

TESLA Recorder PMU Capabilities

The image displays several overlapping screenshots of the TESLA software interface. The main window shows a tree view of system components and a list of parameters. A secondary window displays a logic function configuration for 'Load Logic', featuring a truth table and a logic diagram. The truth table is as follows:

Label	Enable	Fault	Swing	Log	Notify	Cross Trigger	Priority	Alarm Contact
ACTIVE State	Active	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1	...
INACTIVE State	Inactive	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1	...

Other screenshots show a logic diagram with inputs like 'Line 1: Va:Line 1[HiLev]' and 'Line 1: Va:Line 1[LoLev]', and a data table with columns for 'Label', 'Status', 'Unit', 'Value', 'Unit', 'Alarm', 'Status', 'Event', 'Time', 'Event', 'Time'.



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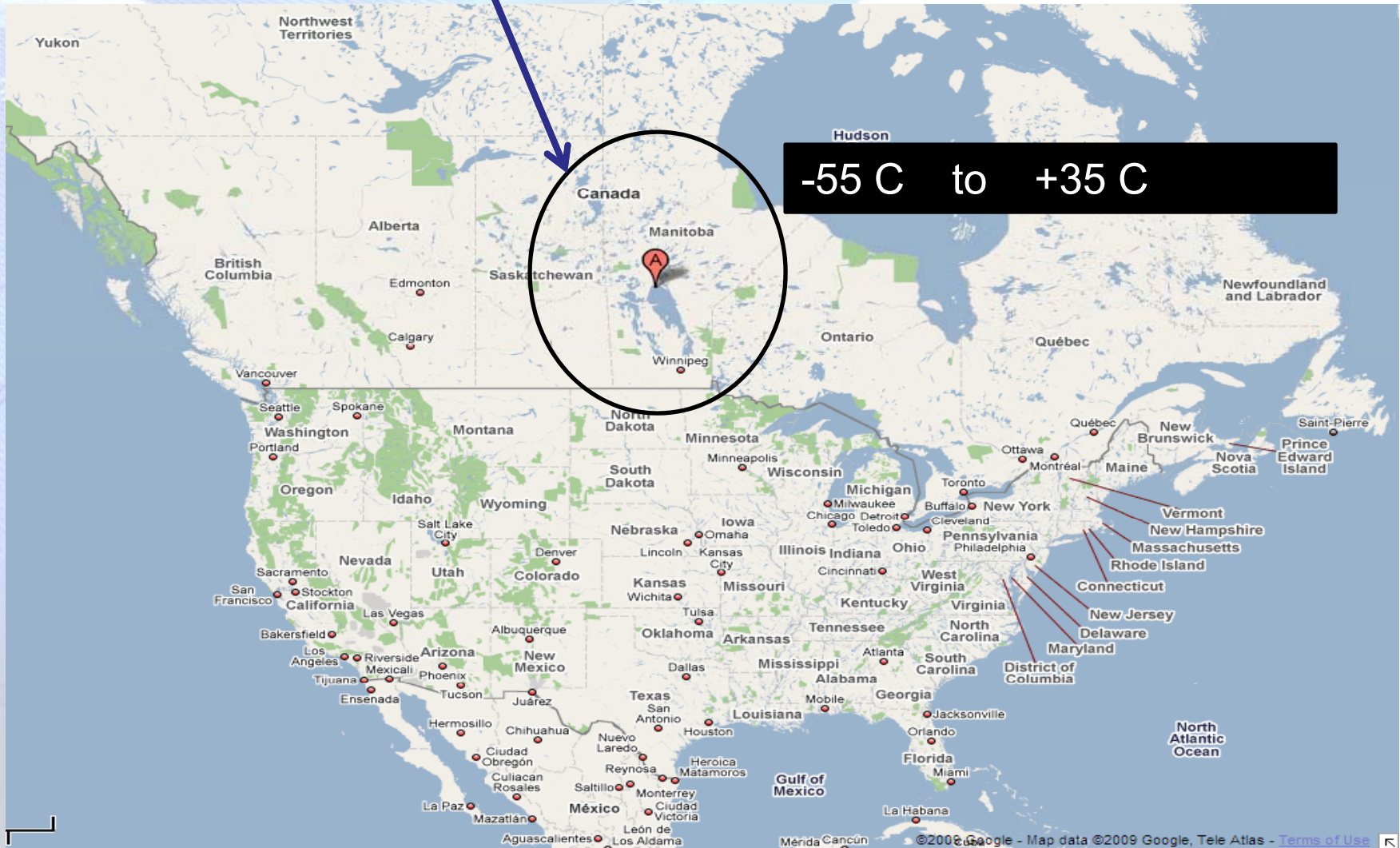
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About ERLPhase

