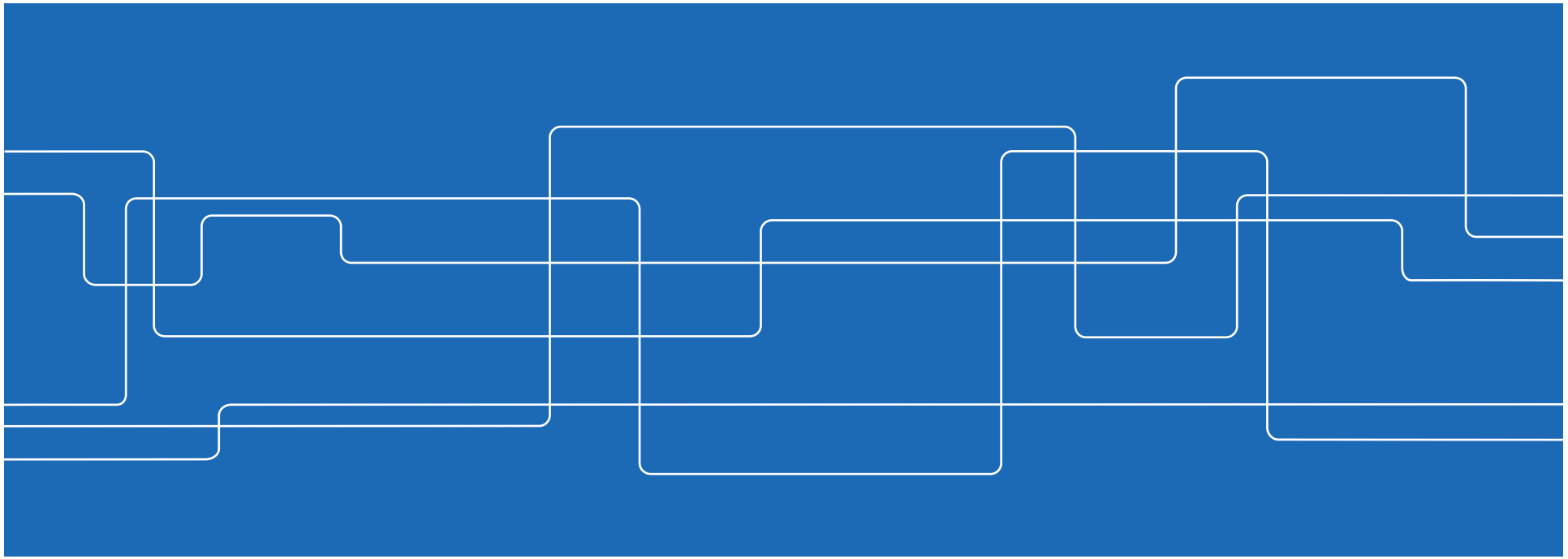
Welcome!

EH2745 Computer Applications in Power Systems
Introductory Course



Agenda

- Course Overview
  - Course philosophy
  - Course memo walk through
- Computer Applications in Power Systems
  - Repeating and looking ahead

- Hands-on

Course Philosophy

The course has two (conflicting) aims

1. Develop the student as a programmer
2. Develop the student in Machine learning and data analysis for power system decision making

Why conflicting?

Course Philosophy

We think you may have taken programming courses before
We think you may know something about information modeling
We think you may know something about data analysis & statistics
If you do not, we will teach you the basics

We want you to combine these skills in this applied course

Course registration

First: Please register for the course on ”My Pages” window open from March 16 – March 26

If you are not signed-up you cannot register. To sign-up, please contact your student counselor (Studievägledare)

Once registered, you will get access to the Social pages of the course.

Assessment & Grading

The course has three components for assessment and grading

Project Assignment #1 & Project Assignment #2

Performed in pairs, handed in as screencasts.

Can be graded as Fail, Pass or Pass with distinction

Voluntary test

To achieve higher grade than E, a 2 hour test will be given at the end of the course covering all topics.

