分散式能源資通訊導入IEC 61850標準
(智慧電網資通訊觀點)

➤ 一、前言

➤ 二、智慧電網IEC標準與IOT技術應用

➤ 三、歐美XMPP相關計畫案例

➤ 四、XMPP在DER(含PV)資通訊整合建議

➤ 五、結論

台電綜研所廖政立
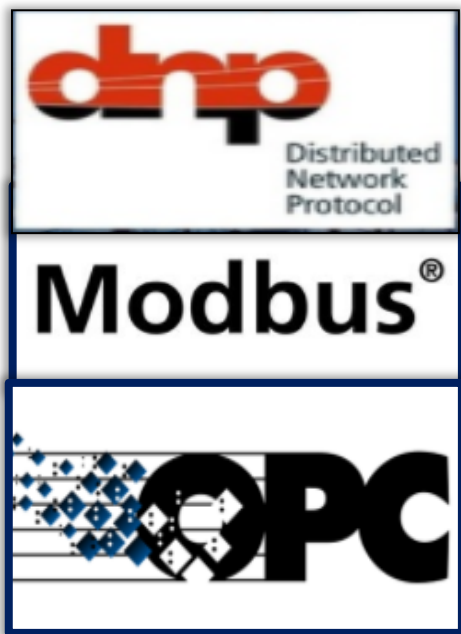於電腦公會 B102 會議室
2017.07.21

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DER(含PV)大規模運用議題

➢ 分散式能源(DER)分布廣泛具跨Internet特性

➢ 須考量大量佈建(Plug-Play)及資安問題

➢ 既有封閉網路所用協定或標準無法直接用於未來發展

➢ IOT技術目前被IEC 61850/62746標準納入的須重視

➢ IEC 61850-8-2/IEC 61850-80-3 XMPP通訊協定 DER應用是個好選項之一

➢ XMPP – eXtensible Messaging and Presence Protocol – An IOT open standard for instant messaging
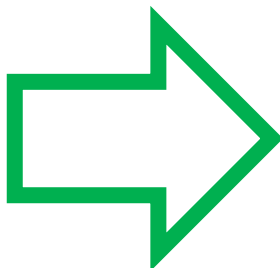
SA與DER在SG應用上比較

Requirements	Station Automation	Smart Grid / Market Use Cases
Number of devices	Up to 100 devices per substation	1.000 – 10.000.000 devices in systems
Number of data points	> 1000 DP per device	Ca. 10-100 DP per device
Engineering	Static, seldom changes	Dynamic system management
Real time Performance	In miliseconds	In seconds / minutes
Communication Structures	Local, homogeneous (LAN, Ethernet)	Heterogeneous (FAN, NAN, WAN)
Networks	Private communication networks	Private and public communication networks
Security	Role based access control (RBAC)	End-to-End Authentication and Confidentiality, RBAC, no open interface ports at device

希望引進符合智慧電網國際標準之IOT技術

IEC 61850-8-2(XMPP) standard for DER are expected

From DNP / Modbus to XMPP

DNP / Modbus /OPC are the main Protocols used in Taipower now.

We are considering replaced these legacy ones by XMPP due to the Scalability , Security, Compatibility, etc. problems
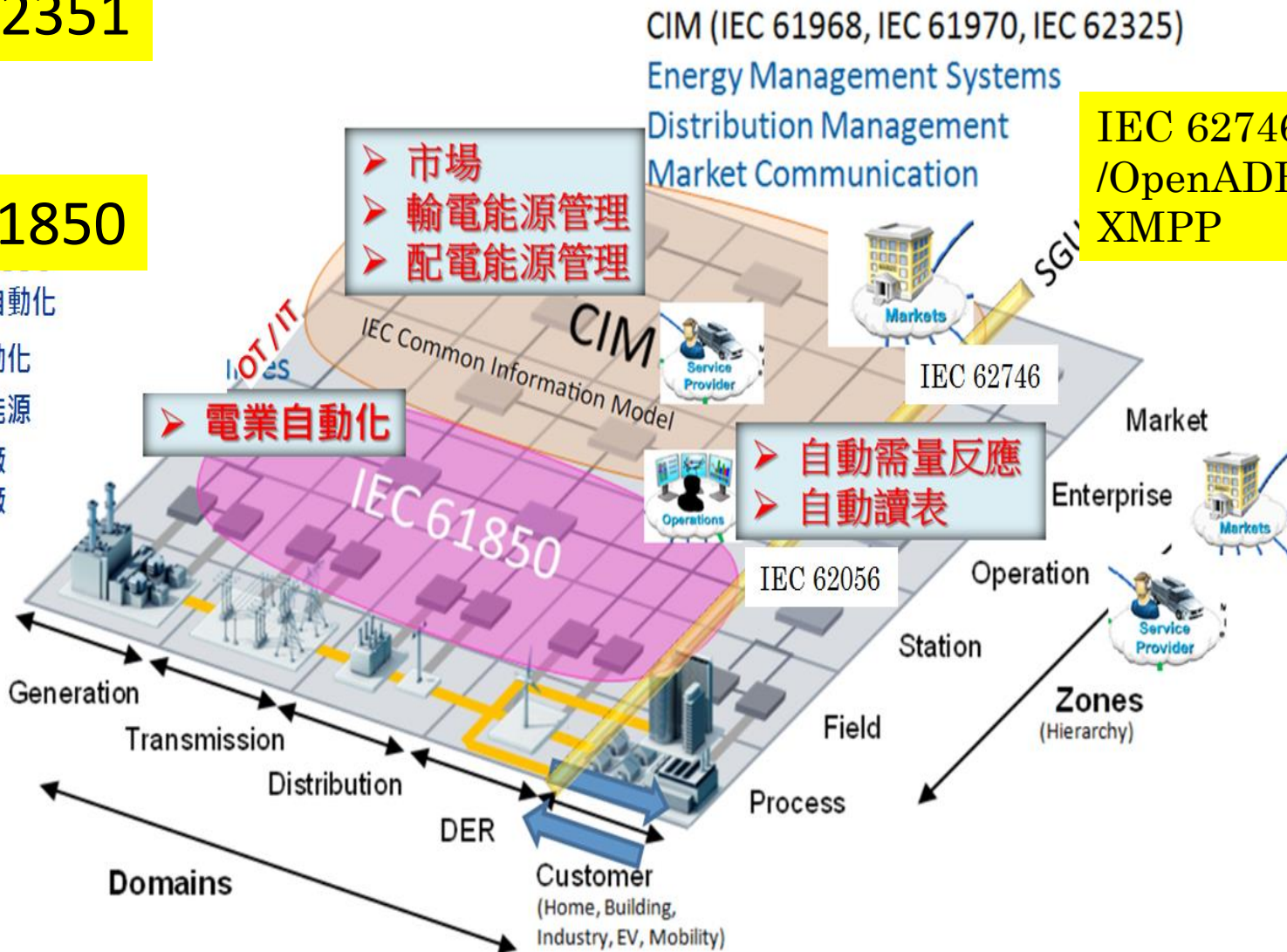
We would like to use IEC 61850 - 8 - 2(XMPP) as the future standard communication protocol for distributed energy resources.

智慧電網核心標準已納IOT技術

IEC 62351

IEC 61850

IEC 62746 /OpenADR/ XMPP

CIM (IEC 61968, IEC 61970, IEC 62325)
Energy Management Systems
Distribution Management
Market Communication

➤ 市場
➤ 輸電能源管理
➤ 配電能源管理

➤ 電業自動化

➤ 自動需量反應
➤ 自動讀表

變電所自動化
配電自動化
分散式能源
水力電廠
風力電廠
...

IOT / IT

IEC Common Information Model

CIM

IEC 61850

Service Provider

Markets

IEC 62746

Operations

IEC 62056

Market

Enterprise

Operation

Station

Field

Process

Markets

Service Provider

Zones (Hierarchy)

Generation
Transmission
Distribution
DER
Customer
(Home, Building, Industry, EV, Mobility)

