ساختار سیستمی

شبکه های توزیع برق

فرهاد یزدی

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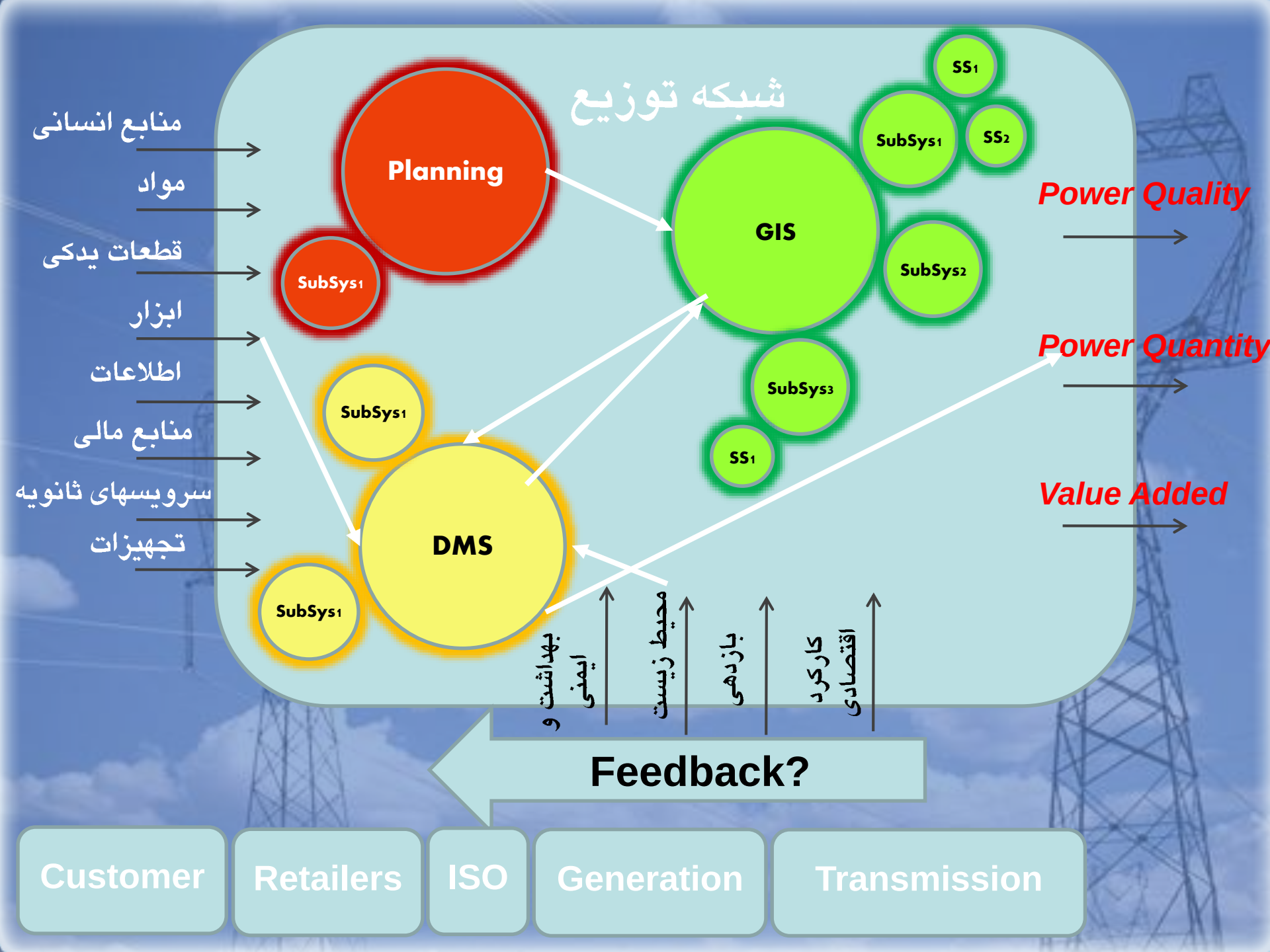

شبکه توزیع
منابع انسانی
مواد
قطعات یدکی
ابزار
اطلاعات
منابع مالی
سرویسهای ثانویه
تجهیزات
Planning
SubSys1
GIS
SS1
SubSys1
SS2
SubSys2
SubSys3
SS1
DMS
SubSys1
SubSys1
Power Quality
Power Quantity
Value Added
بهداشت و ایمنی
محیط زیست
بازدهی
کارکرد اقتصادی
Feedback?
Customer
Retailers
ISO
Generation
Transmission

Toward the Smart Grid, 2005

http://www.ece.umn.edu/facultyECE/AMIN_MASSOUD.html

2001 Performance Recognition Award, “for commitment to society in the development and advocacy of the Common Information Model (CIM), the Application Program Interface (API) standards and the application of API to Grid Operations and Planning software products”, EPRI, Palo Alto, CA, Jun. 2001

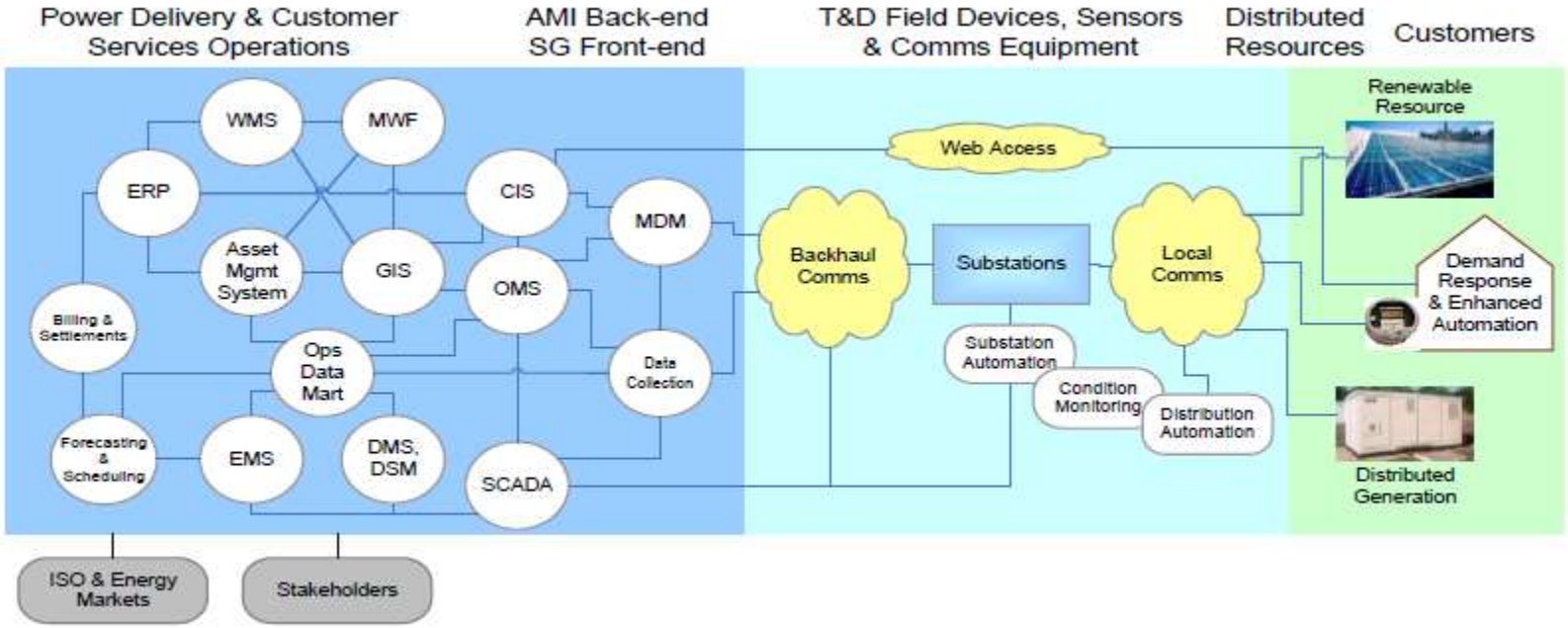


Figure 3. Systems impacted by Distribution Smart Grid

مدل IEC

در استاندارد IEC به جای سیستم و زیر سیستم از اصطلاحات Business Function Model و Business Sub-Function Model استفاده شده است .

