NASPI North American SynchroPhasor Initiative

NASPI Work Group meeting and
first International Synchrophasor Symposium

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DSS4LA: Decision Support System for Look-Ahead

- Integrated applications of real-time event detection and historical event discovery for operators -

March 24, 2016

Hitachi, Ltd.,
Hitachi America, Ltd.,
Pacific Northwest National Laboratory

1. Background

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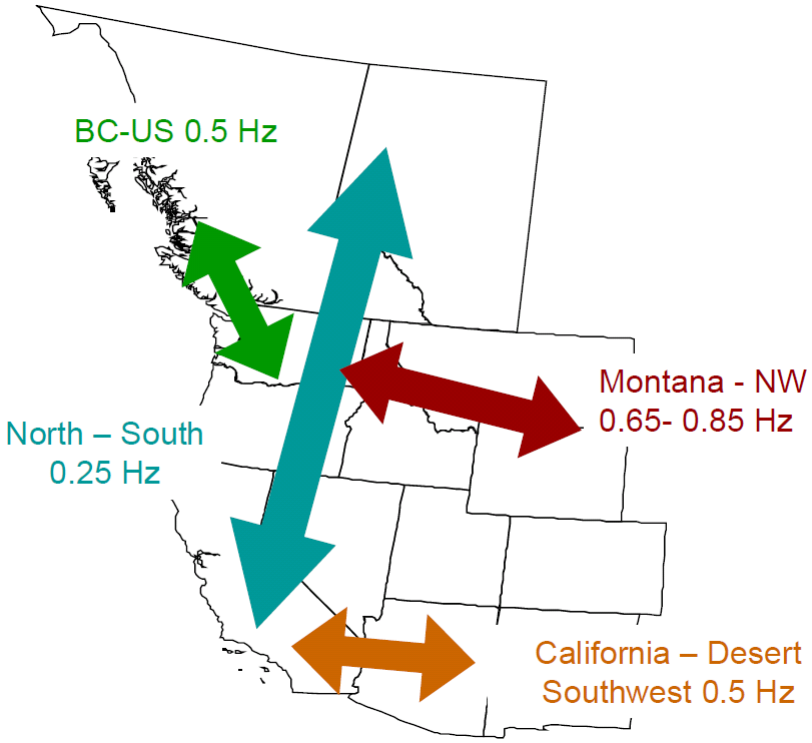
- Various events like line-fault affect power system stability.
  (Small signal stability, Voltage stability, Frequency stability, etc.)
- Renewables and inverter-based devices change grid dynamics.

Four major oscillation modes in WECC are well-known as shown below



[Source] "Synchrophasor based Oscillation Detection at Bonneville Power Administration" ; Nick Leitschuh(BPA) [March 2014]