Domains

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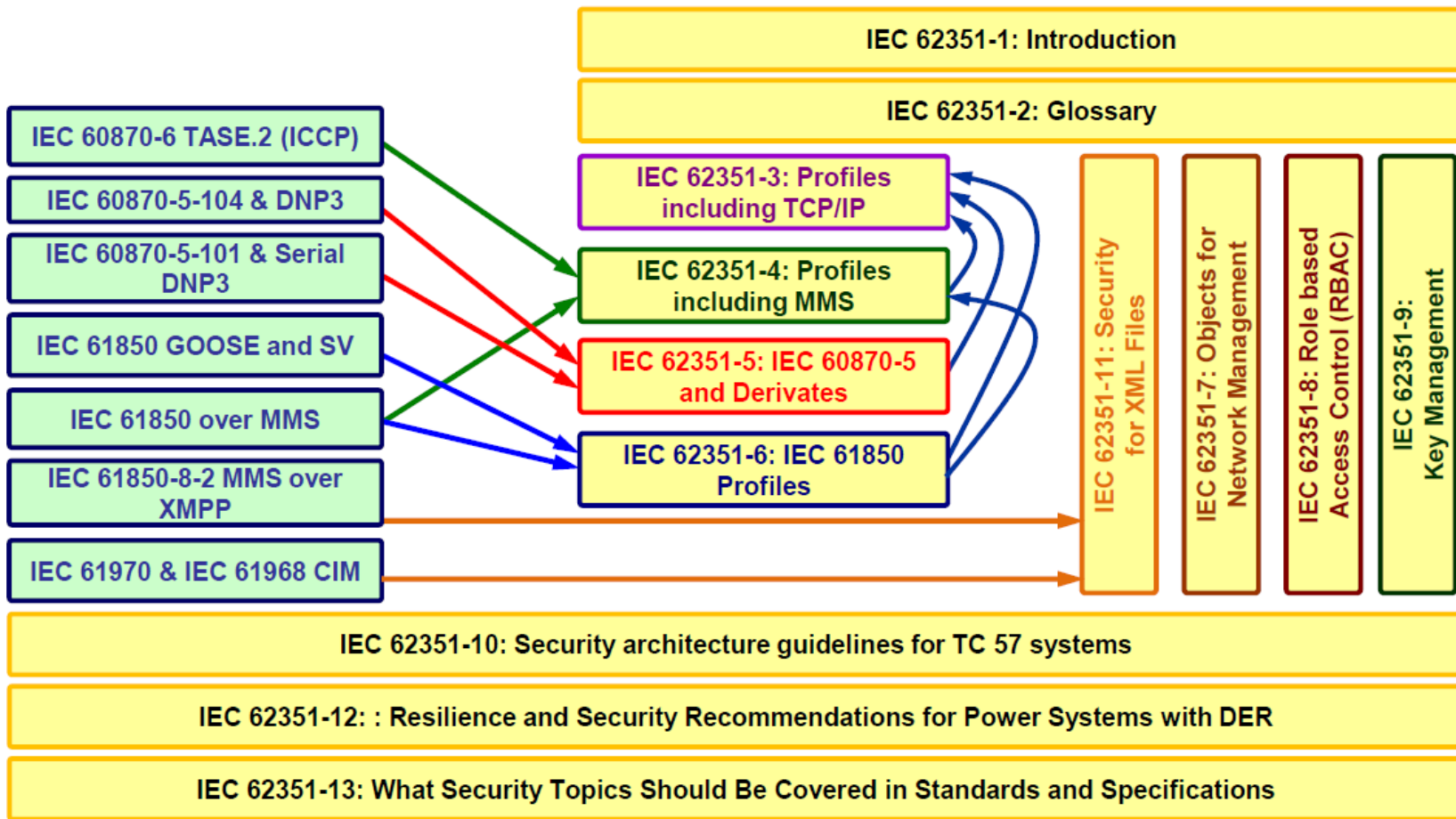
- **62746 Ed.1: Systems Interface between Customer Energy Management System and the Power Management System**
  - 62746-1 Overview (include Glossary)
  - TR 62746-2 Use Cases and Requirements
  - TS 62746-3 Architecture
  - 62746-4 Data Model
  - 62746-5 Service interface to customer system
  - 62746-10 Mapping
  - **62746-10-1 PAS OpenADR 2.0b**
  - 62746-10-2 CIM compliant Mapping to XMPP
    - Message content and exchange patterns
    - Message transport and services
    - Security
    - Availability, redundancy
    - Profiles, Interoperability
    - ...

IOT技術目前已被IEC 61850/62746/62351標準納入

IEC TC57 Communication Standards

- IEC 60870-6 TASE.2 (ICCP)
- IEC 60870-5-104 & DNP3
- IEC 60870-5-101 & Serial DNP3
- IEC 61850 GOOSE and SV
- IEC 61850 over MMS
- IEC 61850-8-2 MMS over XMPP
- IEC 61970 & IEC 61968 CIM

IEC 62351 Security Standards

IEC 62351-1: Introduction

IEC 62351-2: Glossary

IEC 62351-3: Profiles including TCP/IP

IEC 62351-4: Profiles including MMS

IEC 62351-5: IEC 60870-5 and Derivates

IEC 62351-6: IEC 61850 Profiles

IEC 62351-11: Security for XML Files

IEC 62351-7: Objects for Network Management

IEC 62351-8: Role based Access Control (RBAC)

IEC 62351-9: Key Management

IEC 62351-10: Security architecture guidelines for TC 57 systems

IEC 62351-12: : Resilience and Security Recommendations for Power Systems with DER

IEC 62351-13: What Security Topics Should Be Covered in Standards and Specifications

IEC 61850 DER相關標準

IEC 61850 標準	DER相關
IEC 61850-7-420	Basic communication structure – DER logical Nodes
IEC 61850-90-6	Using IEC 61850 for DAS
IEC 61850-90-7	Object models for inverter based applications
IEC 61850-90-8	Object model for electric mobility
IEC 61850-90-9	Object models for electrical energy storage systems
IEC 61850-90-10	Modeling of schedules in IEC 61850
IEC 61850-90-15	DER Grid Integration using IEC 61850
IEC 61850-80-3	Requirement analysis for mapping to Web Protocols
IEC 61850-8-2	SCSM mappings to XMPP

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目前IEC 61850-80-3 (TR)已公布

IEC

已公布

IEC TR 61850-80-3

Edition 1.0   2015-11

TECHNICAL
REPORT

IEC/TR 61850-80-3與將公
布的IEC 61850-8-2新通訊
協定息息相關

**Communication networks and systems for power utility automation –
Part 80-3: Mapping to web protocols – Requirements and technical choices**

IEC 61850-80-3候選技術

- XMPP
- IEC 62541 (OPC UA)
- IEC 61400-25-4 Annex A
- XML over WebSocket
- DPWS
- REST
- ACSI XML

IEC 61850-8-2 (IS)將公布

TC 57 Power systems management and associated information exchange

Scope | Structure | Projects / Publications | Documents | Votes | Meetings | Collaboration Tools

Projects / Publications > Project: IEC 61850-8-2 Ed. 1.0

(Log in) | En | Fr

Detail

Committee	Working Groups	Project Leader	Current Status	Frcst Pub Date	Stability Date
TC 57	WG 17	B. Bony	ACDV	2017-04	

History

Stage	Document	Downloads	Decision Date	Target Date
PNW	57/1181/NP	434 kB	2011-10-07	
ANW	57/1221/RVN	233 kB	2012-03-09	2012-02-29
1CD	57/1583/CD	5019 kB	2015-06-05	2015-02-28
ACDV	57/1642/CC	319 kB	2015-11-06	2015-10-15
CCDV				2015-12-31

Project

IEC 61850-8-2 Ed. 1.0
Communication networks and systems for power utility automation - Part 8-2: Specific communication service mapping (SCSM) - Mapping to Extensible Messaging Presence Protocol (XMPP)

Remark:
- SMB/5347/DL: CDV 2015-04 - Project plan: CDV 2012-09 FDIS 2013-09 - IECs 61400-25, all parts of 61850, 62351, 62357, 61970-451, 61968-100 to be considered - Liaison org: OASIS - OPC foundation - Coord. with: TC57/WGs: 10, 13, 14, 15, 18, 19; TC65, SC65C, SC65E, TC69, TC88
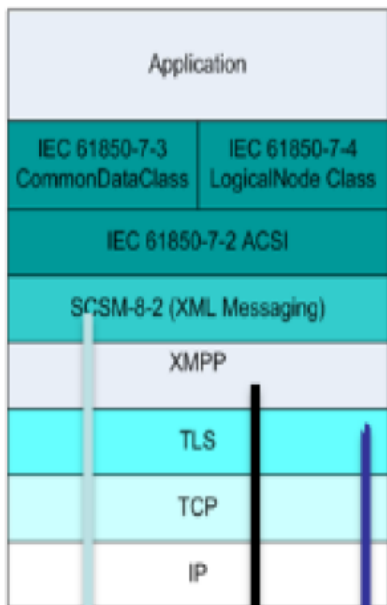
Associated Documents:
SMB/4881/DL
348 kB
SMB/5256/DL
186 kB
SMB/5347/DL
220 kB
57/1584/DTR
2951 kB
57/1585/INF
1560 kB

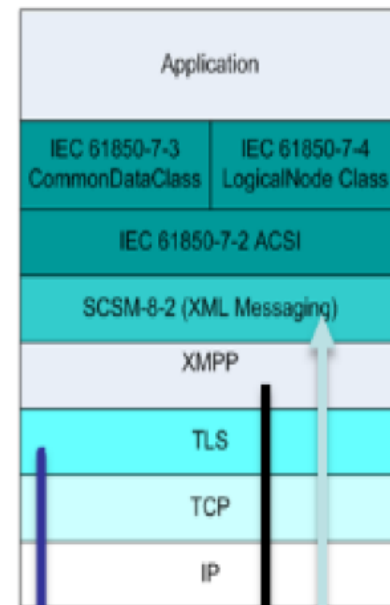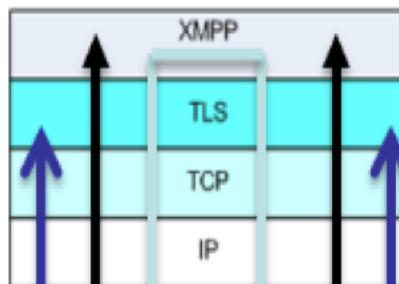**IEC 61850-8-2有助於分散式能源資訊廣泛應用在電力管理及需量反映上。此部分(Part)標準誕生後，將加速再生能源資通訊在多領域複雜的智慧電網系統上應用之實現。**