- Key standards:
  - IEC 61970-301 (Core CIM, transmission focus)
  - IEC 61968-11 (Distribution extensions)
- Standards that leverage the CIM:
  - IEC 61970-552-4 (CIM XML Model Exchange Format)
  - IEC 61970-452 (CIM Transmission Network Model Exchange Profile)
  - IEC 61968-13 (CIM RDF Model Exchange Format for Distribution)
  - IEC 61968-9 (Integration of Metering Systems)
- Key efforts in progress:
  - (IEC TC57) XML NDR
  - IEC62325-301 (CIM Market Extensions)

IEC 61968

IEC 61968

From Wikipedia, the free encyclopedia

IEC 61968 [1] is a series of standards under development that will define standards for information exchanges between electrical distribution systems. These standards are being developed by Working Group 14 of Technical Committee 57 of the IEC (IEC TC 57 WG14). IEC 61968 is intended to support the inter-application integration of a utility enterprise that needs to collect data from different applications that are legacy or new and each has differe interfaces and run-time environments. IEC 61968 defines interfaces for all the major elements of an interface architecture for Distribution Management Systems (DMS) & is intended to be implemented with middleware services that broker messages among applications.

Contents [hide]

Standards [edit]

- IEC 61968-1 – Interface architecture and general requirements [Published]
- IEC 61968-2 – Glossary [Published]
- IEC 61968-3 – Interface for *Network Operations [NO]* [Published]
- IEC 61968-4 – Interfaces for *Records and Asset management [AM]* [Published]
- IEC 61968-5 – Interfaces for *Operational planning & optimization [OP]* [Under Development]
- IEC 61968-6 – Interfaces for *Maintenance & Construction [MC]* [Under Development]
- IEC 61968-7 – Interfaces for *Network Extension Planning [NE]* [Under Development]
- IEC 61968-8 – Interfaces for *Customer Support [CS]* [Under Development]
- IEC 61968-9 – Interface Standard for *Meter Reading & Control [MR]* [Published]
- IEC 61968-10 – Interfaces for Business functions external to distribution management [Under Development]. This includes *Energy management & trading [EMS], Retail [RET], Supply Chain & Logistics [SC], Customer Account Management [ACT], Financial [FIN], Premises [PRM] & Human Resources [HR]*
- IEC 61968-11 – Common Information Model (CIM) Extensions for Distribution [Published]
- IEC 61968-12 – Common Information Model (CIM) Use Cases for 61968 [Under Development]
- IEC 61968-13 – Common Information Model (CIM) RDF Model exchange format for distribution [Published]
- IEC 61968-14-1-3 to 14-1-10 [2] – Proposed IEC Standards to Map IEC61968 and MultiSpeak Standards [Under Development]
- IEC 61968-14-2-3 to 14-2-10 – Proposed IEC Standards to Create a CIM Profile to Implement MultiSpeak Functionality [Under Development]