WECC: Western Electricity Coordinating Council

2. Monitoring of power system stability

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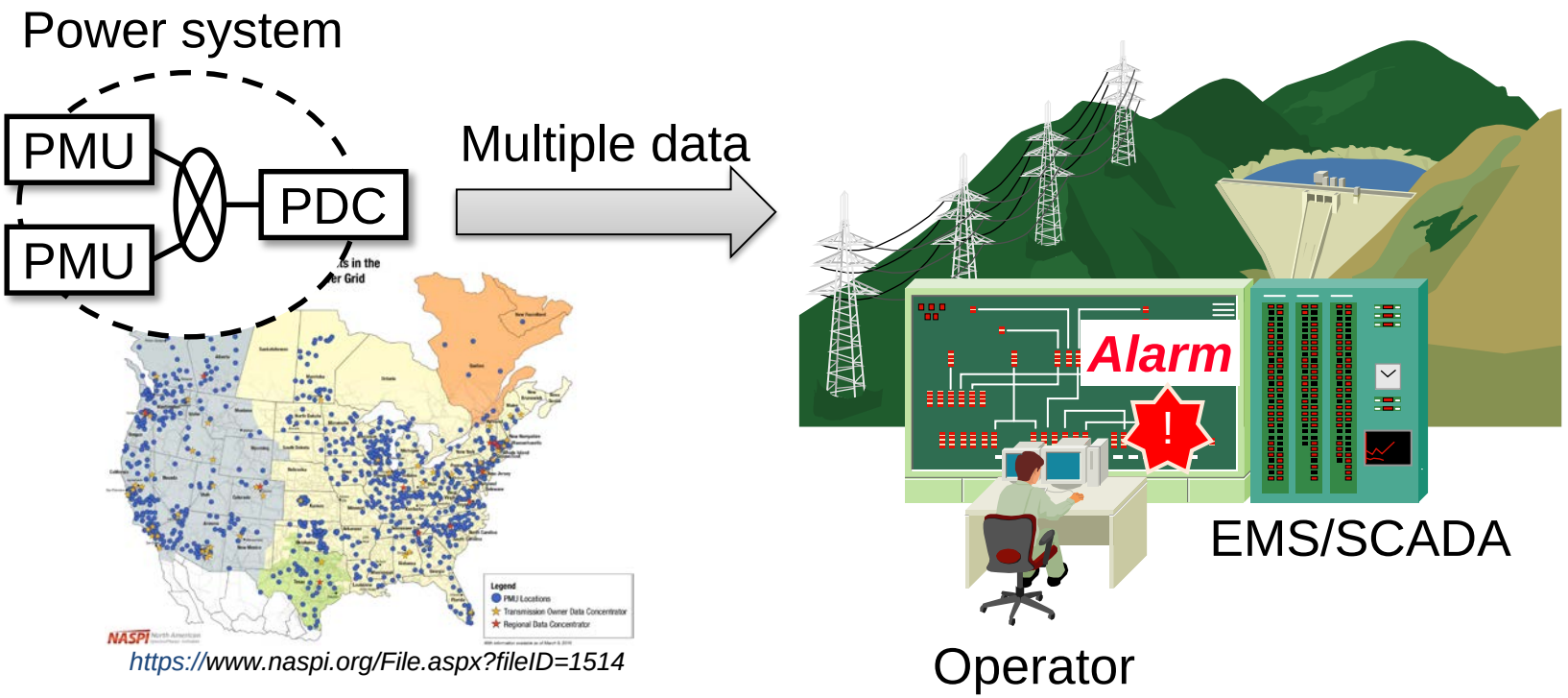
- Multiple data such as PMU, EMS/SCADA, etc. are used to monitor power system Stability and Alarm operators.
- PMU-based applications are crucial for situational awareness.



PMU: Phasor Measurement Unit, SCADA: Supervisory Control and Data Acquisition,
EMS: Energy Management System

