



OSIsoft®

UC2010

Real Time Information — Currency of the New Decade

Hilton San Francisco Union Square | San Francisco, CA

April 26-28, 2010

# OSIsoft PI Platform at CFE - The Future of Mexico's Transmission Infrastructure

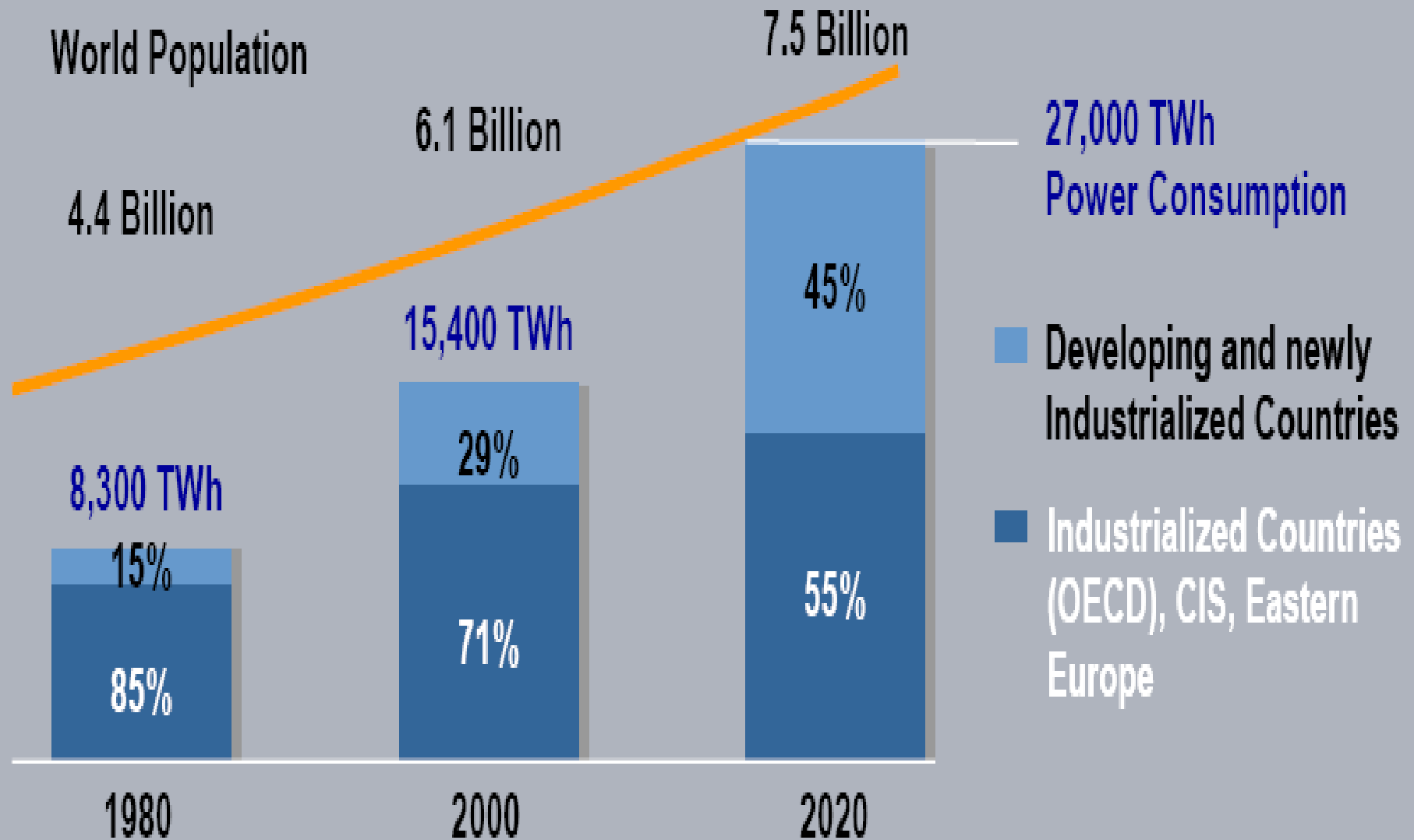
Raul Lopez – Chief of Information and Technology in Transmission  
Comision Federal de Electricidad, Mexico  
Ann Moore – Business Development Executive, OSIsoft

