DLR and Transmission Capacity Forecasting

Jack McCall
Lindsey Manufacturing Co
jmccall@lindsey-usa.com

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SMARTLINE TCF

Dynamic Line Rating

Transmission Capacity Forecasting

Since 1947

SMARTLINE

TCF

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Feature Summary

- Provides real-time (instantaneous) DLR
- By direct measurement, methodology assures:
  - Clearance-to-ground limits are not violated
  - Thermal limits of the conductor are not violated
- Provides forecasts of line capacity capability
  - 1+ hours ahead
  - 1+ days ahead
  - Complex forecast “packages”
  - 98% confidence factor by default
- Line sensors directly measure critical parameters
- Cloud-based software provides direct EMS input
- Cyber-secure
- SOON: Transmission Line Asset Management

Overview of SMARTLINE-TCF

Live conductor data from line mounted monitors

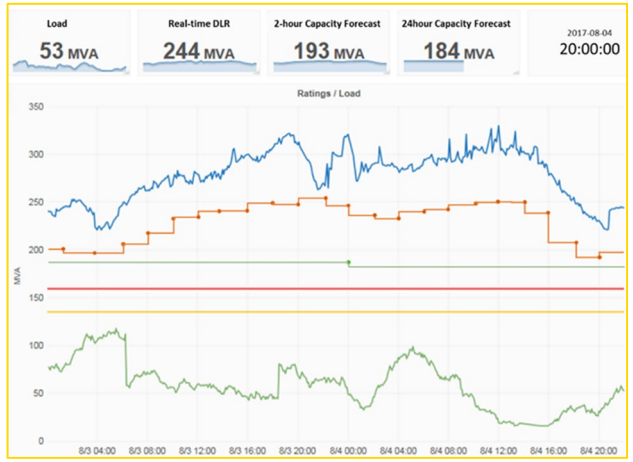
Live weather data

Weather forecast data

Develop Learned Conductor Behavior Model

Line Power Capacity Forecast

Compute Instantaneous DLR



Based on:

- Clearance
- Conductor temperature

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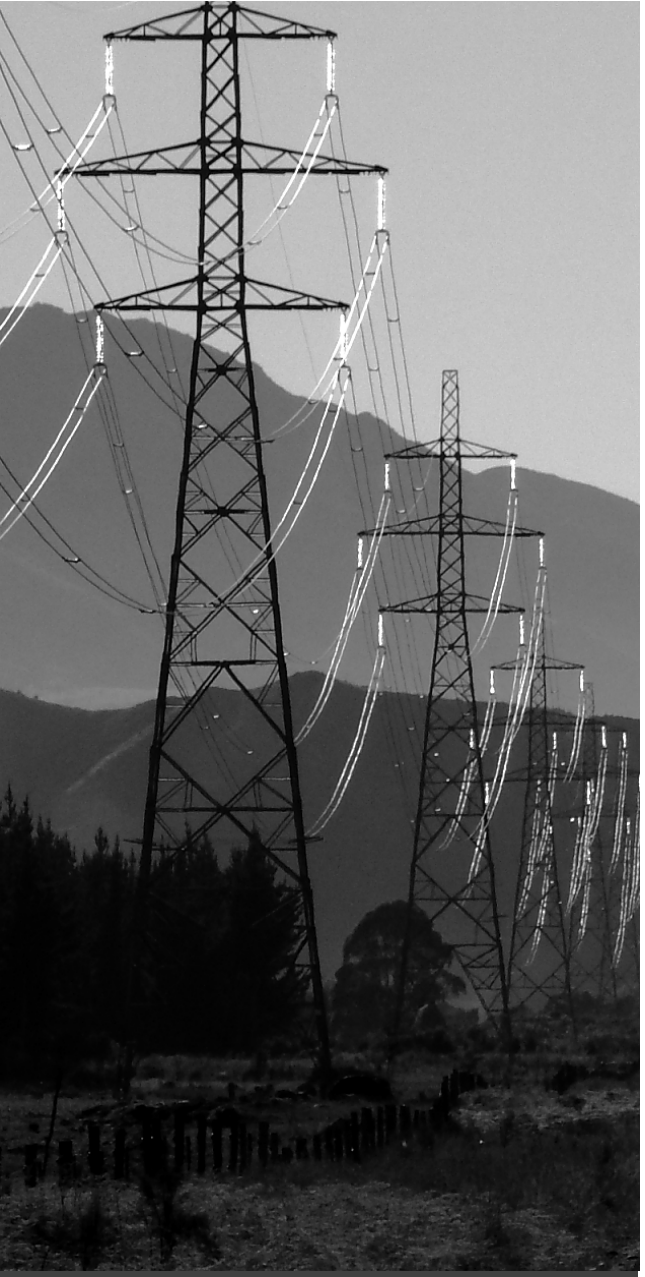


