Developing Power System Operations: Combining Visualization and Online Analysis Using the PI System

Presented by **Antti-Juhani Nikkilä**

FINGRID

Introduction

Fingrid is the transmission system operator of the Finnish electricity transmission system, which is part of the Nordic power system.

Transmission system operators have system responsibility:

- technical use of the power system
- managing power balance
- imbalance settlement and energy reporting

Power exchanges:

- electricity price formation
- market-based allocation of cross-border transmission capacity

PI System Overview

2 PI Systems and a test environment

- 150 000 tag high availability system for SCADA, Power Quality, etc. data
- 1000 tag system for PMU data

For PMU data

- 2 PI Servers
  - one for 400 day storage, automatic deletion
  - one for continuous storage
- Over 4 TB storage processed continuously

PI Visualization Suite

PI AF

High Availability

PI Interfaces
PI OPC

Aspects on Analyzing Power System Data

Several use cases and analysis requirements
- Both real-time and archived data
- Short and long time periods
- Sampling rate of data sources vary from few seconds to tens of samples per second

Developing new methods and analysis algorithms is an iterative process
- Platforms need to be flexible
- Ability to test different methods before full scale implementation
- Basic functionalities should be easy to use

Asset management

System monitoring and disturbance analysis

Analysis of long term trends and changes

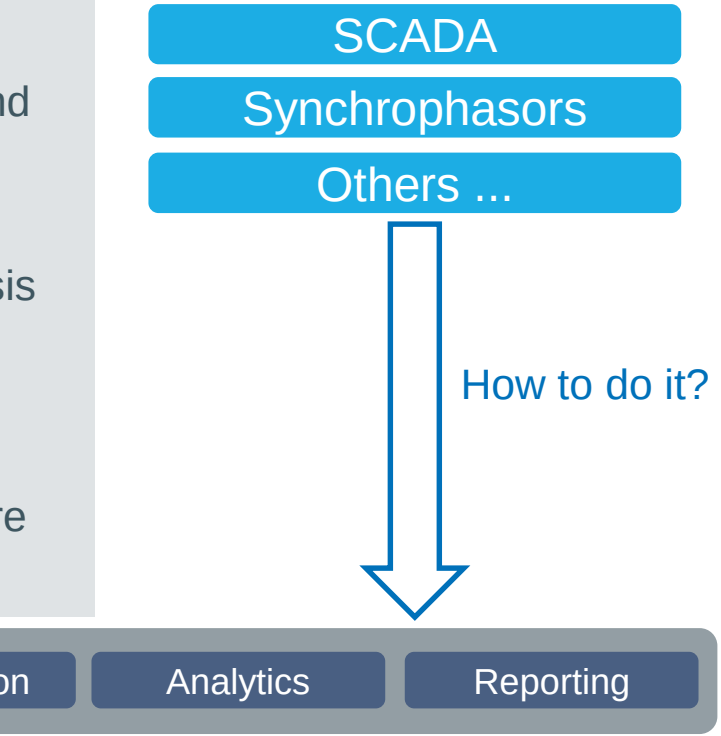
Model validation and improvement, forecasting

