

Touching High Voltage Everyday

**Next Generation
DLR
SMARTLINE™**

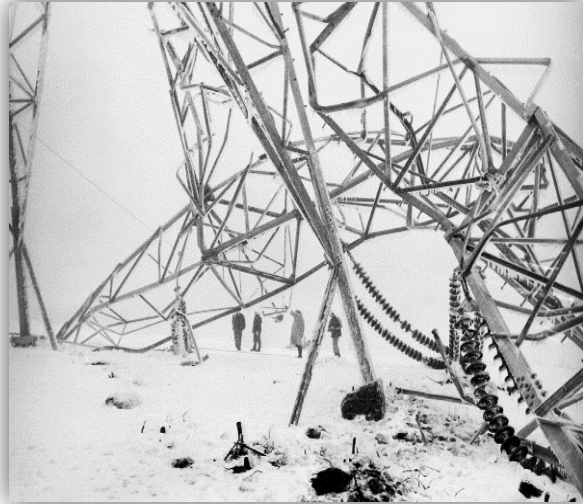
LINDSEY

Lindsey has been a Specialist in Transmission and Distribution Technology for almost 70 years

- Addressing unique needs of electric utilities with focused, engineered products
- Systems designed for simply solving complex problems
- Unexcelled hands-on experience with high voltage



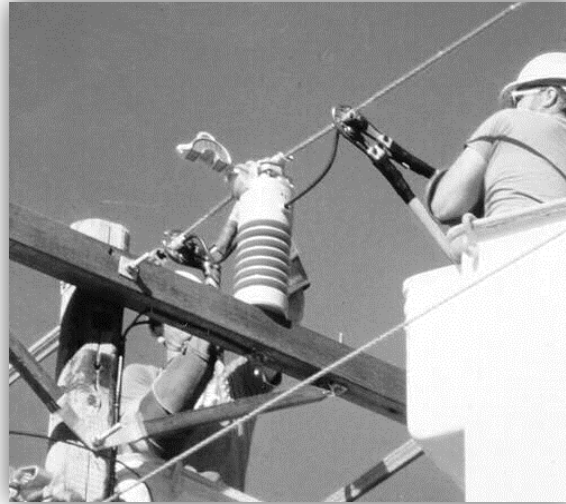
Product Portfolios



GRID RESILIENCE

Addressing What-if Scenarios:

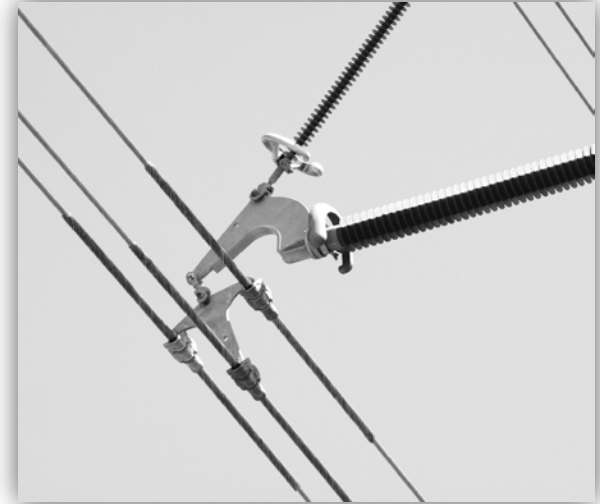
- Emergency transmission tower restoration
- Real-time emergency transmission system power flow ratings
- Tower intrusion sensing



MEASUREMENT

Unique solutions for:

- Dynamic Line Rating and Forecasting
- Overhead and underground MV power systems
- Transmission line clearance monitoring



HARDWARE

Specialized aluminum and steel hardware for:

- HV and EHV transmission lines
- Highly critical applications



What is a Dynamic Line Rating (DLR)?

- A Dynamic Line Rating reflects the fact that Line Capacity Is Constantly Changing
- Therefore Dynamic Line Ratings:
 - Must use Real-Time Data, and
 - Do not use any assumed Limiting Weather Events (i.e., very low wind speed, max solar radiation, etc.)
- Dynamic Line Rating (DLR) Requires Real-Time Monitoring of the Transmission Line's behavior
- A line's instantaneous DLR (the Maximum Capacity) is a value calculated using:
 - Monitored, real-time data in conjunction with
 - IEEE 738 or CIGRE TB 299 methodology to meet MACT
 - DLR is computed - and changes - continuously

DLR is based on the line's MACT.

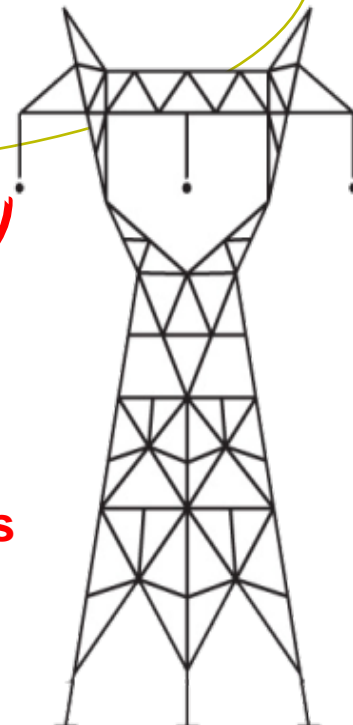
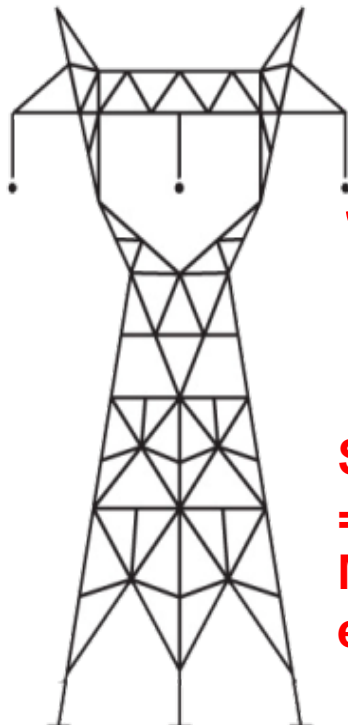
Applying up to the DLR ensures no thermal damage to the line