3. Future solutions for decision support

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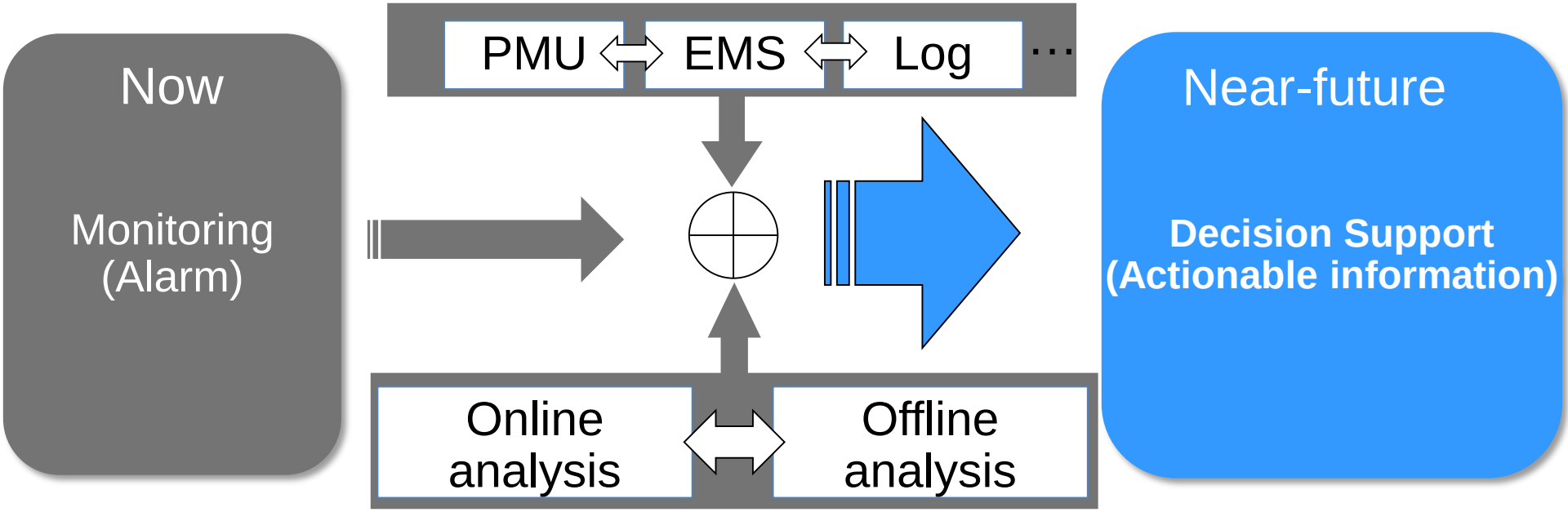
Goal: Prevent critical wide-area blackouts and economical damage.
Our Solution: Decision Support System

- Decision support with actionable information in addition to the current operation: monitoring and alarming.
- Heterogeneous big data management (PMU, EMS/SCADA, …) and integration scheme for online/offline analysis.



4. Use case of Decision Support System (DSS)

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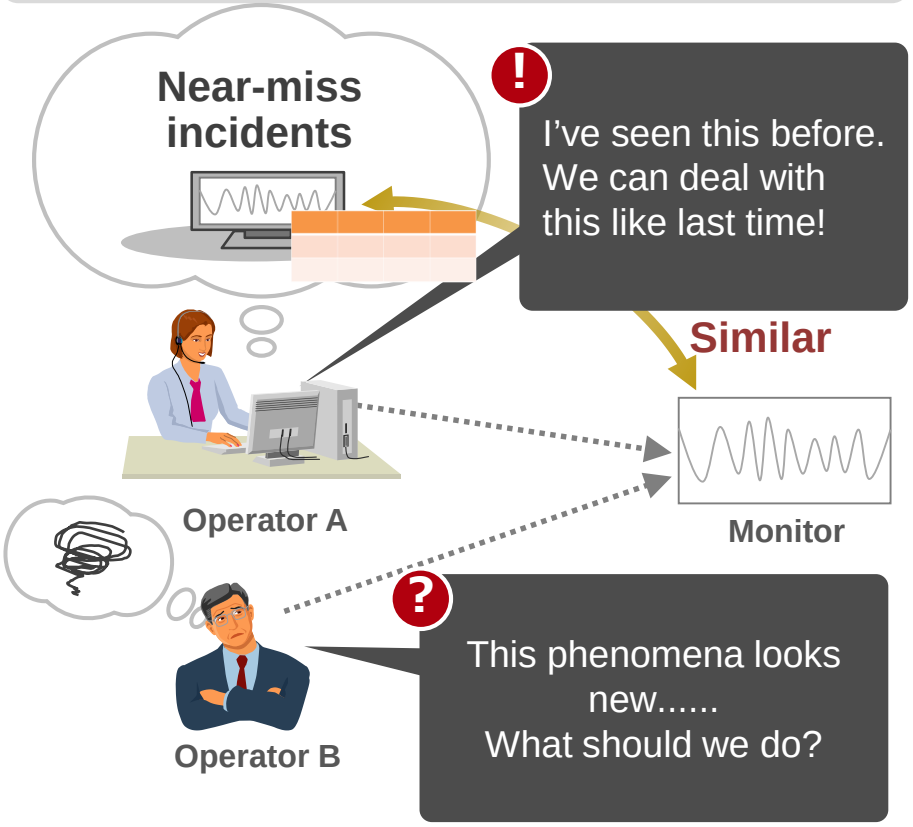
- DSS suggests the similarity to past events, that will help operators with timelier, faster, more accurate and robust decision making.

