

DRAFT

Clarus

Preliminary Discussion of Use Case Scenarios

Submitted to:

Federal Highway Administration

November 22, 2004



This document contains the core scenario descriptions that will be included in the Clarus Concept of Operations document. The Concept of Operations report will include a background section (setting the stage for Clarus), Clarus vision and goals, Stakeholders, and user needs, as well as discussion of technical and institutional issues. All this information will be included in the later versions of this report.

Section 1 of this document, describes briefly the scenario considered for Clarus. Section 2 describes, in detail, the corresponding Clarus scenario. In all the scenarios the Clarus functionality is, by design, the same at this level. It is expected that there may be differences in vehicle data collection based on the type of vehicle. It is also expected that different weather service providers will want different data sets from Clarus. This concept of operation will result in stable, streamlined interfaces into and out of the Clarus system.

1. 0 - Summaries of the Scenarios

Although the focus will be on the interfaces with the Clarus system, it is important to show the end-to-end connectivity from the Clarus data collection (e.g., ESS controlled by DOTs, railroads, transit systems, etc. and various vehicle inputs) to the end users who will rely on enhanced, quality-controlled weather data for decision-making. The number of end users will expand over time with the implementation of Clarus, but for the sake of example, a select subset of users has been chosen to describe use case scenarios envisioned within Clarus.

Scenario A - ROADWAY MAINTENANCE TREATMENT FUNCTION

The scenario for the Clarus roadway maintenance treatment function will explore the possible interactions between actors and the Clarus system in the treatment of roadways. Using environmental data from maintenance vehicles coupled with ESS data provided by Clarus, roadway maintenance personnel will be able anticipate and maintain roadways

Scenario B - TRAFFIC OPERATIONS FUNCTION

The scenario for the Clarus traffic operations function will depict how the Clarus system will help the management of traffic during diverse weather periods. Data derived from service patrol vehicles, coupled with the ESS data and other vehicular data that Clarus might have, will give traffic management personnel a better picture of overall and specific roadway conditions for a region.

Scenario C - TRAVEL INFORMATION FUNCTION

The scenario for the Clarus travel information function will explore the possible interactions between actors and the Clarus system to provide enhanced weather and road condition information to travelers. In the future, it is expected that widespread environmental condition data will come from private vehicles to help create the big picture for travel information across regions.

Scenario D - TRANSIT MANAGEMENT FUNCTION

The scenario for the Clarus transit management function will explore the possible interactions between actors and the Clarus system in transit management. The combination of

environmental data from transit vehicles and ESS data will aid transit management personnel with transit scheduling.

Scenario E - LOCAL EMERGENCY AND DISASTER MANAGEMENT FUNCTION

The scenario for the Clarus emergency and disaster management function will explore the possible interactions between actors and the Clarus system in the handling of emergency and local disaster situations. Emergency vehicles, instrumented to provide environmental data, will improve incident management and response by taking into account existing weather conditions en-route and at the scene.

Scenario F - RAIL CARRIER FUNCTION

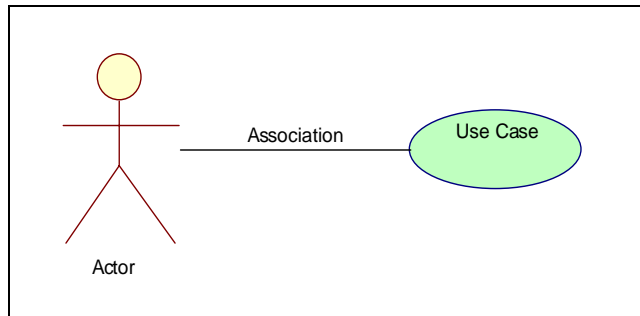
The scenario for the Clarus railroad operations management function will explore the possible interactions between actors and the Clarus system to provide enhanced weather and rail condition information to support rail operations. Clarus will provide railroad management personnel with better information for rail operations using data environmental data from railroad vehicles coupled with ESS data.

Scenario G - COMMERCIAL VEHICLE OPERATION FUNCTION

The scenario of the Clarus commercial vehicle operation function will explore the possible interactions between actors and the Clarus system to provide improved road weather support for commercial travel including just-in-time delivery. Scheduling of commercial traffic and distribution of goods and products will be improved through the use of weather data from Clarus for route planning and resource management decision support

2.0 Clarus Scenarios

Each Clarus scenario in this section is described in narrative text and illustrated in a Use Case Diagram and a Sequence Diagram. Both of these diagrams are based on the Unified Modeling Language (UML) standard. **Use case diagrams are used to describe the outwardly visible operations of a system.** Use case diagrams in the concept of operations define the system boundary.

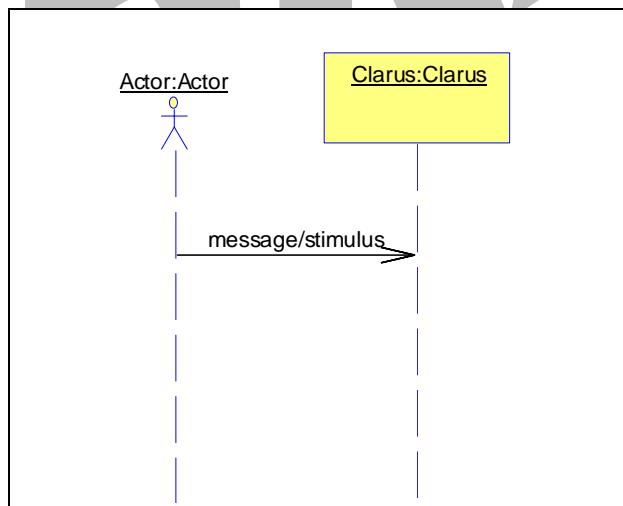


The use case diagrams in this section have three primary elements: Actors, Use Cases and Associations. Actors, represented by the stick figures, represent any external operator or system interfacing with Clarus. Use Cases, represented by ovals, describe the things the actors want the system to do, such as querying the ESS (Environmental Sensor Station) in order to retrieve ESS data from an ESS Data Collector. The lines

connecting actors with use cases are associations. Associations indicate that there is some sort of interaction between the actor and the use case. The use case diagrams are based on the narrative text of the scenario.

In general, use case diagrams should reflect scenarios from each actor's point of view. For Clarus, separate scenarios have been defined for Roadway Treatment Maintenance, Traffic Operations, Travel Information, Transit Management, Local Emergency and Disaster Management, Rail Carrier, and Commercial Vehicle Operations. For the diagrams in this section, actors and use cases that don't directly interface with Clarus have been defined in order to show end-to-end scenarios and help the developer see where Clarus fits in the whole scheme of things.

Whereas the use case diagram defines the things that the actors want the system to do, the sequence diagram portrays a typical sequence of operation between the actors and Clarus. In this section, there is one sequence diagram corresponding to each use case diagram.



The sequence diagram contains vertical lines with a label at the top representing all the actors from the use case diagram for that scenario. Clarus is represented by a rectangular box and vertical line from the box. Arrows represent the action or message/stimulus between the actors and Clarus. The arrows directionality represents the direction of data flow. Time begins at the top of the sequence diagram and goes down to the bottom of the diagram.