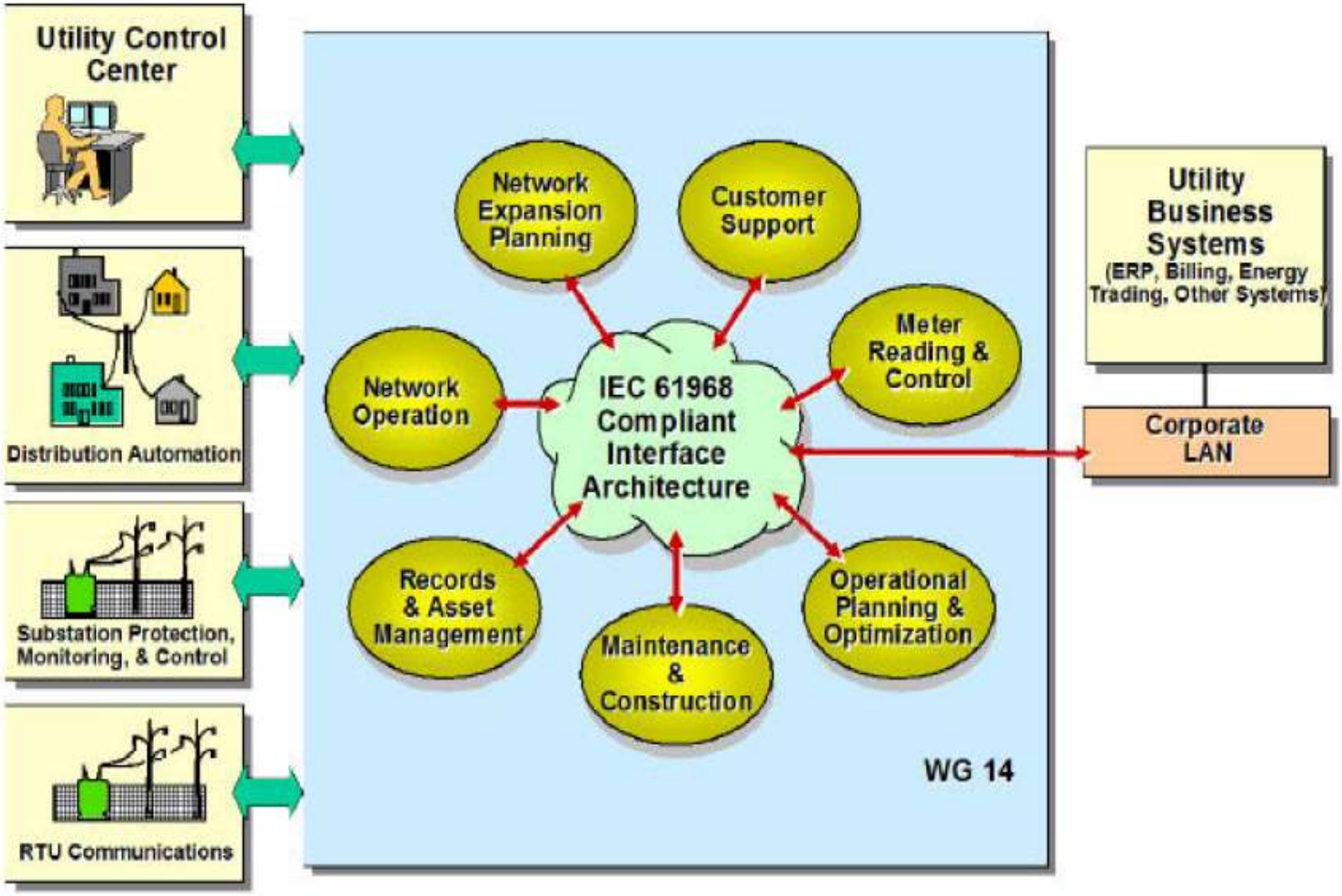
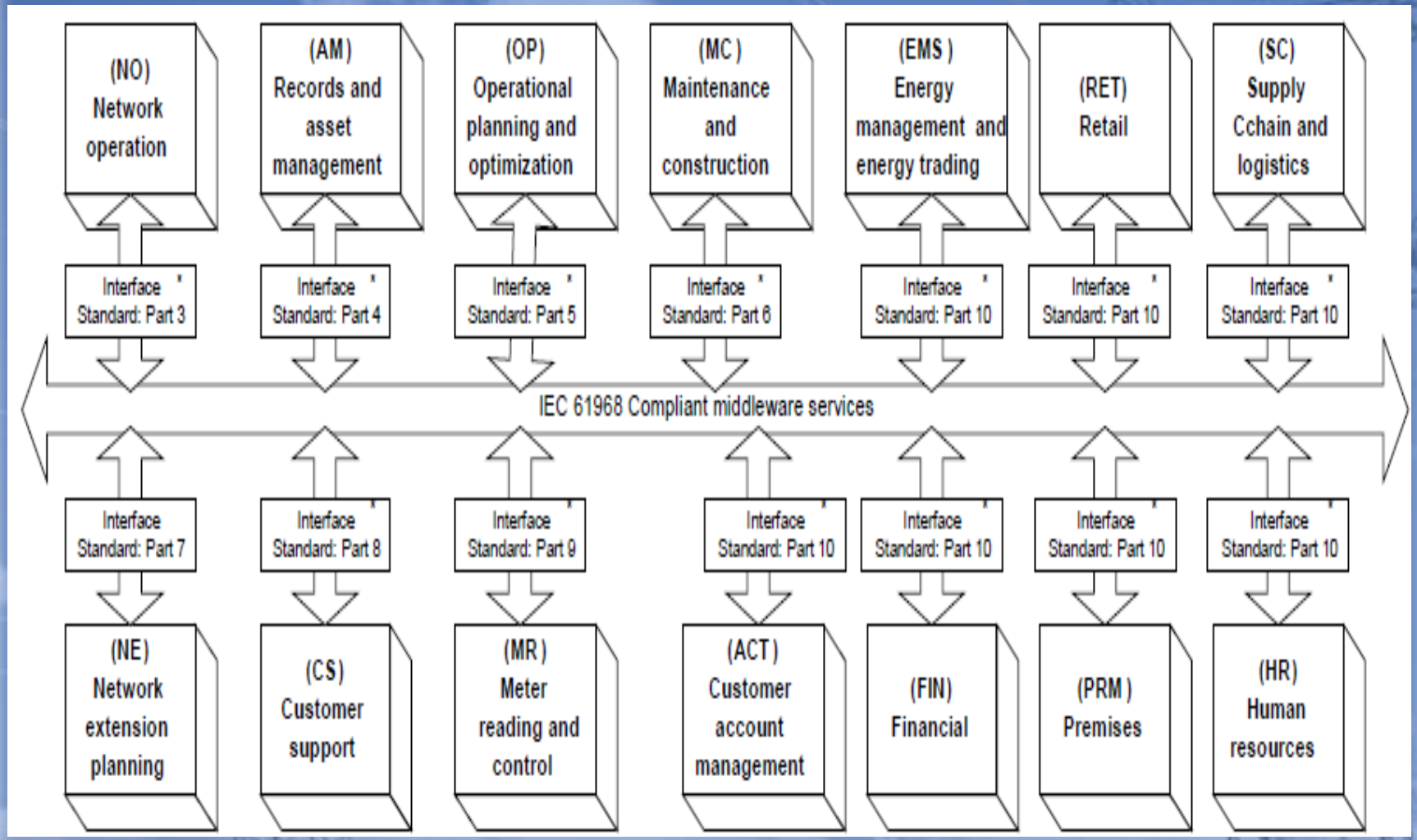
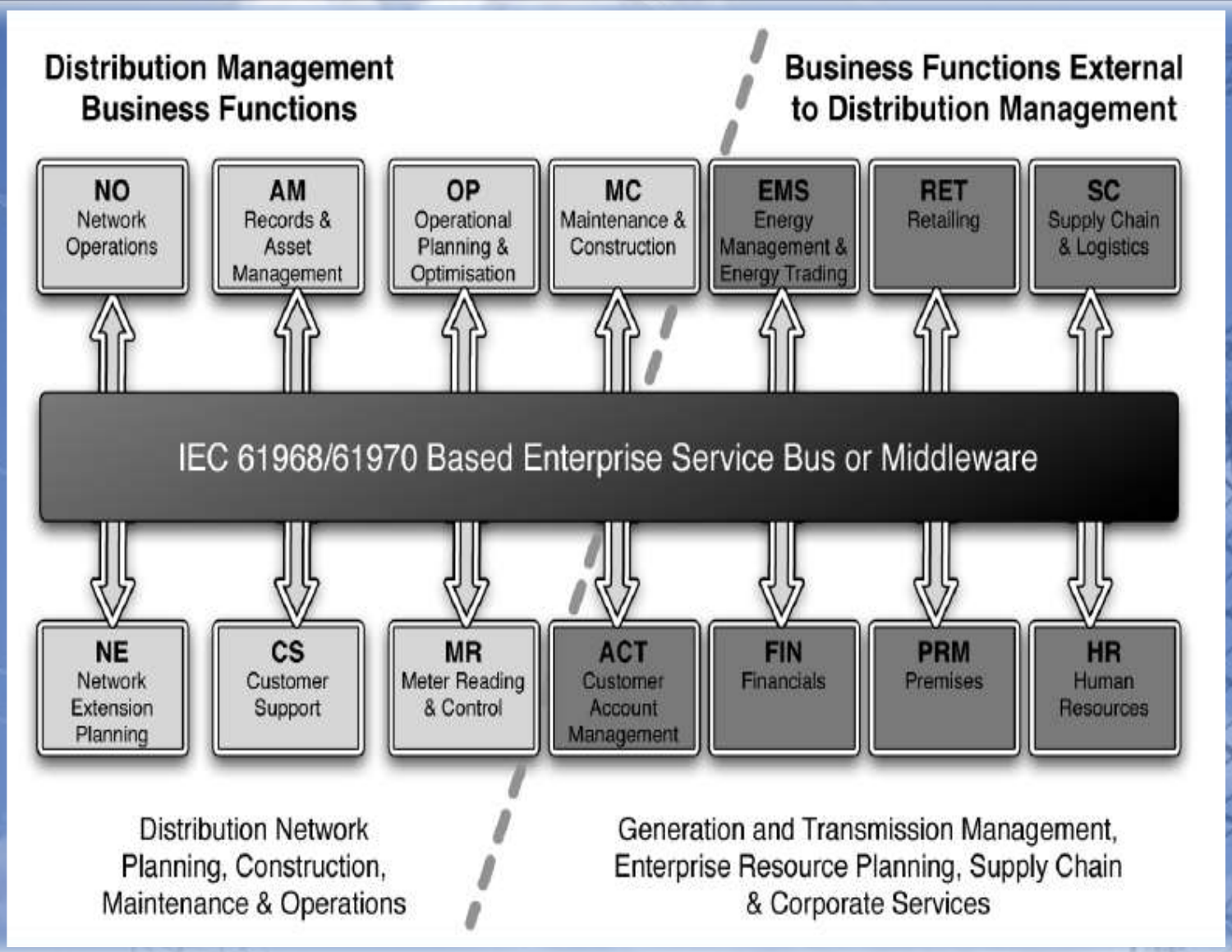


