

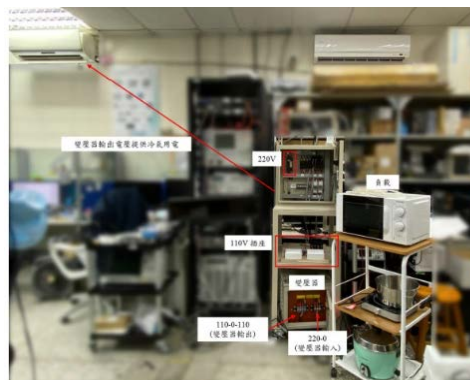


- **Education: PhD, EE Dept, University of Washington, USA**
- **Expertise: Industrial Internet of Things (IoT) Technology, Wireless Sensor Networks (WSNs), Signal Measurement, Feature Recognition, Smart Grid**
- **RCEC Principal Research: Smart grid technology IEC61850, Non-Intrusive Load Monitoring**
- **RCEC Research Goals:**
  - (1) Substation Automation
  - (2) Distributed Energy
  - (3) Event Detection (accuracy:98%~99%)
  - (4) Load Identification(accuracy:97%~98%)

**Office: Room 605-1,  
Integrated Technology  
Complex**

**Phone: +886-2-2771-  
2171 ext. 4326**

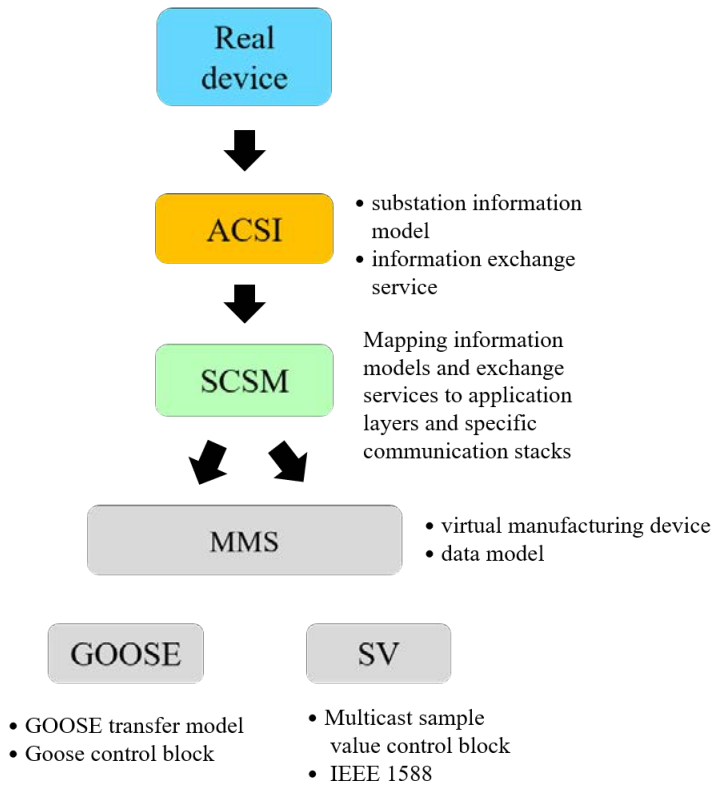
**E-mail:  
mstsai@mail.ntut.edu.tw**



Power Consumption Environment

# Research Method and Application

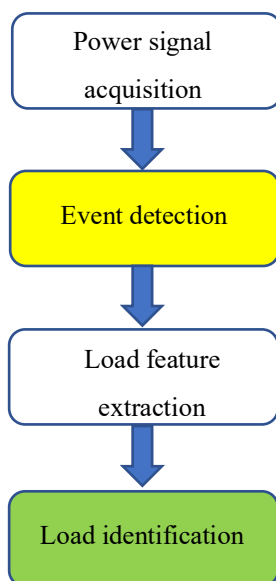
## IEC61850 communication services



### Research Focus:

1. Construction of sampling system with Precision Time Protocol
2. Merging Unit
3. Construction of voltage triggered analog protection system
4. Low voltage control protection relay
5. Circuit Breaker IED

