



Integrated Power Plant Monitoring & Analysis System (iPMA)

June 2020

3IC (주) 쓰리아이씨

Patent Registered

✓ Patent Title:

Integrated Monitoring & Analysis System for Power Generation and Transmission System



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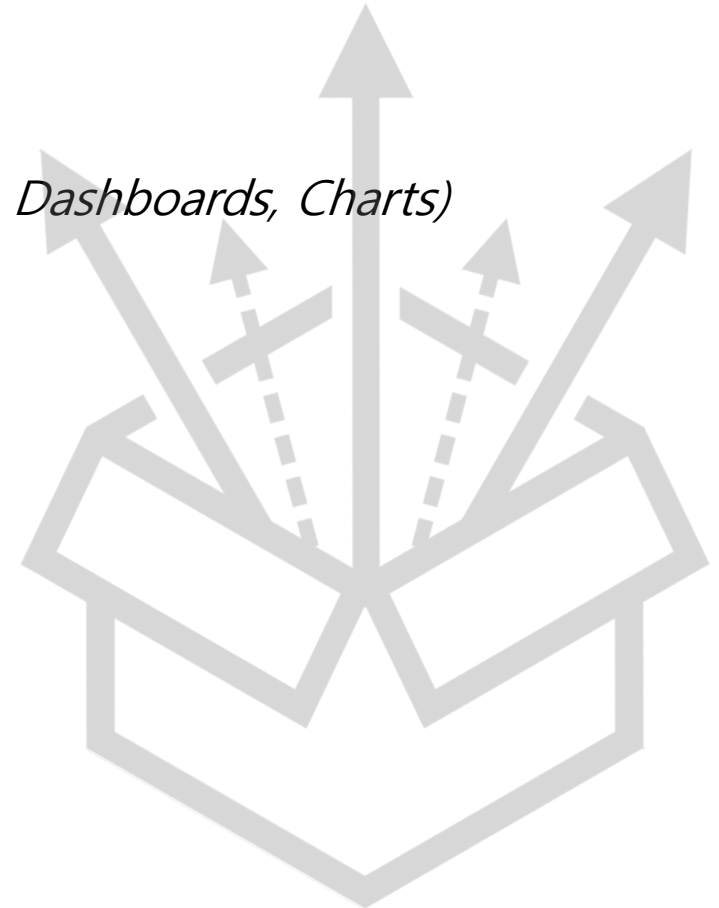
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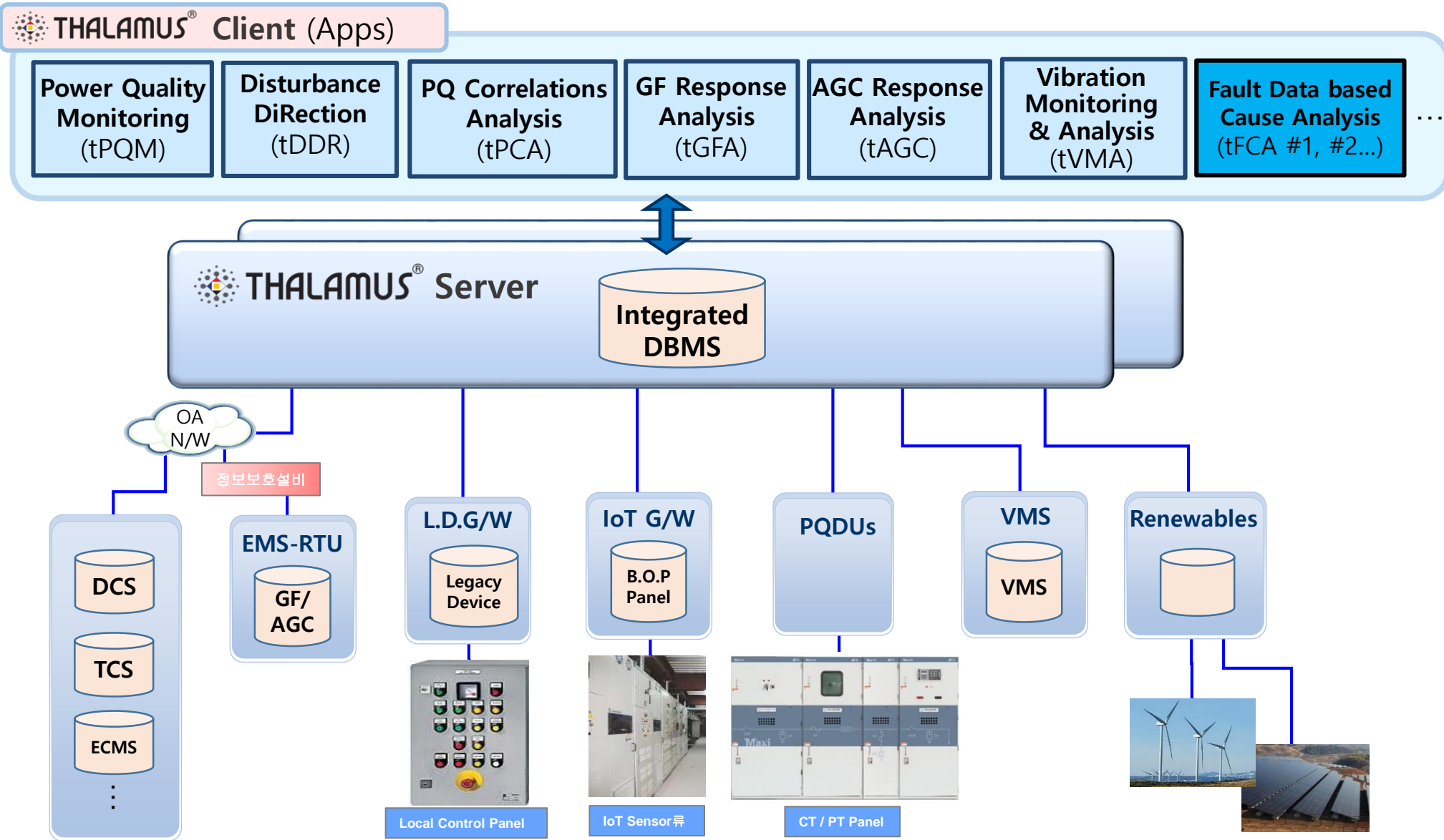