Charles Legeyt Fortescue

- Inventor of SYMMETRICAL COMPONENTS



About ERLPhase



NXTPHASE



- ERLPhase was formed in 2007 as the next generation of APT Power Technologies and the Relay and Recorder division of NxtPhase T&D Corp.
- ERLPhase is formed as a division of Easun Reyrolle Ltd., a growing international company.

ERLPhase Relays & Recorders

Protection Relays



L-PRO 2100 / 4000
(line relay)



T-PRO 8700 / 4000
(transformer relay)



B-PRO 8700 / 4000
(bus relay)



F-PRO 5100 / 3000
(feeder relay)



RecordBase
(central station)

Disturbance Recorders

TESLA 3000 / 4000 Recorders

ALL 4000 Series
Products and
F-PRO 3000
Support
IEC 61850
communication
protocol

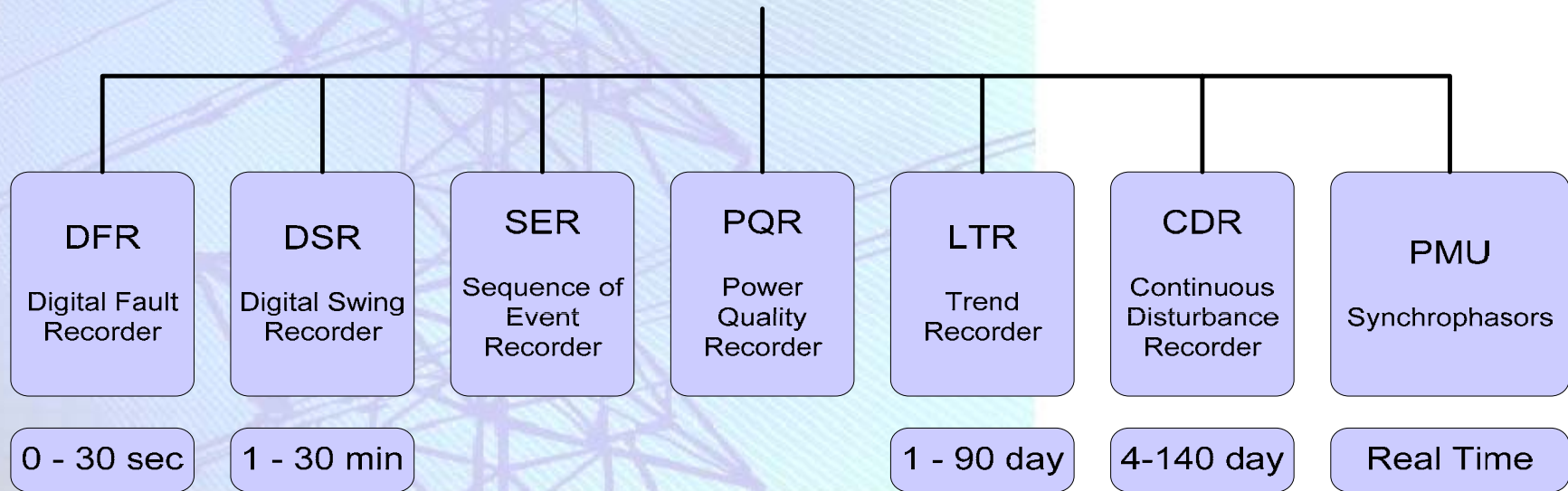
TESLA LITE

New!