Static Line Rating



Assume Limiting Weather Conditions

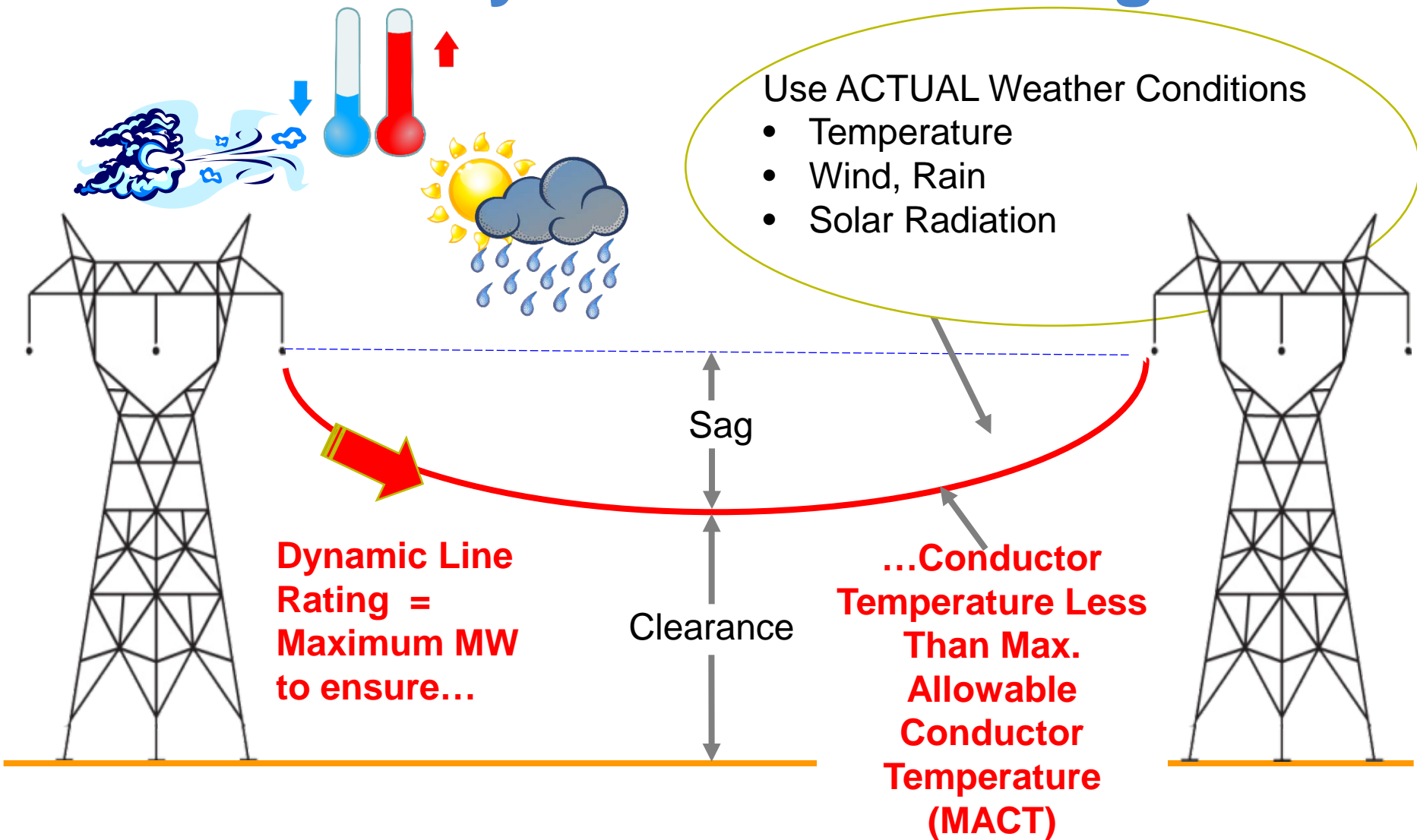
- Relatively Hot Day
- Little Wind
- High Solar Radiation



**Static Rating
= Maximum
MW to
ensure...**

**...Conductor
Temperature Less
Than Max.
Allowable
Conductor
Temperature
(MACT)**

What is a Dynamic Line Rating?



First Generation Dynamic Line Rating

- Dynamic Line Rating has been around more than 25 years
- Technology available in the past limited performance, reliability, and acceptance of the concept
- Early innovators in the practice worked from conductor tables and sag charts developed for sizing and string conductor
- First Generation DLR made conductor assumptions based on span tension, inclination, magnetic field, photographic image comparison

Benefits of Dynamic Line Rating

- 10-25%+ more capacity, 95% of the time
- Increased transmission capacity at minimal investment
- Mitigation of transmission congestion
- Increased situational awareness for operators
- More efficient integration of renewables such as wind and solar energy

And more recently . . .

- FERC incentive ROE
- FERC Order 1000 competitive response

FERC Policy Statement 11/15/12: Promoting Transmission Investment through Pricing Reform

Page 15 (Section 21) - an incentive ROE may be available for certain types of transmission projects that meet the following:

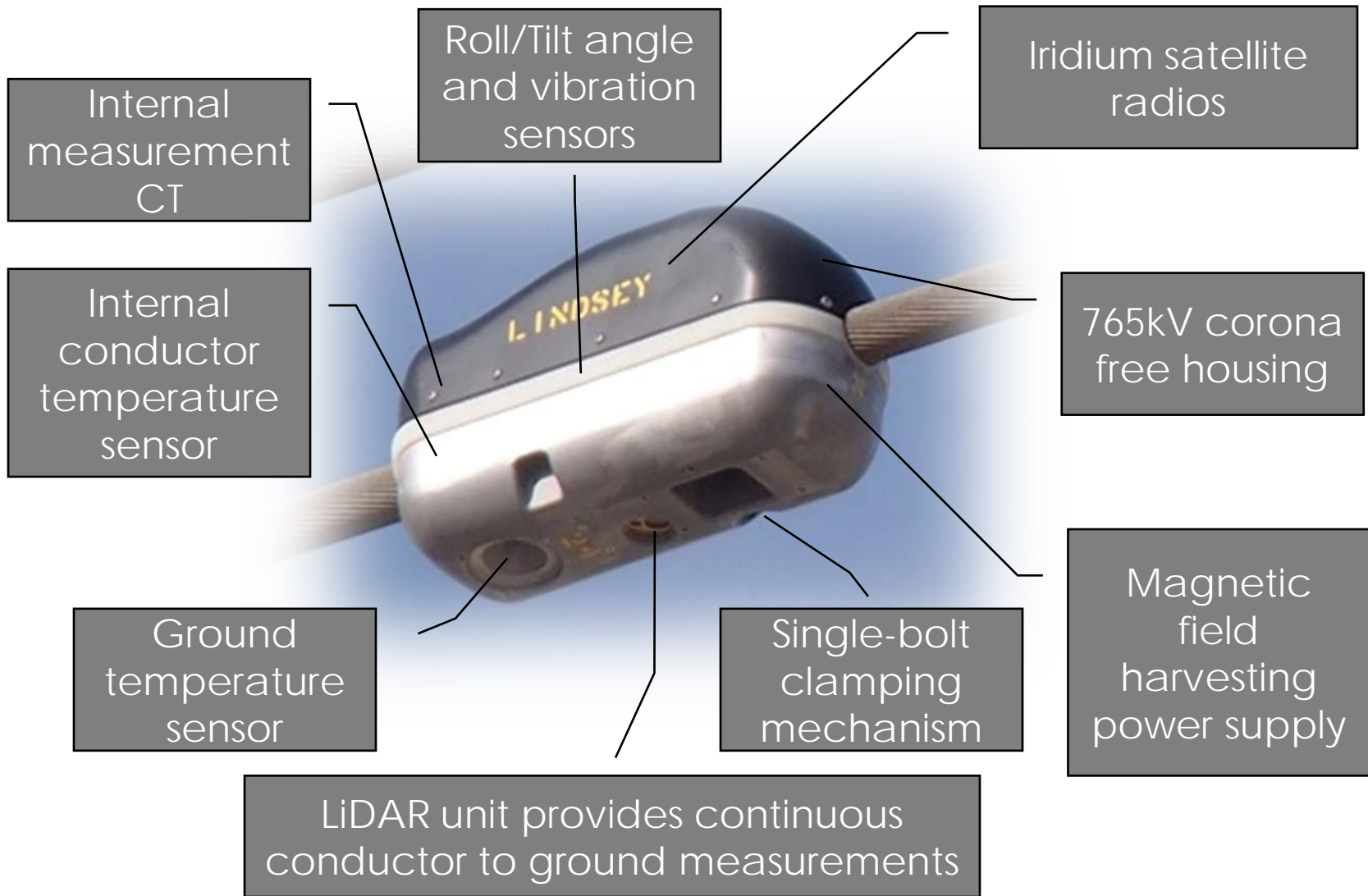
1. projects to relieve chronic or severe grid congestion that has had demonstrated cost impacts to consumers;
2. projects that unlock location constrained generation resources that previously had limited or no access to the wholesale electricity markets;
3. projects that apply new technologies to facilitate more efficient and reliable usage and operation of existing or new facilities

