, Graeme notes, lies in the few relays required in zone substation design.

"We're going for partial implementation with our brownfield sites. We work with numerous vendor devices in a parallel system defined by two competing networks. Which is why we needed a way to ensure that when work is done on a relay, our technicians can maintain and test the zone substation without creating stray signals that can result in station outages," Graeme notes.

Technicians can test two relays together and ensure the communicated signals remain in that test mode. The relay is still physically connected and no fibre connections are broken in the process, staving off signals from the main substation system.

Modern test instruments have GOOSE signals integrated with conventional overcurrent-type testing regimes, in addition to the binary inputs and outputs.

IEC 61850 is of great significance to smart grid technology as an enabler for interoperability. AusNet Services' foray into helping develop the Victoria University's Zone Substation Simulator Centre, and developing a strategy for partial implementation for brownfield sites, indicates there's only more to come from a capability perspective.

Below you can view the presentation presented by Graeme McClure at the last SCADA conference, where he discussed the main isolation criteria, challenges, user implementation solutions, and isolation examples.

IEC 61850 GOOSE isolation

Graeme McClure – Principal Engineer, AusNet Services

Main Isolation criteria

- To be able to test an installed relay without Blacking out a Zone Substation
- Isolation **must not** affect non-isolated IEDs
- **Must work** on Ed 1 and Ed 2 IEDs from any vendor
- **Must work** reliably and safely in a live substation

Challenges

- GOOSE uses publish-subscribe:
  - 1 GOOSE message can have several recipients
  - Each recipient can use the GOOSE data differently

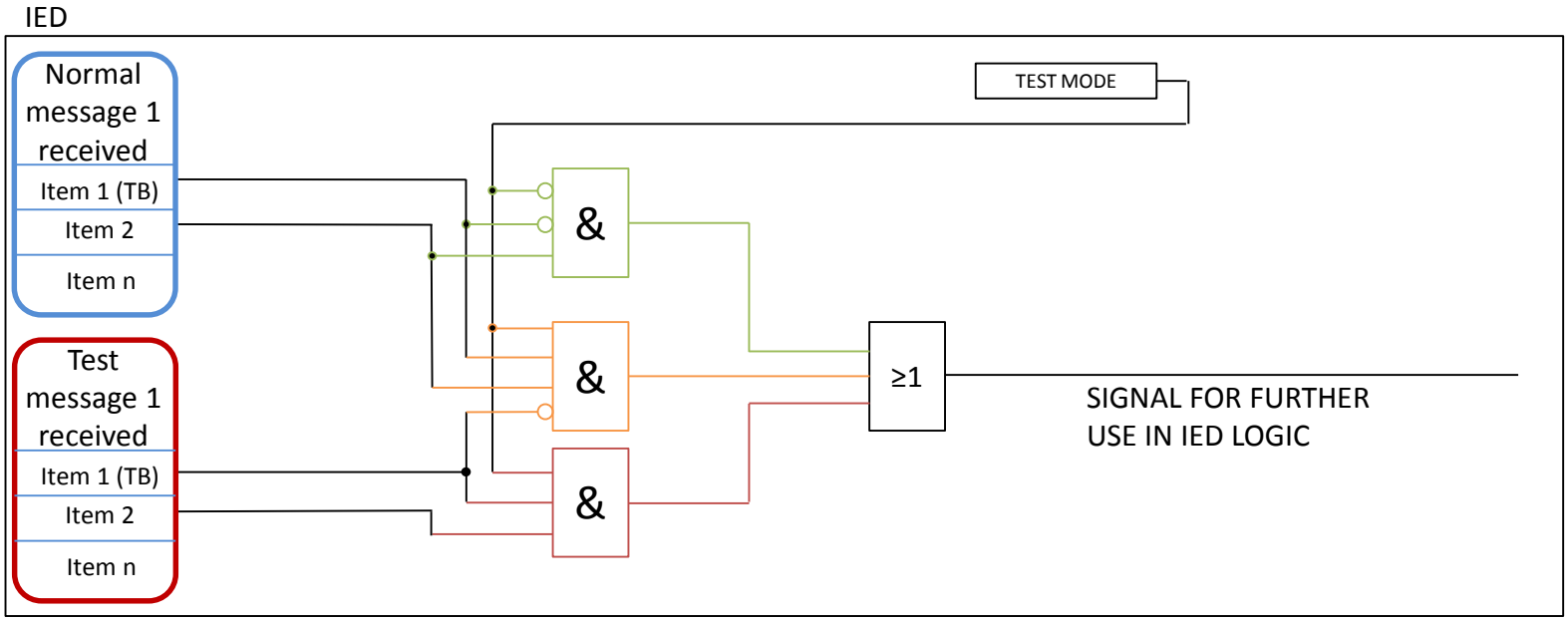
- Standardized IEC 61850 isolation mechanisms exist, however:
  - Differ between Edition 1 and Edition 2
  - Full support for these mechanisms in not mandated