1. iPMA Overview

Big Data Platform based integrated Monitoring & Analysis System for Power Plant

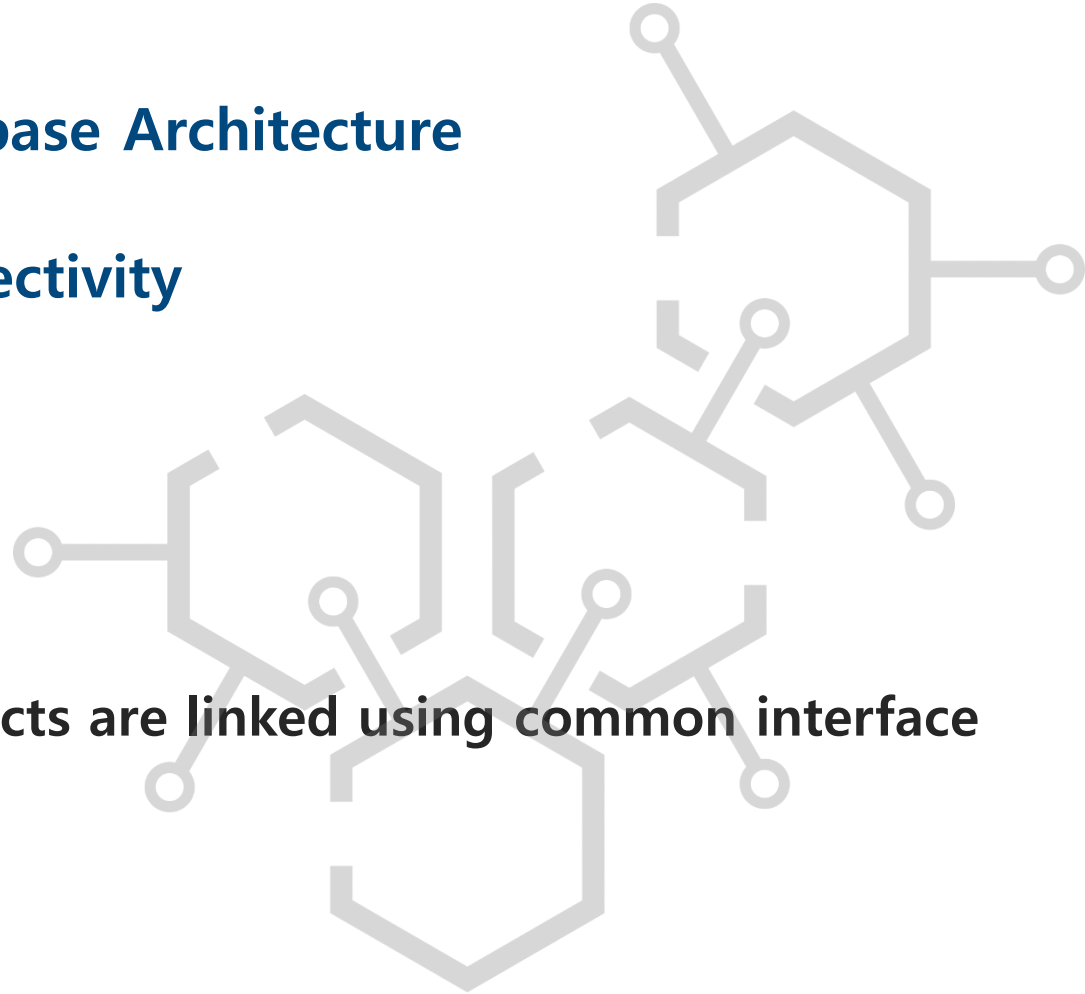
- ✓ Building integrated DB by aggregating data from TCS/DCS/ECMS/VMS etc.
- ✓ In-house Power Quality Monitoring, Data Gathering & Analysis
 - Fault Cause Analysis by analyzing Event/Fault Correlations
 - Disturbance Direction Analysis
 - Taking Proactive Measures by identifying signs of abnormalities in advance
- ✓ GF / AGC Response History Analysis
- ✓ Facility Vibration Monitoring & Cause Analysis
- ✓ Building Integrated DB & analyzing Correlations for Renewable Energies (Wind, PV, etc.)

2. iPMS Configuration



3. Platform : THALAMUS main feature (1)

- ✓ **Software Platform «brick set»**
- ✓ **Cross Platform & Cross Database Architecture**
- ✓ **Device and data source connectivity**
 - Multiprotocol vendor-agnostic
 - Device Drivers, DDK, Agents
- ✓ **Unified Data Model**
 - Every Device and System Objects are linked using common interface
- ✓ **Development and Integration**



* THALAMUS Device Drivers (examples of supported protocols)

AggreGate Protocol	BACnet	CAP	CoAP	CORBA	DLMS/COSEM
DNP3	DNS	FTP	GPS/GLONASS и M2M Data	HTTP/HTTPS	IEC 60870-5-104
ICMP	IMAP	IPMI	JMX	KNX	LDAP
LON/LonTalk	Meter-Bus	Modbus	MQTT	NetFlow	NMEA 0183
OPC	OPC UA	POP3	Radius	SIP	SMB/CIFS
SMI-S	SMPP	SMTP	SNMP	SOAP	SQL
	SSH	Syslog	Telnet	WMI	

and more...

3. Platform : THALAMUS main feature (2)

✓ System Architecture

- Modular & Scalable
- Secure HA (High Availability) via Failover Clustering
- Support Distributed Architecture
 - Enable Load Balancing & Multi-tier Deployment

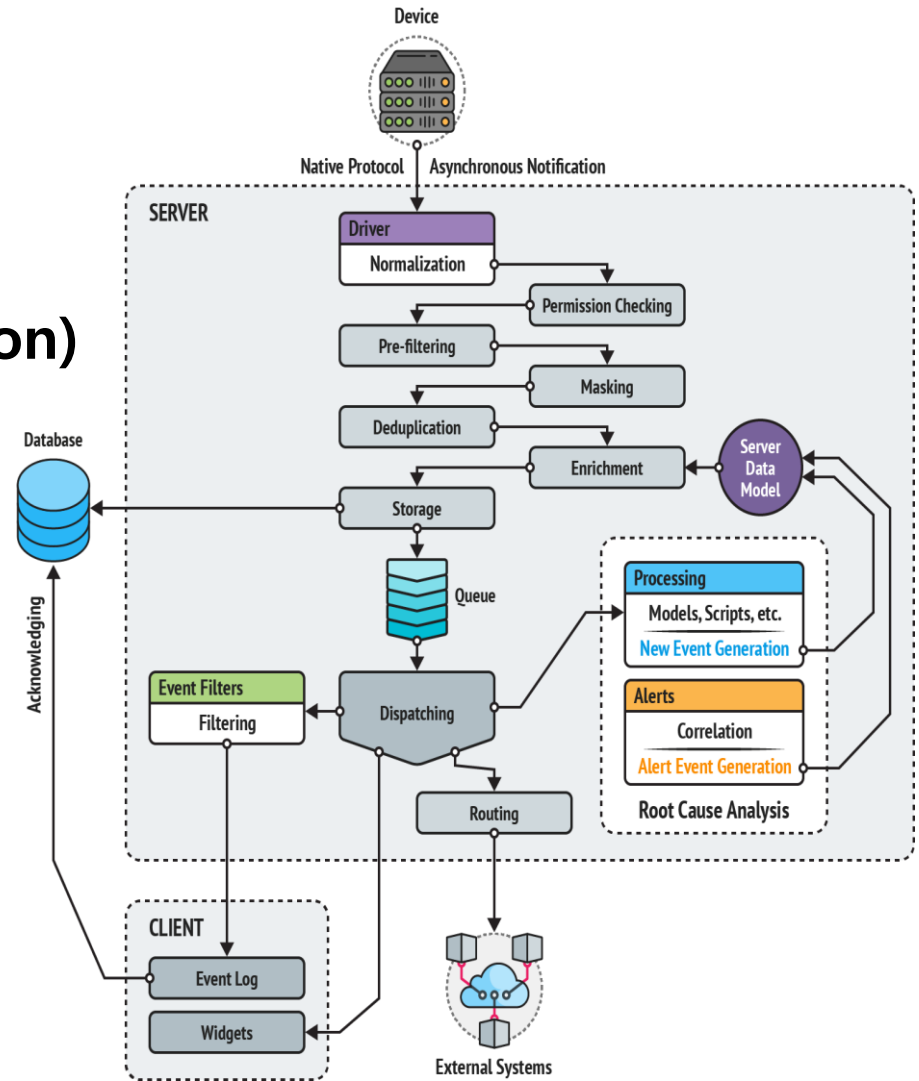
✓ Performance

- Support 100k devices and 5~10 million metrics per Server
- Update 10 billion events/values per day
- Store 100k~500k events per Server/sec
- Unlimited Scalability via Muti-tier Distributed Architecture