The policy statement specifically calls out dynamic line ratings as an example

Next Generation Dynamic Line Rating .. Smartline

- TL Mounted and Powered Measurement System Learning Conductor Behavior
- Satellite Communications/ Hourly Forecasted Weather
- Cloud Based Analytic, VPN Connections
- Reliability Based Analytic Learns Conductor Behavior
- One Hour, Two Hour, and Day Ahead Load Forecast

Next Gen DLR Lindsey Smartline



Device Installs in Minutes Live Line

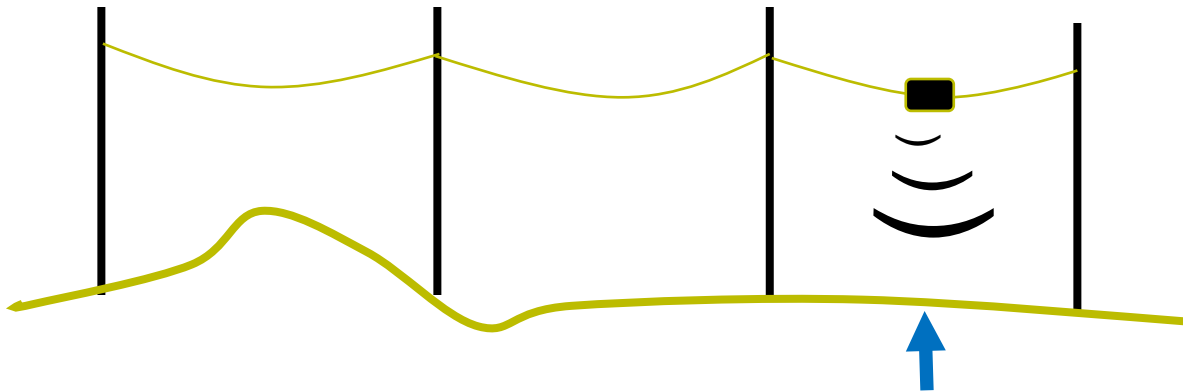


Single Bolt Attachment

