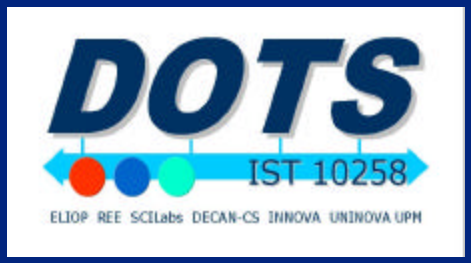

Mapping IEC 61850 to CORBA

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Universidad Politécnica de Madrid

José Antonio Clavijo
SCILabs Ingenieros

Presentation Structure

- **DOTS Context**
  - What is DOTS ? What is the objective ?
  - What are we doing? Where are we going?
- **A CORBA Model for SAS**
  - Understanding Substation Automation Systems
  - SAS as CORBA systems
- **61850 ACSI Mapping to CORBA**
  - Mapping core ideas
  - Mapping itself

DOTS Context

What is DOTS ?

DOTS is a project

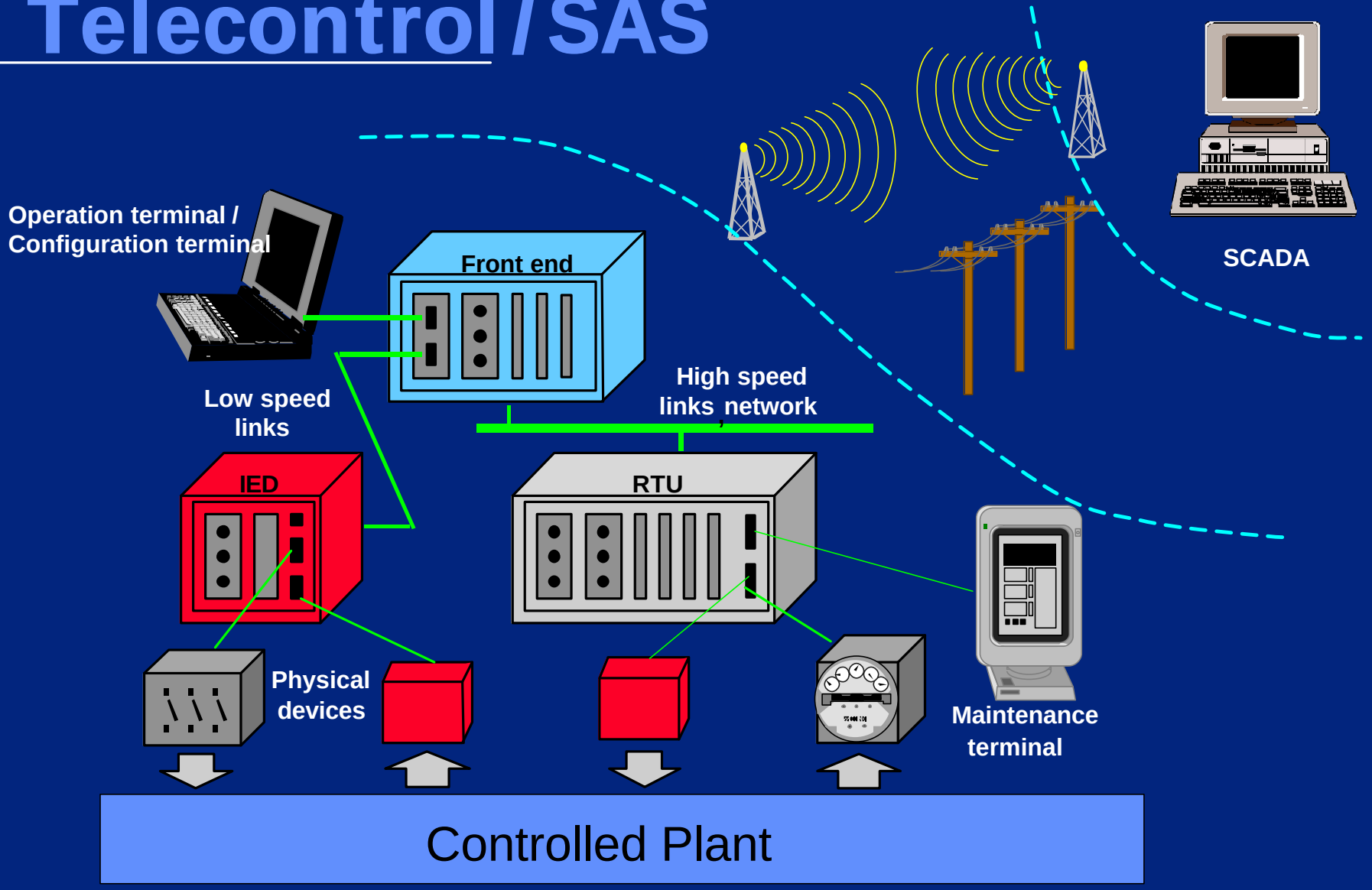
- Distributed Object Telecontrol Systems and Networks
- Supported by the European IST programme
- Main objective:

  ” to establish an open software model, built upon real-time distributed object technologies and emergent telecontrol standards to allow the optimum exploitation of the interoperation capabilities of devices and systems in the distributed context of an electric power grid “

DOTS Consortium

- ELIOP (manufacturer, Spain)
- UPM (university, Spain)
- DECAN (IT company, France)
- SCILabs (industrial DOC, Spain)
- UNINOVA (non-profit Research, Portugal)
- INNOVA (technology marketing, Italy)
- REE (power transmission, Spain)