*Comisión Federal de Electricidad*

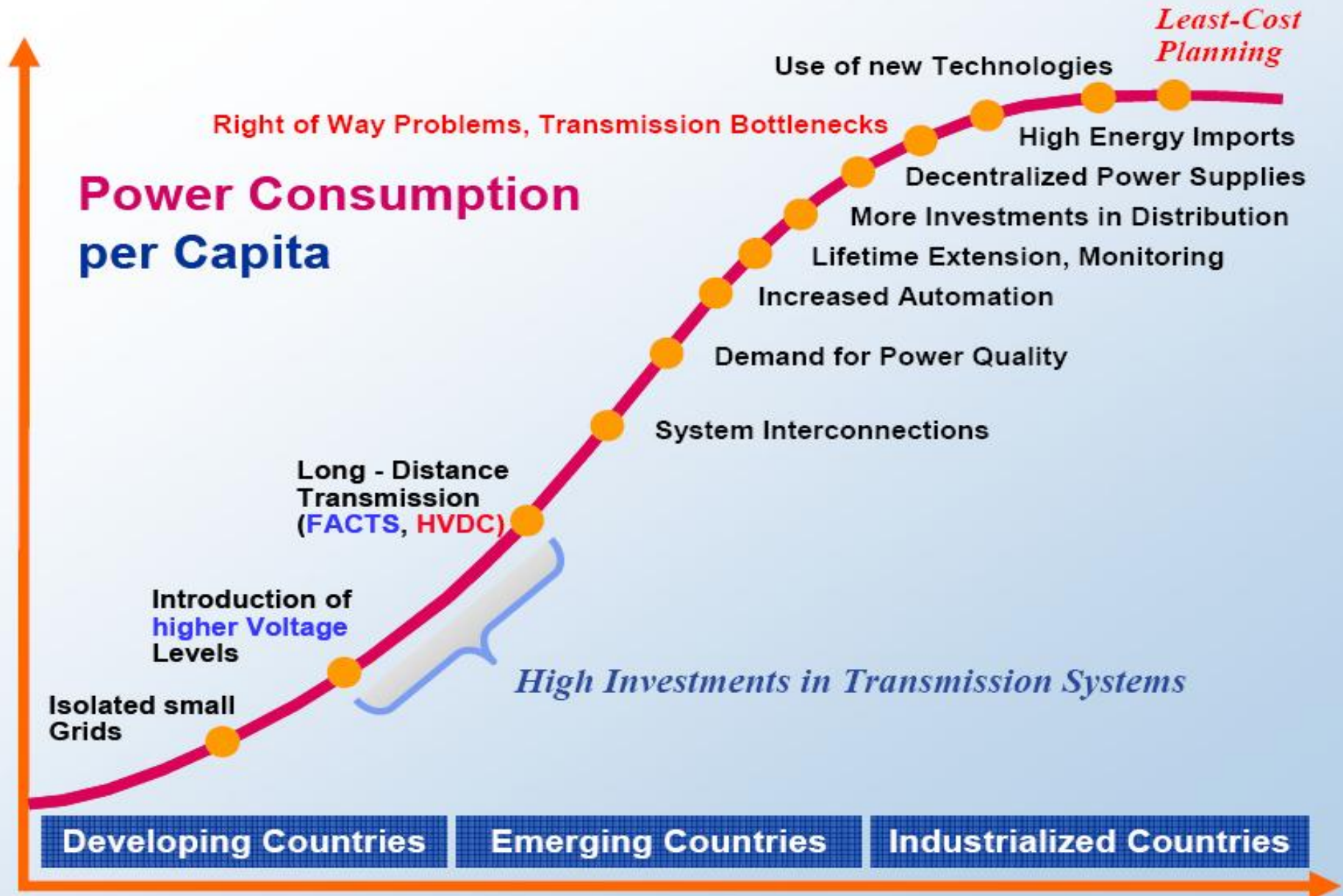
# Agenda

- World Energy Growth
- CFE Transmission System and Growth
- Objectives, Goals and Initiatives
- PI Infrastructure
- Future Vision
- Implementation Strategy
- Summary and Benefits

