Real-time and Forecasted DLR
Use Cases

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Introduction

This document contains two use cases for the utilization of dynamic line ratings (DLR) in operational practices. These use cases were developed in support of the task force convened for the Transmission Optimization and Grid Enhancing Technologies (TOGETS) project aimed at facilitating the deployment of DLR and power flow technologies across the United States. The TOGETS project includes a demonstration of the technology on the Idaho National Laboratory (INL) power system test bed. The procurement documents, tests scripts, and field-validated results from multiple vendors will be published to improve industry's familiarity with the products. Because of the urgency in performing this work and INL's unique test setup, the task force identified a need for additional public information on the information exchanges required for operationalizing DLR (i.e., integrating DLR's within actual system operations). As such, this use case document and an accompanying interoperability profile have been developed with input from the task force and various vendors whose systems would ultimately support the functionality described. This use case and interoperability profile support two distinct functionalities with different purposes. Accordingly, this document is organized into the following three sections:

Version Management

Version	Date	Author	Status
1	July 2022	Morash	Draft
2	Sept 2022	Morash, TOGETS Task Force	Final Draft

Overview and General Terms

Use Case Identification

ID	Domains	Name
1	Transmission, Operations, Markets, Generation	Real-Time DLRs Used to Support Switching Operations
2	Transmission, Operations, Markets, Generation	Forecasted DLRs Used in Generation Fleet Unit Commitment

Scope of Use Cases

Information exchanges between the DLR Calculation Engine, Bulk Power Management Systems (BPMS) and human actors in the loop required to ensure appropriate action(s).

Objective of Use Cases

Define required information exchanges between DLR engines, BPMS, and human operators (e.g., Grid Operators) to support and enable the utilization of:

1. Real-time line ratings to inform switching operations
2. Forecasted line ratings to inform unit commitment decisions

Definition of Terms

Dynamic Line Rating – "A transmission line rating that applies to a time period of not greater than one hour and reflects up-to-date forecasts of inputs such as (but not limited to) ambient air temperature, wind, solar heating, transmission line tension, or transmission line sag."[1]

Unit Commitment – The process of deciding when and which generating units start-up and shut-down. It is typically performed on an hours-ahead to days-ahead schedule.

Bulk Electric System – Per NERC, the Bulk Electric System includes "All Transmission Elements operated at 100 kV or higher and Real Power and Reactive Power resources connected at 100 kV or higher. This does not include facilities used in the local distribution of electric energy."[2] For the purposes of this use case, we are primarily interested in BPMS, which could include both BES facilities and those operated at lower voltage levels.

[1] *Managing Transmission Line Ratings, Order No. 881, 177 FERC ¶ 61,179, at PP 235, 238 (2021); 18 CFR 35.28(b)(14).*

[2] *Bulk Electric System Definition Reference Document version 3. NERC. August 2018.*

Actors

Name	Type	Description
Bulk Power Management Systems (BPMS)	Software	The software system used to operate the bulk electric system in a particular region. The BPMS may include a commercially available energy management system (EMS) or transmission management system (TMS).[3]
DLR Calculation Engine	Software	The software system used to calculate DLR based on up-to-date forecasts or measurements of inputs such as (but not limited to) ambient air temperature, wind, solar irradiation, transmission line tension, or transmission line sag. The software system can be either cloud based or located on the premise of a utility owned/operated data center.
DLR Sensor Device	Device	A device deployed in the field that communicates measurements relevant to the calculation of DLRs with the DLR Calculation Engine.
Grid Operator	Person or Organization	The person (or group of people) who manages and operates the BPMS. This person may use a variety of software and hardware tools to accomplish the function.
Switching Optimization Engine	Software	A software system that optimizes the configuration of the bulk electric system in a particular area. This engine may be a subcomponent of the larger BPMS. The switching optimization engine has the capability to optimize power system topology, whether that is intentionally switching lines in/out of service, adjusting power flow control setpoints, or any number of transmission adjustments.
Unit Commitment Engine	Software	A software system that optimizes the startup and shutdown of generating facilities in a particular area. This engine may be a subcomponent of the larger BPMS.
Weather Provider	Service	A data feed made available that provides historical and forecasted weather information, which could include ambient air temperature, wind speed and direction, solar irradiance, humidity, etc.