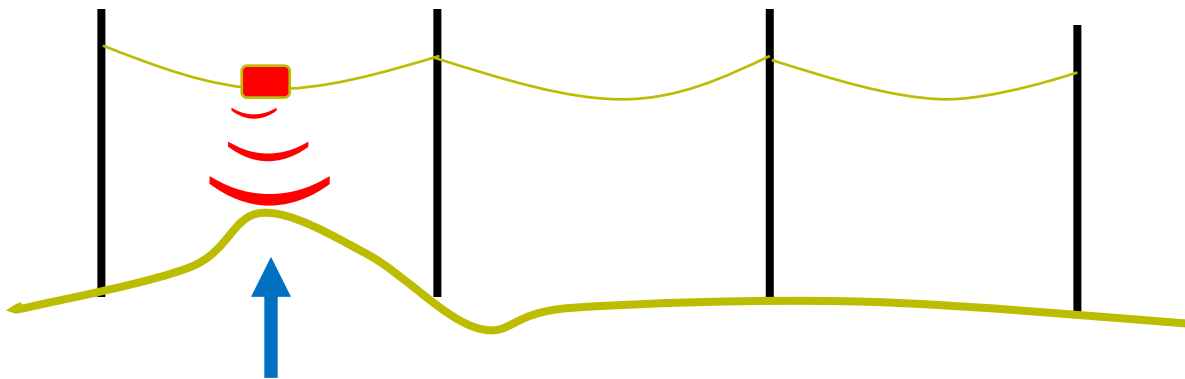


Transmission Line Monitor Installation

- TLM units may be mounted on any span in a line section

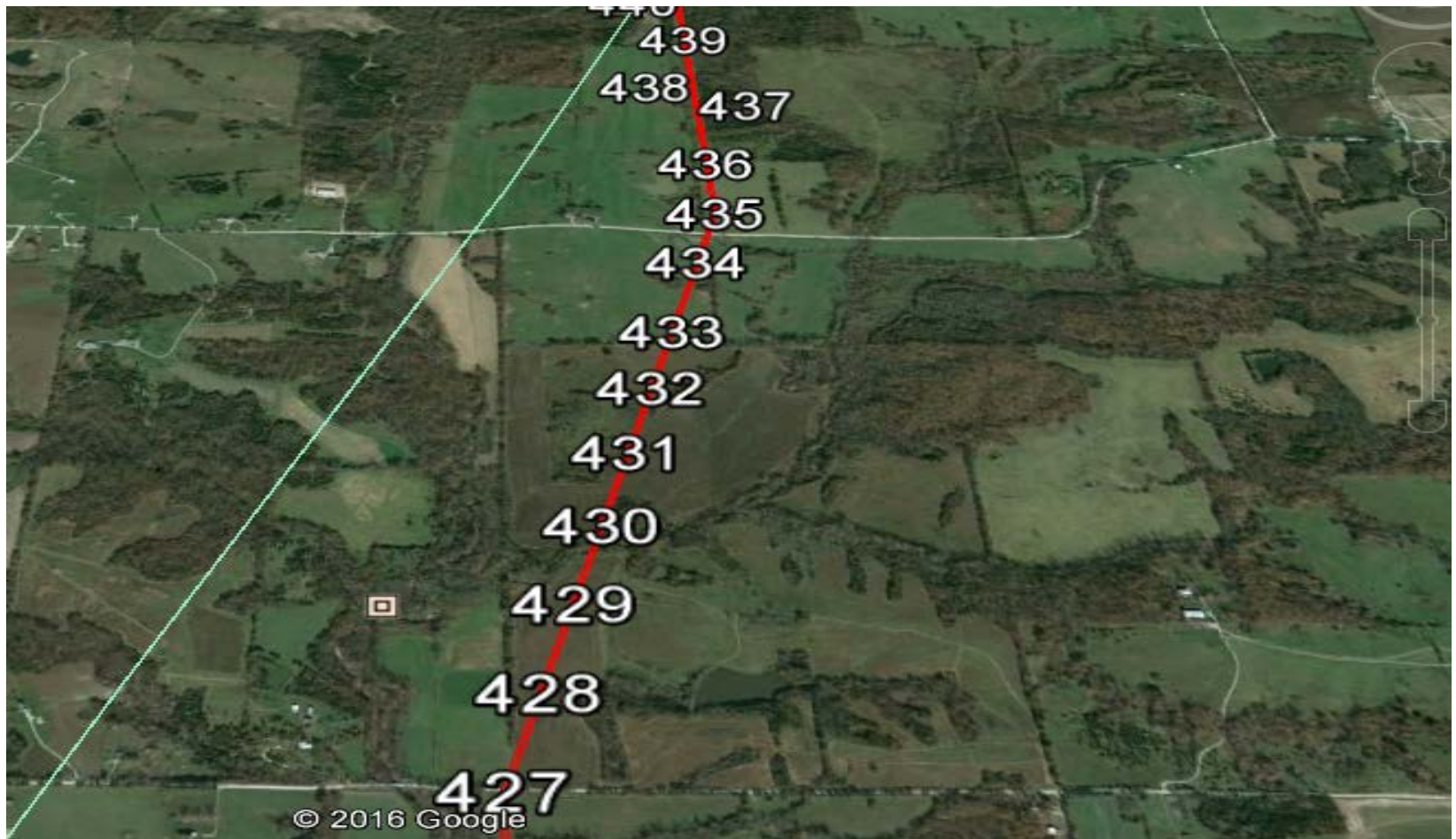


Some Spans Can Be More Critical Than Others

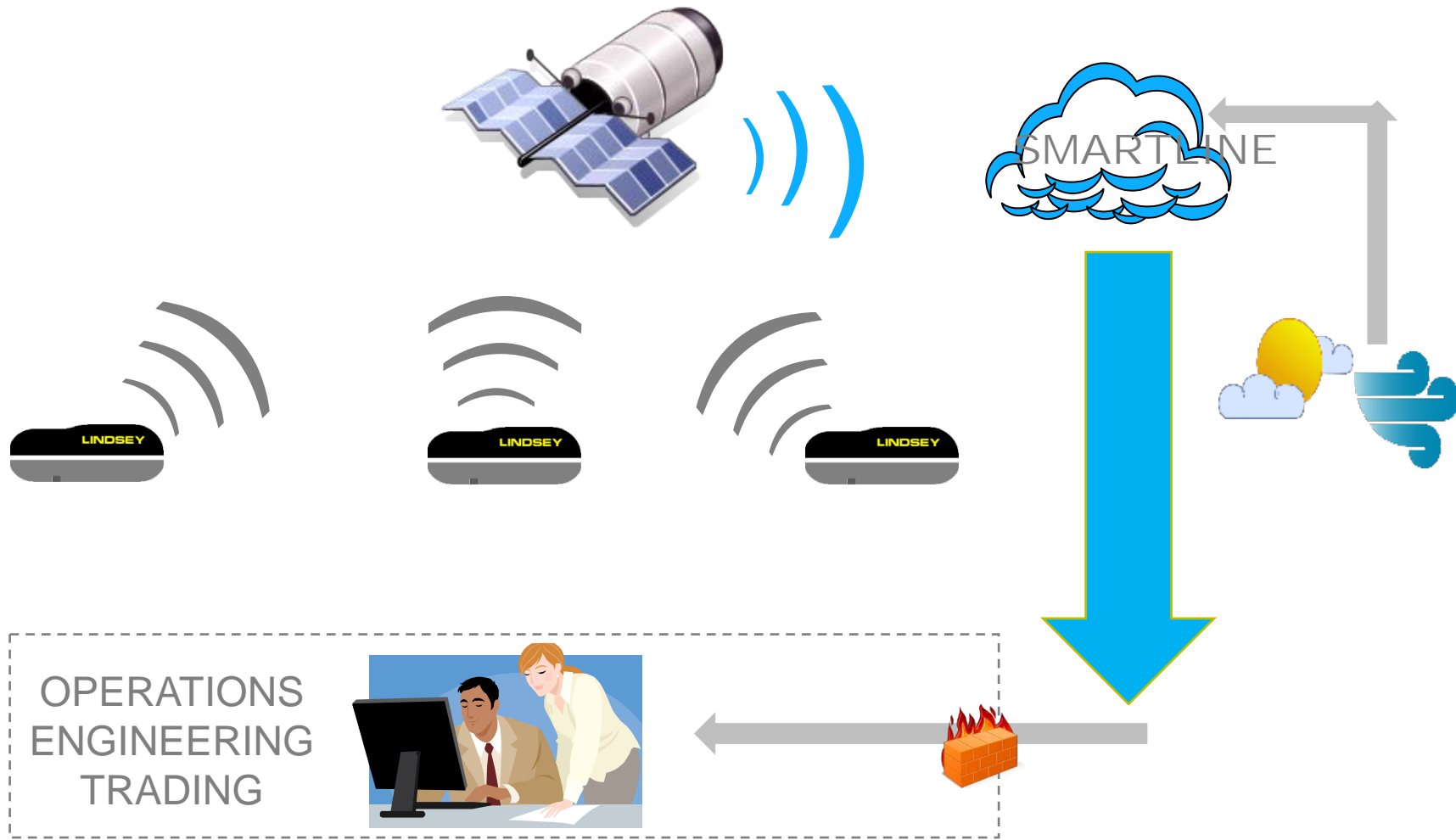


SMARTLINE measures clearance 16 times each minute with an accuracy of ± 4 " Ratings and Forecast are based upon clearance and effective average span conductor temperature

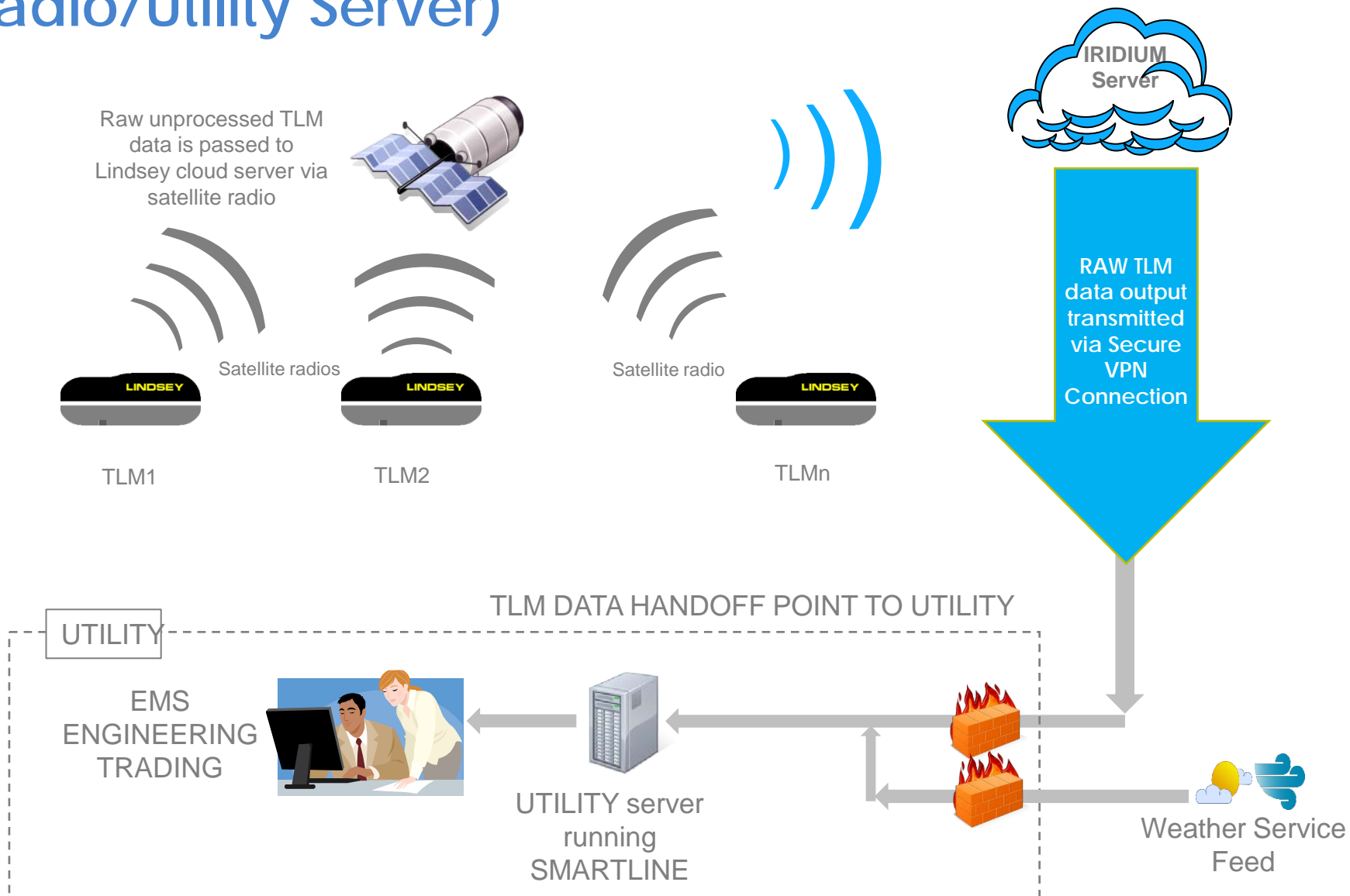
Vegetation, Eco Zones + Line Azimuth, Determine Number and Location of Devices



