Webinar: Substation Protective Relay Conversion from Analog to Digital Technology

GRUPO equatorial ENERGIA

TECHNICAL AND COMMERCIAL CORPORATE DIRECTORY
AUTOMATION EXECUTIVE

DIGITALIZATION OF EQUATORIAL GROUP SUBSTATIONS

REF – 2021/MAY

Overview

1. Equatorial Group in Numbers
2. Existing Substation Digitalization Program
3. Advantages of Digitized Substations
4. Equatorial Projects Highlights Using IEDs (Intelligent Electronic Devices)
5. Conclusions

1. Equatorial Group in Numbers

Population served: 22.3 million

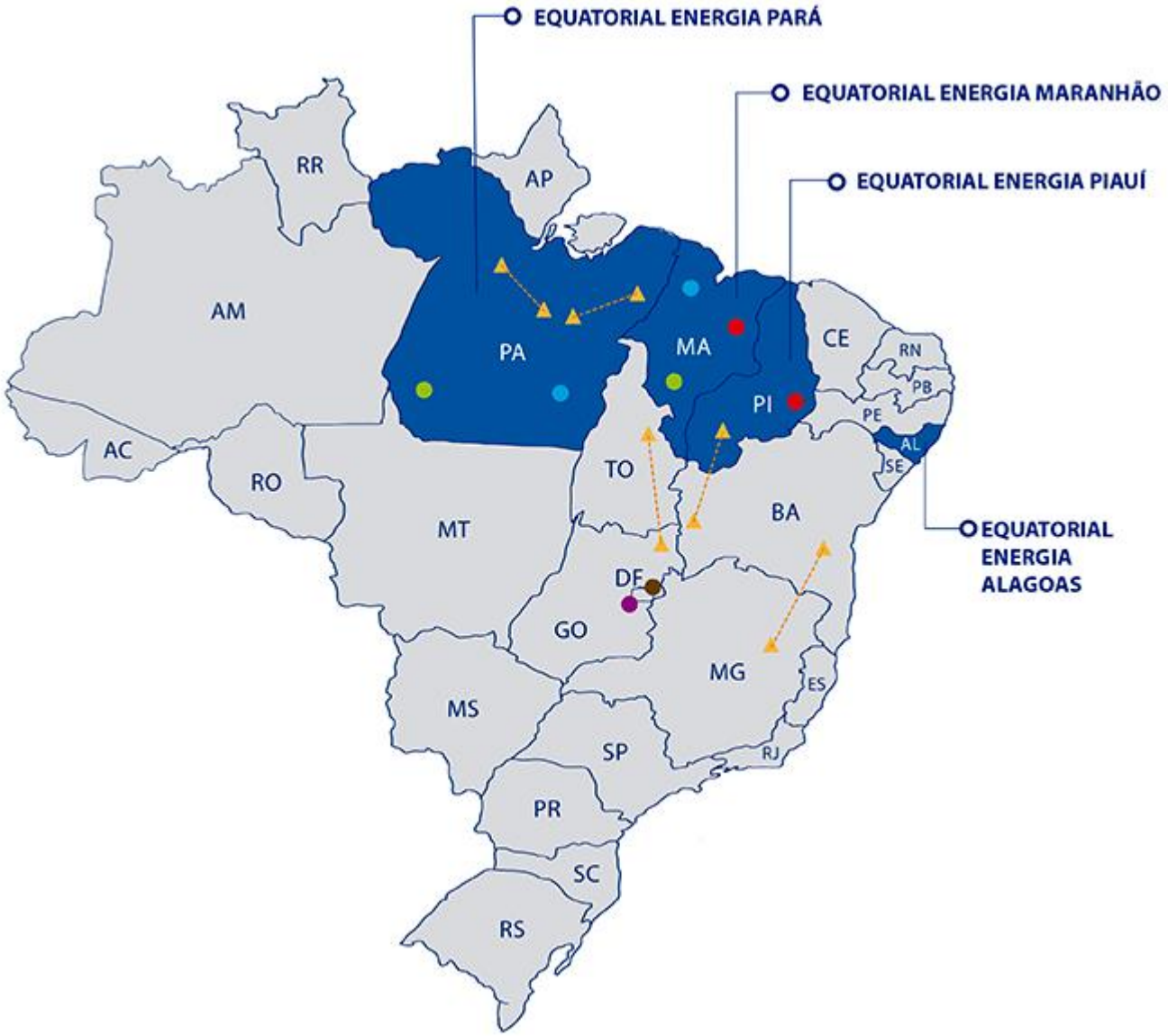
Area: 1.859.234 km^2

Municipalities: 687

Dist. Substations: 380

Trans. Substations: 12

Trans. Lines: 3.281 km



2. Existing Substation Digitalization Program (1)

- Started in 2005 at Equatorial Maranhão (EQTL MA).
  - Relays
  - Meters
  - HMI
  - Auxiliary dc system
- 10-year program.
- Acquired other companies in 2016. Same program deployed.
  - CELPA (EQTL PA)
  - CEPISA (EQTL PI)
  - CEAL (EQTL AL)

