Genco Technical IT Support Systems and Generation Management System Interdependencies

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Outline

1. **Introduction**/motivation/problem formulation
2. **Existing IT support for GenCo's**
3. **New architectures for GenCo IT support sys.**
4. **Technology**
5. **Two examples from the current projects**
6. **Open issues/Future work**

Message

Increased system complexity can be coped with:

- **New CC (hierarchical) architectures that enable interoperability between many local control systems, and provide new functionalities (like GPMS)**
- **Existing integration technologies to enable existing (legacy) systems**

1. ESI is characterized to day with:

- Increased share of DG/RES +storage and EV's
- Mostly power electronic (PE) interfaced
- Advent of new market actors, like load aggregators, generation aggregators (commercial VPP) and DR/DSM aggregators
- Market providers of, not only "standard" AS but also black start, restoration services and soon to come provision of the system inertia
- Ever changing market rules and push to reduce CO2 emissions by closing down fossil fuel power plants (PP).

ESI is characterized also with:

- Generation volatility (wind, solar)
- RES at LV ⇨low observability
- RES, low or no inertia ⇨lower controllability
- New and unexpected PFlows ⇨Congestions
- More dynamic phenomena observed
- Voltage/frequency quality problems
- Customer requirements regarding reliability and quality are increasing
- Gen Cos-TSO/ISO-DSO interfaces might sometimes be inadequate

Key Gen Co. problems to be analyzed

- To cope with increased market competition, it is of paramount importance to maximize the existing Genco asset market value.
- New IT support systems architecture to accommodate diferent actors, changes in controllability and observability, employing new ICT and control theory advancements, are nedeed.
- Focus on architecture, that support PP equipment performance and generation control functionality.
- High importance, each % in PP/Fleet efficiency improvement results in a M$.

2. Existing GenCo IT support scope

- SCADA/GMS-mainlly old VIU solutions
- SCADA+ for RES (SCADA+Forecasting app's)
  - ➢ Along the traditional centralized architecture
- Historians
- EAM
- MMS
- ETRM
  - ➢ Slow accomodation to changes going on in ESI
- ERP

Existing GenCo IT support allocation

- **PP level (PLC, DCS, SCADA, PMU, RTU, GW…)**

GCC: Gen monitoring and control ⇨

- **Generation control (SCADA, SCADA/GMS)**
- **Generation control and trading (GMS+ETRM)**
- **Control of RES**
- **Gen control + RES**
- **PP Fleet operation performance monitoring CC**
- **Equipment monitoring and Diagnostic center**

- **Corporate/HQ level (EAM, MMS, ERP…)**

Gen Co IT support sys. solutions available

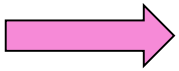
- PP/fleet Historian+ sys (OSI Soft PI system)
- Several solutions for GCC available (ABB, Siemens, GE,...)
- ETRM/CTRM systems (Atos PTRS, FIS, Allegro,...)
- Generic EAM systems (IFS, Infor, IBM Maximo, SAP EAM, Oracle EBS-eAM , Ventyx,Invensis/Schneider, IPS/Energy)
- Generic MMS (CMMS-computerized MMS)
- ERP systems (many: SAP, Oracle EBS,...)

If Genco has customers, then in addition:

- CIS
- CRM
- ...

Typical characteristics of existing systems

- **Proprietary,** not easy to expand or integrate
- **Different vendors** (heterogenous environment)
- **Standards generally exist for comm. protocols**
- **Systems are typically non-integrated**
- **Week connections between process and corporate IT support systems**
- **Still mostly silos of information**
- **Often no real time info. at corp. level**

Need for new architectures 

3. New architectures for Gen Co IT support sys.

Requirements:

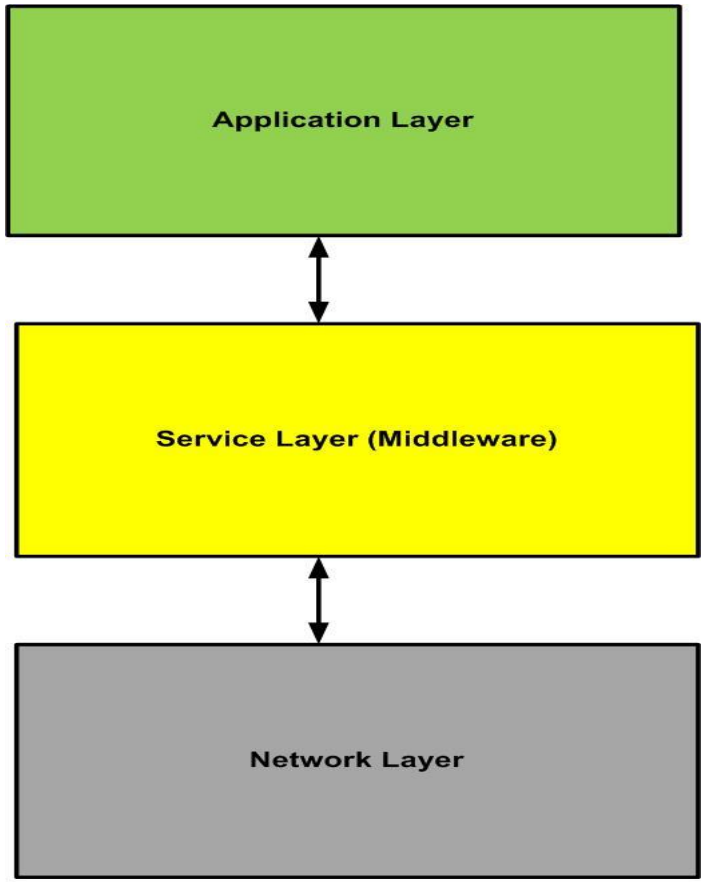
- **Need to incorporate DG/RES info into GMS**
- **Need to integrate systems/data from DG generation aggregators (VPP)**
- **To enable measurements-equipment relation**
- **Need to have PP operations performance info**
- **Need to incorporate maintenance and equip. diagnostic info.**
- **To enable interoperability of GMS with ETRM**
- To integrate with other sys.: meteorological, ecology monitor.