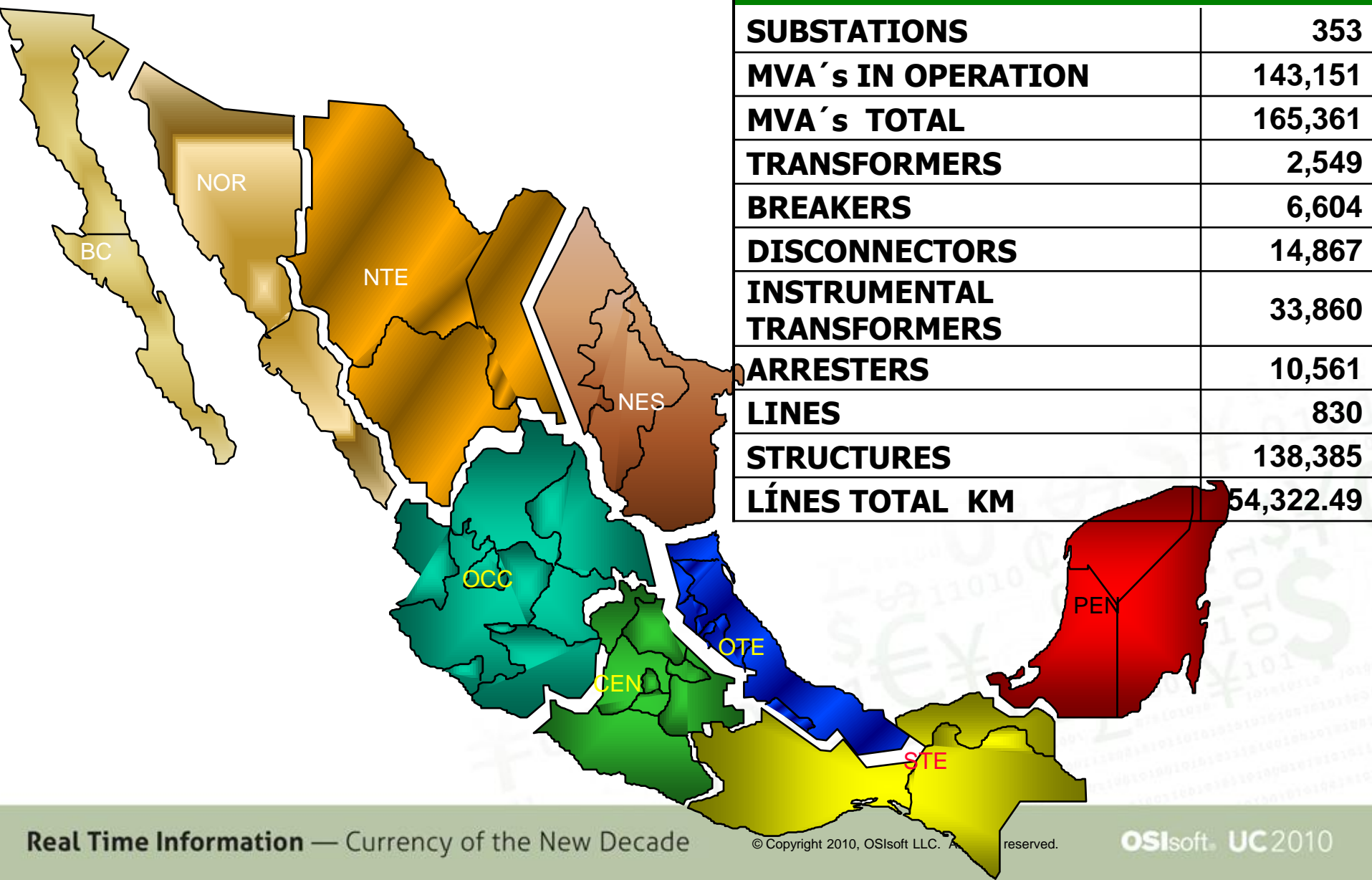
# World Energy Growth



# Power System Investment



# CFE Transmission System Overview

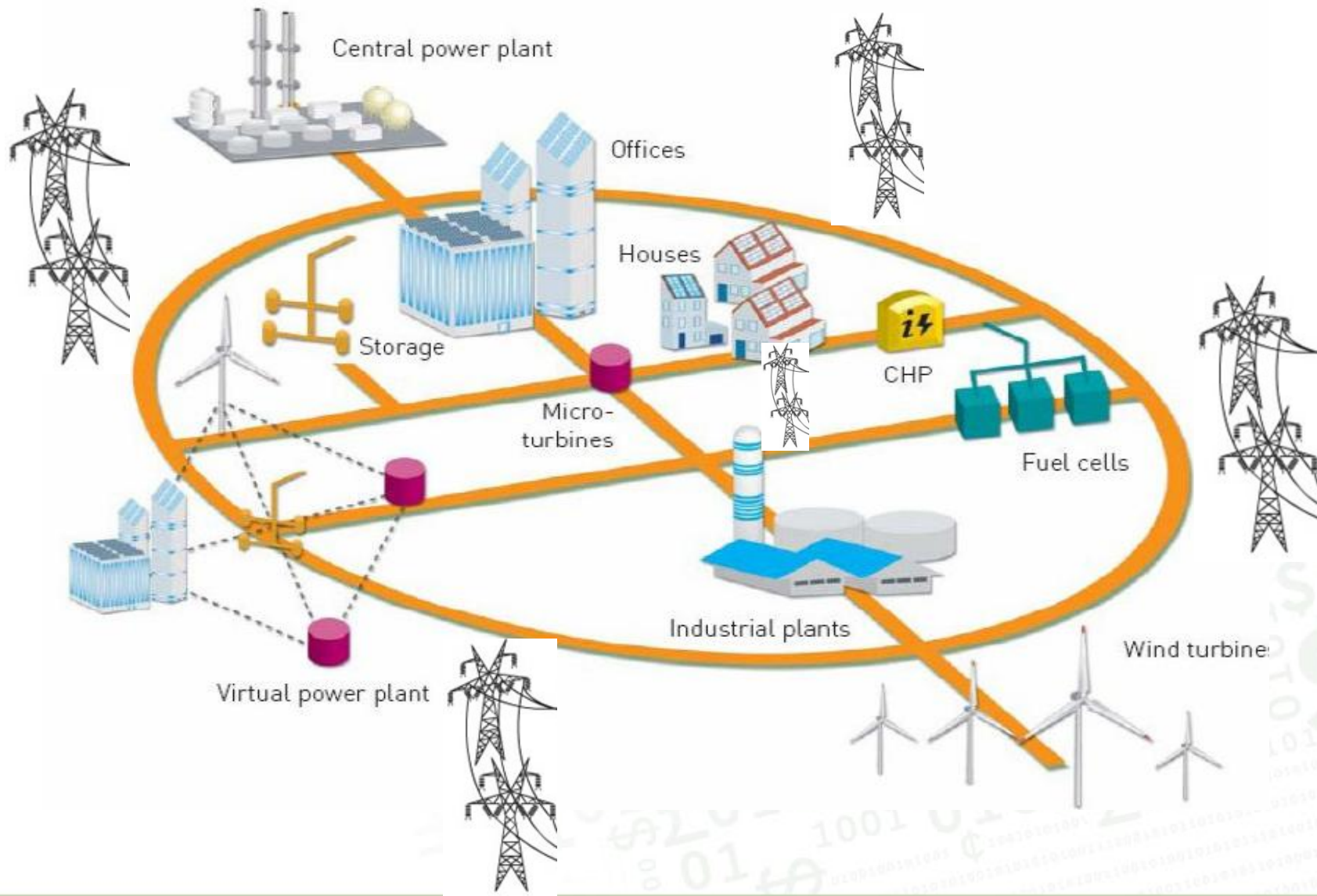


ELECTRICAL SUBSTATIONS & LINES	
SUBSTATIONS	353
MVA's IN OPERATION	143,151
MVA's TOTAL	165,361
TRANSFORMERS	2,549
BREAKERS	6,604
DISCONNECTORS	14,867
INSTRUMENTAL TRANSFORMERS	33,860
ARRESTERS	10,561
LINES	830
STRUCTURES	138,385
LÍNES TOTAL KM	54,322.49