Use cases and sequence diagrams are part of an iterative process and should be continued in more detail past the Concept of Operations phase of Clarus. **The use cases and actors in this draft document may change significantly over the course of the Clarus Concept of Operations development.**

Scenario A - ROADWAY MAINTENANCE TREATMENT FUNCTION

Rocky, the traffic engineer responsible for maintaining the roadways for the City of Frostbite Falls, is worried that the citizens of the city will once again be unhappy with the performance of his snowplow fleet. Sure enough, the evening television weathercast is forecasting a huge winter storm for tonight. His snowplow fleet has been put on high alert and additional contracted plows are also available for him to use. The City of Frostbite Falls has invested heavily in a region-wide deployment of **Environmental Sensor Stations (ESS)** but they are not always operational and sometimes provide erroneous data. Rocky has been hesitant on relying on the data from the ESS. The City has recently integrated their ESS with the national **Clarus** weather system that promises to provide quality control for their ESS data and provide this information back to the City and third party **weather service providers**. Frostbite Falls has contracted with the Winter Express **service provider** who promises to provide the city with accurate and timely weather nowcasts and forecasts down to the roadway segment.

Sure enough, the temperature starts to fall in Frostbite Falls and Rocky...

The Clarus initiative is driven by the needs of the customers of the various service providers and these needs or interests are incorporated into a use case analysis. The formal Clarus system includes data acquisition, data integration, quality control, and service provider interface components. For the roadway maintenance community, value added products created by members of the service provider community become an essential part of their decision support tools. Service providers acquire quality-controlled Clarus data and integrate it with data from other sources (e.g., observed meteorological data from other public and private sources, numerical weather prediction model data, road condition reports, and camera imagery) to produce consumer products. Observed data from Clarus enhances and complements the observed data set acquired from the national and private weather observation networks creating a refined analysis of existing

conditions. Service providers integrate all observation sources into a composite presentation of each key parameter. They further enhance the presentation by adding analyzed fields using color gradations to represent small ranges of values in the total spectrum of observed values.

Many of the maintenance community's decision support requirements are focused on the future impact of observed conditions projected forward in time and the impact of forecasted weather conditions on pavement surface conditions. The prediction of pavement conditions requires the application of sophisticated energy and mass balance models that transform projected or forecasted meteorological conditions into predicted surface conditions based upon maintenance actions completed or projected by maintenance crews. The pavement and weather conditions from Clarus become essential initialization parameters for these pavement condition models. The continued improvement of systems such as the Maintenance Decision Support System depends upon the continual input of transportation-specific observations (ESS reports, road condition reports, and maintenance activity reports). In return, members of the roadway maintenance community benefit from improved forecasts of pavement, weather conditions, and guidance regarding effective treatment options to address the anticipated pavement conditions.

Support for roadway maintenance functions by Clarus involves weather- and pavement-related data collected from diverse sources owned and/or operated by surface transportation

organizations. The data are transferred at routine intervals to one or more data fusion centers forming the Clarus database. The data collection process checks the raw, incoming data for obvious anomalies. After all of the data are merged, the Clarus system performs a quality assurance evaluation at routine intervals to flag data anomalies. The quality-controlled data are stored in the Clarus database and become available to a group of users designated as Service Providers. These are the private and public organizations that have a need for the observed Clarus data. The Clarus system returns the quality-controlled data to the provider agencies with indicators of potential data anomalies within their data set. These system owners also maintain and update the metadata database that defines the characteristics of each site and each reported parameter at that site. This quality control feedback is part of a process to assure a dynamic metadata characterization.

Service providers extract data, as needed, from the Clarus system. They receive quality-controlled data and associated metadata information for the specified data request. Service providers then integrate the Clarus data with other pertinent weather and non-weather data to produce specific products and services that respond to the needs of the maintenance community such as pavement treatment actions. These products and services are distributed to the maintenance user following accepted procedures that satisfy their particular needs.

Step-by-Step Flow of Activities for Roadway Maintenance Treatment Function

The information that follows provides a step-by-step flow of activities that depicts a general scenario for how a roadway maintenance treatment function would occur. Each successive heading and set of bullets constitutes the next stage of activities with a general flow of time increasing as the list progresses. The entity responsible for each is noted on the line before each set of bullets.

ESS MEASUREMENT – TRANSPORTATION AGENCY (AUTONOMOUS ENTITY)

- Weather and pavement values measured in field Environmental Sensor Station (ESS)
- Weather and pavement values stored in field ESS as current report
- Aggregated weather and pavement values stored in field ESS as a series of reports

ESS COLLECTION– TRANSPORTATION AGENCY (AUTONOMOUS ENTITY)

- ESS Data Collector polls ESSs and transfers new stored reports in stored series from each ESS
- ESS Data Collector stores reports in database

VEHICLE COLLECTION – TRANSPORTATION AGENCY (AUTONOMOUS ENTITY)

- Maintenance Vehicles detect weather information and upload to the Vehicle Data Collector
- Vehicle Data Collector stores aggregated vehicle-based weather data in database

CONSOLIDATION - CLARUS

- Clarus server directly collects data from the ESS Data Collector and Vehicle Data Collector
- Collection process performs quality control checks on incoming data and flags obvious errors
- Clarus server stores the data with quality control flags
- Clarus server accepts and stores External Weather data for quality assurance check

- Data from multiple sites is sorted into data sets having common date, time and location reference

QUALITY ASSURANCE CHECK - CLARUS

- External Weather data is compared with Clarus data for the purpose of data validation and quality assurance processing
- Quality assurance check is run on the time- and location-sorted data
- Observations deviating from expected values by a specified amount are flagged as potential errors
- Clarus stores the error flags with the data
- Clarus sends notification to the data provider when suspect data occur

DATA TRANSFER - CLARUS

- Data in the Clarus database are acquired by public and private members of the Service Provider community based on timeframe and location

DATA INTEGRATION – SERVICE PROVIDER

- The Service Providers collect, store, and consolidate the Clarus data with observed meteorological data from various sources
- The Service Providers acquire forecast guidance products to complement the observed data
- Observed data are consolidated and composed into presentations showing the data from various sites displayed on a GIS background
- The observed and forecasted data are composed into weather forecast products
- The forecasts are organized into text and graphical presentations

DATA TRANSFORMATION – SERVICE PROVIDER

- Meteorological data are run through a pavement condition model that transforms the weather forecast components into projections of pavement temperatures and road conditions
- Pavement conditions are computed for segments of a given highway having relatively uniform physical and environmental characteristics
- Computed pavement temperatures and road conditions are organized into tabular and graphical representations of current and forecasted pavement conditions

MAINTENANCE DECISION SUPPORT – SERVICE PROVIDER

- The observed weather and pavement conditions are coupled with reported maintenance actions to assess the current condition of the road surface for numerous representative points along a segment of highway
- Using the forecasted weather conditions, the MDSS (Maintenance Decision Support System) assesses the most effective maintenance approaches to accomplish the necessary maintenance actions to provide the highest level of service
- MDSS provides the most effective maintenance response based upon the resource limitations affecting operations along a specific route.
- MDSS also provides the user with the capability to provide “what-if” maintenance responses to try
- MDSS provides notification techniques to advise users of adverse conditions that are developing or that have develop recently.

- These products are composed into value-added deliverables and stored for distribution to end-users.

ROADWAY MAINTENANCE ACTIVITIES – PRODUCT CONSUMER

- Weather and maintenance planning information is acquired from Service Providers
- Decisions are made on treatment activities for pavement undergoing weather impacts
- Crew shifts are set and the timing of activities planned
- Maintenance activities are conducted
- Maintenance Vehicles are directly notified of current and forecasted pavement information

Use Case and Sequence Diagrams

The Use Case and Sequence Diagrams based on the above functionality are depicted below in Figure 1 and Figure 2.