Telecontrol / SAS



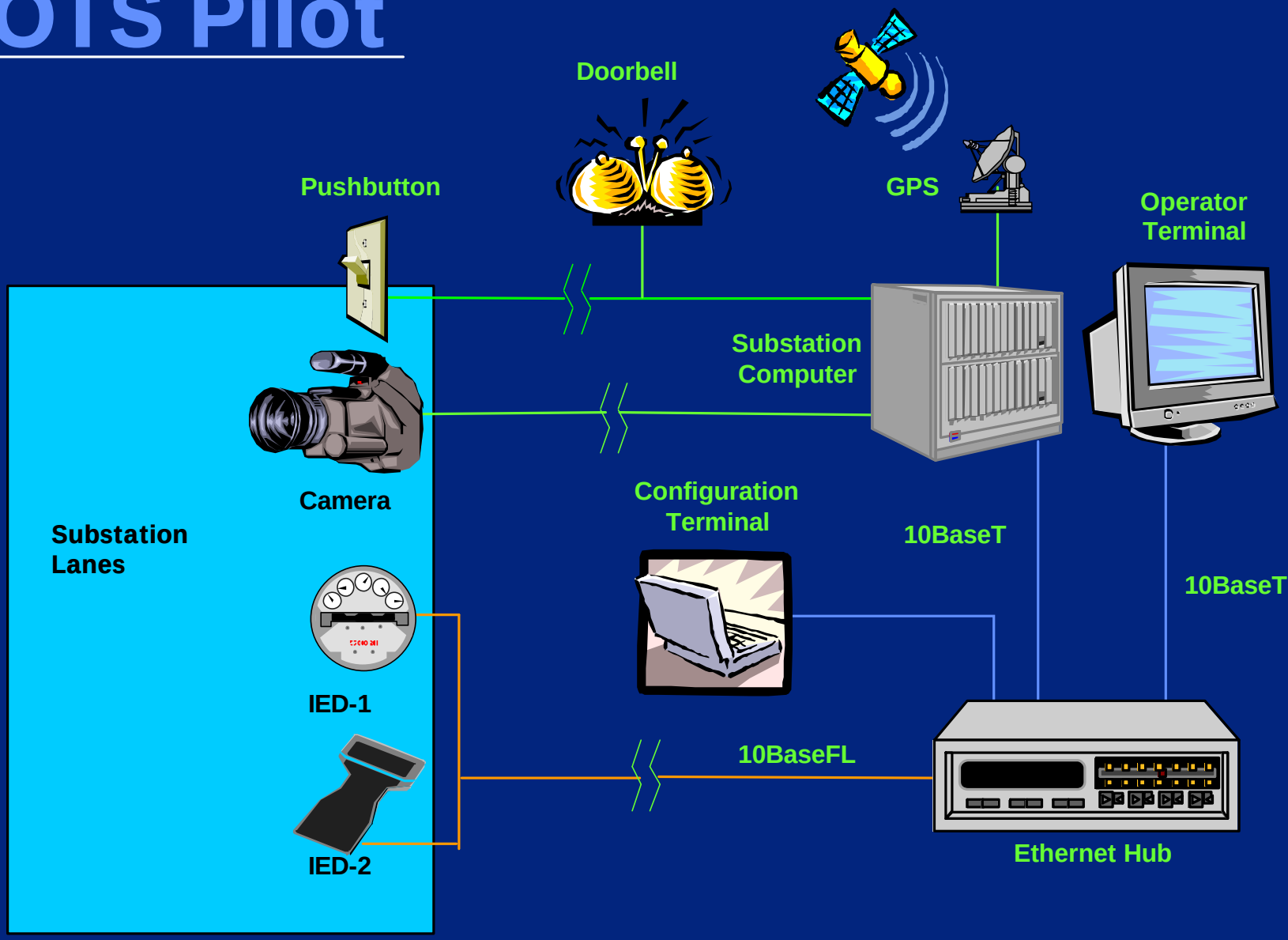
IEC 61850

- Communication Networks and Systems in Substations
- The standard should ensure, among others, the following features:
  - The complete communication profile will be based on existing IEC / ISO / OSI communication standards, if available.
  - The protocols used will be open and will support self descriptive devices. It will be possible to add new functionality.
  - The standard will be based on objects related to the needs of the electric power industry.
  - The communication syntax and semantics will be based on the use of common objects related to the power system.
  - The communication standard will consider the implications of the substation being one node in the power grid, i.e. of the SAS being one element in the overall power control system.

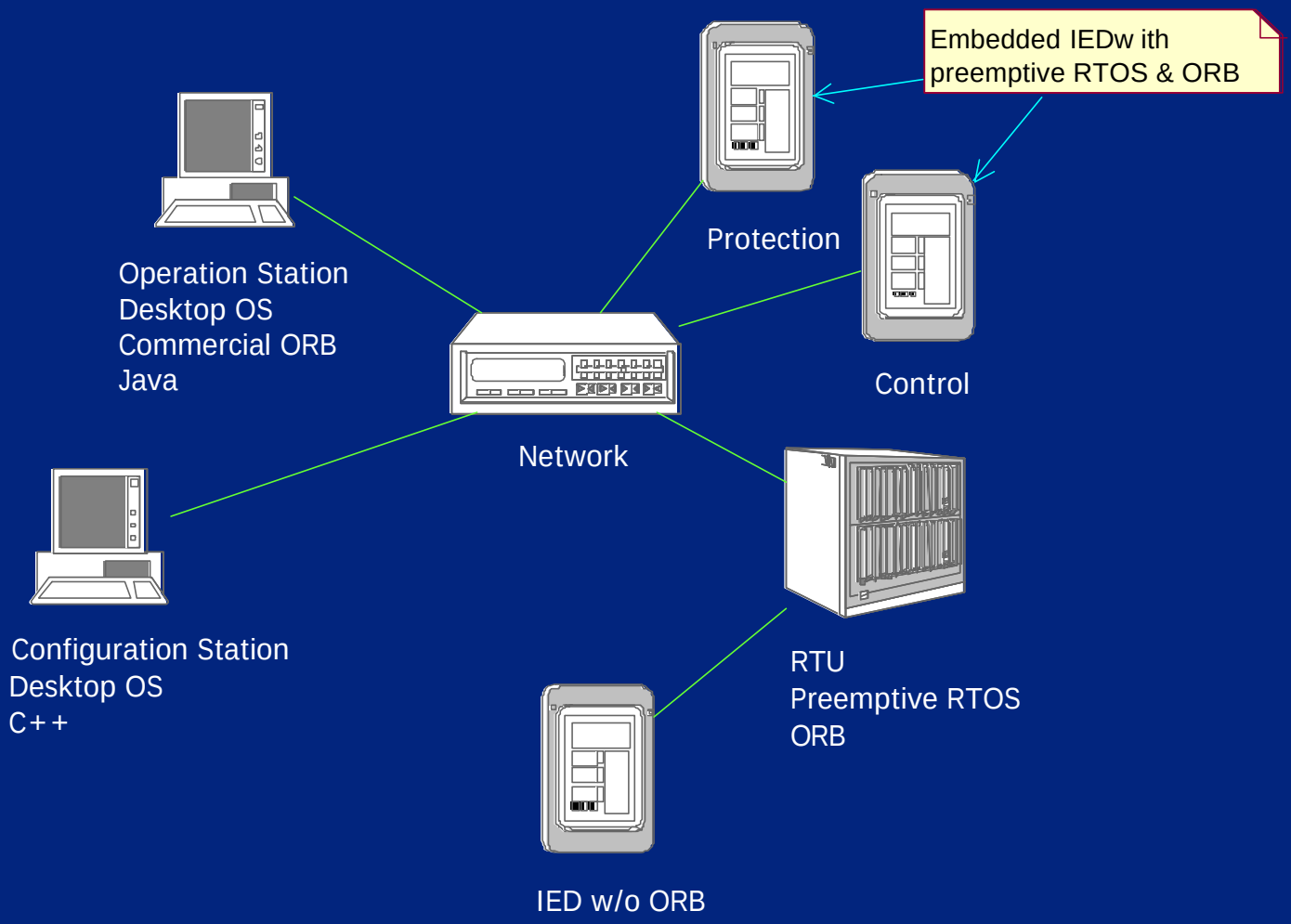
Domains in DOTS

- IEC 61850 Domain
- CORBA Domain
- Real-time CORBA Domain
- Embedded CORBA Domain
- Fault-tolerance CORBA Domain
- DOTS Domain

DOTS Pilot


Doorbell
Pushbutton
GPS
Operator Terminal
Substation Computer
Camera
Substation Lanes
Configuration Terminal
10BaseT
10BaseT
IED-1
10BaseFL
IED-2
Ethernet Hub

Pilot Deployment



DOTS Public Documents

- DOTS DL1.2 **General Model Definition**
  - A general description on how IEC Models can be implemented using CORBA technology
- DOTS DL3.1 **ACSI Mapping to CORBA**
  - A mapping of the IEC 61850-7-2 (ACSI) to CORBA

