# 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**

Power System data modeling | Machine Learning

Software Development in Java

We are using a ”learning by doing” approach to be able to create an interest in the topic and at the same time build some understanding

## Machine Learning at KTH

There is a lot of Machine learning courses at KTH

DD2421 Machine Learning 7.5 credits – P1
DD2434 Machine Learning, Advanced Course 7.5 credits – P2
DD2380 Artificial Intelligence 6.0 credits – P1

Our hope and ambition, is that you take one of these as a follow up to this brief introduction

## Why Java?

Why are we "insisting" on Java as opposed to
Matlab? R? Python? C?
*Well, we are not really…...*

We want you to develop algorithms from scratch
Matlab, R, Python, Java, C,..
We want it to result in stand-alone running applications
~~Matlab, R,~~ Python, Java, C,..
We want to work with Industry type Power System Data files
~~Matlab, R,~~ Python, Java, C,..
We think that some of you are beginners in programming
Matlab, R, Python, Java, ~~C,..~~

So yes, you can work in Python if you wish

## Can we use libraries? Copy code?

Yes, but all code used needs to be explained at the sourcecode level in your screencasts.

- The trouble of learning a third party code library for a certain algorithm, and adapt it to your assignment is more work than writing the code from scratch.
- Exceptions include libraries for e.g. Complex numbers other math libraries

How about collaborating across groups?

- You are not allowed to collaborate at the code level – i.e. Sharing code and then only creating separate screencasts. The handed in code will be checked for ”plagiarism”

## Course registration

First: Please register for the course on ”My Pages” window open now!

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 C, a 2 hour test will be given at the end of the course covering all topics.

## Course Memo Walk-through

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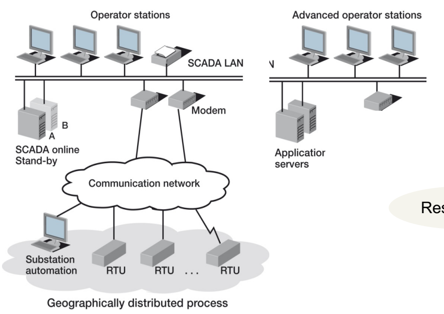
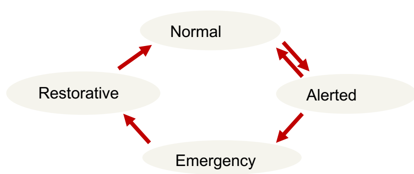
## Power System Operation

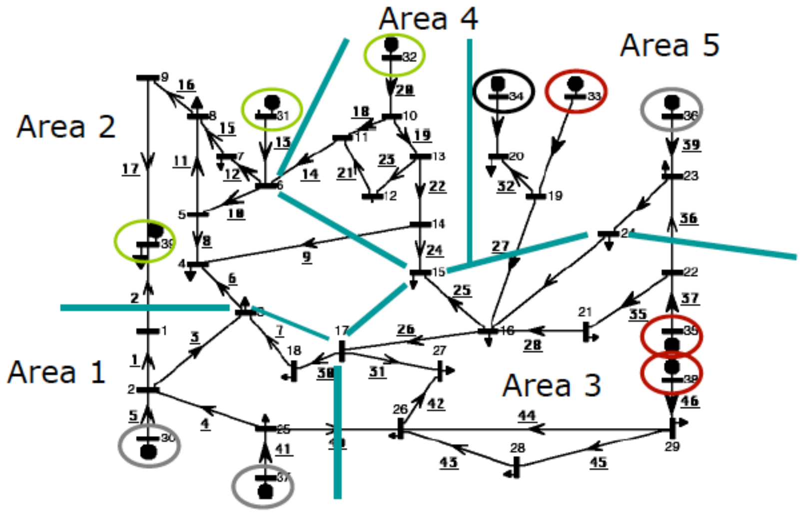
System-wide monitoring, planning & optimisation for reliable and cost efficient operation of the power system

Time scale: seconds to hours.

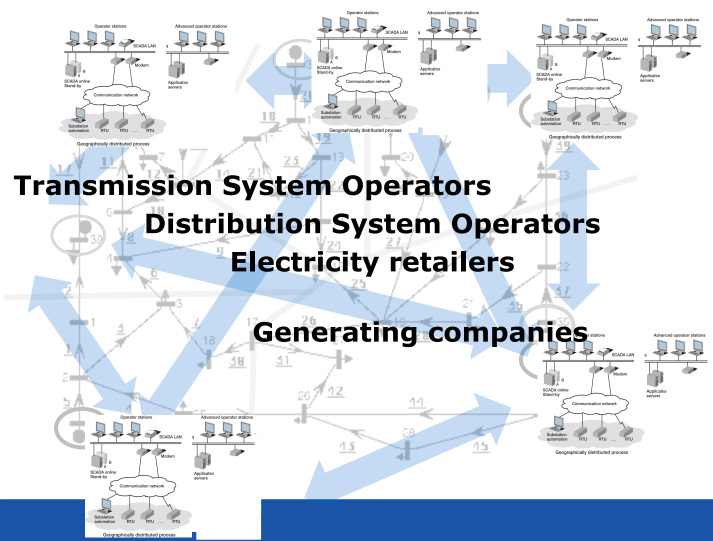


## Deregulation – in practice




## Coordination between actors



**Transmission System Operators**

**Distribution System Operators**

**Electricity retailers**

**Generating companies**

## Safe and Optimal operation

Each actor wants to optimise their 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 for this***