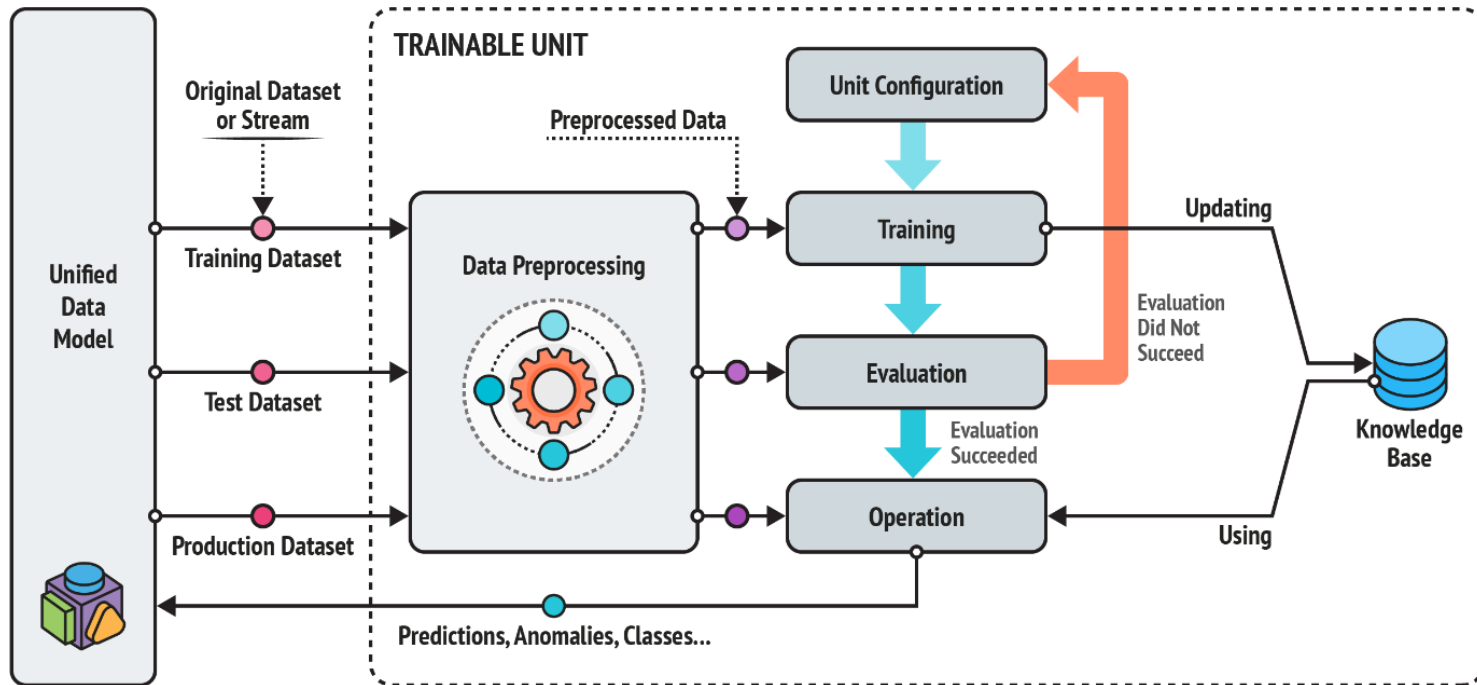
* THALAMUS Event Management

Event Processing Steps

- ✓ Event filtering
- ✓ Event aggregation (de-duplication)
- ✓ Event masking
- ✓ Event Correlation
- ✓ Root cause analysis

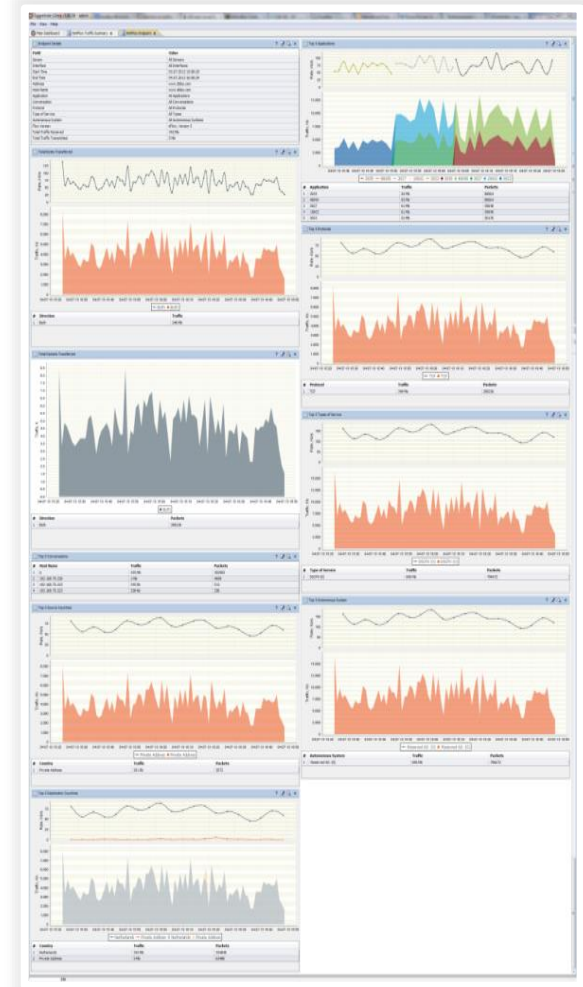
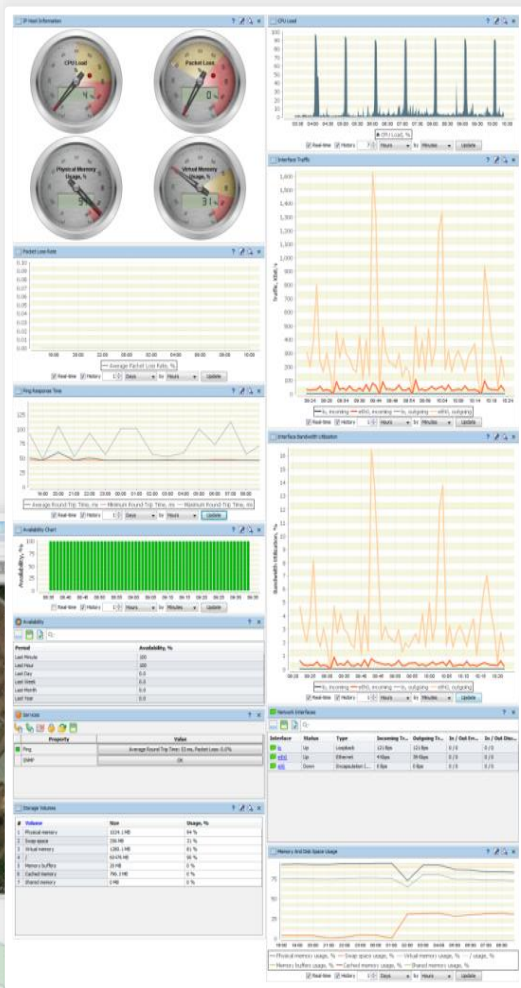


* THALAMUS Machine Learning (ML)

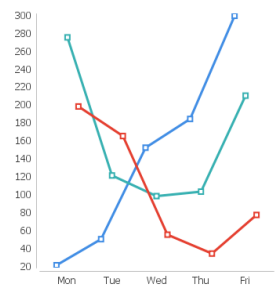


- Supervised Training-based
 - **Dozens of algorithms built-in** : linear / logic regressions, decision trees, neural networks, SVM, naive Bayes classifier, etc.
- Prediction, Classification, Anomaly Detection

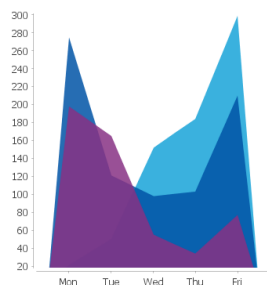
3. Platform : Data Visualization (Widgets & Dashboards)



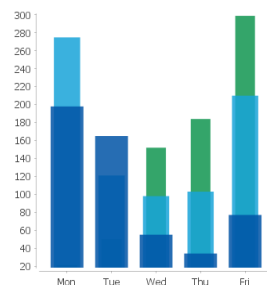
3. Platform : Data Visualization (Chart / Diagram)