Find us

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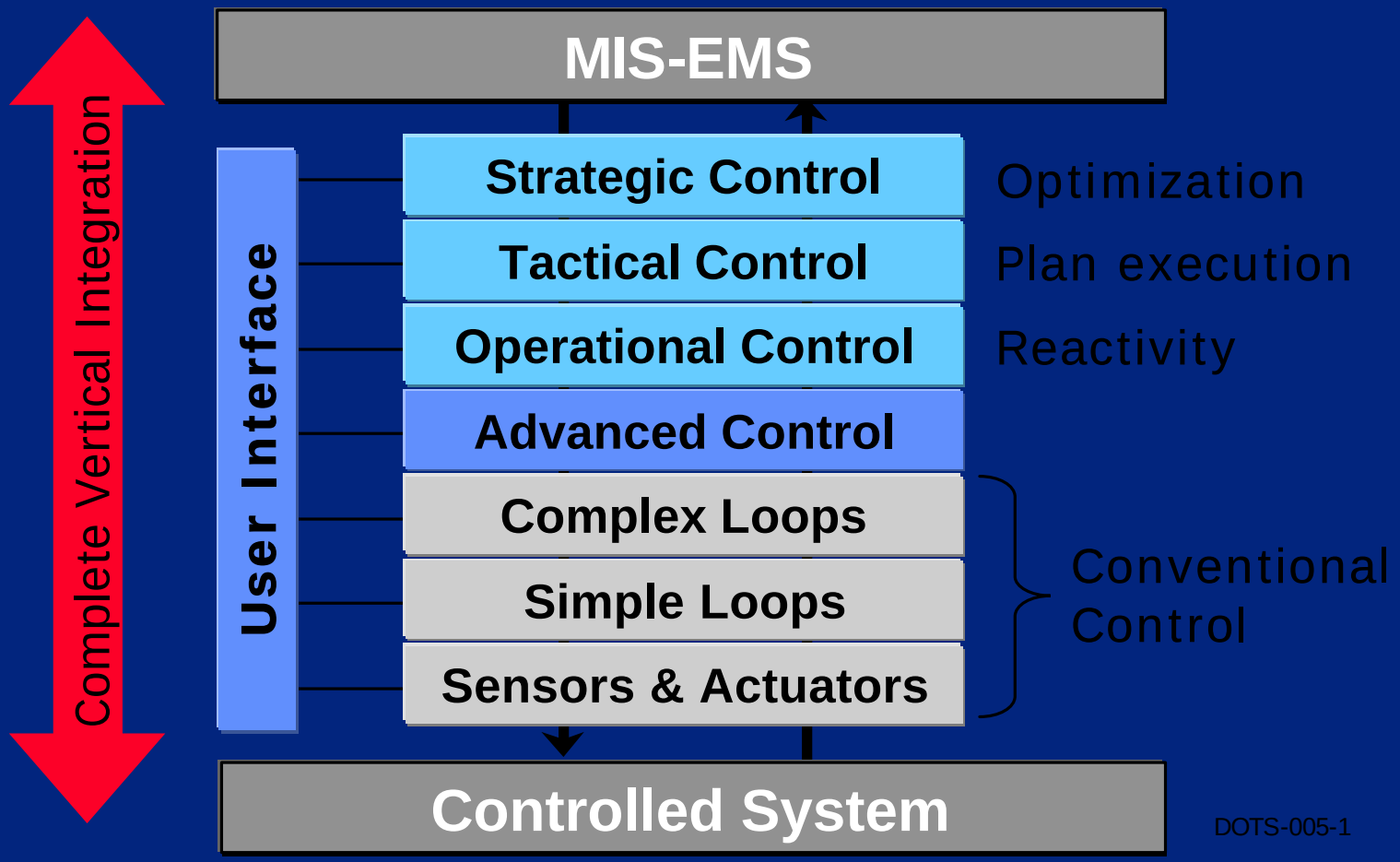
  jaclavijo@scilabs.es

- Future informative web site
  www.ist-dots.org

CORBA in Control Systems

What is the role of the Common Object Request Broker Architecture in control systems ?

CVI / CHI


MIS-EMS
Complete Vertical Integration
User Interface
Strategic Control
Tactical Control
Operational Control
Advanced Control
Complex Loops
Simple Loops
Sensors & Actuators
Optimization
Plan execution
Reactivity
Conventional Control
Controlled System
DOTS-005-1

Design Principles

- Conformant
- Suitable
- Composable
- Modular
- Extensible
- Scaleable
- Simple
- Standard
- Proven
- Performant

A CORBA Model for IEC-61850

Structure and contents of the GMD document

Alignment of IEC 61850

- Alignment of IEC61850 with OMA
  - Function and logical node concepts
  - Interface model
  - Pervasive 3-leveling
  - Message concept
  - Logical connections
  - Object activity and interaction

