

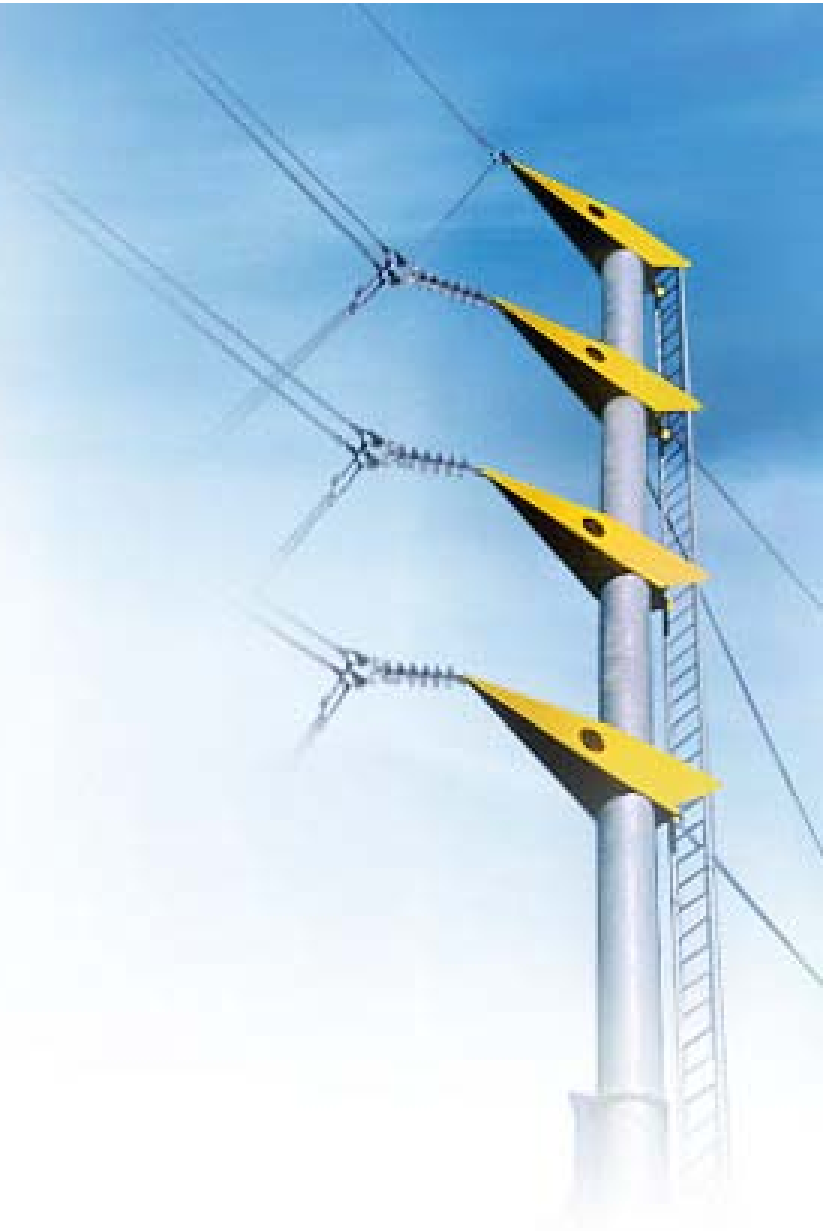


FINGRID

Power system operation and control - R&D challenges

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Workshop 26.10.2005



Fingrid organisation

GRID SERVICE	POWER SYSTEM OPERATION	ASSET MANAGEMENT	CORPORATE SERVICES
<ul style="list-style-type: none"> - Customer Service - Grid Development - Cross-Border Services - Market Analyses 	<ul style="list-style-type: none"> - System Management - Balance Management - Balance Settlement - Grid Operation 	<ul style="list-style-type: none"> - Grid Investments - Maintenance Management - Regional Operation - Reserve Power Plants 	<ul style="list-style-type: none"> - Communications - Market Development - Treasury - Finance - Technology - Environment - Security - Information Systems - Human Resources - Administration