Figure 1: Distribution management with IEC 61968 compliant interface architecture


(NO) Network operation
(AM) Records and asset management
(OP) Operational planning and optimization
(MC) Maintenance and construction
(EMS) Energy management and energy trading
(RET) Retail
(SC) Supply Cchain and logistics
Interface Standard: Part 3
Interface Standard: Part 4
Interface Standard: Part 5
Interface Standard: Part 6
Interface Standard: Part 10
Interface Standard: Part 10
Interface Standard: Part 10
IEC 61968 Compliant middleware services
Interface Standard: Part 7
Interface Standard: Part 8
Interface Standard: Part 9
Interface Standard: Part 10
Interface Standard: Part 10
Interface Standard: Part 10
Interface Standard: Part 10
(NE) Network extension planning
(CS) Customer support
(MR) Meter reading and control
(ACT) Customer account management
(FIN) Financial
(PRM) Premises
(HR) Human resources


Distribution Management Business Functions
Business Functions External to Distribution Management
NO Network Operations
AM Records & Asset Management
OP Operational Planning & Optimisation
MC Maintenance & Construction
EMS Energy Management & Energy Trading
RET Retailing
SC Supply Chain & Logistics
IEC 61968/61970 Based Enterprise Service Bus or Middleware
NE Network Extension Planning
CS Customer Support
MR Meter Reading & Control
ACT Customer Account Management
FIN Financials
PRM Premises
HR Human Resources
Distribution Network Planning, Construction, Maintenance & Operations
Generation and Transmission Management, Enterprise Resource Planning, Supply Chain & Corporate Services

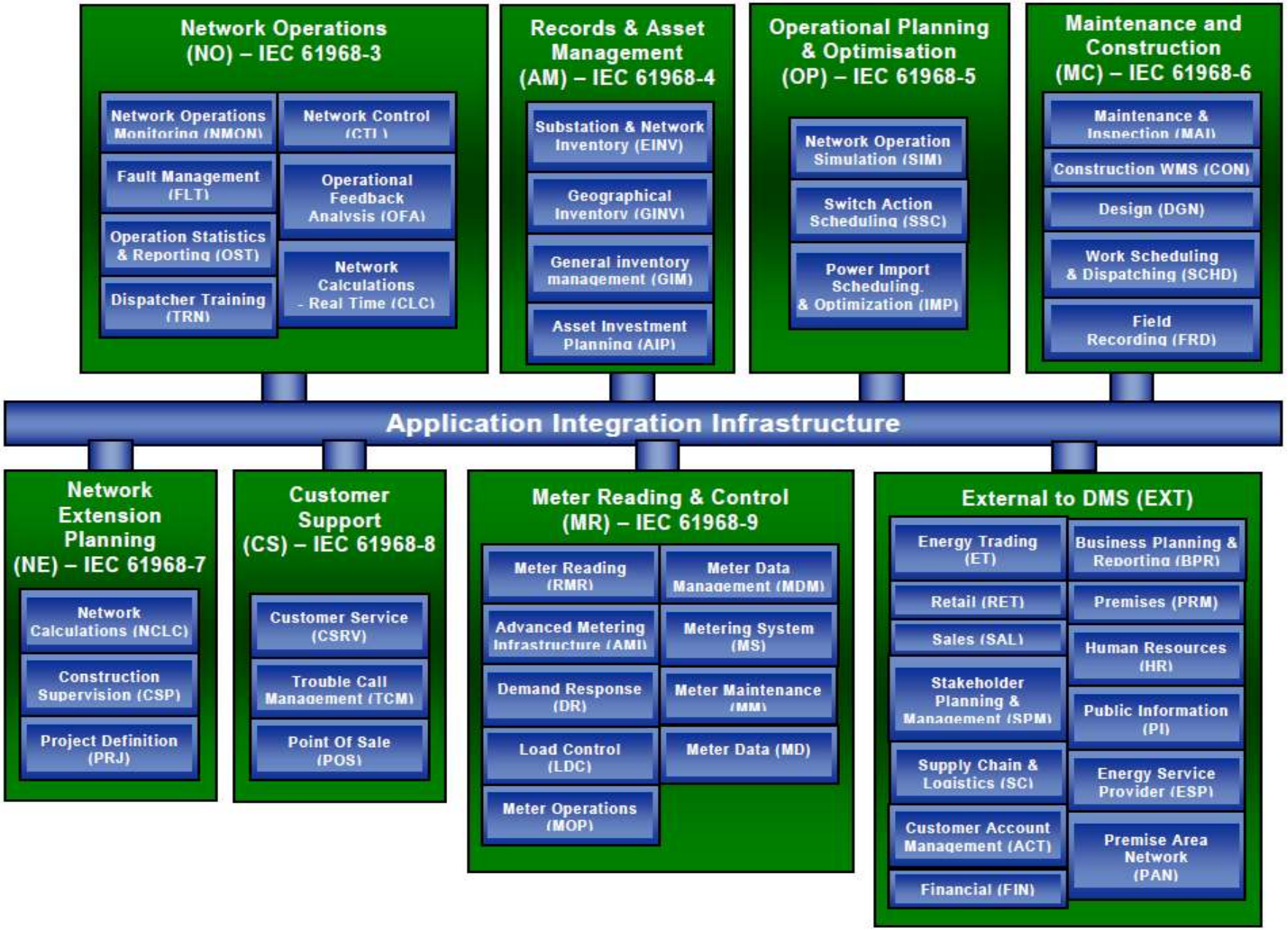
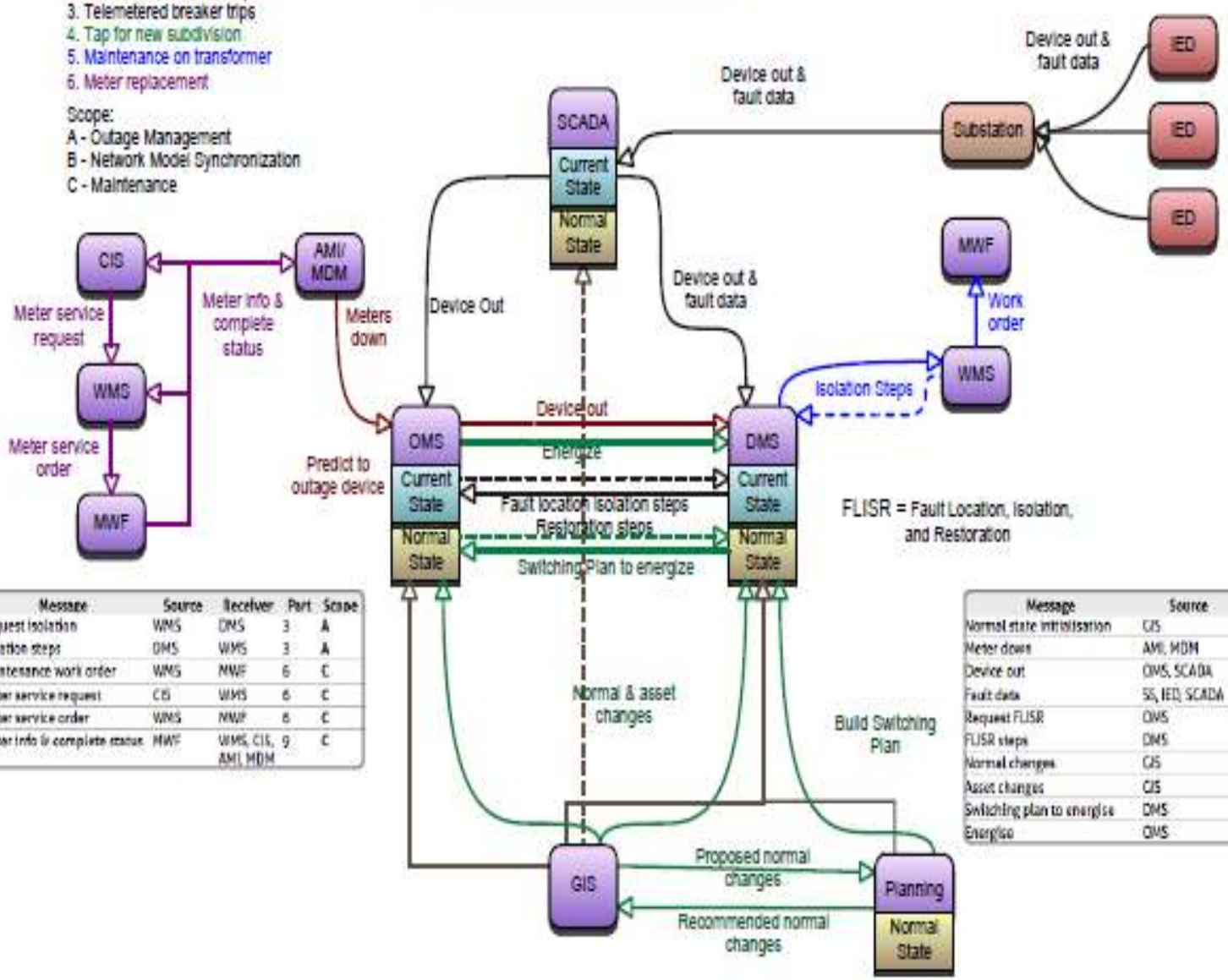