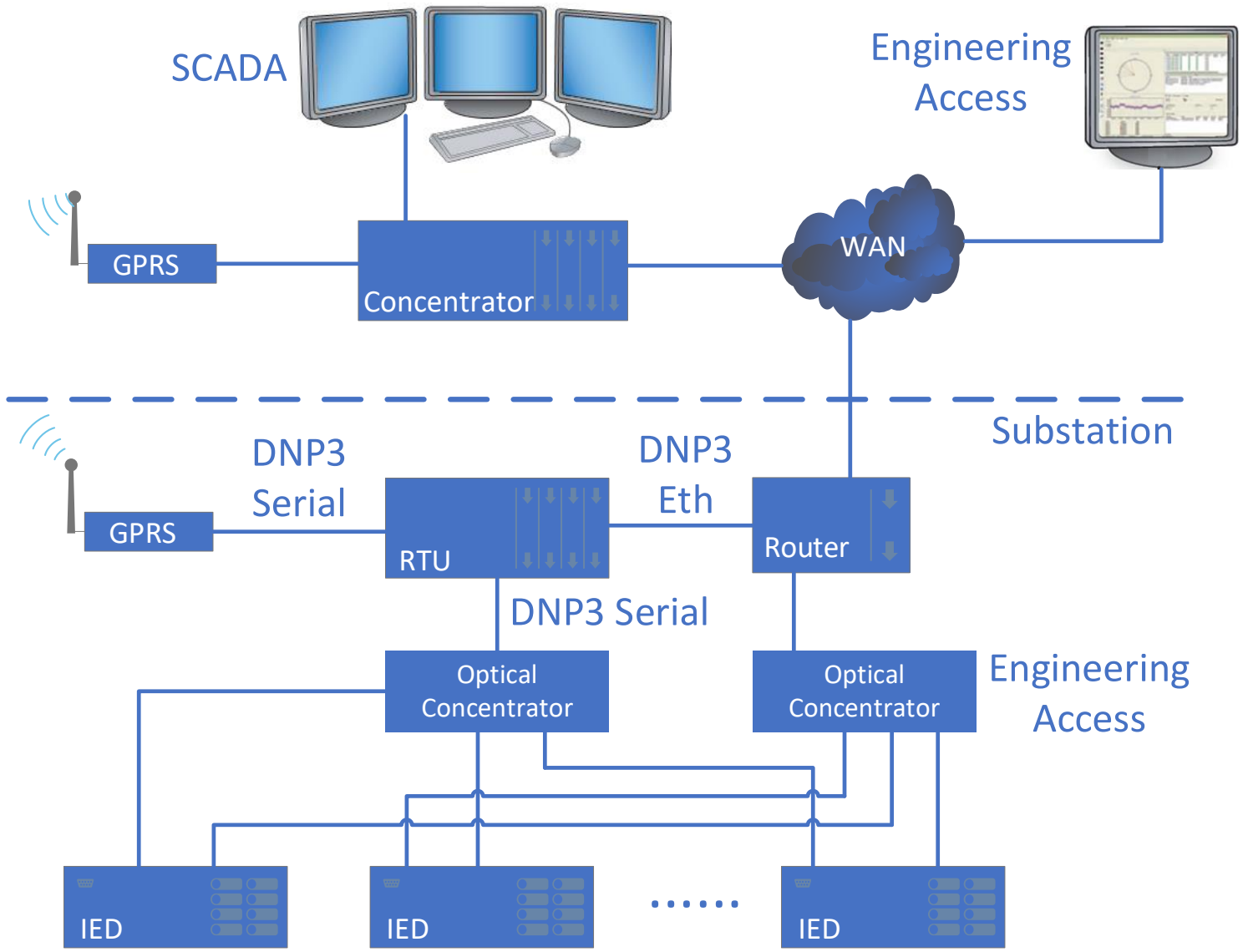
2. Existing Substation Digitalization Program (2)

- Important points were analyzed:

  - Quality and reliability of devices should be priority – Reduce cost and personnel for maintenance.
  - Flexible communication architecture and structure – Possible to be restored/configured remotely or managed by the operator on site.
  - All IEDs should have remote access for configuration.
  - Use of auxiliary relays should be avoided.
  - SCADA communication protocol to be adopted should be simple, standardized, and commonly used by relay vendors.
  - The communication links should be optical fiber to avoid noise.

* Due to the current technology existing at that time (2005), some criteria were only possible to achieve with the emergence of Ethernet equipment and communication networks for critical infrastructure.