General Remarks

The actors described within this use case are abstracted to maintain consistency and segmentation of responsibilities/roles. In a real-world implementation, certain actors may appear as single humans or as multiple systems working together to achieve the described functionality. For instance:

- The BPMS effectively controls the behavior of the bulk power system. This system may be a single software system located within a single organization, or it may be a variety of systems across organizations (e.g., Transmission System Operator and Independent System Operator) working together to manage the power system.
- The DLR Calculation Engine is a software system that may take information from a variety of sources. It may be located within the BPMS and primarily function off of weather data. It may be a separate system offered by a vendor who specializes in DLR calculations.

The use cases described here were selected as examples of operational use of both real-time and forecasted DLRs, but they are not the only potential uses of DLRs. The following items are out of scope for this particular effort, but could still be valid use cases for effective use of DLRs:

- Redispatch of generation in real time based on up-to-date DLRs
- Short-term redispatch of generation based on thermal inertia of the line (i.e., hour ahead)
- Short-term redispatch and unit commitment of generation based on thermal inertia of the line and forecasts (i.e., 1-4 hours ahead)
- Scheduling maintenance of generating units based on medium-term DLR forecasts (week ahead)
- Deferral of transmission system upgrades (construction, refurbishment, voltage upgrades) while still integrating more renewable generation (months/years ahead)

References

No.	Reference Type	Reference	Status	Impact on Use Case	Originator/ Organization
1	Template	IEC Use Case Template	FINAL	Served as template for use case creation	IEC
2	Use Case	SEPA EV Fleet Management Use Case	FINAL	Served as inspiration for content developed in this use case	SEPA
3	Standard	IEC CIM	FINAL	Informed information exchange formatting	IEC

[3] *For the purposes of this use case, we have aggregated the variety of systems and organizations that could be required to operate the bulk power system. For instance, the practical implementation of this use case may require transmission operators to receive DLRs from a third party vendor and pass that rating to an independent system operator. This use case is focused on the DLR and operational system's information exchange.*

Real-Time DLR Informs System Reconfiguration Use Case

DLRs reflect up-to-date weather factors that can lead to different line carrying capabilities than static assumptions, due to conservative estimates informing those static assumptions. This use case covers the information exchange enabling real-time line ratings informing system reconfiguration decisions (e.g., switching lines in or out of service, adjusting power flow controller settings, or any number of potential transmission adjustments).

This Real-Time DLR Informs System Reconfiguration use case addresses the following elements:

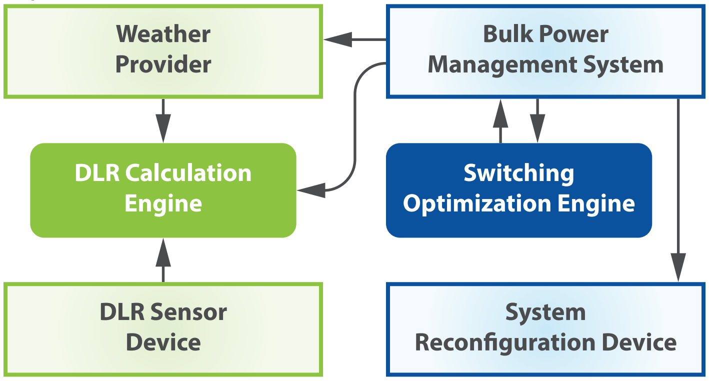
- Actors involved in the information exchanges,
- Information required to be exchanged between actors,
- Conditions required to initiate information exchange between the actors,
- Frequency of information exchange between the actors,
- Response generated upon information receipt, and
- What actions are enabled by the information exchanged.

Description

This use case addresses the information exchanges needed to enable DLRs to inform real-time system reconfiguration of a transmission system. As outlined in the definitions section, the Grid Operator/Operators is responsible for operating the grid. This person could manage a fleet of generating units, the transmission system, and demand side resources. This use case primarily covers the DLR and BPMS (system-to-system) data exchanges, and only calls for Grid Operator intervention occasionally, when necessary or desired. Moreover, the use case outlines that the DLRs inform emergency transmission system reconfiguration[4] or adjustments, such as optimizing power flow control setpoints.