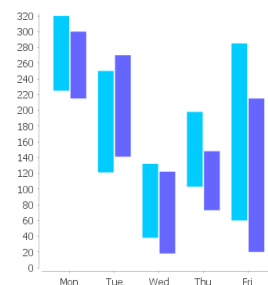
Category Line Chart



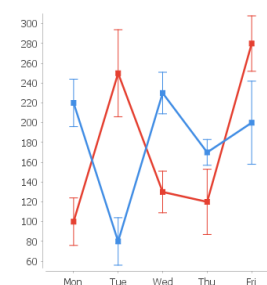
Category Area Chart



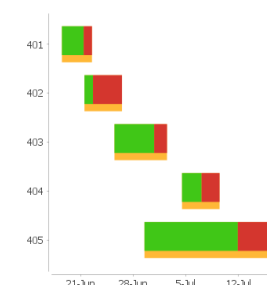
Category Bar Chart



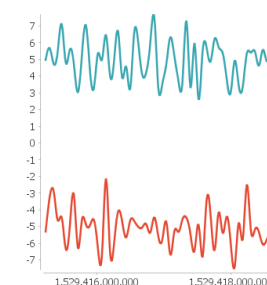
Interval Bar Chart



Statistical Chart



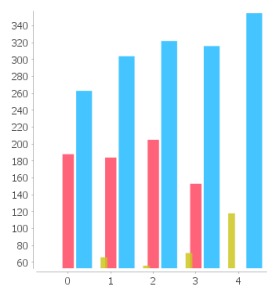
Gantt Chart



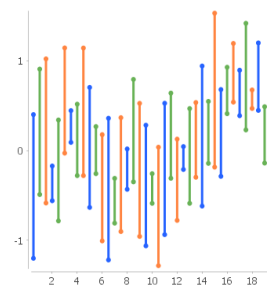
XY Line Chart



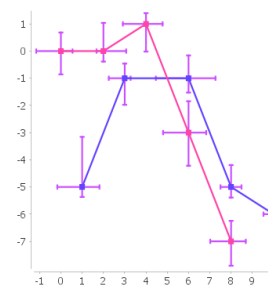
XY Area Chart



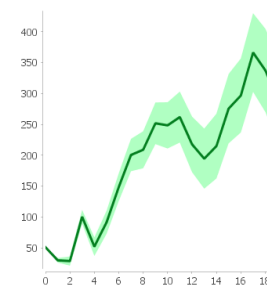
XY Bar Chart



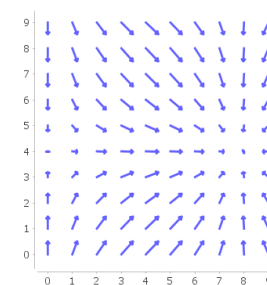
Interval Chart



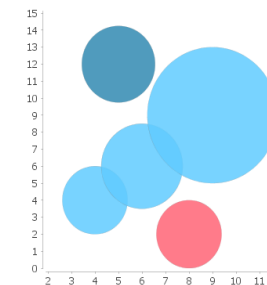
Error Chart



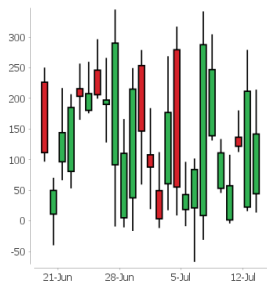
Deviation Chart



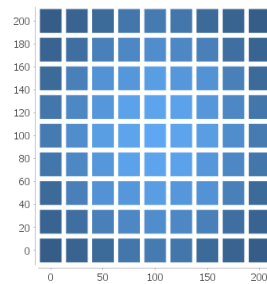
Vector Chart



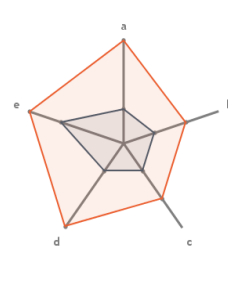
Bubble Chart



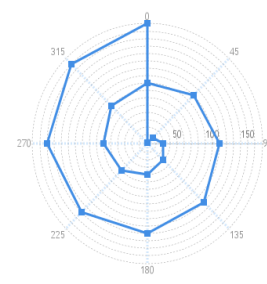
Financial Chart



Block Chart



Spider Chart



Polar Chart



Pie Chart



Ring Chart

4. Application : Screen (example)

신인천발전본부 전력품질 분석 SYSTEM

2019.11.14(월) 17:25:57

아이디로그인 인증서로그인

적합하지 않은 용도 및 타인계정 사용을 금지합니다.

1CC |
 2CC |
 3CC |
 4CC |
 000 |
 000 |
 000 |
 000 |
 SWYD
SETTING

GT1	
MW	00.0
MVAR	00.0
KV	00.0
Hz	00.0

GT2	
MW	00.0
MVAR	00.0
KV	00.0
Hz	00.0

ST1	
MW	00.0
MVAR	00.0
KV	00.0
Hz	00.0

GT3	
MW	00.0
MVAR	00.0
KV	00.0
Hz	00.0

GT4	
MW	00.0
MVAR	00.0
KV	00.0
Hz	00.0

ST2	
MW	00.0
MVAR	00.0
KV	00.0
Hz	00.0

TPQ	
MW	00.0
MVAR	00.0
KV	00.0
Hz	00.0

TDIR	
MW	00.0
MVAR	00.0
KV	00.0
Hz	00.0

TAGC	
MW	00.0
MVAR	00.0
KV	00.0
Hz	00.0

TGF	
MW	00.0
MVAR	00.0
KV	00.0
Hz	00.0

TPA	
MW	00.0
MVAR	00.0
KV	00.0
Hz	00.0

TFA	
MW	00.0
MVAR	00.0
KV	00.0
Hz	00.0

GT7	
MW	00.0
MVAR	00.0
KV	00.0
Hz	00.0

GT8	
MW	00.0
MVAR	00.0
KV	00.0
Hz	00.0

ST4	
MW	00.0
MVAR	00.0
KV	00.0
Hz	00.0

SWYD	
MW	00.0
MVAR	00.0
KV	00.0
Hz	00.0

발전소 현황

신인천

현재전력
kW 4.4

금월발전량

금월발전량
kWh 16.5

금일발전량

금일발전량
kWh 16.5

남부발전			
전일 발전량	27.3 kWh	금월 발전량	0.34 MWh
누적 발전량	11.1 MWh	누적 CO2 절감량	4.7 TON

Alert 확인

2019.10.09(수) 17:25:57 TGF 보조서비스 탈락.txt ●

2019.10.10(목) 17:30:57 TAGC 보조서비스 탈락.txt ●

Event log 확인

2019.10.11(금) 15:28:52 피더4 유효전력 상한기동.txt ●

2019.10.12(토) 10:27:50 신경서 A선로 지락 사고 기동.txt ●

4. Application : ① Power Quality Status Monitoring (tPQM)

Major Features

- ✓ **Detect Power Quality across Power Generation System & Points of Interconnection w/ Transmission Systems**
 - Monitor & Analyze Power Quality Status in & out of Power Plant
- ✓ **Gather Data via PQDU which supports 256 sampling/cycle (15,360 Hz)**
 - Provide accurate PQ status
 - Detect real-time Harmonics
- ✓ **Measure & Monitor PQ over Exciters and Control Power within Power Plant**
 - Identify Power Quality Degradation factors in the Power Plant