Course Memo Walk-through

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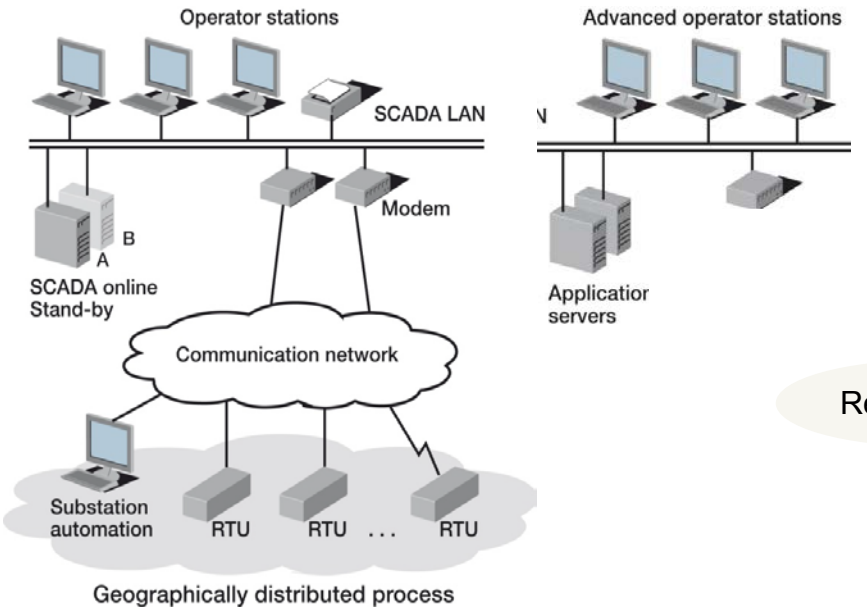
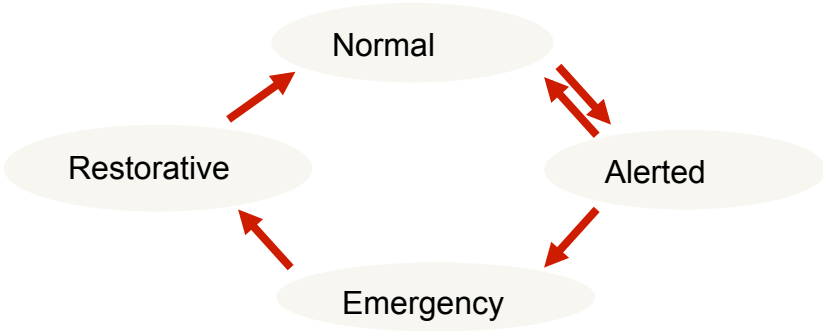
Power System Operation