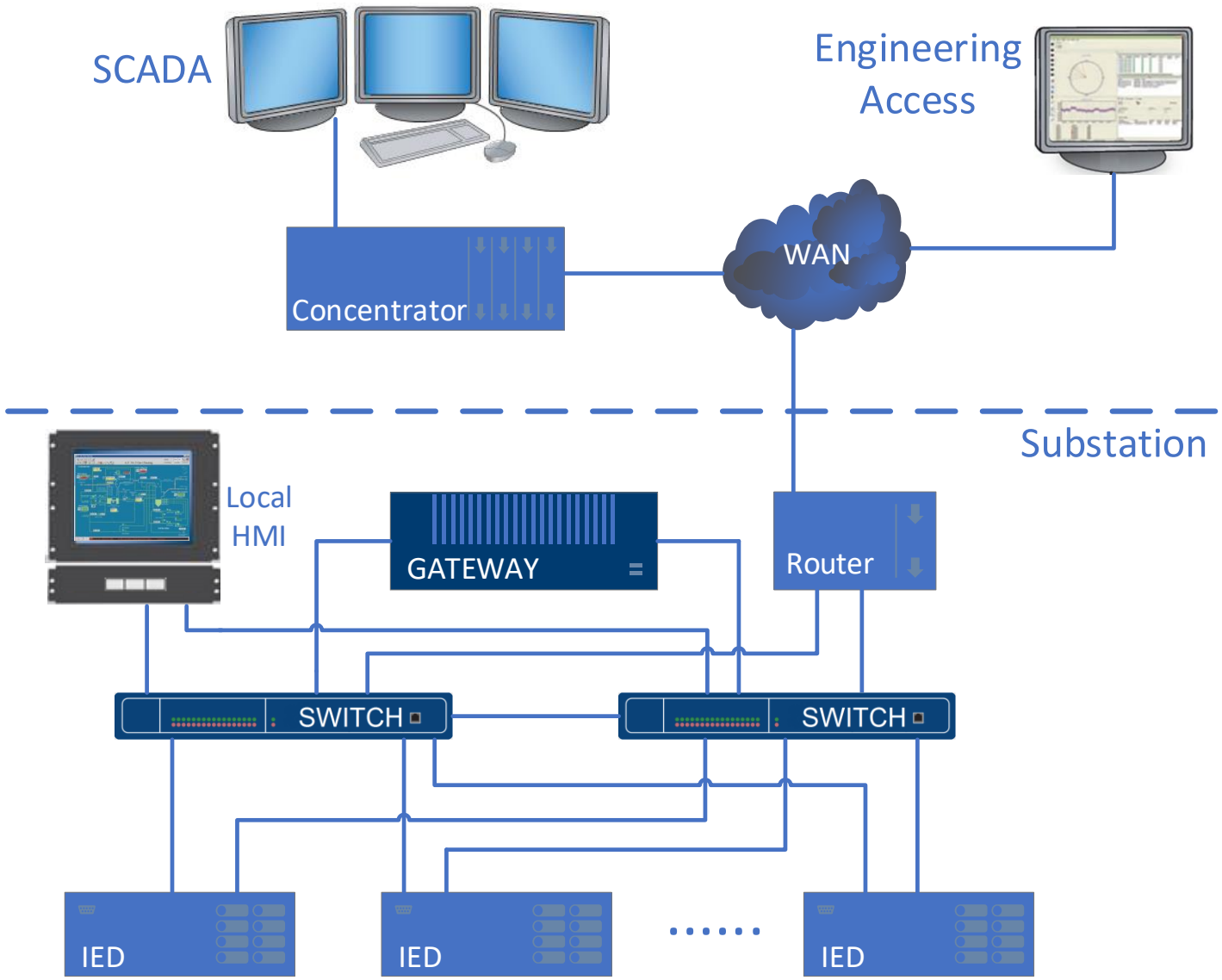
2. Existing Substation Digitalization Program (3)



Architecture I:

- Serial comms digital relays
- RTU (DNP3)
- IT network or GPRS connection to control center (SCADA)

2. Existing Substation Digitalization Program (4)



Architecture II:

- Redundant Ethernet comms digital relays
- Rugged Ethernet switches, ring topology
- Gateway/RTU with redundant comms (DNP3 LAN/WAN)
- Router with redundant connection to the Eth switches
- IT network connection to control center (SCADA)

3. Advantages of Digitized Substations (1)

- Reduced space for panel installation:
  - Multifunction IEDs with protection, control, metering, and automation
  - Significant reduction of wiring
  - No need for auxiliary relays
  - Same panel can accommodate several IEDs

- IEDs with self-diagnostic indicate internal problems before failures affect power system.

