The Relevance of Protocol, API, and Modeling Standards to Control Centers

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Objective

To provide an overview of the rational for developing and the benefits of using a comprehensive set of standards for model driven integration in the electric utility environment.

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Definitions:

Interoperability

The ability of computer systems to exchange information with other systems.

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Definitions:

Integration

The ability of computer based applications to interact with other systems in order to perform a useful function for the user.

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Interoperability and Integration

- Easy to Achieve:

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A Better Way

- Interoperability and Integration without having to program it all yourself:
  - “Plug-and-Play” where applications are inherently capable of interoperating with other systems and performing integrated application functions.
  - This is only possible if there are standards to enable it.
  - This work is progressing.

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A Cautionary Note

- Plug and Play of applications is a path, not an end point.
- By the time we get to were we are going today, someone will have moved the goal.
- If you don’t set out on the path, you will never make any progress.
- The first on the path will work the hardest and will also reap the most reward.

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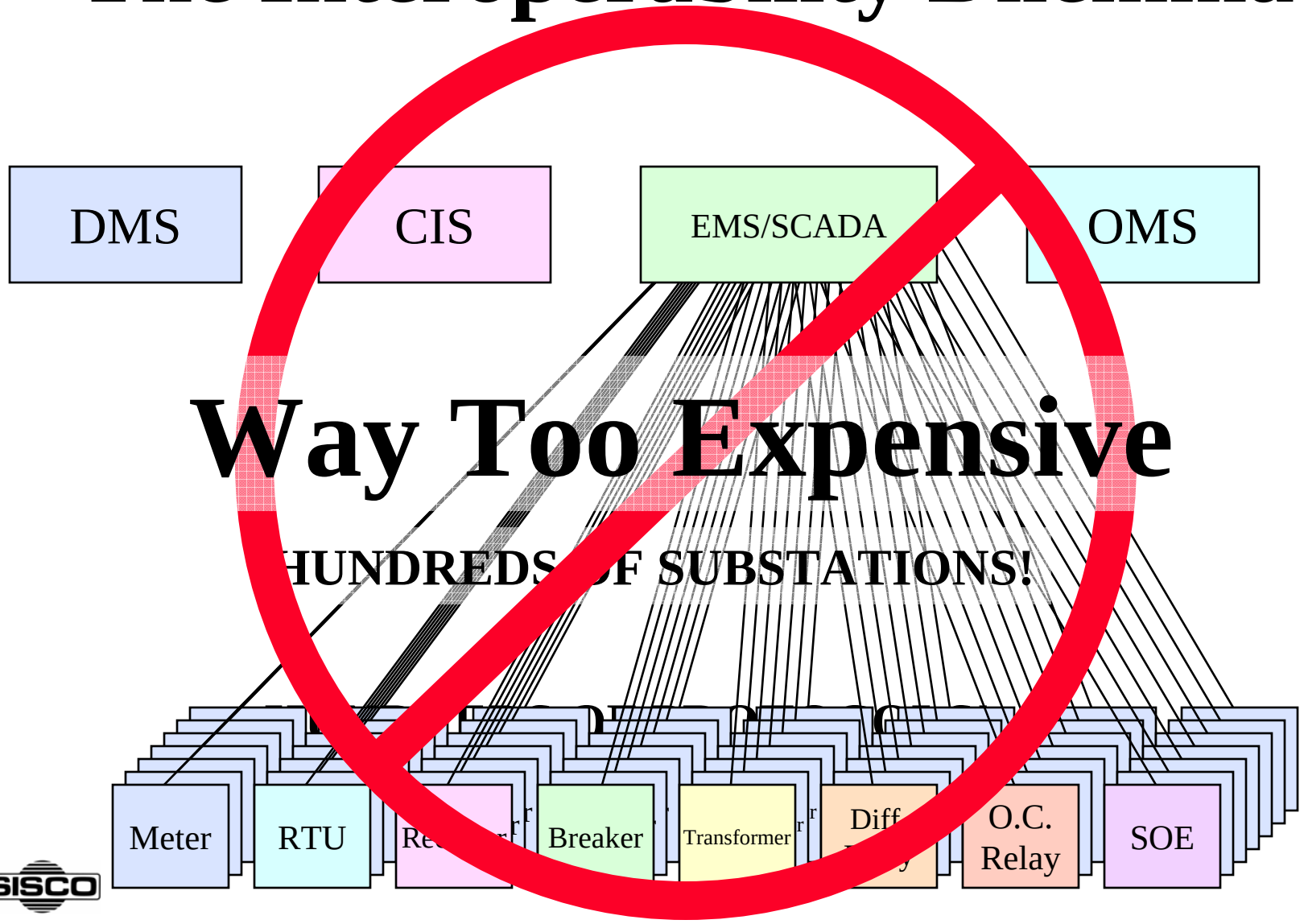
Obligatory Motivational Quote

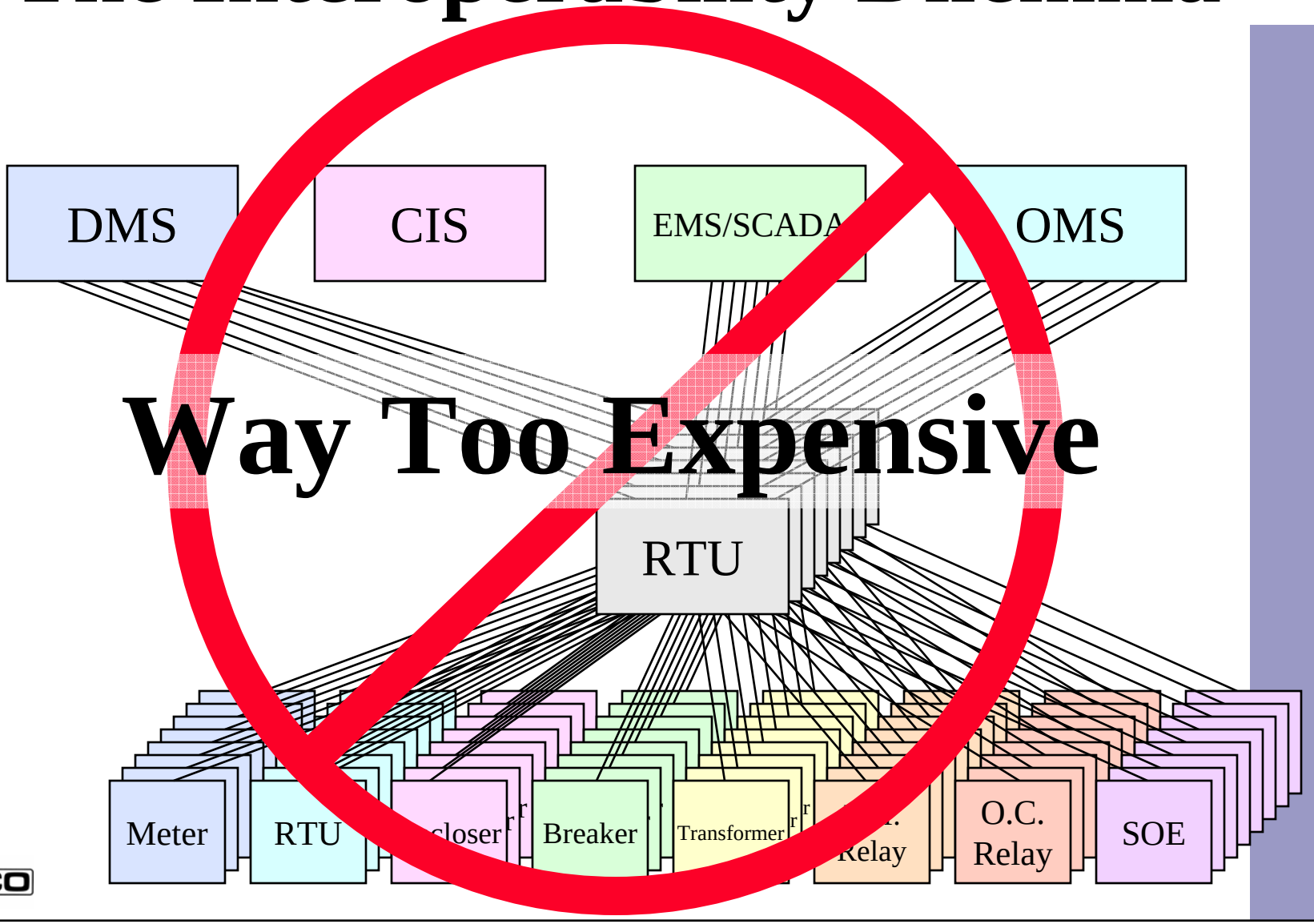
"Obstacles are those frightful things that appear when you take your eyes off your objective."