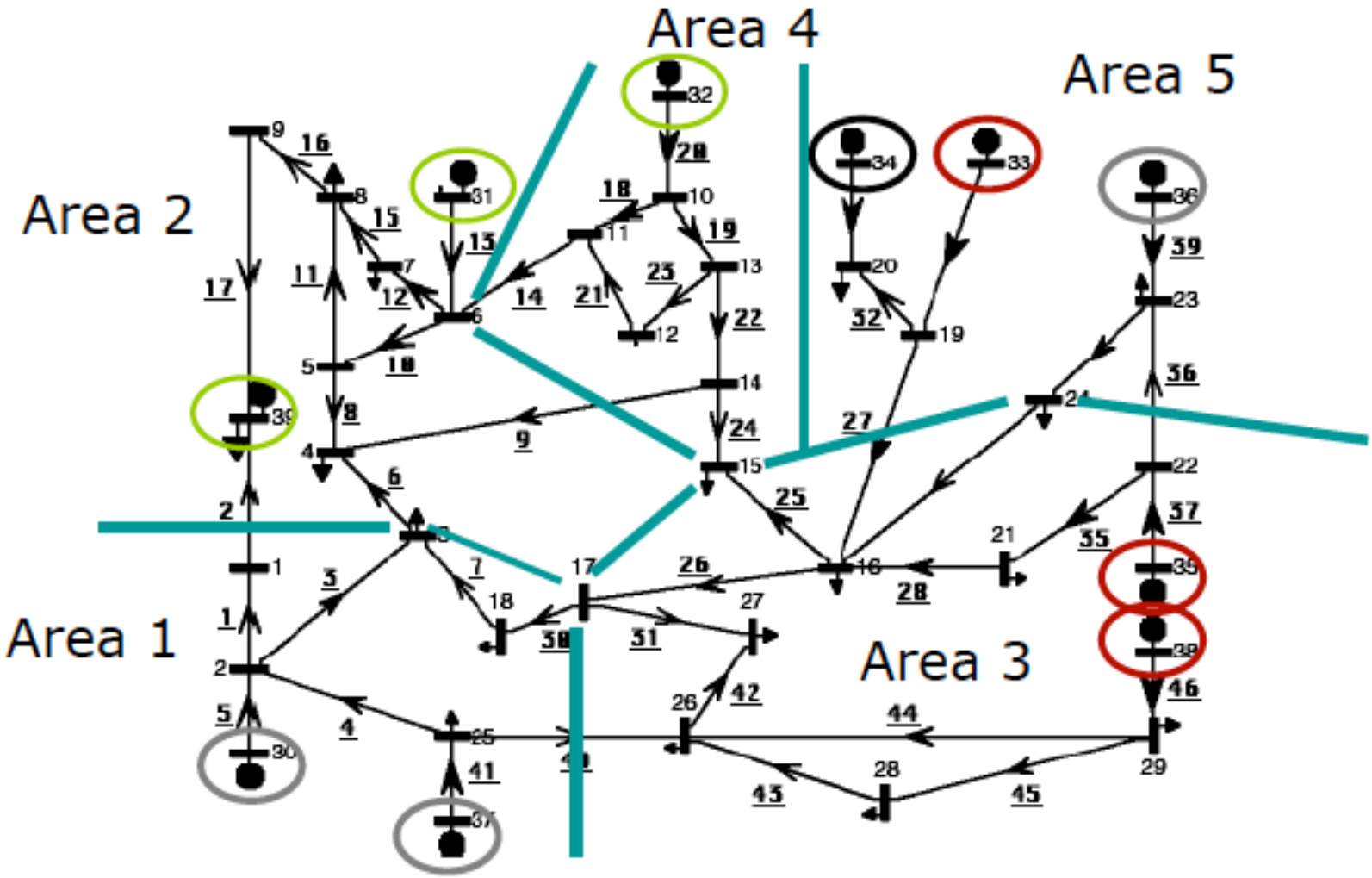
System-wide monitoring, planning & optimisation for reliable and cost efficient operation of the power system

Time scale: seconds to hours.