XMPP 資安選項

XMPP-HADDOOP/Big Data

ISO/IEC/IEEE P21451-1-4
(Big Data SOA)

NCAP XMPP

NCAP XMPP

MCAP (Public)

NCAP XMPP

NCAP XMPP

Internet

MCAP (Private) Service Broker

Intranet

BD NCAP XMPP HADOOP

BD NCAP XMPP HADOOP

BD NCAP XMPP HADOOP

4. MCAP would contain directory services and other capabilities

6. MCAP bridge public and private clouds

7. HADOOP passes semantic control to clients

1. All Public MCAP are federated serviers which have capacity to register devices and share without private MCAPs

3. MCAP and ICAP's control which devices can communicate to each other

2. Local Intranet looks the same as Internet

5. All devices can be make use of DHCP
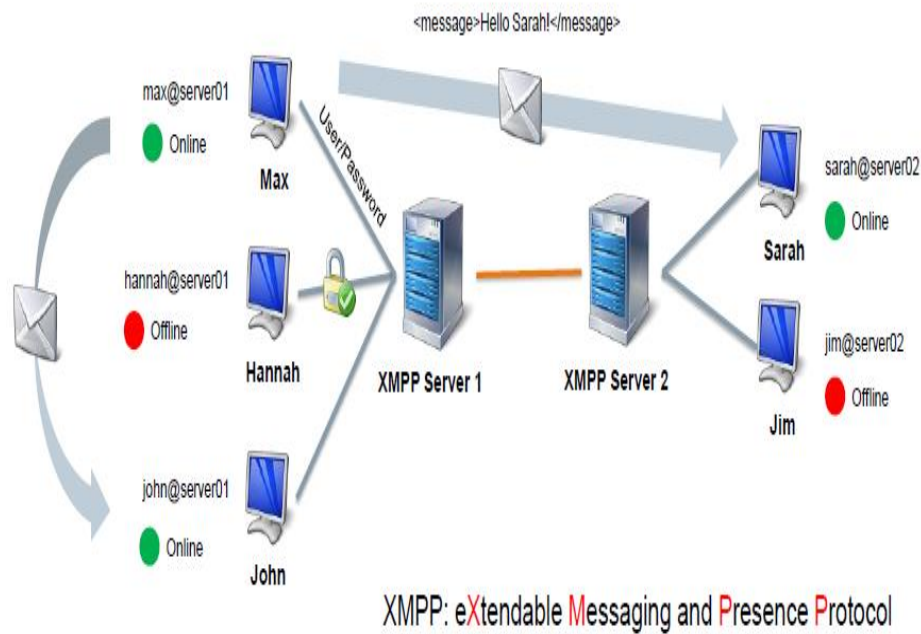
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IOT 通訊協定與應用時間反應

IOT Protocol Overview

- **MQTT**: a protocol for collecting device data and communicating it to servers (D2S)

- **XMPP**: a protocol best for connecting devices to people, a special case of the D2S pattern, since people are connected to the servers

- **DDS**: a fast bus for integrating intelligent machines (D2D)

- **AMQP**: a queuing system designed to connect servers to each other (S2S)

- ....

XMPP – Siemens應用例

XMPP – Siemens應用例

DER應用XMPP 案例

SIEMENS

Security Relations of DER Integration
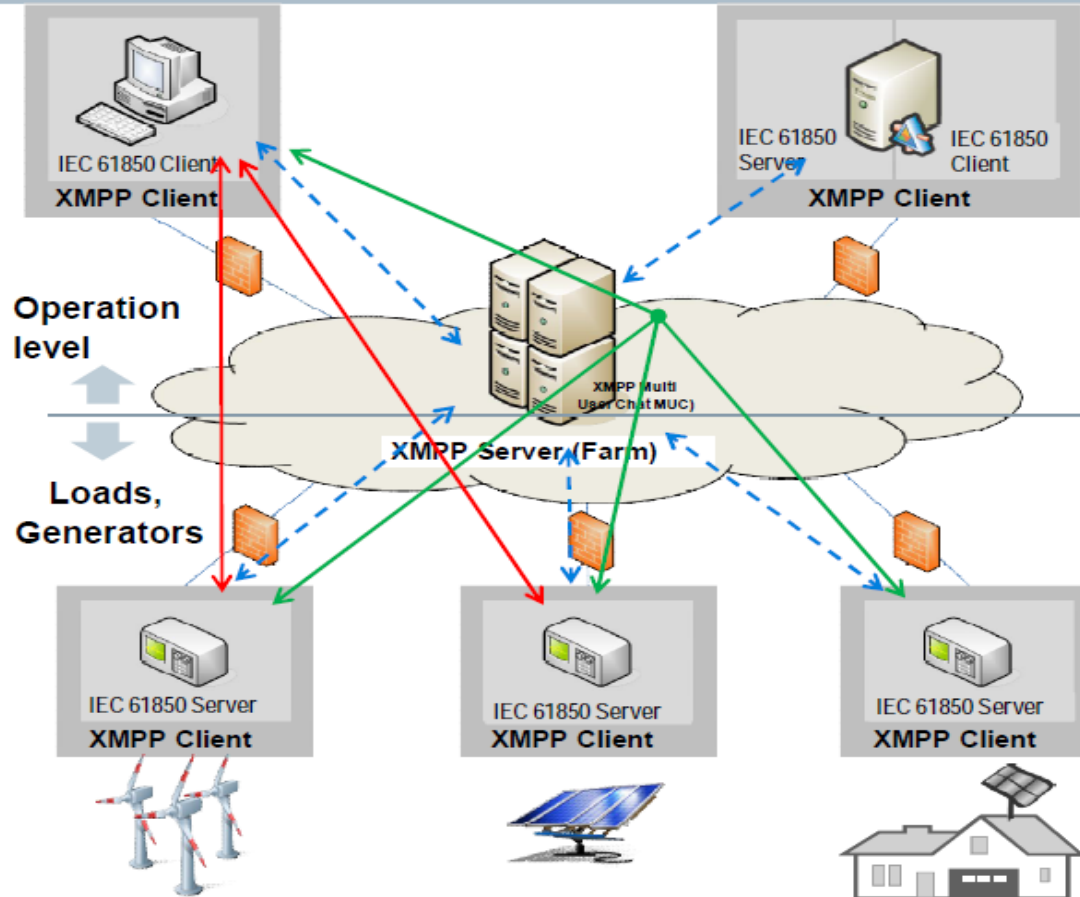
Trust relations

- DER resource (XMPP client on IEC61850 server) belongs to DER owner
- DER control (XMPP client on IEC 61850 client/server) incl. control center belongs to DNO
- XMPP server may belong to DNO or 3rd party service provider

Resulting requirements

- **Authentication**
  - End-to-middle between XMPP client and server or between XMPP servers
  - End-to-end authentication between IEC 61850 client and server instances
- **Integrity** protection between all instances
- **Confidentiality** protection between IEC 61850 client and server instances

↔ Hop-to-Hop
↔ End-to-End unicast
↔ End-to-End multicast

Page 10   2015-04-14

Dawidczak / EM EA PRO D

典型作法

Szenario 2

SIEMENS

Integration of Distributed Energy Resources (DER)

Typical Set-Up for DER
- Prosumer connecting resources and loads to the electrical grid via public or private network
- Usage of IEC 60870-5-104 for communication

- Security is often provided by using IPSec based VPNs connecting the network domains