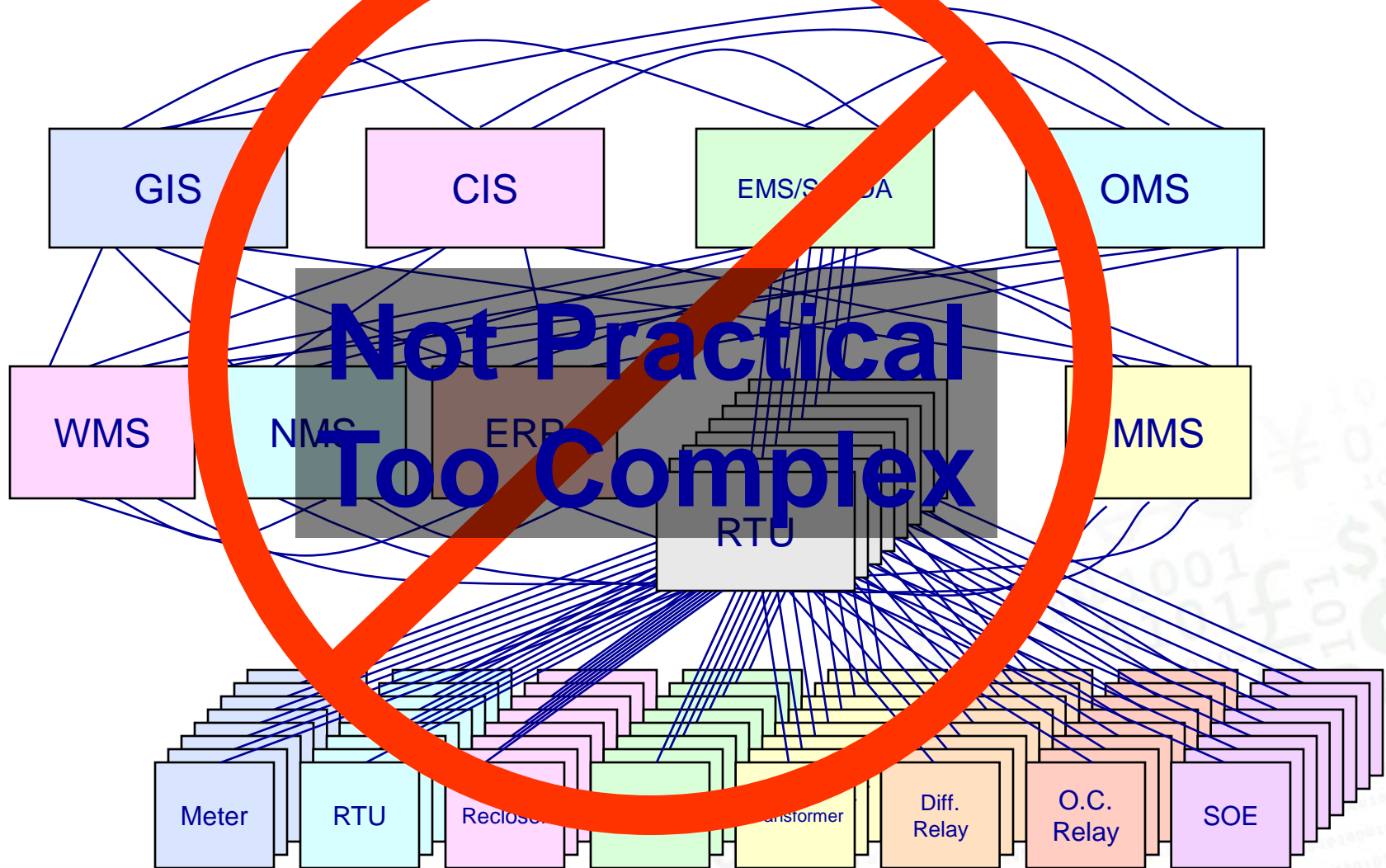
# CFE Transmission Asset Growth

CFE Asset	2008	2009	GROWTH %
# SUBSTATIONS	353	438	24.07
MEGA VOLT - AMPERE TOTAL	166,132	192,028	15.58
TOTAL LINES IN KILOMETERS	54,322	56,094	3.26
# TRANSMISSION LINES	830	973	17.22
FIBER OPTICS IN KILOMETERS	21,411	28,794	34.48

# The Evolving Grid at CFE



# The Integration Dilemma



# Objectives

- To build an enterprise PI infrastructure using a comprehensive set of standards for model-driven smart substation integration
- To establish a service oriented architecture to collect, integrate, correlate, analyze and visualize data from various substation data sources
- To develop techniques to extract calculated data or metrics for evaluating performance metrics

# Goals

- Maximize asset performance at lowest life-cycle cost
- Reduce maintenance and corresponding O&M expense
- Dispatch skillful technicians for specific problems
- Manage trouble response to minimize cost
- Maximize equipment performance utilization & reliability
- Optimize asset replacement strategy

# CBM Initiatives

## Develop **Equipment and System Condition Based Maintenance (CBM)**

- **Equipment-focused** CBM analyzing the current operation of individual equipment based on equipment parameters and sensor data to make decisions about current equipment health
- **System-focused** CBM analyzing current and historical information for sets of equipment to compare actual equipment performance with corporate objectives

Data related to equipment and system CBM is accessed via a single unified CBM Server/Portal

# Approaches

- Thinking at the enterprise level while integrating at the substation level
- Looking at the system from a high level view to enable higher reliability and lower cost
- Do not want to undertake a major project that requires many years to complete
- Need a long-term enterprise-wide integration strategy so a small project does not become just another slightly larger island of automation
  - For a long-term plan, the architecture needs to tackle the problem of integration in a staged approach

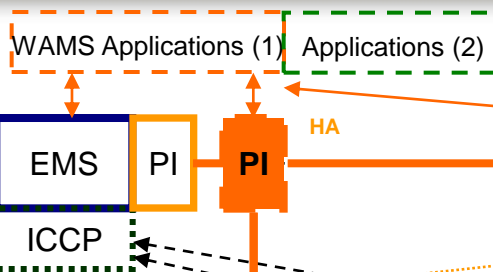
# CFE PI Infrastructure

NATIONAL CENTER

All Control Centers using PI

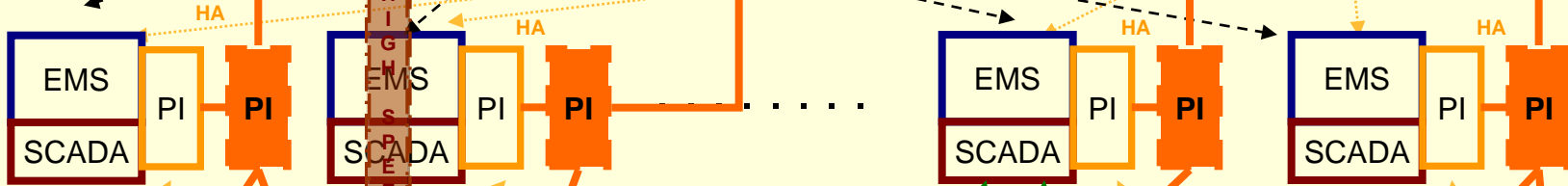
HA-High Availability  
Multiple Broadcasting