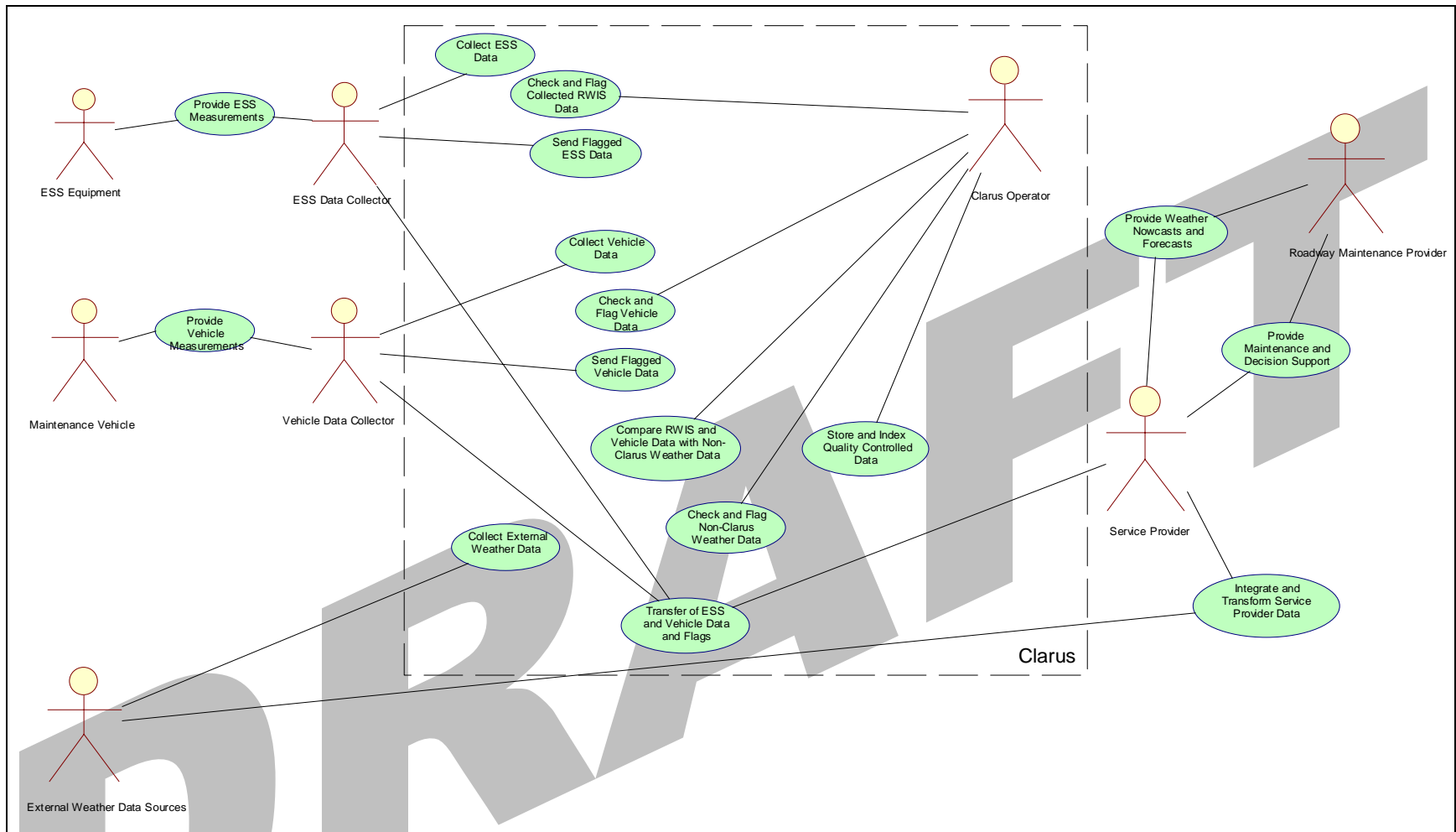


Figure 1. Clarus Roadway Maintenance Treatment Use Case Diagram

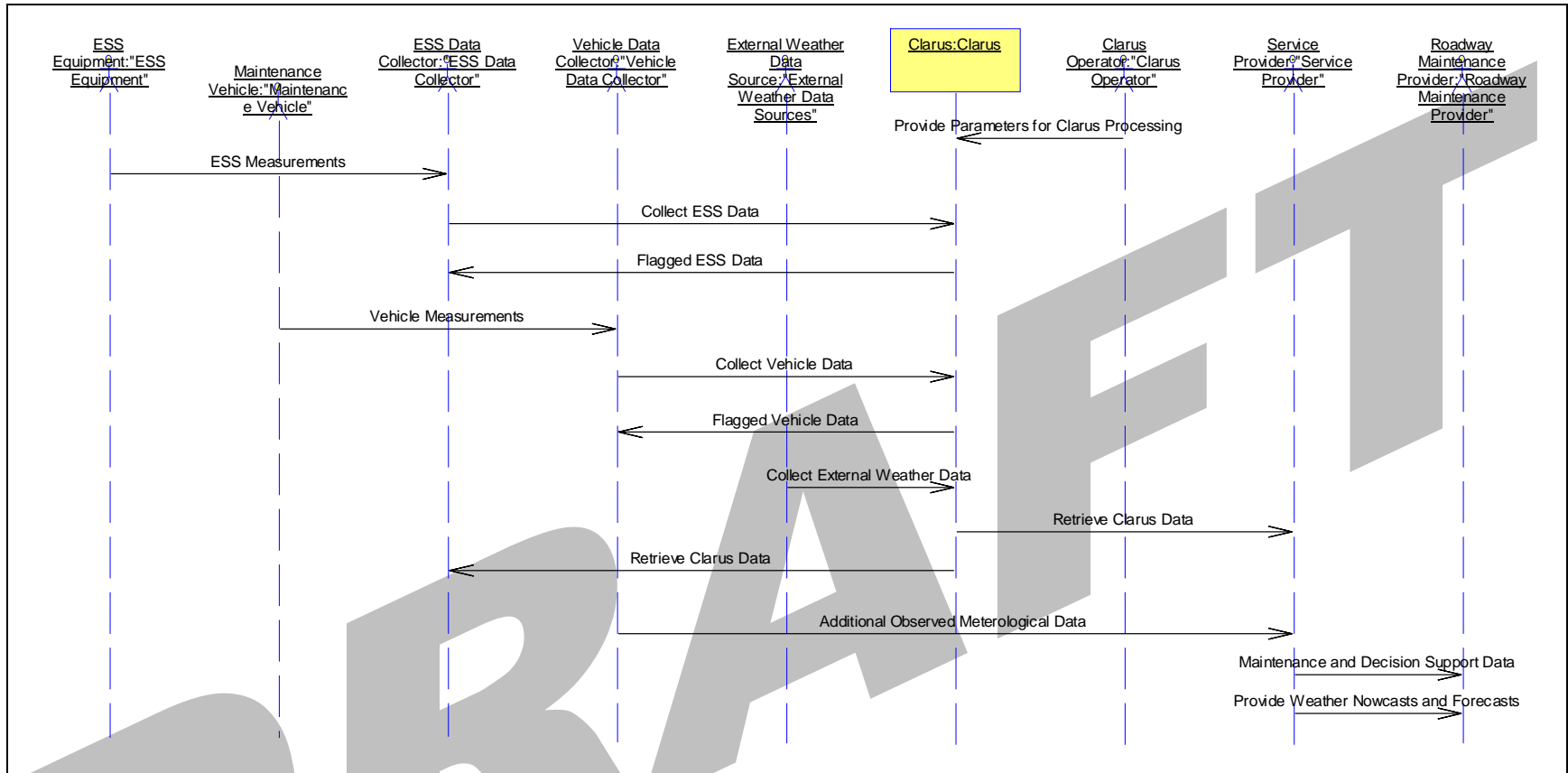


Figure 2. Clarus Roadway Maintenance Treatment Sequence Diagram

SCENARIO B - TRAFFIC OPERATIONS FUNCTION

Step-by-Step Flow of Activities for Traffic Operations Function

The information that follows provides a step-by-step flow of activities depicting a general scenario for a traffic operations function. Similar to other functions, each successive heading and set of bullets constitutes the next stage of activities with a general flow of time increasing as the list progresses. The entity responsible for each is noted on the line before each set of bullets.