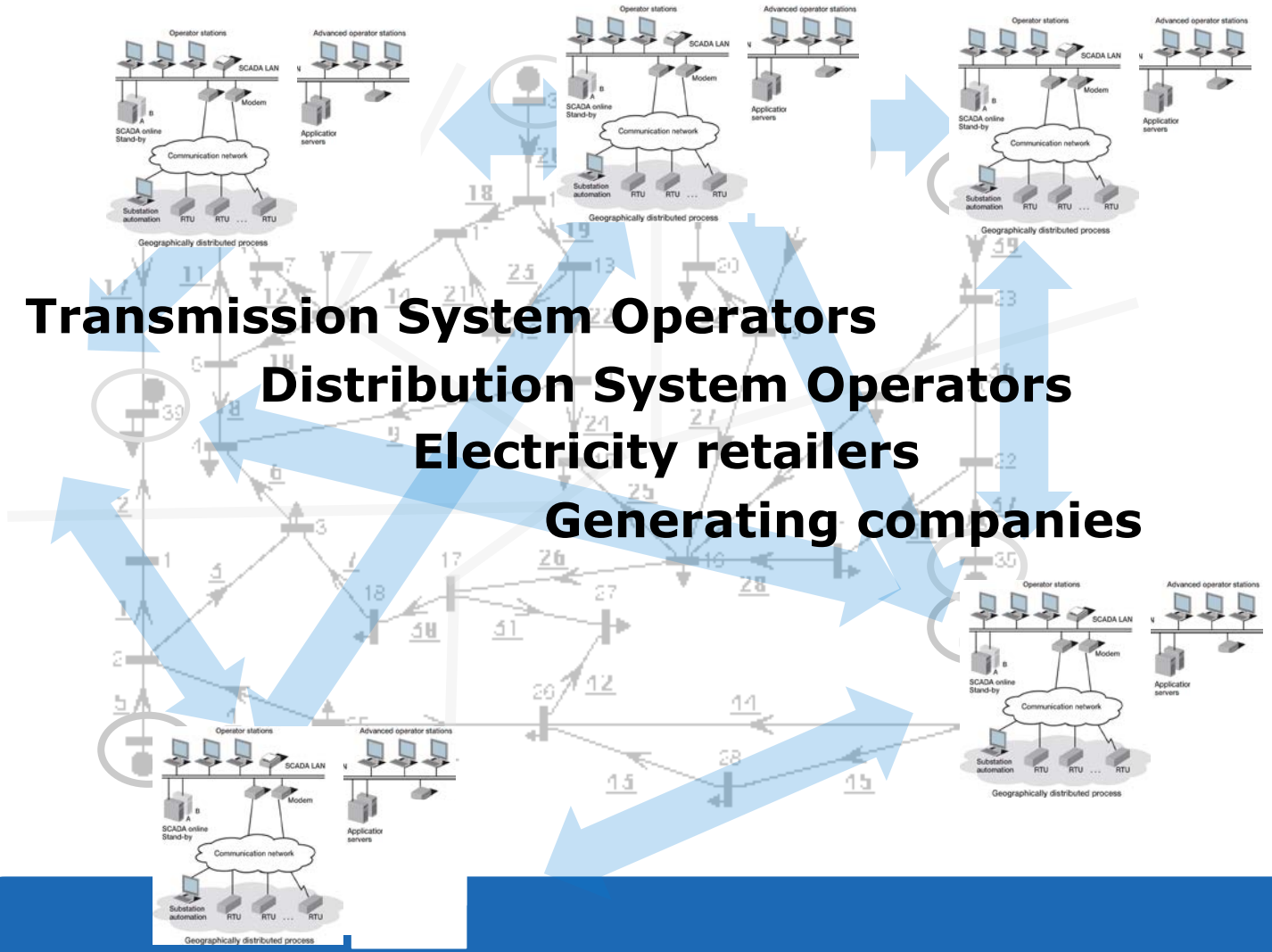




Deregulation – in practice



Coordination between actors



Transmission System Operators

Distribution System Operators

Electricity retailers

Generating companies

Safe and Optimal operation

Each actor wants to optimise theior operation within their limitations

Some of the actors have conflicting goals

The safety of the power system must not be jeopardised

Contingencies (unplanned events) must be managed

Access to data across organsiations is critical for some aspects fo this

Forecasting and predicting data you cannot get is a valuable replacement

Transmission vs Distribution

Transmission: backbone of the power systems and its main purpose is to transport energy in large volumes over large distance, from production to consumption center. With a purpose to minimize the resistive losses, the systems are operated at a high voltage levels, 100-400kV in EU.

Large systems, real-time control requirements

Distribution: deliver electrical energy to the end consumer. The network topology can be meshed but it is also possible to be operated as radial systems. Distribution grid employs all voltage levels between 100kV and 0.22kV.