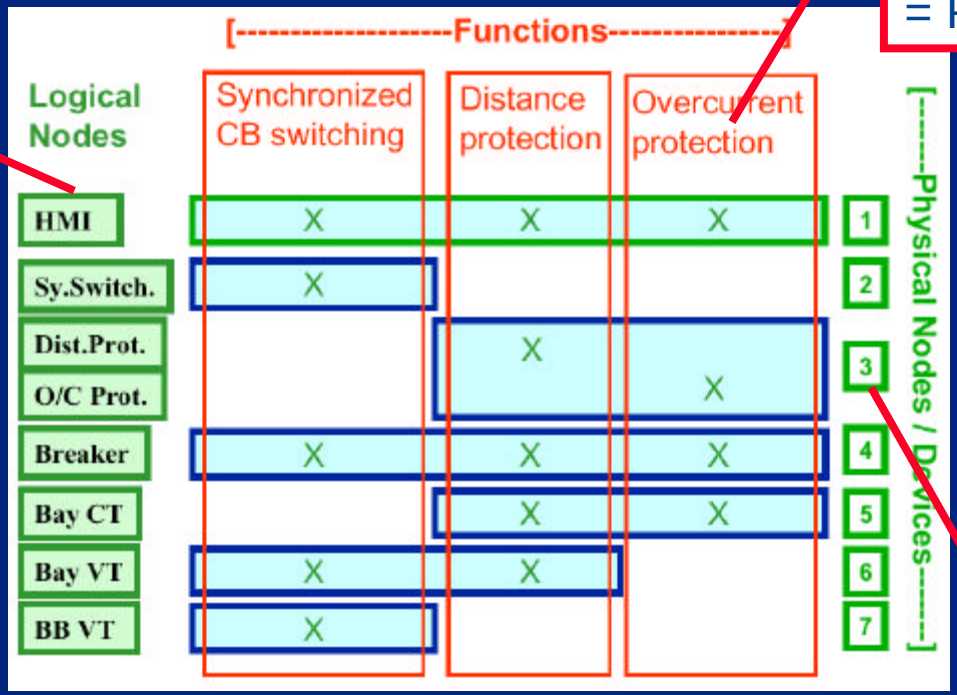
Core Modeling Guidelines

- Functions
- Logical Nodes
- PICOMs
- Logical Devices

DOTS Base Mapping

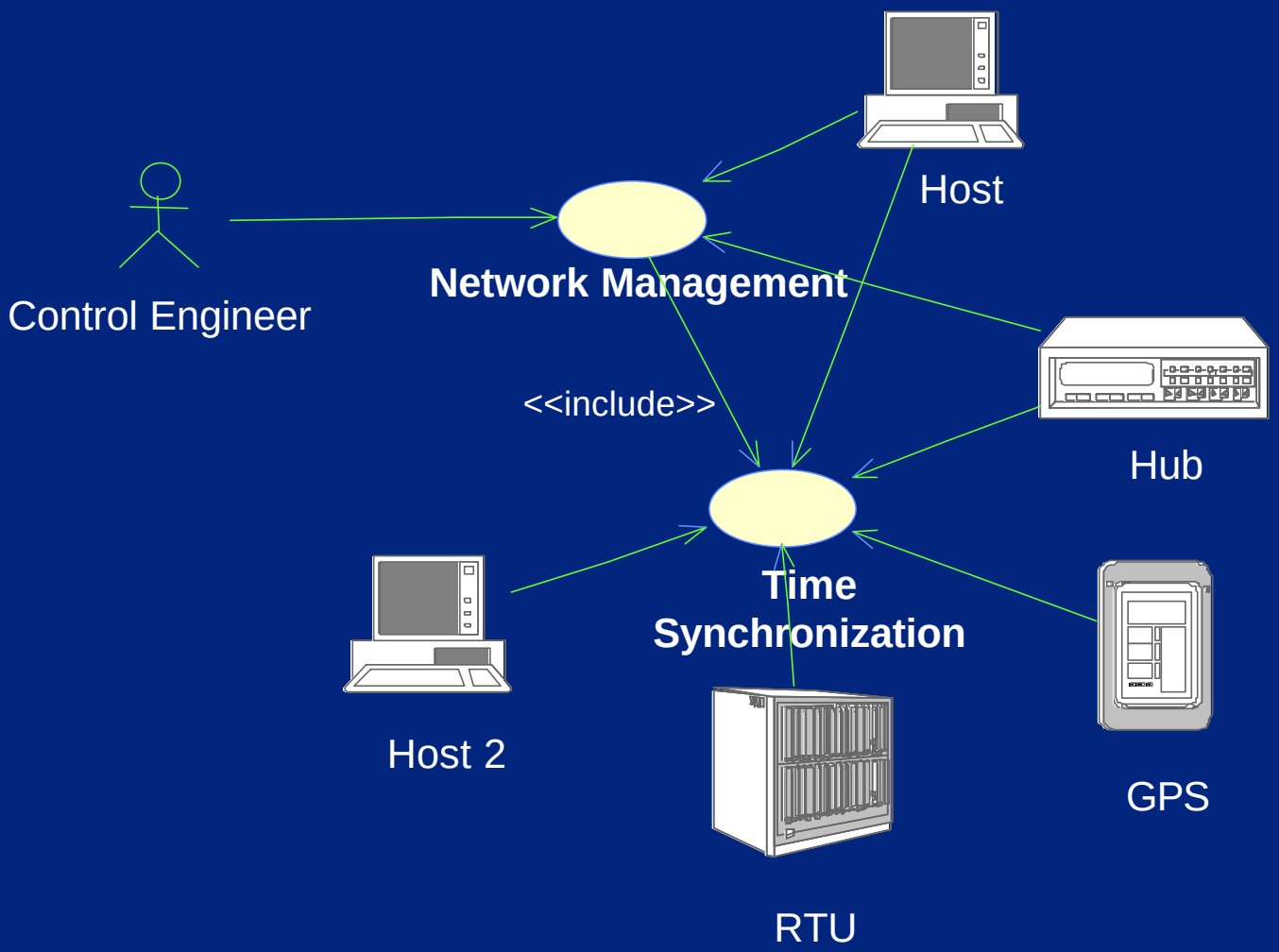
Objects
= Servants

Collaborations
= Patterns

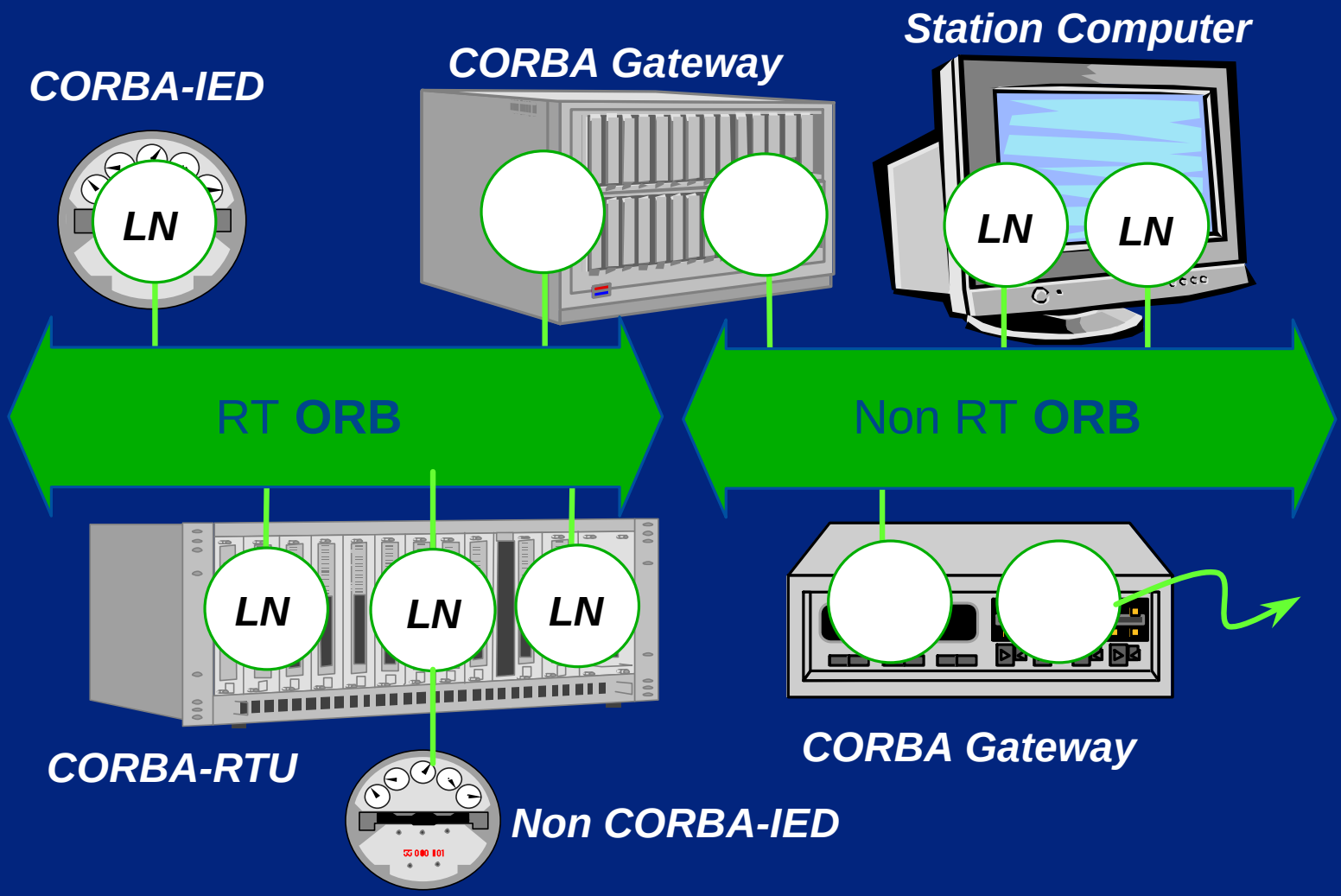


Deployment
= Servers
+Nodes

Use-Cases


Host
Control Engineer
Network Management
<<include>>
Hub
Time
Synchronization
Host 2
GPS
RTU

Domain Architecture

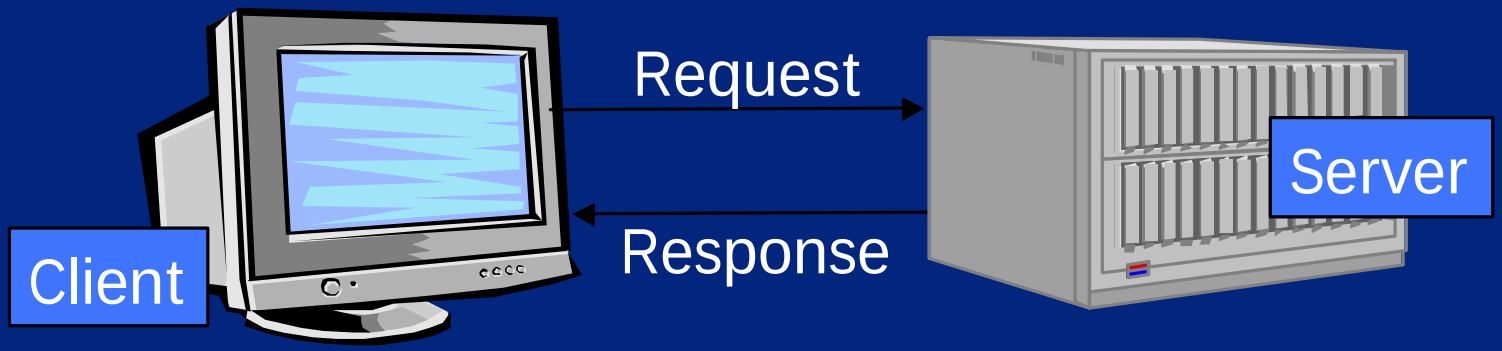


Specific Communication Service Mapping

Structure and contents of the SCSM to CORBA document

What is the ACSI

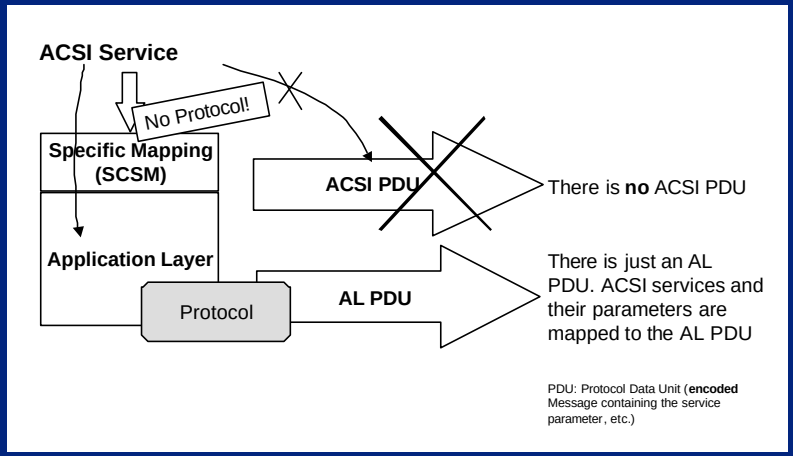
- The ACSI is an Abstract Communication Service Interface
- Is used by IEC 61850 clients to request services from IEC 61850 servers