The Traffic Management Center in Frog Creek, Pennsylvania deals with 124,000 vehicles per hour at peak hour on four regional interstates and divided highways. Twice each day the facility receives a weather forecast from Sprockets Weather Inc., the local **weather service provider**. It's been a busy week for Jack, the manager of the TMC, with several level 4 incidents snarling rush hour traffic, one requiring multi-hour detours and extra overtime by staff. The weekend is just around the corner and with it some relief. Just over the border an early, unseasonable and wet snowstorm is brewing. There hasn't been time to check the weather forecast and besides, the weather has been perfect all week.

Sure enough, at 5:17AM on Saturday morning Annie, the person on call for the weekend, hears her pager go off. The interstate leading to Frog Creek from the Ohio border is slushing up. Annie is surprised by the details on her text message and remembers that Frog Creek now subscribes to Sprocket Weather's premium service, which bases its data, in part, on information received from the national **Clarus** weather observing system.

ESS MEASUREMENT – TRANSPORTATION AGENCY (AUTONOMOUS ENTITY)

- Weather and pavement values measured in field Environmental Sensor Station (ESS)
- Weather and pavement values stored in field data loggers as current report
- Aggregated weather and pavement values stored in field data loggers as a series of reports

ESS COLLECTION– TRANSPORTATION AGENCY (AUTONOMOUS ENTITY)

- ESS Data Collector polls ESSs and transfers new stored reports in stored series from each ESS
- ESS Data Collector stores reports in database

VEHICLE COLLECTION – TRANSPORTATION AGENCY (AUTONOMOUS ENTITY)

- Service Patrol Vehicles detect weather information and upload to the Transportation Management Center
- Vehicle Data Collector stores aggregated vehicle-based weather data in database

CONSOLIDATION - CLARUS

- Clarus server directly collects data from the ESS Data Collector and Vehicle Data Collector
- Collection process performs quality control checks on incoming data and flags obvious errors
- Clarus server stores the data with quality control flags
- Clarus server accepts and stores External

Weather data for quality assurance check

- Data from multiple sites is sorted into data sets having common date, time and location reference

QUALITY ASSURANCE CHECK - CLARUS

- External Weather data is compared with Clarus data for the purpose of data validation and quality assurance processing
- Quality assurance check is run on the time- and location-sorted data
- Observations deviating from expected values by a specified amount are flagged as potential errors
- Clarus stores the error flags with the data
- Clarus sends notification to the data provider when suspect data occur

DATA TRANSFER - CLARUS

- Data in the Clarus database are acquired by public and private members of the Service Provider community based on timeframe and location

DATA INTEGRATION – SERVICE PROVIDER

- The Service Providers collect, store, and consolidate the Clarus data with observed meteorological data from various other sources
- The Service Providers acquire forecast guidance products to complement the observed data. Traffic Management data is acquired by Service Provider and integrated with weather products to product composited information
- The observed and forecasted data are composed into weather forecast products
- The forecasts are organized into text and graphical presentations

TRAFFIC OPERATION ACTIVITIES – PRODUCT CONSUMER

- Weather forecasts are acquired from Service Providers
- TMC staffing is reviewed for weather incident coverage
- Product Consumer collects, stores, and analyzes the Clarus data. Traffic managers add Clarus data to existing Traffic Management decision making methods
- Traffic managers alerted of change in road weather conditions 2 to 3 hours “upstream” at selected ESS reporting through Clarus
- TMC manager confirms changes by viewing CCTV images from affected region
- Traffic managers confirm staffing and weather incident plan preparedness
- Traffic monitored for changes due to weather conditions

Use Case and Sequence Diagrams

The Use Case and Sequence Diagrams based on the above functionality are depicted below in Figure 3 and Figure 4.