Enormous systems, less strict real-time control

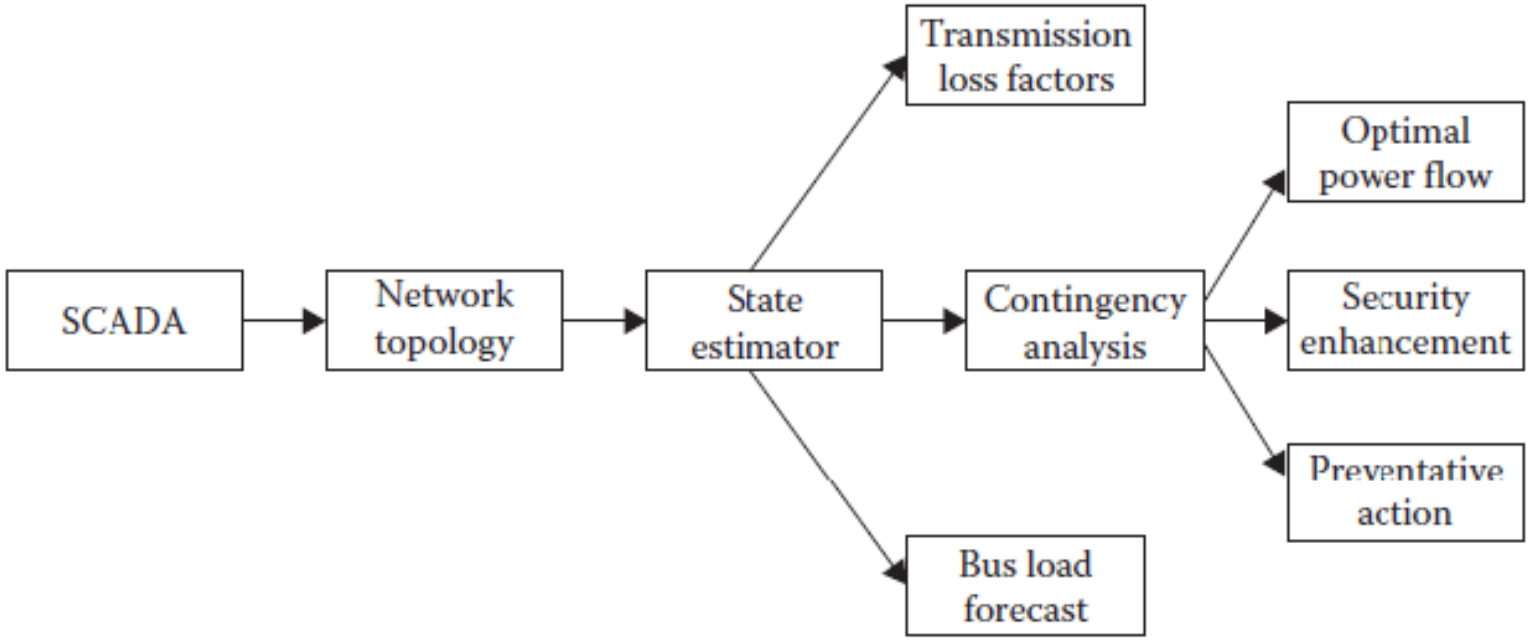
Coordination structures

In the **United States**, a system of regional transmission organizations is being implemented to help coordinate the activities of individual transmission system operators within larger regional markets. Independent System Operators (ISO) have responsibility for system security and are involved in market operation.

In the **Nordic region**, system operation is undertaken by Transmission System Owners (TSO) in each country with coordination achieved through cooperative agreements that address operational standards and emergency procedures. The Nordic TSOs are involved in electricity market operation

In the **United Kingdom**, system operation is undertaken by a single independent transmission owner, and market operation is independent of the transmission owner.