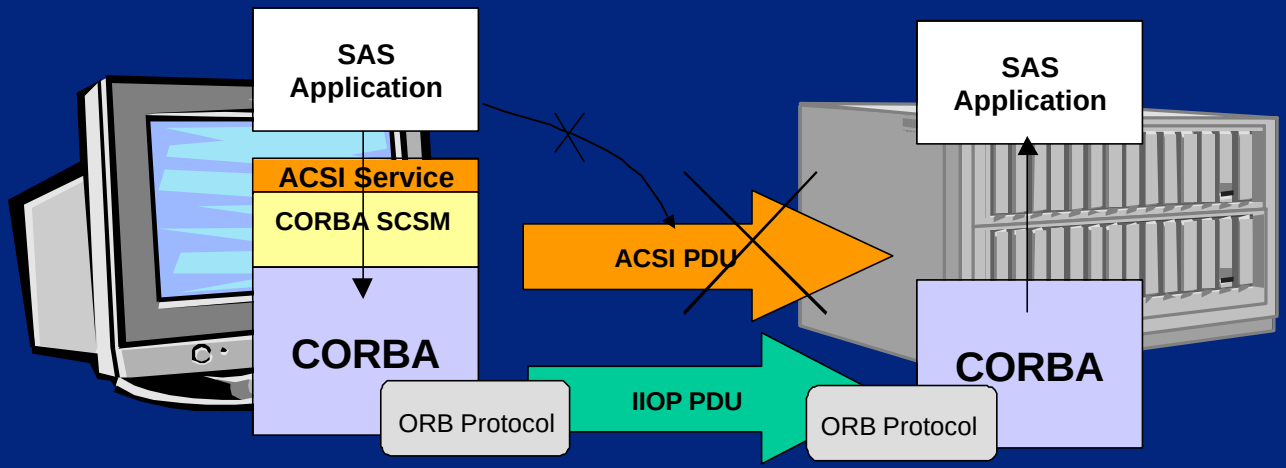


Why SCSMs ?

- Because the ACSI is abstract it needs concrete realizations to be usable
- They are called SCSMs, i.e.
  - Specific
  - Communication
  - Service
  - Mappings
- The purpose of this work is to elaborate a SCSM to CORBA

What is the mapping ?



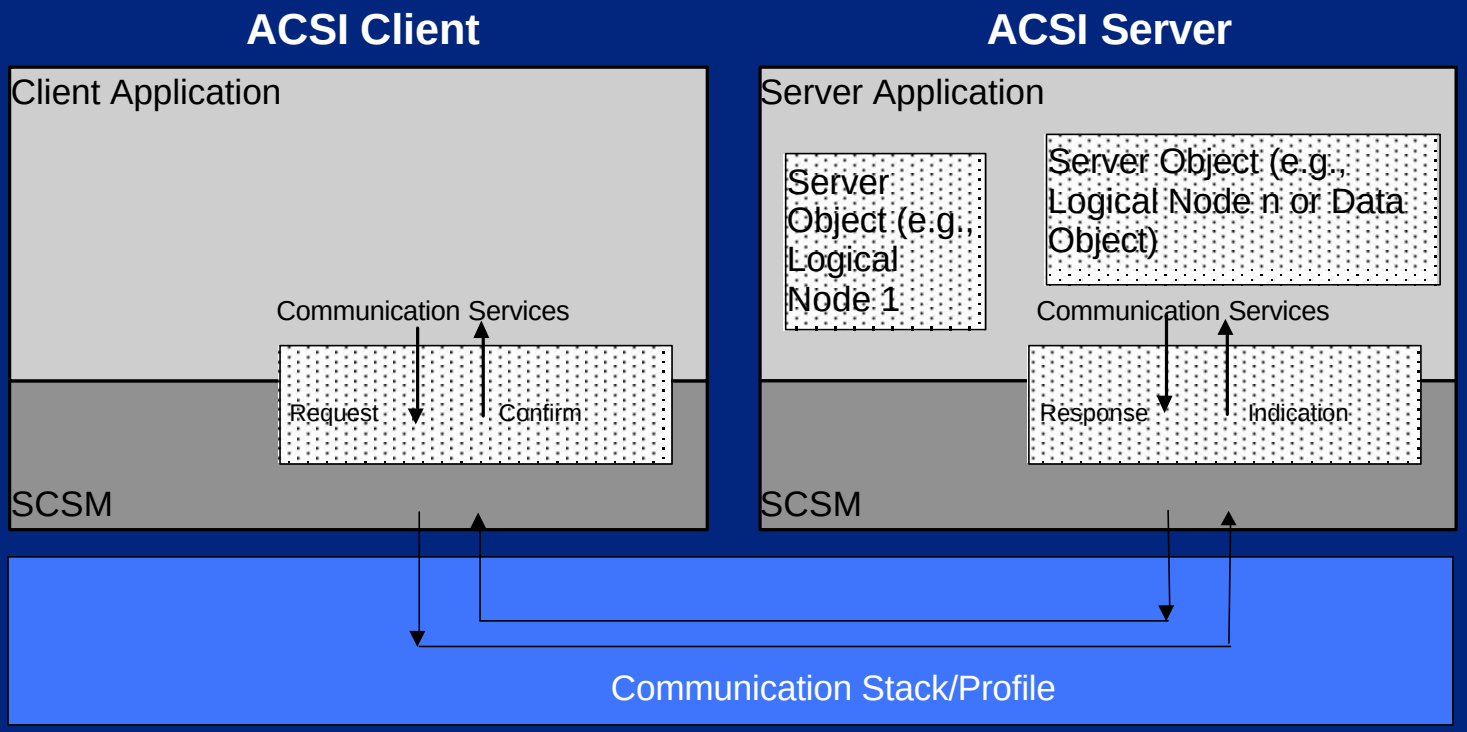


61850 & CORBA Assessment

Assessment of the fitness of 61850 ACSI and CORBA models

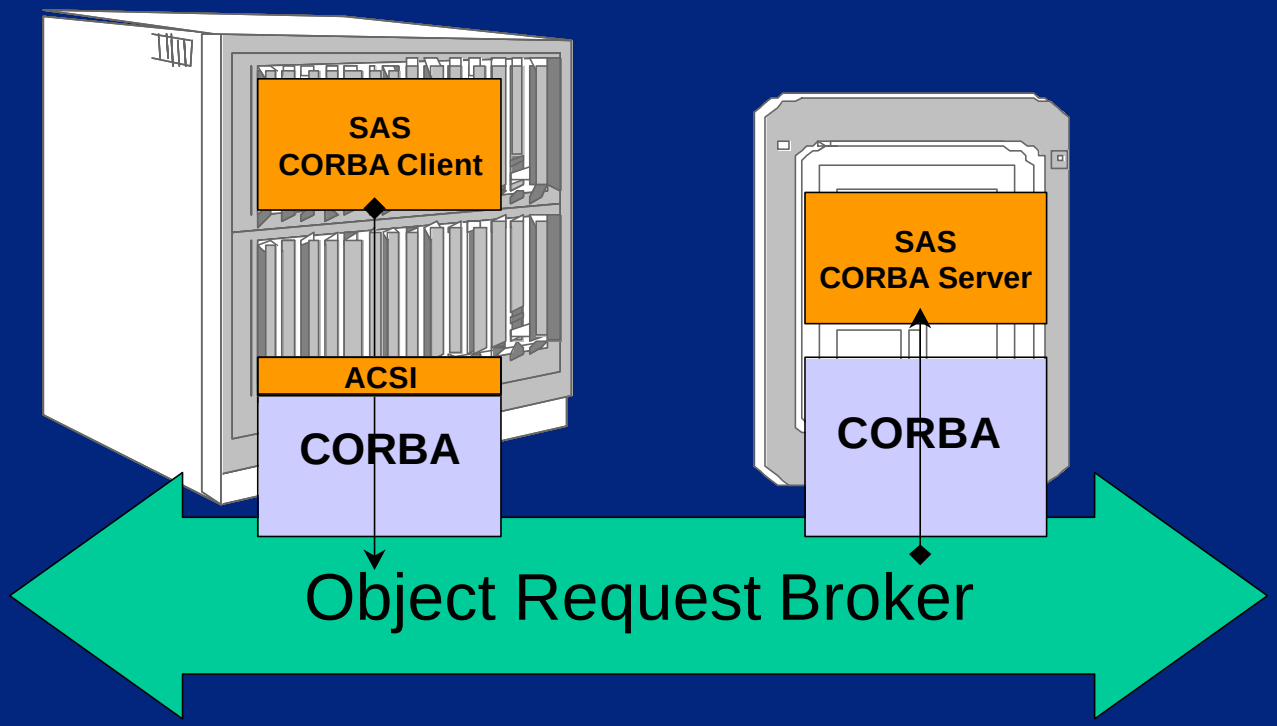
Does it Fit ?