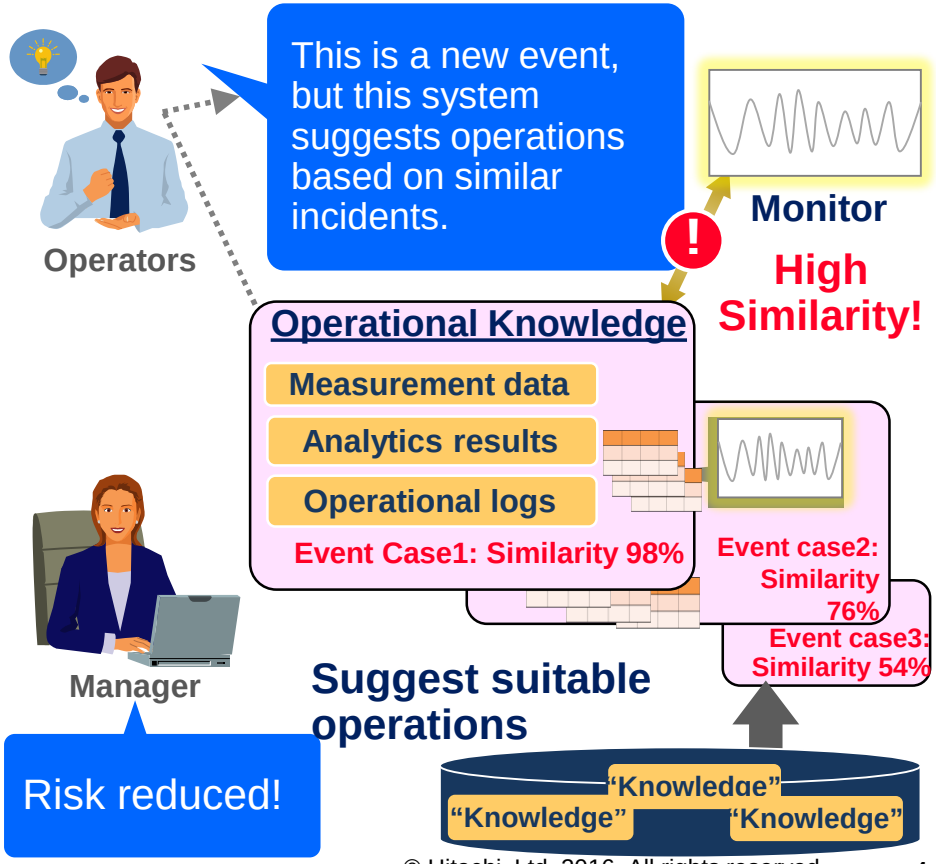
Now

Operation quality varies (High risk on power disturbance)