## Non-Intrusive Load Monitoring(NILM)



### 1.Event Detection:

probabilistic statistics : CUSUMs

Non-parametric test

Machine learning: CNN

Self-Attention Based

### 2.Load Identification:

probabilistic statistics : Gaussian Mixed Model

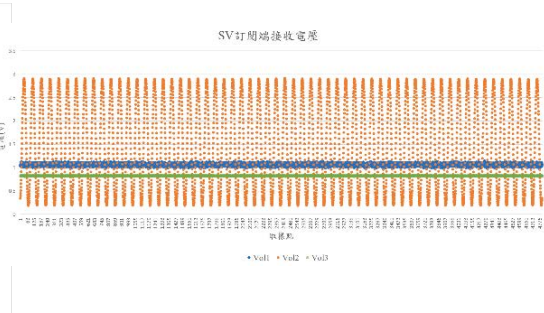
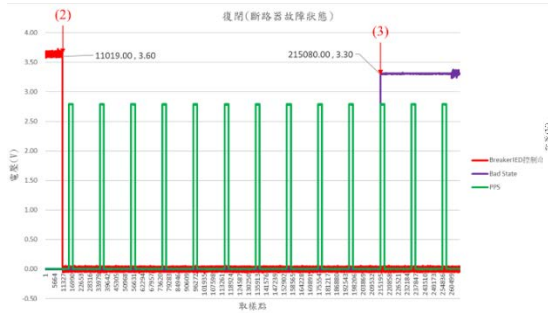
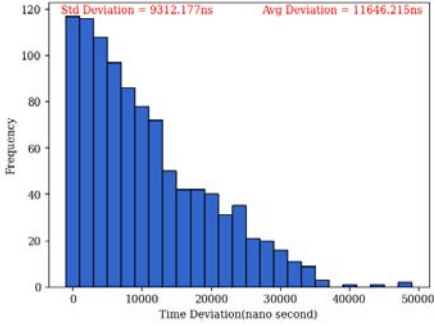
Machine learning : 1D-CNN

2D-CNN

Siamese network

Transfer learning

# Related Research Highlights



## Implementation of an Under Voltage Protection System by Integration of IEC 61850 GOOSE and SV

```
GOOSE event:
GoCBref: TEMPLATEProCtrl/LLN0G008gcbTrip
dataSet: TEMPLATEProCtrl/LLN0SDS4_GOOSE
appID: 4096
stNum: 4 sqNum: 4
timestamp: 165665703.984
[false]
DS match: TEMPLATEProCtrl/LLN0SDS4_GOOSE
member: TEMPLATEProCtrl/PTRC1.Tr.general
DataAttributeType = 0 : BOOLEAN
Bool value : 0
Flow!!!!!!!!!!!!!!
GOOSE event:
GoCBref: TEMPLATEProCtrl/LLN0G008gcbTrip
dataSet: TEMPLATEProCtrl/LLN0SDS4_GOOSE
appID: 4096
stNum: 4 sqNum: 0
timeOfLive: 1500
timestamp: 165665703.267
[true]
DS match: TEMPLATEProCtrl/LLN0SDS4_GOOSE
member: TEMPLATEProCtrl/PTRC1.Tr.general
DataAttributeType = 0 : BOOLEAN
Bool value : 1
```

PTRC1 Protection trip conditioning

Name	Value
Mod	0
Beh	0
Health	0
Tr	true
Op	false
Str	false, unknown
NamPit	

LLN0G008gcbTrip

Name	Value
Enabled	false
Control Block reference	TEMPLATEProCtrl/LLN0G008gcbTrip
Destination MAC address	01-0C-CD-01-00-02
Application ID	16314
GOOSE ID	gcbTrip
DataSet reference	TEMPLATEProCtrl/LLN0SDS4_GOOSE
VLAN ID	1
VLAN priority	4
Needs commissioning	false
Configuration revision	1

Information received in last GOOSE

Name	Value
Source MAC address	DCAE1215842D
Simulation/test	false
Entry time	2022/7/1 T 04:55:03.267
Status number	4
Sequence number	0
Time allowed to live (ms)	1500
Remaining time to live (ms)	
Number of DataSet entries	1

LLN0G008gcbTrip

Name	Value
general	[ST] true

IEDs

TEMPLATE

IP address: 192.168.0.100

- GOOSE
  - LD ProCtrl
  - LLN0G008gcbTrip
  - LLN0G008gcbcontrol

Reports

Setting Groups

Files

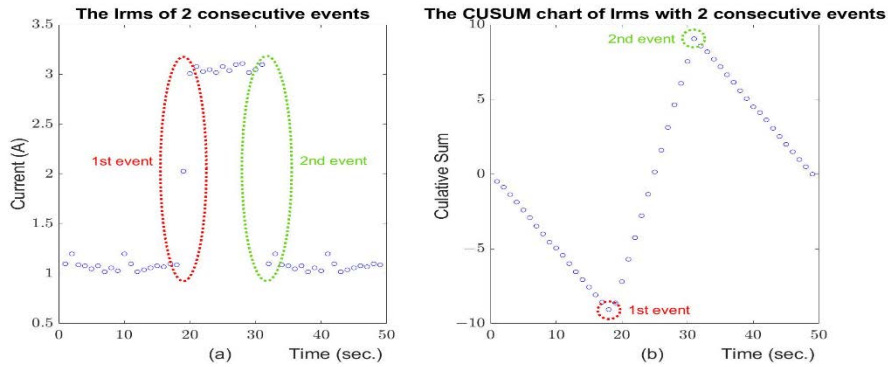
DataSets

Data Model

TEMPLATE - Data Model - ProCtrl - PTRC1

Name	Value
Mod	0
Beh	0
Health	0
Tr	true
general	[ST] true
q	[ST] good
t	[ST] 2022/7/1 T 04:55:03.267
Op	false
Str	false, unknown
NamPit	

## GOOSE Transmission for IEC61850 Based Circuit Breaker Intelligent Electronic Devices



測試項目	編號	負載名稱	分離/合成波形	分離/合成 V-I軌跡	實際波形	實際波形 V-I軌跡	RMSE
電流分離	7	微波爐					2.1341
	8	電磁爐					2.1341
電流合成	9	微波爐+電磁爐					2.0275

## Results of Nonlinear-Load hybrid experiment