- This is the IEC 61850 view of the ACSI



Does it Fit ?

- YES
- This is the CORBA View:



Main problems

- The ACSI is not fully OO
  - In some parts it is truly OO
  - In others is a classical procedural system

- For example:
  - All interactions are performed against one single object: The ACSI server
  - Objects to manipulate are passed as parameters

Example

```
sequence <ObjectName> ObjectNameList;

// Strict 61850 version ---------------------
ObjectNameList Server::DataObjectDirectory(
    in DataObjectName name)
    raises (DirectoryFailed,NoSuchObject);

// More OO version --------------------------
ObjectNameList DataObject::Directory()
    raises (DirectoryFailed);
```

Mapping criteria

What are the decisions done in the mapping

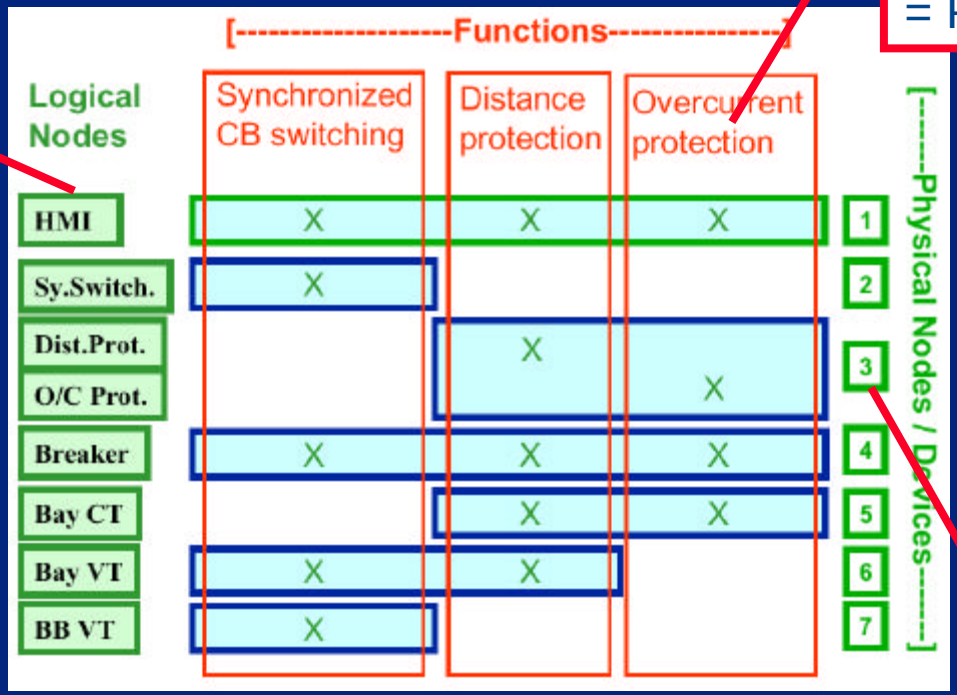
Fundamental Types

ACSI Data Type	CORBA Data Type
OCTET STRING	sequence <octet>
VisibleString	string
BIT STRING	sequence <boolean>
INTEGER	long
REAL	float
Sequence	struct
Array	Array
ENUMERATED	enum
NULL	Nil

DOTS Base Mapping

Objects
= Servants

Collaborations
= Patterns



Deployment
= Servers
+Nodes

Mapping of common types

- ObjectName and ObjectReference
- TimeStamp
- RelativeTime

Object Naming

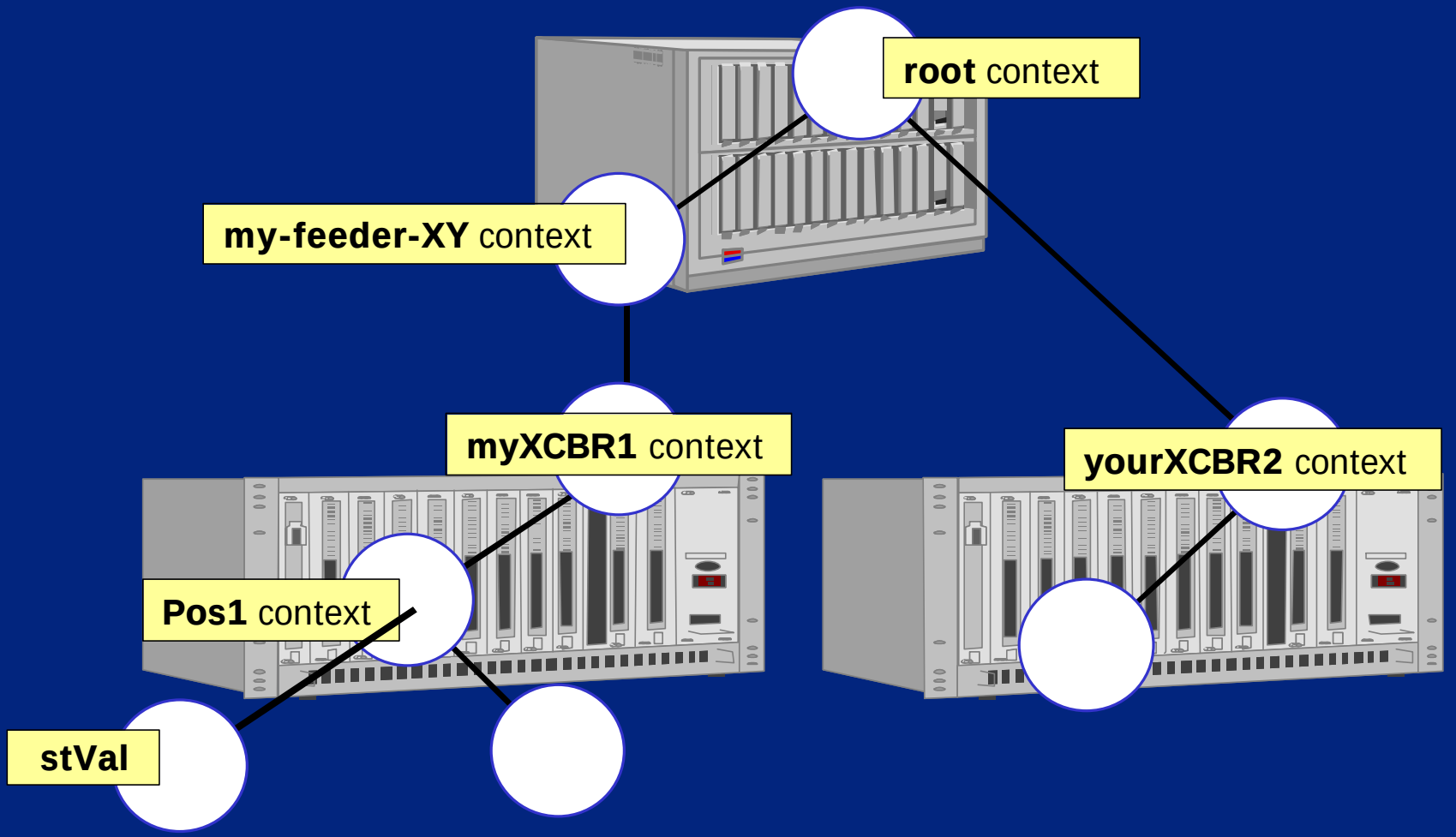
- CORBA Names generated according to naming rules in 61850:

```
<LD instance name>/
  <LN instance name>.
  <Data object instance name>.
  <Data attribute instance name>
```