Near-future

Reduce Power disturbance risk by DSS based on historical data



DSS: Decision Support System

5. Overview of Decision Support System

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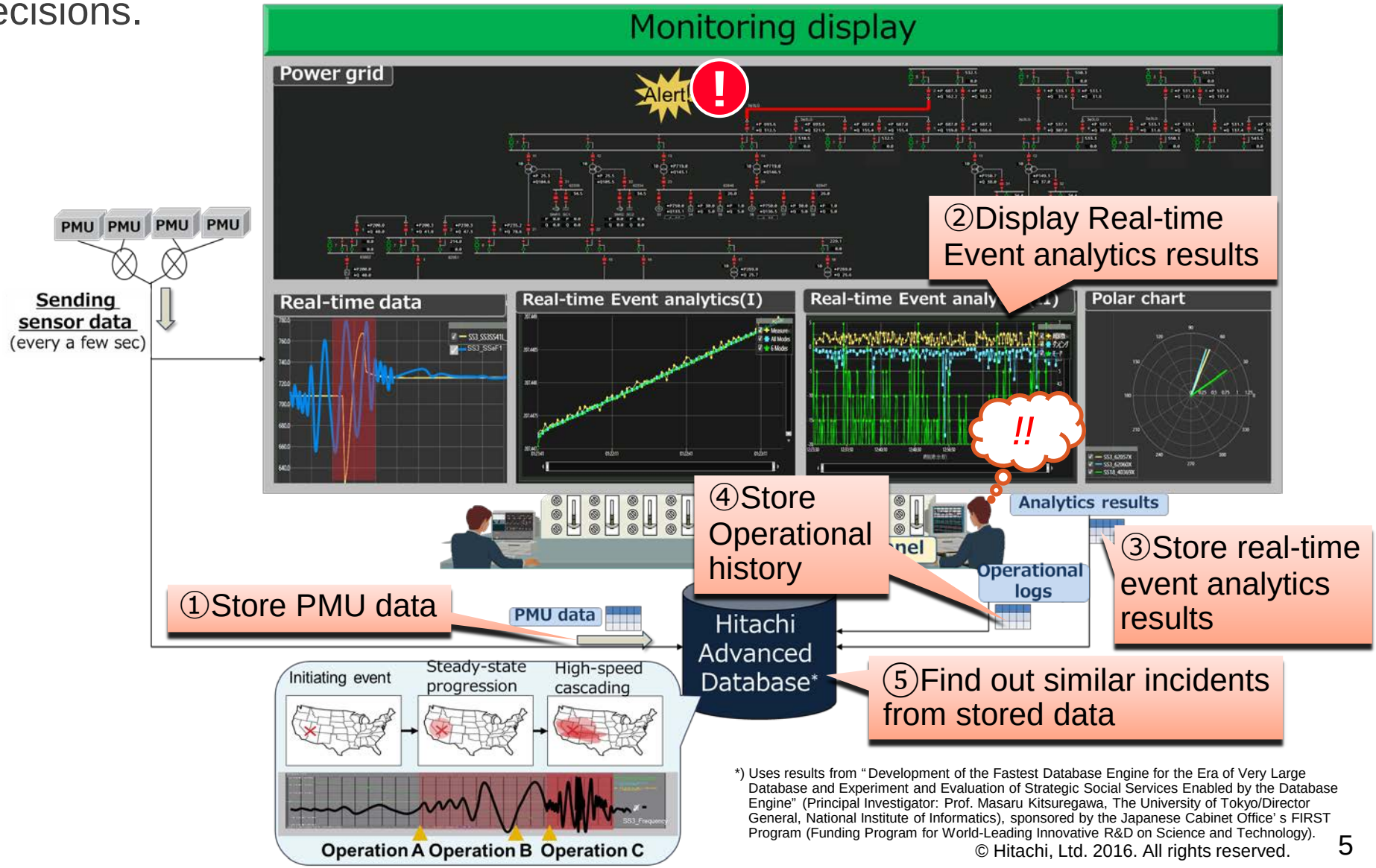
DSS leverages PMU data and a robust platform to support operators in making decisions.



*) Uses results from "Development of the Fastest Database Engine for the Era of Very Large Database and Experiment and Evaluation of Strategic Social Services Enabled by the Database Engine" (Principal Investigator: Prof. Masaru Kitsuregawa, The University of Tokyo/Director General, National Institute of Informatics), sponsored by the Japanese Cabinet Office's FIRST Program (Funding Program for World-Leading Innovative R&D on Science and Technology).