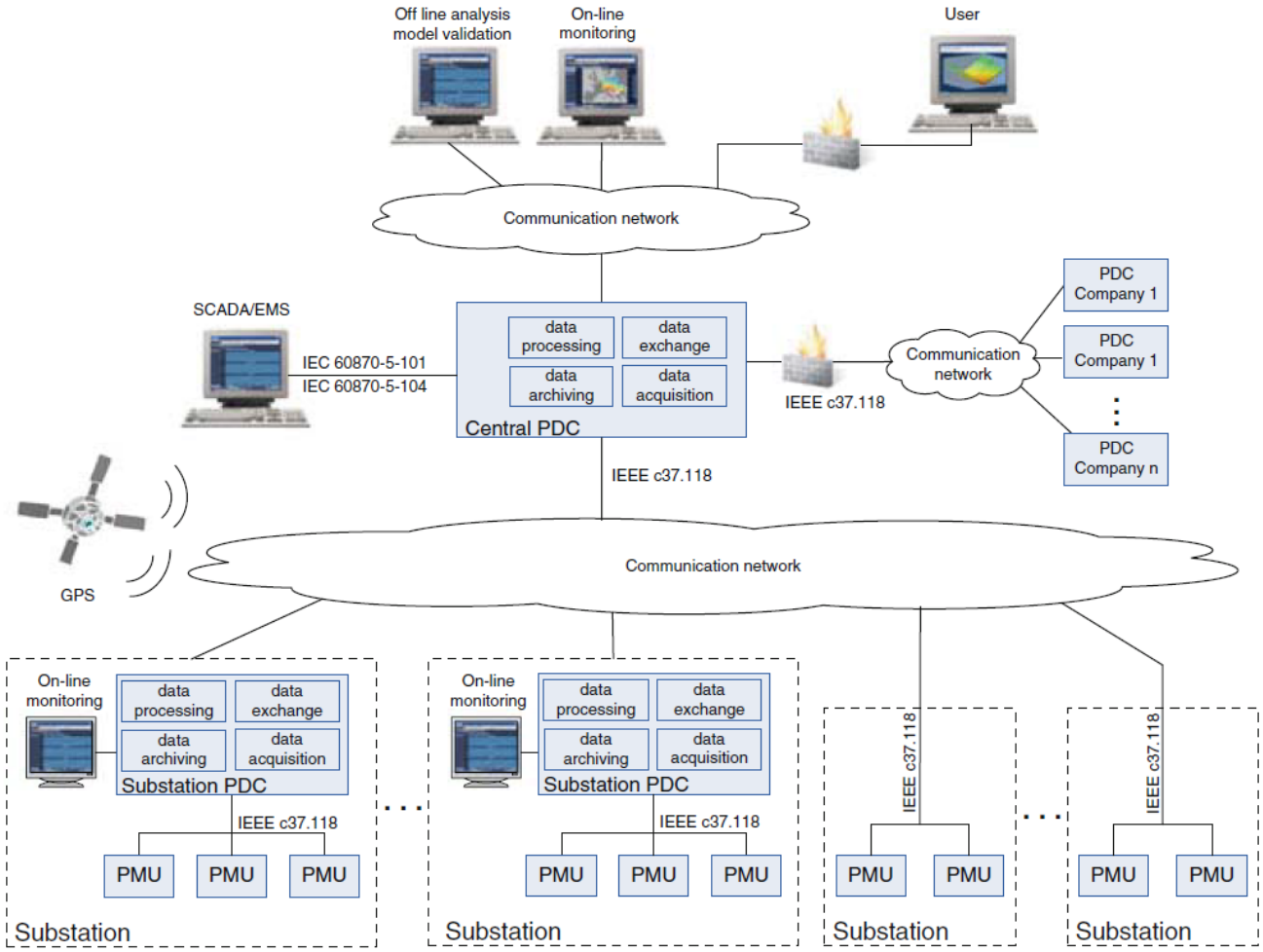
Traditional Static security analysis



Study network analysis

Power flow	Contingency analysis	Optimal power flow	Short circuit analysis

Wide Area Measurement and Control Systems



Transmission System Challenges

If, when and how the data can be used effectively, it will assist in several diverse fields of control and operation of transmission systems

- Enhanced contingency analys through the integration of probabilisitic models
- Enhanced day ahead planning incorporating forecasts of renewable production, load variations and grid models
- Real-time dyanmic security assessment using Phasor Measurement units

