10X: Power System Technology 10 Years Ahead of Industry – International Standards- Based Communications

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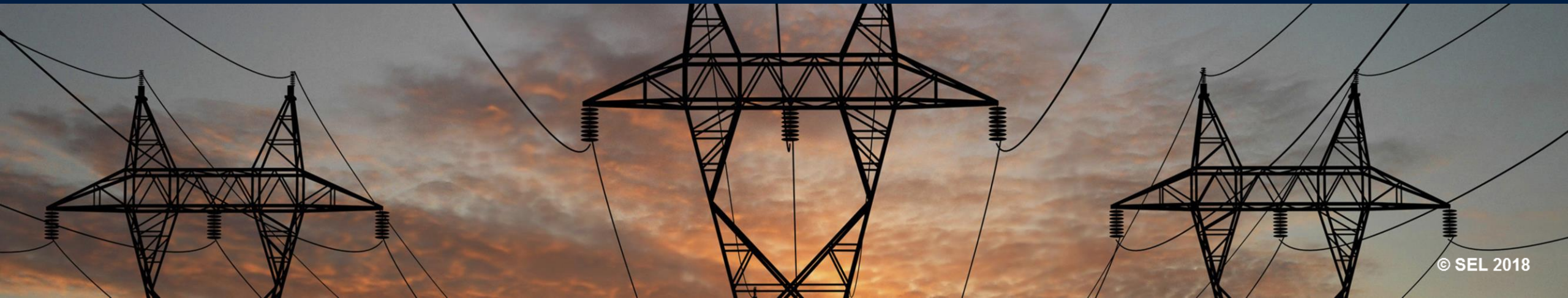

10X
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Information Technology (IT) Methods Jeopardize Operational Technology (OT) ECSs

- IT technology is often “fit for use” – replaces serial cables and communications processors with Ethernet network
- IT Ethernet moves data with IP packets
- Upon assembly, Ethernet appears to work but performance is unknown

Engineers Need to Specify, Design, Build, and Test

- Data exchange needs service level specification (SLS)
- SLS requires “fit for purpose” – Ethernet replacement of serial signal exchange must satisfy protection and automation
- Design must include service level agreement (SLA) – performance, gaps, risks, mitigations

International Standards Drove the Energy Control System (ECS) Specification

1984

2017

Innovation Validation Standardization Certification Combination Verification Specification

"How Do We Specify Edition 2?"
Six Out of Ten Parts of IEC 61850 Are Now Edition 2

Committee Standardized Requirements With Unintended Consequences

Field-Proven Technologies

Validation

SDO Standardization

SDO Certification

- Incomplete features
- Multiple incompatible methods
- SCADA enhancements that negatively affect protection

✓ IED features

✓ Older methods

x Performance

x Interoperability

x Recent innovations

"How Do We Specify Edition 2?"
Six Out of Ten Parts of IEC 61850 Are Now Edition 2

Committee Standardized Requirements With Unintended Consequences

- Edition 2 now certifies many device features available for 10+ years
- Similar to todays 10X initiative, many features used 10 years before they were certified
- Standardized features 8+ years old
- Certified features 10+ years old
- Inhibits innovation

Message Delivery Performance Criteria Defined by International Standards

- IED performance requirements
  IEC 61850, IEC 60834, IEC 15802, IEEE 802.1
- Latency specifications
  IEC 61850, IEC 60834, IEC 15802, IEEE 802.1
- Speed
  IEC 61850

International Standards Dictate SLS for IED and LAN

Speed, Dependability, Reliability, and Performance

Signal exchange success > 99.99% of the time

- Signal transfer between devices is <3 ms*
- Ethernet transit via LAN is <1 ms

The only criteria defined by IEC 61850*

International Standards Dictate SLS for IED and LAN

Speed, Dependability, Reliability, and Performance

- LAN failures during signal exchange must be corrected fast enough to maintain protection and automation
- Device Ethernet failover must occur within 1 processing cycle

Ethernet Resiliency Requirements for Bumpless Protection Signal Transfer

- Boolean protection logic, <4 dropped GOOSE packets and <15 ms outage
- Analog protection calculations, <3 dropped SV packets and <433 µs outage

Service Level Agreements (SLAs) Document That System Is Designed to Meet SLS Performance