Figure 3: Typical Functions Mapped to Interface Reference Model

IEC61968 2011 Scope

Use Cases:
1. Initialize network
2. Non-telemetered fuse trips
3. Telemetered breaker trips
4. Tap for new subdivision
5. Maintenance on transformer
6. Meter replacement

Scope:
A - Outage Management
B - Network Model Synchronization
C - Maintenance



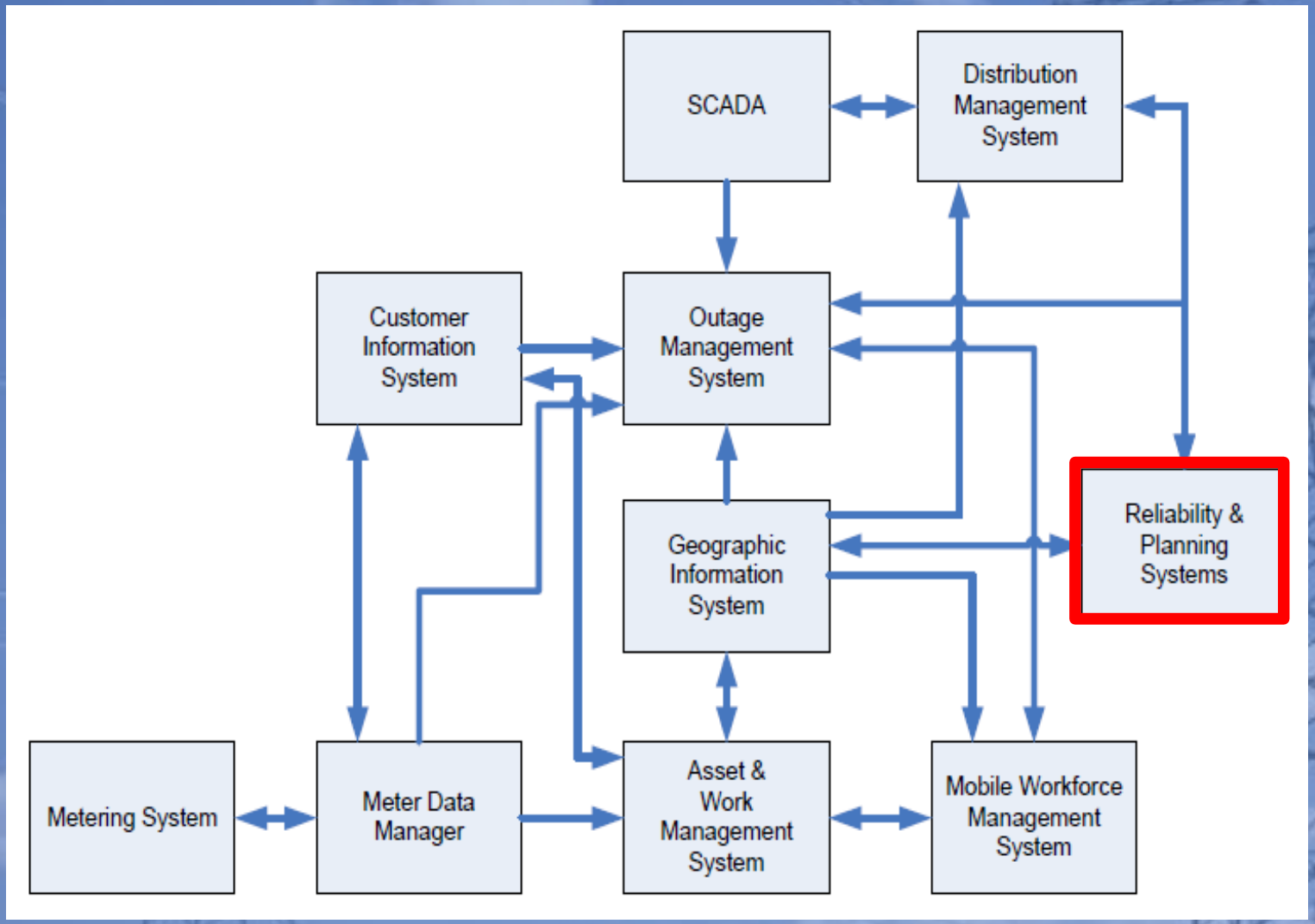
Message	Source	Receiver	Part	Scope
Request isolation	WMS	OMS	3	A
Isolation steps	OMS	WMS	3	A
Maintenance work order	WMS	MWF	6	C
Meter service request	CIS	WMS	6	C
Meter service order	WMS	MWF	6	C
Meter info & complete status	MWF	WMS, CIS, AMI, MDM	9	C