4. Application : ① Power Quality Status Monitoring (tPQM)

HMI Screens

MainWindow

데이터 감시 데이터 기록 데이터 분석 시스템 설정

환경설정 **트리거설정** FRAS설정 관리자암호 장치확인

기본 트리거 설정

트리거 종류 설정 RMS DATA Sync Trigger Manual Trigger

AUTO Trigger HOUR MIN DAY

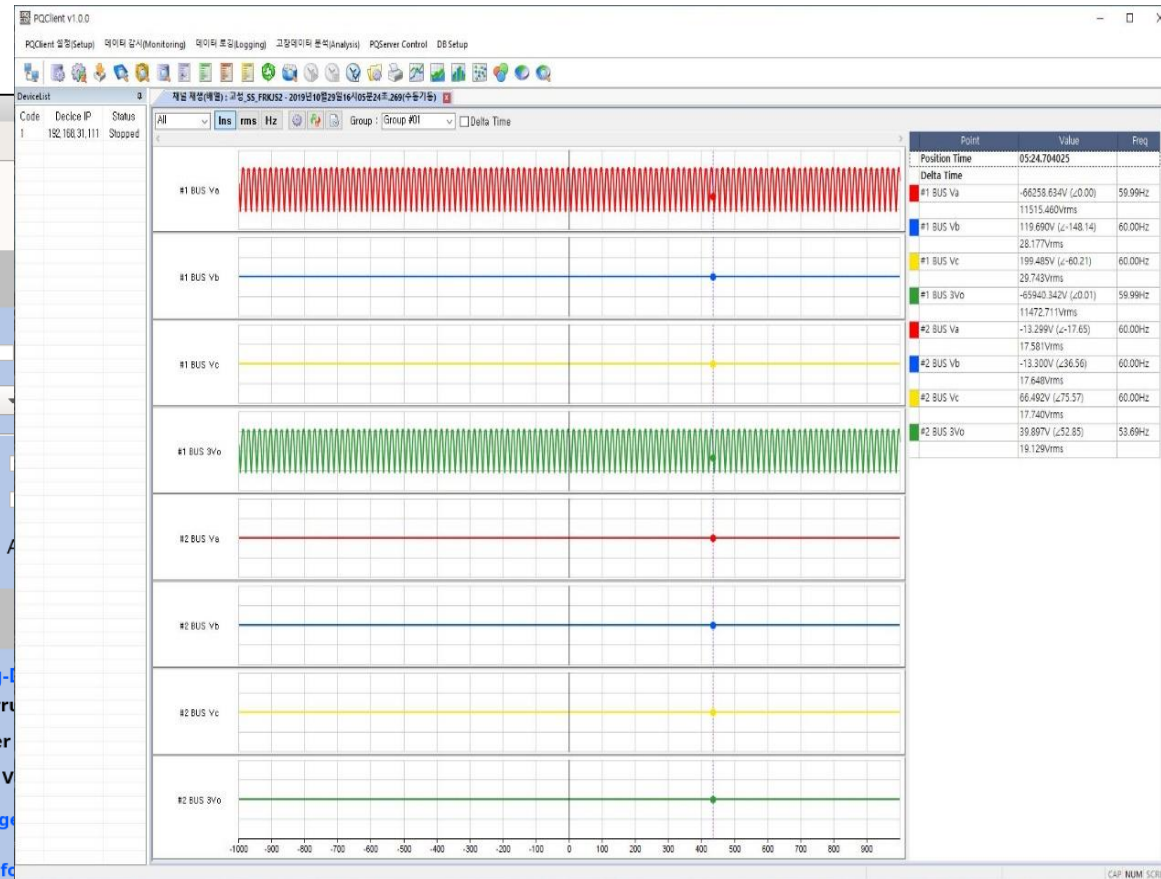
저장시간설정

PRE TRIG.	[100 ~ 1,000]	9,999 [msec]	고장파일저장
POST TRIG.	[100 ~ 1,000]	9,999 [msec]	
PRE PHA.	[1 ~ 10]	9,999 [sec]	고장파일재생
POST PHA.	[1 ~ 1,200]	9,999 [sec]	

전력품질 판정 설정

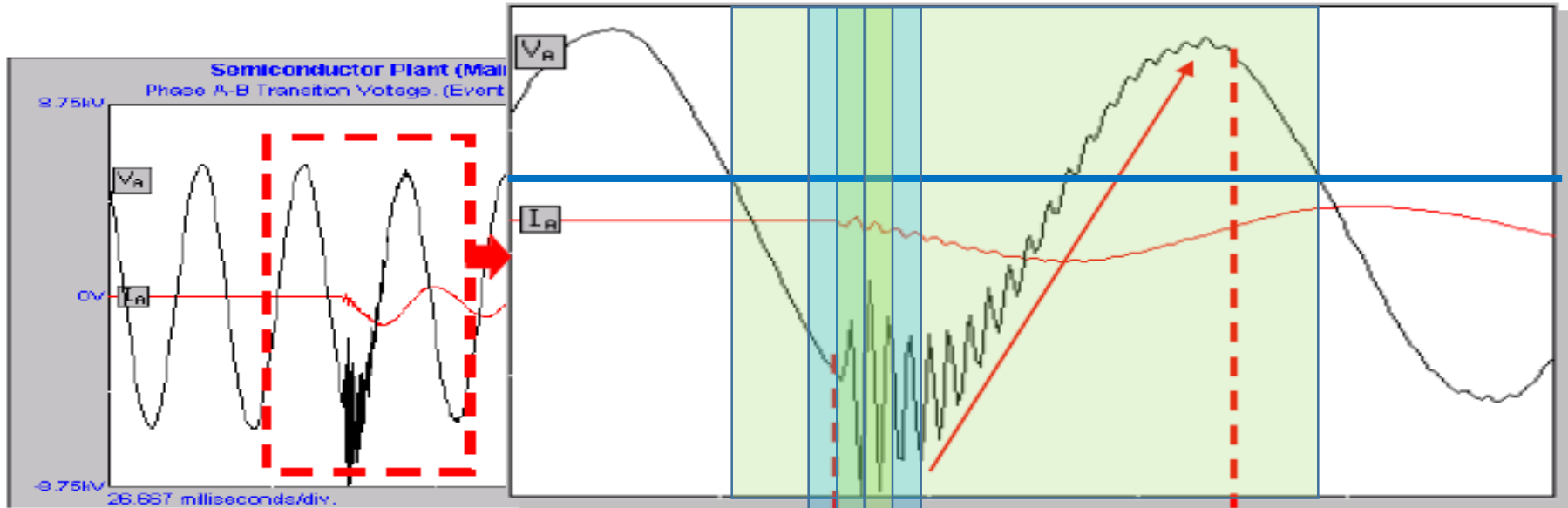
Short Duration Variation

Instanteous [0.5~30cycle]	Sag [10 ~ 90%]	999 [Cycle]	99.9 [%]	<input type="checkbox"/> Trig Enabled
	Swell [110 ~ 180%]	999 [Cycle]	99.9 [%]	<input type="checkbox"/> Trig Enabled
Momentary [0.5~3sec]	Interruption [<10%]	999 [sec]	99.9 [%]	<input type="checkbox"/> Trig Enabled
	Sag [10 ~ 90%]	999 [sec]	99.9 [%]	<input type="checkbox"/> Trig Enabled
	Swell [110 ~ 180%]	999 [sec]	99.9 [%]	<input type="checkbox"/> Trig Enabled
Temporary [3~60sec]	Interruption [<10%]	999 [sec]	99.9 [%]	<input type="checkbox"/> Trig Enabled
	Sag [10 ~ 90%]	999 [sec]	99.9 [%]	<input type="checkbox"/> Trig Enabled
	Swell [110 ~ 180%]	999 [sec]	99.9 [%]	<input type="checkbox"/> Trig Enabled

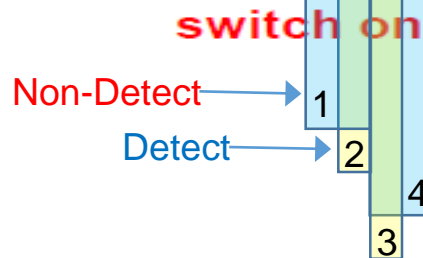


* PQDU (Power Quality Detection Unit)

- ✓ Higher speed 256 sampling over 128 sampling
- Accurate Triggering & Analysis

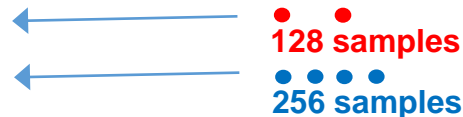


- 128 sample/cycle
- 256 sample/cycle



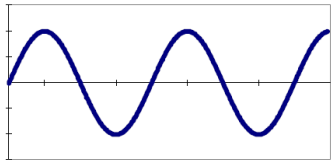
About 4msec delay occurs with a single disturbance (transient)
 $1000\text{msec} / 256 \text{ sample} = 3.906\text{msec}$