TESLA Power System Recorder



TESLA 3000 Power System Recorder



TESLA Overview



The TESLA is a complete, state of the art, user friendly multi timeframe dynamic power system recorder with advanced PMU and Continuous Disturbance Recording capabilities

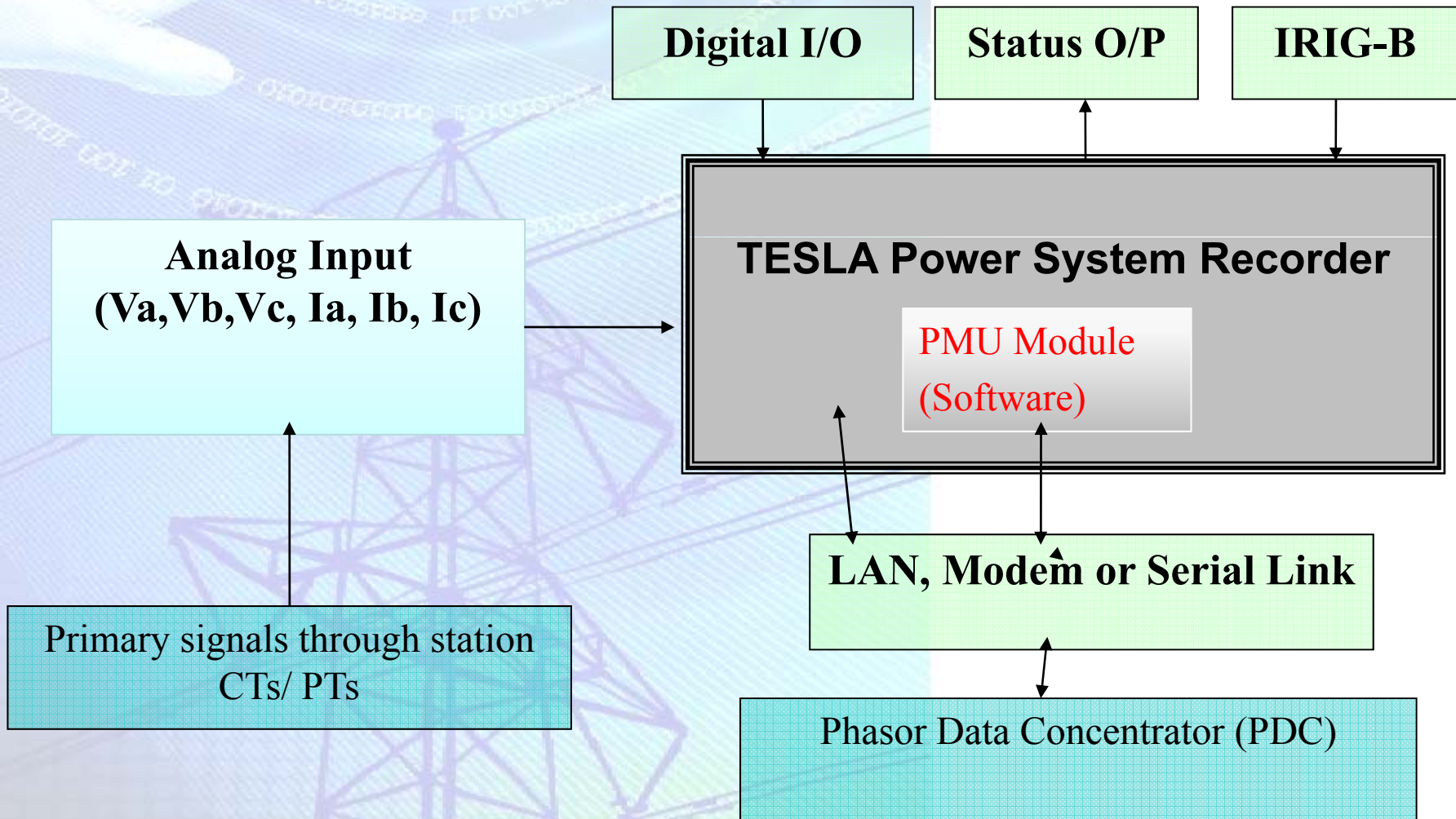
- 36A (64 DI) and 18A (32 DI) Channels; cooperative mode: 144A (256 DI)
- Sampling: 32, 64, 96, 128, 256 & 384 samples/cycle
- NERC Compliant Continuous Disturbance Recording Capabilities
- Multiple Time-Frame Recording Device
 - Transient (Fault) Recording
 - Extended Disturbance (Swing) Recorder
 - Event Logger (SOE)
 - Long term Trend Recorder
 - Continuous Disturbance Recording (FIFO)
- PMU – Phasor Measurement Unit (IEEE C37.118)
- Fault Location (10 devices)