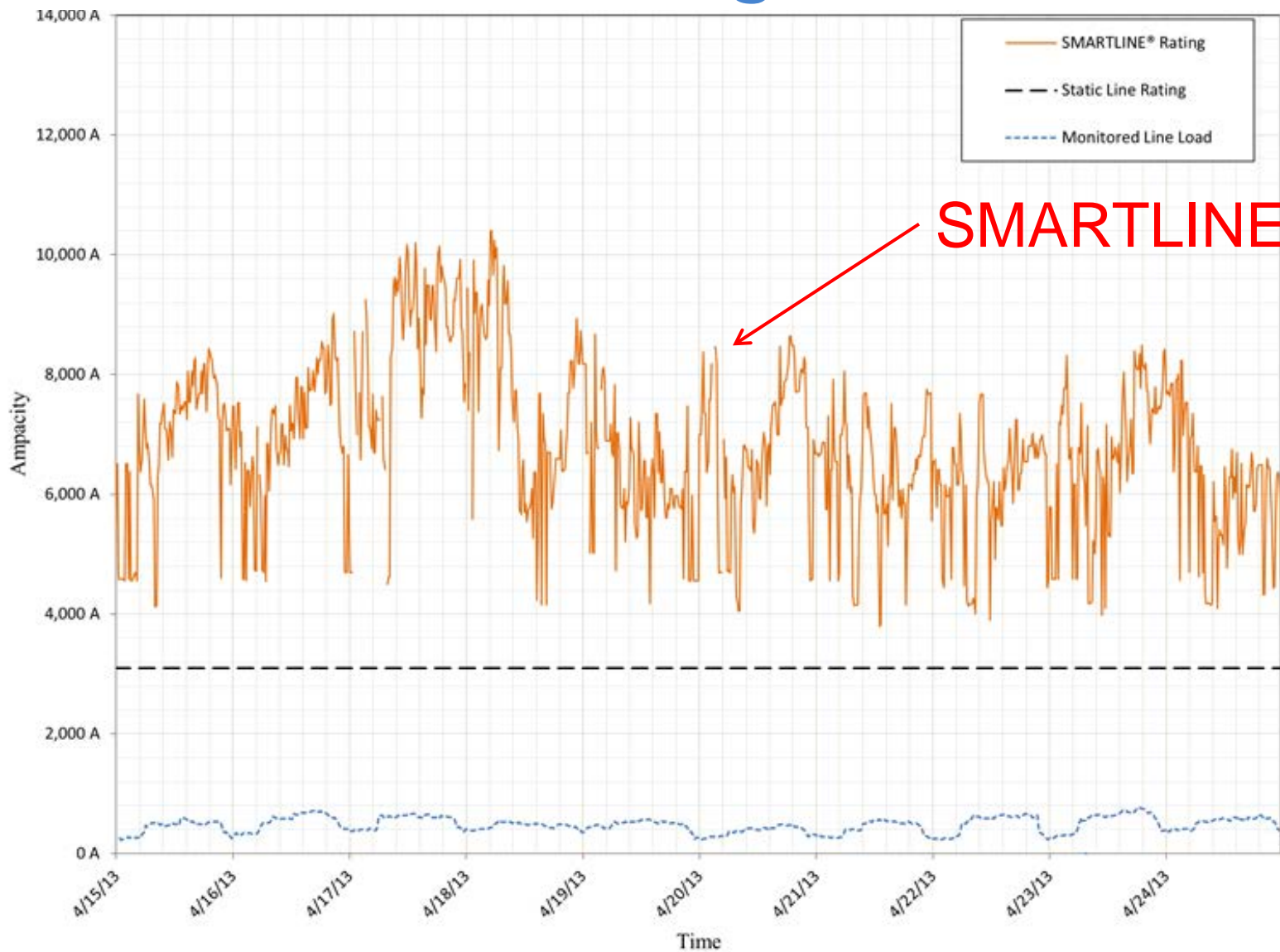
SMARTLINE System Diagram (Satellite Radio/ Cloud Server)



SMARTLINE System Diagram (w/Satellite Radio/Utility Server)