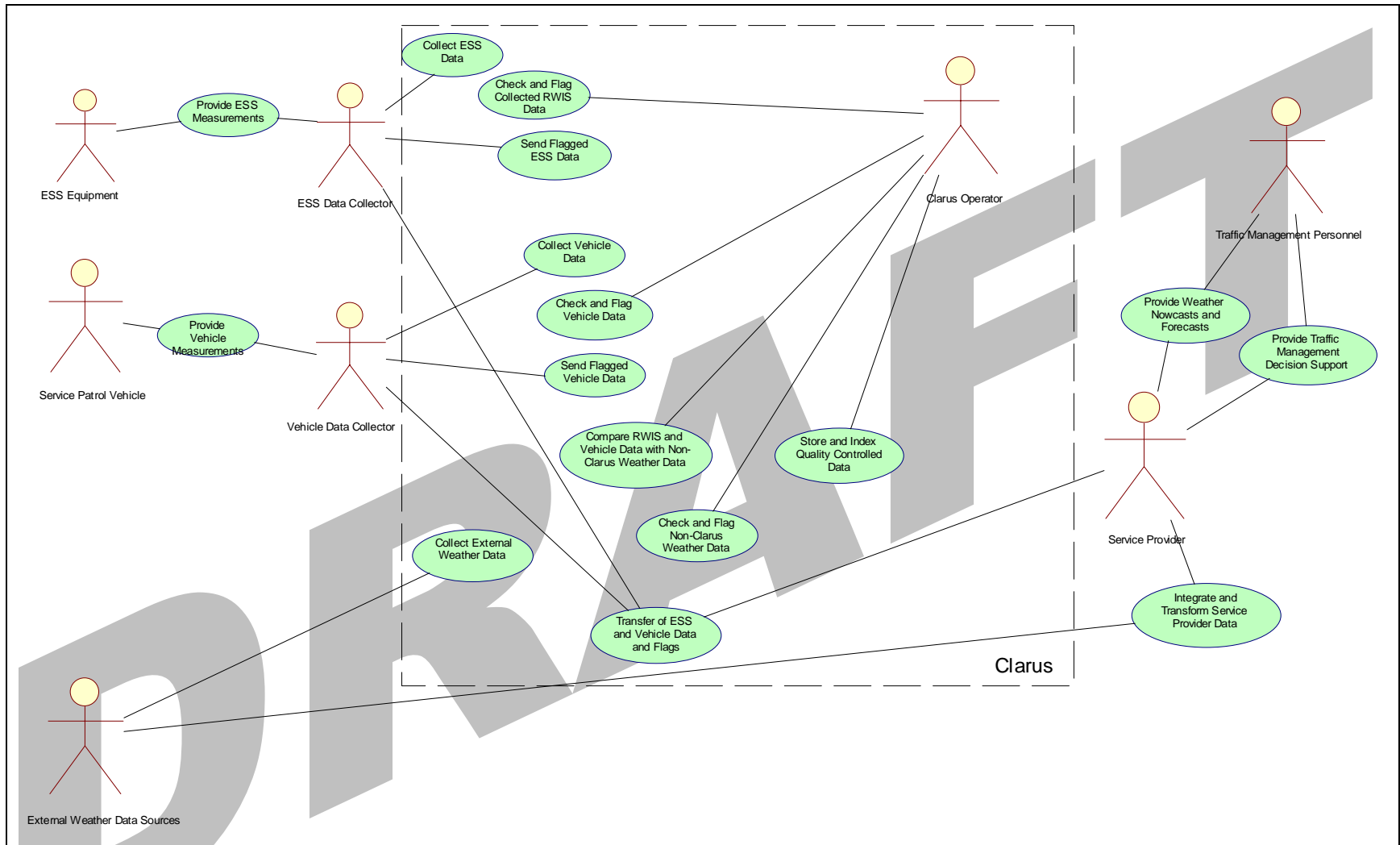


Figure 3. Clarus Traffic Operations Use Case Diagram

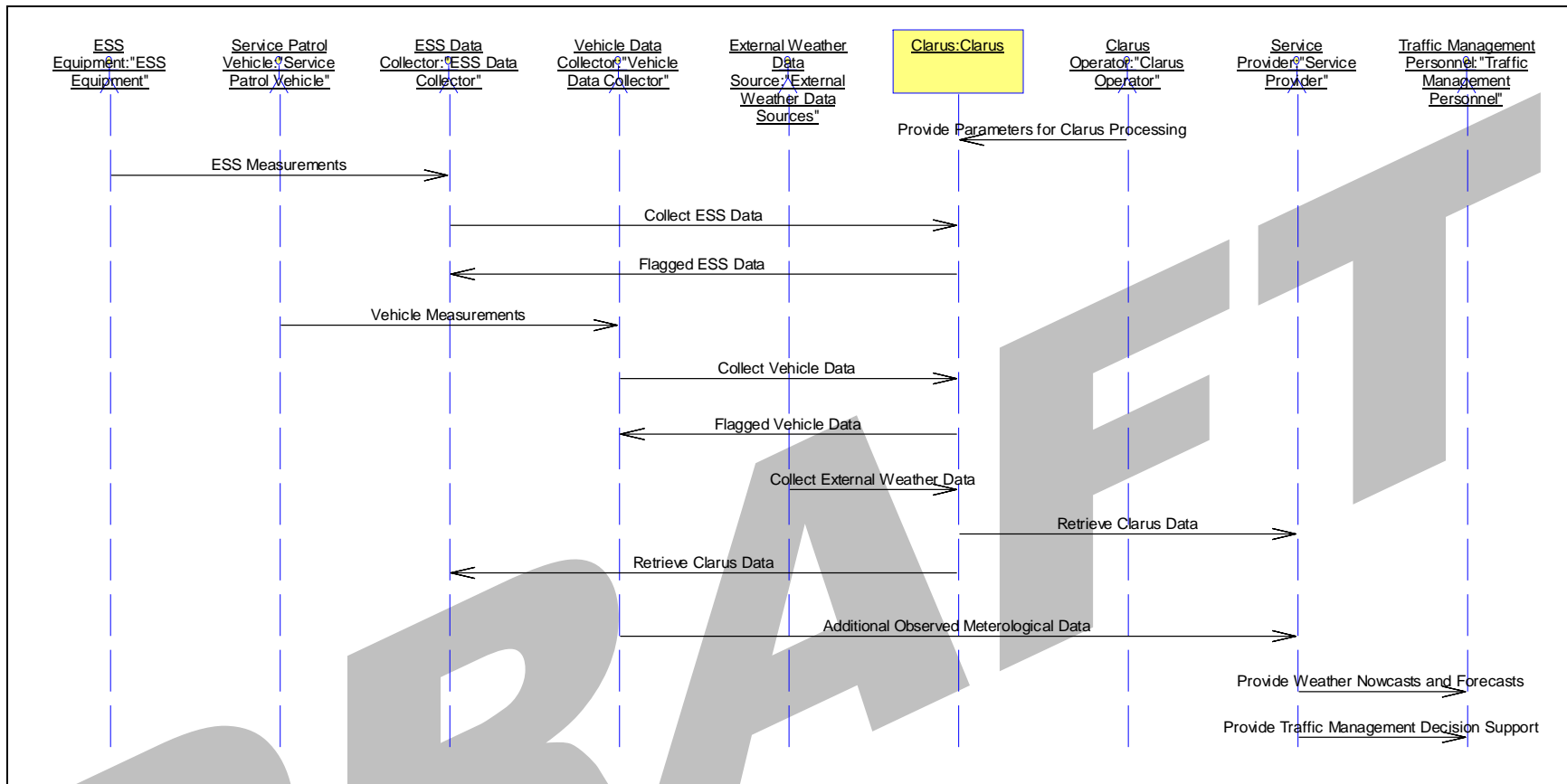


Figure 4. Clarus Traffic Operations Sequence Diagram

Scenario C - TRAVEL INFORMATION FUNCTION

The Clarus initiative is driven by the needs of the customers of the various service providers and these needs or interests are incorporated into a use case analysis. The formal Clarus system includes data acquisition, data integration, quality control, and service provider interface components. For the traveling community, value-added products created by members of the

Getting ready for her trip home over the long weekend from college, Kerry Ingsbe is in such an excited hurry that she forgets to check one of the most important items before traveling across the winter landscape, the weather forecast and road conditions. As she dashes out of her dormitory, her duffel bag slung over one shoulder, she remembers to check the weather as her breath ices up outside in the chilly air even though there isn't any snow on the ground. After starting in her car and while waiting for the engine to warm, Kerry takes out her cell phone and dials in 5-1-1. Hearing the familiar introduction to the regional traveler information system, Kerry used the voice enable features of the system to indicate that she will be traveling on State 200, heading west from Rowley.

Listening to the weather forecast and road conditions for her route and alternate routes, she finds out that the roads out west on State 200 are icy and heavy snow is falling. Kerry has no idea that behind the scenes the 5-1-1 system is tapping into the national **Clarus** weather observing and forecasting system which is augmenting the weather information obtained from the 5-1-1 systems **weather service provider**.

Hanging up, Kerry gives a brief call to her parents before driving home to tell them that she'll be a bit later arriving because of the weather she will be driving on US 25 instead of her usual route home...

service provider community become an essential part of evolving advanced traveler information systems e.g. 511 and travel information kiosks. Service providers acquire quality-controlled Clarus data and integrate it with data from other sources (e.g., observed meteorological data from other public and private sources, numerical weather prediction model data, road condition reports, and camera imagery) to produce consumer products. Observed data from Clarus enhances and complements the observed data set acquired from the national and private weather observation networks creating a refined analysis of existing conditions. Service providers integrate all observation sources into a composite presentation of each key parameter. They further enhance the presentation by adding analyzed fields using color gradations to represent small ranges of values in the total spectrum of observed values.

Travel decisions rely upon the availability of timely road conditions and weather information. The preparation of travel information requires the use of a broad range of weather data to formulate how weather conditions will evolve over an entire road network. This information is consolidated with the latest road condition reports from State DOTs and State Law Enforcement to provide an information service to travelers conveyed through various communications methods.

Service providers extract data, as needed, from the Clarus system. They receive quality-controlled data and associated metadata information for the specified data request. Service Providers then integrate the Clarus data with other pertinent weather and non-weather

data to produce specific products and services that respond to the needs of the traveler such as road condition information. These products and services are distributed to the traveler through various devices and communications methods to satisfy their particular needs.