Approaches to the problem solution

- **To enable all of that, standard open distributed computing environment is needed that provides standard midlleware for all system appl, appart from necessary governance and other tools.**

- Such open DCE solutions were proposed but were not supported by the IT giants (MS, Oracle), thus are not widelly used.
- **Instead, development went towards SOA, then cloud (XaaS) sevices of today and future IoT technology.**

Middleware & Interoperability



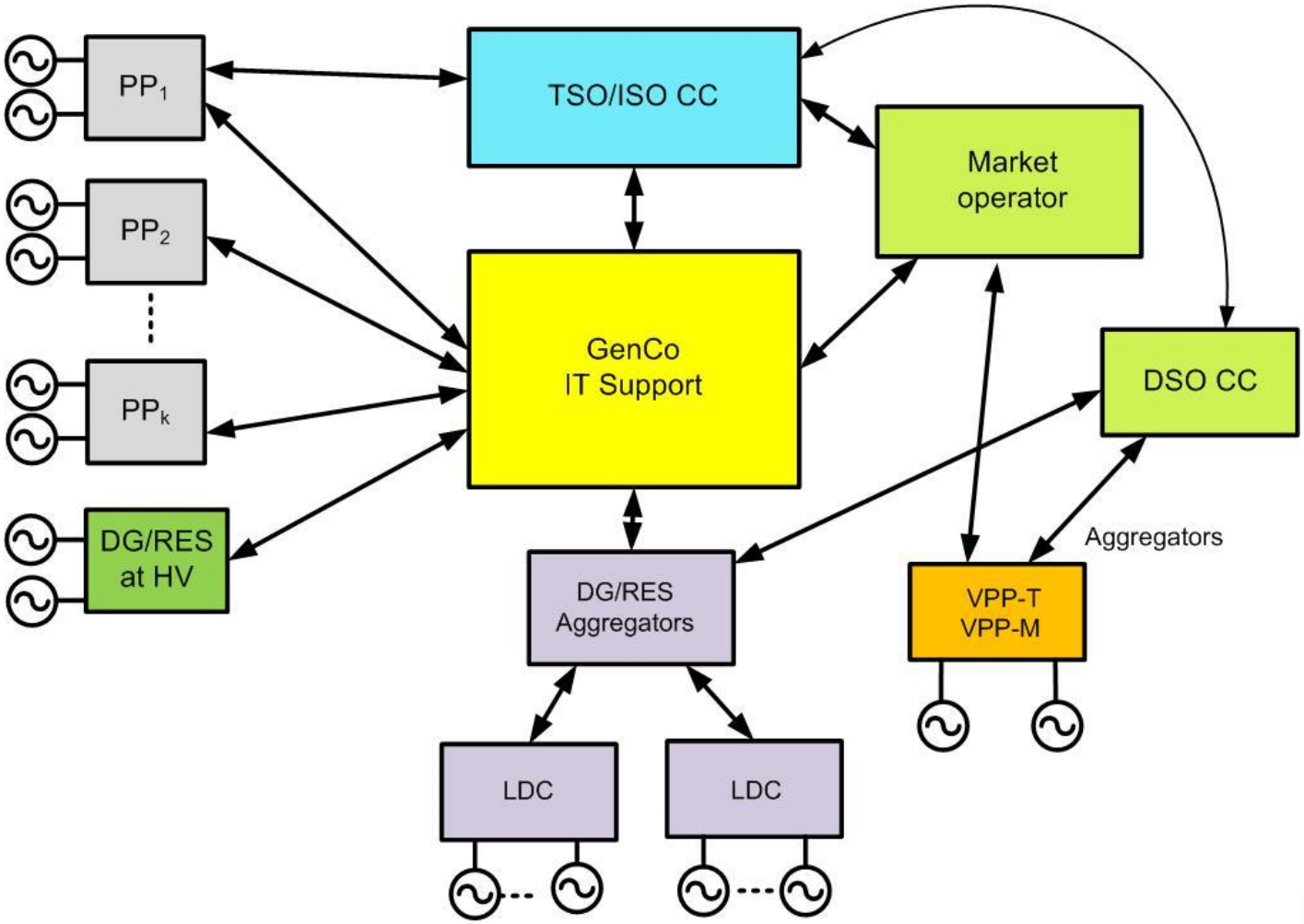
oneM2M IoT Platform Architecture

- **For information interop. key element is to have syntatic and semantic interoperability, i.e. to exchange and understand common data structures and understand concepts in the data they exchange.**
- **Canonical data model: CIM**