In this use case, the DLR Calculation Engine regularly publishes real-time ratings to be made available to the BPMS. The BPMS may provide the DLR Calculation Engine with historical line loadings for DLR system calibration via an offline process. The DLR Calculation Engine may use a variety of inputs to calculate the DLRs, including historical and forecasted weather. The BPMS identifies a system emergency that requires system reconfiguration. The DLR Calculation Engine regularly publishes updated DLR's for at least the next hour (H +1) in 15-minute intervals. This real-time DLR, provided in amperes (A), is updated and published at least hourly for each line. The published DLRs represent ampacity for the entire line, informed by the segment along the line with the minimum rating. The published DLRs are then retrieved by the BPMS, which combines the DLRs with other limits, forecasts, and other subcomponents or optimization engines (particularly the Switching Optimization Engine) to optimally reconfigure the transmission system.

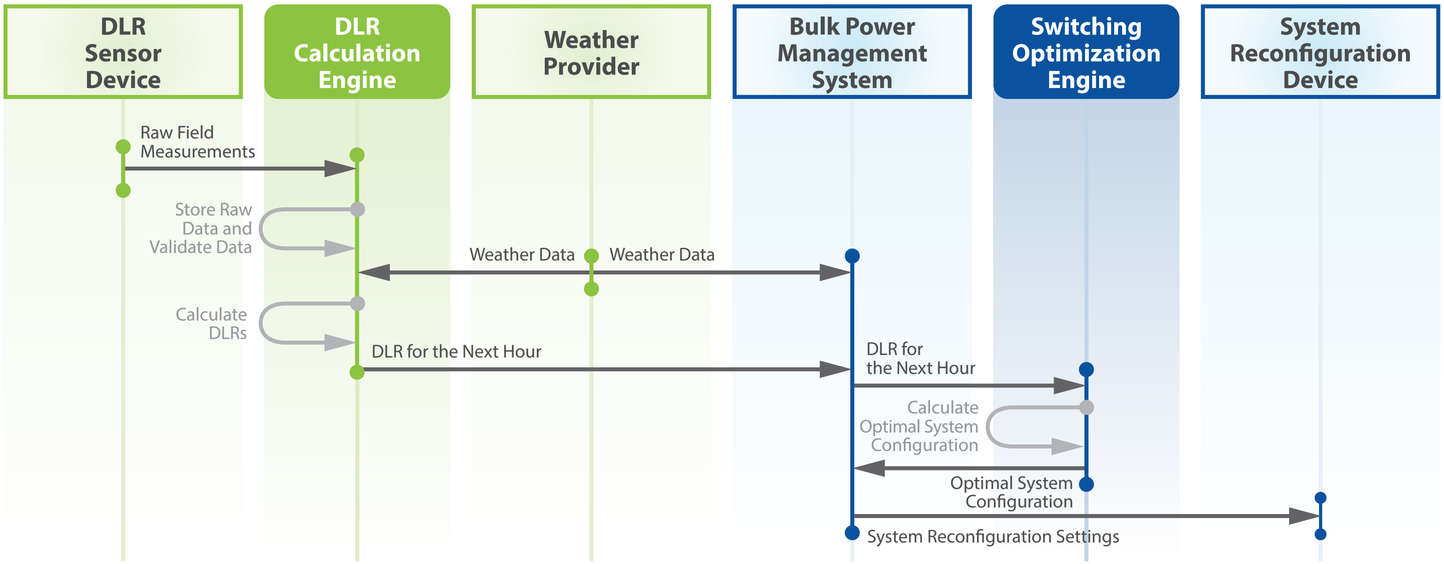
The high-level system architecture for this use case is captured below:



[4] *DLRs could also be used for a variety of other use cases, including daily topology optimization, redispatch of generating units, or to adjust power flow controller setpoints.*

Use Case 1: Real Time DLRs Inform System Reconfiguration

Precondition: Communication tested and secure, field device data validation period complete.