Step-by-Step Flow of Activities for Travel Information Function

The information that follows provides a step-by-step flow of activities that depicts a general scenario for a traveler information function. Each successive heading and set of bullets constitutes the next stage of activities with a general flow of time increasing as the list progresses. The entity responsible for each is noted on the line before each set of bullets.

ESS MEASUREMENT – TRANSPORTATION AGENCY (AUTONOMOUS ENTITY)

- Weather and pavement values measured in field Environmental Sensor Station (ESS)
- Weather and pavement values stored in field ESS as current report
- Aggregated weather and pavement values stored in field ESS as a series of reports

ESS COLLECTION– TRANSPORTATION AGENCY (AUTONOMOUS ENTITY)

- ESS Data Collector polls ESSs and transfers new stored reports in stored series from each ESS
- ESS Data Collector stores reports in database

VEHICLE COLLECTION – INFORMATION SERVICE PROVIDER (AUTONOMOUS ENTITY)

- Private Vehicles detect weather information and upload to the Vehicle Data Collector
- Vehicle Data Collector stores aggregated vehicle-based weather data in database

CONSOLIDATION - CLARUS

- Clarus server directly collects data from the ESS Data Collector and Vehicle Data Collector
- Collection process performs quality control checks on incoming data and flags obvious errors
- Clarus server stores the data with quality control flags
- Clarus server accepts and stores External Weather data for quality assurance check
- Data from multiple sites is sorted into data sets having common date, time and location reference

QUALITY ASSURANCE CHECK - CLARUS

- External Weather data is compared with Clarus data for the purpose of data validation and quality assurance processing
- Quality assurance check is run on the time- and location-sorted data
- Observations deviating from expected values by a specified amount are flagged as potential errors
- Clarus stores the error flags with the data
- Clarus sends notification to the data provider when suspect data occur

DATA TRANSFER - CLARUS

- Data in the Clarus database are acquired by public and private members of the Service Provider community based on timeframe and location

DATA INTEGRATION – SERVICE PROVIDER

- The Service Providers collect, store, and consolidate the Clarus data with observed meteorological data from various other sources
- The Service Providers acquire forecast guidance products to complement the observed data

- Observed data are consolidated and composed into presentations showing the data from various sites displayed on a GIS background
- The observed and forecasted data are composed into route-specific weather forecast and road condition products

DATA TRANSFORMATION – SERVICE PROVIDER

- Weather condition and forecast data for specific route segments are stored in a database on information delivery systems ready for access by travelers, transportation agencies and the media. Maintenance activity information is collected and added to Clarus data and stored in a database for use in generating road condition information
- Pavement conditions are computed for segments of a given highway, combined with reported road condition information, and stored along with the weather condition and forecast information

TRAVEL INFORMATION – PRODUCT CONSUMER

- Weather and maintenance planning information is acquired from service providers
- Calls to statewide 511 systems support decisions on travel plans and enroute travel activities
- Information is displayed on dynamic message signs of rapidly changing weather and road conditions anticipated along a direction of travel. Information on adverse travel conditions is provided to State Patrol for use in planning activities.
- Information is displayed in the vehicle regarding changing weather and road conditions anticipated along current direction of travel and driver-selected route
- Roadside kiosks provide graphical display and printed outputs of current and forecasted travel weather conditions
- Media outlets access traveler information systems and relay the information on radio and television supporting traveler planning activities

Use Case and Sequence Diagrams

The Use Case and Sequence Diagrams based on the above functionality are depicted below in Figure 5 and Figure 6.