When analyzing fault wave, wave distortion occurs

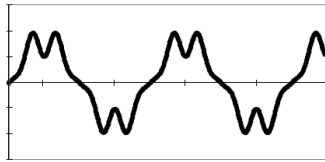


* Real-time Harmonics Detection Algorithm Applied

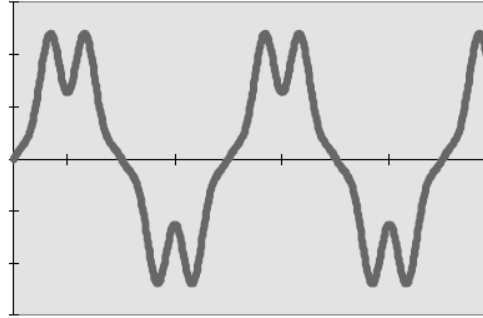
❖ Harmonics



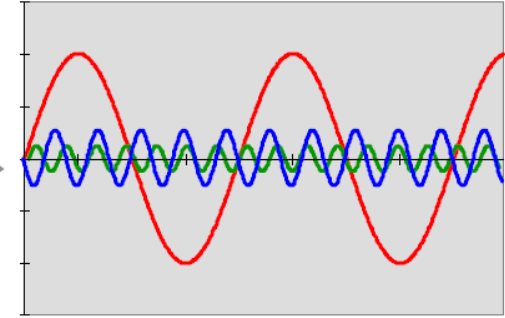
- Current sine wave
- Linear Load



- Distorted Current
- Non-linear Load



- Distorted Current



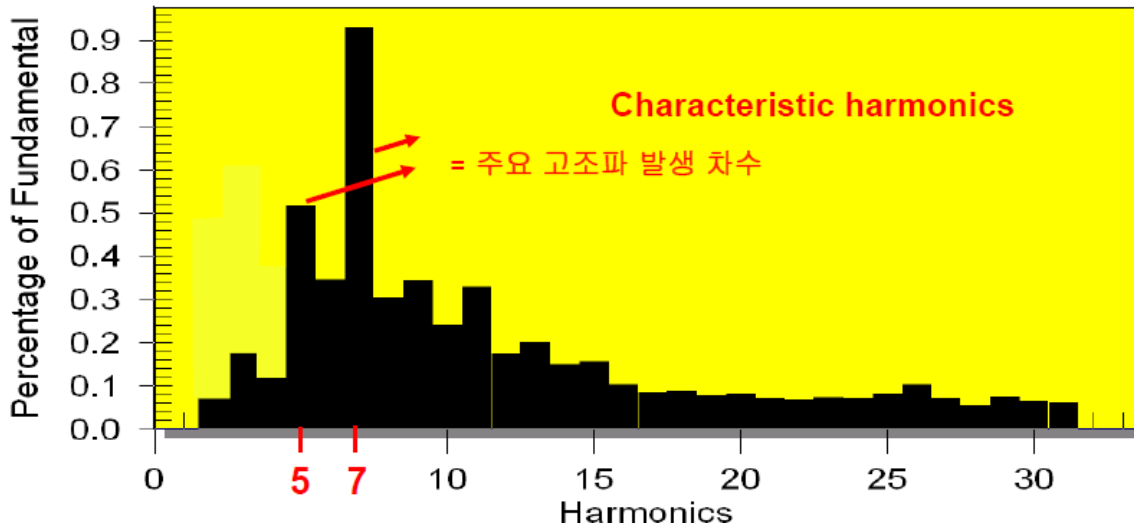
Analyze as individual harmonics

- Large 1st Harmonics
- Small 5th Harmonics
- Smaller 7th Harmonics

...

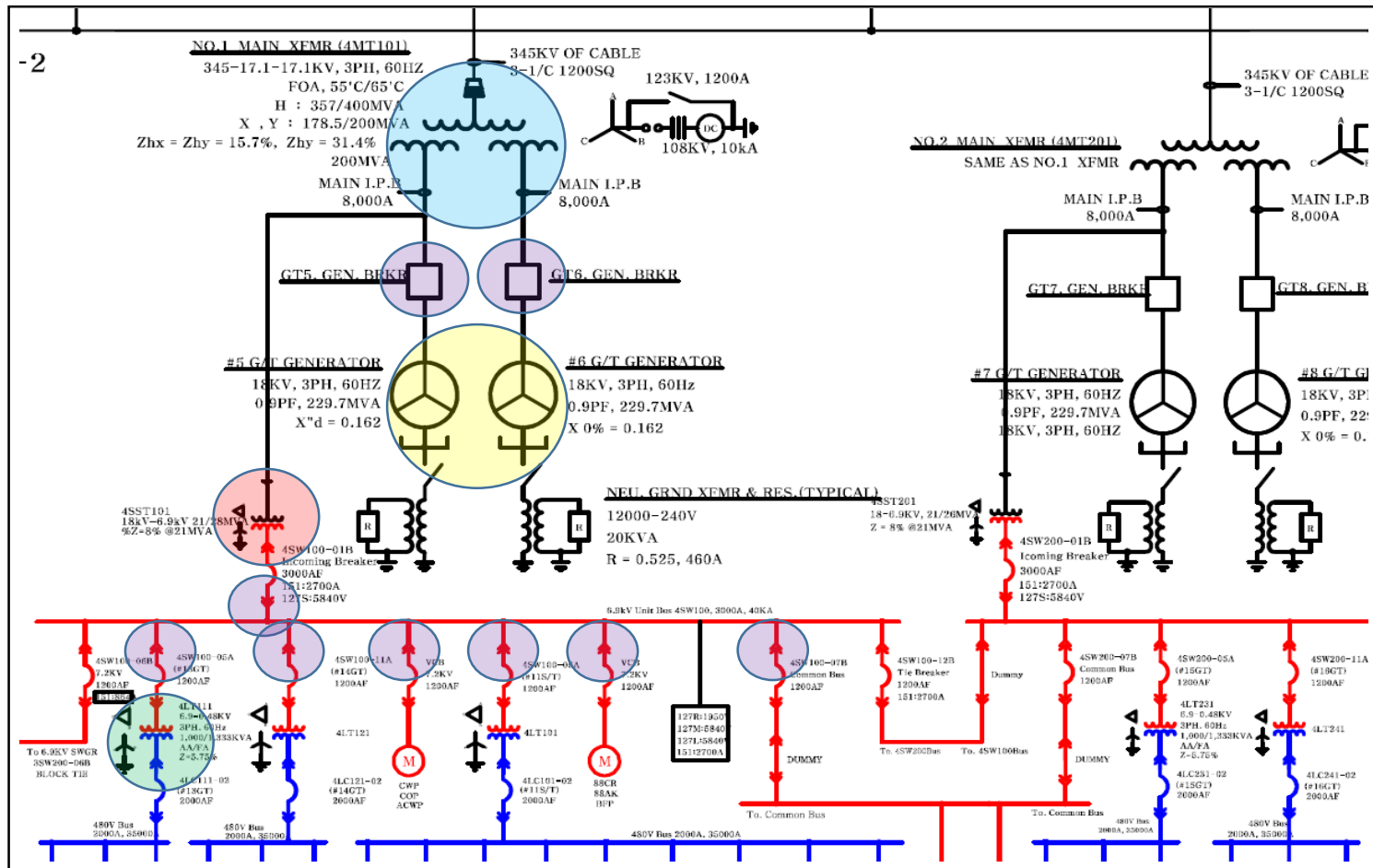
Phase A-B Voltage

Spectral analysis (cycle range 1 - 4) - Normal Resolution










4. Application : ② Disturbance Direction (tDDR)

✓ Show Disturbance Direction on SLD (downstream or upstream) when trouble occurs due to disturbance → Point of trouble, Cause and Responsibility can be Identified

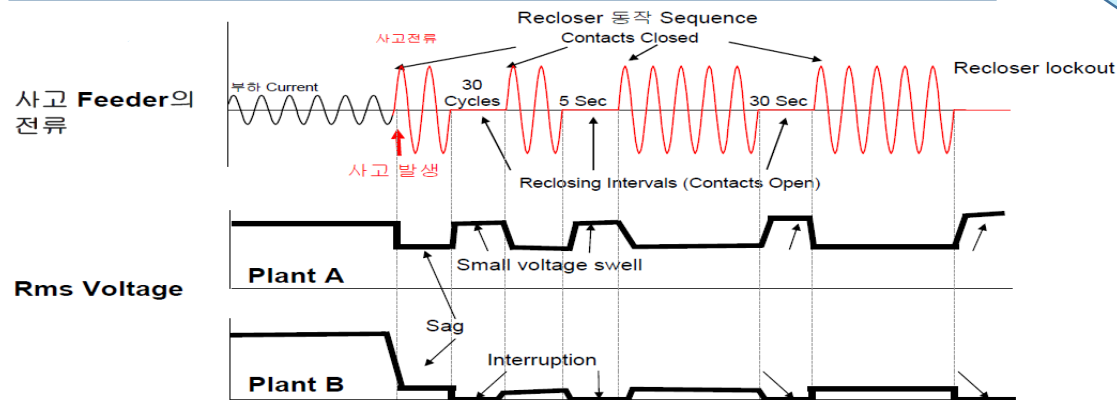
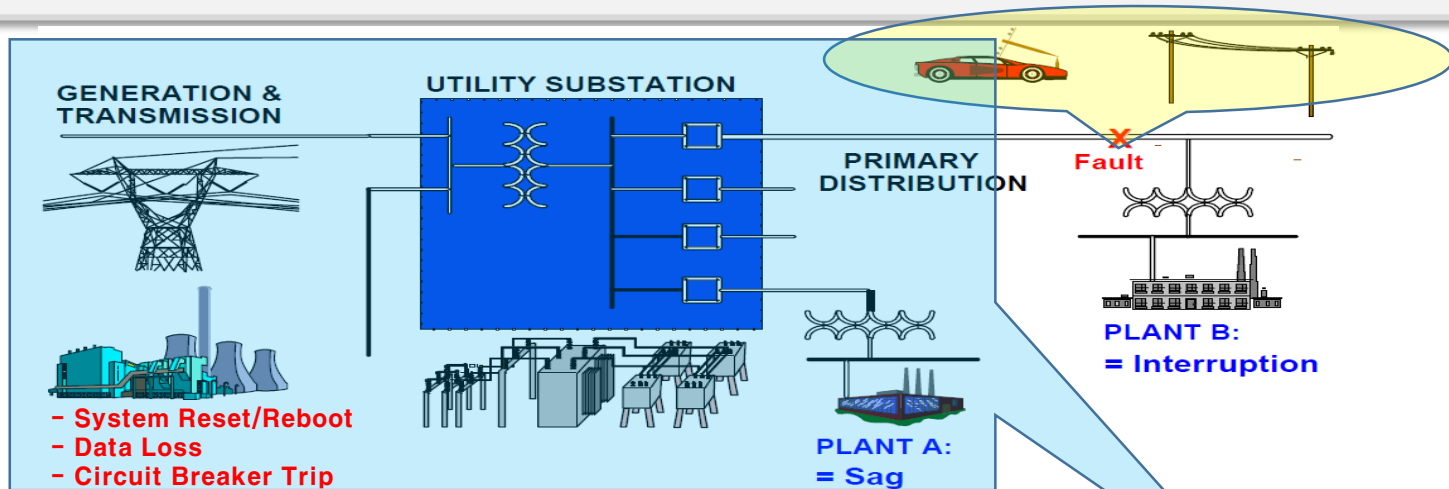