Real-Time Use Case Conditions

Actor	Role	Pre-conditions	Assumptions
Grid Operator	Identified need to implement DLR on some set of lines within their territory Verified performance of DLR Calculation Engine. Safely maintains power system such that conductor temperature limits provide sufficient clearance on transmission.	Grid Operator has established DLR implementation to meet identified grid need.	Grid Operator has validated performance of DLR Calculation Engine, including providing any data/ time necessary DLR calculation calibration. Grid Operator has business processes in place to rely upon DLRs, with appropriate failure measures identified. The conductor temperature limits provided by the grid operator align with clearance standards for transmission.
BPMS	Houses the digital model of the bulk power system components.	The physical attributes that make up the bulk power system are sufficiently captured in the digital network model.	The BPMS, or some subcomponent therein, houses a digital representation of the physical network model that can be shared with DLR Calculation Engine with sufficient detail for DLR calculations, including line length, conductor type, and conductor size.
BPMS	Retrieves and manages DLRs for subsystem and Grid Operator usage.	BPMS and DLR Calculation Engine have established data exchange pathway, complete with commissioning testing and verification.	The BPMS is configured to receive and leverage DLRs from the DLR Calculation Engine. The BPMS has additional information required from other systems/devices to accomplish its functions, including limits, measurements and forecasts for all transmission facilities (i.e., not just thermal line limits).
BPMS	Safely manages the bulk power system.	BPMS uses information from multiple systems to recognize a variety of potential constraints beyond thermal line limits.	The BPMS is configured to interpret when the DLR offers excess thermal capacity that isn't necessarily implementable, due to other operational considerations. The BPMS can still use the DLR thermal capacity up to any other operational constraint.
DLR Calculation Engine	Calculates DLRs for the next hour, updating that data at least hourly, and publishing the DLRs via standard interface.	Data exchange pathways established in secure manner. Field calibration period for field deployed sensors complete.	The DLR Calculation Engine has established and validated data streams required to calculate DLR, including data measured by the DLR Sensor Device, via weather providers, the grid operator, and BPMS.

Step by Step Analysis of Use Case

No	Optional	Event or Name of Process/Activity	Info Producer (Actor)	Info Receiver (Actor)	Information Exchanged
1	Yes	DLR Sensor Device captures field measurements	DLR Sensor Device	DLR Sensor Device	DLR Sensor Device Internal
2	Yes	DLR Sensor Device sends field measurements to DLR Calculation Engine	DLR Sensor Device	DLR Calculation Engine	Field Measurements
3	Yes	DLR Calculation Engine stores raw data from DLR Sensor Device and performs any validation, editing, estimation required.	DLR Calculation Engine	DLR Calculation Engine	DLR Calculation Engine Internal
4	Yes	DLR Calculation Engine retrieves data from the weather provider	Weather Provider	DLR Calculation Engine	Weather
5	No	DLR Calculation Engine calculates DLRs for the next hour based on available data.	DLR Calculation Engine	DLR Calculation Engine	DLR Calculation Engine Internal
6	No	DLR Calculation Engine publishes DLRs for the next hour	DLR Calculation Engine	BPMS	DLRs, Limiting Line Segment
7	No	BPMS retrieves DLRs	DLR Calculation Engine	BPMS	DLRs, Limiting Line Segment
8	No	BPMS provides DLRs to the Switching Optimization Engine	BPMS	Switching Optimization Engine	DLRs, Limiting Line Segment
9	No	Switching Optimization Engine calculates optimal system configuration using system characteristics, including DLRs	Switching Optimization Engine	Switching Optimization Engine	Switching Optimization Engine Internal
10	No	Switching Optimization Engine provides optimal system configuration to BPMS	Switching Optimization Engine	BPMS	Optimal System Configuration
11	No	BPMS sends system reconfiguration settings to system reconfiguration device (switch)	BPMS	System Reconfiguration Device	Reconfiguration Settings

Steps → Requirements

Step	Optional?	Name of Process/Activity	Information Exchanged	Requirements	R-ID
1	Yes	DLR Sensor Device captures field measurements	N/A	- The DLR vendor solution shall capture field measurements at the identified locations. - The vendor solution shall perform regardless of terrain roughness. - The vendor solution shall report ratings regardless of precipitation, humidity, and atmospheric pressure.	1-3
2	Yes	DLR Sensor Device sends field measurements to DLR Calculation Engine	Field Measurements	- The DLR Sensor Device shall leverage wireless telecommunication technology from any and all field deployed sensors.	4
3	Yes	DLR Calculation Engine stores raw data from DLR Sensor Device and performs any validation, editing, estimation required	N/A	- Raw data processing shall be contained within the vendor's equipment, whether localized at the sensor or aggregated at vendor servers. - Raw data shall be made available through standard reporting mechanisms. - Each data type shall be marked as such (validated, edited, estimated, raw, etc.). - The DLR Calculation Engine shall provide estimated DLRs in the event of that communication is interrupted with the DLR Sensor Device.	5-9