6. Event detection and similarity search

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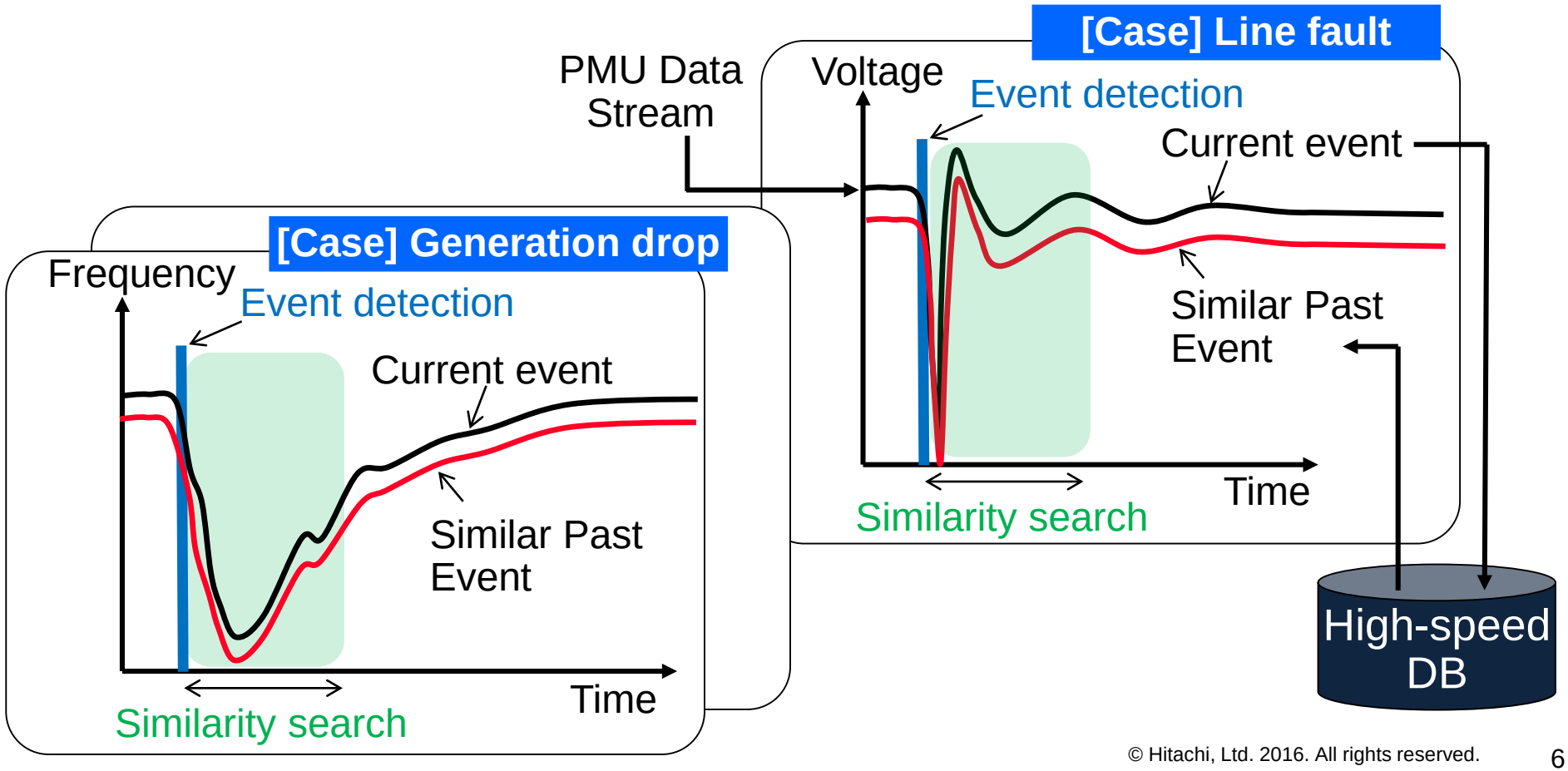
- Events are detected out of streaming PMU data using power system-tuned statistical methods.
- Similar events are extracted by utilizing the power of a high-speed database.