Disturbance Direction

-  Main XFMR 345-17.1
-  Gen. BKR
-  Generator
-  Station Service Tr.
-  Incoming BKR
-  7.2k VCB
-  LV Tr.

4. Application : ③ Power Quality Correlations Analysis (tPCA)

- ✓ Data Pattern Analysis when fault occurs over Transmission/Distribution System
 - Correlations Analysis between ECMS Data (CB Trip, Relay Trip) & PQDU Data
- ✓ PQDU Data Trend Analysis → Analyze impact of the disturbance onto Gen. System in Power Plant
- ✓ Fault Prediction with Correlations Analysis and Threshold Value Setting



Example of OOO Power Plant

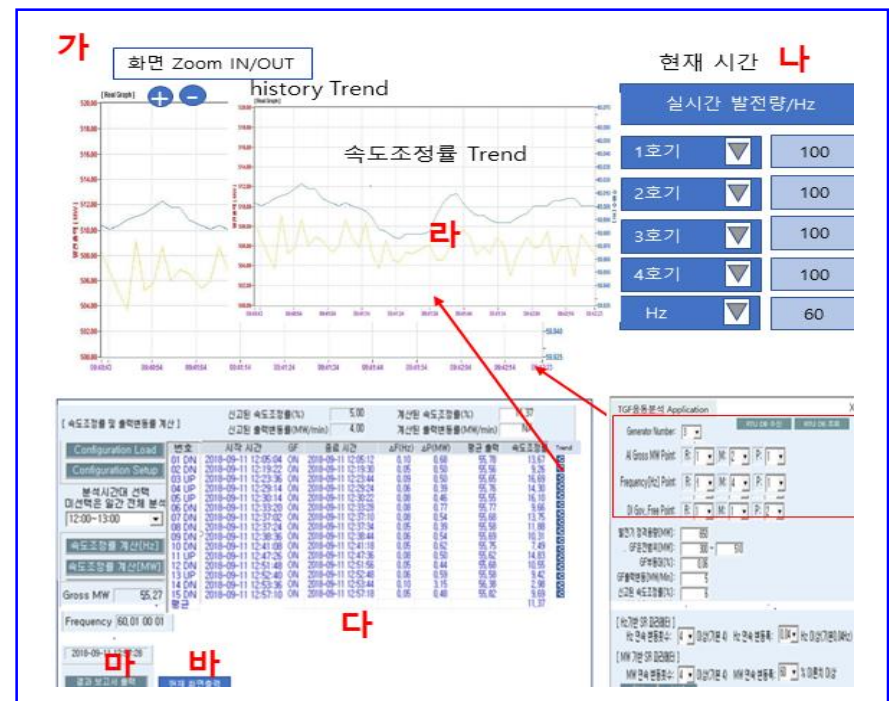
4. Application : ④ GF Response Analysis (tGFA)

- ✓ Apply GF response analysis algorithm which is same as that is used by KPX
- ✓ Calculate GF Droop Rate of the Turbine being operated
- ✓ Provide comparison/analysis report between data submitted to KPX and value calculated

< Trend Chart on GF Droop Rate >



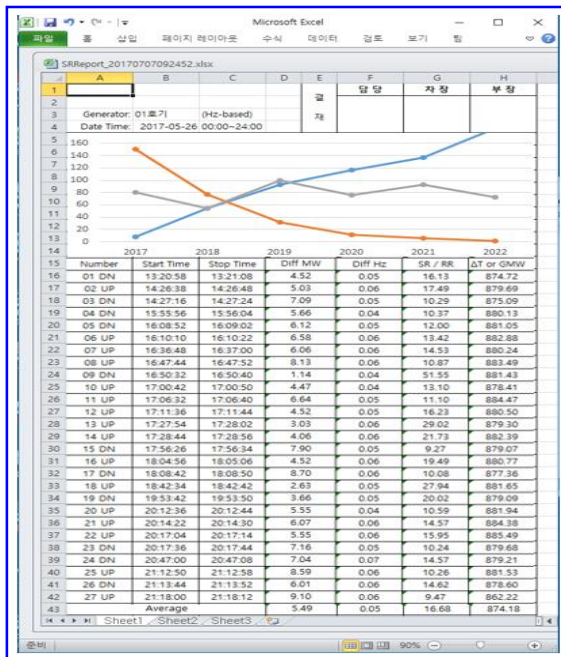
< Condition Setting for Trend Chart >



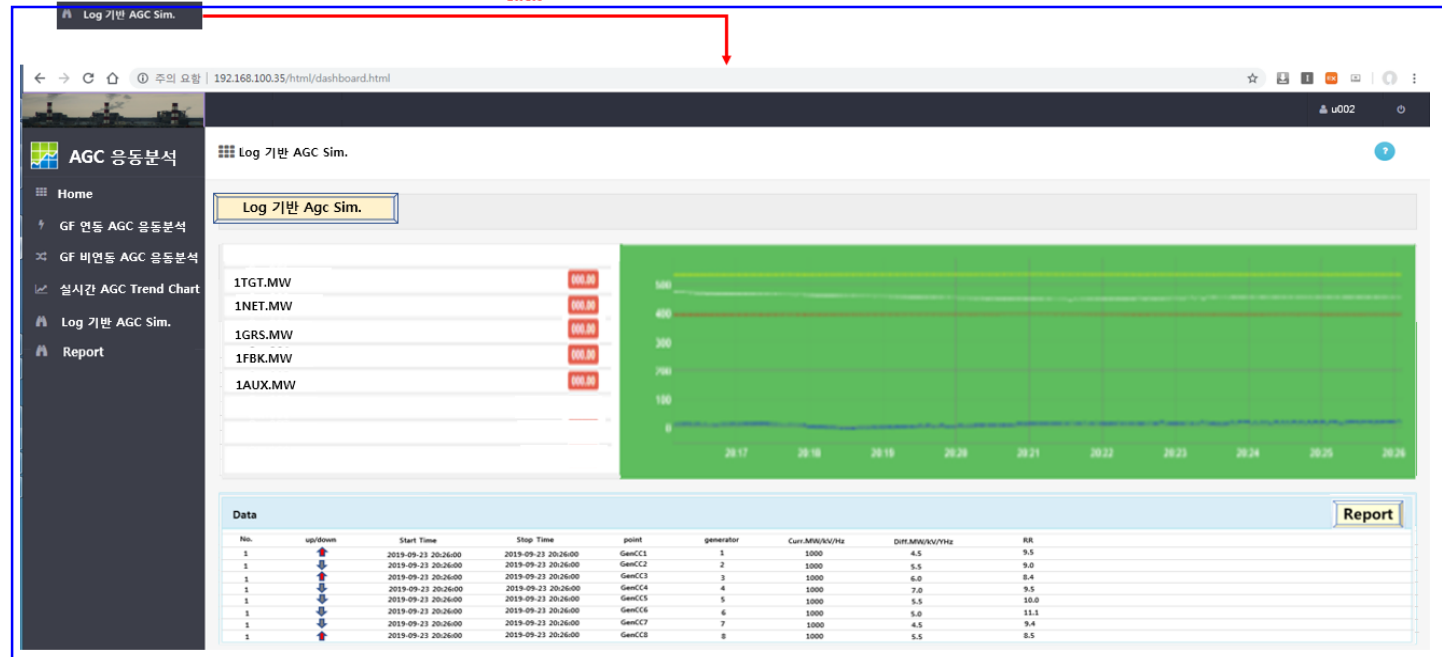
4. Application : ⑤ AGC Response Analysis (tAGC)