The Challenge

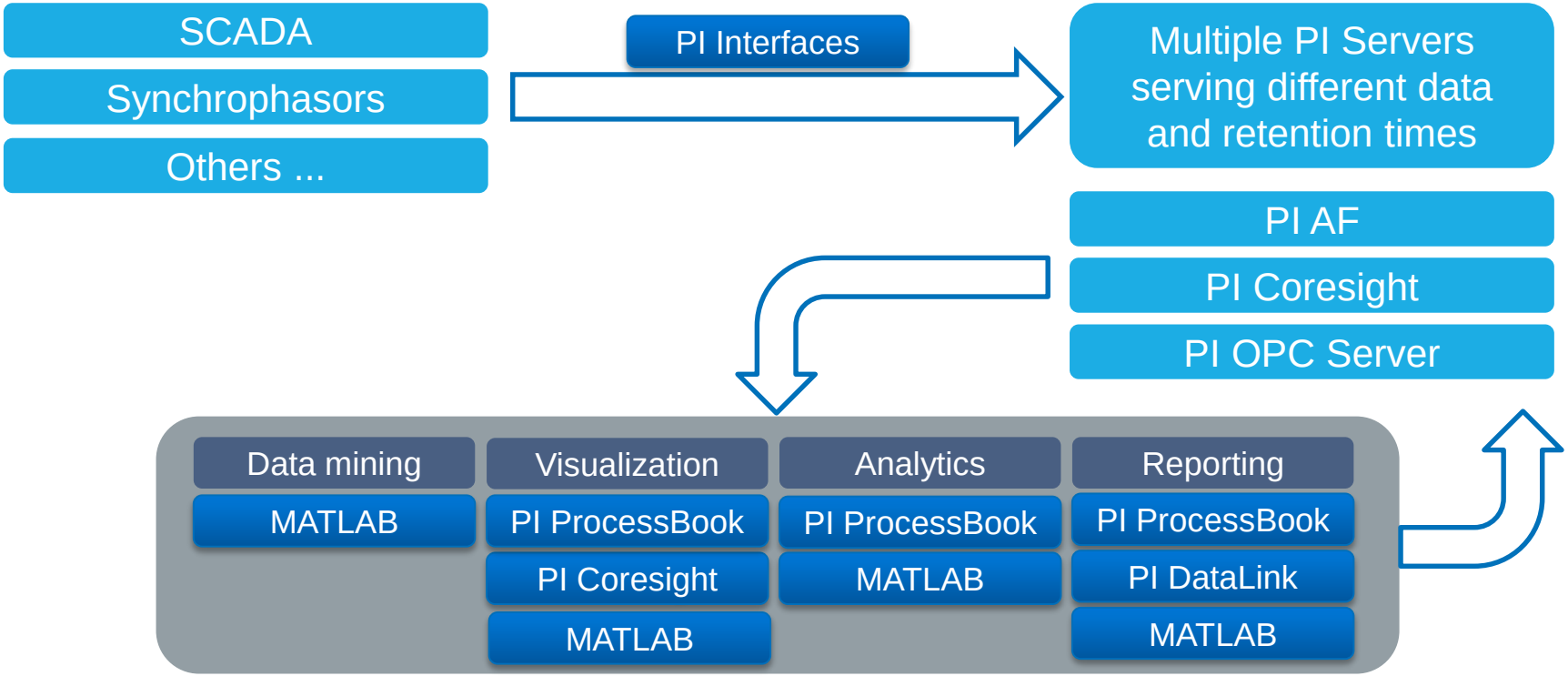
Several different data sources
- Easy and flexible access to data is needed
- Flexible visualization and analysis tools for end users are important

Manual processing and analysis is time consuming
- Need to automate analysis but custom analysis algorithms are needed