7. Two similarity search modes for operational support

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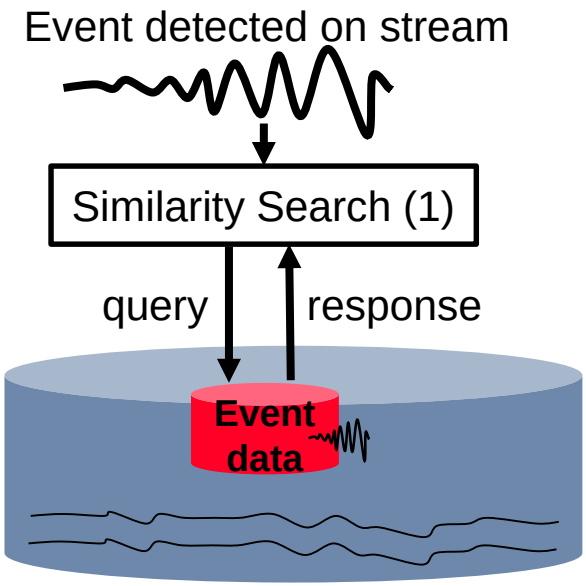
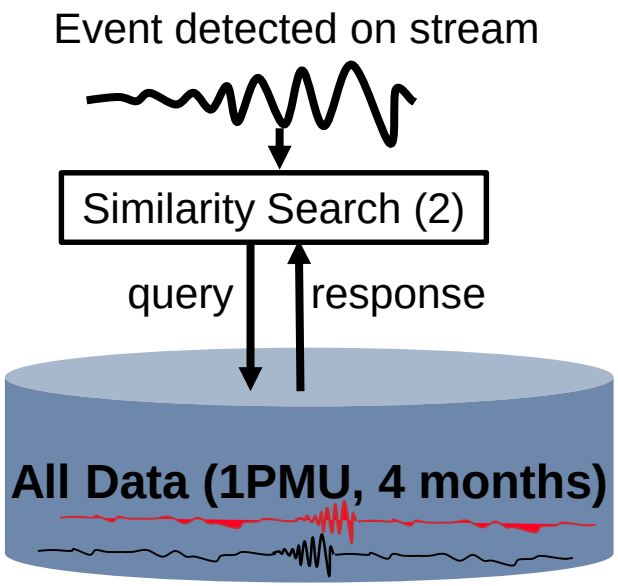
Today's DEMO

	(1) Known-event similarity search	(2) Latent similarity search
Customer value	■ Support operators to stabilize known phenomena with good accuracy	■ Support operators to stabilize both known & unknown phenomena
Challenge	■ Can only detect known events	■ Large search area ■ High CPU cost
Technology	■ Good precision similarity search with power principle	■ Fast similarity search technology with good sensitivity
		

8. DEMO

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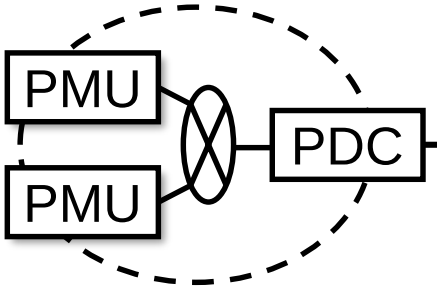
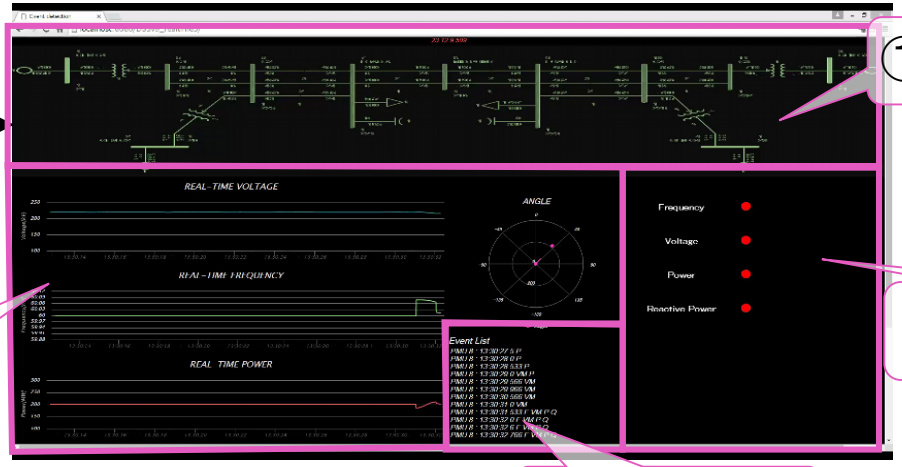
Real-time monitoring and event detection