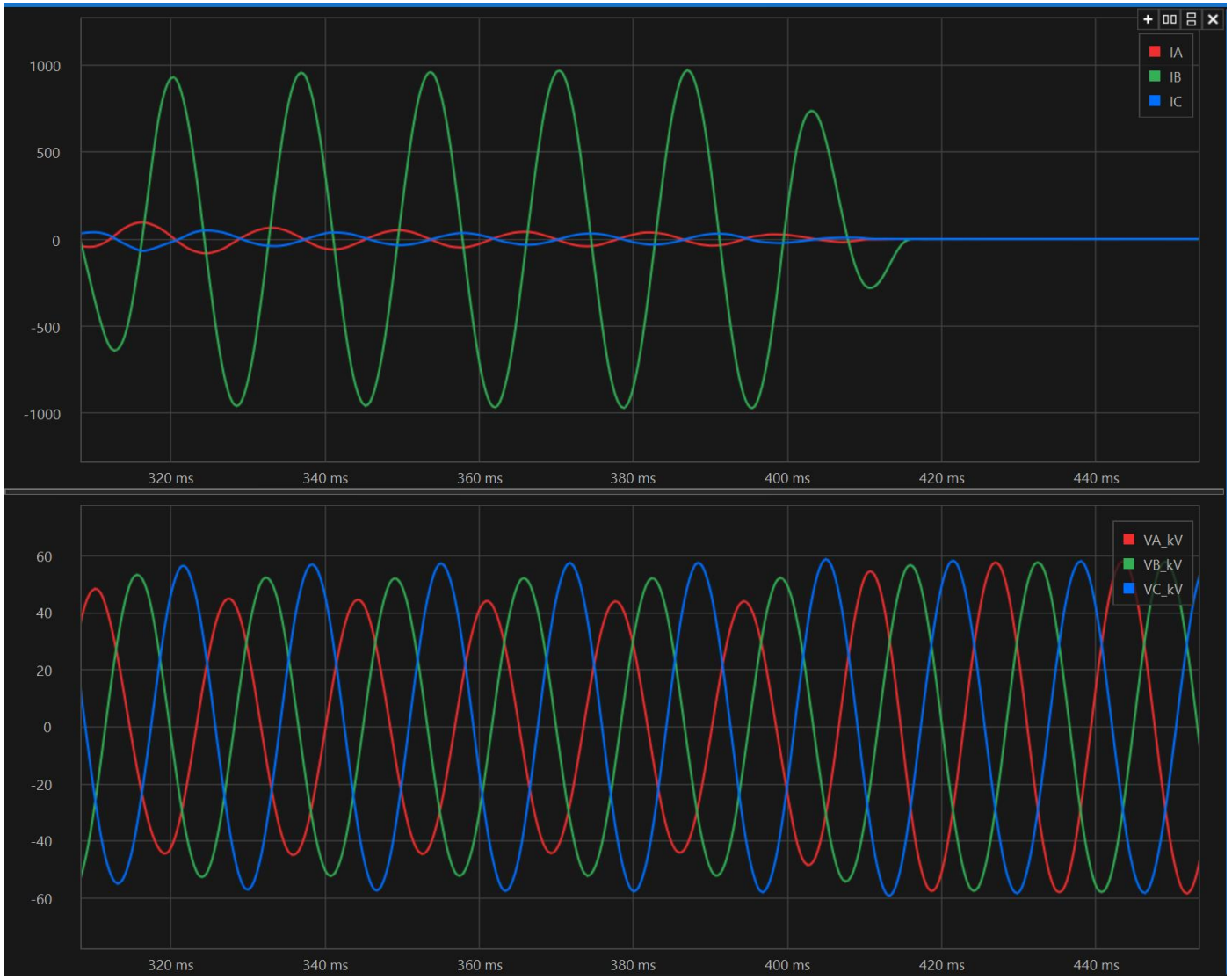
3. Advantages of Digitized Substations (2)

Eventos

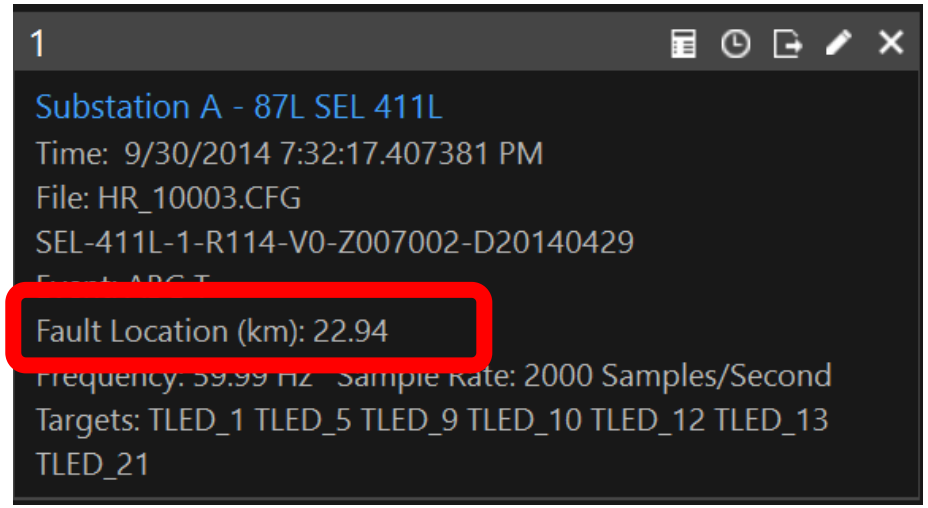
976	19/09/26	16:58:22.175	51P	Asserted
975	19/09/26	16:58:22.200	51P	Deasserted
974	19/09/26	16:58:24.758	51P	Asserted
973	19/09/26	16:58:24.775	51P	Deasserted
972	19/09/26	16:58:25.441	51P	Asserted
971	19/09/26	16:58:25.458	51P	Deasserted
970	19/09/26	18:13:20.456	51P	Asserted
969	19/09/26	18:13:21.044	51G	Asserted
968	19/09/26	18:13:21.298	51PT	Asserted
967	19/09/26	18:13:21.298	79CY	Asserted
966	19/09/26	18:13:21.298	79RS	Deasserted
965	19/09/26	18:13:21.298	TRIP	Asserted
964	19/09/26	18:13:21.302	LT16	Asserted
963	19/09/26	18:13:21.314	IN102	Deasserted
962	19/09/26	18:13:21.344	IN102	Asserted
961	19/09/26	18:13:21.352	51G	Deasserted
960	19/09/26	18:13:21.356	51P	Deasserted
959	19/09/26	18:13:21.373	51PT	Deasserted
958	19/09/26	18:13:21.410	IN101	Asserted
957	19/09/26	18:13:21.419	52A	Deasserted
956	19/09/26	18:13:21.452	IN101	Deasserted
955	19/09/26	18:13:21.452	52A	Asserted
954	19/09/26	18:13:21.473	IN101	Asserted
953	19/09/26	18:13:21.481	52A	Deasserted
952	19/09/26	18:13:21.798	TRIP	Deasserted
951	19/09/26	18:13:21.902	IN101	Deasserted
950	19/09/26	18:13:21.902	52A	Asserted