Test Mode

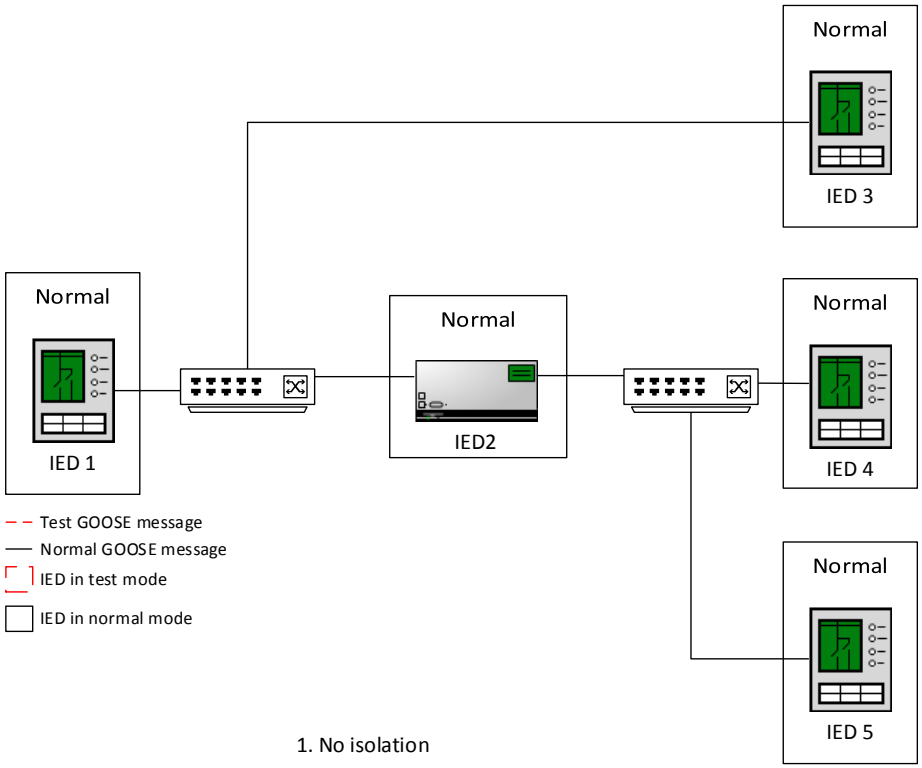
- Push button programmed to be “Test mode”
  - Used to identify GOOSE signals originating from relay as be due to test
  - Relay is programmed to respond only to incoming relay in test GOOSE signals
  - Creates a SCADA point showing when relays was in Test and out of TEST – Aides with Data historian Data Analytics
  - DOES NOT block any physical contact Outputs or Inputs

User Implementation Solution

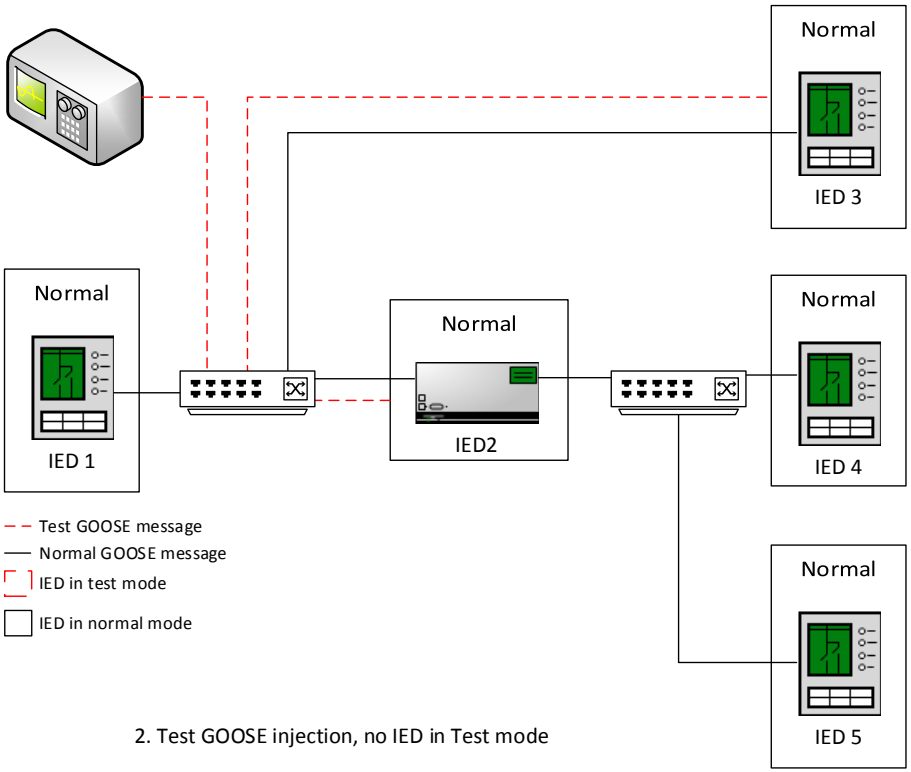
1. Include “test” bit as first data item in all GOOSE messages
2. Have separate “test GOOSE message” for all messages



Isolation examples (1/2)