Primary Control Center  
México DF

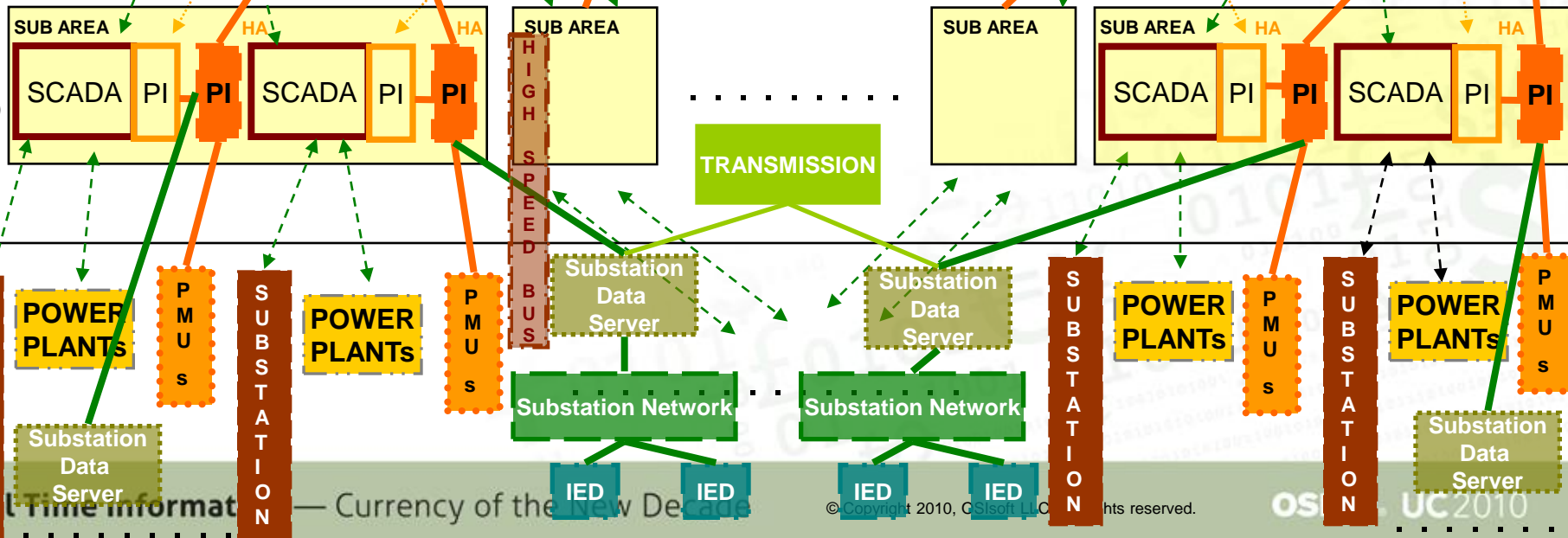


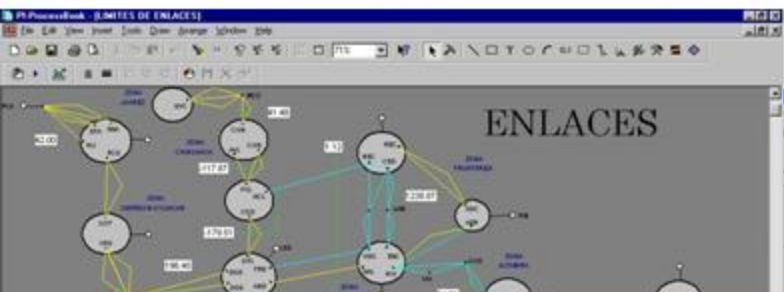
Backup Control Center  
Puebla

AREAS (8)



SUBAREAS (29)





SISTEMA INTERCONECTADO		SISTEMA ELECTRIC NACIONAL	
GENERACION	1712.00 MW	GENERACION	1706.95 MW
DEMANDA	1712.00 MW	DEMANDA	1706.95 MW
RESERVA	80.00 MW	RESERVA	80.00 MW
FRECUENCIA	60.018 Hz	FRECUENCIA	60.000 Hz

### DEPARTAMENTO DE PROGRAMACION BASICA

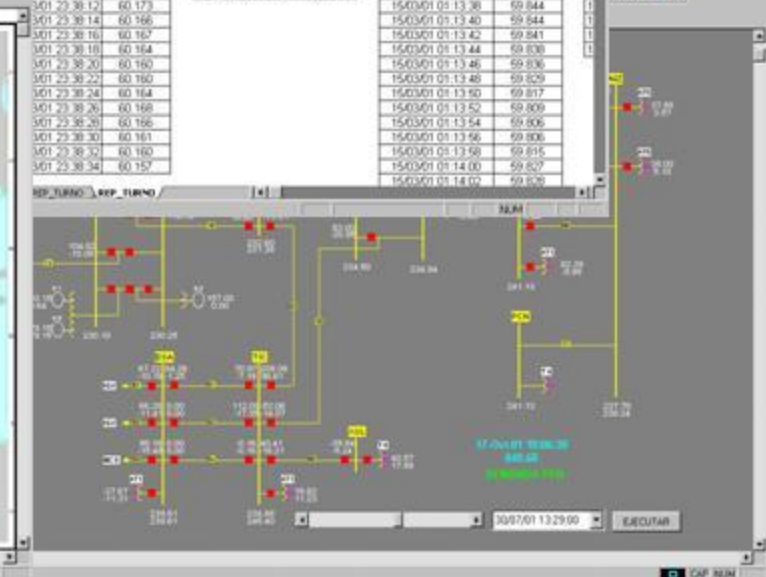
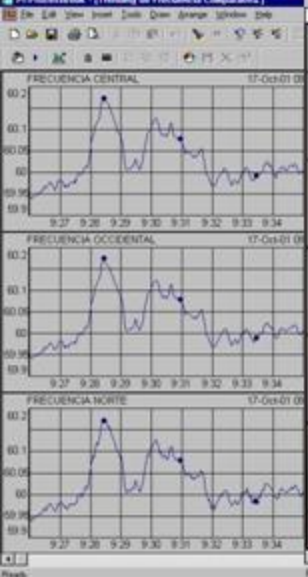
#### REPORTE DE VIOLACIONES DE FRECUENCIA POR TURNO DEL SISTEMA SITRACEN

REPORTE DEL: Marzo 14, 2001 VALOR MAXIMO: 15.0301 3.3739 60.235 TIEMPO TOTAL: 0.2150  
 AL: Marzo 15, 2001 VALOR MINIMO: 15.0301 6.0605 59.734