- **Semantic representation language: RDF/XML w3c stnd.**
- **Semantic representation language for building ontology's: OWL w3c stnd.**

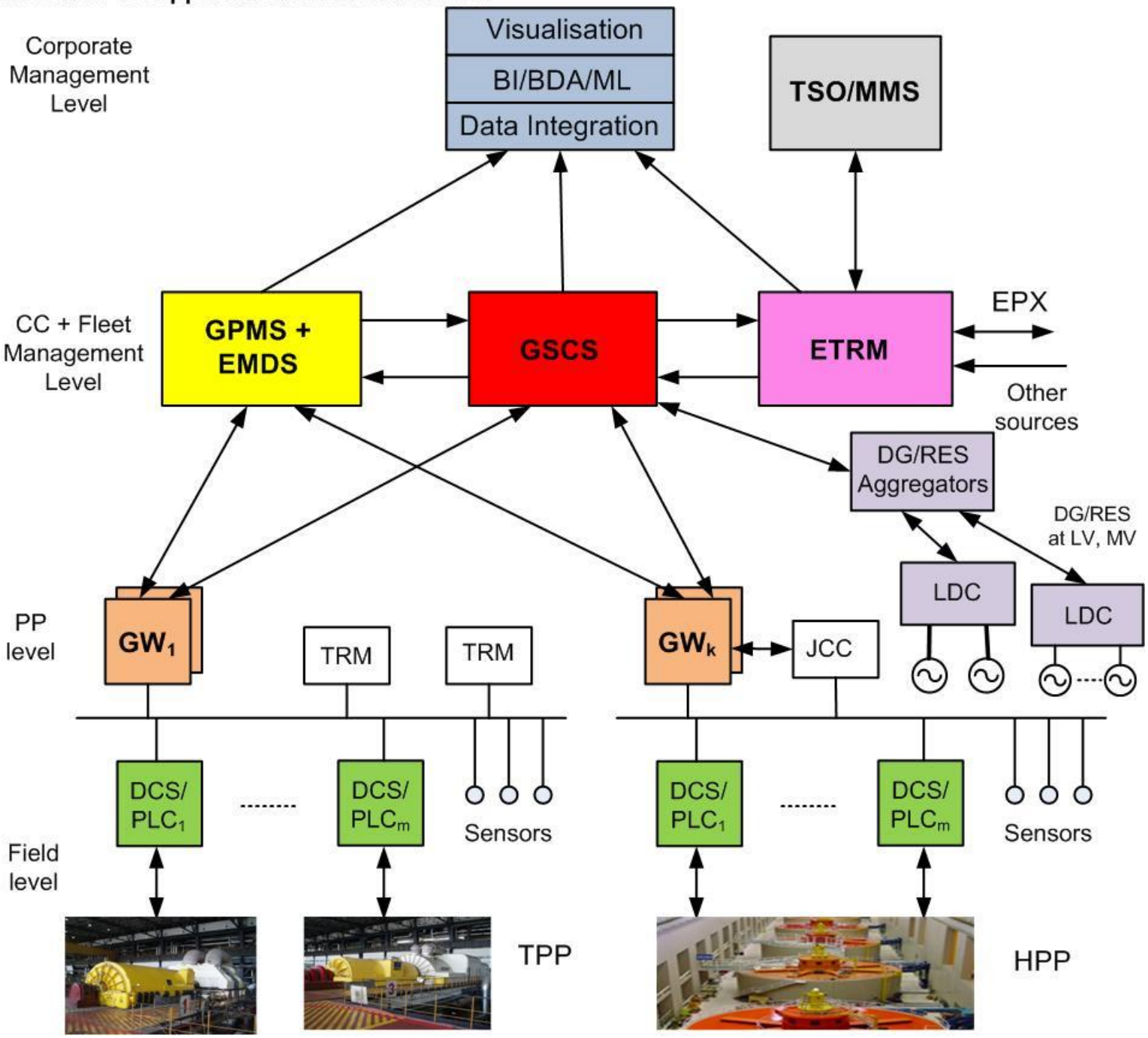
Standardization efforts within ESI

- **Several standard architectures were proposed (Gridwise + NIST: GWAC, EPRI:Intelli grid, IEEE P2030, CEN/CENELEC/ETSI 2012: SGAM, IEC...)**
- **Important for better understanding of the whole, but with limitted practical use, probably due to sizable numbers of legacy applications/systems.**
- **Simillar with other overall (reference) architectures, general conceptual frameworks are excelant if start building systems from scratch.**
- **Big sw vendors don't have much interest in "rewriting" their complex systems along the stnd. arch. lines but limit them selves tipically to converters or wrapers.**