TESLA Overview

OVER 120 CALCULATED CHANNELS PER RECORDER:

- Summation: (30 channels) High & Low Magnitude; + & - ROC triggers
- Sequence: (12 channels) +, -, 0 sequence triggers
- Watts/Vars: (18 channels) high & low magnitude; + & - ROC triggers
- Impedance: (18 channels) ROC within defined impedance circle around origin
- Logic: (30 channels) AND, OR, etc triggers on transition to ON or OFF state
- Power Factor: (18 channels) separate triggers for lagging (inductive) and leading (capacitive)
- Fault Locator: (10 channels) creates event message
- Frequency: (2 channels) High & Low Magnitude; + & - ROC triggers

TESLA Recorder PMU (IEEE C37.118) Capabilities



TESLA PMU Module

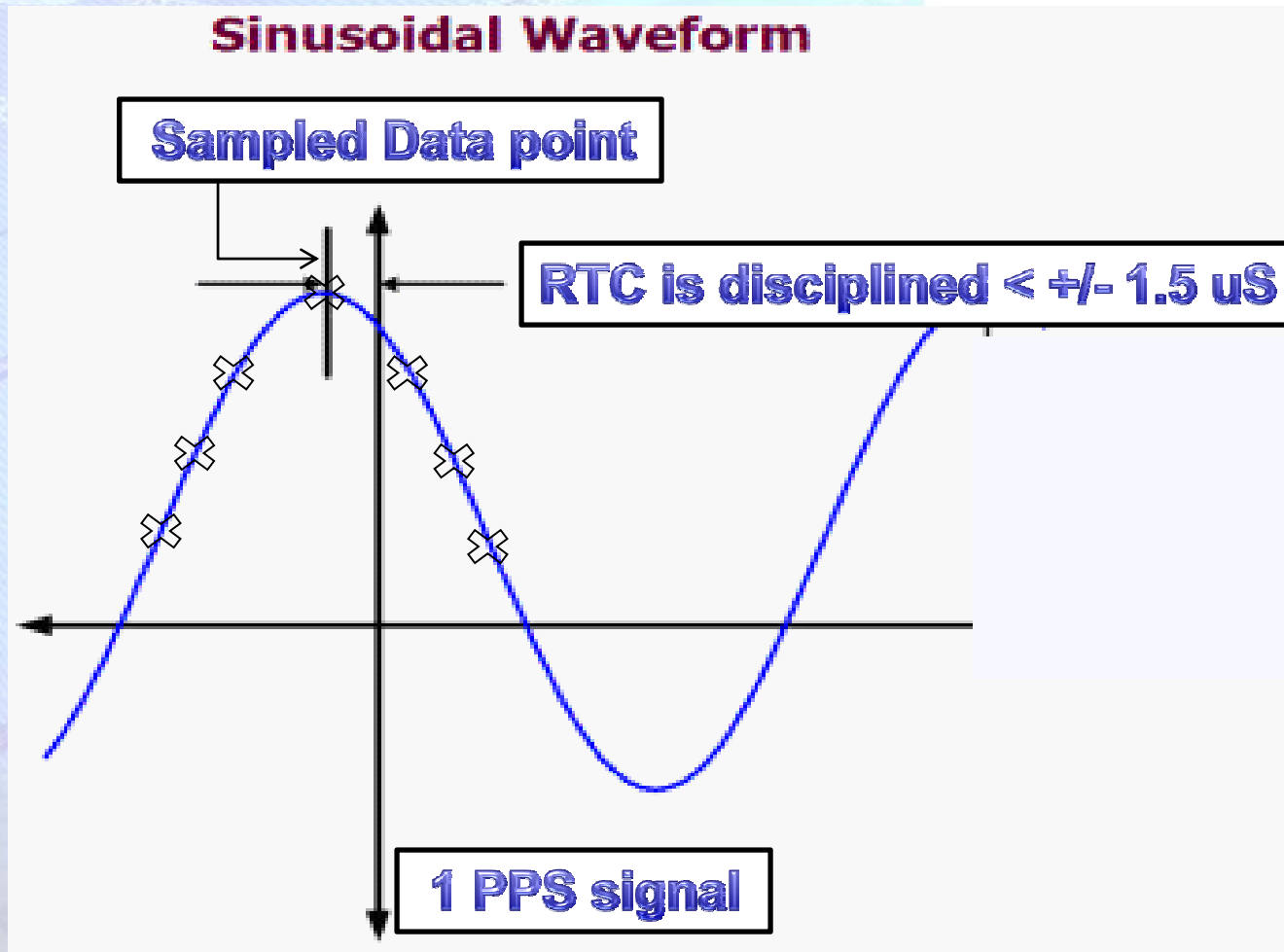
- **Complies with IEEE C37.118**
- **Field upgradeable**
- **Exists simultaneously with the other recording features**
- **Superior communication capabilities**
- **Wide range frequency response**
- **Easy to configure and use**
- **Excellent time synchronization accuracy (+/- 1.5 μ S)**