SCADA | Virtual Power Plant | Demand Response

IEC 60870-5-104

Public or Private Network

IEC 60870-5-104

DER | DER | DER
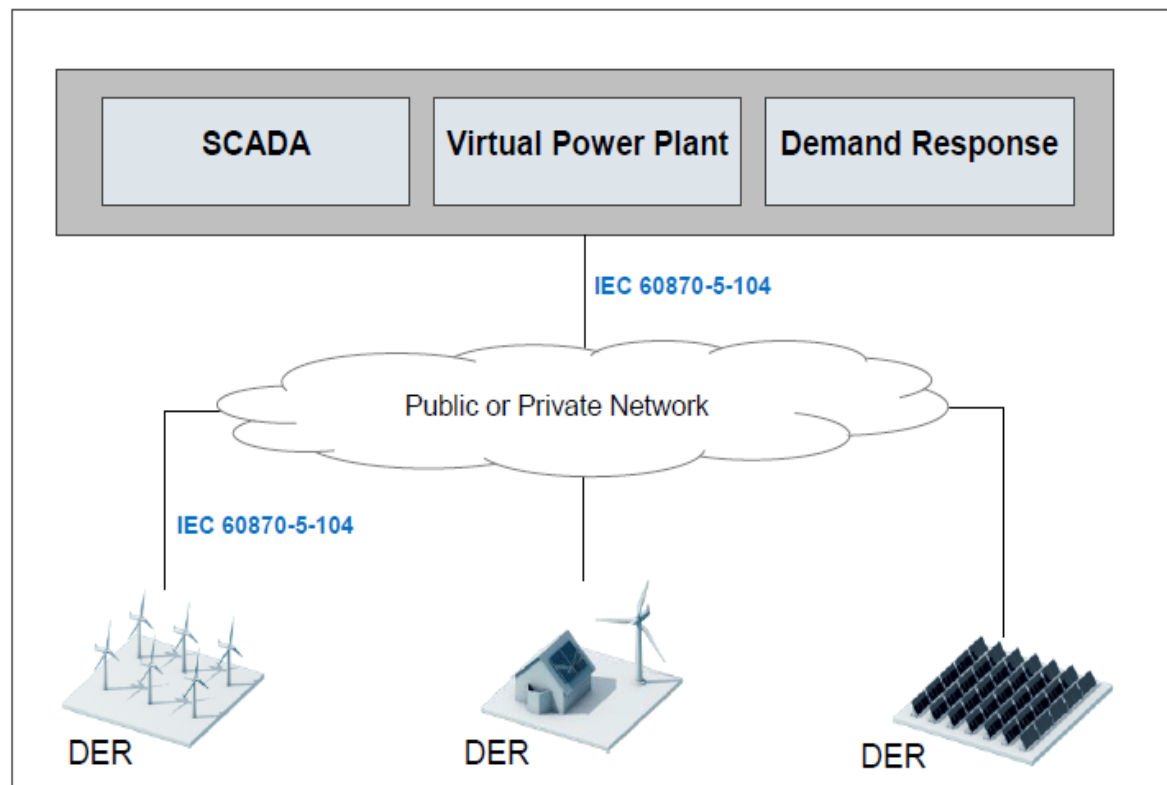
© Siemens AG 2014 All rights reserved.
Page 14   2014-10-30
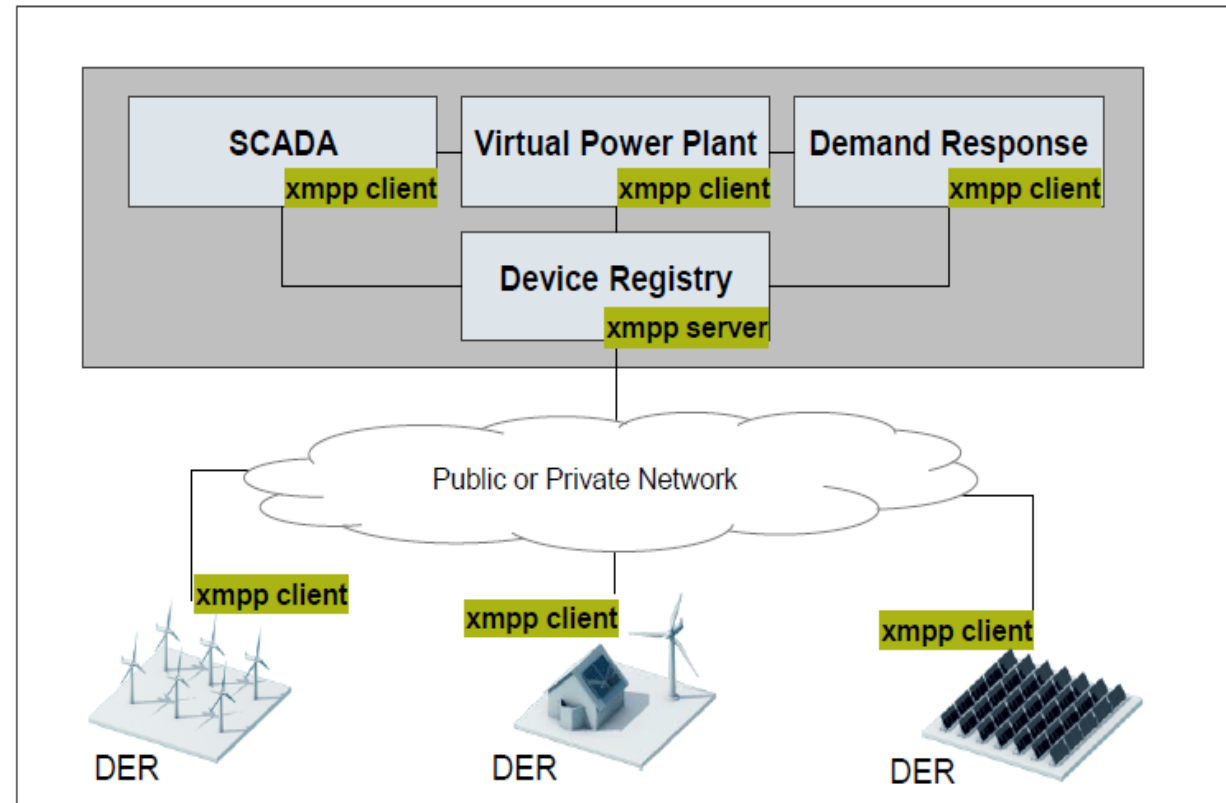
Dr. Volker Distelrath, Siemens AG

Szenario ②

Application of IEC 62351 on Integration of Distributed Energy Resources (DER)

SIEMENS

Future Set-Up for DER
- XMPP (RFC 6120) is a middleware messaging and presence protocol supporting decentralized architectures
- Usage of IEC 61850-8-2 MMS over XMPP

- End-to-end authentication and integrity can be achieved by applying the IEC 62351-4 ed.2 MMS secure session concept

SCADA — xmpp client
Virtual Power Plant — xmpp client
Demand Response — xmpp client
Device Registry — xmpp server

Public or Private Network

xmpp client — DER
xmpp client — DER
xmpp client — DER

Dr. Volker Distelrath, Siemens AG

XMPP應用案例- Echelon

XMPP Smart Grid Applications

- Demand Response
  - Traditional Commercial DR
  - Residential DR / DSM
  - OpenADR
- Renewable Energy
  - Solar
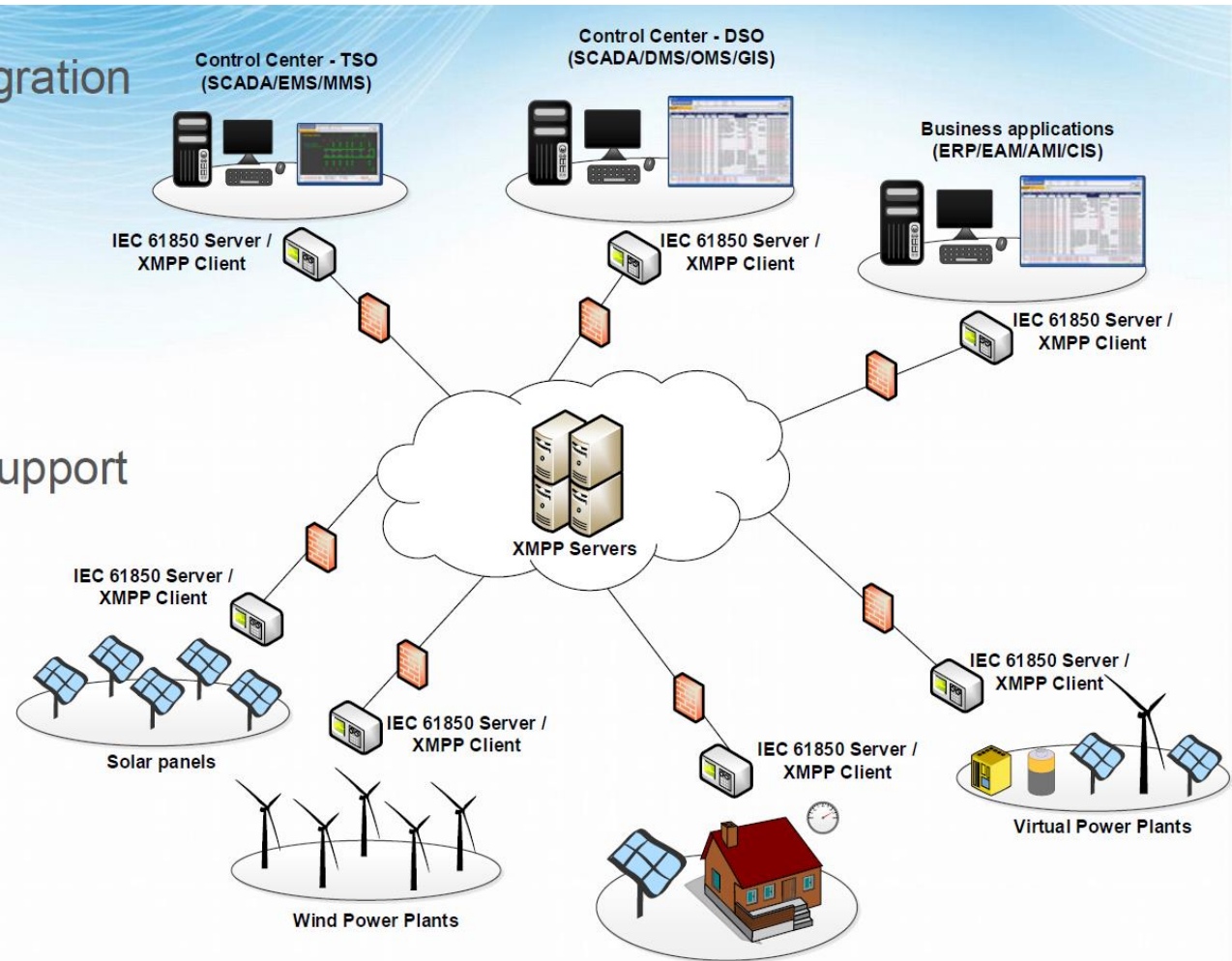- Building Energy Management (BEM)
- EV Charging
- Etc.