- Henry Ford

The Interoperability Dilemma



The Interoperability Dilemma



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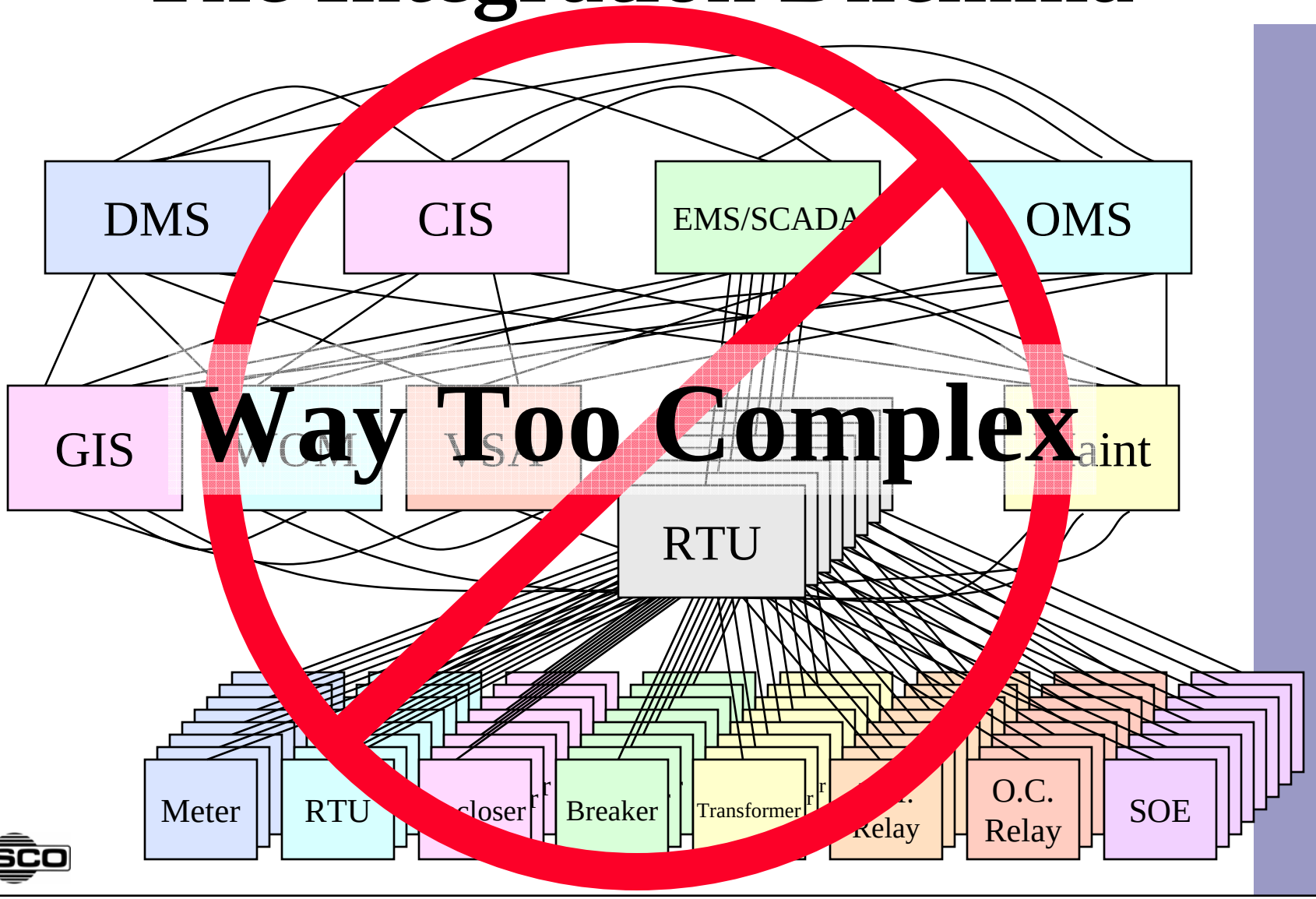
The Integration Dilemma



Way Too Complex

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Standards are Good!

"Standards are great. Everyone should have one."

– Bob Metcalfe,
Co-inventor of Ethernet

Fewer of the Right Standards are Better

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Traditional Protocol Standards

- Specified how you arrange bytes on the wire in order to transfer bytes of data between a device and an application
- Good News: It worked! Device communications costs were lowered.
- Bad News: No standard for data representation or how devices should look and behave to network applications.

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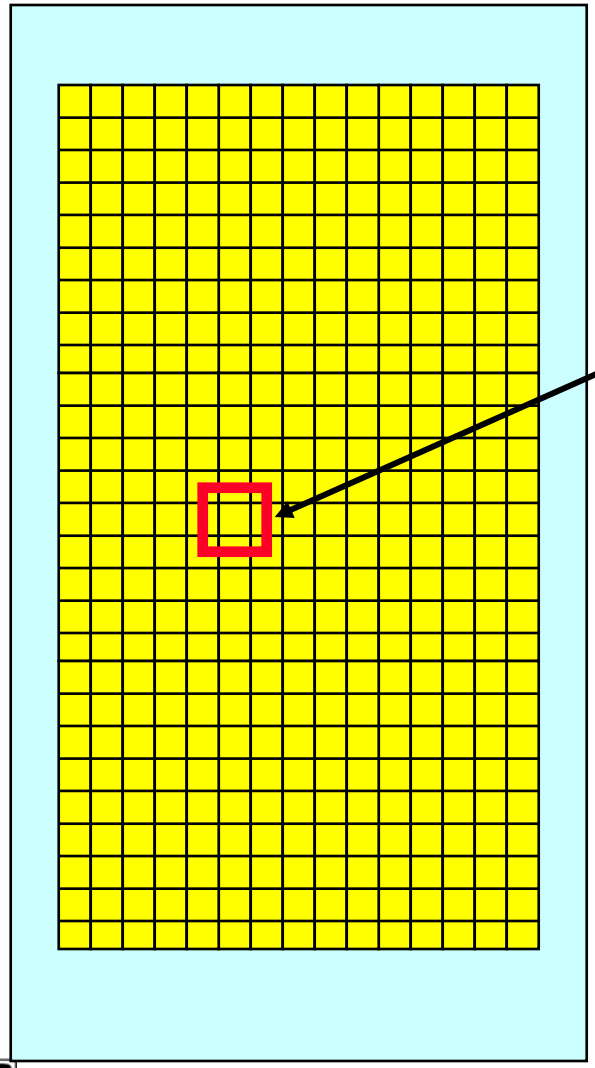
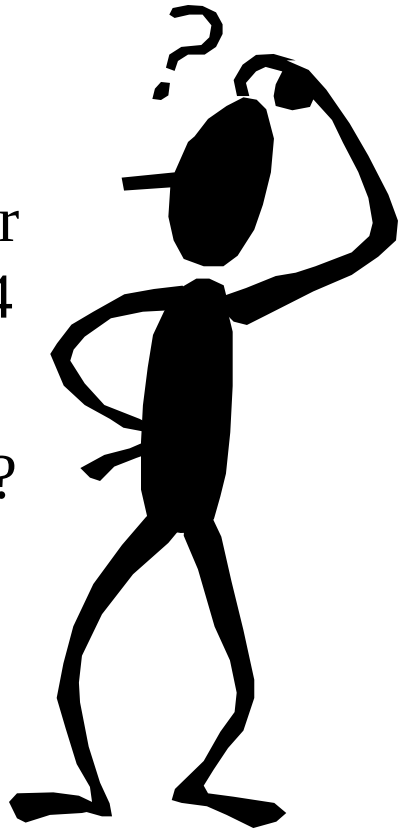
Typical Legacy Protocol Data Model



It is in Register 4023 and 4024

That's intuitive?



I need the Phase A voltage for the 345KV primary feeder

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Behavior Modeling

- Assume R400220 holds breaker status.
  - Does 1 mean open or closed?
  - Can I write this object to operate the breaker?
  - Where is the select?
  - Is it selected?
- Even if every device used R400220 to hold breaker status this still isn’t enough to provide interoperability.

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A New Approach Needed

- For protocols to provide interoperability at the system level they need to:
  - Specify the bytes/format of the data on the wire
  - Specify the meaning of data
  - Specify the behavior of the data

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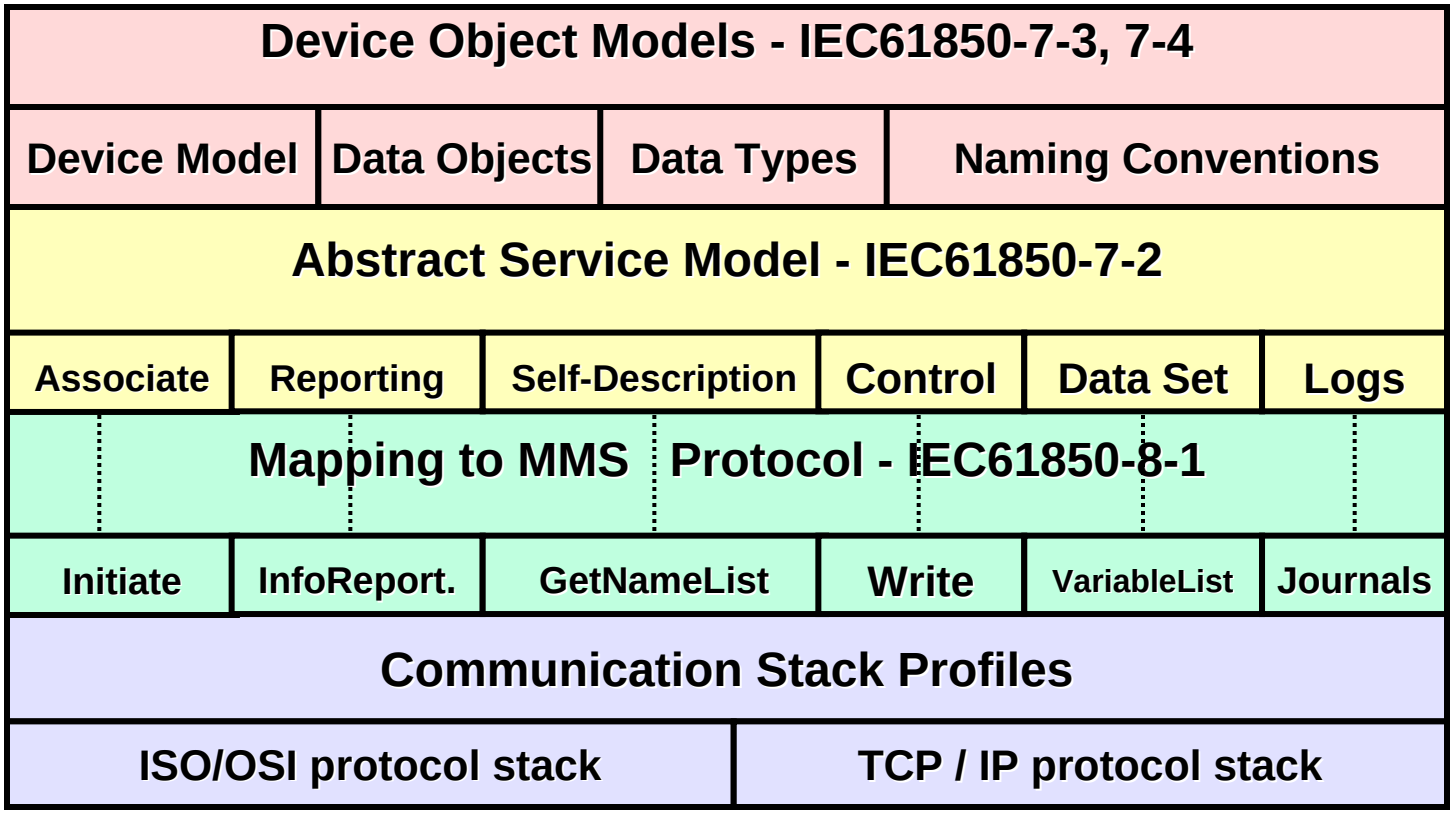
IEC61850 – A Layered Standard



Layering Benefits

- Enables definition beyond just the bytes on the wire.
- Each layer is optimized independently.
- Enables protocols to be separated from application functions to enable use of existing standards.