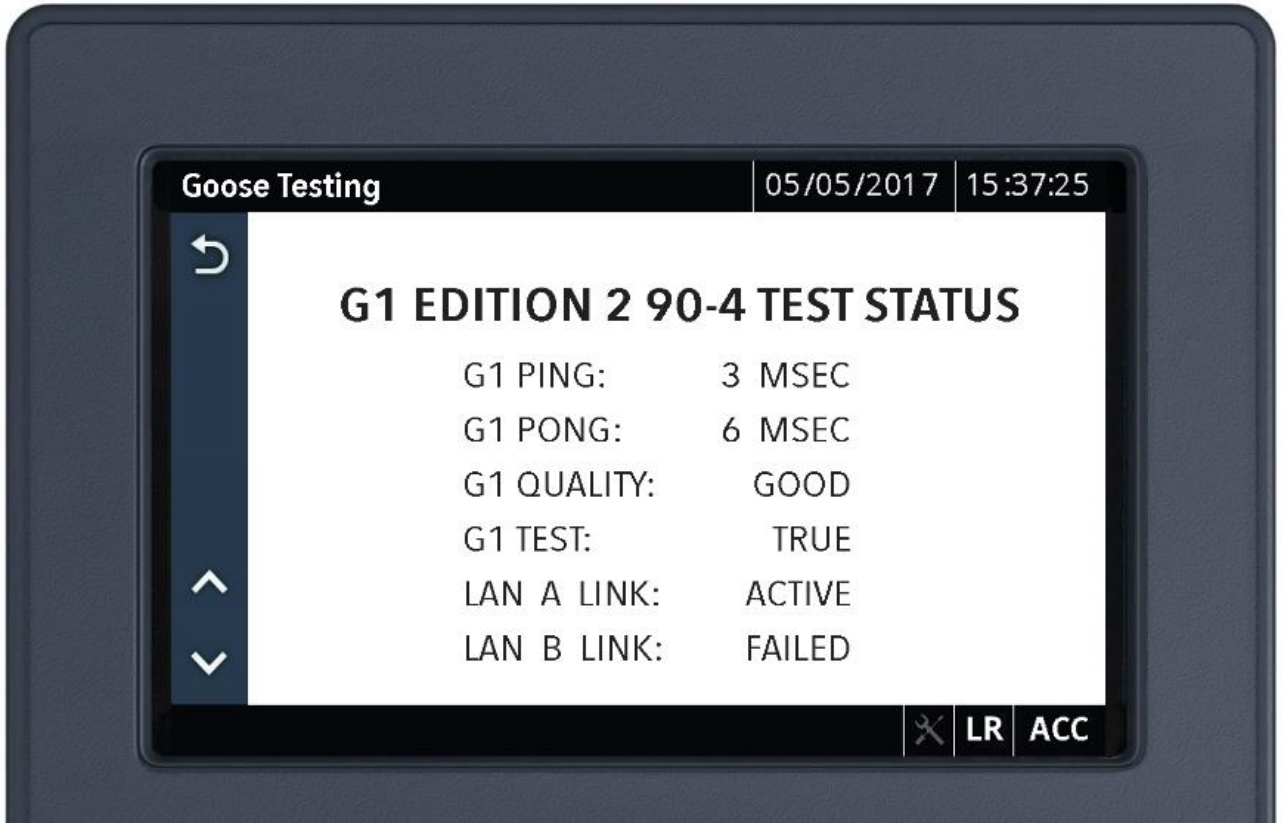
TABLE I
EXAMPLE KPI METRIC DESIGN

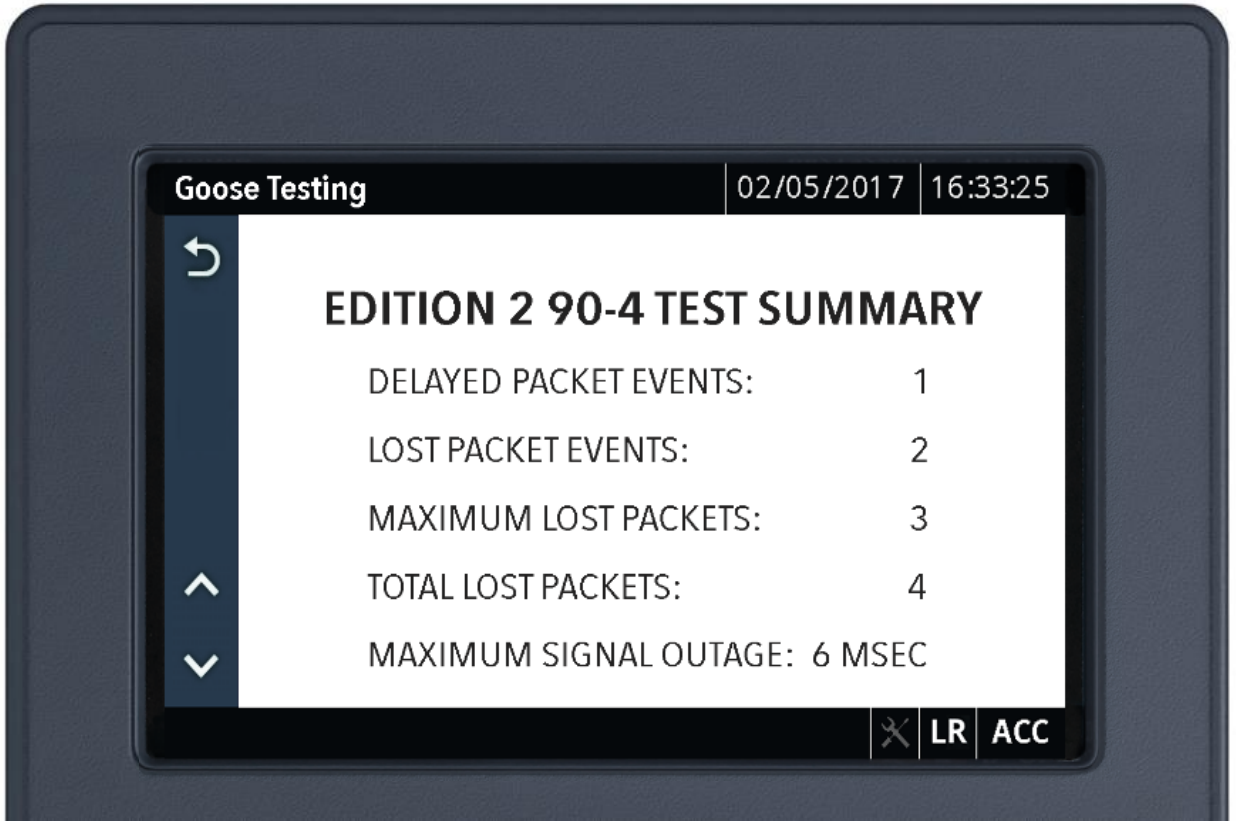
KPI Component	Description
Metric	Availability of communications-assisted protection scheme measured as successful receipt of each Ethernet GOOSE packet from publisher.
Target Performance Level	Zero undelivered GOOSE messages received from publisher since last IED reset.
Format1	Message failure indication in real time as IED front-panel HMI alarm.
Interval1	Updated in real time.
Format2	Message failure indication in real time as status to substation monitor and SCADA via digital messages.

- System provider and end user agree on acceptable service
- Key performance indicators (KPIs) identified in system specification
  - Metric
  - Performance target
  - Format of measurement
  - Interval of metric