A Few XMPP Applications

- Instant messaging
- Group chat
- Social networking
- Multi-user gaming
- System control, alerts, and notifications
- **Machine-to-machine communication**
- Geolocation
- Middleware and cloud computing
- Intelligent workflows
- Real-time collaboration
- Data syndication
- Voice over IP
- Identity services

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DER應用XMPP 案例-KONČAR

IEC 61850-8-2- SCSM mappings to XMPP

- Secure DER integration
- Authentication
- Integrity
- Confidentiality
- Mandatory TLS support
- IEC 62351 ed.2

Control Center - TSO
(SCADA/EMS/MMS)

Control Center - DSO
(SCADA/DMS/OMS/GIS)

Business applications
(ERP/EAM/AMI/CIS)

IEC 61850 Server /
XMPP Client

IEC 61850 Server /
XMPP Client

IEC 61850 Server /
XMPP Client

XMPP Servers

IEC 61850 Server /
XMPP Client

IEC 61850 Server /
XMPP Client

IEC 61850 Server /
XMPP Client

IEC 61850 Server /
XMPP Client

Solar panels

Wind Power Plants

Virtual Power Plants

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OS4ES –Project partners

Partners	Abbreviation	Nationality
Forschungsgemeinschaft für Elektrische Anlagen und Stromwirtschaft e.V.	FGH e.V.	
Hamburg University of Applied Science	HUAS	
Hypertech IT Solutions	Hypertech	
It4power	IT4	
KONČAR-Power Plant and Electric Traction Engineering Inc.	KONCAR	
Stedin	STEDIN	
Fundación Tecnalia Research and Innovation	Tecnalia	
The Netherlands Organisation for Applied Scientific Research	TNO	
T-Systems Multimedia Solutions GmbH	T-Systems MMS	