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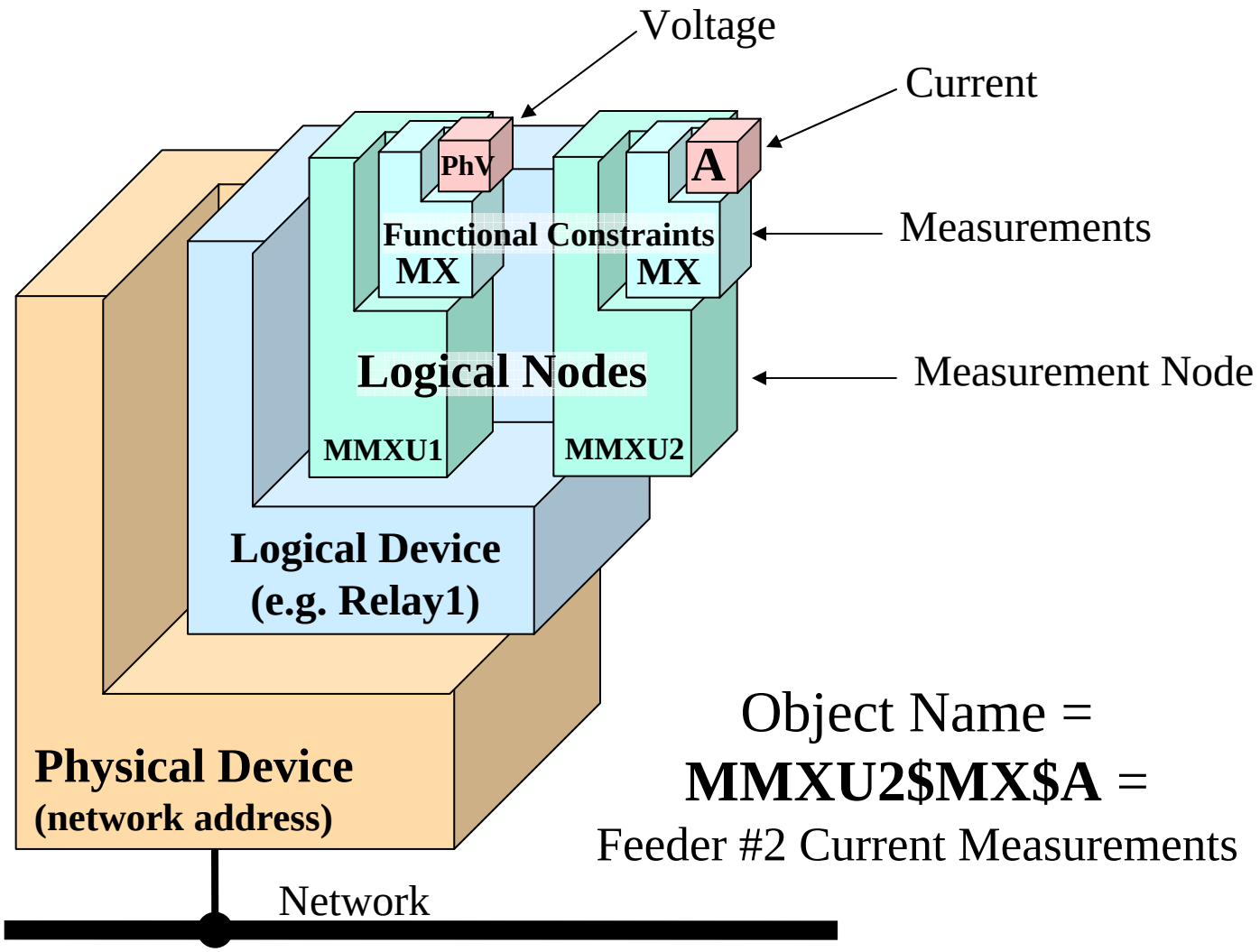
IEC61850 Data Model



Object Name =

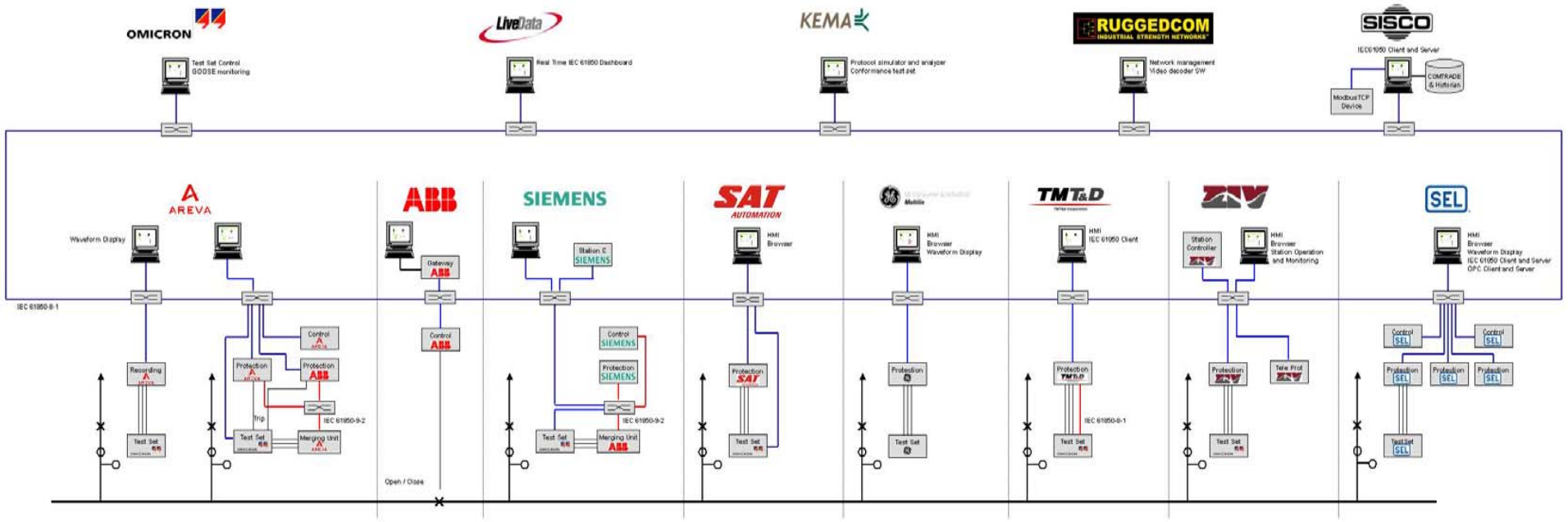
MMXU2MXA =

Feeder #2 Current Measurements

IEC61850 Overview

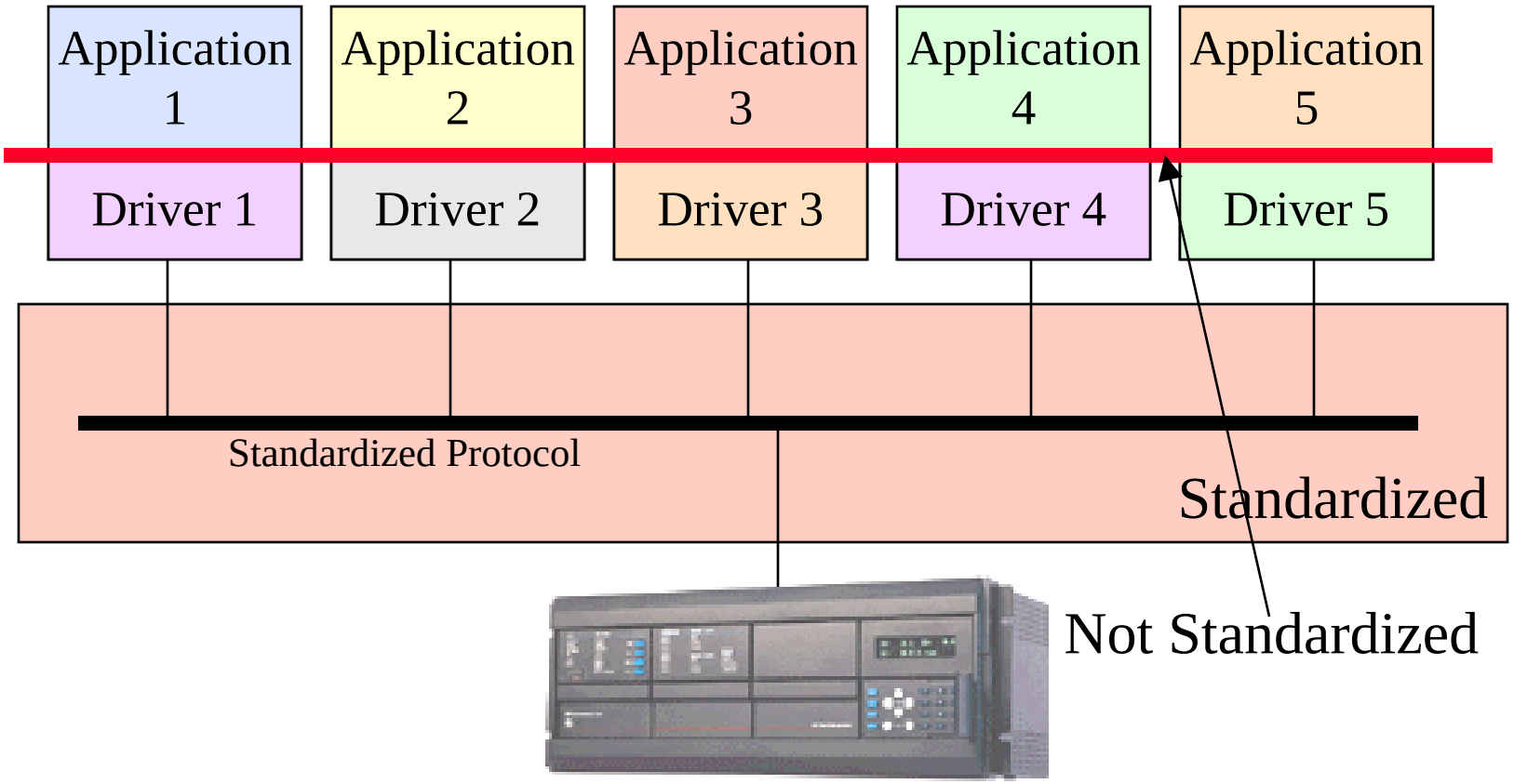
- IEC61850 is an object oriented substation automation protocol that provides standardized names, data meaning, device behavior, self-describing devices, and a common configuration language.
- Available now.
- Major demo at CIGRÉ 2004.