Step	Optional?	Name of Process/Activity	Information Exchanged	Requirements	R-ID
4	Yes	DLR Calculation Engine retrieves data from the weather provider	Weather Data	- The DLR Calculation Engine shall have access to granular weather data.	10
5	No	DLR Calculation Engine Calculates DLRs for the next hour based on available data	N/A	- The DLR Calculation Engine shall calculate DLRs for the next hour in 15-minute intervals. - The DLR Calculation Engine shall calculate the limiting line segment for the next hour in 15-minute intervals. - The DLR Calculation Engine shall use IEEE 738 to calculate DLRs. - The vendor solution shall timestamp data using GPS accuracy.	10-13
6	No	DLR Calculation Engine publishes DLRs for the next hour	DLR, Limiting Line Segment, Duration, Start Time	- The DLR Calculation Engine shall publish DLRs and their associated limiting line segment for the next hour in 15-minute intervals via secure processes. - The DLR Calculation Engine shall support data retrieval from a different network. - The DLR Calculation Engine shall make this information available at least 5 minutes before the target hour begins. - The DLR Calculation Engine shall update the real time ratings at least hourly. - The vendor solution timestamps shall be reported in local time of the line segment. - The DLR Calculation Engine shall publish data using the CIM Data format. - The DLR Calculation Engine shall make data available in downloadable CSV format.	14-20
7	No	BPMS retrieves DLRs	DLR, Limiting Line Segment, Duration, Start Time	- The BPMS shall be configured to retrieve data from the DLR Calculation Engine. - The BPMS shall be configured to leverage the CIM data format for DLR and line segment data ingestion. - The BPMS shall be configured to leverage the duration and start time for the DLRs.	21-23
8	No	BPMS provides DLRs to the Switching Optimization Engine	DLRs, Limiting Line Segment	- The BPMS shall provide the Switching Optimization Engine with the updated DLRs.	22
9	No	Switching Optimization Engine calculates optimal system configuration using system characteristics, including DLRs	N/A	- The Switching Optimization Engine shall leverage the DLR data to calculate optimal system configurations.	23
10	No	Switching Optimization Engine provides optimal system configuration to BPMS	Optimal System Configuration	- The Switching Optimization Engine shall provide the BPMS with the optimal system configuration.	24
11	No	BPMS sends system reconfiguration settings to system reconfiguration device	Reconfiguration Settings	- The BPMS shall send system settings to remotely deployed devices. - The remotely deployed devices shall remotely receive setpoint updates.	25-26

Information Exchanged

Name of Information Exchanged	Description of Information Exchanged	Requirements to information data R-ID
Start Time	Start Time of the DLR.	Data shall be exchanged using a package that supports the HH:MM:SS YYYY-MM-DD format
Duration	Duration after the start time the DLR is to be presumed valid for the operator or systems that utilize this data.	Data shall be made expressed in seconds
DLR	The DLR is updated and published at least hourly for each line.	DLR shall be provided in amperes (A)
Limiting Line Segment	The segment of the line that represents the limiting element driving the DLR for each 15-minute interval.	Line Segment as defined in the IEC CIM with associated mRID

Forecasted DLRs in Generation Fleet Unit Commitment

DLRs reflect up-to-date weather factors that can lead to different line carrying capabilities than static assumptions, due to conservative estimates informing those static assumptions. This use case covers the information exchange enabling forecasted line ratings to inform generator commitment decisions.

This Forecasted DLRs Used in Generation Fleet Unit Commitment use case addresses the following elements:

- Actors involved in the information exchanges,
- Information required to be exchanged between actors,
- Conditions required to initiate information exchange between the actors,
- Frequency of information exchange between the actors,
- Response generated upon information receipt, and
- What actions are enabled by the information exchanged.