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IPDX產品

IEEE 1451.1.4
ISO/IEC/IEEE
21451-1-4
XMPP
SERVICE

WEB SERVICE

SENSOR SERVICE BUS

LEGACY DEVICE ADAPTER

FIREWALL
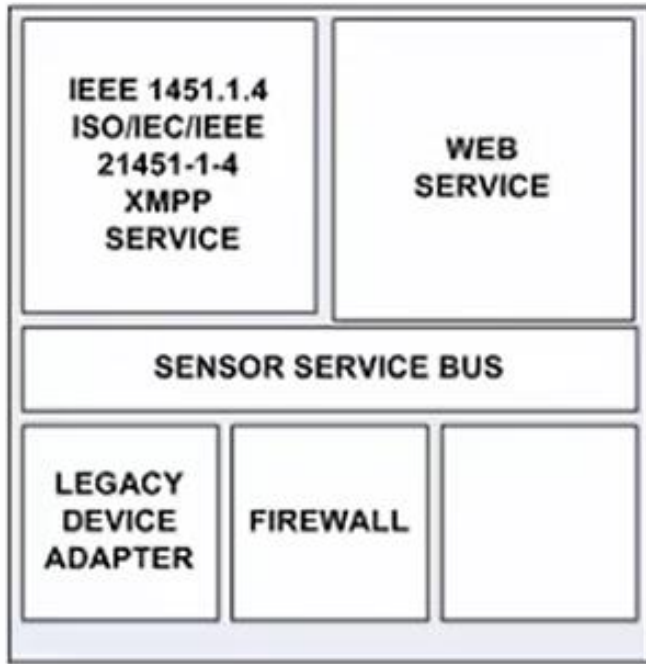
IPDX is the first to offer capabilities based upon the use of XMPP to offer an event driven messaging system for enterprise integration of large scale heterogeneous sensor networks. IPDX offers a distributed decentralized client-server architecture which includes registration, policy administration and management including directory services, data sharing, and security. IPDX provides a reference implementation for the ISO/IEC/IEEE 21451-1-4 standard.
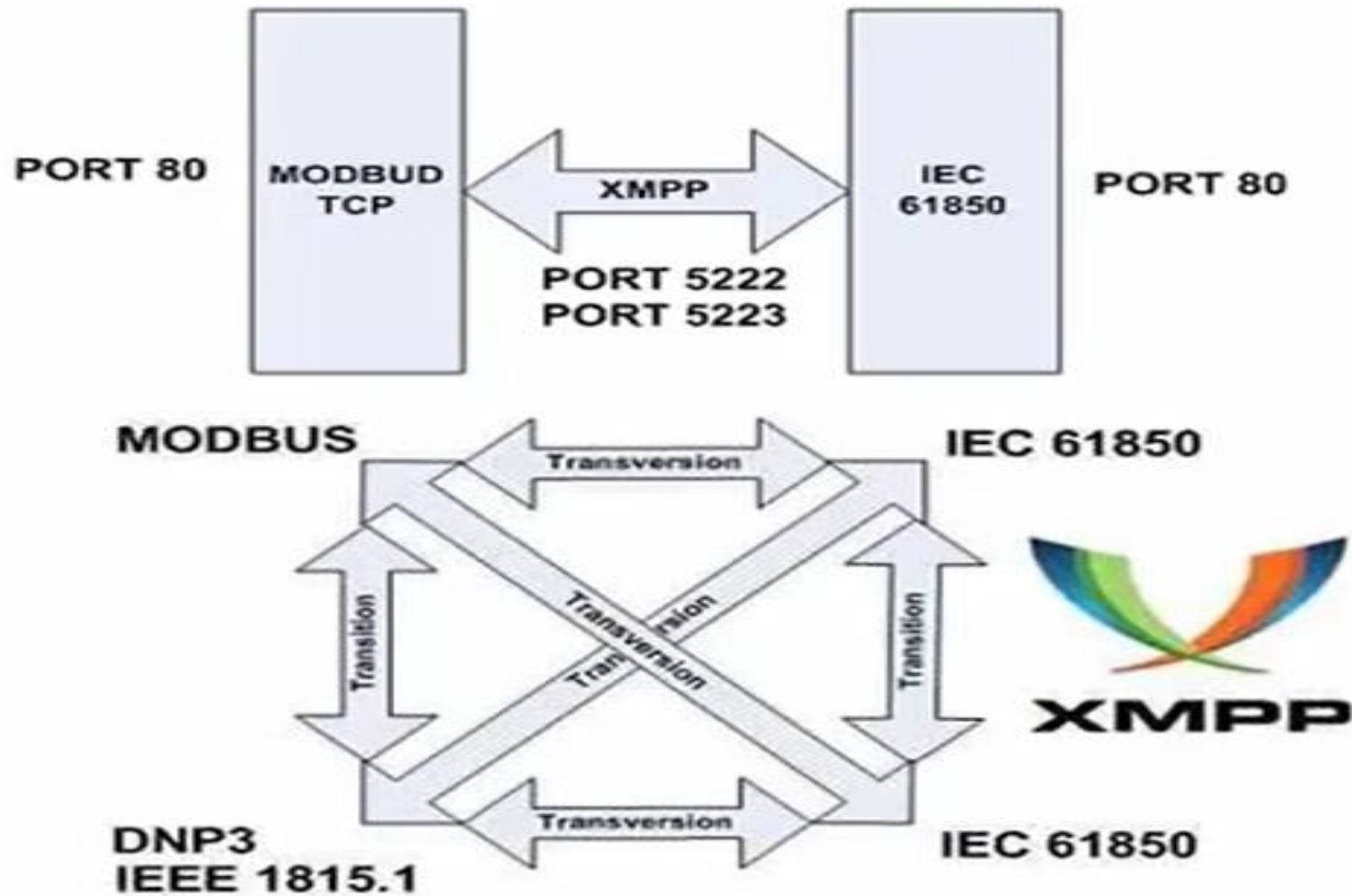
IPDX for Android brings XMPP power for mobile M2M sensor networks.
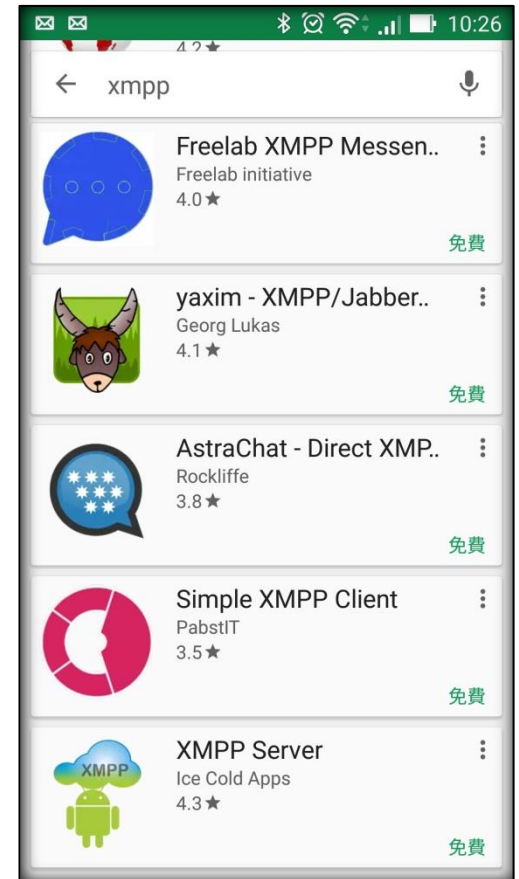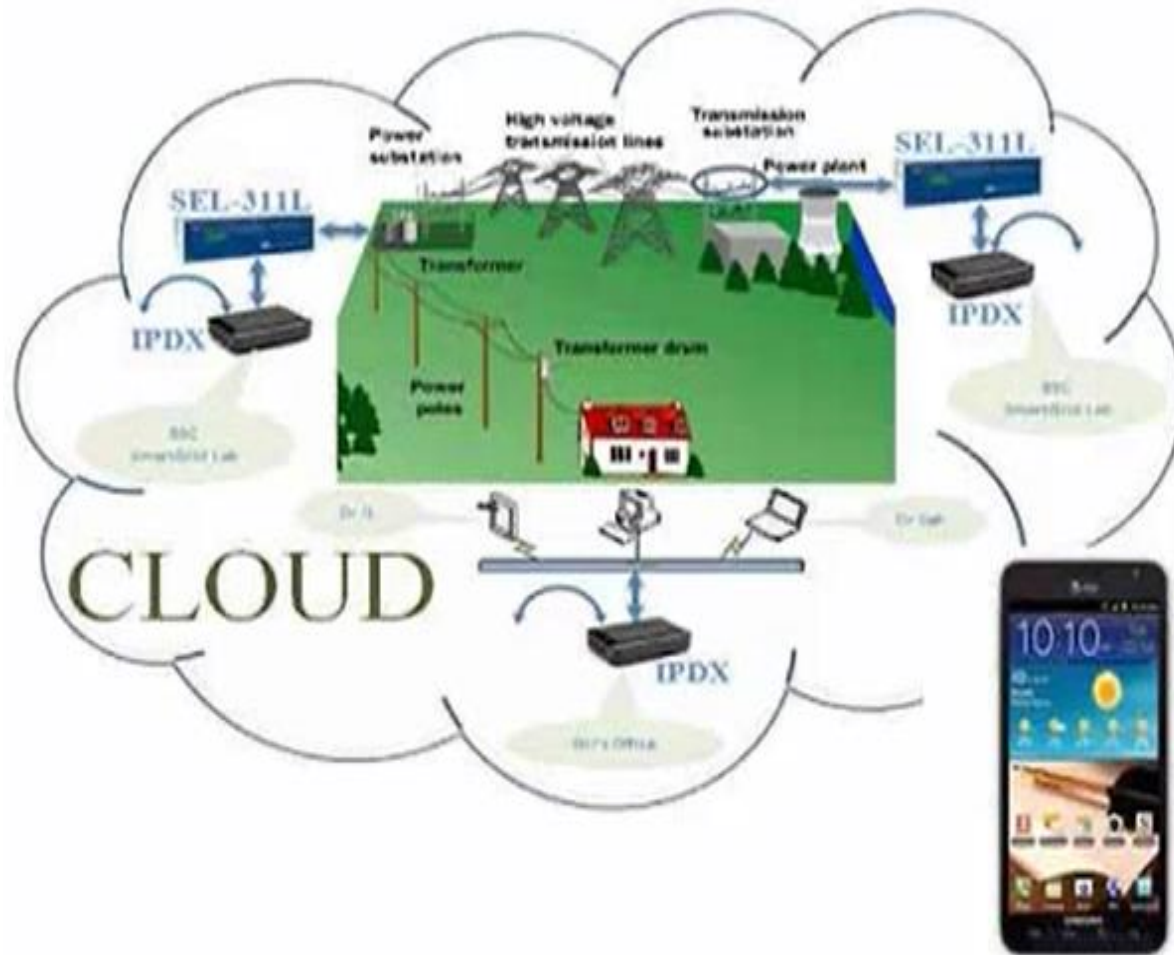
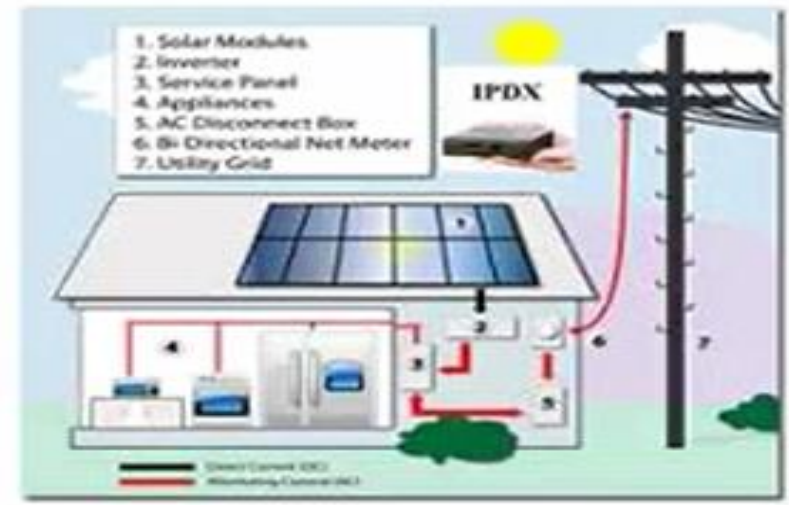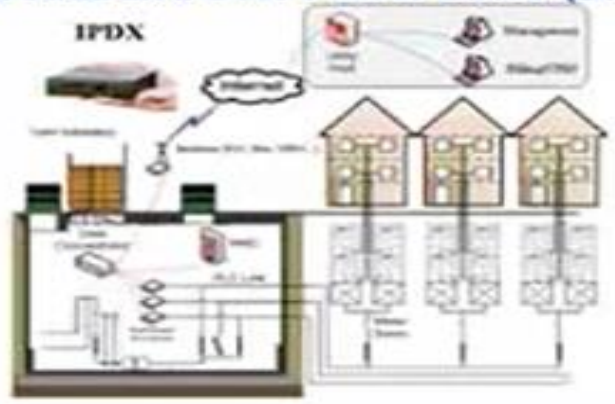摘自: MaCT USA