Context diagram for new GenCo IT support



New GenCo IT support architecture-detailed



Question, interdependenncy over LFC

- **Today typically TSO/ISO is directly LFC controling Genco's regulating (AS) units.**
- **At the local Genco, requirement is that ACE from the TSO should be sent to the Genco CC and there alloccated to regulating units/PP, and units directly controled from there.**
- **Difference in regulating unit reaction time is not substantial?**
- **Reasons *pro et contra*?**

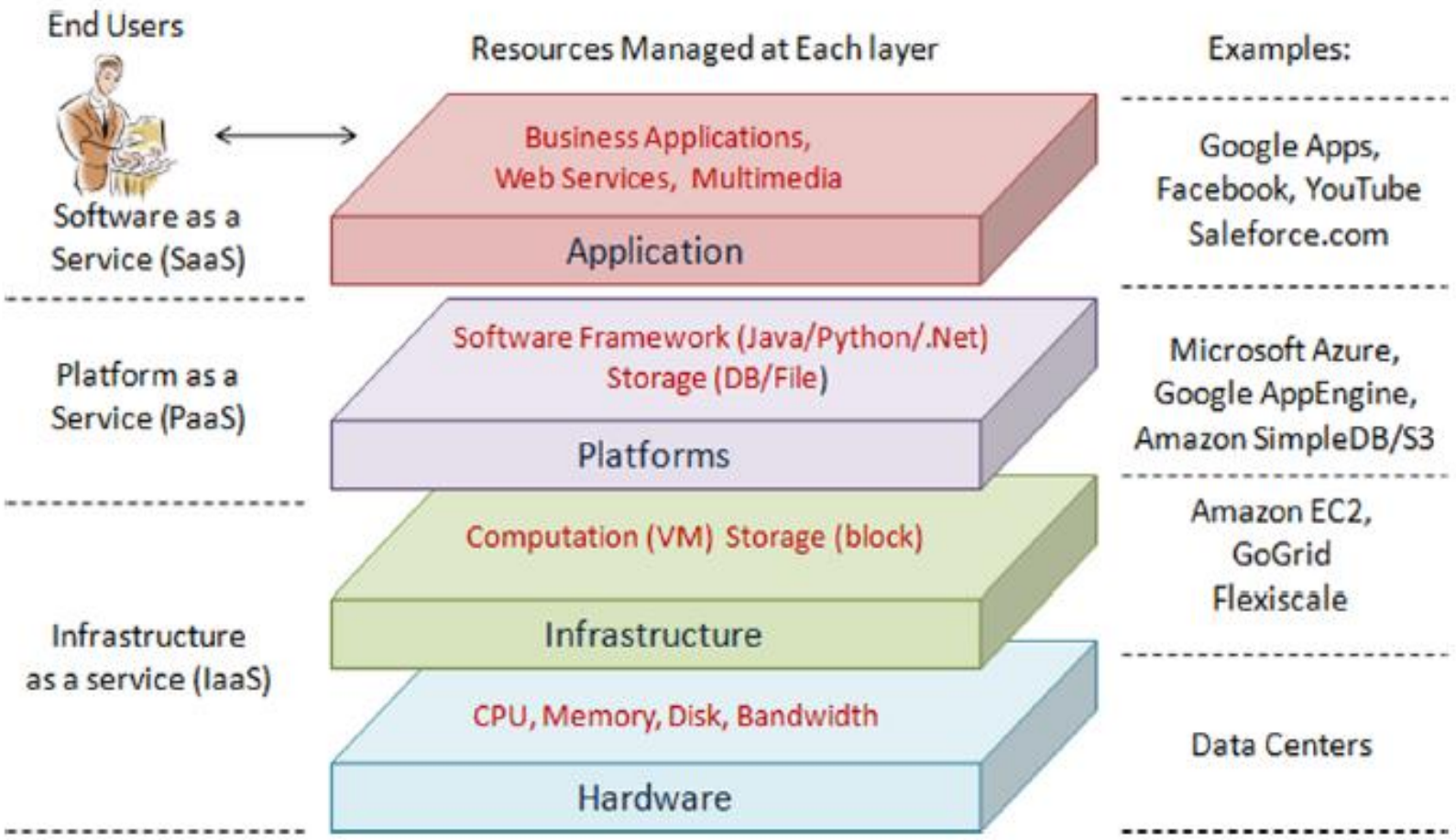
4. Technology

- **Operational Technology (OT) consists of hardware and software systems that monitor and control physical equipment and processes. This technology can be distributed or centralized, like PLC, DCS, SCADA systems, etc.**
- **Information Technology (IT), is the application of computers to process, transmit and store data, typically in a business or enterprise environment.**
- **Historically, OT and IT** have not overlapped and were managed **as separate organizational silos**.
- Development of IT and its expanding use in ESI (not just SG) **are pushing OT-IT convergence.**