- ✓ Apply AGC response analysis algorithm which is same as that is used by KPX
- ✓ Calculate AGC Ramp Up/Down Rate of the Turbine being operated
- ✓ Provide comparison/analysis report between data submitted to KPX and value calculated

< Report >



< AGC Simulator Screen >

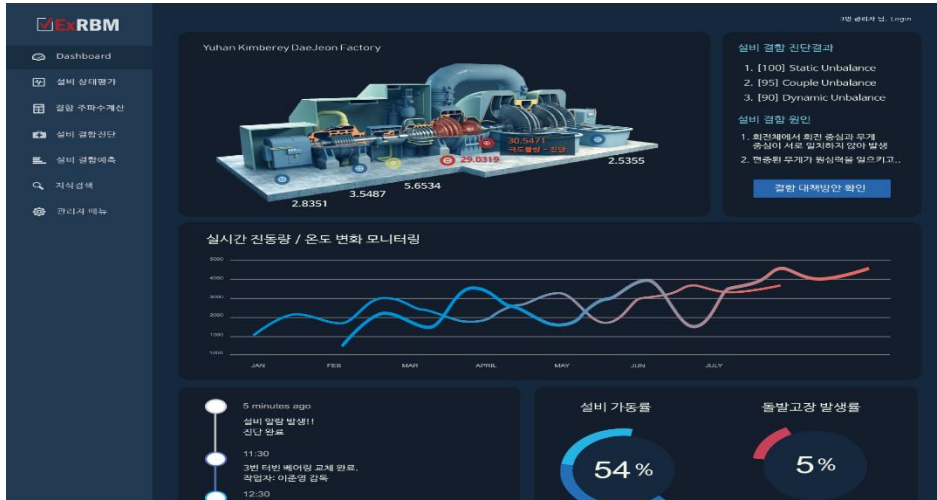


4. Application : ⑥ Vibration Monitoring & Analysis (tVMA)

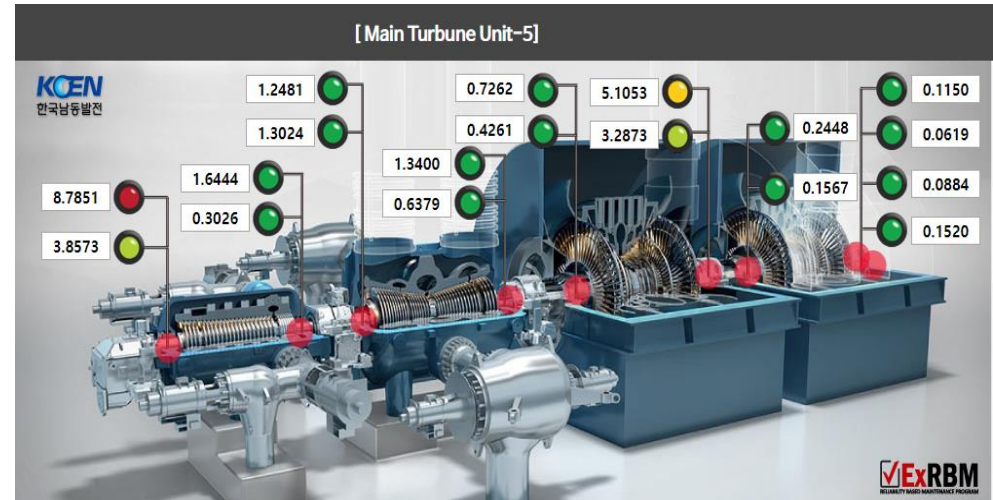
- ✓ Optimal Management Solution enabling Preventive Maintenance of Facilities
- ✓ Apply A.I. based on Big Data collected from 640 on-site facilities (Fault Analysis, Pattern Data...)
- ✓ Enable locating early-stage fault(s) of facilities w/o experts
- ✓ Easy system implementation by interfacing w/ legacy systems



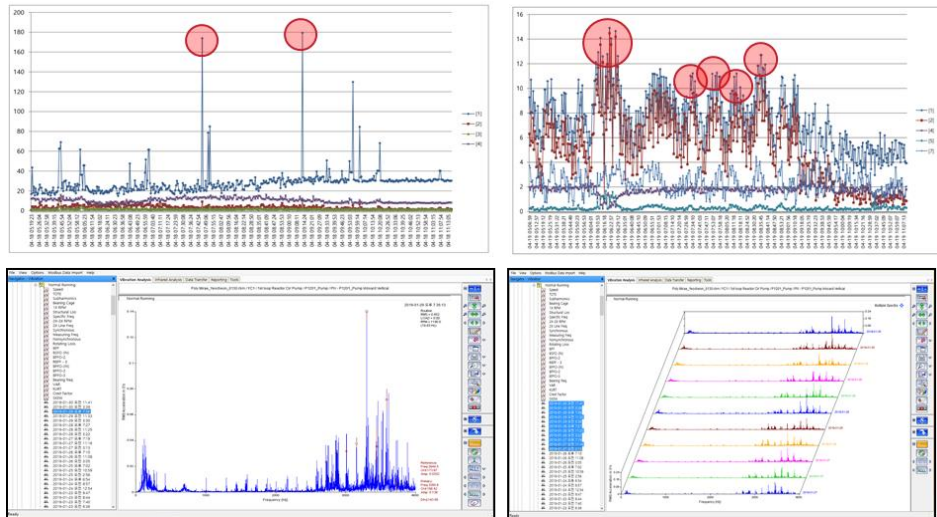
4. Application : ⑥ Vibration Monitoring & Analysis (tVMA)



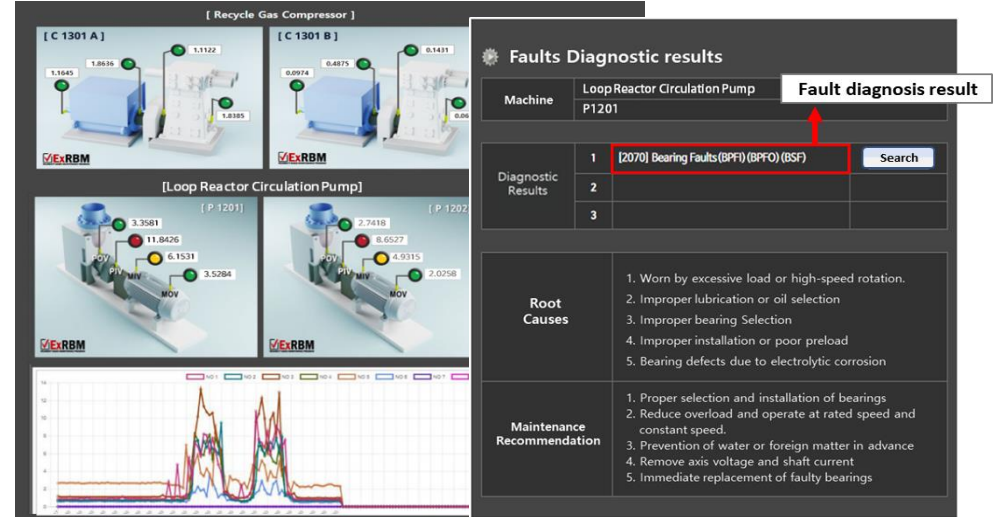
Prediction Maintenance System for Power Plant



Real Time Monitoring for Main Turbine



Actual Data & FFT analyze



Faults Diagnostic Results : Bearing Faults