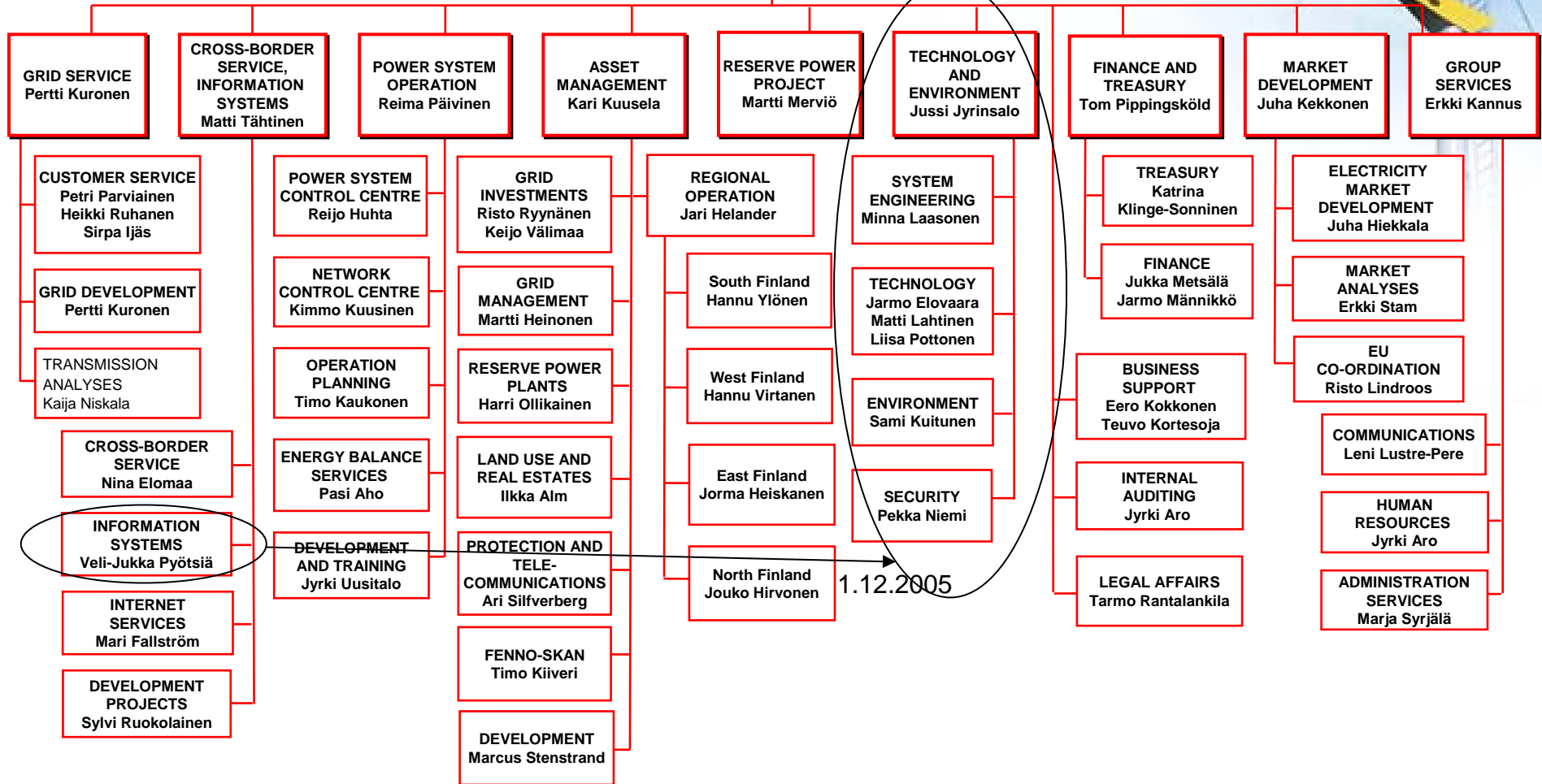


FINGRID OYJ (FINGRID PLC)

1 Oct 2005

BOARD OF DIRECTORS

PRESIDENT & CEO
Timo Toivonen



The main goals of R&D in Fingrid

- 1. To maintain security of transmission and, at the same time, to utilise full capacity of the grid**
- 2. To adapt the grid to it's environment and to study and to promote the positive effects of power line right-of-ways on the nature**
- 3. To promote competencies, innovation and cooperation inside the company as well as among it's interest groups**