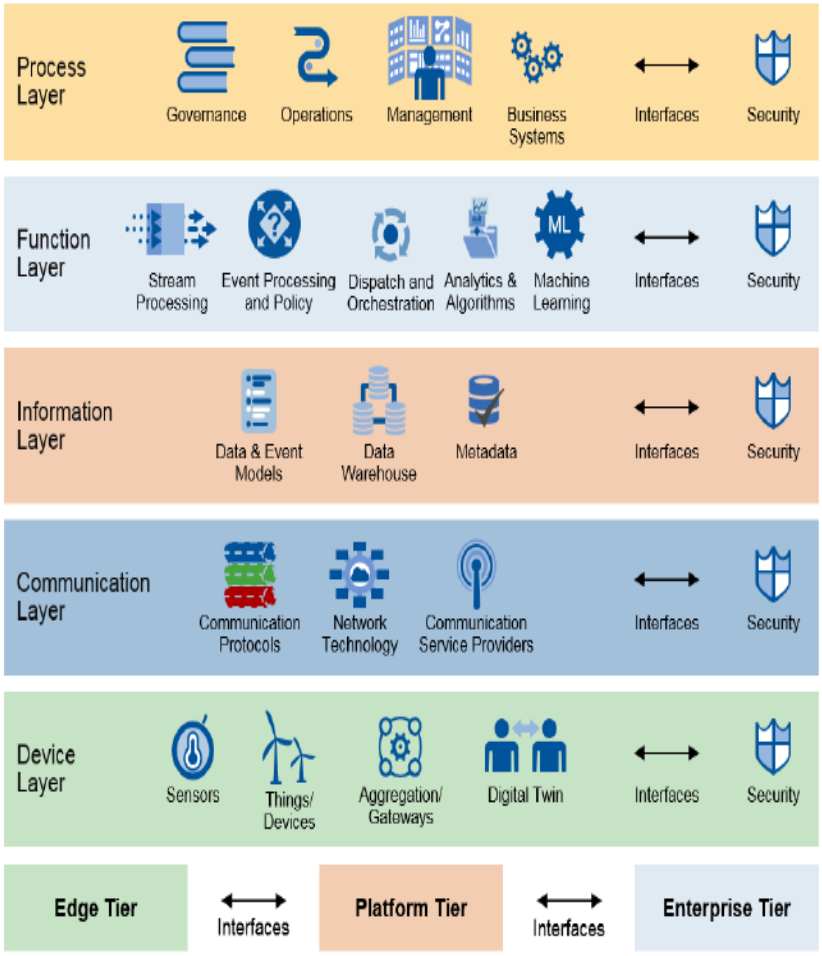
State-of-the-art **Information Technologies**

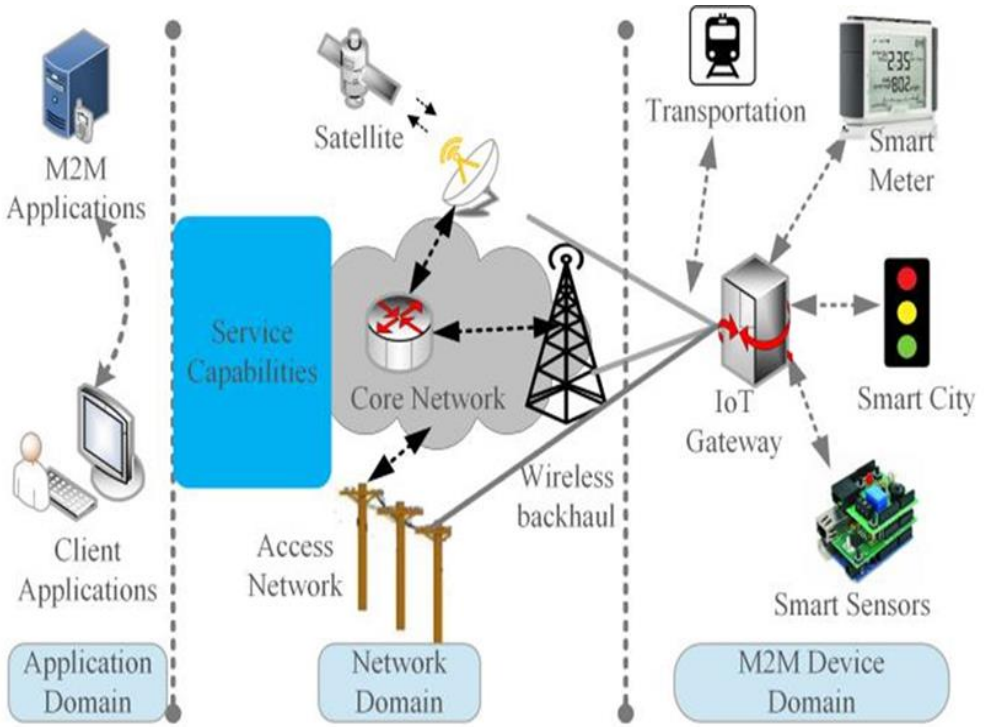
- **Virtualization-**is a technology that ”hides” the details of physical hardware and provides virtualized resources for high-level applications and dynamically assigning virtual resources to app’s on-demand.
- **Cloud computing,** the word is used to describe the business model of providing services across the Internet. Deff. ⇨ **IaaS, PaaS, SaaS,..., XaaS**
- **Internet of things (IoT),** is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment

Cloud computing architecture, source:Q.Zhang, 2010



IoT Reference Model, source: Gartner 2017+ IEEE, 2015 Hakiri





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5. Example projects

1. **PE EPS (Gen Co) new generation/production performance monitoring and control system GPMS (PROTIS Project), i.e.** operations and maintenance management **for the entire PP fleet at PU EPS** (21 TPP, HPP)**.**

2. **PE EPS (Gen Co) new GSCS (CDS-CPS Project)** for generation scheduling and control

Current Challenges and Needs at EPS

- **Initial situation:**
- Daily work was performed mostly using heuristic approach
- Not many technical applications at corporate level
- SCADA data were obtained via ICCP from TSO!
- New ETRM system in place
- Luck of on-line/RT unit efficiency, unit production cost and other plant/unit data
- **Need for GCC and Operational Performance monitoring and optimization system.**

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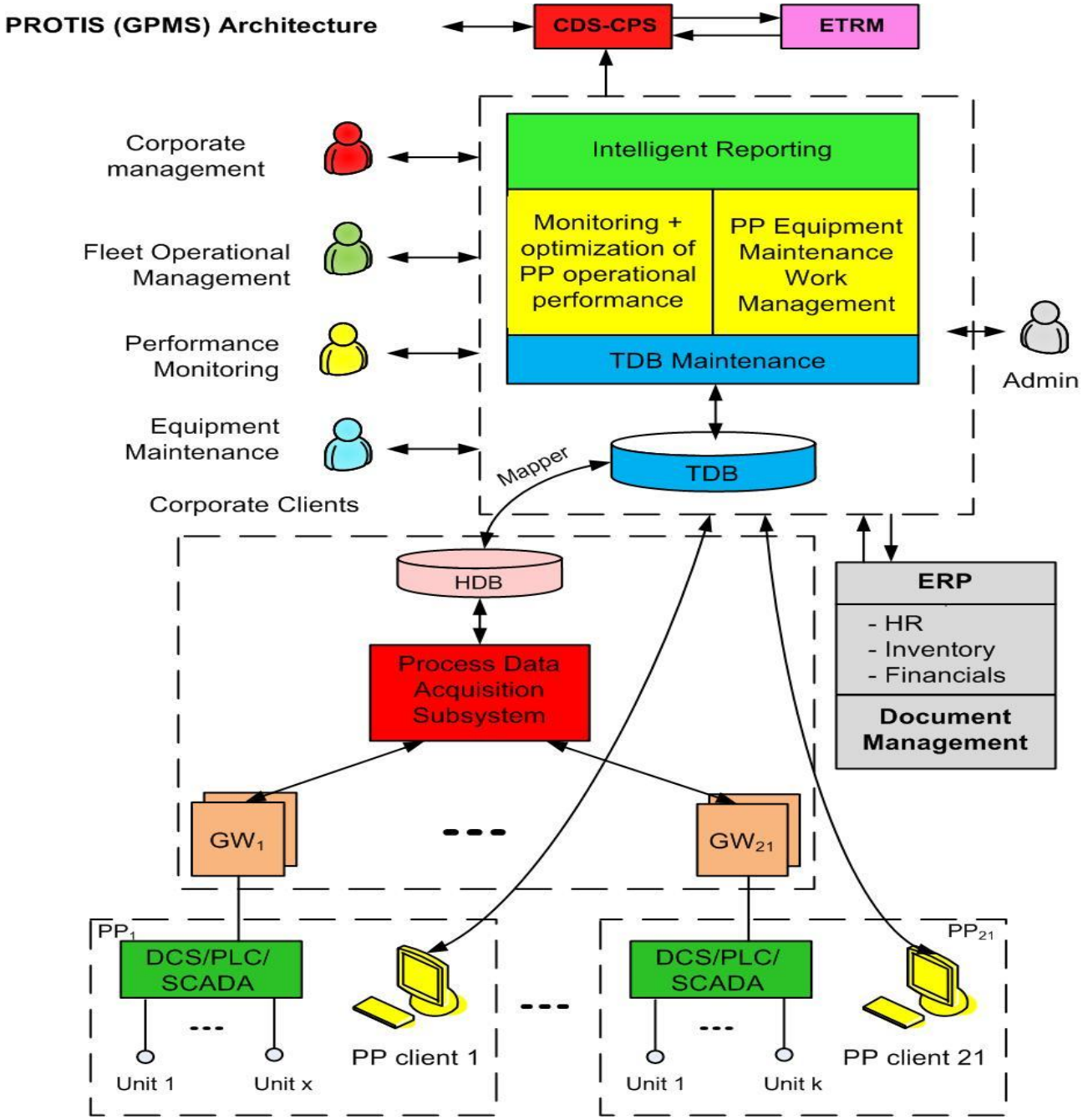
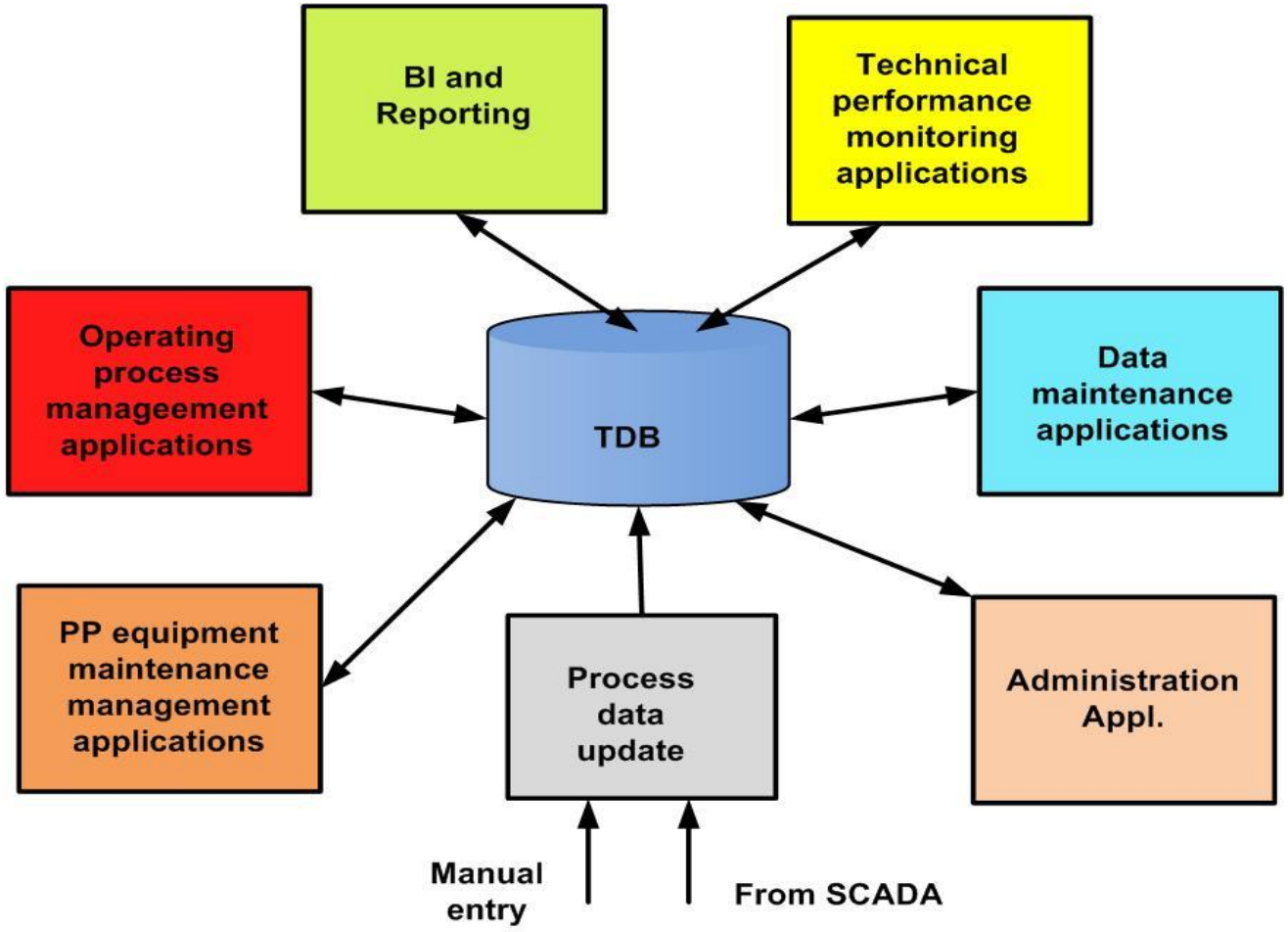

PROTIS (GPMS) Architecture
CDS-CPS
ETRM
Corporate management
Fleet Operational Management
Performance Monitoring
Equipment Maintenance
Corporate Clients
Intelligent Reporting
Monitoring + optimization of PP operational performance
PP Equipment Maintenance Work Management
TDB Maintenance
Admin
Mapper
TDB
HDB
Process Data Acquisition Subsystem
ERP
- HR
- Inventory
- Financials
Document Management
GW1
GW21
PP1
DCS/PLC/ SCADA
Unit 1
Unit x
PP client 1
PP21
DCS/PLC/ SCADA
Unit 1
Unit k
PP client 21