- IEDs log and store data for post analysis:
  - Sequence of events
  - Metering data logger
  - Oscillography
- Data can be retrieved remotely:
  - Identify problems and propose solutions quickly
  - Speed up returning-to-service process
  - Outage duration easily measured
- Most common failures and errors identified:
  - CTs/PTs wiring/connections errors
  - Wrong logic implemented
  - Failures in the auxiliary dc power supply
  - Slow circuit breaker operation
  - Failures in equipment auxiliary contacts
  - Improper sequence of manual operations

3. Advantages of Digitized Substations (3)

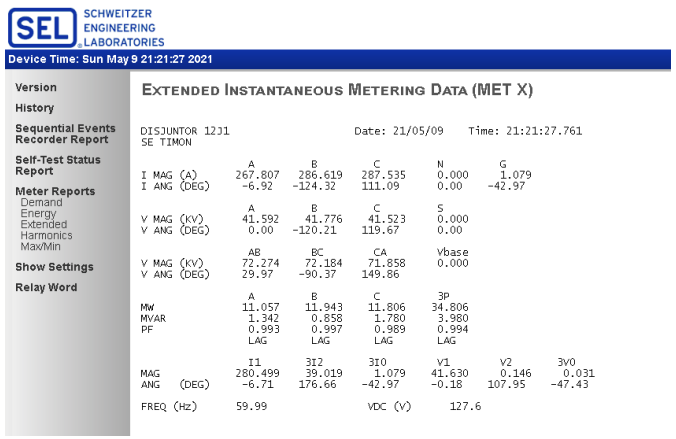


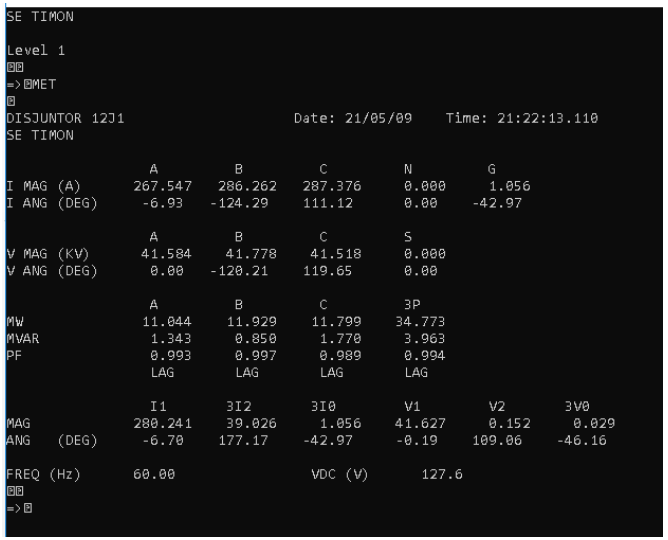
- Remote oscillograph retrieval:
  - Digital relays produce detailed reports for each occurrence
  - Data can be retrieved remotely and automatically
  - Quick identification of problems and service restoration – Fault location