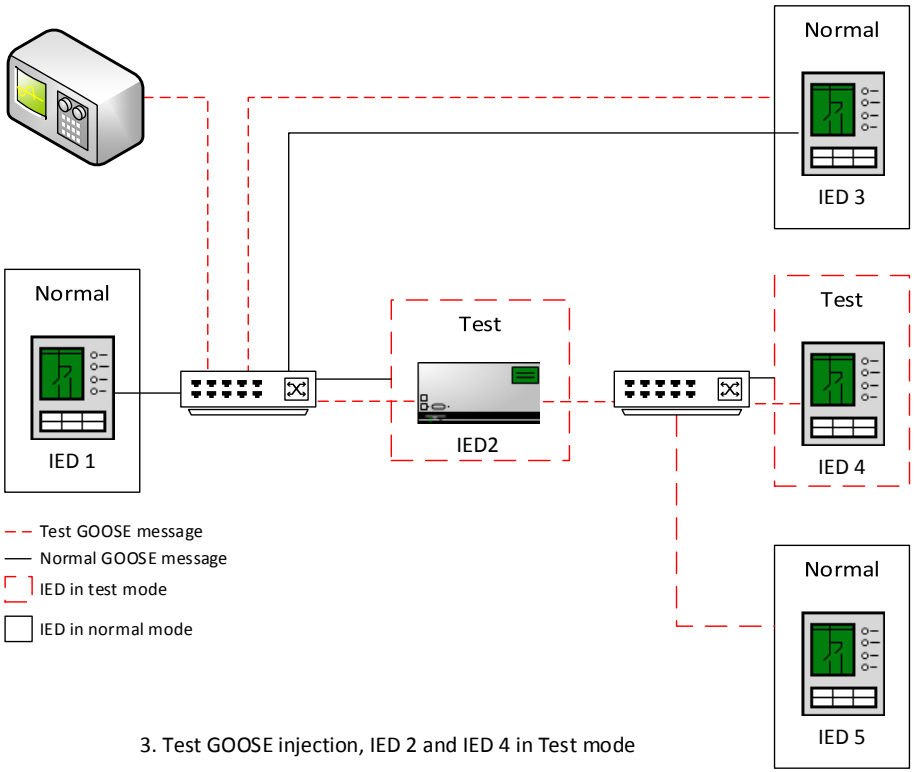


1. No isolation

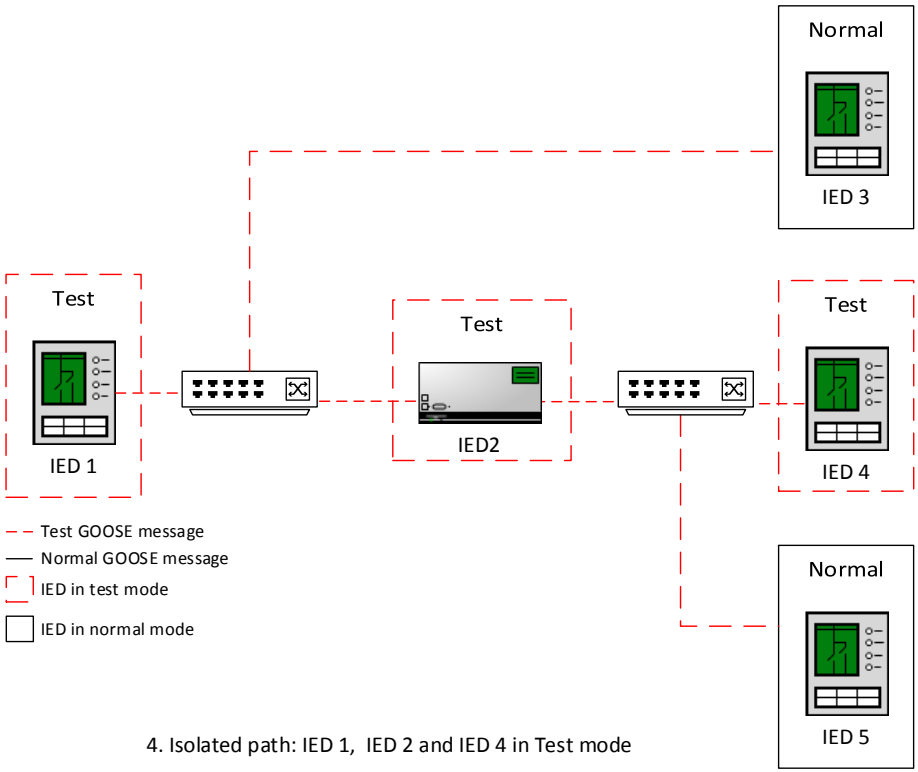


2. Test GOOSE injection, no IED in Test mode

Isolation examples (2/2)



3. Test GOOSE injection, IED 2 and IED 4 in Test mode



4. Isolated path: IED 1, IED 2 and IED 4 in Test mode

Summary

- Logic allows for relays with Different Editions of IEC61850 to be used together
- Allows for different Vendor relays to be used together
- Testing of Individual Installed relays
- Enables testing of Multi Relay Systems