CIGRÉ 2004



Protocol Standardization Works!

Interfacing Protocols to Apps



Impact of Lack of API Standards

- Each application developer had to develop drivers for all popular protocols.
- Application developers spent considerable resources on drivers instead of applications.
- Result:
  - Less application functionality
  - Higher application costs

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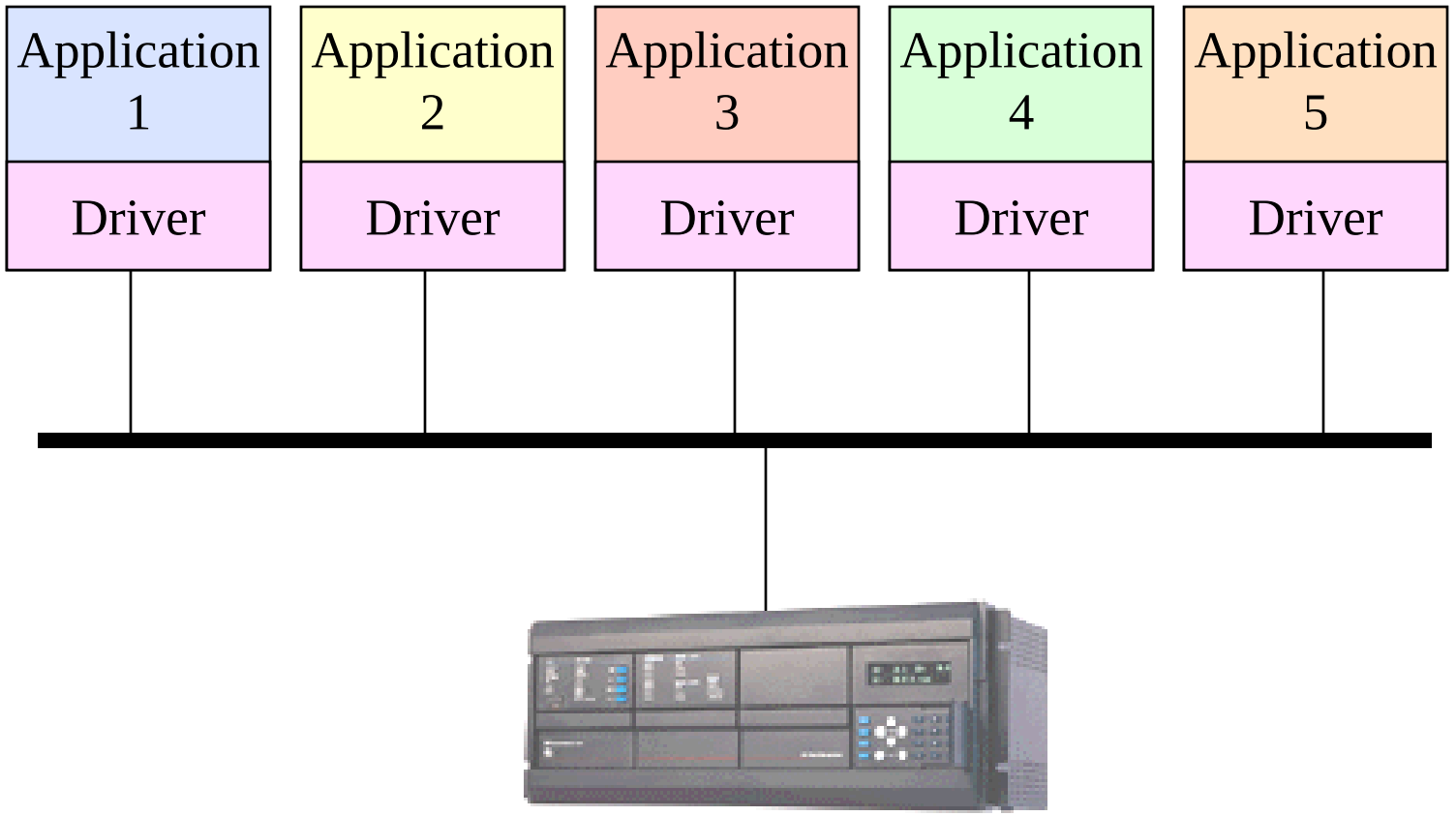
Using Protocols: API Standards Useful



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API Standards

- Enables 3rd party market for drivers
  - Enables niche application players to exist
- Allows more resources for applications
- All parties have a self-interest in seeing that this works
- Results
  - More Choice
  - Less Work
  - Lower Costs

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DDE

- Dynamic Data Exchange (DDE) introduced in Windows 3.1
- Enabled DDE servers for protocols to be used for any application supporting DDE interface
- Created a market for third party communications drivers.

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DDE Limits

- Designed for linking data between spreadsheets:
  - Resource intensive
  - Low throughput
  - No pre-defined structure
- Interface was standard, but the configuration and usage was different between drivers.

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OPC – OLE for Process Control

- Based on MS Object Linking and Embedding (OLE) and Component Object Model (COM) technology.
- Rigorous defined resource efficient API that provides plug'n play of applications and drivers.
- Result: **Widespread** usage and **many** off-the-shelf interoperable products available.

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OPC Today

- Hundreds of protocols and applications.
  - Data Access
  - Historical Data Access
  - Alarms and Events
  - Data Exchange
  - XML Messaging
  - Complex Data
  - Commands

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OPC Shortcomings

- Windows specific. What about Unix used in many EMS/SCADA?
- Data was still a collection of items without context (the meaning of the data).

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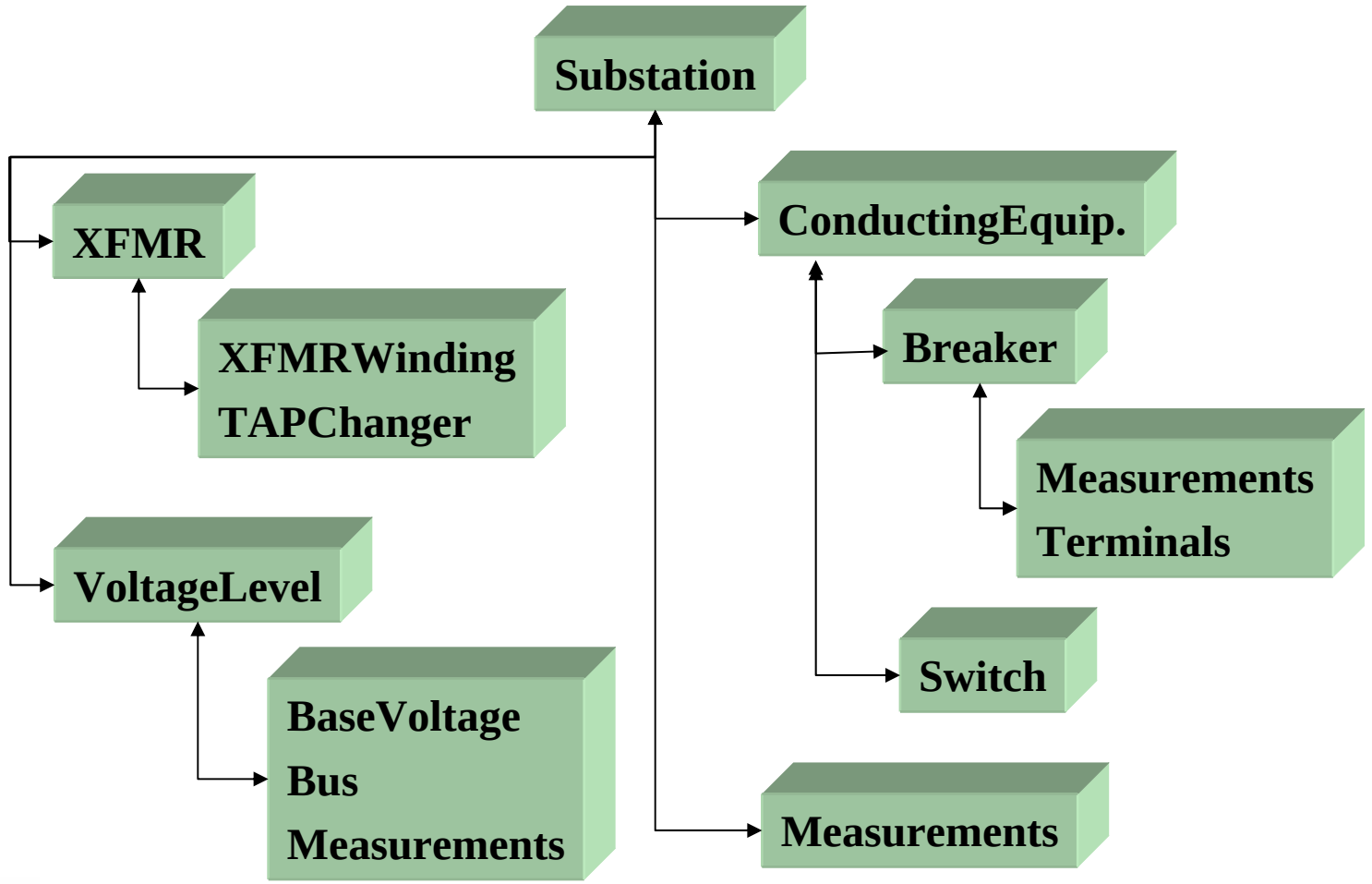
The Common Information Model