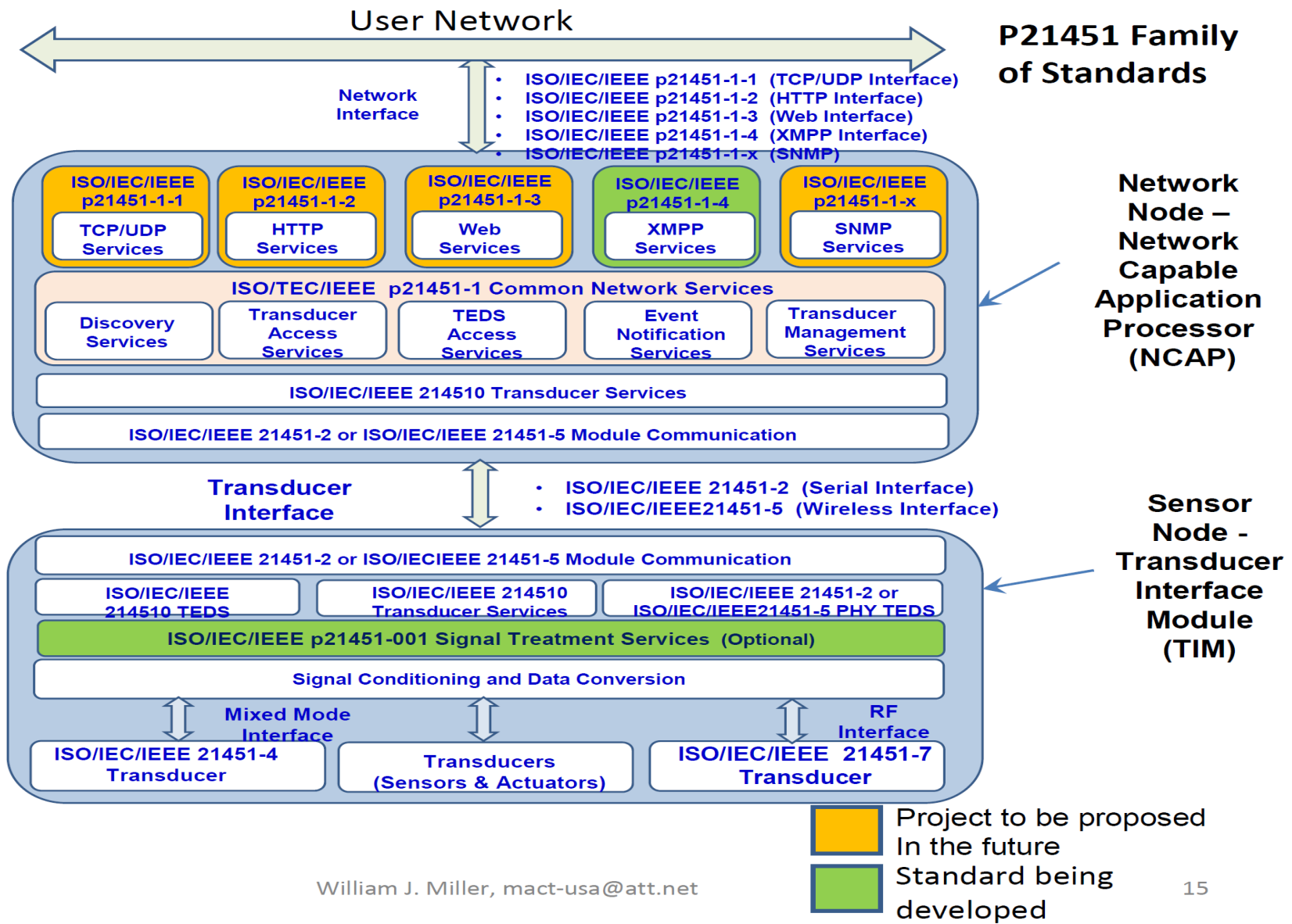# 智慧電網XMPP, ISO IEC IEEE 21451.1

摘自: MaCT USA

智慧電網IPDX CLOUD應用

IPDX在再生能源之應用

P21451 Family of Standards

User Network

P21451 Family of Standards

Network Interface
- ISO/IEC/IEEE p21451-1-1 (TCP/UDP Interface)
- ISO/IEC/IEEE p21451-1-2 (HTTP Interface)
- ISO/IEC/IEEE p21451-1-3 (Web Interface)
- ISO/IEC/IEEE p21451-1-4 (XMPP Interface)
- ISO/IEC/IEEE p21451-1-x (SNMP)

ISO/IEC/IEEE p21451-1-1	ISO/IEC/IEEE p21451-1-2	ISO/IEC/IEEE p21451-1-3	ISO/IEC/IEEE p21451-1-4	ISO/IEC/IEEE p21451-1-x
TCP/UDP Services	HTTP Services	Web Services	XMPP Services	SNMP Services

ISO/TEC/IEEE p21451-1 Common Network Services

Discovery Services	Transducer Access Services	TEDS Access Services	Event Notification Services	Transducer Management Services

ISO/IEC/IEEE 214510 Transducer Services

ISO/IEC/IEEE 21451-2 or ISO/IEC/IEEE 21451-5 Module Communication

Network Node – Network Capable Application Processor (NCAP)

Transducer Interface
- ISO/IEC/IEEE 21451-2 (Serial Interface)
- ISO/IEC/IEEE21451-5 (Wireless Interface)

Sensor Node - Transducer Interface Module (TIM)

ISO/IEC/IEEE 21451-2 or ISO/IECIEEE 21451-5 Module Communication

ISO/IEC/IEEE 214510 TEDS	ISO/IEC/IEEE 214510 Transducer Services	ISO/IEC/IEEE 21451-2 or ISO/IEC/IEEE21451-5 PHY TEDS

ISO/IEC/IEEE p21451-001 Signal Treatment Services (Optional)

Signal Conditioning and Data Conversion

Mixed Mode Interface   **RF Interface**

ISO/IEC/IEEE 21451-4 Transducer	Transducers (Sensors & Actuators)	ISO/IEC/IEEE 21451-7 Transducer

Project to be proposed In the future

Standard being developed

15

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28

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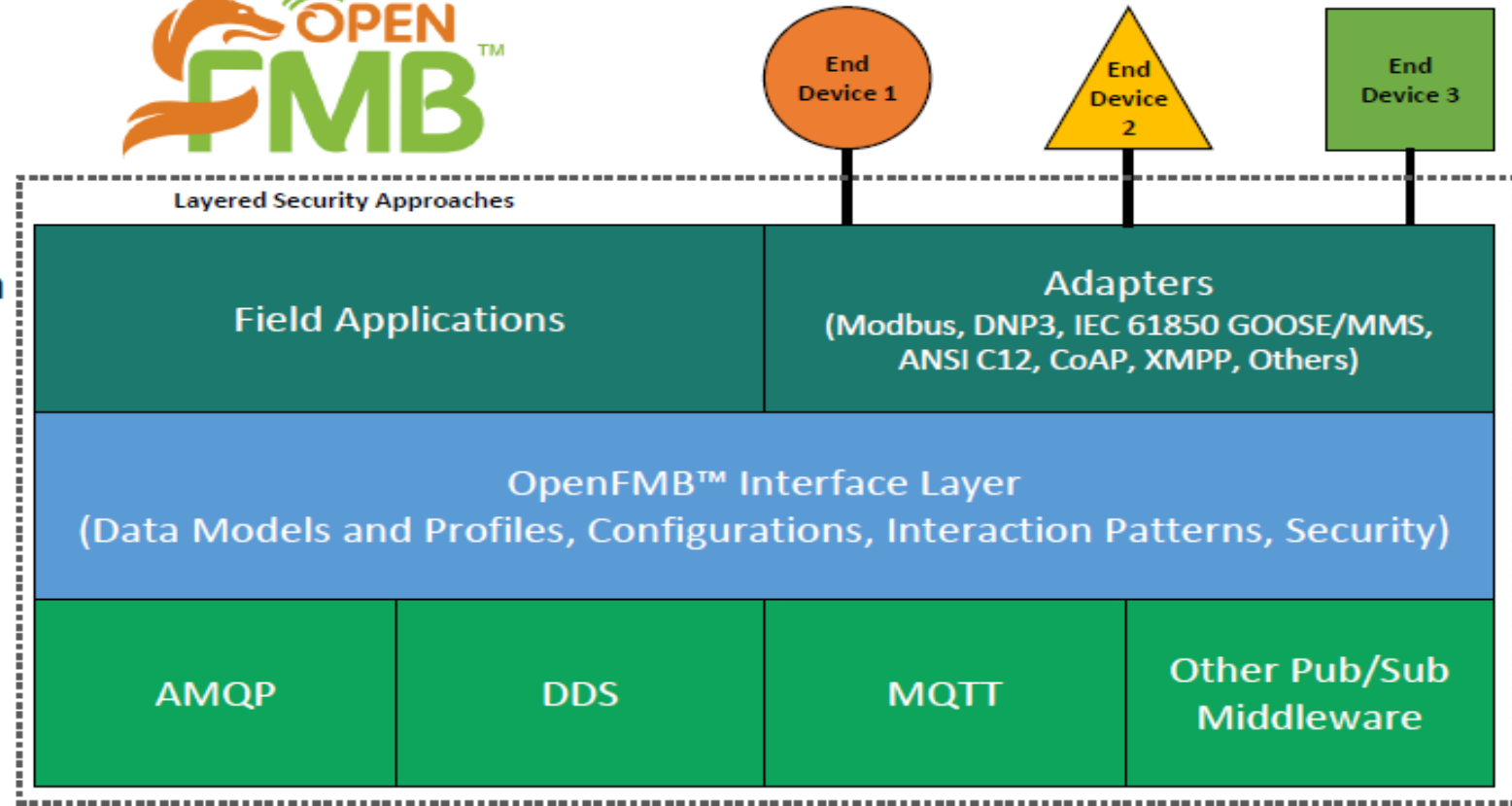
美國目前IOT在SG之另一發展
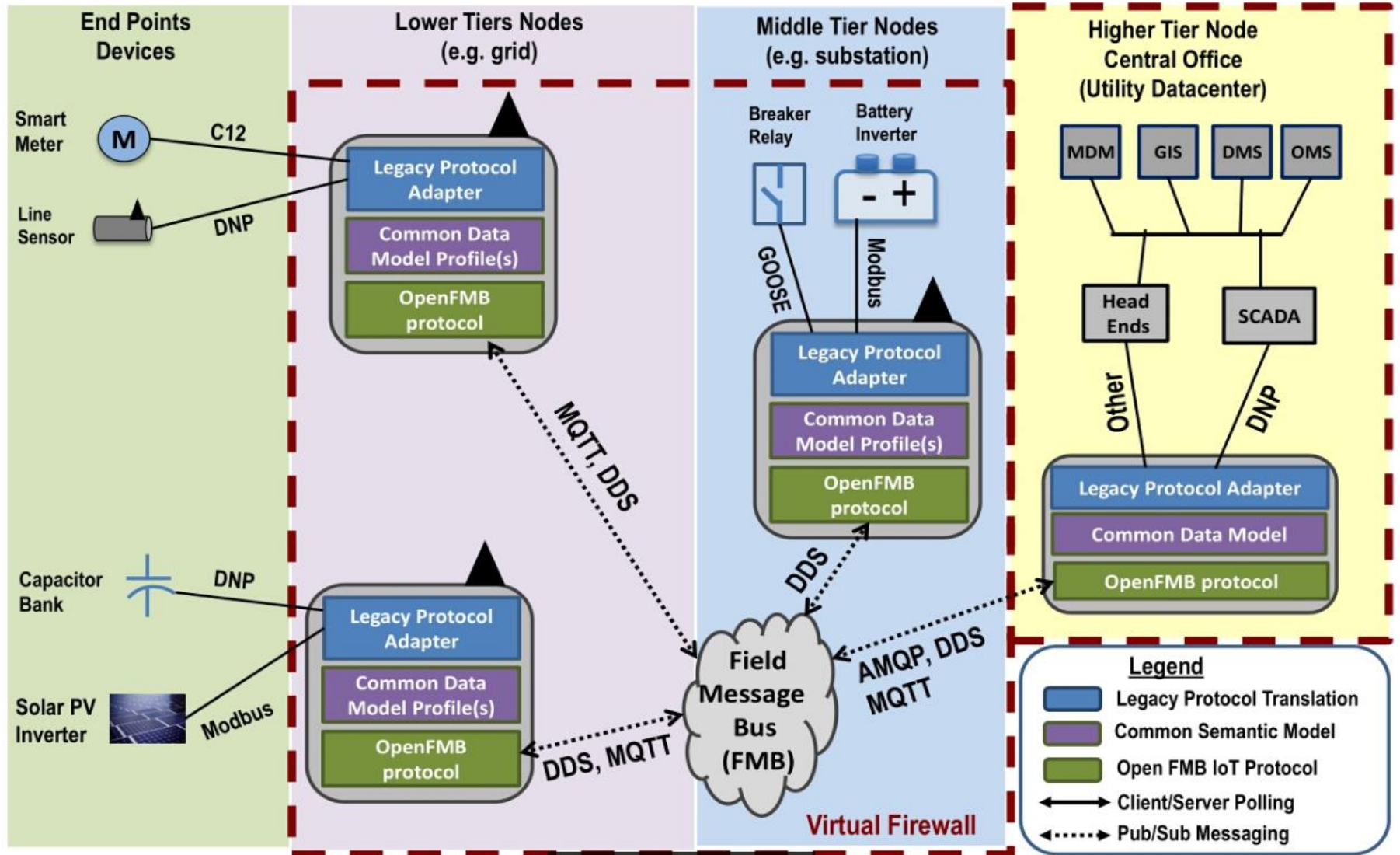