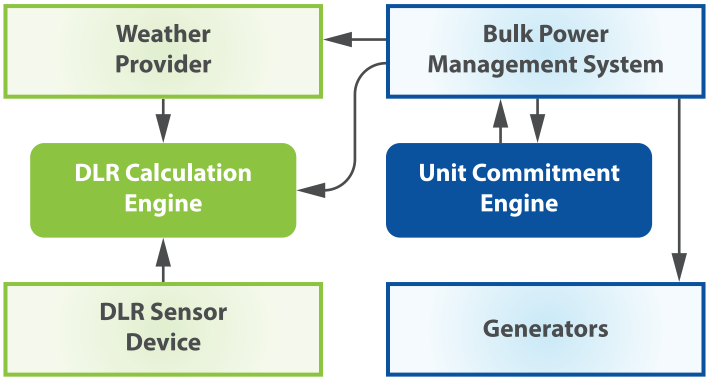
Description

This use case addresses the information exchanges needed to enable DLRs to inform the day-ahead generation scheduling process. As outlined in the definitions section, the Grid Operator is the human person or persons responsible for operating the grid. This person could manage a fleet of generating units, the transmission system, and demand side resources. This use case primarily covers the DLR and BPMS (system-to-system) data exchanges, and only calls for the Grid Operator intervention occasionally, when necessary or desired. Moreover, the use case outlines that the DLRs inform day ahead unit commitment, but DLRs could also be used for a variety of other use cases, including daily topology optimization, redispatch of generating units, adjusting power flow controller setpoints, or emergency situations.

In this use case, the DLR Calculation Engine publishes forecasted line ratings covering the next 48 hours at noon daily. The BPMS may provide the DLR Calculation Engine with historical line loadings for DLR system calibration via an offline process. The DLR Calculation Engine may use a variety of inputs to calculate the forecasted DLRs, including historical and forecasted weather. The DLR forecast refresh publishes DLRs for each hour within the 48 hour forecast horizon and for each line within the territory, as agreed upon during the commissioning process. The published DLR forecasts represent ampacity for the entire line, informed by the segment along the line with the minimum rating. The published DLR forecasts are then retrieved by the BPMS, which combines the DLRs with other limits, forecasts, and subcomponents or optimization engines (particularly the Unit Commitment

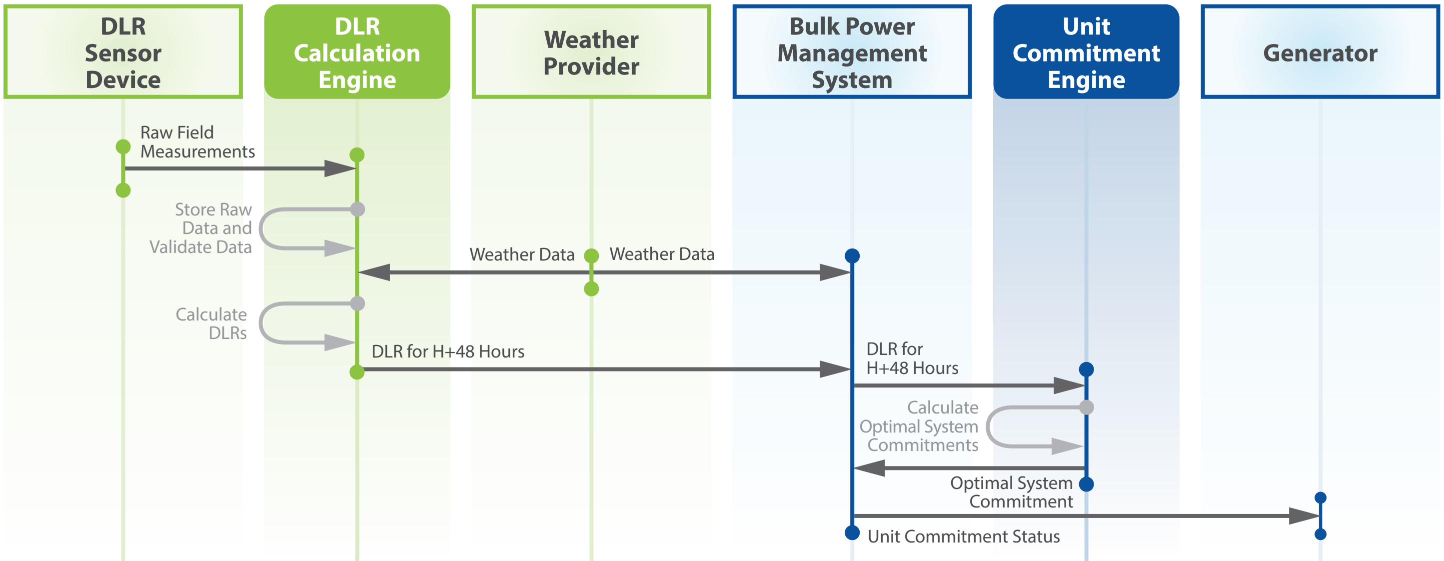
Engine) to optimally commit the generation system. To maintain a reliable system, the DLR forecasts represent some conservative value as specified by the Grid Operator.