Responsibiliites of the DSO

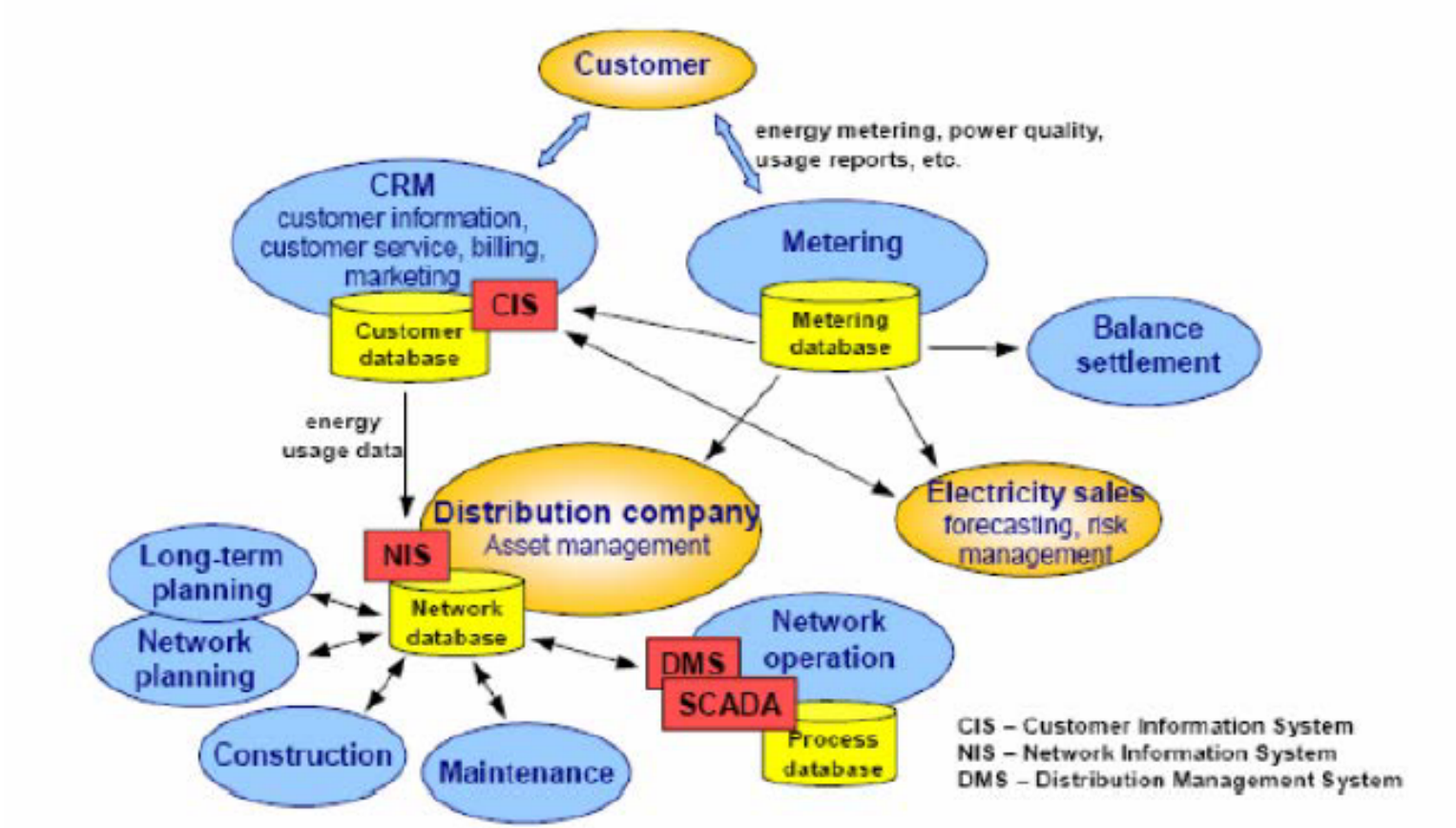
The overall aim of a Distribution System operator is to

- Maintain grid quality in terms of reliability and voltage profile while at the same time keeping costs low.
- Considering the monopoly status of a DSO, all partners should be treated fairly.