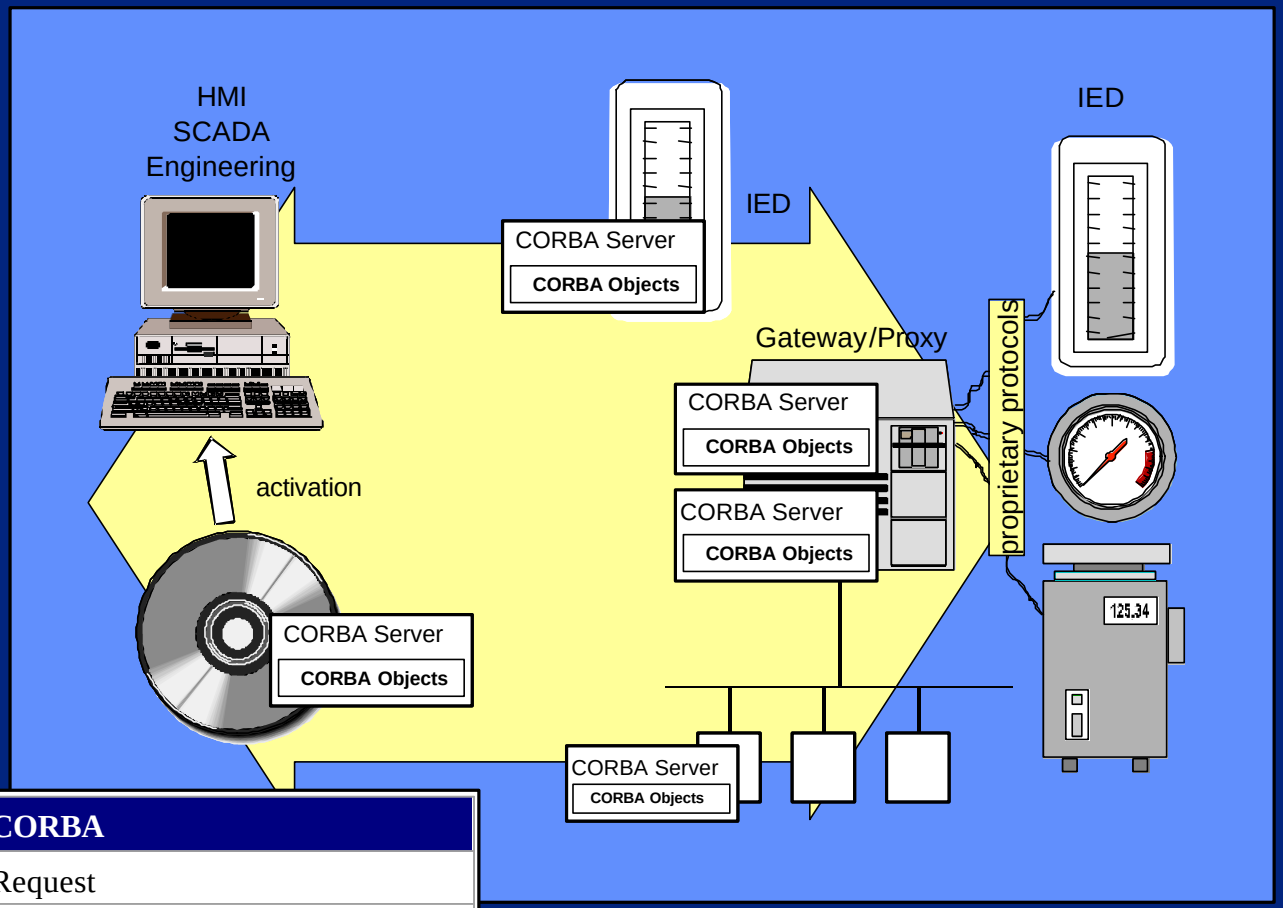
- Names managed using CORBA Naming Service

CosNaming::name	
id field	**kind field**
Process-AX	SERVER
my-feeder-XY	LOGICAL_DEVICE
myXCBR1	LOGICAL_NODE
Pos1	DATA_OBJECT
StVal	DATA_ATTRIBUTE

Naming context trees



Communication models



ACSI	CORBA
Request/response	Request
Request/no response	Oneway request
GOOSE message	Push event channel
Sampled value transmission	Push/pull real-time event channel

The mapping

Details and examples of the mapping

Sections

- Mapping of Server Model
- Mapping of Association Model
- Mapping of Logical Device Model
- Mapping of Logical Node Model
- Mapping of Data Object Model
- Mapping of Data Attribute Model
- Mapping of Publish And Subscribe Data Transfer
- Mapping of Generic Object Oriented System-wide Events
- Mapping of Control Model
- Mapping of Substitution Model
- Mapping of Transmission of Sampled Measured Values
- Mapping of Time Synchronisation Model
- Mapping of File Transfer

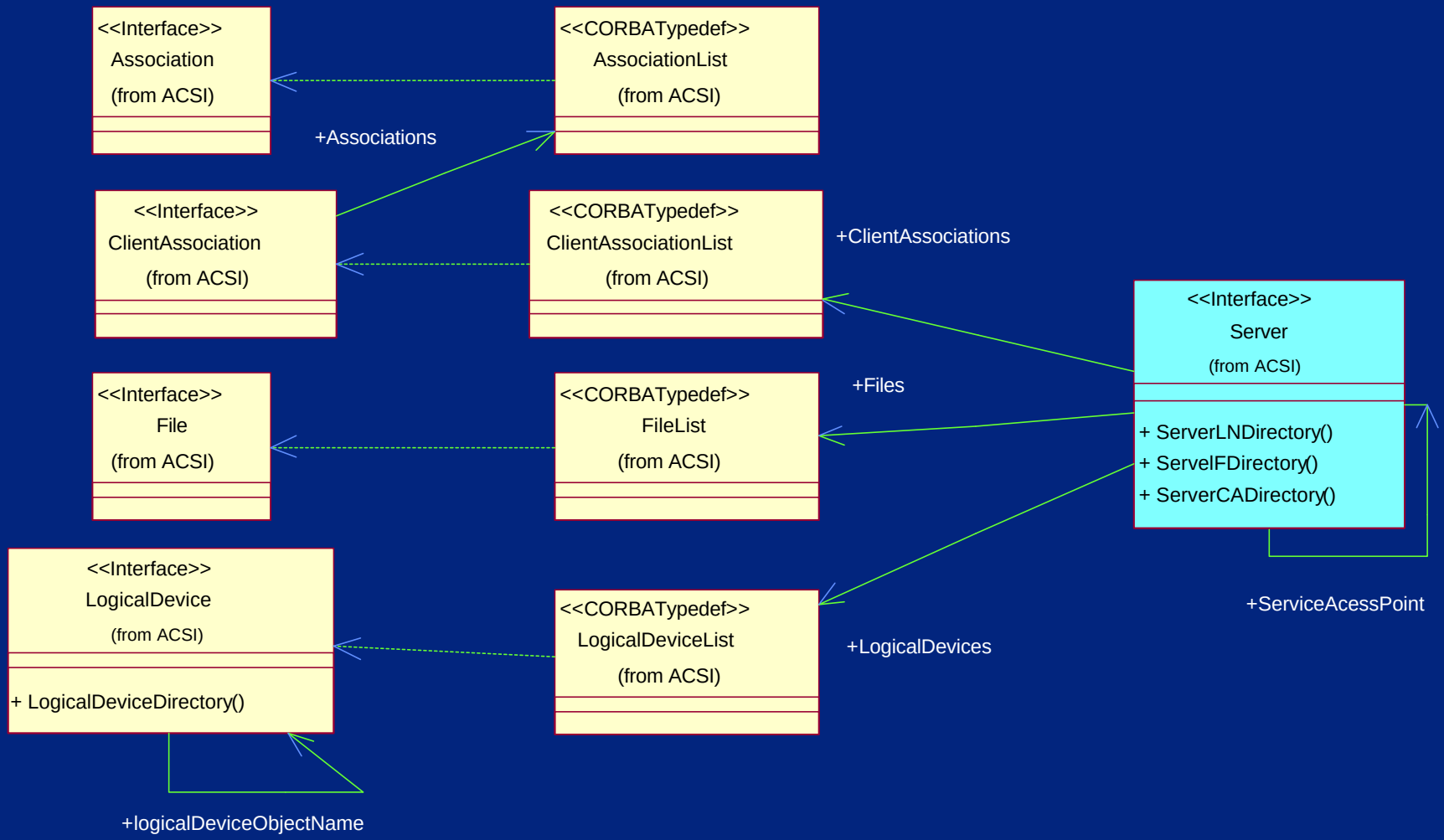
Typical structure

- Overview
- Data and class definition
- Services definition
- IDL
- UML

Example of IDL

```
interface Server {
  attribute ObjectName ServiceAccessPoint;
  attribute LogicalDeviceList LogicalDevices;
  attribute FileList Files;
  attribute ClientAssociationList ClientAssociations;
  any ServerDirectory (in ClassTypeCode classtype)
    raises (FailedDirectory,NoSuchType);
};
```