The high-level system architecture for this use case is captured below:



Use Case 2: Real Time DLRs Inform System Reconfiguration

Precondition: Communication tested and secure, field device data validation period complete.



Real-Time Use Case Conditions

Actor	Role	Pre-conditions	Assumptions
Grid Operator	Identified need to implement DLR on some set of lines within their territory. Verified performance of DLR calcula-tion engine. Safely maintains power system such that conductor temperature limits provide sufficient clearance on trans-mission.	Grid Operator has established DLR implementation to meet identified grid need.	Grid operator has validated performance of DLR Calculation Engine, including providing any data/time necessary DLR calculation calibration. Grid Operator has business processes in place to rely upon DLRs, with appropriate failure measures identified. The conductor temperature limits provided by the grid operator align with clearance standards for transmission.
BPMS	Houses the digital model of the bulk power system components.	The physical attributes that make up the bulk power system are sufficiently captured in the digital network model.	The BPMS, or some subcomponent therein, houses a digital representation of the physical network model that can be shared with DLR Calculation Engine with sufficient detail for DLR calculations, including line length, conductor type, and conductor size.
BPMS	Retrieves and manages DLRs for subsystem and Grid Operator usage.	BPMS and DLR Calculation Engine have established data exchange pathway, complete with commissioning testing, and verification.	The BPMS is capable of receiving and leveraging DLRs from the DLR Calculation Engine. The BPMS has additional information required from other systems/devices to accomplish its functions, including limits, measurements and forecasts for all transmission facilities (i.e., not just thermal line limits).
BPMS	Safely manages the bulk power system.	BPMS uses information from multiple other systems to recognize a variety of potential constraints beyond thermal line limits.	The BPMS is configured to interpret when the DLR offers excess thermal capacity that isn't necessarily imple-mentable, due to other operational considerations. The BPMS still uses the DLR thermal capacity up to the other operational constraint.
Grid Operator	Oversees the operation of the bulk power system.	Grid Operator has performed a study to determine the appropriate forecast certainty to use in unit commitment decisions to balance system reliability and economics.	The DLR forecast used in unit commitment decisions usually represents a different thermal limit than the static line rating, and differs from the real-time rating in that it is more conservative.
DLR Calculation Engine	Calculates DLRs for the next hour, updating that data at least hourly, and publishing the DLRs via standard interface.	Data exchange pathways established in secure manner. Field calibration period for field deployed sensors complete.	DLR Calculation Engine has established and validated data streams required to calculate DLRs, including any data measured by the DLR Sensor Device or via weather providers.

Step by Step Analysis of Use Case

No	Optional	Event or Name of Process/Activity	Info Producer (Actor)	Info Receiver (Actor)	Information Exchanged
1	Yes	DLR Sensor Device captures field measurements	DLR Sensor Device	DLR Sensor Device	DLR Sensor Device Internal
2	Yes	DLR Sensor Device sends field measurements to DLR Calculation Engine	DLR Sensor Device	DLR Calculation Engine	Field Measurements
3	Yes	DLR Calculation Engine stores raw data from DLR Sensor Device and performs any validation, editing, and estimation required.	DLR Calculation Engine	DLR Calculation Engine	DLR Calculation Engine Internal
4	Yes	DLR Calculation Engine retrieves data from the Weather Provider	Weather Provider	DLR Calculation Engine	Weather
5	No	DLR Calculation Engine calculates forecasted DLRs based on available data.	DLR Calculation Engine	DLR Calculation Engine	DLR Calculation Engine Internal

No	Optional	Event or Name of Process/Activity	Info Producer (Actor)	Info Receiver (Actor)	Information Exchanged
6	No	DLR Calculation Engine publishes forecast DLRs for H+48	DLR Calculation Engine	BPMS	DLR Forecast, Limiting Line Segment
7	No	BPMS retrieves DLR forecast	DLR Calculation Engine	BPMS	DLR Forecast, Limiting Line Segment
8	No	BPMS provides DLRs to the Unit Commitment Engine	BPMS	Switching Optimization Engine	DLR Forecast, Limiting Line Segment
9	No	Unit Commitment Engine calculates unit commitments for the system using system characteristics, load/weather forecasts, and DLR forecasts	Unit Commitment Engine	Unit Commitment Engine	Unit Commitment Engine Internal
10	No	Unit Commitment Engine provides optimal unit commitments to BPMS	Unit Commitment Engine	BPMS	Optimal System Commitments
11	No	BPMS sends unit commitment instructions to generators	BPMS	Generator	Commitment Instructions