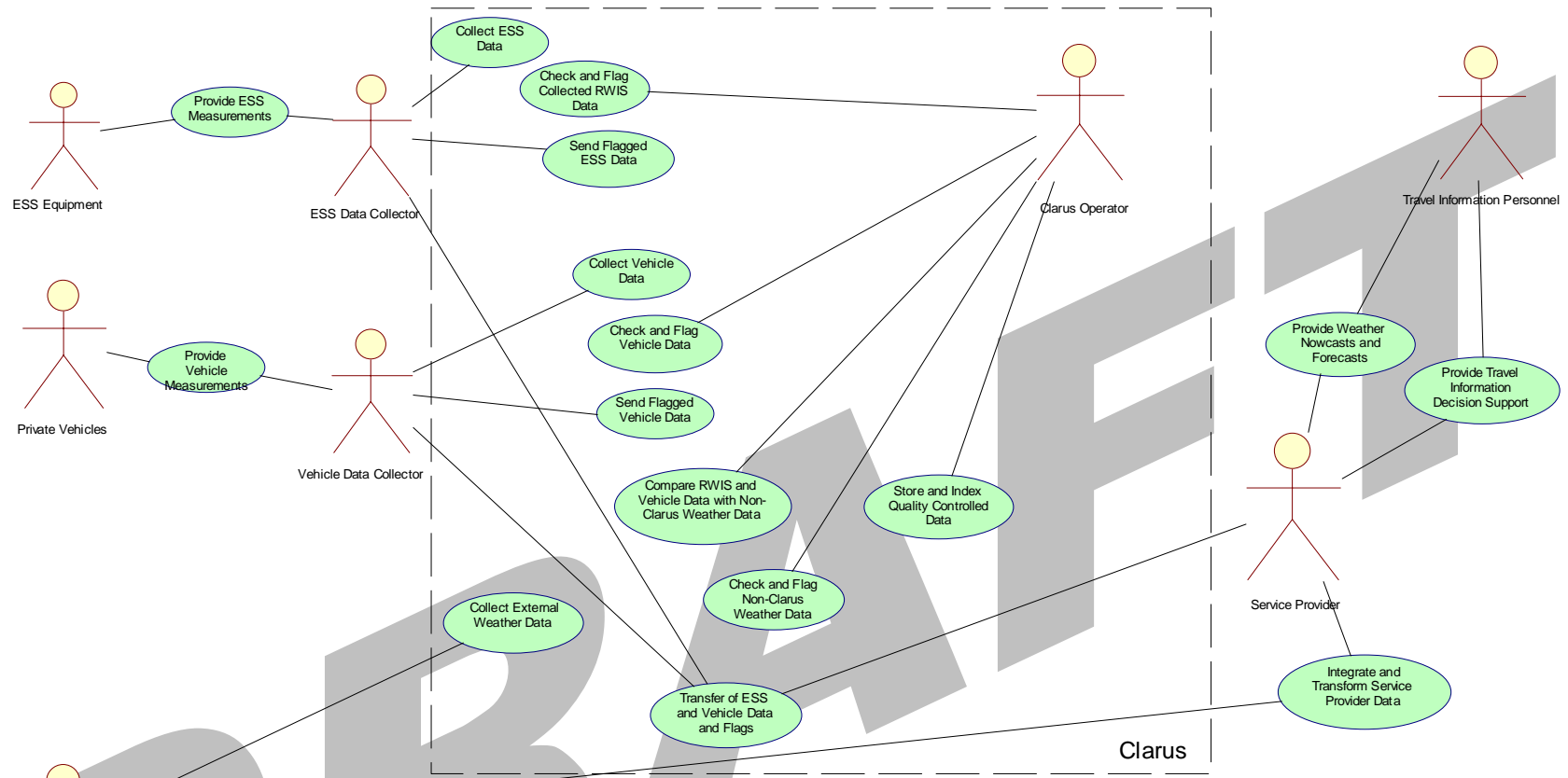


Figure 5. Clarus Travel Information Function Use Case Diagram

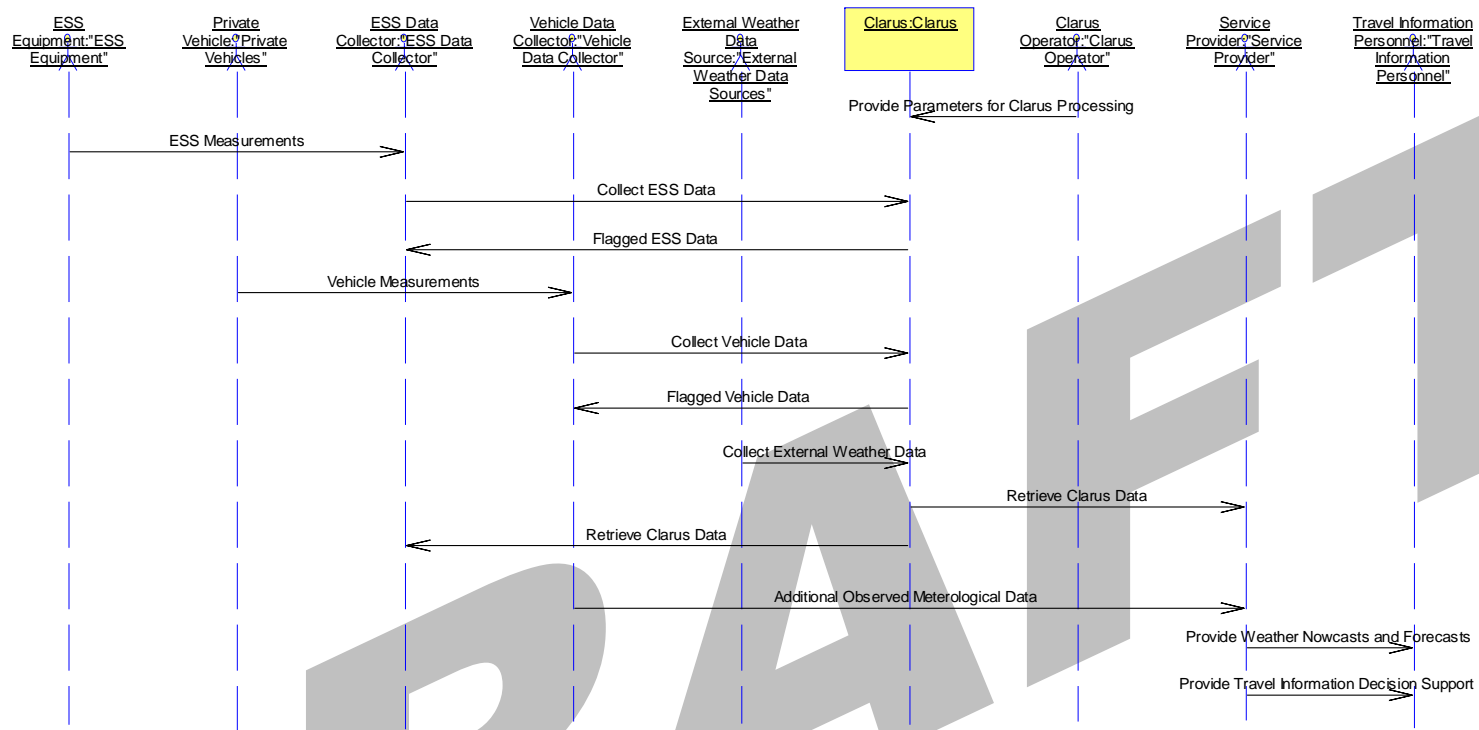


Figure 6. Clarus Travel Information Sequence Diagram

Scenario D - TRANSIT MANAGEMENT FUNCTION

The Clarus initiative is driven by the needs of the customers of the various service providers and these needs or interests are incorporated into a use case analysis. The formal Clarus system

We are about to interview Buster Overstreet, the manager for the transit authority in Mobile Flats which recently completed an extensive rapid transit train service to assure the viability of the vibrant medical research center and hospital complex near the heart of the city. The success of the program revolves around the well-orchestrated coordination between the bus feeder system and the modern train service. But Buster knows that the occasional snow or ice storms that hit the city can totally disrupt the schedule, thus he depends upon Whether or Not, a local weather service provider to provide the authority with short term weather for all routes and pavement condition forecasts for all the bus routes. Mobile City has invested in an extensive network of **Environmental Sensor Stations (ESS)**. Buster has access to this municipal system as well as the state DOT RWIS network but has to access them separately. Buster is aware that the new national **Clarus** weather system promises to integrate both of these sources while providing quality-controlled data to the city and state providers. In addition, Whether or Not will have more uniform access to the weather and pavement information from all ESS sites in the region plus access to the maintenance and operations data collected by maintenance and transit authority vehicles.

includes data acquisition, data integration, quality control, and service provider interface components. The management of transit operations, and the subsequent guidance the transit authority provides to its users, is impacted by the support services provided. Service providers acquire quality-controlled Clarus data and integrate it with data from other sources (e.g., observed meteorological data from other public and private sources, numerical weather prediction model data, road condition reports, and camera imagery) to produce consumer products. Observed data from Clarus enhances and complements the observed data set acquired from the national and private weather observation networks creating a refined analysis of existing conditions. Service providers integrate observations from all available sources into a composite presentation of each key parameter. They then enhance the presentation by adding analyzed fields using color gradations to represent small ranges of values in the total spectrum of observed values.

Transit operations revolve around scheduling and it is essential that all components of the multi-modal transportation scheme reach each designated location at specified times. Transit system users depend upon this scheduling consistency. However,

inclement weather affects different components of the multi-modal system in different ways. Therefore, it becomes important to know specifically what the type and intensity of weather is expected and how this weather scenario is likely to impact the performance of the fleet. . Winter storm conditions tend to disrupt bus and ferry scheduling more significantly than rail performance, thus significant attention needs to be placed on pavement and wave conditions and its impact on bus and ferry traffic flow.

Support for transit management functions by Clarus involves weather-, pavement-, and transit-related data collected from diverse sources owned and/or operated by surface transportation organizations. Transit organizations own a few data collection systems or provide services within jurisdictions that maintain collection systems for other transportation requirements. The data from these systems are transferred at routine intervals to one or more data fusion centers to form the Clarus database. The data collection process checks the raw, incoming data for obvious anomalies. After all of the data are merged, the Clarus system performs a quality

assurance evaluation at routine intervals to flag data anomalies. The quality-controlled data are stored in the Clarus database and become available to the private and public organizations, Service Providers, that have a need for the observed Clarus data. The Clarus system returns the quality-controlled data to the provider agencies with indicators of potential data anomalies within their data set. These system owners also maintain and update the metadata that defines the characteristics of each site and each reported parameter at that site. This quality control feedback is part of a process to assure a dynamic metadata characterization.

Service providers extract data, as needed, from the Clarus system. They receive quality-controlled data and associated metadata for the specified data request. Service Providers then integrate the Clarus data with other pertinent weather and non-weather data to produce specific products and services that respond to the needs of the maintenance community such as pavement treatment actions. These products and services are distributed to the maintenance user following accepted procedures that satisfy their particular needs.

Step-by-Step Flow of Activities for Transit Management Function

The information that follows provides a step-by-step flow of activities that depicts a general scenario for a transit management function. Each successive heading and set of bullets constitutes the next stage of activities with a general flow of time increasing as the list progresses. The entity responsible for each is noted on the line before each set of bullets.