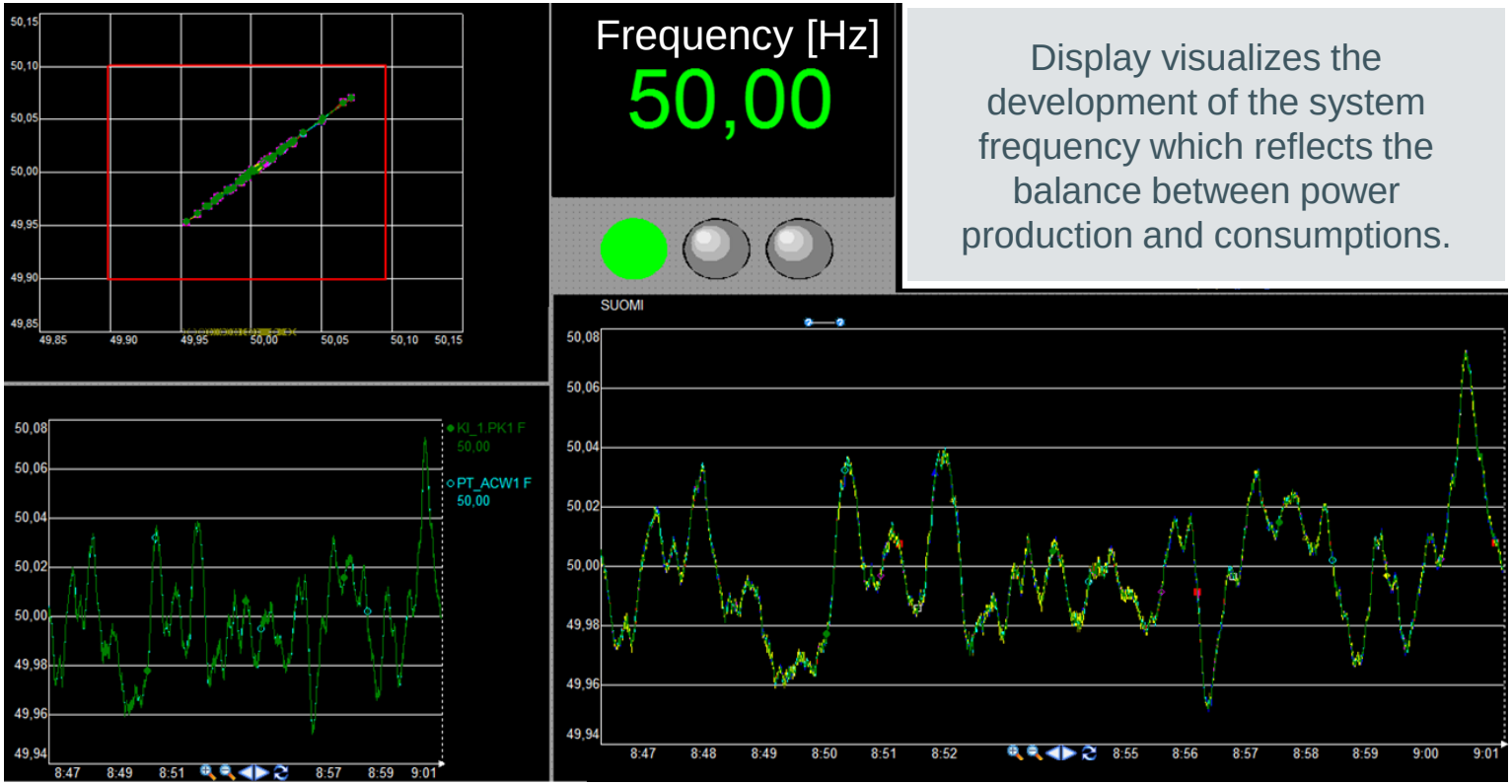
Developing analysis algorithms needs iterative work
- Important to understand how algorithms work
- Framework to test and develop routines before full scale implementation is needed