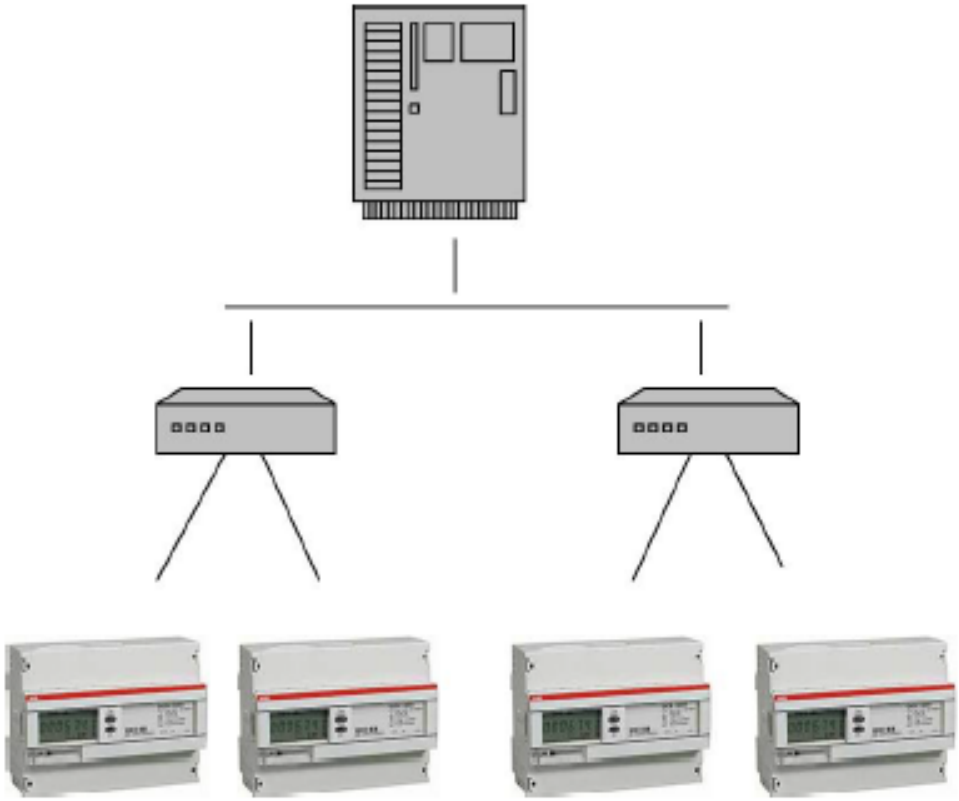
Traditionally, this has invovled offline optimisation of a stable grid with predictable consumers making the challenge less ”electroctechnical” and more administrative in nature.

Changes in production (PV, RES) and consumption (prosumers, EVs) are graudlaly changing this.

Systems at DSOs for power system control



Automatic Meter Reading



- Consists of
  - Central system
  - Collecting points
  - Intelligent meters
- Communication
  - PLC
  - Radio
  - GSM/GPRS
- Collects meter values cyclically or on request.
  - Hourly, daily, monthly…
  - The data rate is lower than SCADA systems

Distribution Systems

And for Distribution system, similarly, if data can be put to work, things like the following can be achieved.

- Enhanced prediction of production in renewables, and its impact on grid stability
- Enhanced prediction of end-user behaviour, including consumption as well as load
- Enhanced analysis of measurements for support in asset management and condition based maintenance
- Identification of non technical losses and low inteisty faults tjhrough anomaly detection in measurements

Common Challenges

Data availability

How to access data from across different systems and different companies – an interoperability challenge

Data quality

How to ensure data is consistently timestamped, checked for accuracy, correctly identified, validated.

Data management

How to store and access large amounts of data once stored in a consistent format

Data Analysis

How to create useful information for decision support for people, or for decisions by machines

So, that is why the course contains

Information modeling

Common Information model to manage data interoperability and data quality

Machine Learning

To develop some (simple) applications that can analyse data to create information for decision support

Java programming

To make it real…..

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