Power system



①System model(*)

Event detection

Real-time monitoring

Event list

Operational support

Detected Event key

The most Similar event

18 PMU, 4 months & 1 year events Data(**)

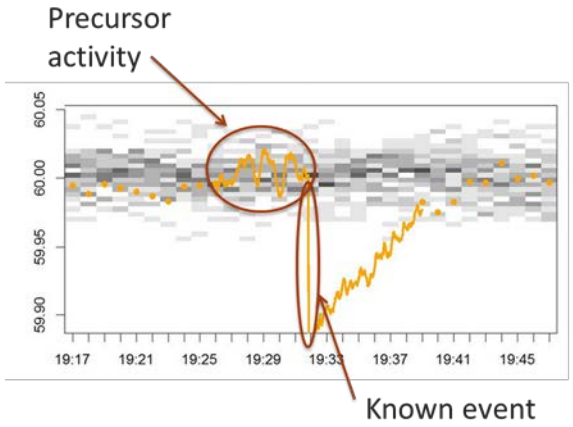
Operational Log

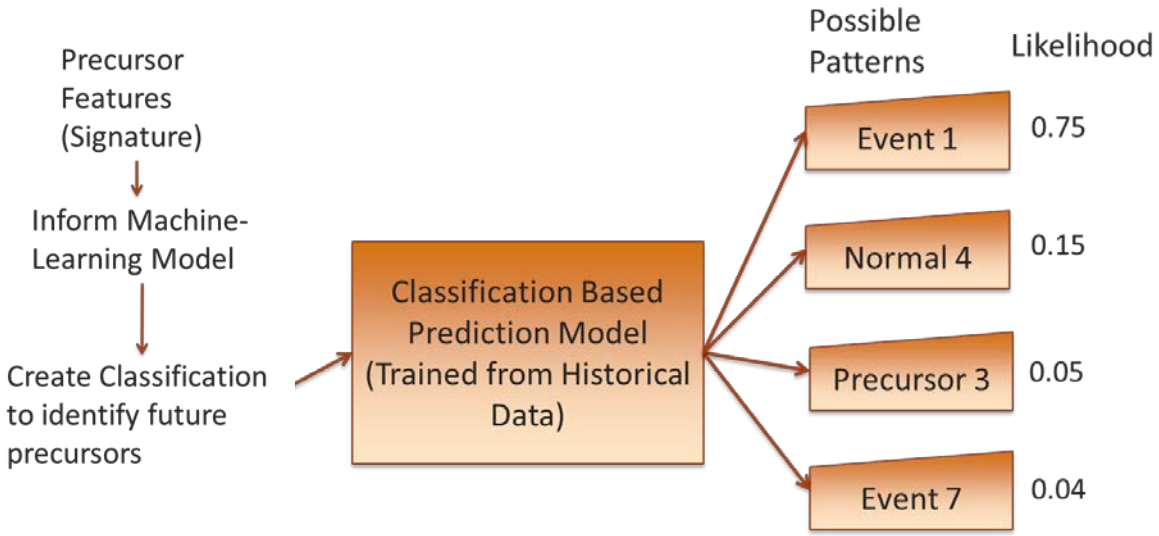
Similar Event lists

(*) Modified Kundur 4-machine model
(**)DB size: About 18TB on HADB

9. Future discussion

- Expansion of similarity search function using different features (oscillation mode, voltage instability,…)
- Advanced event detection and classification with machine learning approach
- Further applications to utilize historical data



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