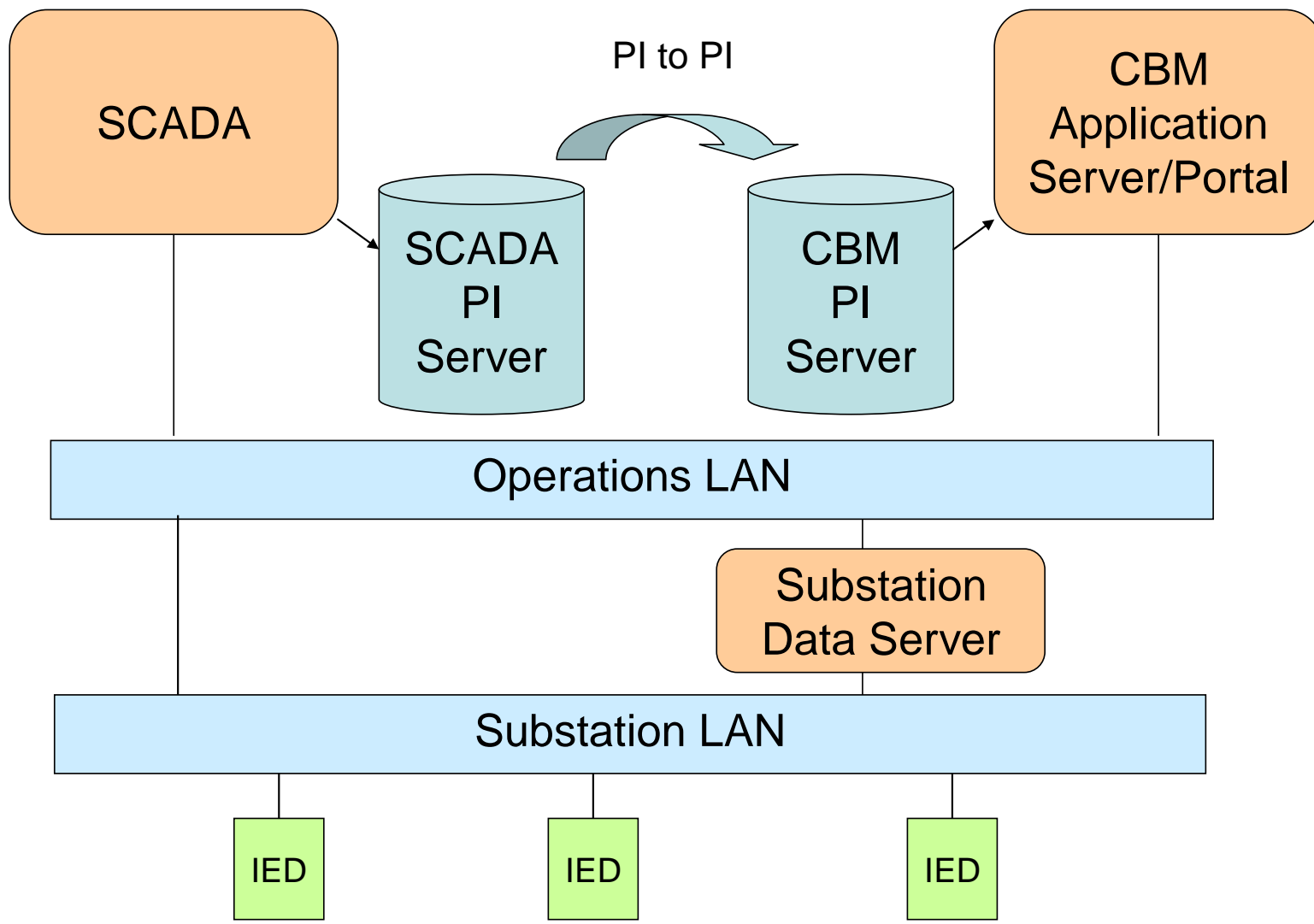
PERIODO	TIEMPO	HZ	PERIODO	TIEMPO	HZ	PERIODO	TIEMPO	HZ	PERIODO	TIEMPO	HZ
PERIODO 23:00:00			PERIODO 01:00:00			PERIODO 03:00:00			PERIODO 05:00:00		
11 TIEMPO ARRIBA	0.00:00		11 TIEMPO ARRIBA	0.00:34		11 TIEMPO ARRIBA	0.00:10		11 TIEMPO ARRIBA	0.00:00	
12 TIEMPO ABAJO	0.00:00		12 TIEMPO ABAJO	0.00:00		12 TIEMPO ABAJO	0.00:00		12 TIEMPO ABAJO	0.06:36	
13 VIOLACION	0.00:00		13 VIOLACION	0.00:34		13 VIOLACION	0.00:10		13 VIOLACION	0.06:36	



REP TURNO	REP TURNO	REP TURNO	REP TURNO
1501233000 60.165	150301003550 60.153	150301011316 59.944	150301011318 59.939
1501233004 60.181	150301003550 60.152	150301011318 59.939	150301011320 59.943
1501233006 60.188	150301003402 60.154	150301011320 59.944	150301011322 59.942
1501233010 60.190	150301003404 60.161	150301011324 59.946	150301011330 59.944
1501233012 60.173	150301003406 60.156	150301011330 59.944	150301011340 59.944
1501233014 60.166		150301011340 59.944	150301011342 59.941
1501233016 60.167		150301011342 59.941	150301011344 59.938
1501233018 60.164		150301011344 59.938	150301011346 59.936
1501233020 60.160		150301011346 59.936	150301011348 59.929
1501233022 60.160		150301011348 59.929	150301011350 59.917
1501233024 60.164		150301011350 59.917	150301011352 59.909
1501233026 60.168		150301011352 59.909	150301011354 59.906
1501233028 60.166		150301011354 59.906	150301011356 59.906
1501233030 60.161		150301011356 59.906	150301011358 59.915
1501233032 60.160		150301011358 59.915	150301011400 59.927
1501233034 60.157		150301011400 59.927	150301011402 59.926



# Future Vision and Implementation Strategy



# Substation LAN

- Maintenance data related to breakers and transformers from substations will be brought into the Substation Data Server
- If the data is available via the IEC61850 or UCA protocol then it will be loaded via SISCO AX-S4 MMS product
- If the data is available via another protocol then it will be loaded via an OSIsoft standard interface