Steps → Requirements

Step	Optional?	Name of Process/Activity	Information Exchanged	Requirements	R-ID
1	Yes	DLR Sensor Device captures field measurements	N/A	- The DLR vendor solution shall capture field measurements at the identified locations. - The vendor solution shall perform regardless of terrain roughness. - The vendor solution shall report ratings regardless of precipitation, humidity, and atmospheric pressure.	1-3
2	Yes	DLR Sensor Device sends field measurements to DLR Calculation Engine	Field Measurements	- The DLR Sensor Device shall leverage wireless telecommunication technology from any and all field deployed sensors.	4
3	Yes	DLR Calculation Engine stores raw data from DLR Sensor Device and performs any validation, editing, or estimation required	N/A	- Raw data processing shall be contained within the vendor's equipment, whether localized at the sensor or aggregated at vendor servers. - Raw data shall be made available through standard reporting mechanisms. - Each data type shall be marked as such (validated, edited, estimated, raw, etc.). - The DLR Calculation Engine shall provide estimated DLRs in the event of that communication is interrupted with the DLR Sensor Device.	5-9
4	Yes	DLR Calculation Engine retrieves data from the weather provider	Weather Data	- The DLR Calculation Engine shall have access to granular weather data (historical). - The DLR Calculation Engine shall have access to granular weather data (forecast).	10-11
5	No	DLR Calculation Engine calculates forecasted DLRs based on available data	N/A	- The DLR Calculation Engine shall calculate DLR forecasts for the next 48-hours in hourly intervals. - The DLR Calculation Engine shall calculate the limiting line segment for the next 48-hours in hourly intervals. - The DLR Calculation Engine shall use IEEE 738 to calculate DLRs. - The vendor solution shall timestamp data using GPS accuracy.	11-14

Step	Optional?	Name of Process/Activity	Information Exchanged	Requirements	R-ID
6	N	DLR Calculation Engine publishes DLRs for the next hour	DLR, Limiting Line Segment, Duration, Start Time	- The DLR Calculation Engine shall publish DLRs and their associated limiting line segment for the next 48-hours in hourly intervals via secure processes. - The DLR Calculation Engine shall support data retrieval from a different network. - The DLR Calculation Engine shall make this information available at least 5 minutes before noon daily. - The DLR Calculation Engine shall update the real time ratings at least daily. - The vendor solution timestamps shall be reported in local time of the line segment. - The DLR Calculation Engine shall publish data using the CIM Data format. - The DLR Calculation Engine shall make data available in downloadable CSV format.	14-20
7	N	BPMS retrieves DLR Forecast	DLR, Limiting Line Segment, Duration, Start Time	- The BPMS shall be configured to retrieve data from the DLR Calculation Engine. - The BPMS shall be configured to leverage the CIM data format for DLR and line segment data ingestion. - The BPMS shall be configured to leverage the duration and start time for the DLRs.	21-23
8	N	BPMS provides DLRs to the Unit Commitment Engine	DLRs, Limiting Line Segment	- The BPMS shall provide the Unit Commitment Engine with the updated DLRs.	22
9	N	Unit Commitment Engine calculates optimal system configuration using system characteristics, including DLRs	N/A	- The Unit Commitment Engine shall leverage the DLR data to calculate optimal system configurations.	23
10	N	Unit Commitment Engine provides optimal system configuration to BPMS	Optimal System Commitment	- The Unit Commitment Engine shall provide the BPMS with the optimal system configuration.	24
11	N	BPMS sends commitment instructions to generators	Commitment Settings	- The BPMS shall send system settings to generators. - The generators shall remotely receive commitment instructions.	25-26

Information Exchanged

Name of Information Exchanged	Description of Information Exchanged	Requirements to information data R-ID
Start Time	Start Time of the DLR.	Data shall be exchanged using a package that supports the HH:MM:SS YYYY-MM-DD format
Duration	Duration after the start time that the DLR is to be presumed valid for the operator or systems that utilize this data.	Data shall be made expressed in seconds.
DLR	Real-time dynamic line rating representing the ampacity that can be safely transferred across the line for at least the next 48-hours in hourly intervals.	DLR shall be provided in amperes (A).
Limiting Line Segment	The segment of the line that represents the limiting element driving the DLR for each hourly interval.	Line Segment as defined in the IEC CIM with associated mRID.

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