What limits line rating?

Clearance to Ground

- A line is not safe unless clearance is maintained
- Compliance requirements

Conductor Temperature

- Overheating leads to weakening and loss of life
- Premature replacement

What effects these parameters? **Weather.**

Optimizing line capacity based on weather

- Line ratings (static) are traditionally based on conservative weather conditions
- **Seasonal Adjusted Ratings** and **Ambient Adjusted Ratings** recognize weather related effects on line capacity
  - Both adjust only on ambient temperature

Optimizing line capacity based on weather

- Line ratings (static) are traditionally based on conservative weather conditions
- **Seasonal Adjusted Ratings** and **Ambient Adjusted Ratings** recognize weather related effects on line capacity
  - Both adjust only on ambient temperature
- Wind has MUCH more impact than ambient
  - +2 mph wind ≅ 15°F change

Lindsey TLM Conductor Behavior Monitor

Internal CT measures **LINE CURRENT**

Internal **CONDUCTOR TEMPERATURE SENSOR**

Ground temperature sensor

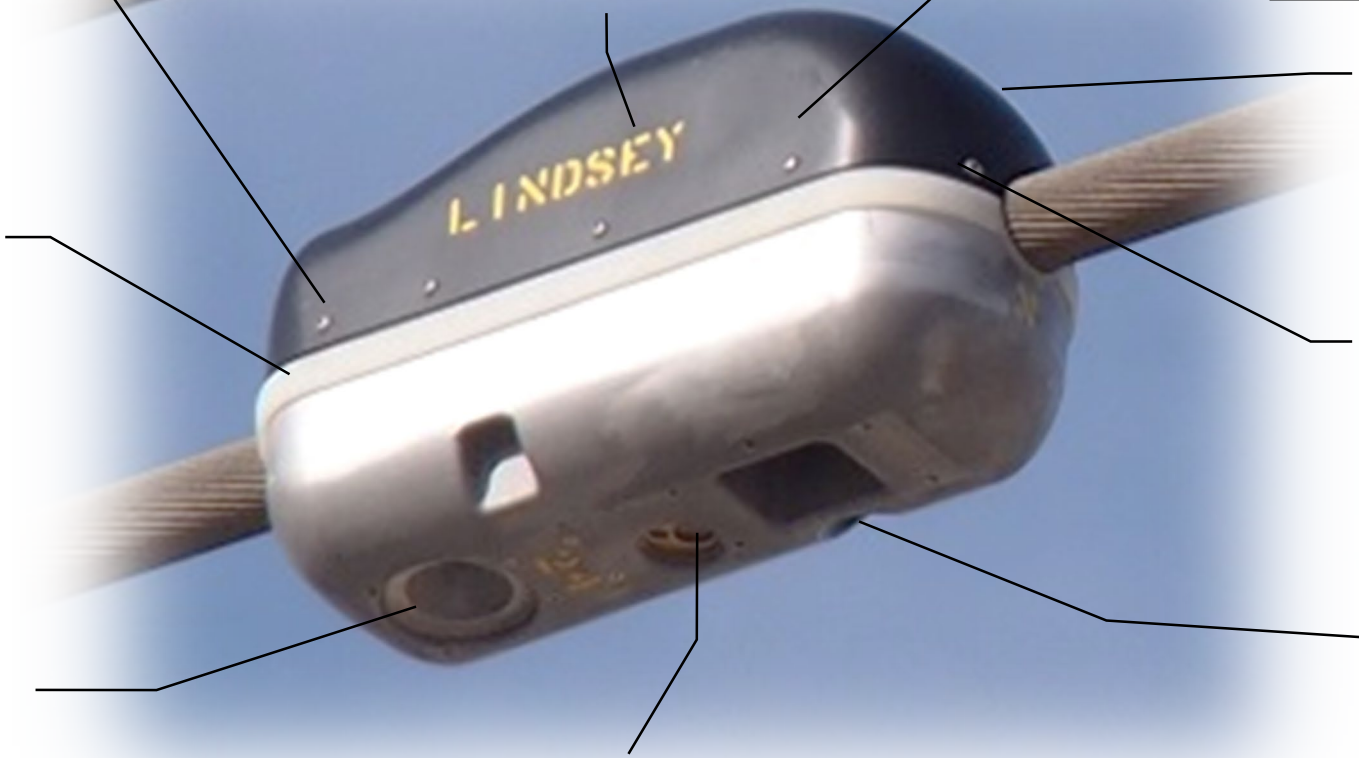
Roll/Tilt angle and vibration sensors

Iridium satellite radio
- Remote locations
- Cyber-security

765kV corona free housing

Magnetic field harvesting power supply

Simple single-bolt clamping mechanism



LiDAR unit provides **CONTINUOUS CONDUCTOR TO GROUND MEASUREMENTS**

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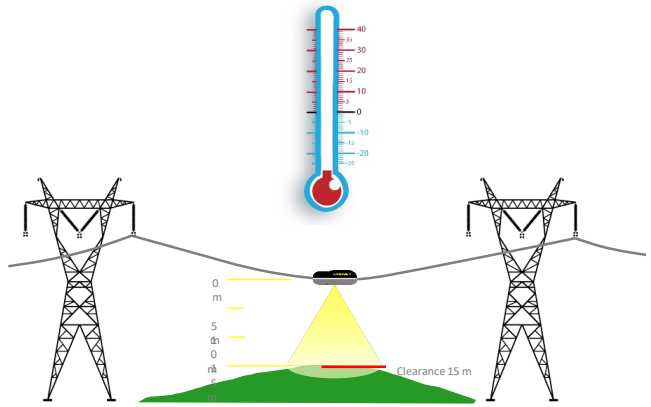
OVERVIEW

SMARTLINE TCF

Combines:

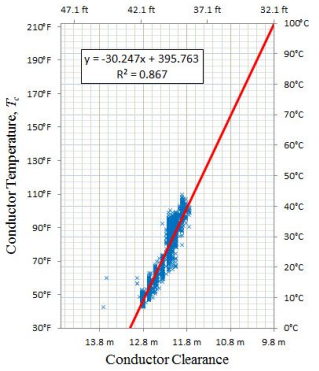
- Real-time weather

- Corresponding **direct measurements**:
  - Conductor temperature
  - Clearance-to-ground
  - Recall these are the critical line parameters