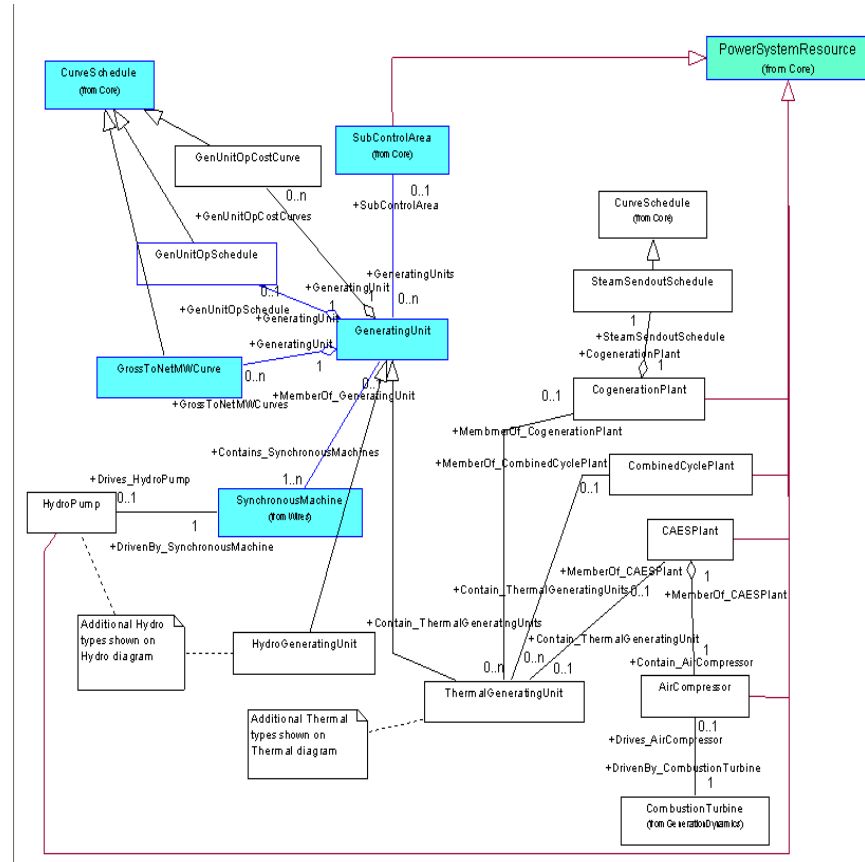
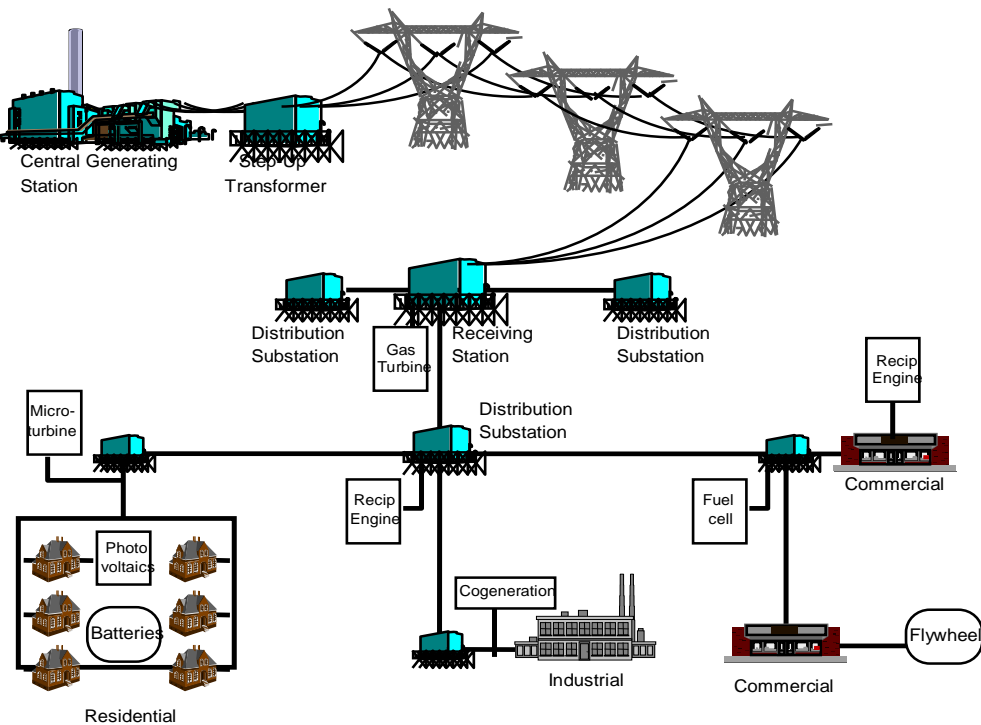
# Substation Data Server

- Could be at each substation
- Provides High Availability of storing and accessing substation data
- Used as a substation data management system
- Organizes and provides access to substation data via IEC61970 CIM (Common Information Model) and IEC61850 models

# CBM Server

- Provides an integration and development platform for applications
- Organizes and provides access to enterprise data via IEC 61970 CIM, SAP, and IEC 61850 models
- Also serves as the Model Store for EMS power system modeling data and SAP asset management data

# From Power System Network to CIM UML (Unified Modeling Language)



# CIM and IEC 61850 Harmonization

- [-] C ReactiveCapabilityCurve(I:1)
- [-] C RegulatingControl(I:1)
- [-] C RegulationSchedule(I:1)
- [-] C ShuntCompensator(I:3)
- [-] C StaticVarCompensator(I:1)
- [-] C SubGeographicalRegion(I:1)
- [-] C SubLoadArea(I:1)
- [-] C Substation(I:2)
- [-] I AIRPORT (Substation)
  - [-] A EquipmentContainer.Contains\_Equipments
    - [-] I TXAP (PowerTransformer)
      - [-] A Equipment.MemberOf\_EquipmentContainer
      - [-] A PowerTransformer.Contains\_TransformerWindings
        - [-] I TXAPH (TransformerWinding)
        - [-] I TXAPX (TransformerWinding)
          - [-] A ConductingEquipment.Terminals
          - [-] A Equipment.MemberOf\_EquipmentContainer
          - [-] A PowerSystemResource.LNode
            - [-] I MMXU1 (LNInst)
              - [-] A LNode.DataObject
                - [-] I A\_phsA (DataObject)
                - [-] I A\_phsB (DataObject)
                - [-] I A\_phsC (DataObject)
                - [-] I Hz (DataObject)
                - [-] I PhV\_phsA (DataObject)
                - [-] I PhV\_phsB (DataObject)
                - [-] I PhV\_phsC (DataObject)
                - [-] I TotPF (DataObject)
                - [-] A DataObject.LNode
                - [-] A DataObject.Measurement
                  - [-] I Power Factor (Analog)
                - [-] I TotVA (DataObject)
                - [-] I TotVAr (DataObject)
              - [-] A LNode.PowerSystemResource
          - [-] A TransformerWinding.MemberOf\_PowerTransformer