TESLA PMU Capabilities

- **All Triggers are based on PMU measurements**
 - Voltage and Current Phasor Trigger
 - Sequence Components Trigger
 - Summation Trigger
 - Impedance Trigger
- (Triggers: high, low, positive, negative, rate of change etc.,.)

TESLA PMU Capabilities...

- Synchronized sampling with IRIG signal (1 PPS)



TESLA PMU Capabilities...

- **PMU Recording in Swing Domain (1 - 30 minutes)**
 - PMU Magnitude and Phase angle recording available based on different trigger event
 - Frequency channels are also available

TESLA PMU Capabilities...

- **Trend PMU Data over 90 days
(10 – 3600 sec interval)**
 - PMU Phase Angle Trending over 90 days
 - PMU Phasor Magnitude Trending over 90 days
 - Frequency channels trending

TESLA PMU Capabilities...

- **Continuous Storage of PMU data from 10 – 60 Frames / sec on a 4GB on board flash disc (mini PDC)**
 - Voltage and Current Phasors can be stored as per NERC's requirement ranging from 3 – 140 days on the local storage memory
 - Recording can be made based using continuous data

TESLA PMU Capabilities...

NERC CDR Compliance:

Number of channels *	Sample rate (RMS records per second per channel)						
	6	10	12	15	20	30	60
36	38	22	19	15	11	7	3.8
24	56	33	28	22	16	11	5.5
18	73	44	36	29	22	14	7
12	106	63	53	42	31	21	10
9	136	81	68	54	40	27	13

No. of days the continuous data can be stored on the TESLA 3000 DFR

6 records per sample is the requirement from NERC and TESLA 3000 DFR can store depending on the number of channels up to 136 days of data

Sample rate – RMS records per second per channel

TESLA PMU Capabilities...