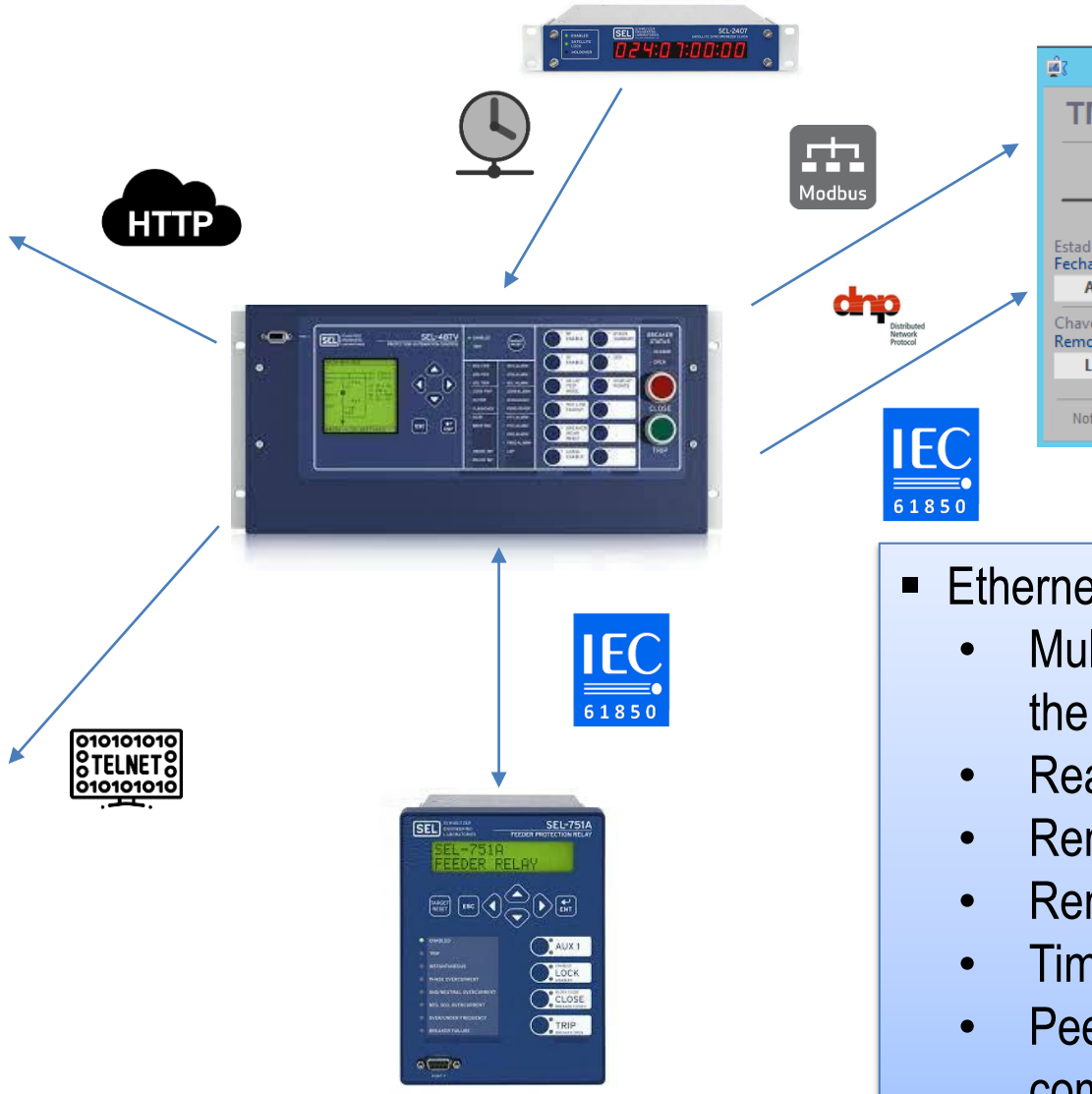


CT wiring error identified – Fault current phase B, Voltage drop phase A

3. Advantages of Digitized Substations (4)



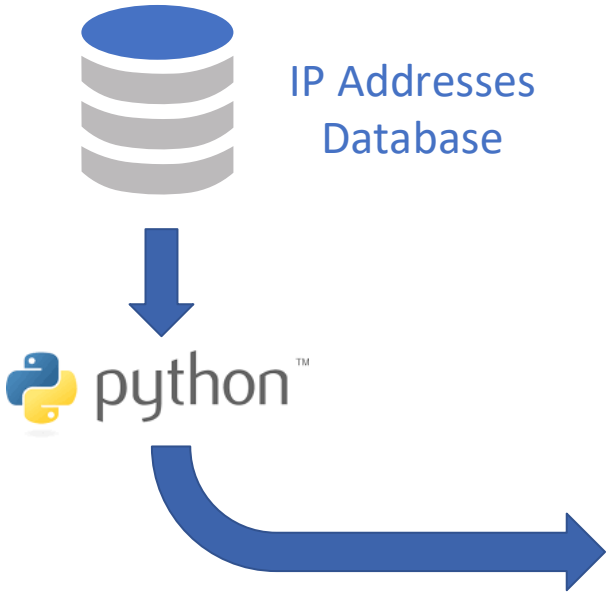




- Ethernet communications:
  - Multiple co-existent protocols in the same pipe
  - Real-time monitoring (SCADA)
  - Remote engineering access
  - Remote configuration
  - Time synchronization
  - Peer-to-peer high-speed communication

4. Equatorial Projects Highlights Using IEDs (1)

- Mass analysis of events and configuration changes:
  - Remote engineering access + custom programs = automated collection of data + automated audit reports + automated modification of settings
  - Carry out mass modifications of settings, such as changing the IP address of the SNTP server for all relays in the substation in seconds.