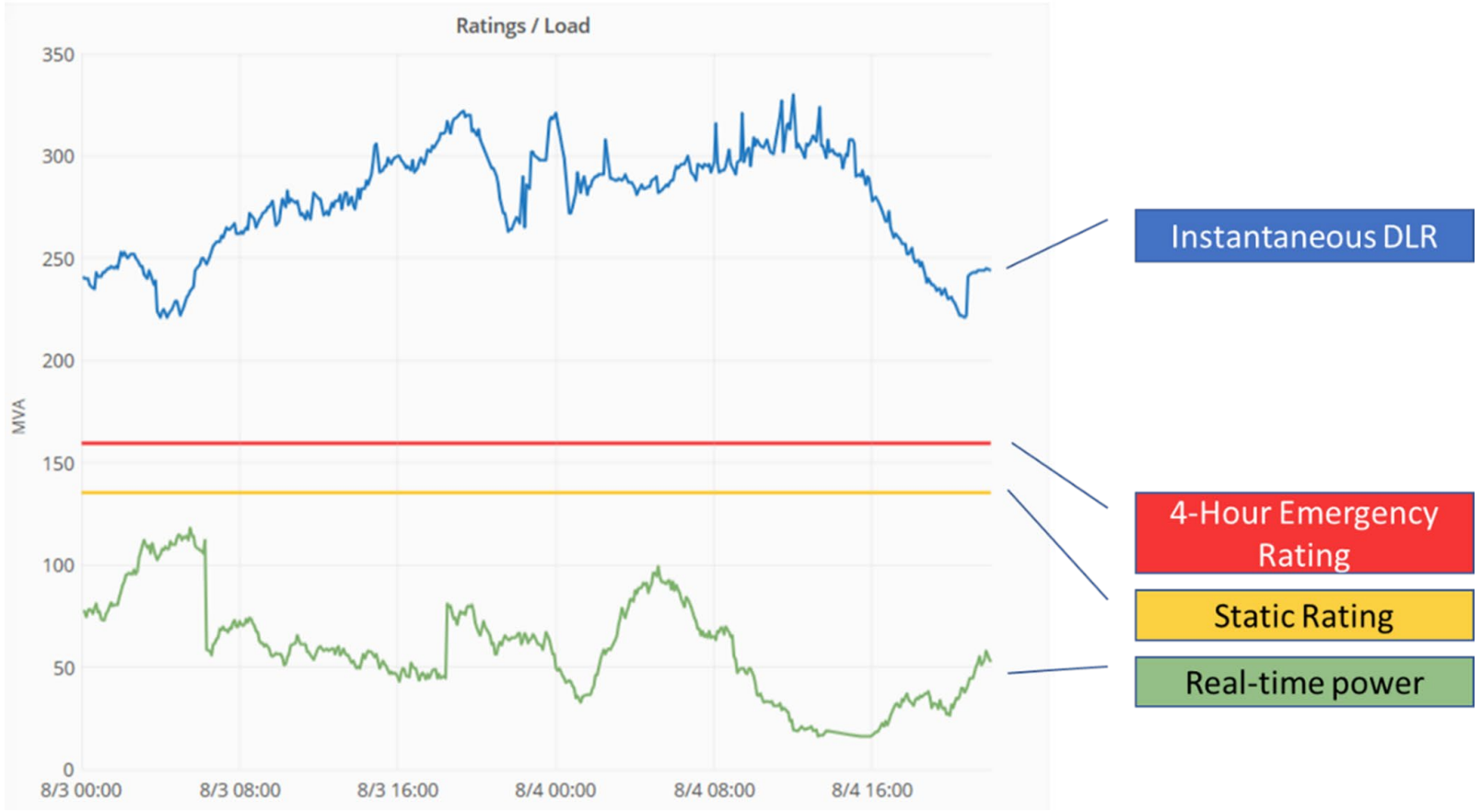
To Produce:

- Continuously learned line behavior model



Dynamic Line Rating

Decades of studies show +10-25% capacity availability 95% of the time



BUT

- Changes rapidly
- Changes erratically
- Real-time

Dynamic Line Rating

The Historical Dilemma

« *What is my next DLR rating?*

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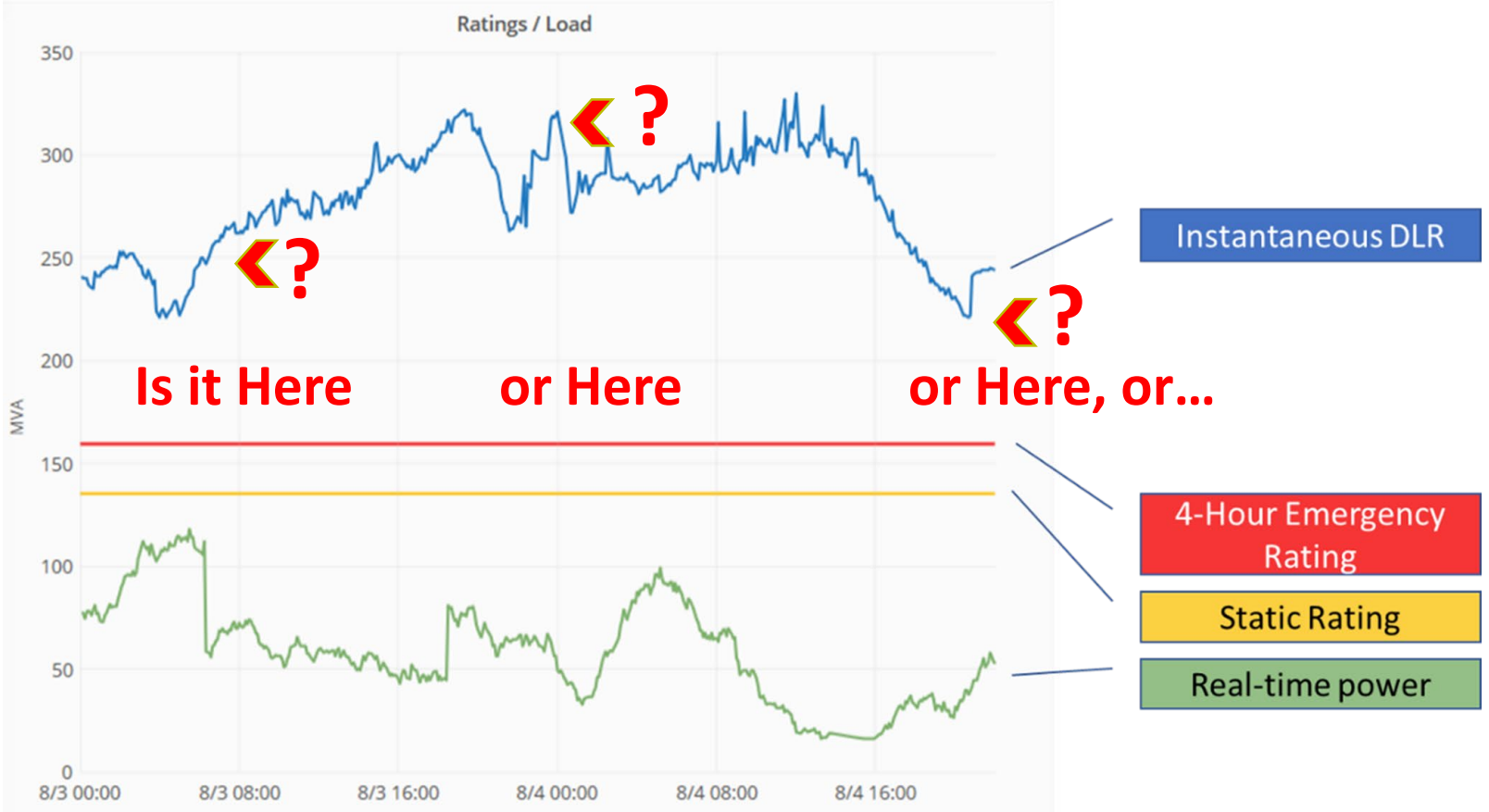
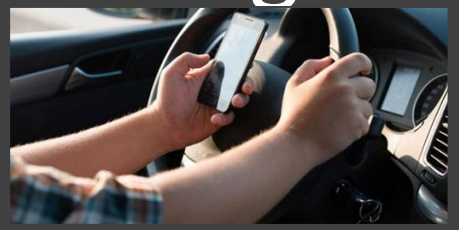
Dynamic Line Rating