Installation Benefits:

- Best retrofit recorder solution to the industry
 - Can use existing wiring (split core CTs)
 - Smallest footprint among recorders allows easy retrofit and installation
- Remote input modules up to 1200 meters (4000 feet) away save on costly CT and PT wiring runs
- Flexible Installation : Centralized, distributed, or hybrid installation
 - PMU and CDR recording capability are field upgradable on existing TESLA 3000 installations

Utilities can save nearly \$250k in installation cost for synchrophasor applications

TESLA PMU Capabilities...

The screenshot displays the PMU Connection Tester software interface, which is used for configuring and monitoring PMU (Phasor Measurement Unit) connections. The interface is divided into several sections:

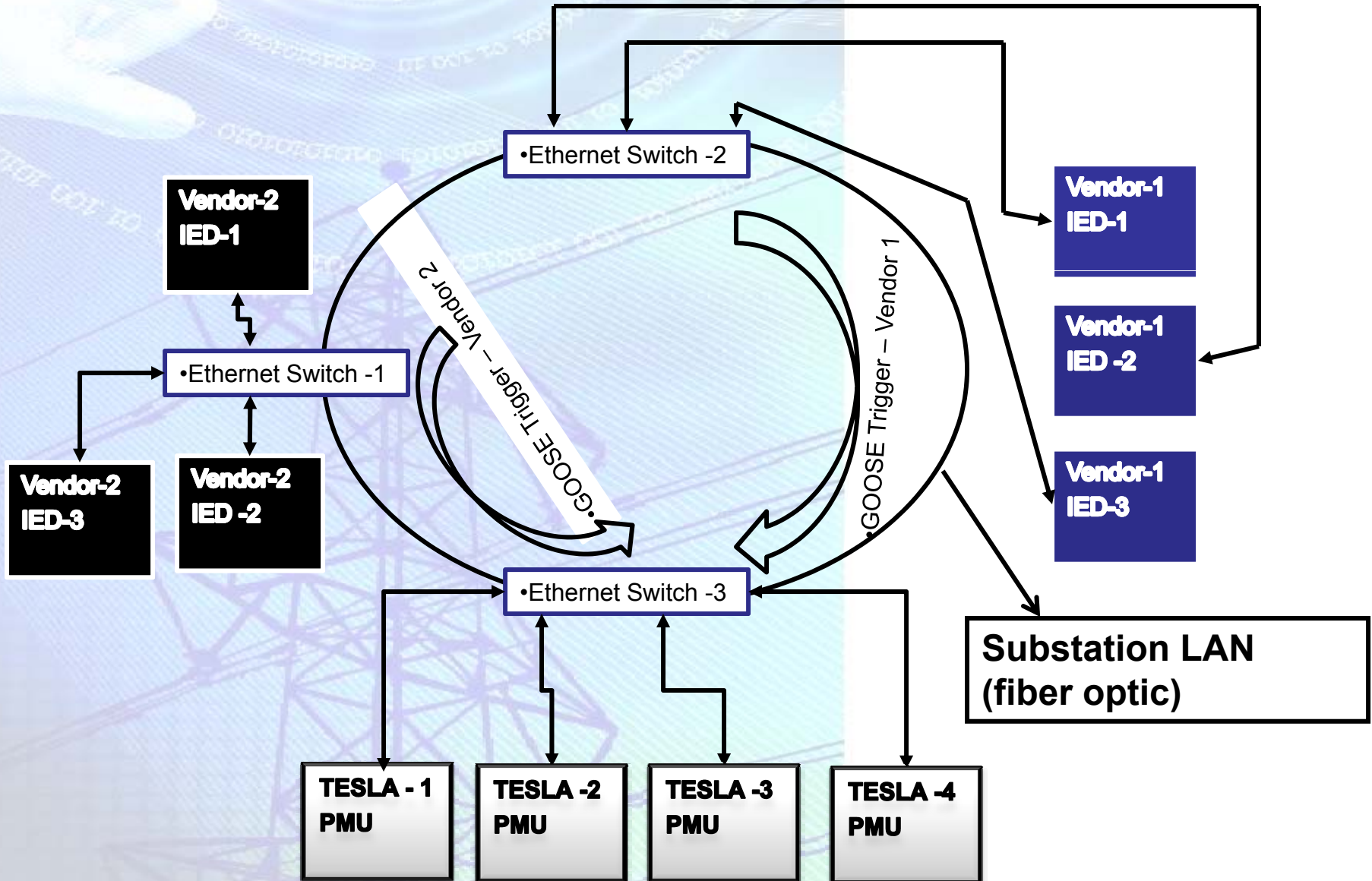
- Connection Parameters:**
 - Protocol: IEEE C37.118-2005 (Version 1)
 - Host IP: 206.45.65.123
 - Port: 4712
 - Device ID Code: 1
 - Command: (empty)
 - Disable Real-time Data: (dropdown menu)
 - Buttons: Establish Tcp Server, Send, Disconnect
 - Version: 2.2.0.24862
- Configuration Frame (IEEE C37_118.ConfigurationFrame):**