Enhancing Power System Analytics with PI System

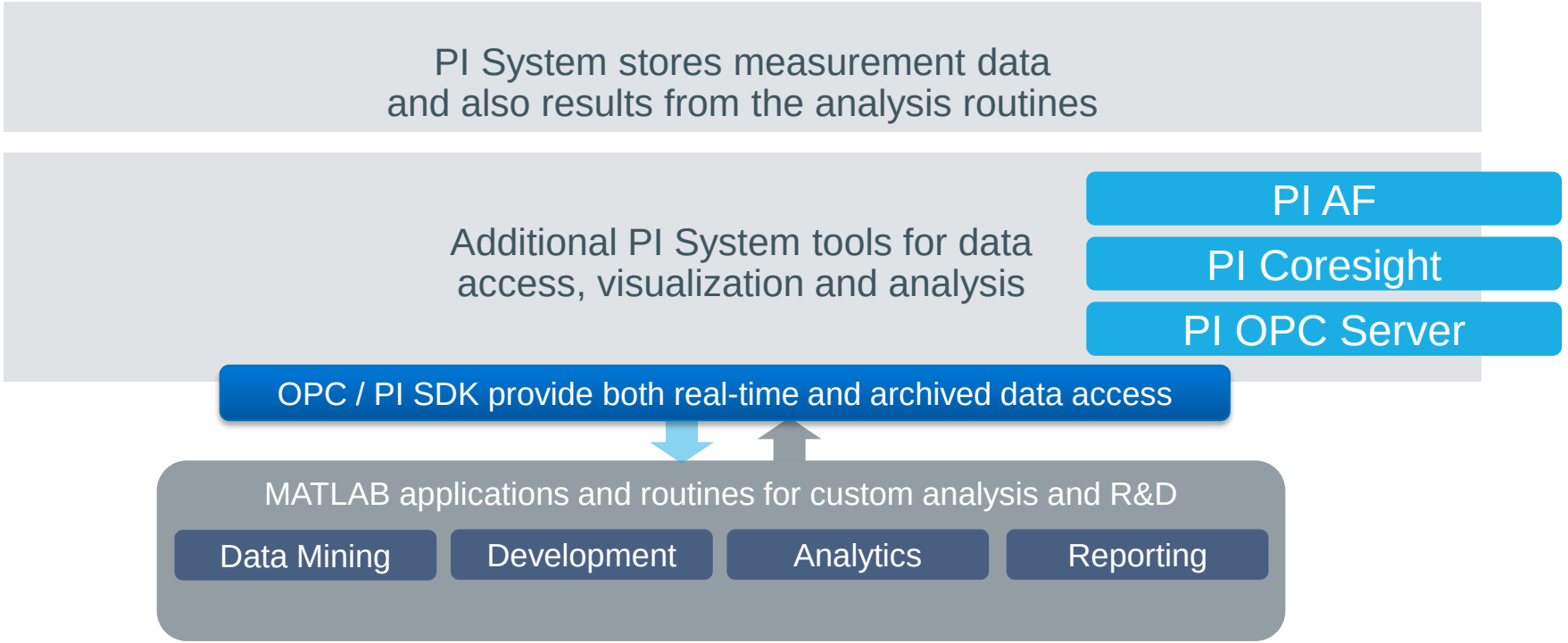


Example of PI ProcessBook display



Display visualizes the development of the system frequency which reflects the balance between power production and consumptions.

Developing Analysis Algorithms Using PI System Data



Online Detection of Power System Events

Real-time synchrophasor from PI System

Developed algorithms running on MATLAB

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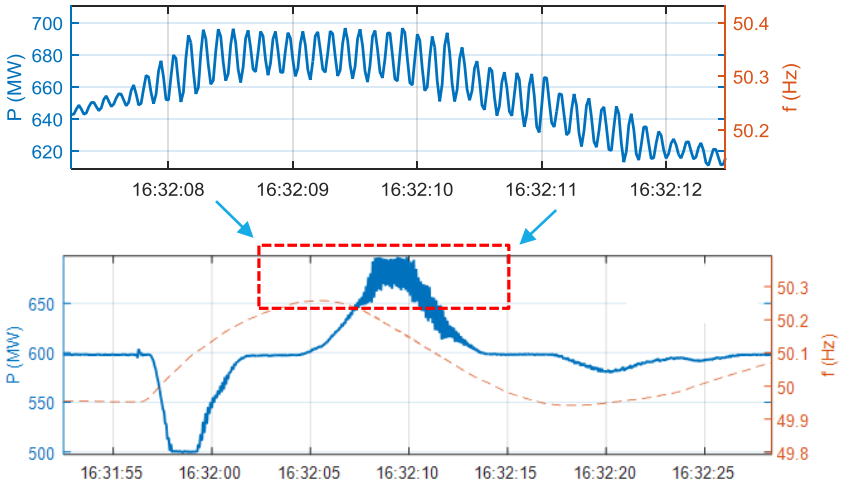
Spectral analysis