- [-] C CurveData(I:4)
- [-] C DataObject(I:94)
- [-] C Disconnecter(I:1)
- [-] C GeographicalRegion(I:1)
- [-] C GrossToNetActivePowerCurve(I:1)
- [-] C LNInst(I:26)
- [-] C LoadArea(I:1)
- [-] C LoadBreakSwitch(I:1)
- [-] C MeasurementValueSource(I:1)
- [-] C PowerTransformer(I:1)
- [-] I TXAP (PowerTransformer)
  - [-] A Equipment.MemberOf\_EquipmentContainer
  - [-] A PowerTransformer.Contains\_TransformerWindings
    - [-] I TXAPH (TransformerWinding)
    - [-] I TXAPX (TransformerWinding)
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            - [-] I A\_phsC (DataObject)
            - [-] I Hz (DataObject)
            - [-] I PhV\_phsA (DataObject)
            - [-] I PhV\_phsB (DataObject)
            - [-] I PhV\_phsC (DataObject)
            - [-] I TotPF (DataObject)
            - [-] A DataObject.LNode
            - [-] A DataObject.Measurement
              - [-] I Power Factor (Analog)
            - [-] I TotVA (DataObject)
            - [-] I TotVAr (DataObject)
          - [-] A LNode.PowerSystemResource
      - [-] A TransformerWinding.MemberOf\_PowerTransformer

# From CIM to PI AF

demo - PI System Explorer

File Edit View Go Tools Help

Database Query Date Back Check In New Element Search

Elements

- SubLoadArea
  - Substation
    - AIRPORT
      - HANGER18
        - TXAP
          - AIRPORT
            - TXAPH
            - TXAPX
            - AIR\_CN12\_TXAPX
            - LTC
            - MMXU1 804e9719-9256-4470-b503-aed76ad952da
              - A\_phsA d22bfb64-08e5-48a7-afad-ea9b0ee3b10e
              - A\_phsB 93b5cb8f-65a5-4abf-aad6-2c197a4599ca
              - A\_phsC a054a823-7d51-4492-952c-f4aac6687289
              - Hz f9dcad44-4c3f-4340-8ae9-73d92993b745
              - PhV\_phsA 11e1ff39-6163-4b1e-b3f4-4483cf0b4a95
              - PhV\_phsB 9fd5eb35-e518-4ff3-9bdc-89ed2bd99d4c
              - PhV\_phsC d5380fd8-cee3-48fc-a889-3beeeb52a97d
              - TotPF 2133d1a7b1a8-48b9-83aa-79254ba81591
              - MMXU1 804e9719-9256-4470-b503-aed76ad952da
                - Power Factor bfe73163-dd9a-4e52b91b-ef71e223e2
                - TotVA 4d8af438-04d7-42dc-bcc6-ce51c2a0a339
                - TotVAr dbf69c14-3b04-4a55-809e-148f8ce69f42
                - Turbine\_9
                - TXAPX
                - TXAP

AIRPORT

General Child Elements Attributes Ports Model View Version

Group by:  Category  Reference Type  Template

Search

| Name                                   | Description  | Category         | Type | Template                   |
|--|--|------------------|------|----------------------------|
| EquipmentContainer.Contains_Equipments | (demo:Equipment.MemberOf_EquipmentContainer/EquipmentContai...         |                  |      |                            |
| TXAP                                   |  | demo; demo:Eq... | None | demo:PowerTransformer      |
| Substation.Region                      | (demo:SubGeographicalRegion.Substations/Substation.Region)             |                  |      |                            |
| HANGE...                               |  | demo; demo:Id... | None | demo:SubGeographicalRegion |
| VoltageLevel.MemberOf_Substation       | (demo:Substation.Contains_VoltageLevels/VoltageLevel.MemberOf_Subst... |                  |      |                            |
| VL_AIRP...                             |  | demo; demo:Eq... | None | demo:VoltageLevel          |
| VL_AIRP...                             |  | demo; demo:Eq... | None | demo:VoltageLevel          |



|                 |         |
|-----------------|---------|
| Phase A Current | 223.666 |
| Phase B Current | 233.982 |
| Phase C Current | 207.689 |
| Phase A Voltage | 324.052 |
| Phase B Voltage | 324.402 |
| Phase C Voltage | 324.402 |
| Winding Temp    | 40.8    |

|              |         |
|--------------|---------|
| Power Factor | 0.93180 |
| Volt-Amperes | 112.539 |

# IEC 61850 in AF and AF XML

```

</AFElement>
- <AFElement ReferenceType="Parent-Child">
  <Name>PowerTransformer</Name>
  <Description>An electrical device consisting of two or more coupled windings, with one or more cores, for introducing mutual coupling between electric circuits. Transformers can be used to increase or decrease voltage and phase shift (active power flow).</Description>
  <Template>IEC61850:PowerTransformer</Template>
  <AFElementCategoryRef>IEC61850:PowerSystemResource</AFElementCategoryRef>
  <AFElementCategoryRef>IEC61850:IdentifiedObject</AFElementCategoryRef>

```

The screenshot shows a tree view of a logical device configuration. The root is 'LogicalDevice(1:2)', which contains 'AIRPORT\_TURBINE2\_MON (LogicalDevice)'. Under this, there is a 'LogicalDevice.LNode' containing several data objects like 'LineCSWI1 (LNInst)', 'MMXU1 (LNInst)', and various phase-related objects. A 'DataObject.LNode' contains a 'DataObject.Measurement' for 'Reactive Power (Analog)', which includes 'Analog.Contain\_MeasurementValues' and 'Measurement.DataObject'. The 'LNNode.LogicalDevice' contains a 'LNNode.PowerSystemResource' with a 'Turbine\_2 (SynchronousMachine)' and various equipment and measurement references.

```

_PowerTransformer</Name>

_Equipment</Name>

_PowerSystemResource</Name>

_IdentifiedObject</Name>

</Name>

ance Traits</Name>

```

# CBM Application Examples

- Circuit Outage Summaries
- Transformer Alarms
- Transformer Loads (time in 100-105%, 105-115% and  $> 115\%$  of rated MVA)
- Transformer LTC (counts, max and min)
- Transformer Completed Work Orders
- Transformer Overloads (counts/durations since last overhaul)
- Bus Voltage Performance
- Transformer Tap Changer Operations
- Active Workorders
- Circuit Repetitive Demand Maintenance
- Transformer Repetitive Demand Maintenance
- Circuit Overloads (counts/durations)

# Benefits

- Creating an open environment for application development
  - Easy to develop custom applications with standard development tools
- Integrating operations, asset, and maintenance
  - Integrate operational and maintenance data
  - Integrate operations and asset models
  - Establish an enterprise standard unified model - CIM
- Enabling model-driven application and system integration
  - Easy for future expansion and enterprise integration



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Thank you

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