Message	Source	Receiver	Part	Scope
Normal state initialisation	CIS	OMS, DMS, SCADA	4,13	B
Meter down	AMI, MDM	OMS	9	A
Device out	OMS, SCADA	OMS, DMS, SCADA	61850	A
Fault data	SS, IED, SCADA	SCADA, DMS	3	A
Request FLISR	OMS	OMS	3	A
FLISR steps	OMS	OMS	3	A
Normal changes	CIS	Planning, OMS, DMS	4,13	B
Asset changes	CIS	OMS, DMS, WMS, AM	4,13	B
Switching plan to energise	OMS	OMS, WMS	3	A
Energise	OMS	OMS	3	A

ساختار سیستمی بر اساس مدل مفهومی CIM

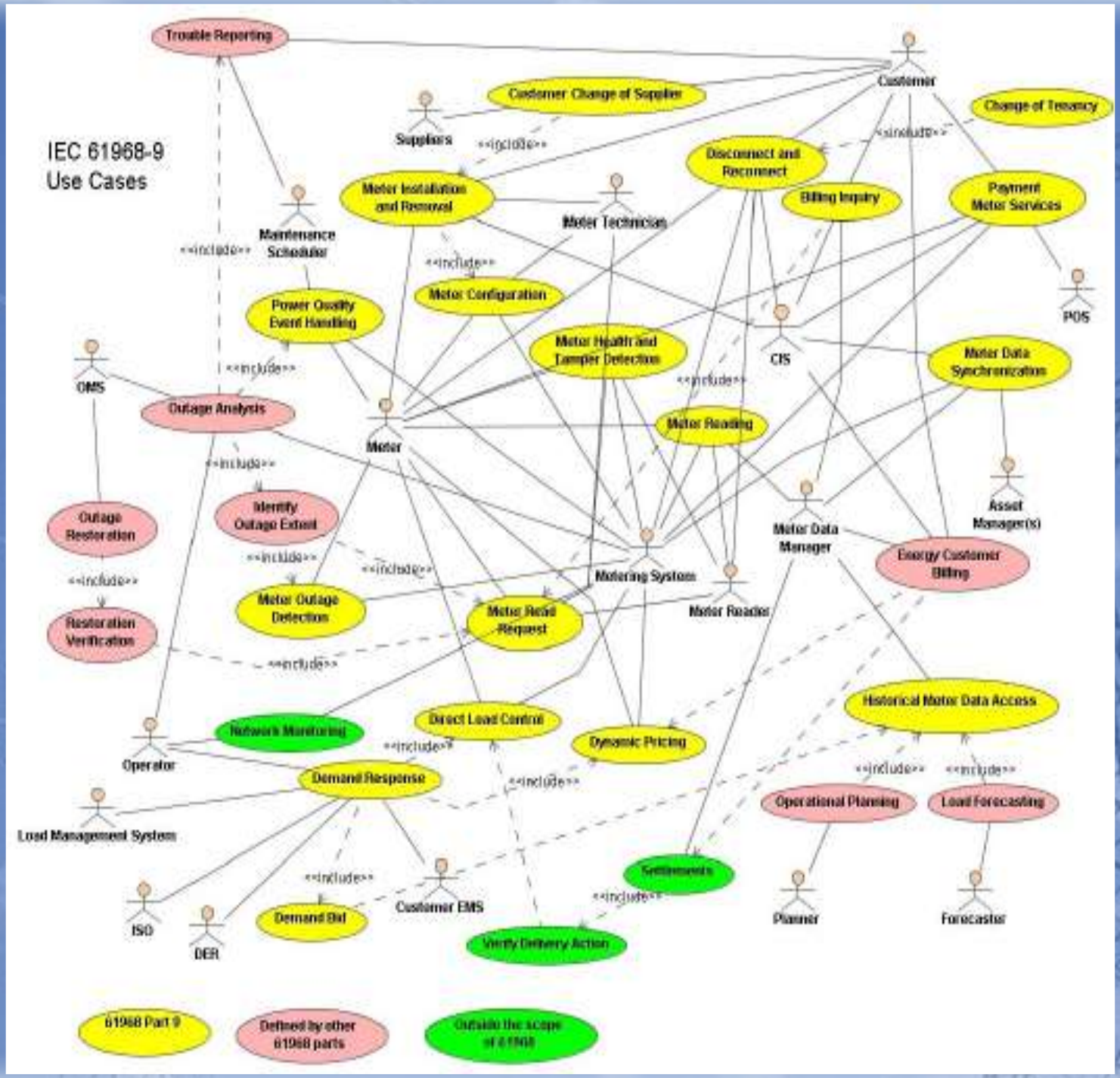
منشاء و تاریخچه

مدل سیستمی شبکه توزیع برق و زیر سیستمهای آن در EPRI



در مهندسی نرم افزار، از مدلی به نام Use Case برای مدلسازی جریان اطلاعات سیستمها بهره گرفته می شود. این مدل توسط زبان UML مورد استفاده قرار می گیرد. EPRIچنین مدلی را برای شبکه های توزیع تولید نموده است.

به عبارت دیگر، مدل Use Case یک شبیه سازی مجازی از سیستم است که در آن اطلاعات جریان داشته و دائما تغییر کلاس داده ایجاد می شود.
Data در سه سطح تبدیل شده و بسته به سطح هوشمندی مورد استفاده قرار می گیرد. کلاس واسط Information است و تبدیل به سطوح بالاتر توسط نیروی انسانی انجام می شود.


IEC 61968-9
Use Cases
Trouble Reporting
Customer
Customer Change of Supplier
Change of Tenancy
Suppliers
<<include>>
Disconnect and Reconnect
Meter Installation and Removal
Meter Technician
Billing Inquiry
Payment Meter Services
Maintenance Scheduler
<<include>>
Meter Configuration
Power Quality Event Handling
POS
Meter Health and Tamper Detection
CIS
Meter Data Synchronization
OMS
Outage Analysis
Meter
Meter Reading
Asset Manager(s)
Identify Outage Extent
Meter Data Manager
Outage Restoration
Energy Customer Billing
Metering System
Meter Outage Detection
Meter Read Request
Meter Reader
Restoration Verification
Historical Meter Data Access
Network Monitoring
Direct Load Control
Dynamic Pricing
Operator
Demand Response
Operational Planning
Load Forecasting
Load Management System
Settlements
ISO
Customer EMS
Demand Bid
Verify Delivery Action
Planner
Forecaster
DER
61968 Part 9
Defined by other 61968 parts
Outside the scope of 61968