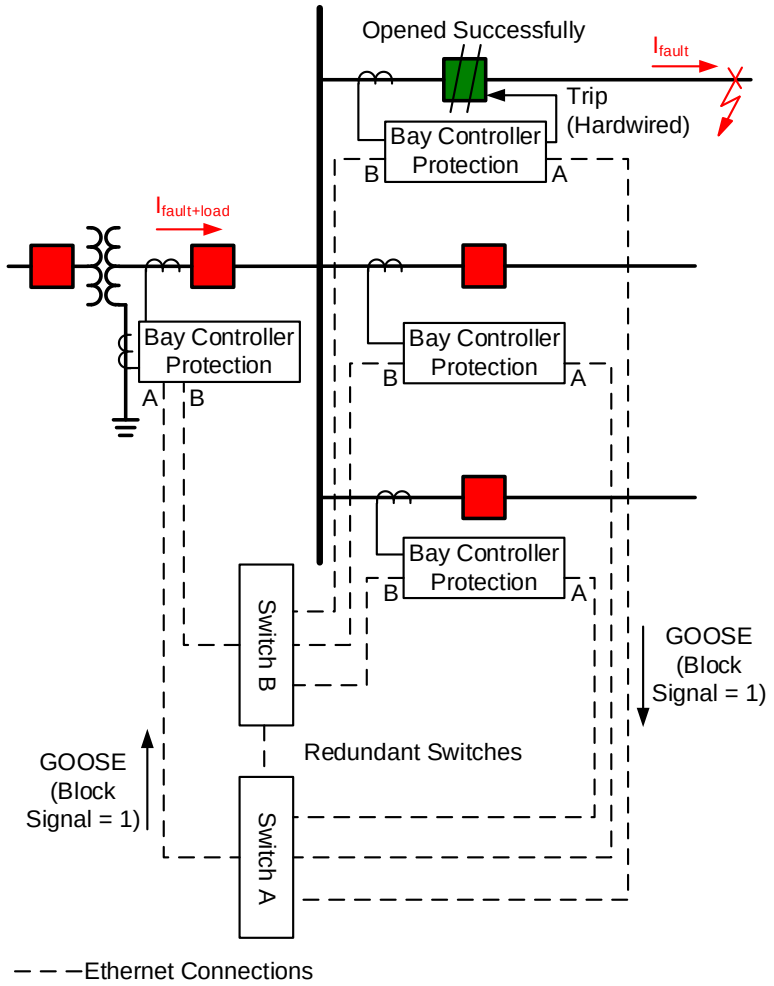


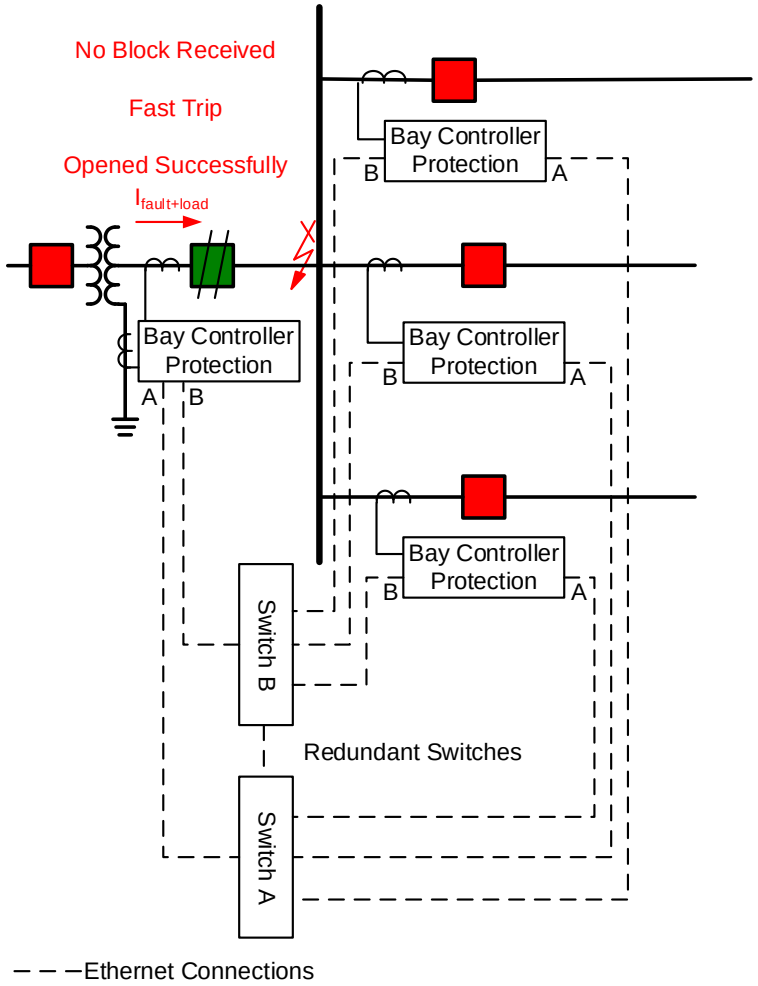
Device	15/07/2019 to 21/07/2019
ITP21C1	1802
PSF21C2	12
PSF21C3	12
SMT29F1	6
RSO29S1	5
BCP21C3	4
MTA21C1	3
MTA21C2	3
MTA21C3	3
UBSR02R1	3
ACL12L8	2
COL29N1	2
CXS29B1	2
MIRM02T1	2
MTA21B1	2

Example:
Weekly report of power supply failures for each IED

4. Equatorial Projects Highlights Using IEDs (2)

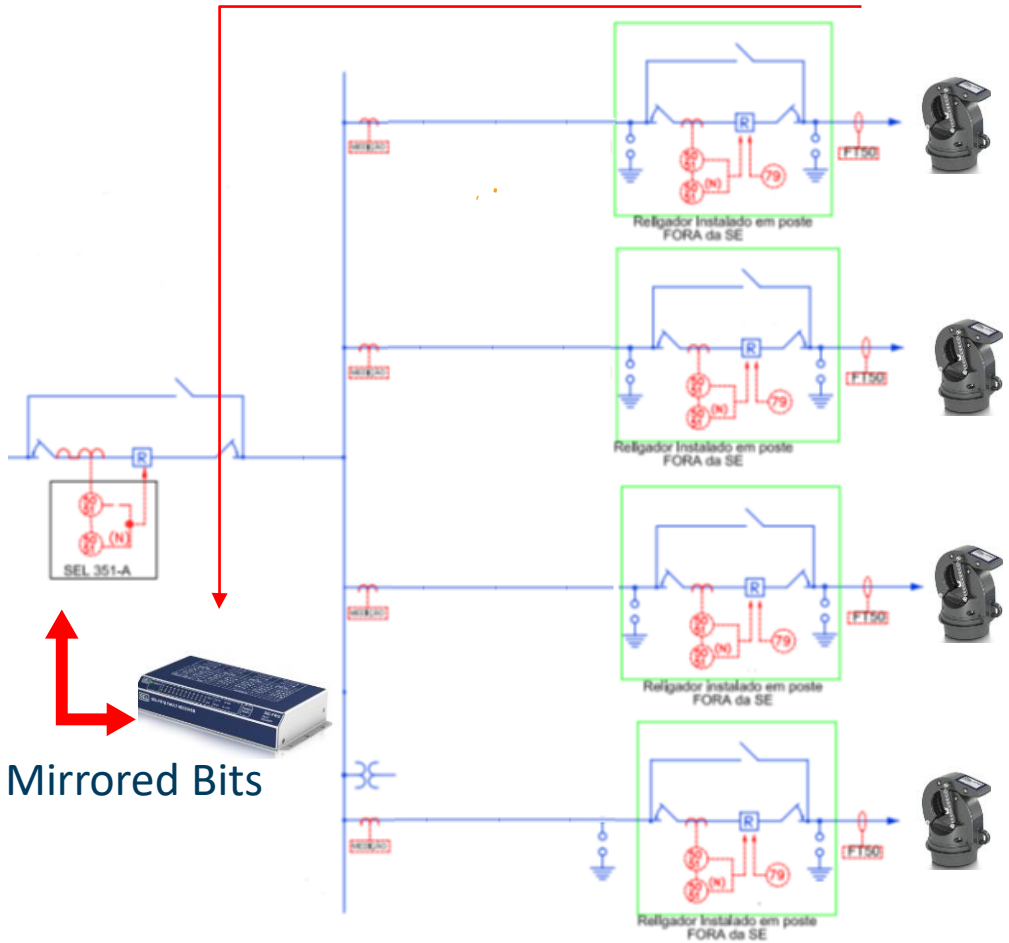
- Improving protection speed:
  - Fast-bus Tripping scheme – Bus fault clearing time reduced by 70% and breaker failure protection incorporated in the scheme