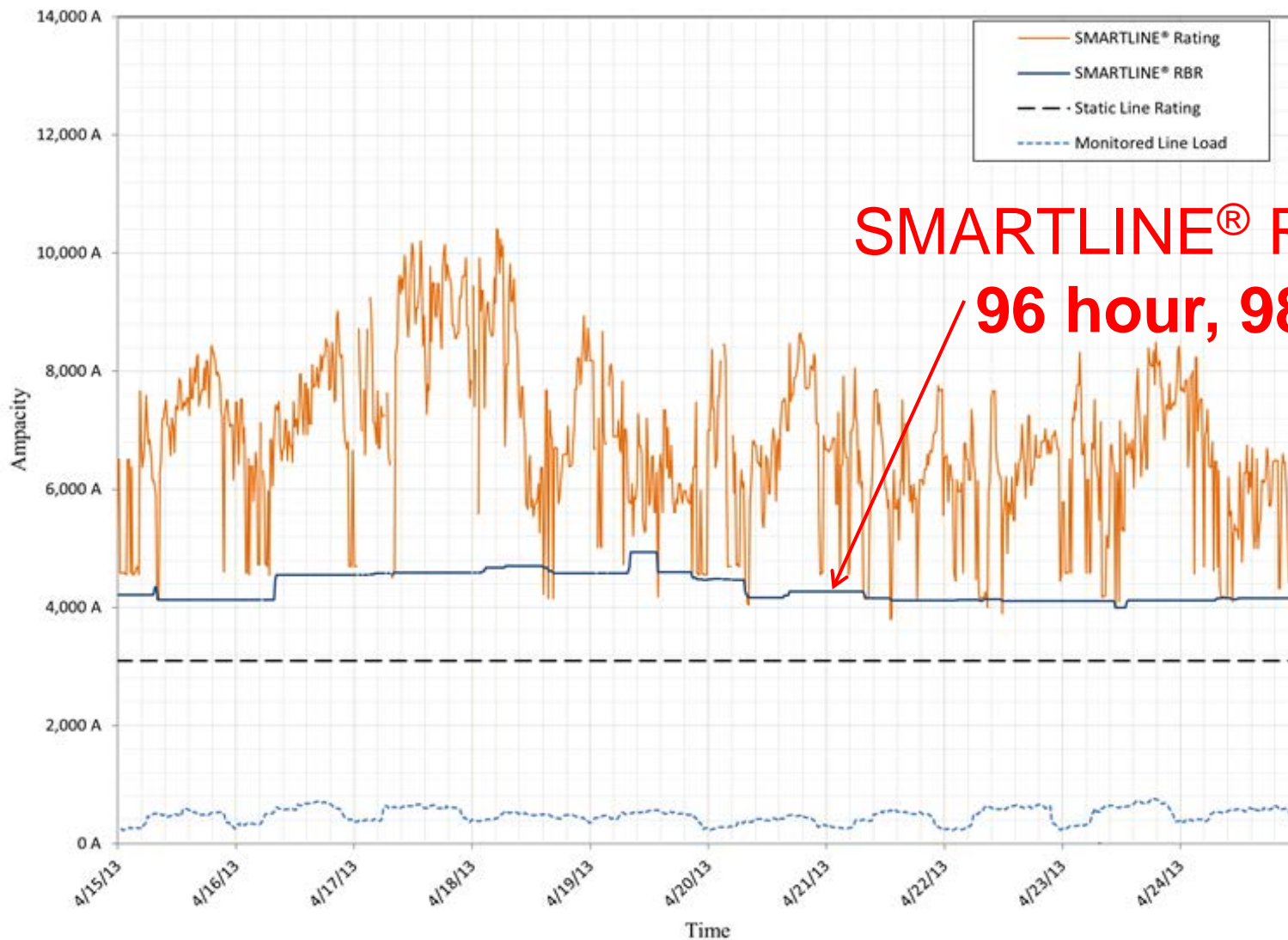


SMARTLINE DLR Rating



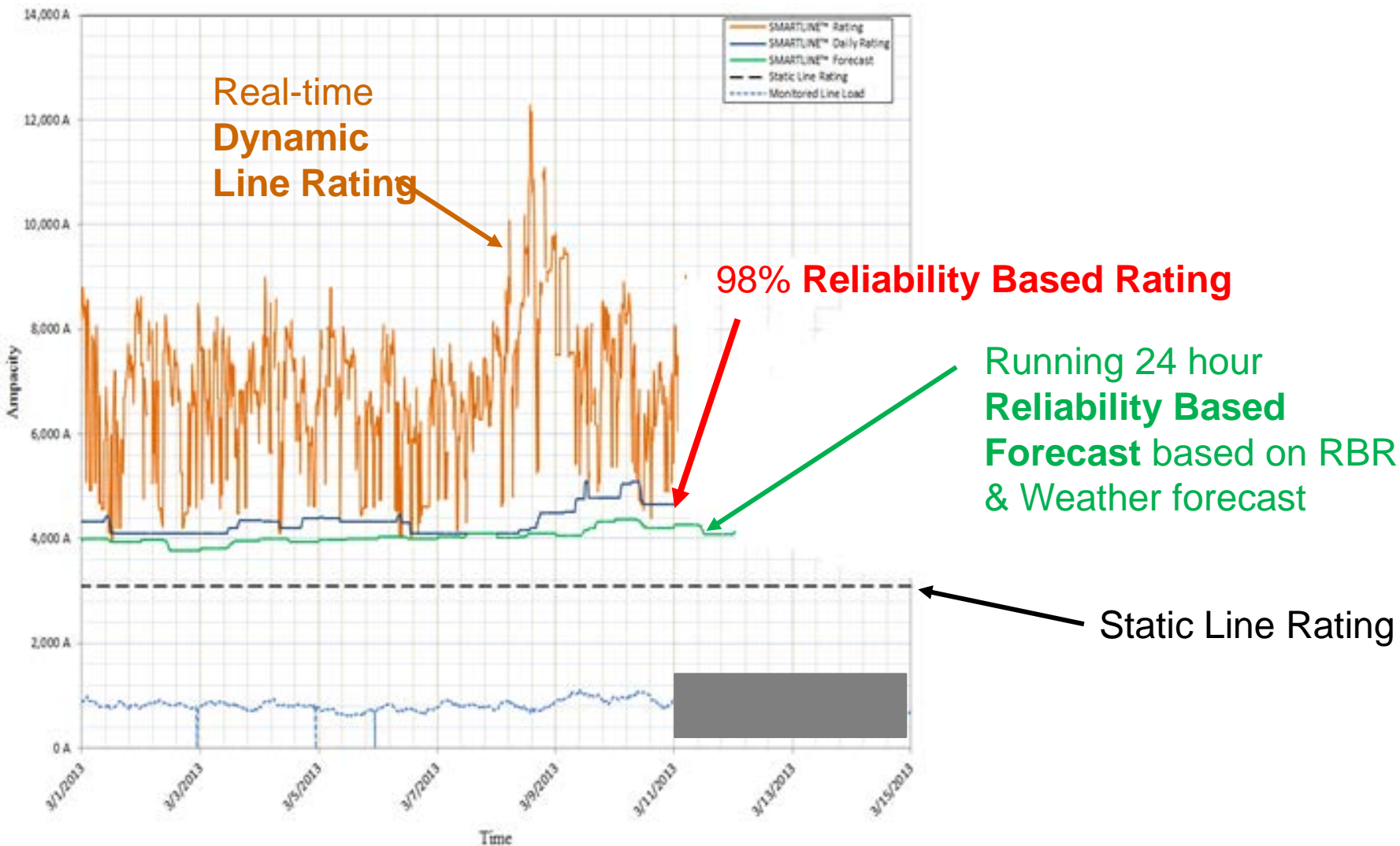
SMARTLINE® DLR

SMARTLINE RBR: A Smoothed DLR Rating