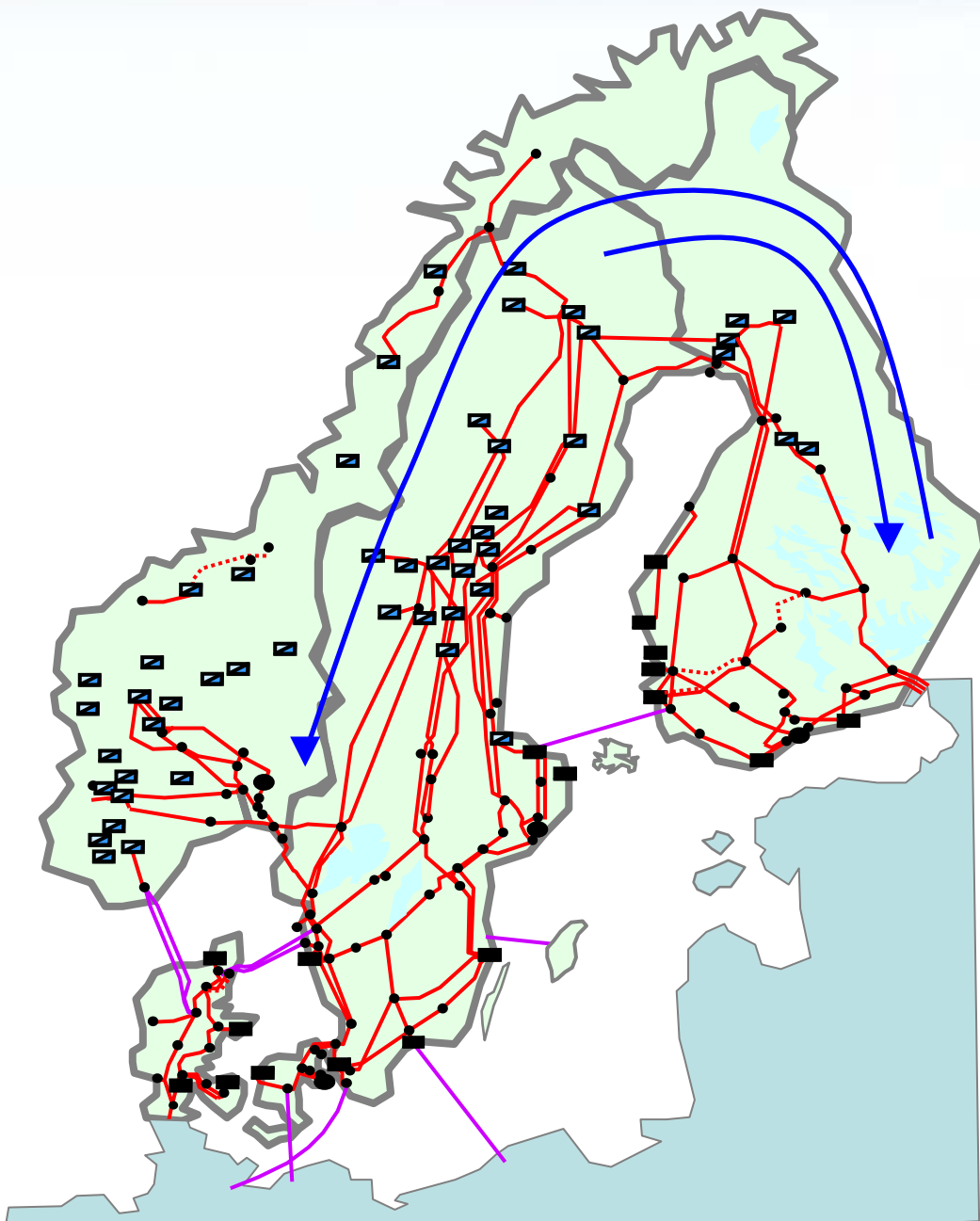
R&D focus areas

1. **Managing operational security and power transfers**
2. **Developing technical solutions and maintenance of the grid**
3. **Adapting the power system to its environment**