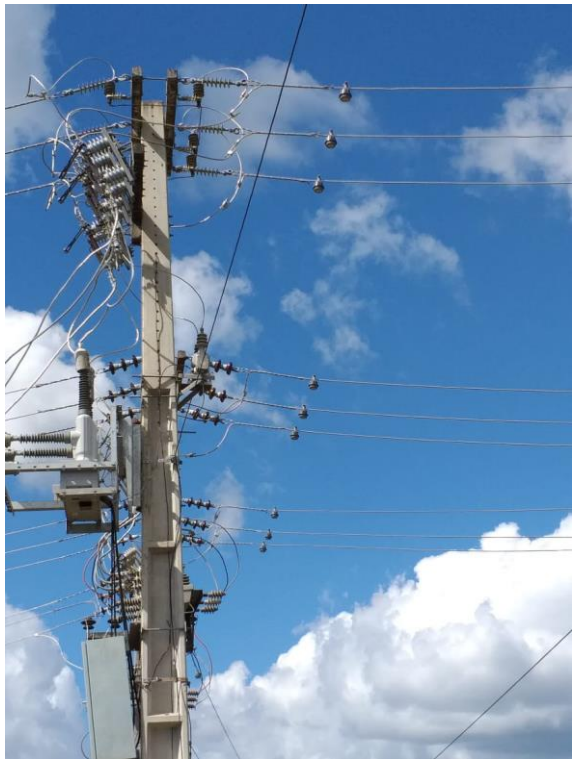
4. Equatorial Projects Highlights Using IEDs (3)

- Improving protection speed:
  - Fault sensor and relay integration – Fast-bus tripping with devices that do not have high-speed (HS) communication protocols



Serial – Mirrored Bits

- Reclosers or fuse switches with no HS comms, but the downstream HS fault sensor sends the block signal to the upstream recloser.



Conclusions

- Substation digitalization improves quality of service and system reliability and reduces operation and maintenance costs
- Distribution companies under Equatorial group management moved from bottom to the top of performance rank (out of 30 companies).

Posição no Ranking	DGC	Sigla	Empresa	Região
1º	0,56	CPFL SANTA CRUZ	COMPANHIA JAGUARI DE ENERGIA	SE
2º	0,61	EQUATORIAL PA	EQUATORIAL PARÁ DISTRIBUIDORA DE ENERGIA S.A.	NO
3º	0,62	COSERN	COMPANHIA ENERGÉTICA DO RIO GRANDE DO NORTE COSERN	NE
3º	0,62	ESS	ENERGISA SUL-SUDESTE - DISTRIBUIDORA DE ENERGIA S.A.	SE
5º	0,63	EMT	ENERGISA MATO GROSSO - DISTRIBUIDORA DE ENERGIA S.A.	CO
5º	0,63	ETO	ENERGISA TOCANTINS DISTRIBUIDORA DE ENERGIA S.A.	NO
7º	0,69	EMG	ENERGISA MINAS GERAIS - DISTRIBUIDORA DE ENERGIA S.A.	SE
8º	0,70	EQUATORIAL MA	COMPANHIA ENERGÉTICA DO MARANHÃO	NE
8º	0,70	EMS	ENERGISA MATO GROSSO DO SUL - DISTRIBUIDORA DE ENERGIA S.A.	CO
10º	0,71	EDP ES	ESPÍRITO SANTO DISTRIBUIÇÃO DE ENERGIA S.A.	SE
11º	0,73	EPB	ENERGISA PARAÍBA - DISTRIBUIDORA DE ENERGIA S.A	NE
12º	0,75	ESE	ENERGISA SERGIPE - DISTRIBUIDORA DE ENERGIA S.A	NE
13º	0,78	COPEL	COPEL DISTRIBUIÇÃO S.A.	SU

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