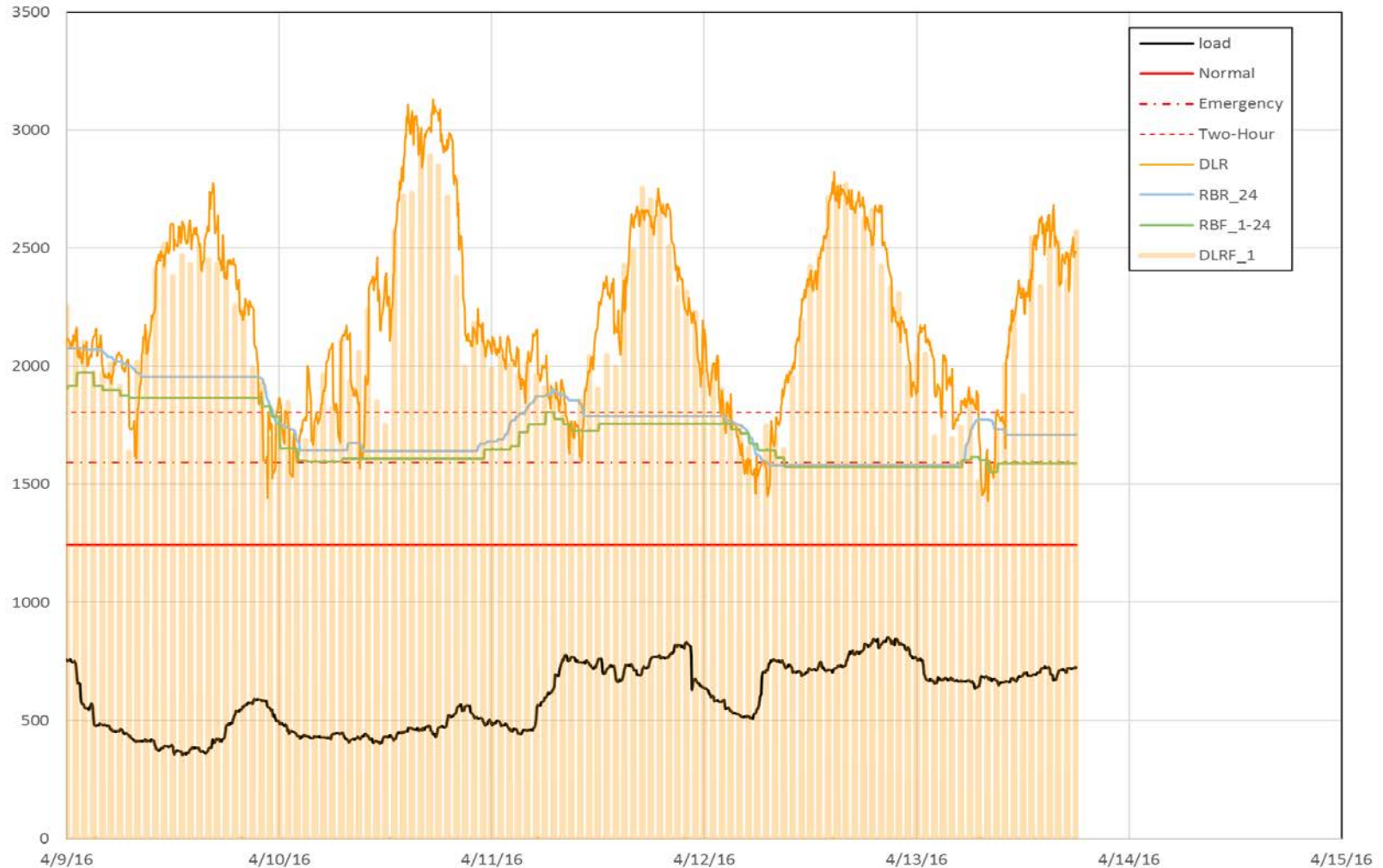


SMARTLINE® RBR
96 hour, 98%

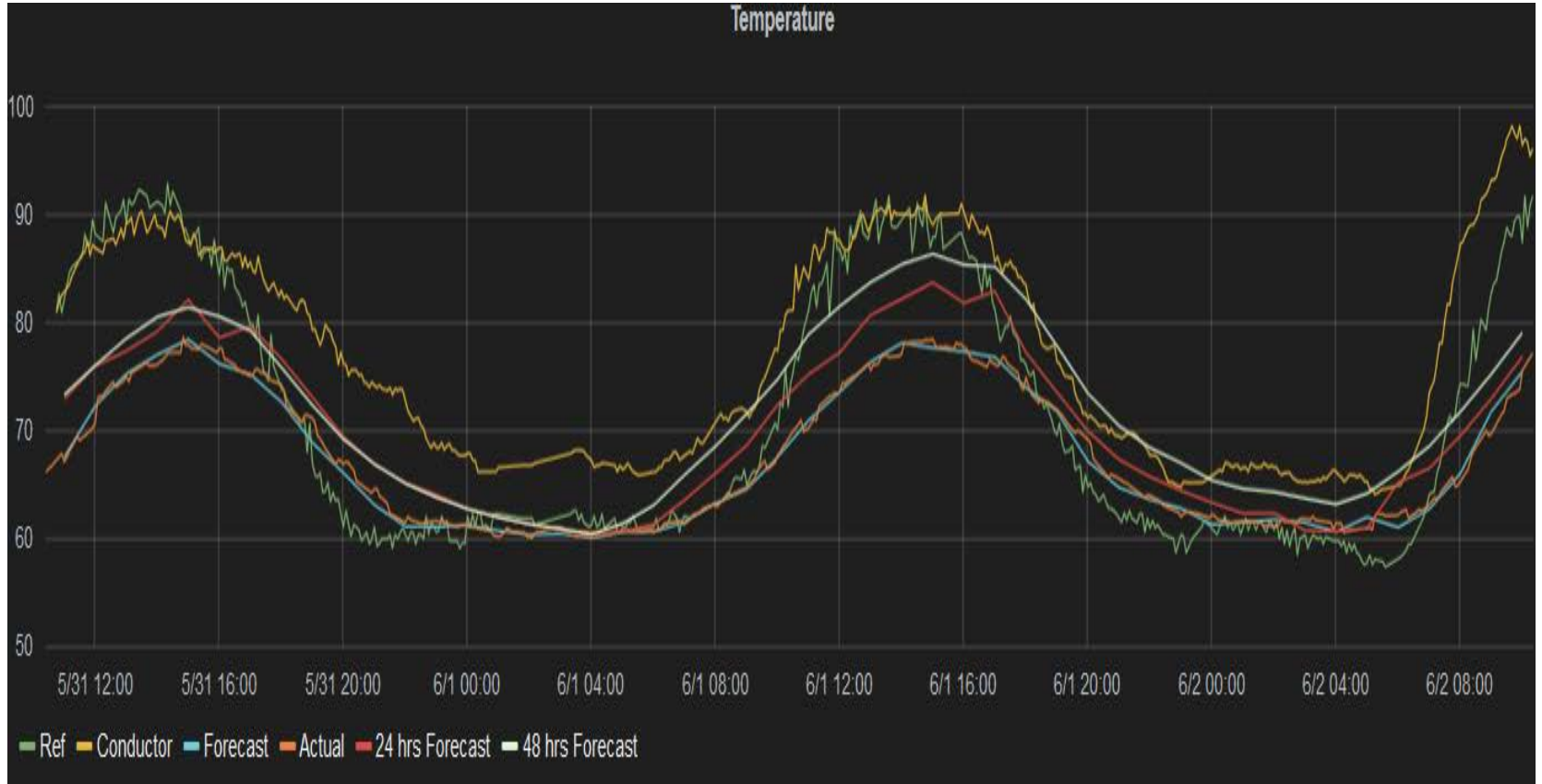
SMARTLINE: Transmission Line Rating Forecasting