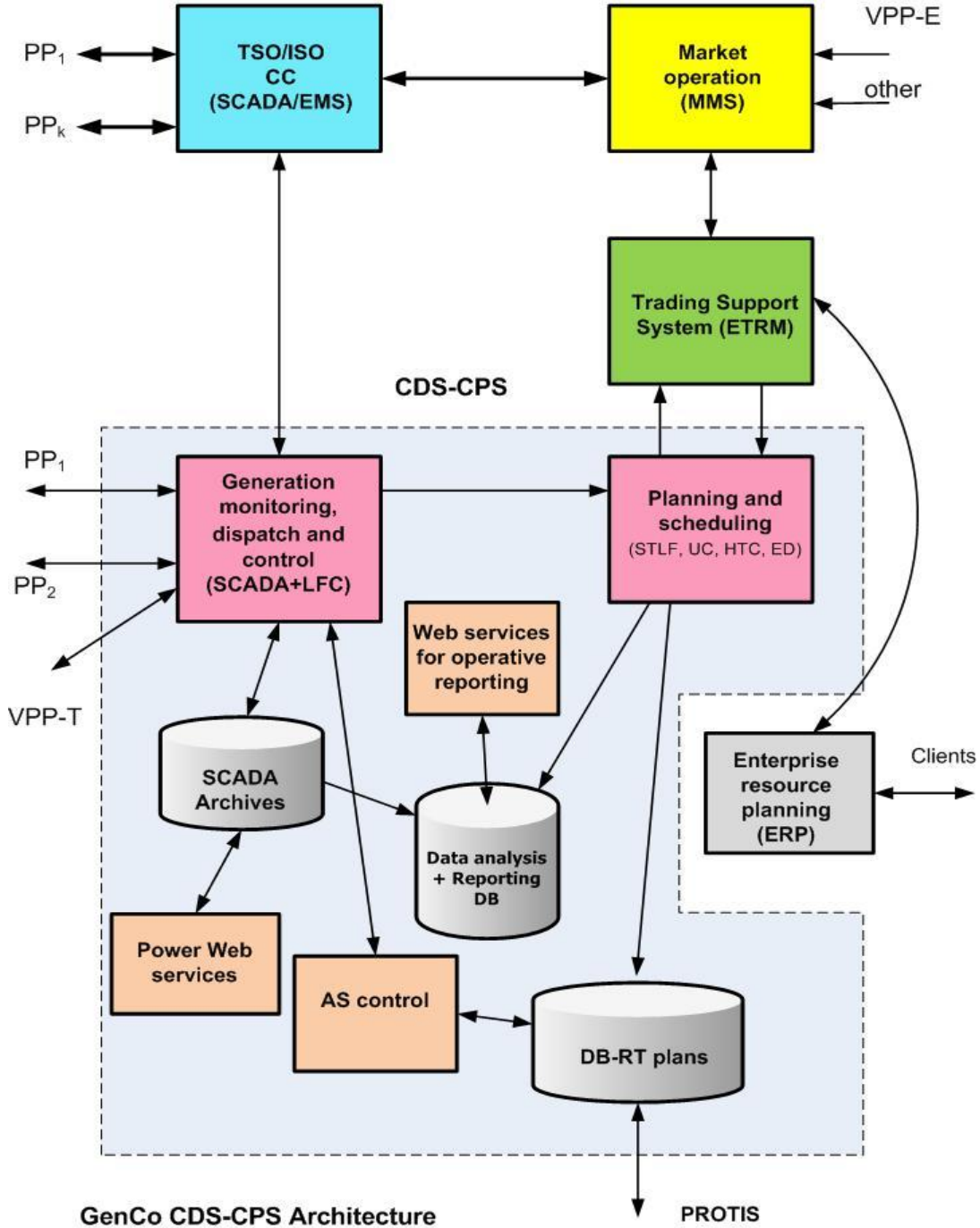
System Protis (GPMS)-functions



PROTIS Central Server part

2. CDS/CPS project (GSCS) for EPS

- SCADA
- HMI
- Alarming
- Archives & Reporting
- Web service
- Notification services
- CDS-CPS interface
- CDS-SUP interface



GenCo CDS-CPS Architecture

GPMS and GSCS- Interdependencies

Within the arch. proposed there are **ID between**:

- The data (RT data in GSCS and extended RT +cumulatives in GPMS), i.e. dif. types, sampling rates,...
- Applications in both systems
- Technologies used

Solved using new cofigurable GW at the PP, and xml and sftp for interfces (at data level).

Q: What might be more generic solution?

6. Open issues/Future work

- To grasp small to medium DER owners without enough resources to operate centralized VPP
- Idea is to move VPP-CC functionality to the cloud as a SaaS.
- New challenges
- That idea is already in place for energy efficient load management of large customers.
- Question: is the VPP-CC same as DERMS?

Conclusion

Increased system complexity can be coped with:

- **New CC hierarchical architectures that enable interoperability between many local control systems, and provide new functionalities (like GPMS)**
- **Existing integration technologies to enable existing (legacy) systems**
- **New IT paradigmas and technologies, preferrably standard, already tested within a larger business IT domain.**

Thanks for your attention!

Questions?

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