IED GOOSE Event Reports

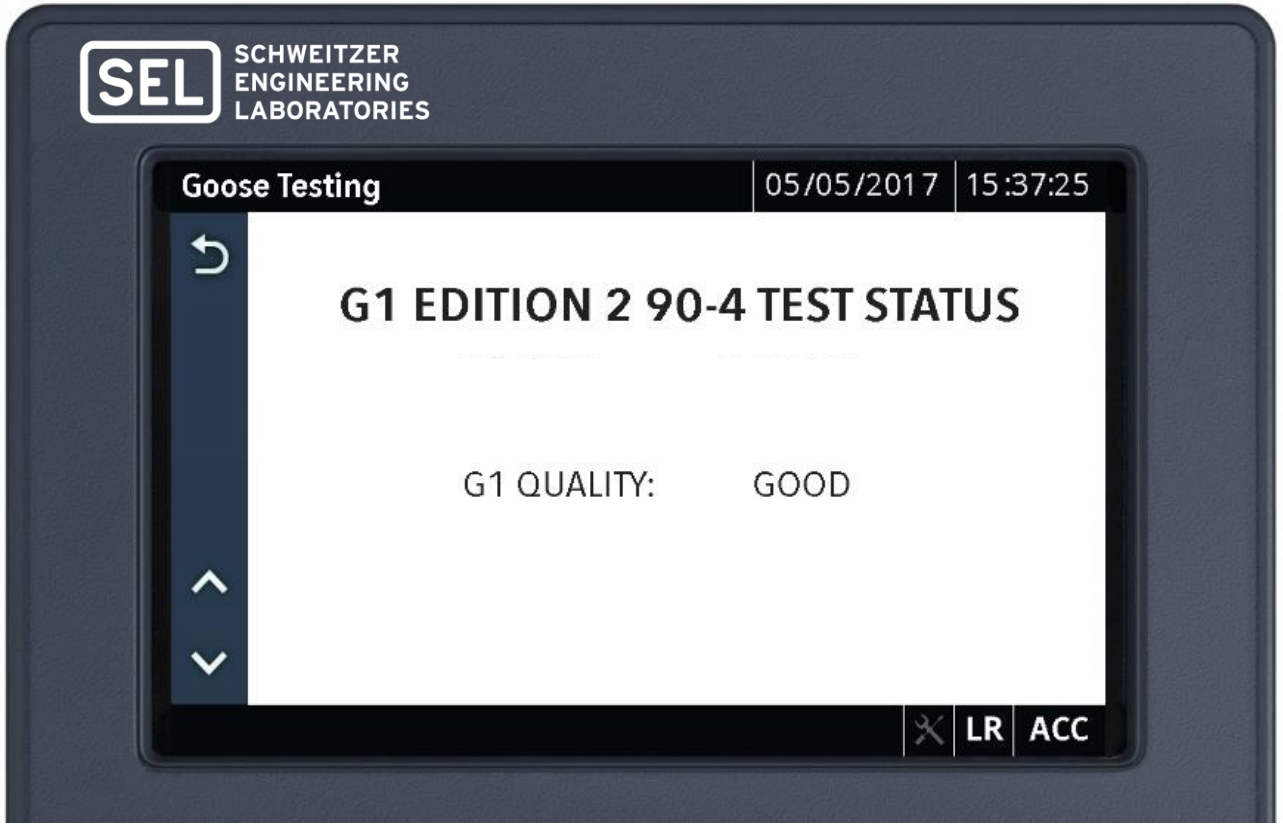
Subscriber Records Delayed and Lost Packets and Provides SLA KPIs for Protection Signal Exchange





Certified Edition 2 LGOS

Very Little Information Included



Limited Vulnerability Design (LVD) Methods Lead to Better Understanding, Specifications

- Document applications *and* services
- Identify and investigate design gaps
- Recognize vulnerabilities associated with gaps
- Recognize risks associated with vulnerabilities
- Design specification to limit vulnerability based on cost, schedule, and performance

Substation Automation Solutions Require 18 Communications Applications

1. Substation automation and remedial action.
2. Self-description of device database contents.
3. Communications parameter configuration.
4. Polling of data from the device via a client.
5. Reporting of data from the device.
6. Unsolicited notification of device alarms.
7. Commanded control from operators or automation logic.
8. Event-driven, peer-to-peer, machine-to-machine signal and status multicasting.
9. Frequency-synchronized multicasting of raw instrument transformer values.
10. Time synchronization.
11. Configuration revision management.
12. File transfer.
13. Engineering access.
14. Detection of failed remote connection and callout.
15. Communications and performance diagnostics.
16. Local- and wide-area synchrophasors.