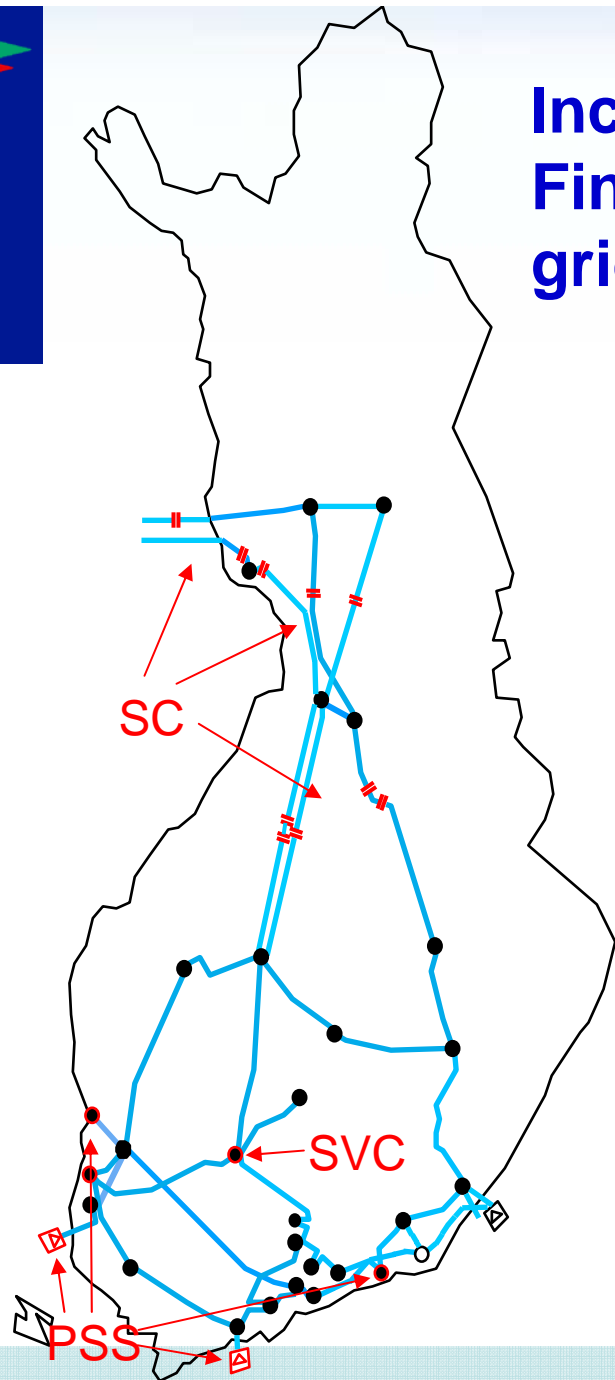
Long-term development programmes are currently being specified in each focus area. One of these is focusing on power system dynamics.

Challenges in the future

- **Large generating units and HVDC connections => more severe single faults, more reserve power**
- **Distributed and/or uncontrolled generation => more regulating and reserve power**
- **Fast changes in electricity price and power transfers => changes in the system security level**
- **Export situation => worse low frequency damping**
- **More IT inside the power system and more dependend on system defence schemes and telecommunication => effects on reliability?**
- **Difficulties in obtaining right-of-ways => several circuits in parallel and on same towers => reliability?**



**Voltage stability
gives transmission
limits when
importing, low-
frequency damping
when exporting**



Increasing the capacity of the Finnish 400 kV transmission grid

Depending on the power transfer direction, voltage instability or inadequate damping restrict the available capacity

Measures taken to increase the capacity:

- Proper tuning of power system stabilizers (PSS) on large generators and HVDC links. Status: 7 generators tuned, 2 links to be tuned
- Series compensation (SC) of critical transmission corridors. Status: 7 capacitor banks installed, 2 more planned for 2009
- Installing an SVC close to the strongly oscillating generators. Status: planned for 2007



Controlling the power system dynamics

Subprojects:

- **Real-time monitoring of low-frequency damping: work in progress**
- **Measuring and modelling the response of loads to voltage and frequency variations: measurement solution in planning phase**
- **Online dynamic contingency analysis: to be started**
- **Studying the alternatives for and reliability of defence schemes and reserve power: to be started**