OpenFMB™: Logical Reference Architecture

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OpenFMB Framework

EPRI 進行之DER ICT
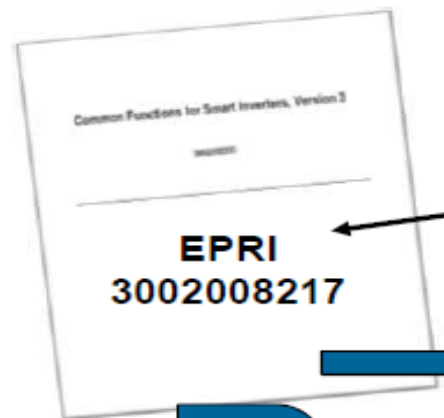

全部採用
IEC 61850之訊模型

Protocols – Four Known Encodings

IEC
61850-7-520
61850-7-420

EPRI
3002008217

Updated
4th Edition
published in
2016

SUNSPEC
ALLIANCE
Modbus RTU and TCP

dnp
Distributed
Network
Protocol
AN 2013-001

IEEE
IEEE 2030.5
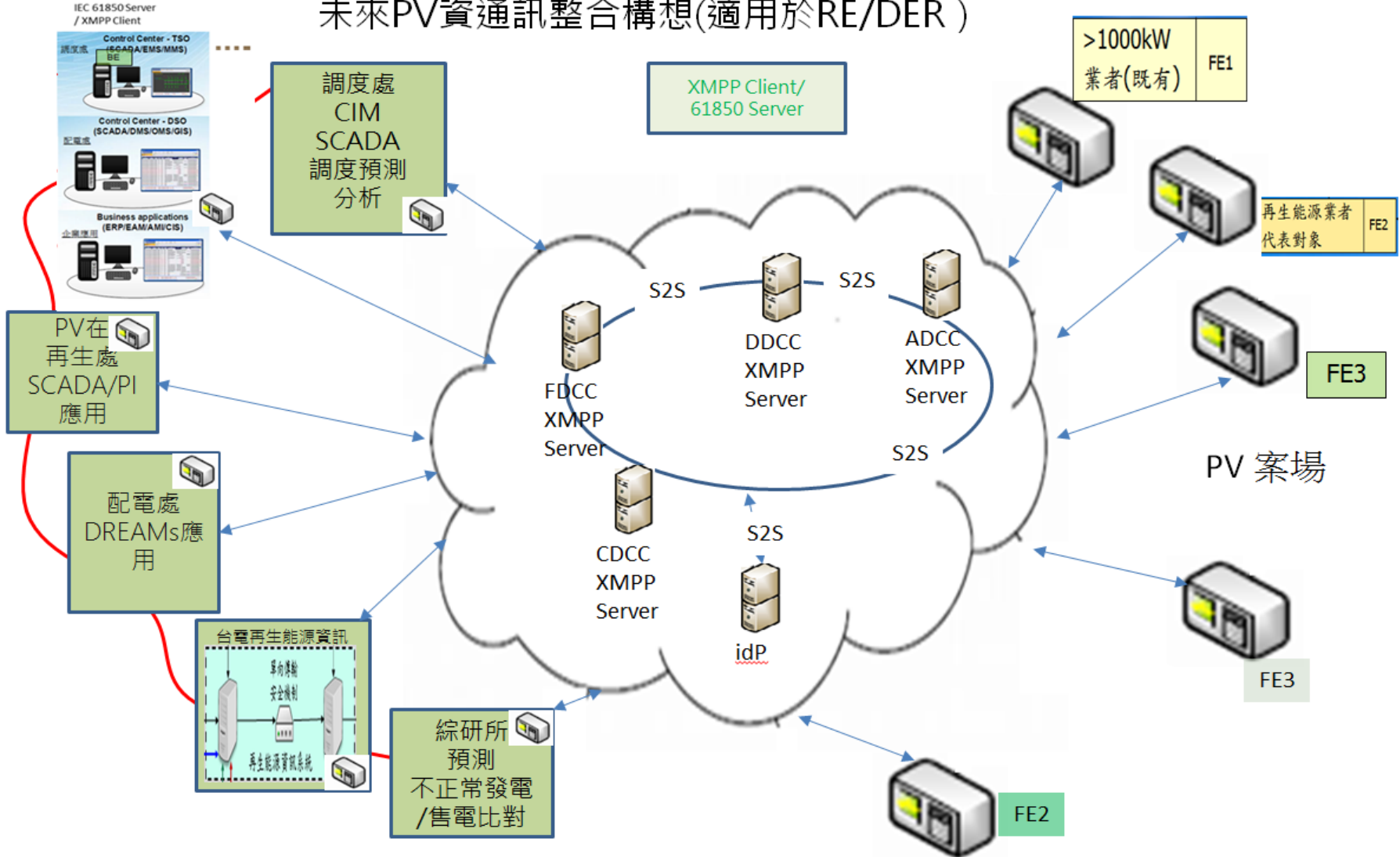
IEC
61850 MMS

openADR
ALLIANCE

New Activity, Adding DER
Support, Driven by Japan

3

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RESEARCH INSTITUTE

XMPP 在RE/DER/PV案場應用構想示意

未來PV資通訊整合構想(適用於RE/DER)

再生能源或DER資通訊議題

➢ 資料封裝格式問題(Information Models)

➢ 資料叫用問題(information Services)

➢ 資訊傳輸問題(Communication Protocols)

未來標準化之建議

- ➤ 採用已納入IEC SG標準之IOT技術
- ➤ 建立先導型IEC 61850/XMPP系統(**兼顧配合原一致化規劃**)
- ➤ 要加速導入時間建議直接與有經驗國家合作或國內IOT廠分工合作
- ➤ 資訊整合標準運用/經費/時間要有優勢
- ➤ DER資通訊在末端標準化並可雲端規劃或設定

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報告完畢

謝謝聆聽 敬請 指正