LVD Requires Understanding Gaps, Vulnerabilities, and Risks

	Technical Gaps	Vulnerabilities and Mitigations
6	Unsolicited notification of device alarms	No event summaries with fault location
11	Configuration revision management	Private end-user processes
13	Engineering access	Nonstandard Telnet and webpages
14	Detection of failed remote connection and callout	No redundant or out-of-band SCADA backup
15	Communications and performance diagnostics	No performance metrics and diagnosis
16	Local- and wide-area synchrophasors	IEEE C37.118 Synchrophasor Protocol
17	Root-cause analysis	No root-cause analysis
18	Time-domain synchronized ultra-high-speed data acquisition	No time-domain synchronized process bus

ECS Identified 63 Features New to Edition 2, Process Lag Means 54 Are Not Certified

And Many Features Not Yet Standardized in IEC 61850

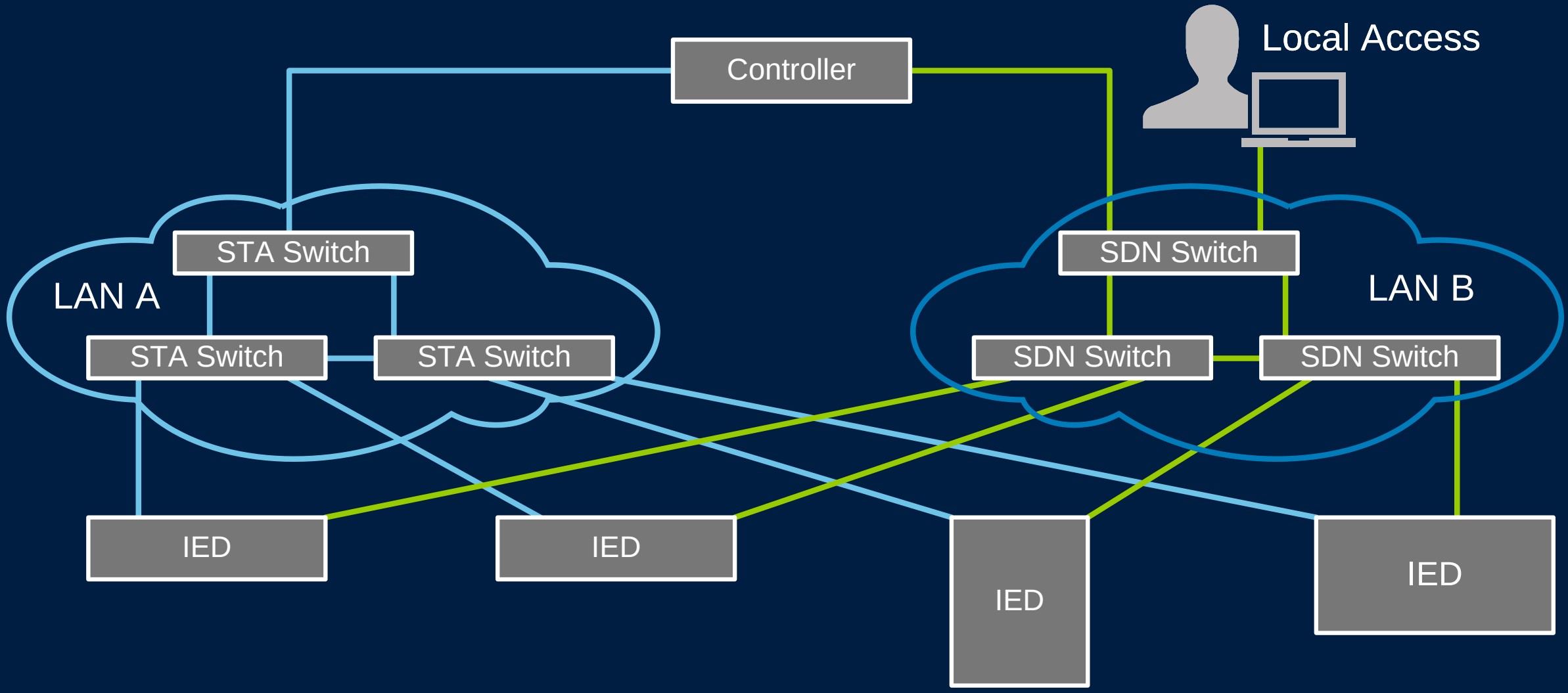
Numerous International Standards

10X Features

- **Security**
- **Configuration**
- **Management**
- **Engineering Access**
- **Testing and KPIs**

Designed to Support Migration to SDN

Performance and Security Improved by Software Defined Network (SDN)



Questions?