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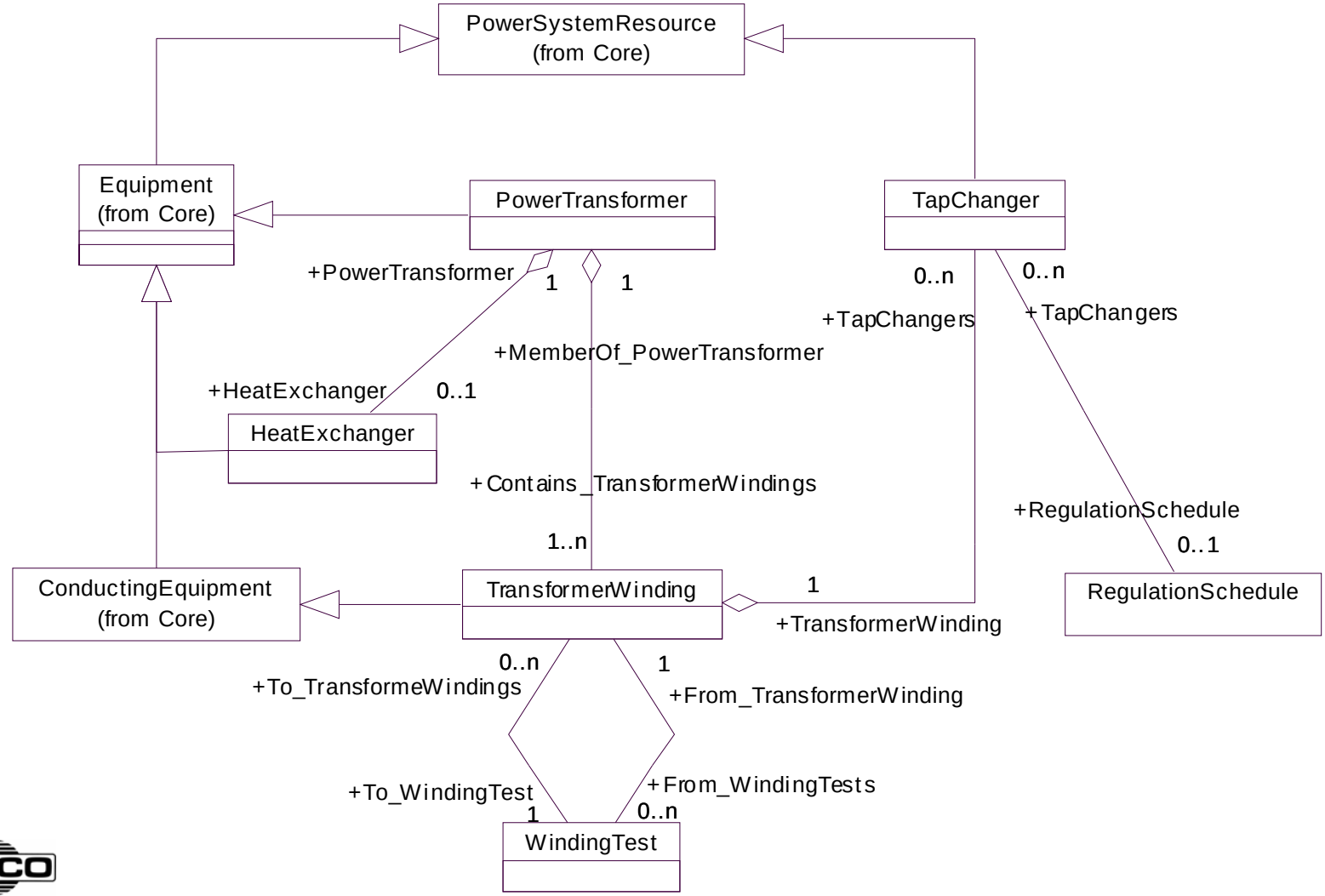
CIM Transformer Model in UML



Benefits of Models

- Models give context and meaning to data improving integration and interoperability.
- The information contained in the model enables automation of setup and maintenance tasks.
- Model aware applications can be made independent of the data.

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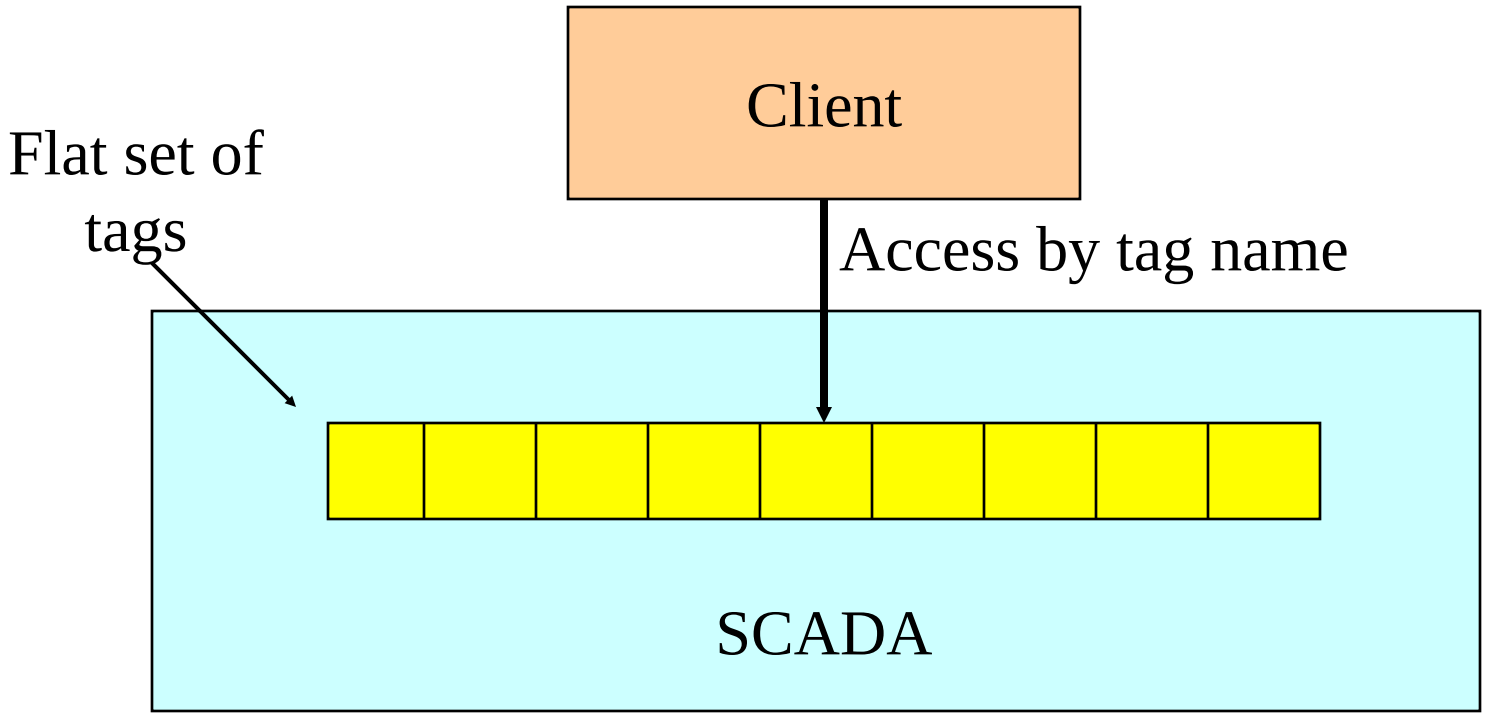
Legacy View of SCADA Data



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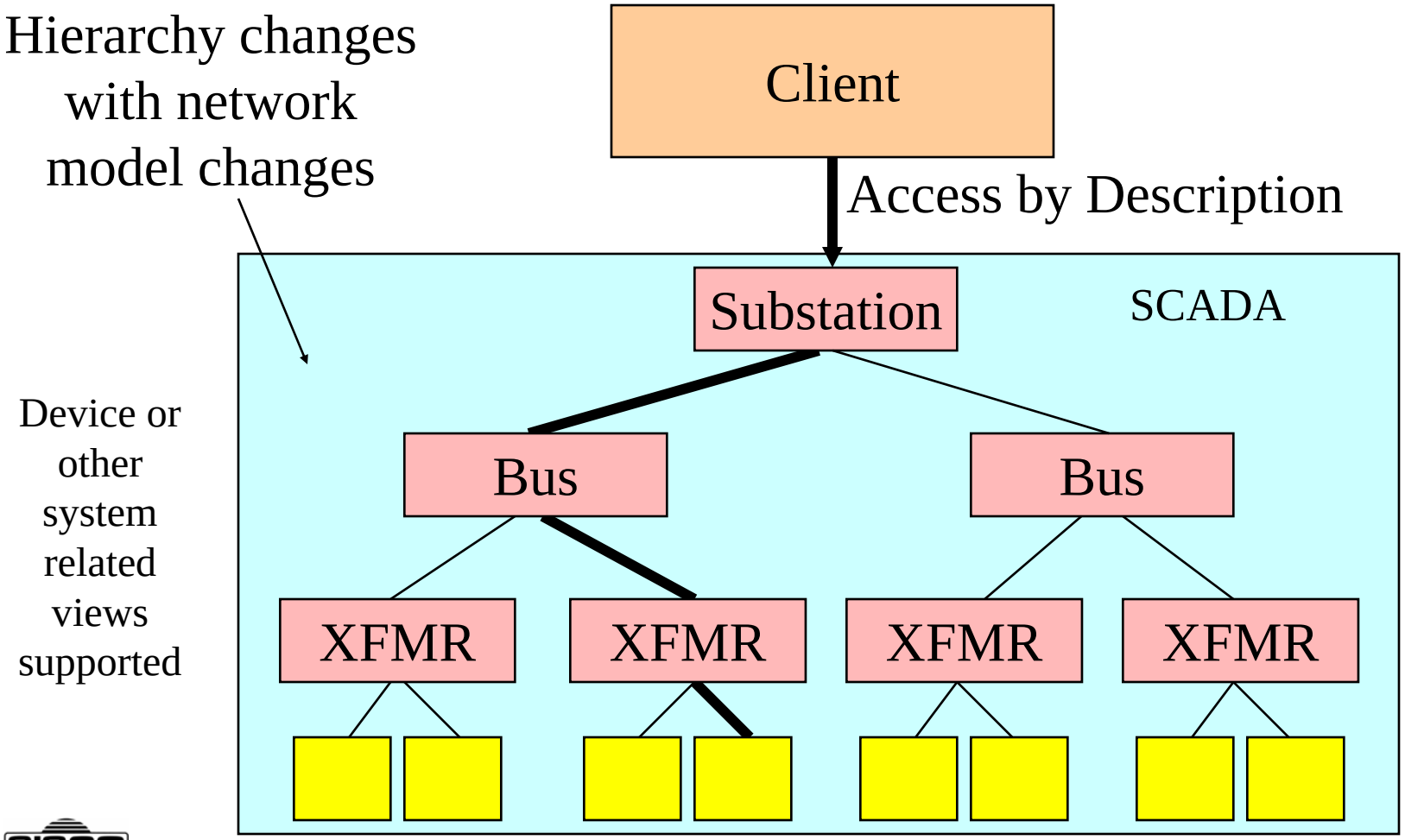
CIM View Of SCADA Data



CIM – IEC61970 & IEC61968

- Originally developed by EPRI's Control Center API (CCAPI) Workshop.
- Now progressing as IEC standards.
- IEC61970 (widely used):
  - Power System Modeling & SCADA
- IEC61968 (increasing usage):
  - Asset Mgmt, Billing, GIS, Work Mgmt, etc.