RAPID
ERRATIC
REAL-TIME



Using Real-time DLR is operationally difficult

Dynamic Line Rating

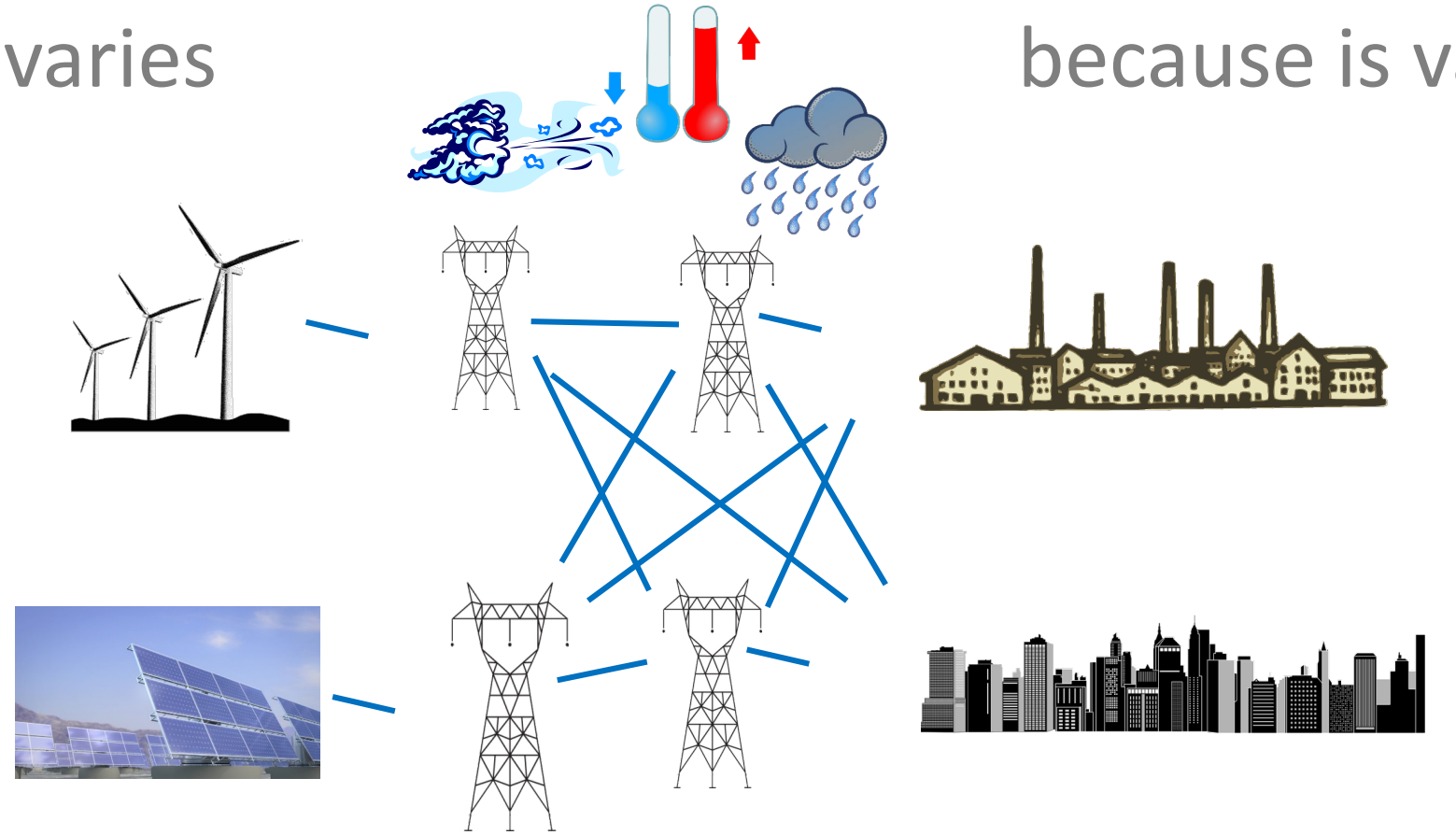


Like a map app in a traffic jam…

…Real-time is too slow

Generation is FORECAST because it varies

Load is FORECAST because is varies



Yet transmission capacity is generally assumed as fixed

Transmission Capacity Forecasting