سیستم DMS و زیر سیستمهای آن

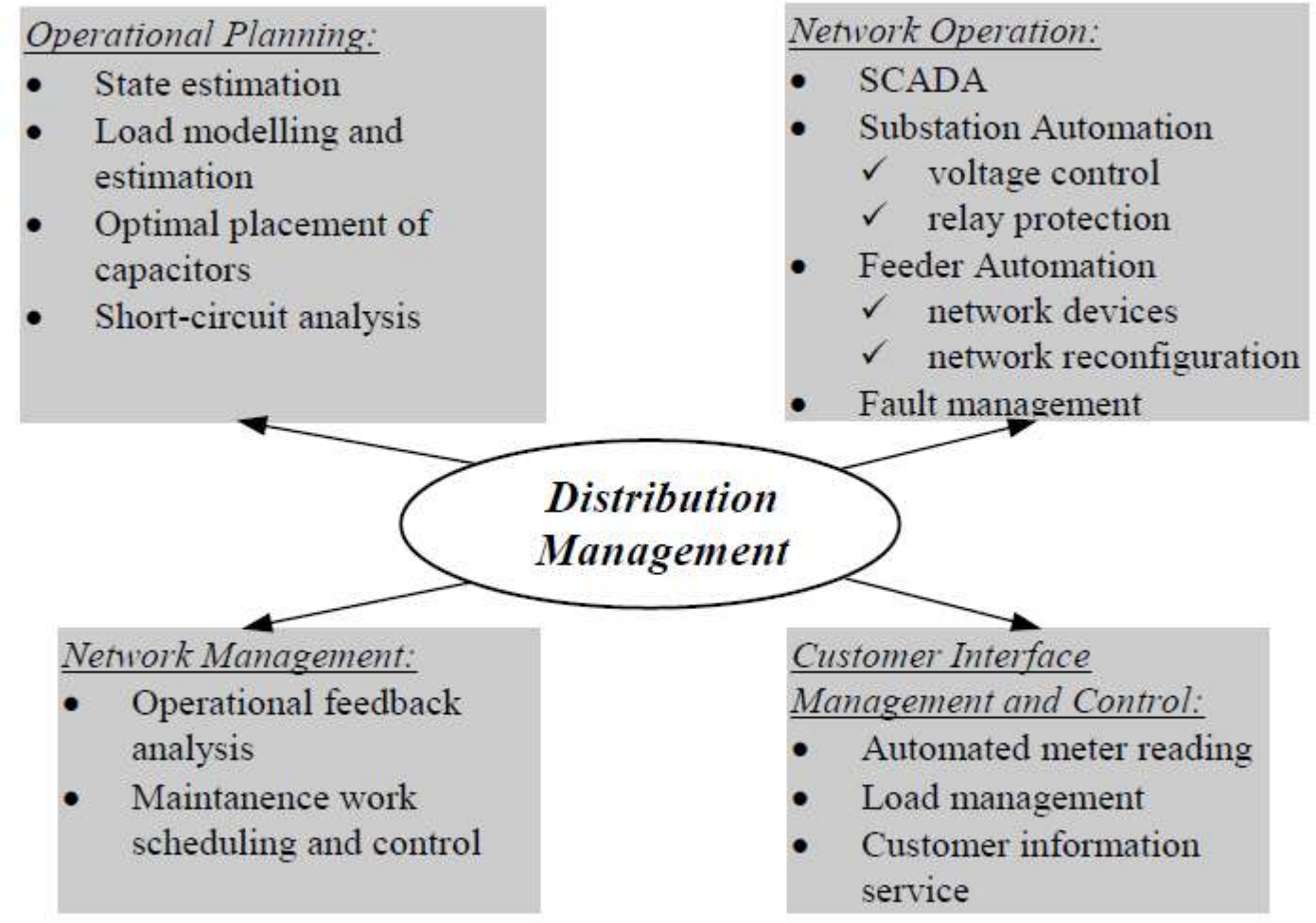
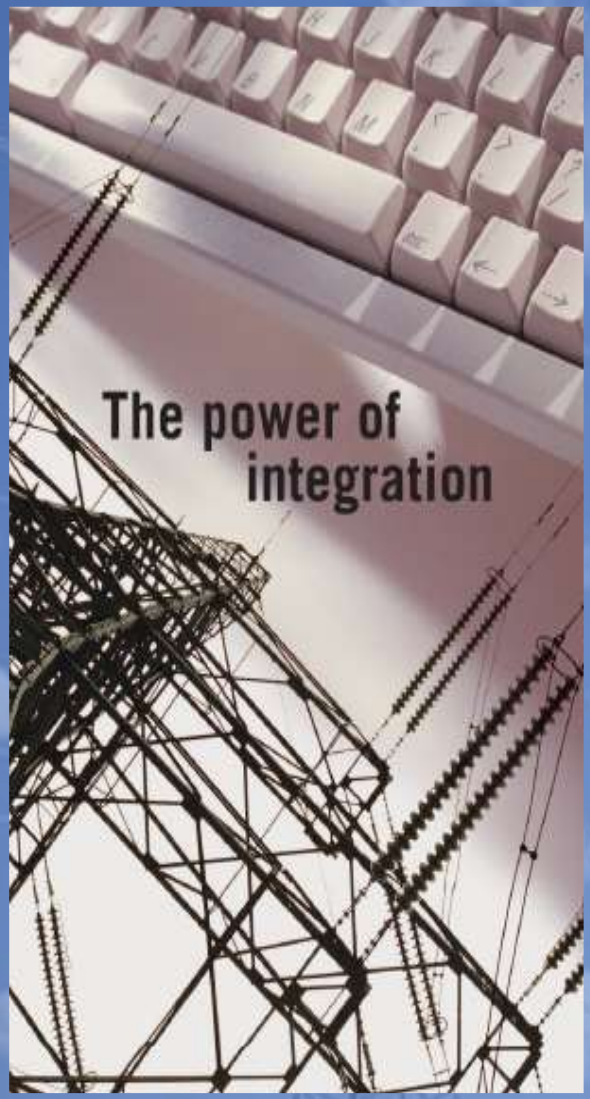


Figure 2-5 Main functional groups of Distribution Management Systems (DMS)



CIM is the ICT architecture of Power Industry

مدل اولیهٔ CIM در Rational Rose پیاده شد
نیاز به یک نرم افزار برنامه نویسی ساده تر و ارزانتر:
EA : Enterprise Architecture
در اصل مبتنی بر برنامه نویسی شیء گرای مبتنی بر مدلسازی UML است. بدین ترتیب هر زیر سیستم می تواند از طریق پروفایلهایی که شامل صفات و روابط هستند با دیگر سیستمها ارتباط برقرار کند

- CIMTool is a free Eclipse plug-in, developed by Arnold DeVos of Langdale Consultants, with aid from a number of companies
- CIMTool provides the means to:
  - Define profiles from a UML model
  - Import profiles from a spreadsheet
  - Validate profiles
  - Validate instance files against a profile
  - Validate incremental files against an instance file and a profile
  - Generate XML schemas from a profile
  - Generate RDF schemas from a profile

IEC 61968 Part	Title
1.	Interface Architecture And General Recommendations
2.	Glossary
3.	Interface Standard For Network Operation
4.	Interface Standard For Records And Asset Management
5.	Interface Standard For Operational Planning And Optimisation
6.	Interface Standard For Maintenance And Construction
7.	Interface Standard For Network Extension Planning
8.	Interface Standard For Customer Support

9.	Interface Standard For Meter Reading And Control
11.	Common information model (CIM) extensions for distribution
13.	CIM RDF Model Exchange Format for Distribution