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CIM and IEC61850

- CIM has power system, asset, business process, work management models.
- IEC61850 has device models
- How do they fit?

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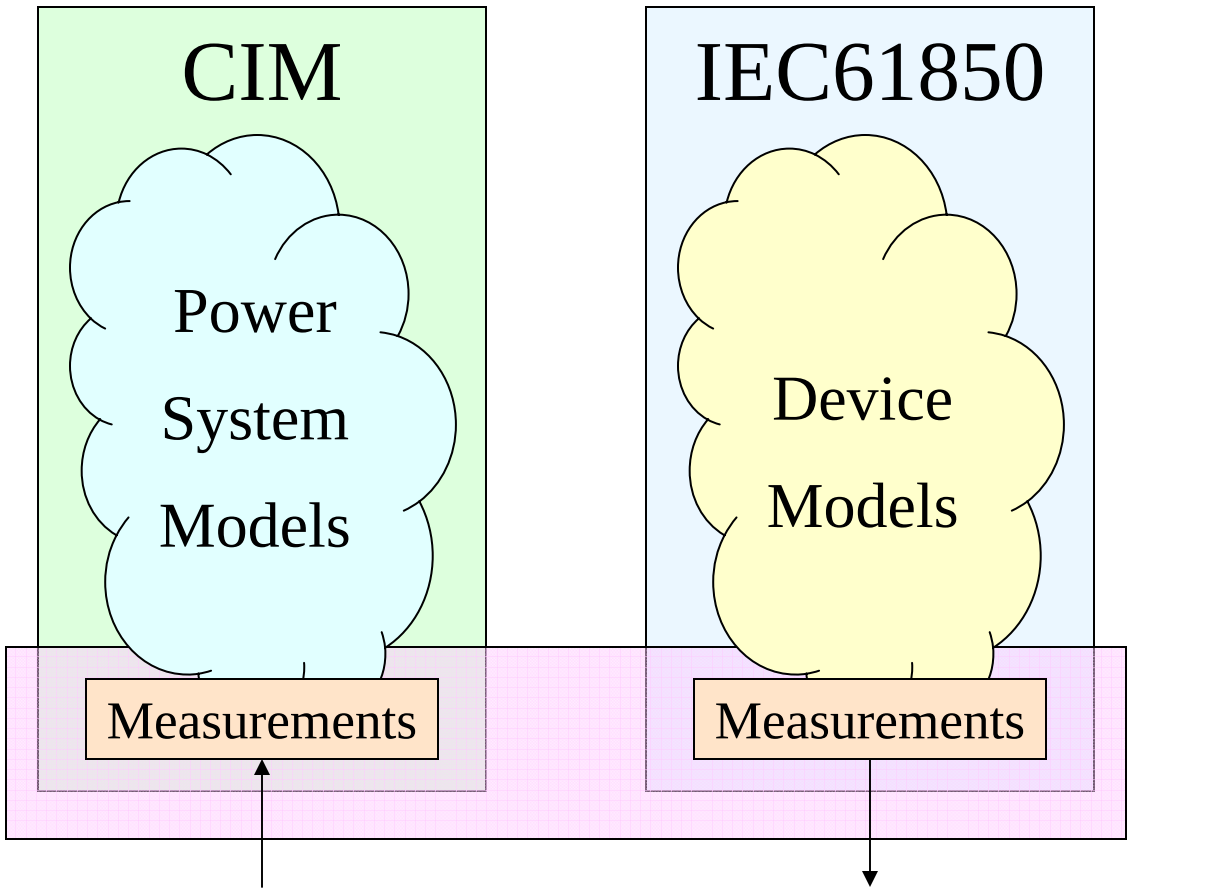
TC57 Architecture



The Next Step: APIs and Models – GID

- With CIM, programs still need a method for accessing both the data and the model information about the data (meta-data)

- EPRI CCAPI project submitted the Generic Interface Definition (GID) to the IEC WG13 for standardization in IEC61970.

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The GID

- GID Application Programming Interfaces (APIs) reference all data in the context of a common data exchange model, the CIM.
- Based on previous work within both OPC and the Object Management Group (OMG)

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GID APIs

- Generic Data Access (GDA) for reading/writing modeling information
- High-Speed Data Access (HSDA) for reading/writing real-time data
- Time Series Data Access (TSDA) for reading/writing historical data
- Generic Events and Subscriptions (GES) for publishing and subscribing to generic XML messages

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GID APIs vs. OPC

- Namespaces:
  - OPC interfaces present a namespace that are specific to the particular server.
  - GID interfaces present a namespace based on the model.
- Platforms:
  - OPC is currently Windows specific
  - GID is platform independent

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GID – OPC - OMG

GID API	OPC	OMG
HSDA High Speed Data Access	DA Data Access	DAIS Data Access from Industrial Systems
TSDA Time Series Data Access	HDA Historical Data Access	HDAIS Historical Data Access from Industrial Systems
GDA Generic Data Access		DAF Data Access Facility
GES Generic Eventing and Subscriptions	AE Alarms & Events	

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IEC TC57 Standards

- The IEC TC57 standards are specifying a model driven architecture for electric utility integration
  - Protocols - Messages
  - Models
  - APIs
- A common approach across industries

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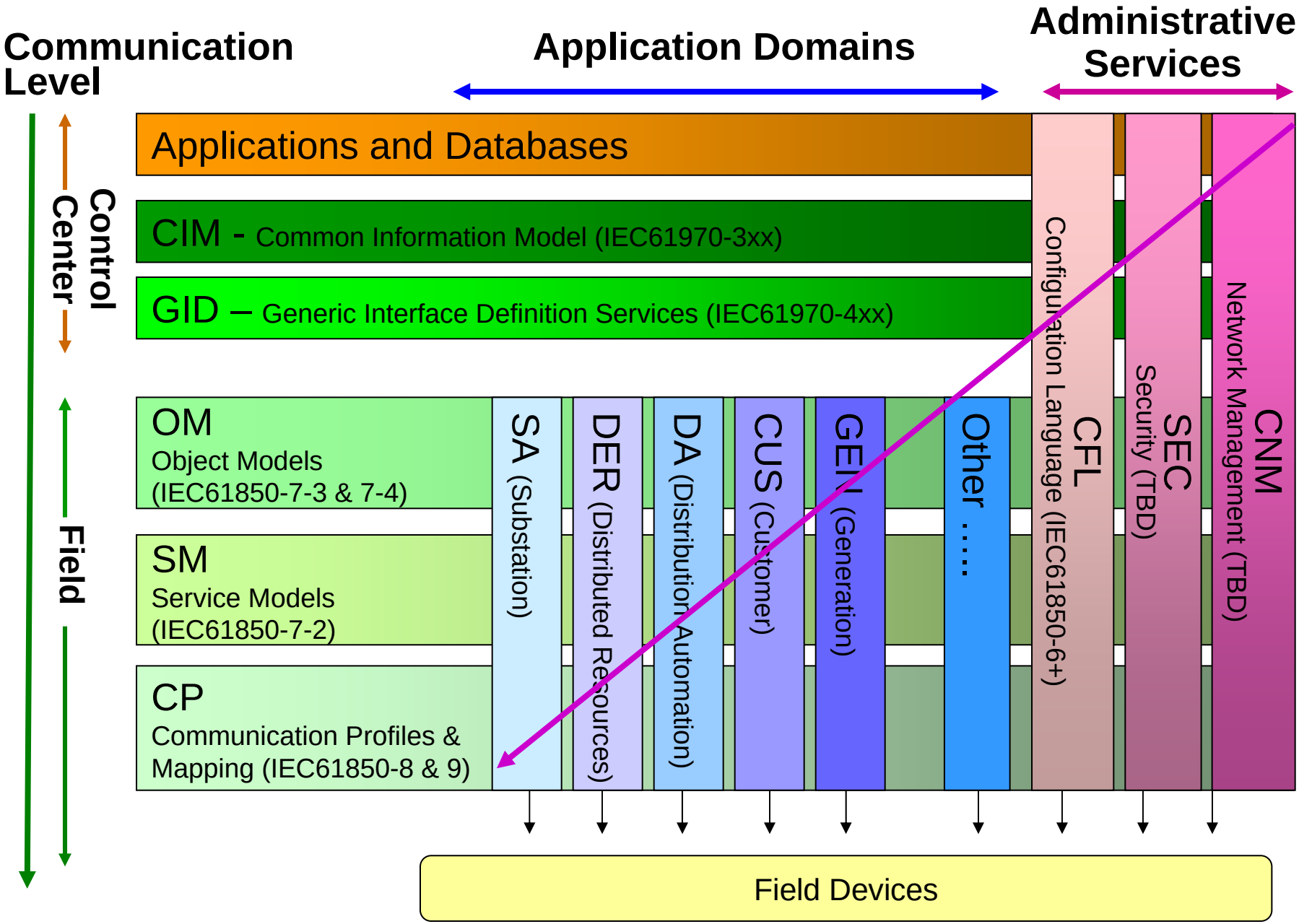
Integrated Energy and communication System Architecture (IECSA)