Example of UML



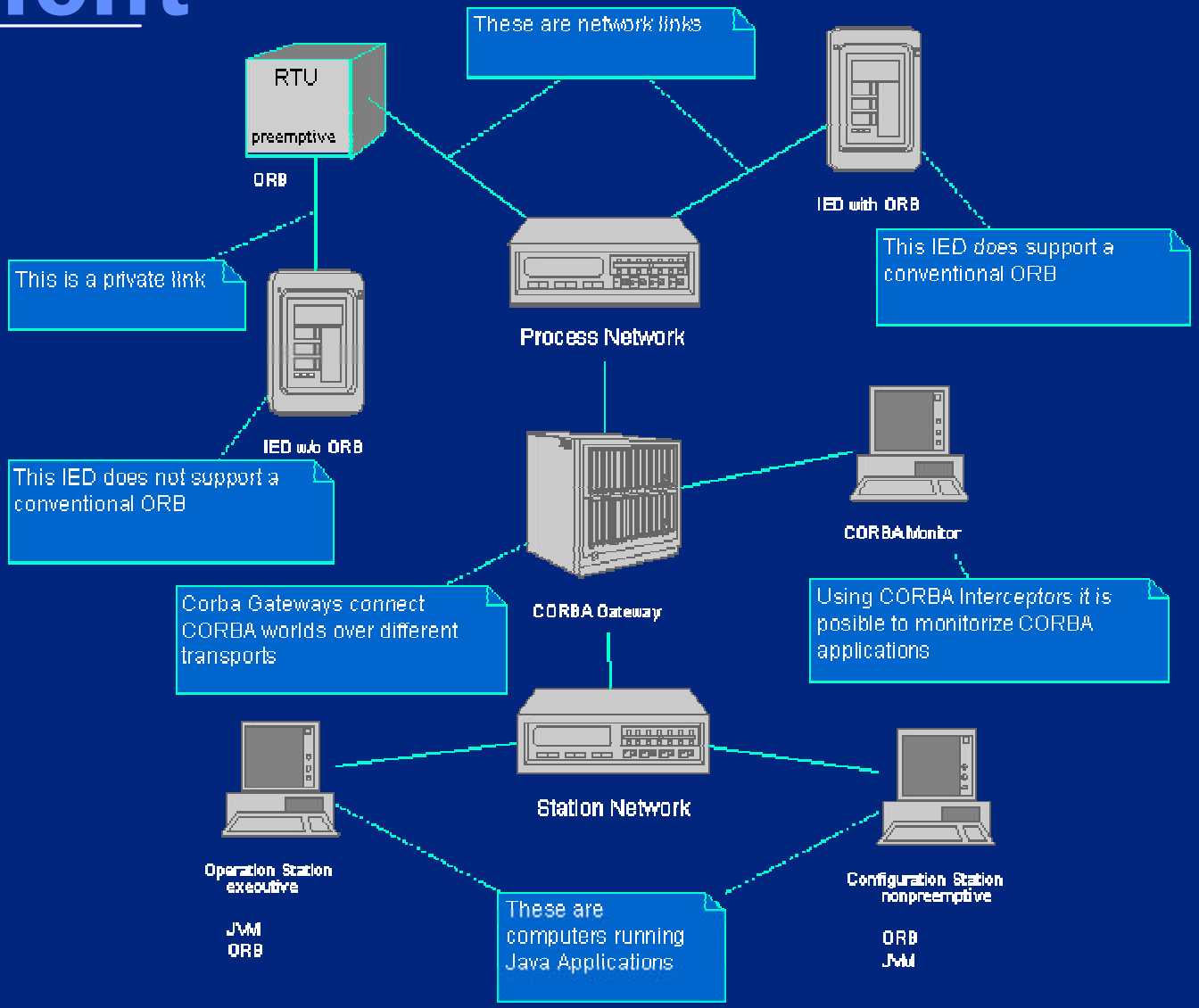
Pending Issues

Things that are still not finished in 61850 and DOTS

IEC 61850

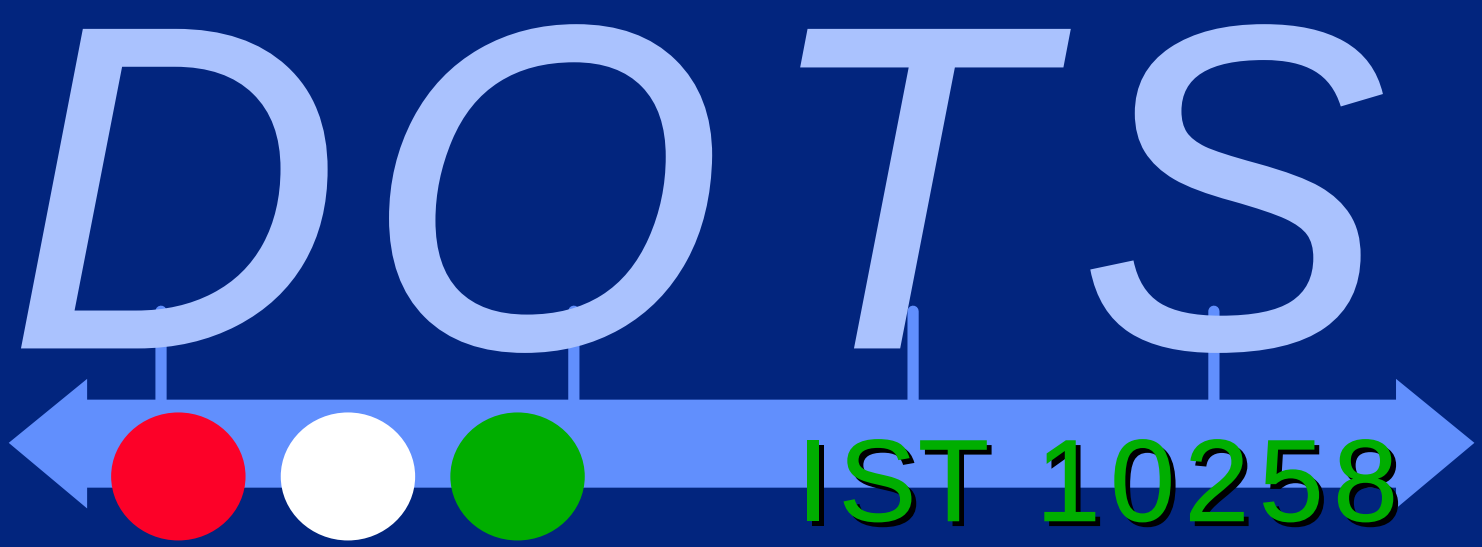
- Frozen (approved) standards
- Complete OO models (UML)

Deployment


These are network links
RTU
preemptive
ORB
IED with ORB
This is a private link
This IED does support a conventional ORB
Process Network
IED w/o ORB
This IED does not support a conventional ORB
CORBA Monitor
Corba Gateways connect CORBA worlds over different transports
CORBA Gateway
Using CORBA Interceptors it is posible to monitorize CORBA applications
Station Network
Operation Station
executive
JVM
ORB
These are computers running Java Applications
Configuration Station
nonpreemptive
ORB
JVM

DOTS activities

- IEC Model implementation
- Pluggable transports for CORBA based on IEC protocols
- Demonstrator application



ELIOP REE SCILabs DECAN-CS INNOVA UNINOVA UPM