Attribute	Value
Binary Length	94
Total Cells	1
Fundamental Frame Type	0: ConfigurationFrame
ID Code	1
Is Partial Frame	False
Published	False
Ticks	63354063855000000
Timestamp	2008-08-11 15:04:15.000
Frame Rate	20
Ticks Per Frame	500000
Frame Type	48: ConfigurationFrame
Frame Length	94
Version	1
Second of Century	1218467055
Fraction of Second	0
Time Quality Flags	0:
Time Quality Indicator Code	0: Locked
Time Base	1000000
Draft Revision	1: Draft7
- Configuration Cell Collection (IEEE C37_118.DataFrame):**

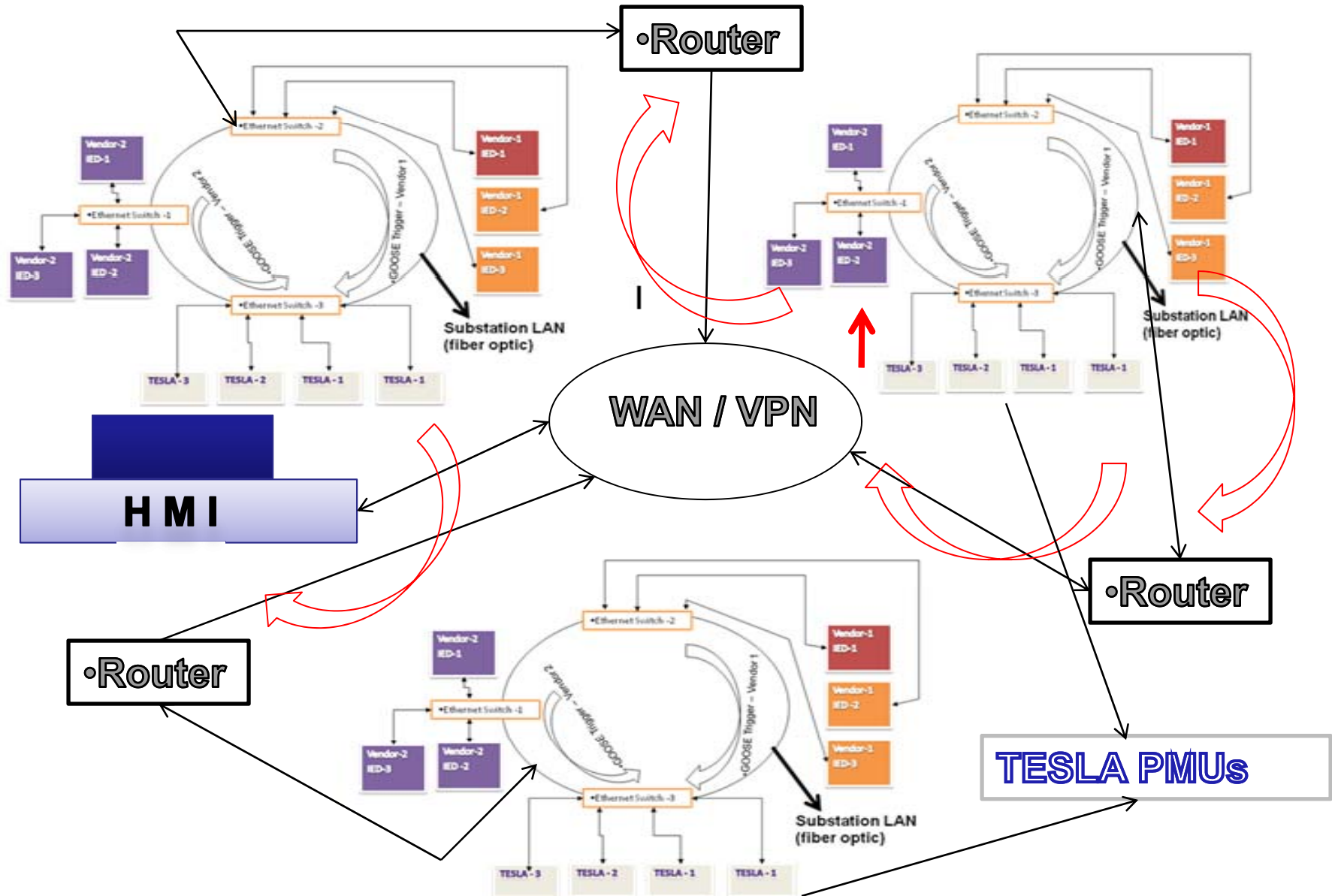
Attribute	Value
Click for Associated Definition	IEEE C37_118
Binary Length	30
Total Cells	1
Fundamental Frame Type	1: DataFrame
ID Code	1
Is Partial Frame	False
Published	False
Ticks	63354063896
Timestamp	2008-08-11 15:05:15.550
Frame Type	0: DataFrame
Frame Length	30
Version	1
Second of Century	1218467096
Fraction of Second	950000
Time Quality Flags	0:
Time Quality Indicator Code	0: Locked
- Real-time Frame Detail:**