SMARTLINE: One Hour Look Ahead



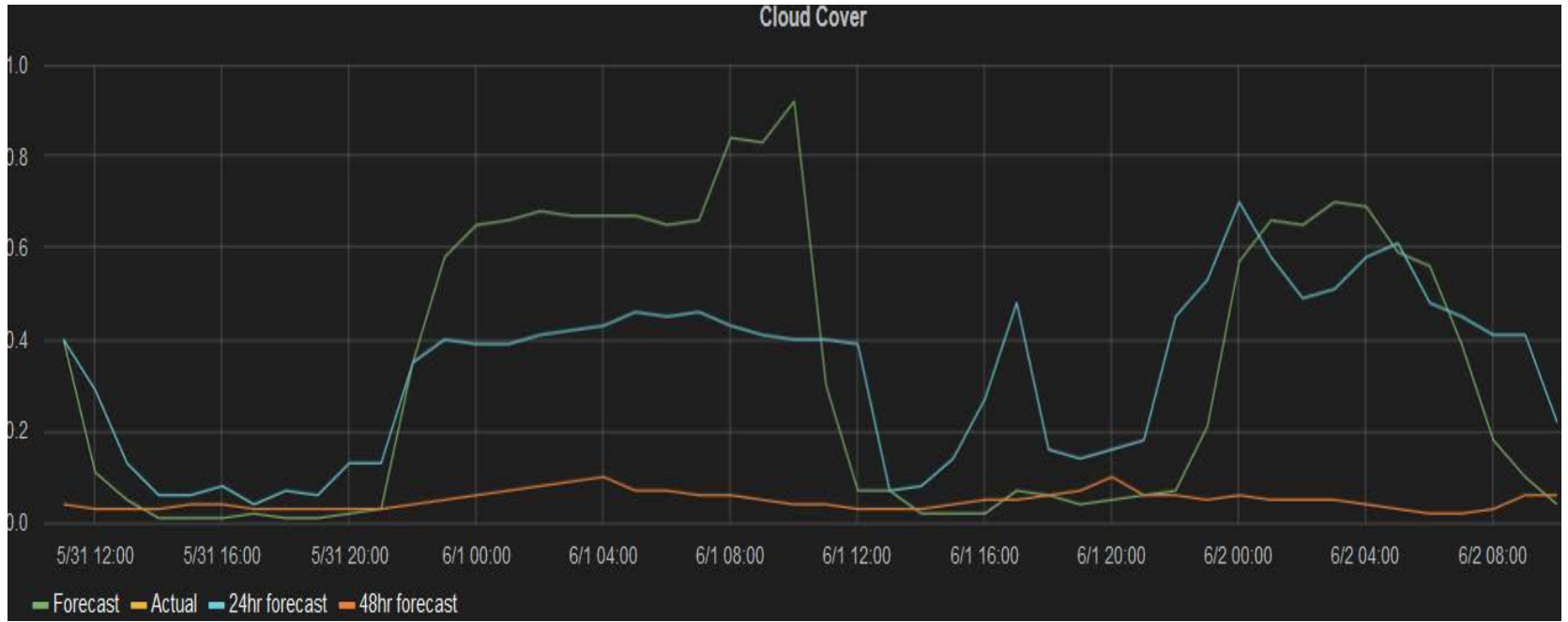


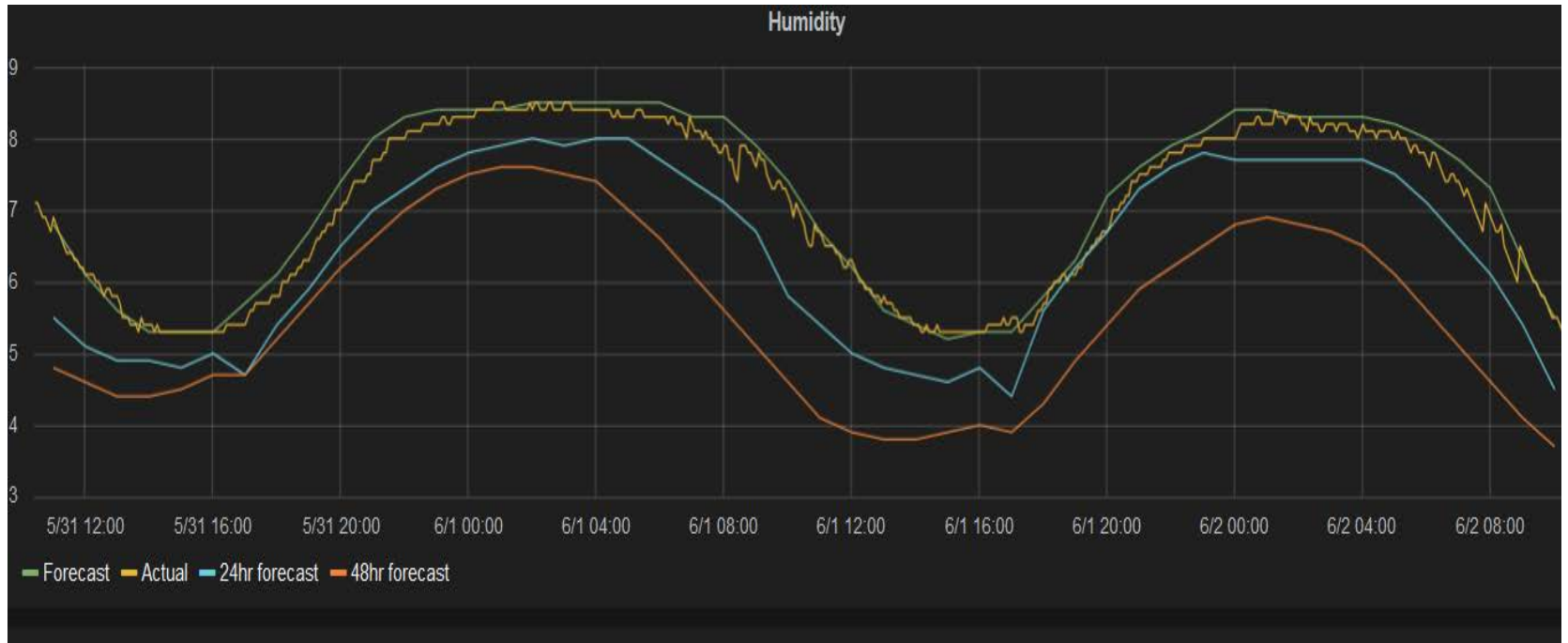


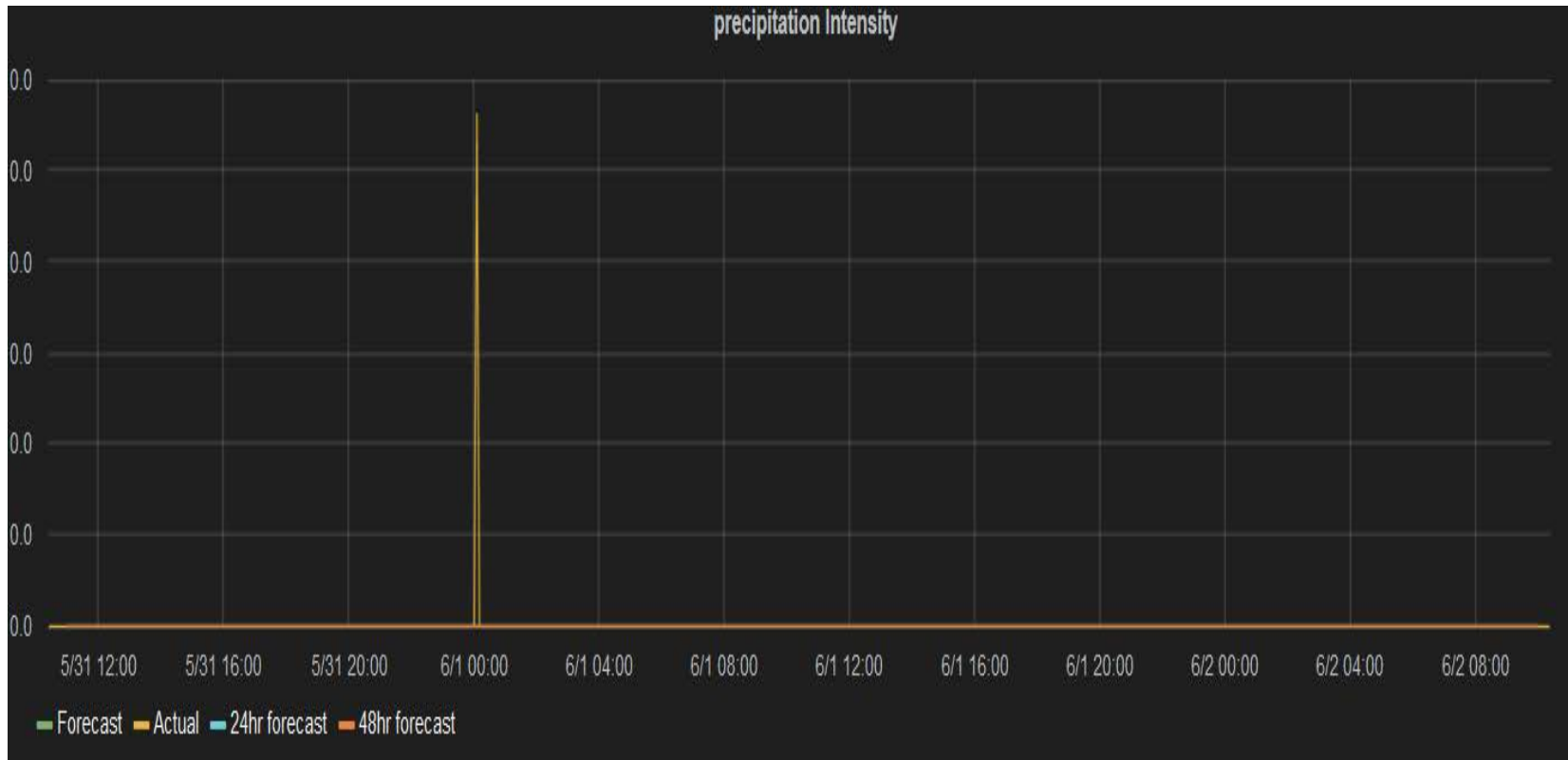












The SMARTLINE System Delivers

- Three SMARTLINE ratings:
 1. SMARTLINE Dynamic Line Rating (SLDLR)
 2. Reliability Based Rating (RBR)
 3. Reliability Based Forecast (RBF)

SMARTLINE ratings are developed from actively learning how the conductor behaves

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for more information:

visit <http://lindsey-usa.com/dynamic-line-rating/>

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