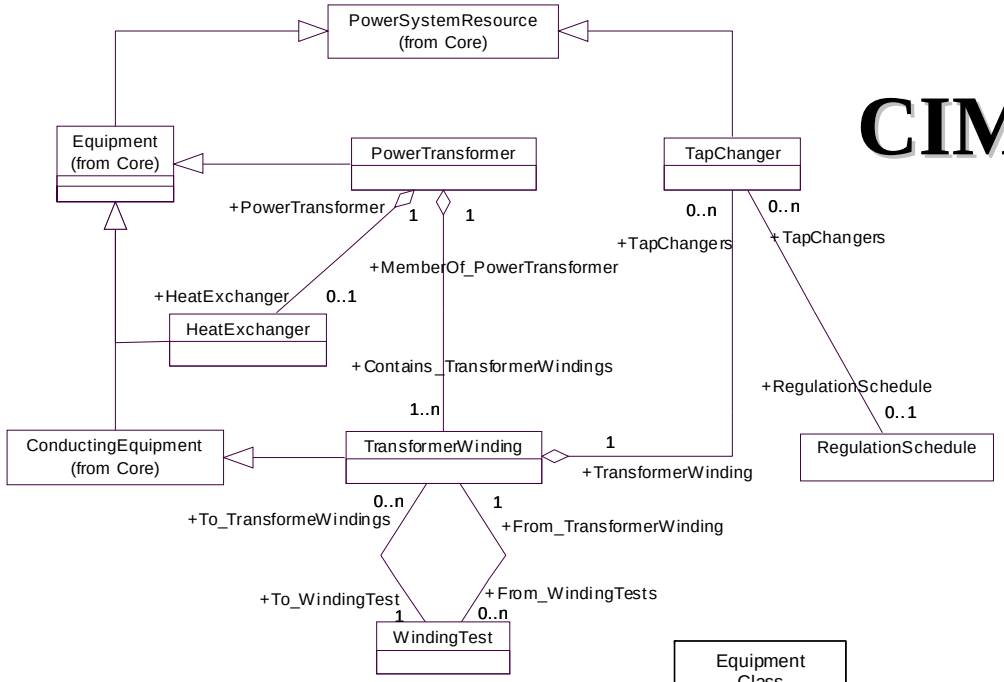


ISA S.95 – IEC62264

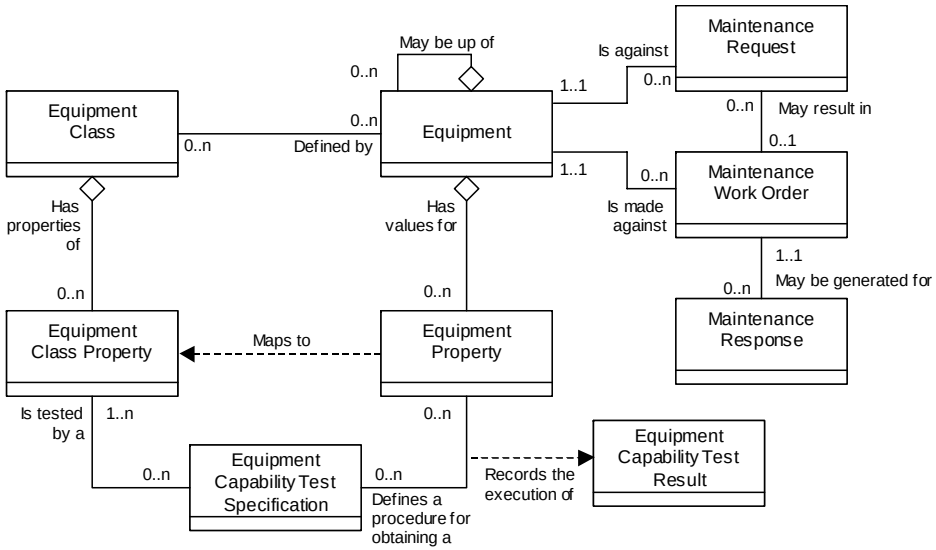
- An ISA standard for the interface between automation and production control.
- Addresses both discrete and continuous process industries.
- Specifies models and terminology for production orders, scheduling, planning, etc.
- S.95 is just now becoming used.

CIM vs. SP95

CIM



S.95



Impact of Being Model Neutral

- Increased data independence.
- Enables user specific customizations without affecting coding.
- Enables application of adapters across industries increasing 3rd party interest in supporting product based adapters.

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Impact: Self Description

- Applications obtain the description of the data from the source of the data.
- Eliminates a great deal of configuration and errors.
- Improves understanding of data
- Increases independence of applications from the sources of data
- **LOWERS THE COST OF USING TECHNOLOGY**

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Impact: Model Awareness

- Applications and users can see the meaning of data and its relationship to other data.
- Allows configuration in the context of the power system.
- Avoids arcane proprietary tag naming conventions.
- Allows model changes to be propagated automatically
- **LOWERS THE COST OF USING TECHNOLOGY**

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Impact: Application Independence

- Application can be independent of the data required by finding what is needed in the model automatically.
- No need to preconfigure each instance of data to be operated on.
- Enables reusability of applications without configuration.
- **LOWERS THE COST OF USING TECHNOLOGY**

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Data Dependent Application

Read All Transformer Voltages

Other algorithms possible. But, regardless of algorithm, programs generally contain hard coded references to either names or tables to access.

Read TSUB23PHA4023
Read TSUB23PHB4023
Read TSUB23PHC4023
Read TSUB24PHA6187

.
.
.
.
.

Read TSUB76PHB5865
Read TSUB76PHC5865
Read TSUB76PHA5977
Read TSUB76PHB5977
Read TSUB76PHC5977

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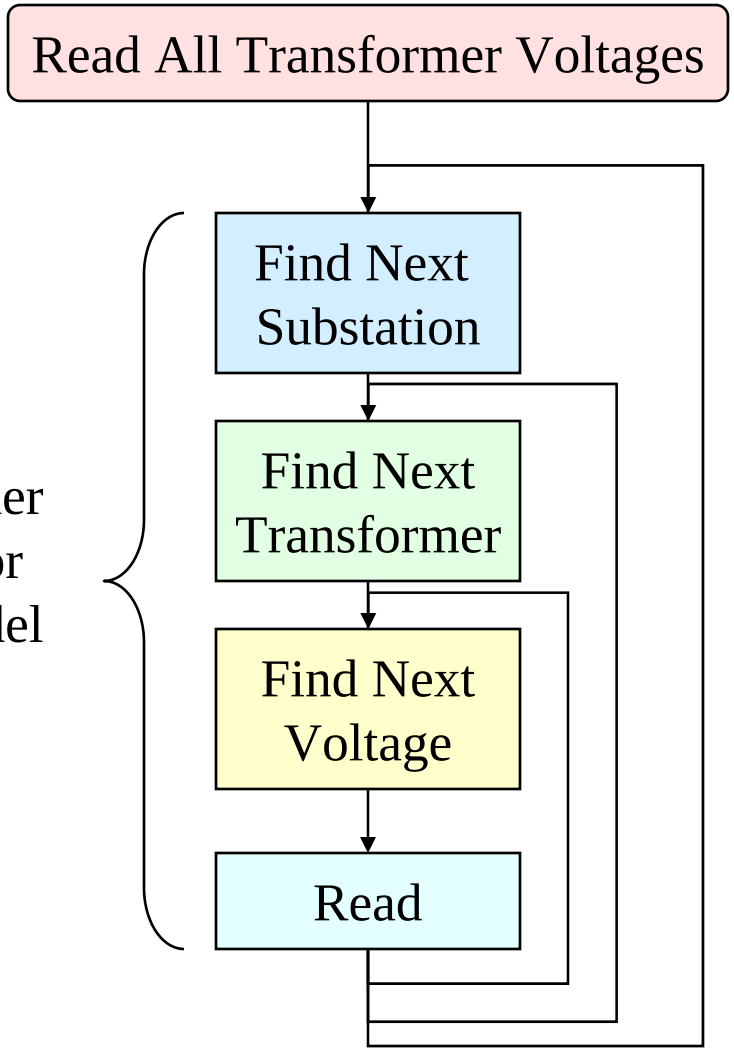
Data Independent Application

Every name is either defined by CIM or defined in the model



Impact: Leverage Existing Technology

- The layered approach enables utility specific functions to be added to existing generic technology that is in widespread use.
- Minimizes the utility specific technology (lower volume) required.
- **LOWERS THE COST OF USING TECHNOLOGY**

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About Benefits & Justification

- Identify all the benefits (obvious).
- Identify ALL the costs:
  - Equipment
  - Installation
  - Engineering
  - Commissioning
  - Utilization Costs
  - Impact on External Systems
  - Costs to Change/Migrate in Future
  - Intangibles (new capability)

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Identifying ALL Costs

- **Requires a complete view of cost.**

You can't justify a system by examining only the price.

- OR -

The benefit of a system is not in the price.