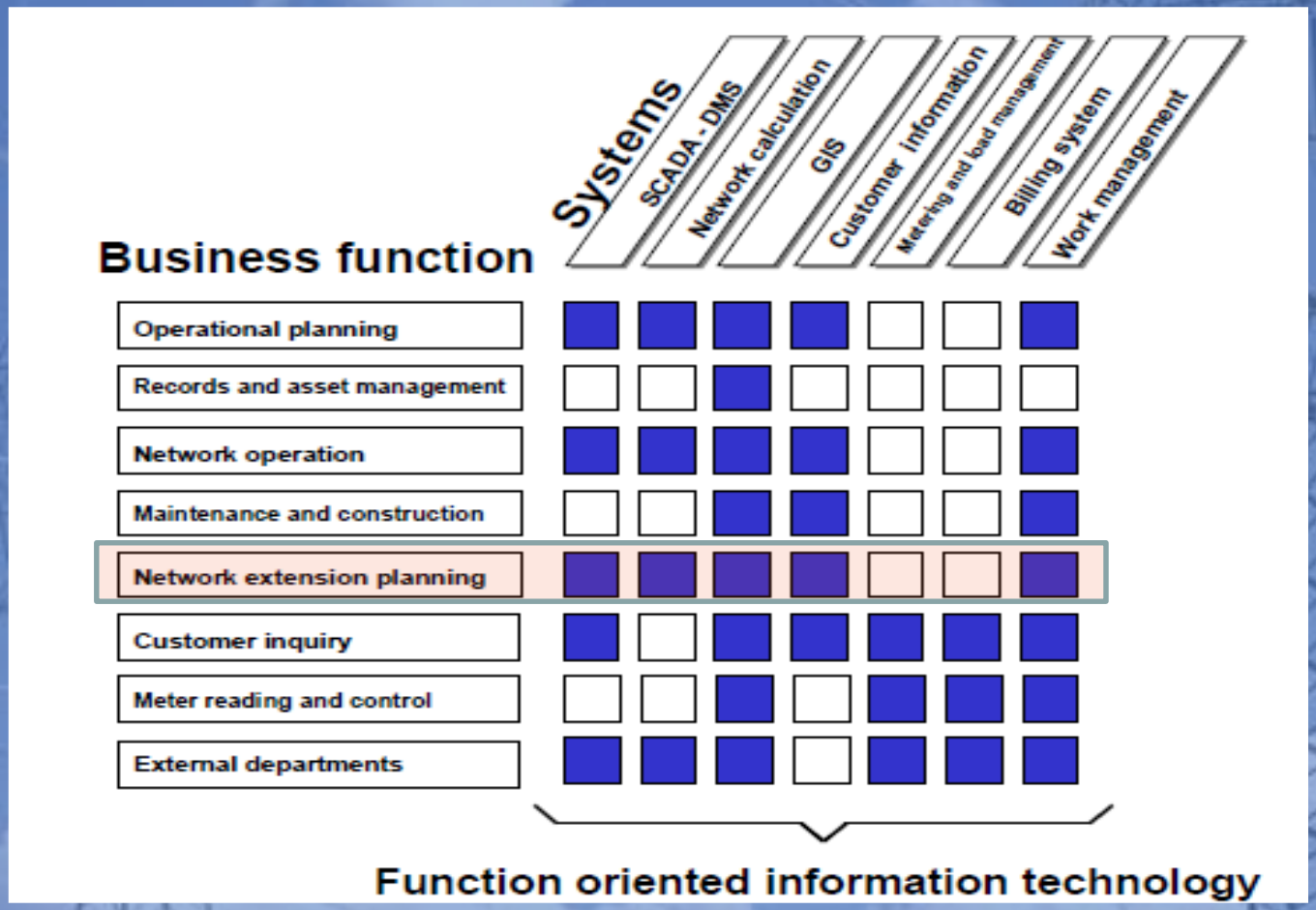

Systems
SCADA - DMS
Network calculation
GIS
Customer information
Metering and load management
Billing system
Work management
Business function
Operational planning
Records and asset management
Network operation
Maintenance and construction
Network extension planning
Customer inquiry
Meter reading and control
External departments
Function oriented information technology

Table E.1 – Typical information exchanged among business functions of the IRM

Information to be exchanged	Business functional areas:													
	Operational planning and optimization	Records and asset management	Network operation	Maintenance and construction	Network extension planning	Customer inquiry (www, outage ETR, connection, customer data)	Meter reading and control	Customer account management	Premises (address, source substation, meter information)	EMS control centers	Financial	Human resources	Weather	Energy trading
Load / usage data	p/c		p/c	c	c	c	p			p/c			p	c
Outage data	c	c	c	c				p		c				c
Trouble call records	c	c	p			c	p	c		c	c		p	
Customer related emergency data	c		p/c				p	c		p/c				
Remote meter reading requests						p	c	p	p					
Remote service connect / disconnect requests			c			p	c	p	p					
Capital expenditure requests	p	p	p	p	p						c	p		
New service requests	c	c		c	p/c	c	c	p/c	p/c		c			
Line extension requests	c	c	p	c	p/c			p			c			
Market sales statistics					c			p/c			c			
Meter theft / tamper detection data						c	p	c						
Meter customer outage detection	c		c			c	p	c		c				
Time-of-use meter programming data			c			c	p/c	c						
Real-time prices			c			c	c	c			c			p
Electronic billing						c		p			c			
Updates to facilities	c	p/c		p/c	c									
Network model updates	p/c	p/c	p/c	c	p/c				c					
Network as-built updates	c	c	c	p/c						c				
Equipment characteristics	c	p/c	c	p/c	c					c				
Equipment drawing specifications		p		c										
Facilities map of service territory	p/c	p	c	p/c	c	c				c				c
Cartographic maps	c	p	c	c	c	c	c	c	c	c				
Landbase maps		p	c	c	c	c		c		c				
Outage statistics	p		c	c	c			c		c	c			
Equipment operation statistics	c	c	p/c	c						p/c				
Maintenance requests	c	c		p/c				p/c						
Maintenance scheduling	p/c	c	c	p						p/c				
Load survey requests	c		c		p		c	p						
Load forecasts information	p		c	c	p			c		p/c				
Load shedding	p/c		c							p/c				
Load control			p/c							p/c				
Outage schedules	p		p/c	p/c		c		c		p/c				
Requests to drop lines	p		p/c	p/c				c						
Protective relay settings			p/c	c	c					p/c				
Protective relay data	c		p/c	c	c					c				
Fault locations estimates	c		p/c	p/c						c				

Information to be exchanged	Business functional areas:													
	Operational planning and optimization	Records and asset management	Network operation	Maintenance and construction	Network extension planning	Customer inquiry (www, outage ETR, connection, customer data)	Meter reading and control	Customer account management	Premises (address, source substation, meter information)	EMS control centers	Financial	Human resources	Weather	Energy trading
Network monitoring data	c		p/c	p/c	c					p/c				
Release / clearance remote switch command scheduling - unvalidated	p		p/c	p						c				
Release / clearance remote switch command scheduling - validated	c		p	c						c				
Safety information	c		p	c	c					c		c		
Interruptible customer list	c		c	C				p/c			c			
Work and QA standards		p	c		p					c		c		
Purchase requests		p/c	c	C	p			p			p/c			
Skills inventory			c	c						c		p		
Crew dispatch	c		p/c	p/c		p						c		
Crew dispatch schedule	p		c	c		c		c		c		c		
Crew tracking reports	c		p	p/c		c		c		c		c		
Time records by work order				c						c		p		
Equipment tracking reports		p	p/c	p/c						c				
New construction records		c	c	p			c	c		c				
p = producer; c = consumer														