Notifications

Report generation



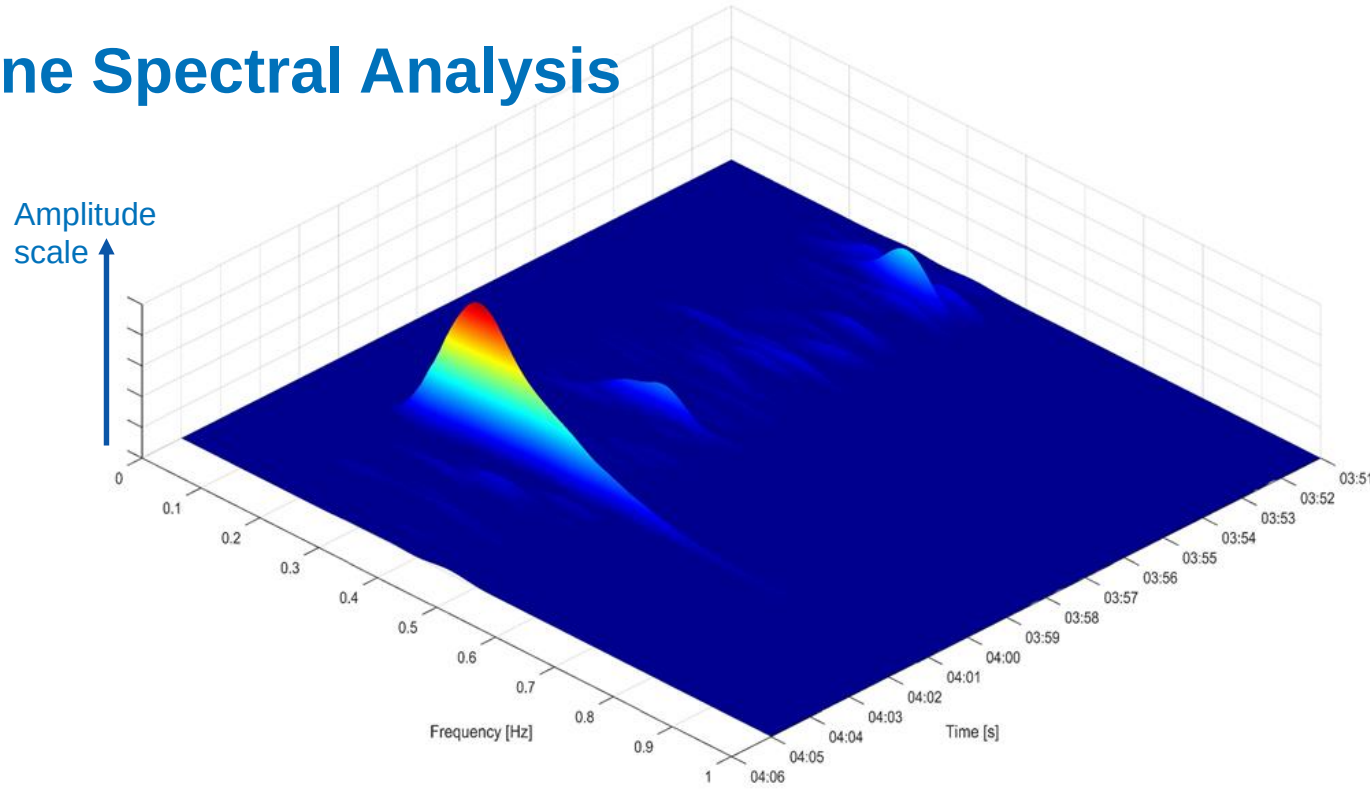
Currently being tested with MATLAB and possibility to integrate with PI Notification and PI Event Frames in future

Example of Online Spectral Analysis

Real-time synchrophasor from PI System

Developed algorithms running on MATLAB

Spectral analysis



Currently being tested with MATLAB and possibility to integrate with PI FFT in future

Results and Conclusions

- Use of already stored and received measurement data have increased significantly
  - Important to pay attention also to performance aspects
- PI System has made it possible to implement custom online analysis algorithms that take advantage of multiple data sources and analysis tools
  - Time consuming manual reporting and analysis work have decreased significantly
  - Automatic disturbance analysis and spectral analysis tools have already spotted problems which would have been difficult to detect manually
  - Results from research and development projects can be tested before full scale implementation
  - Ability to test and develop completely new analysis methods

Enhancing Power System Analytics with PI System

COMPANY and GOAL

Fingrid is the transmission system operator of the Finnish power system, which is part of the synchronously operated Nordic power system.

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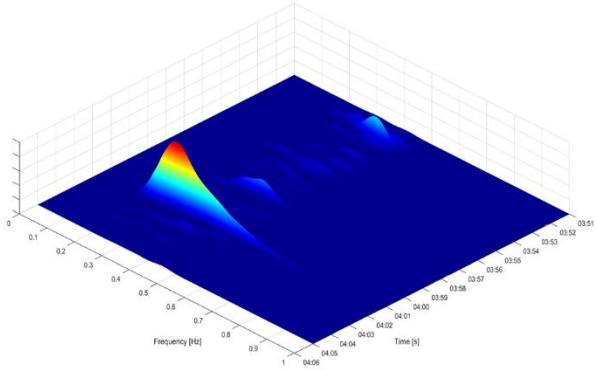

CHALLENGE

Lot of measurement data - how to utilize efficiently to support power system analysis

- Manual analysis of measurement data is time consuming and it is possible to miss important findings in power system performance
- Development of analysis algorithms requires iterative work

SOLUTION

Power system measurements are connected to PI System for visualization and analysis

- Specialists have easy access to both online and archived data
- Built-in tools are used for both visualization and analysis
- Flexible interfaces make it possible to develop advanced analysis algorithms for R&D

RESULTS

Use of data in analysis has increased significantly

- Measurements are used systematically to analyze power system performance
- Anomalies and errors in system performance have already been detected
- Analysis algorithms are being constantly developed and enhanced

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Questions

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谢谢

Danke

Gracias

Merci

Thank You

ありがとう

Спасибо

Obrigado