Virtual Digital Fault Recorder

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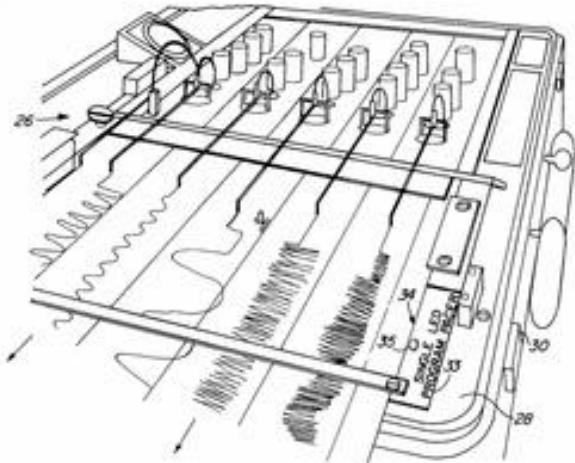**Dan Morman P.E.**

Consulting Engineer – Substation Automation and Control

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The Need

- Post mortem analysis when equipment or power grid fails.

- Can we at least record the voltages, currents, and breaker position!

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The Invention – Part 1

- Strip charts!!   What?.....1940s?

The Invention – Part 2

- The microprocessor and digital storage!
- <u>Digital</u> Fault Recorder

- NOT TO SCALE -

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Why a DFR vs Strip Chart?

- High speed recording of the grid's operating levels observed locally to that substation during a system event

- Analogous to an airplane's "Black Box"

- …and NERC PRC-002 Requirements

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PRC-002
Dynamic Disturbance Recording

- Sections R7 through R11 of the PRC-002 standard require the system to collect the calculated rms quantities at 960 samples per second and store the calculated rms values at a minimum rate of six measurements per second.

- Achieved by Ametek DFR and protective relay phasor data and fault records.

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PRC-002
Sequence of Events Recording

- Requires the 52a contact status be recorded with an <u>accuracy</u> of +/- 2 mS

- Achieved by Ametek DFR and specific protective relay's internal SOE recorder.
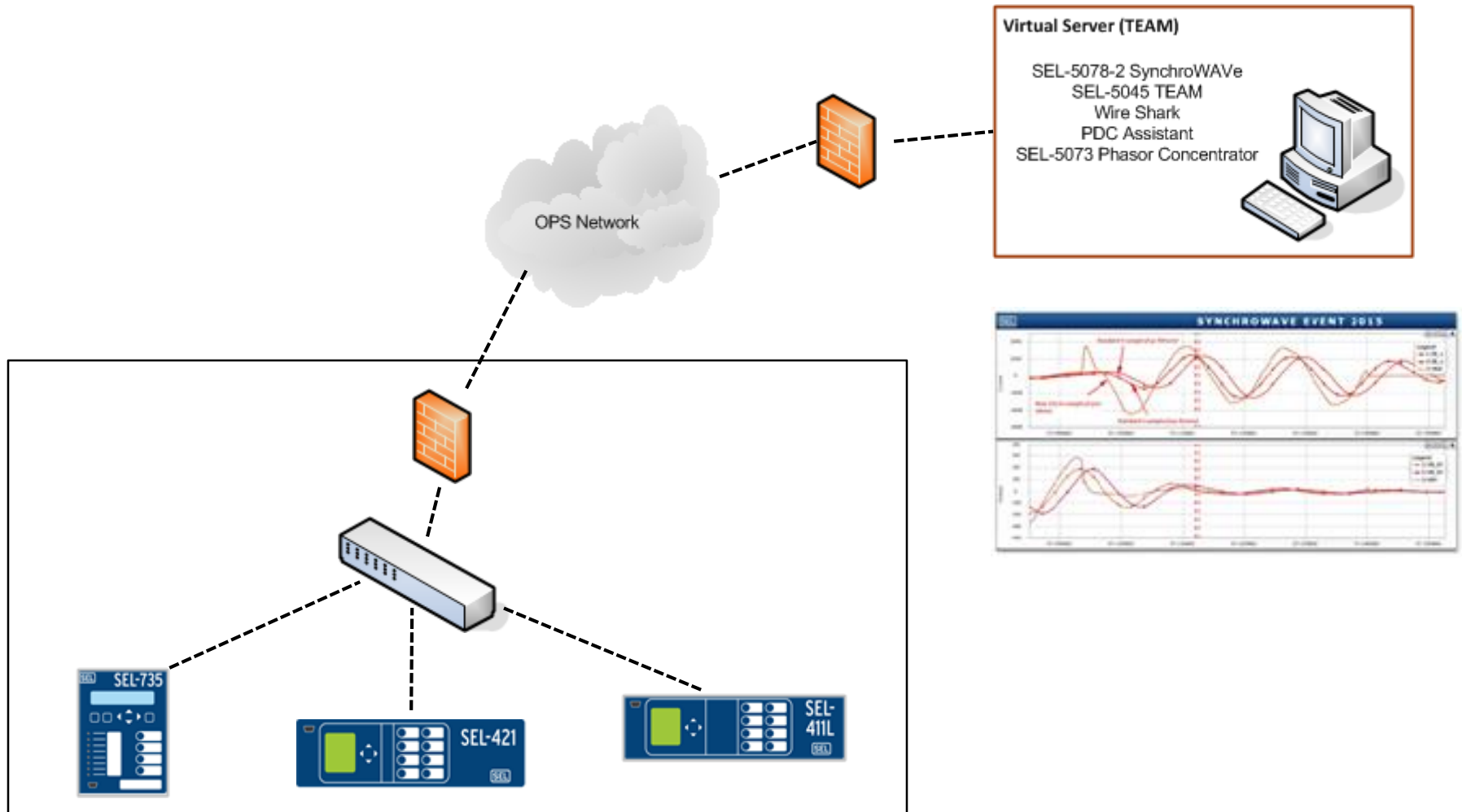
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The Invention – Part 3

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What is a Virtual DFR?