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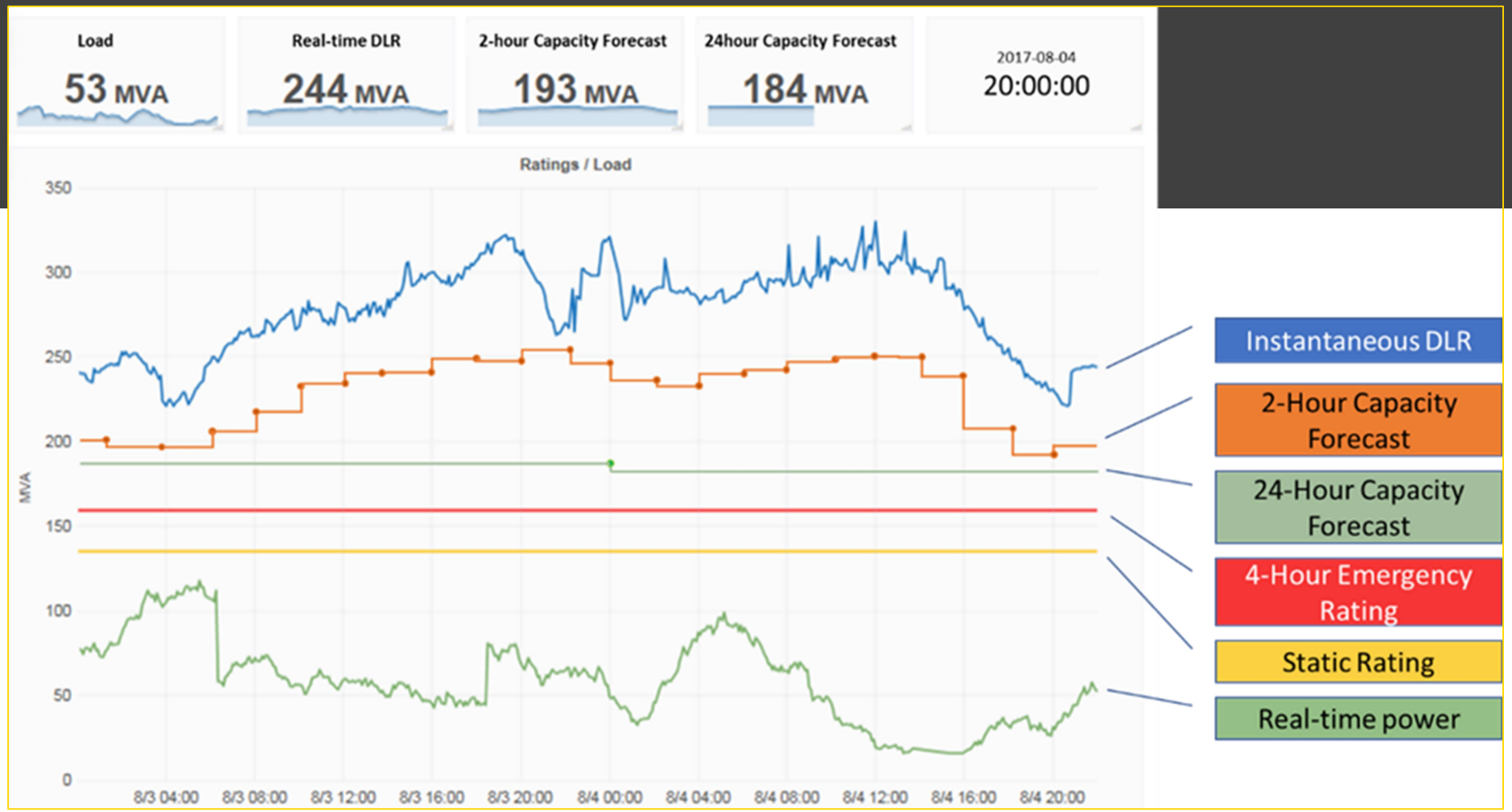
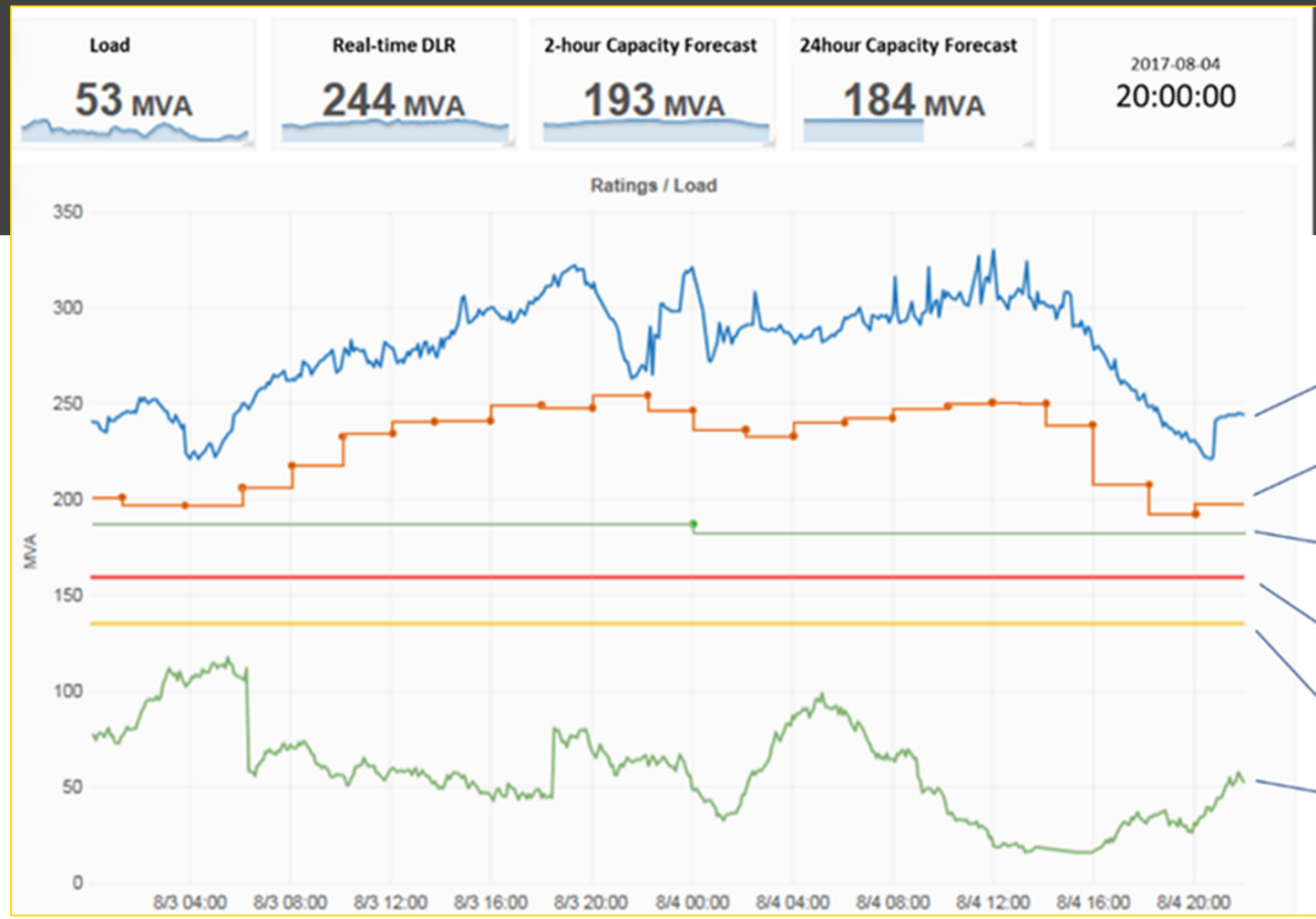
What is it?

- **An advanced statistical process that provides:**
  - Forecasts of transmission line capacity from 1-hour to 1-week ahead
  - Very high (98% or greater) confidence factors
  - Local line measurements avoids weather-only errors
- **Can provide direct EMS input**
- **Combines:**
  - Learning-based conductor behavior models
  - Continuous Forecasting

Transmission Capacity Forecasting



Transmission Capacity Forecasting



Per DOE Report, DLR and TCF Provide:

- Congestion Relief
- Increased Resilience
- Increased Reliability
- Enhanced Market Operations
- Situational Awareness
- Curtailment Reduction