***Forecasting and predicting data you cannot get is a valuable replacement***

## Transmission vs Distribution

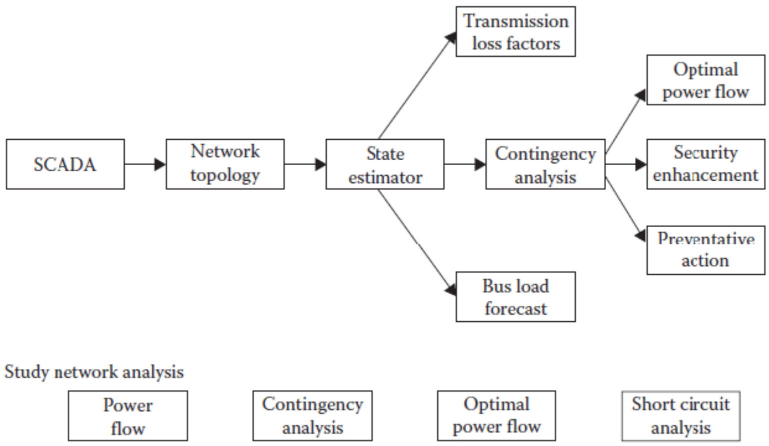
**Transmission:** backbone of the power systems and its main purpose is to transport energy in large volumes over large distance, from production to consumption center. With a purpose to minimize the resistive losses, the systems are operated at a high voltage levels, 100-400kV in EU.

***Large systems, real-time control requirements***

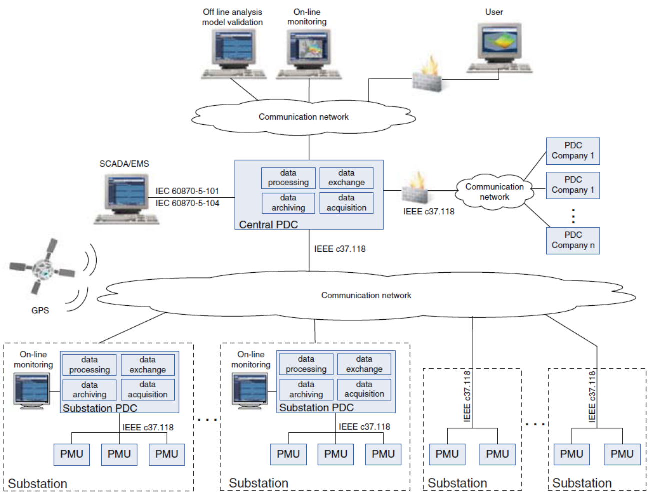
**Distribution:** deliver electrical energy to the end consumer. The network topology can be meshed but it is also possible to be operated as radial systems. Distribution grid employs all voltage levels between 100kV and 0.22kV.

***Enormous systems, less strict real-time control***

## Traditional Static security 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 dynamic security assessment using e.g. Phasor Measurement units

## Responsibiliites of the DSO

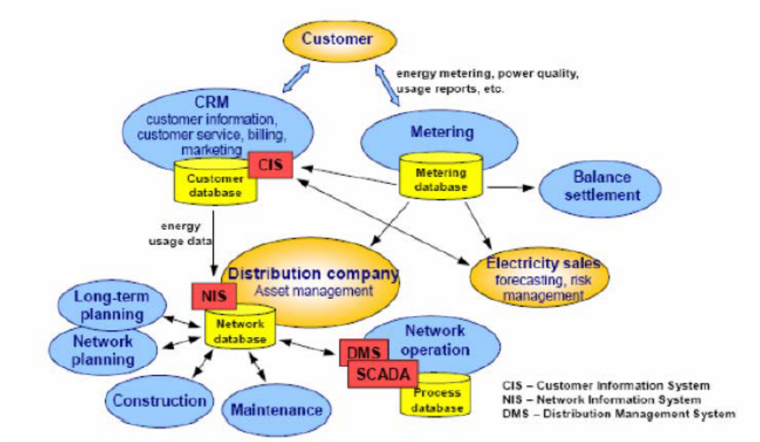
The overall aim of a Distribution System operator is to

- 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.

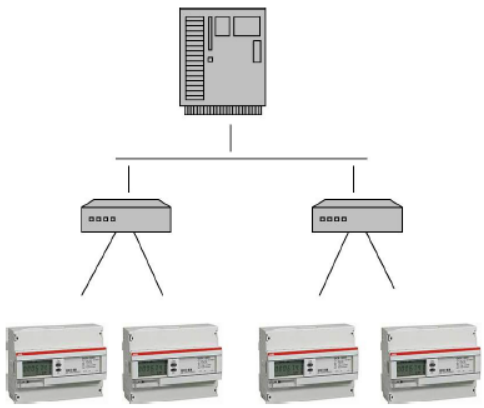
Traditionally, this has invovled offline optimisation of a stable grid with predictable consumers making the challenge less ”electroctechnical” and more administrative in nature.

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 (or python) programming***

To make it real…..

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