- In contrast to a specific, local recording machine, a VDFR uses software, a server, and many individual devices such as protective relays and meters to acquire, assemble, and store data.

VDFR Components

Virtual Server (TEAM)

SEL-5078-2 SynchroWAVe
SEL-5045 TEAM
Wire Shark
PDC Assistant
SEL-5073 Phasor Concentrator

OPS Network

SEL-735

SEL-421

SEL-411L

Cost

- Existing Ametek, local DFR solution costs anywhere from $60,000 to $120,000 installed per substation initial cost.

- VDFR requires a server and software for approximately $80,000

- VDRF requires relays or other devices that can sample the grid quantities at a high rate.

- VDFR requires an Ethernet network. Cost ??

- VDFR requires less than 10% the labor as a local DFR

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Reliability

- Existing Ametek, local DFR has an observed failure rate of maybe 30 years (MTBF)

- VDFR server and software has an observed failure rate of ? Not a simple calculation.

- VDFR uses relays for data source. The relays have an observed failure rate of +300 years.

- VDFR uses communications to remotely store data

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Availability
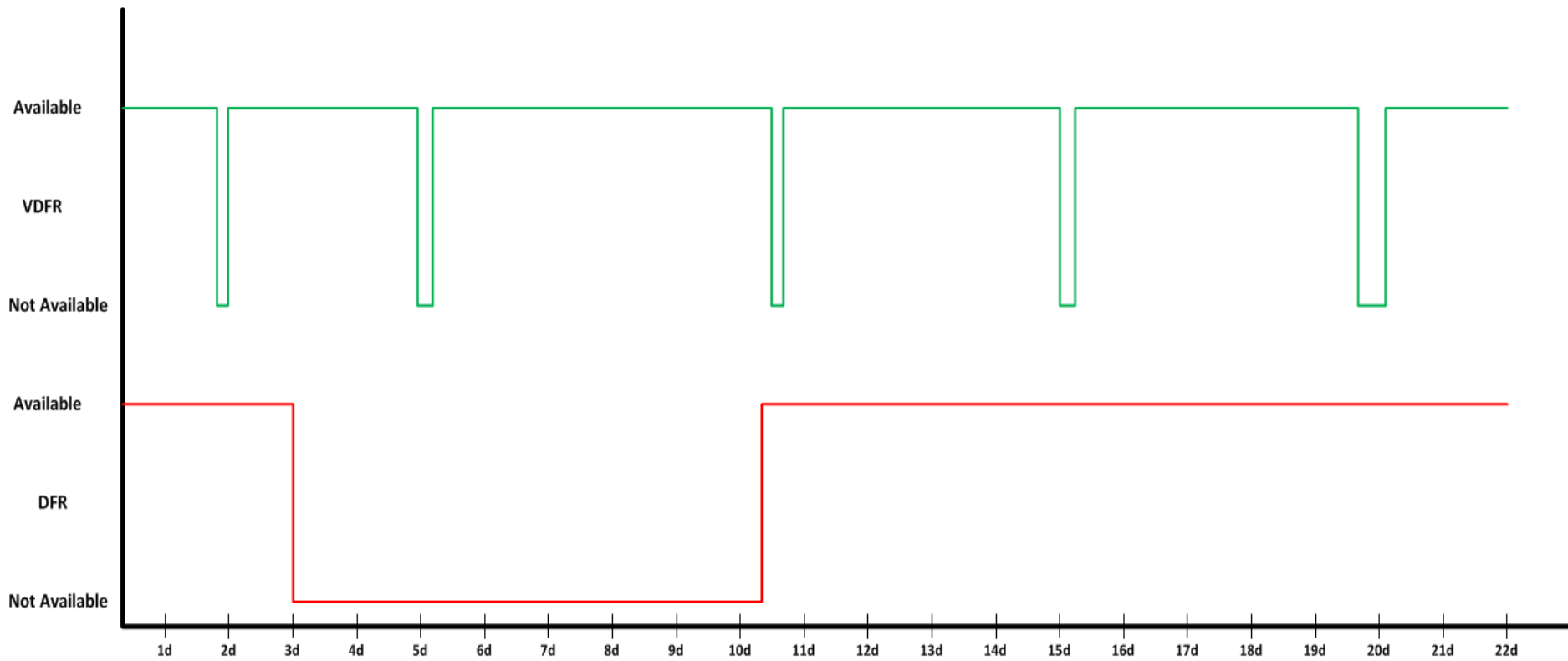
Security

- Active directory authentication

- Server requires relay "Level 1" access.

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Summary

- The VDFR only becomes practical if the existing substation architecture is IP based.

- There is an installed IP based, permanent and secure connection to the substation.

- Have the ability to create a virtual server to run the software.

- Close relationship to IT support staff.

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Questions?