Frame Type: DataFrame AA 01 00 1E 00 01 48 A0 55 2B 00 0C 03
 Time: 2008-08-11 15:05:15.550
 Frequency: 60.0090 Hz
 Angle: 48.34618°
 Magnitude: 38.0990 (65.9894) kV
 Display: Hexadecimal
- Graphs:**
 - Top Graph:** Shows a fluctuating blue line representing voltage magnitude over time. The y-axis ranges from 60.0170 to 60.0326. The x-axis represents time. A legend indicates 'Before UPS:Vac:V'.
 - Bottom Graph:** Shows a flat red line at 0, representing phase angle. The y-axis ranges from -100 to 100. A legend indicates 'Before UPS:Fac:A'.
- Status Bar:**
 - Total frames: 115 / Frames/sec: 19.7239 / Total bytes: 3474 / Bit rate (mbps): 0.0054 / Queued: 0
 - Total frames: 86 / Frames/sec: 28.5996 / Total bytes: 2644 / Bit rate (mbps): 0.0070 / Queued buffers: 0

TESLA 4000 PMU & IEC 61850



TESLA 4000 PMU Cross Triggering



Conclusions:

- **TESLA PMUs are field upgradable through firmware update, easy to install, and cost effective**
- **Provides built in redundancy to PMU Phasor Data, and supports event based recording capabilities at 60Hz sample rate**
- **Still need to establish interoperability for wide area monitoring and control**
- **IEC 61850 and PMU standards are implemented in small scale (especially in North America) and hence the limitations are not fully understood**
- **Number of challenges for both vendors and utilities ahead to adopt to the rapid changing standards and regulations.**

The background of the slide is a composite image. At the top, a hand is shown interacting with a glowing digital interface that features a central bright light and various data-like patterns. Below this, the image transitions into a perspective view of several high-voltage power transmission towers and their associated power lines, set against a light blue and green gradient background.

QUESTIONS ??