Identifying ALL Costs

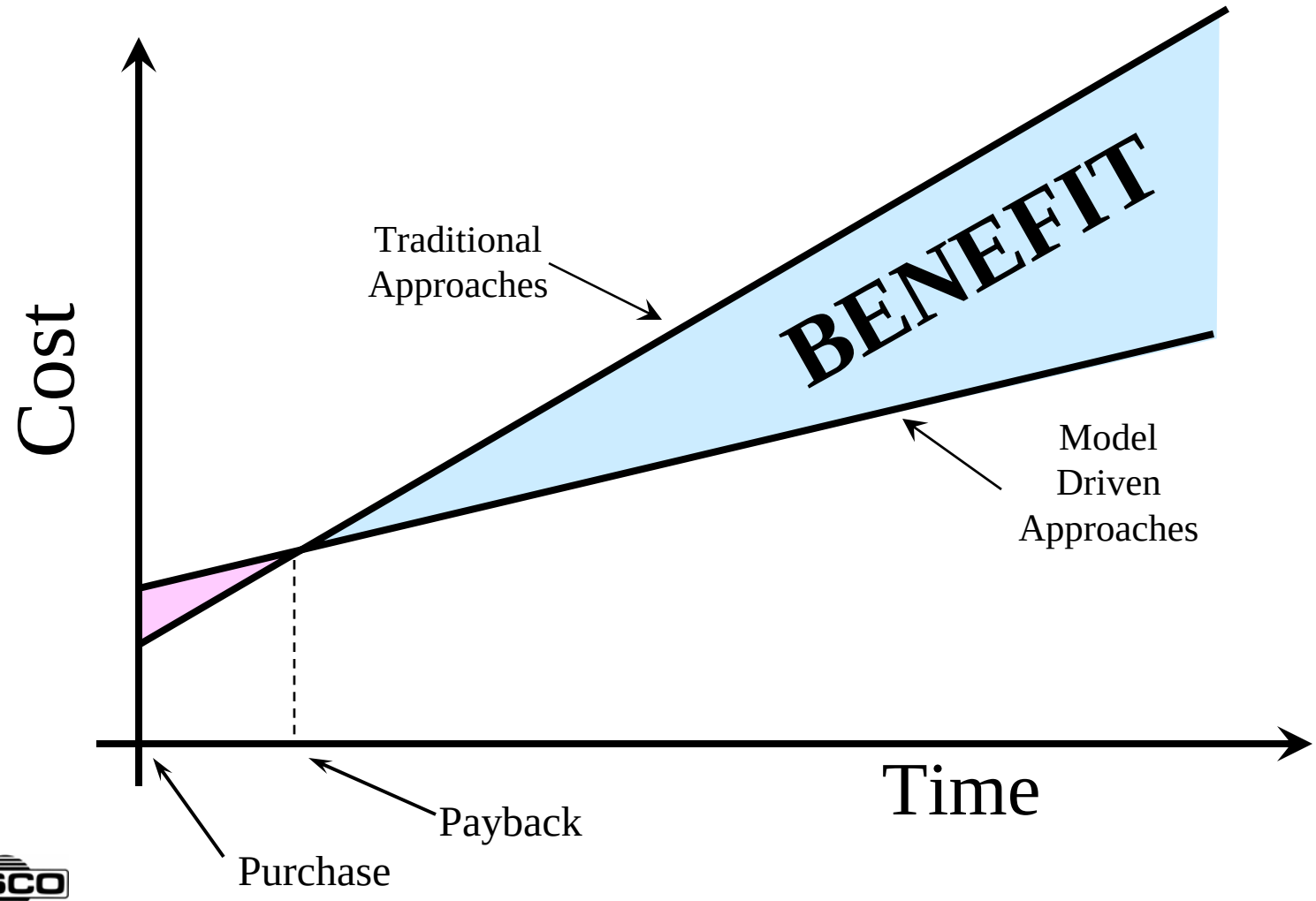
- **Requires a longer time frame.**

It is hard to justify any system by examining only the purchase price.

- OR -

Benefits are received as systems are used, not when they are purchased.

Model-Driven Cost Justification



Example: Power Plant Dispatch

Control Center

Corporate Network

1 of 32 Power Plants

Generator

Interface Added

ICCP-TASE.2 Interface

OPC Server

Existing Systems

OPC Client

HMI/SCADA Package

OPC Client

OPC Server

PLC Driver

I/O

PLC

PLC Network

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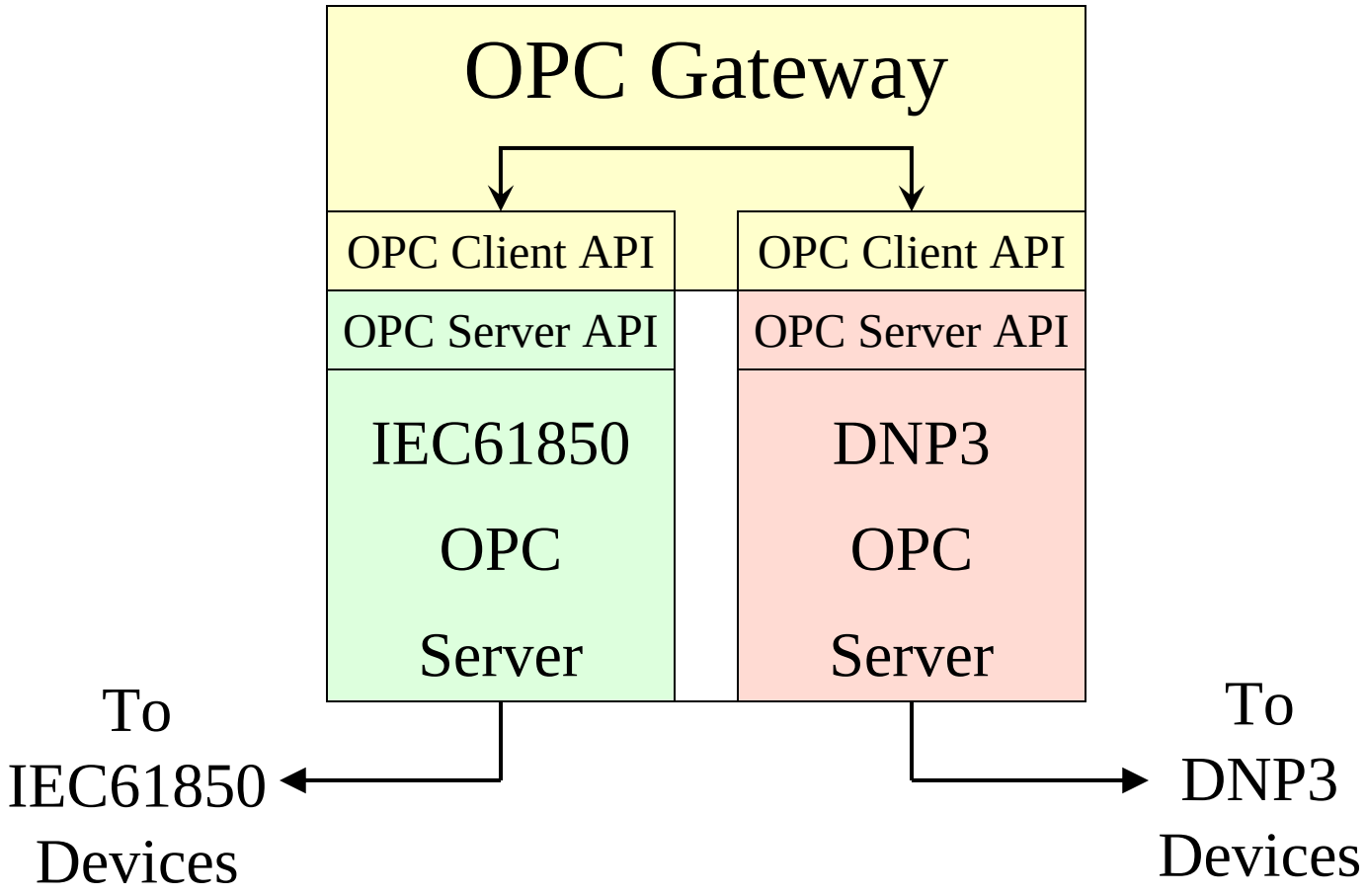
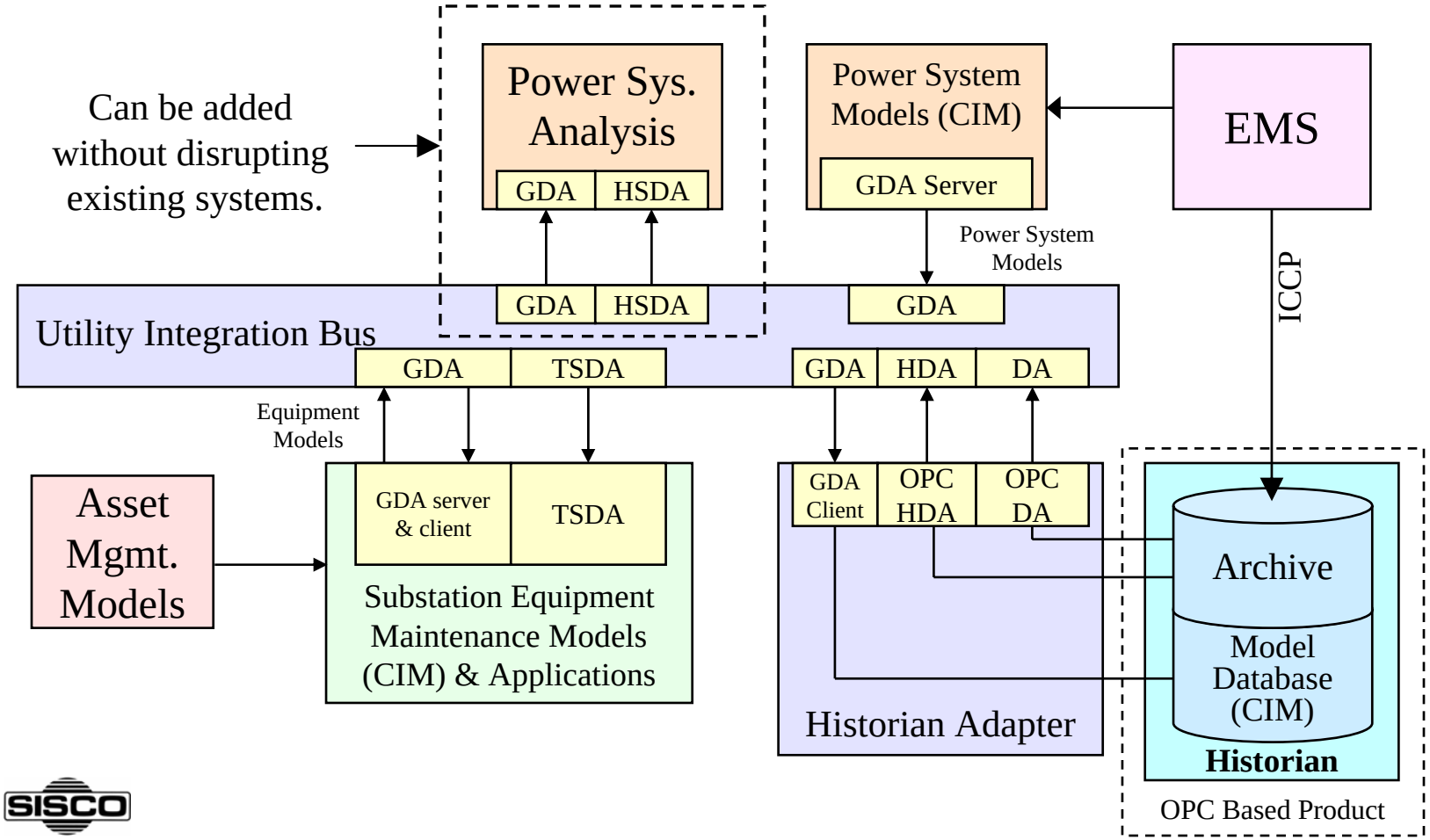
Example: Plug'n Play With OPC



Simple Gateway Using OPC

Example: Substation and EMS Integration



UCA – Protocols, Models, and APIs

The UCA® International Users Group is a forum where interested parties can meet and cooperate in the implementation and usage of IEC TC57 standards.

http://www.ucainternational.org

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Thank You

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