ESS MEASUREMENT – TRANSPORTATION AGENCY (AUTONOMOUS ENTITY)

- Weather and pavement values measured at field Environmental Sensor Stations (ESS)
- Weather and pavement values stored in field ESSs as current report
- Aggregated weather and pavement values stored in field ESS as a series of reports

ESS COLLECTION– TRANSPORTATION AGENCY (AUTONOMOUS ENTITY)

- ESS Data Collector polls ESSs and transfers new stored reports from each ESS
- ESS Data Collector stores reports in a database

VEHICLE COLLECTION – TRANSIT AGENCY (AUTONOMOUS ENTITY)

- Transit Vehicles detect and store weather and transit operations information as a function of time and location
- The Vehicle Data Collector uploads the data from the transit vehicle at specified intervals, or drop points, and stores the aggregated vehicle-based weather and operations data in an operational database

CONSOLIDATION - CLARUS

- Clarus server directly collects data from the ESS Data Collector and the Vehicle Data Collectors
- Collection process performs quality control checks on incoming data and flags obvious errors
- Clarus server stores the data with quality control flags
- Clarus server accepts and stores External Weather data for quality assurance check
- Data from multiple sites is sorted into data sets having common date, time and location reference

QUALITY ASSURANCE CHECK - CLARUS

- External Weather data is compared with Clarus data for the purpose of data validation and quality assurance processing
- Quality assurance check is run on the time- and location-sorted data
- Observations deviating from expected values by a specified amount are flagged as potential errors
- Clarus stores the error flags with the data
- Clarus sends notification to the data provider when suspect data occur

DATA TRANSFER - CLARUS

- Data in the Clarus database are acquired by public and private members of the Service Provider community based on timeframe and location

DATA INTEGRATION – SERVICE PROVIDER

- The Service Providers collect, store, and consolidate the Clarus data with observed meteorological data from various other sources. Meteorological data are run through a wave height model that transforms the weather forecast components into projections of ferry transit conditions.
- The Service Providers acquire forecast guidance products to complement the observed data
- Observed data are consolidated and composed into presentations showing the data from various sites displayed on a GIS background
- The observed and forecasted data are composed into weather forecast products
- The forecasts are organized into text and graphical presentations

DATA TRANSFORMATION – SERVICE PROVIDER

- Meteorological data are run through a pavement condition model that transforms the weather forecast components into projections of pavement temperatures and road conditions
- Pavement conditions are computed for segments of a given highway having relatively uniform physical and environmental characteristics
- Computed pavement temperatures and road conditions are organized into tabular and graphical representations of current and forecasted pavement conditions

TRANSIT DECISION SUPPORT – SERVICE PROVIDER

- The observed weather and pavement conditions are coupled with reported maintenance actions to assess the current condition of the road surface for numerous representative points along a segment of highway
- Using the forecasted weather conditions, the Maintenance Decision Support System (MDSS) assesses the anticipated pavement conditions assuming no maintenance
- MDSS also assesses the anticipated pavement conditions based upon input from highway crews and their expected route timing.
- These observations and projections are composed into value-added deliverables and stored for distribution to the end users.

TRANSIT MANAGEMENT ACTIVITIES – PRODUCT CONSUMER

- Weather and road condition advisory information is acquired from Service Providers
- Decisions are made on the impact of the projected conditions on the schedules of transit vehicles within the fleet

- Schedules are adjusted to accommodate for the impact of the weather, road conditions, wave height conditions, and traffic flow
- Revised schedules are computed and made available to transit system users

Use Case and Sequence Diagrams

The Use Case and Sequence Diagrams based on the above functionality are depicted below in Figure 7 and Figure 8.

DRAFT

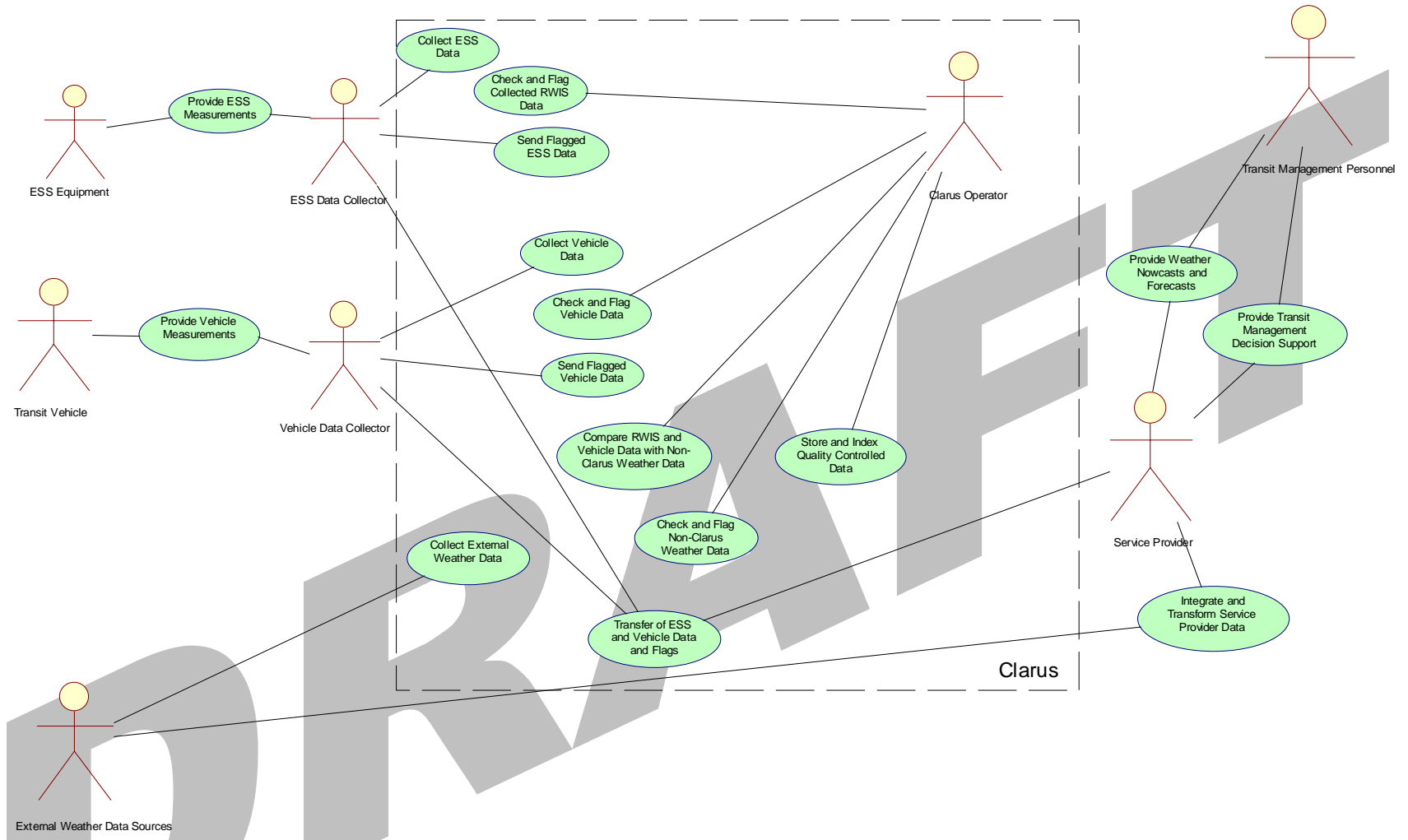


Figure 7. Clarus Transit Management Use Case Diagram

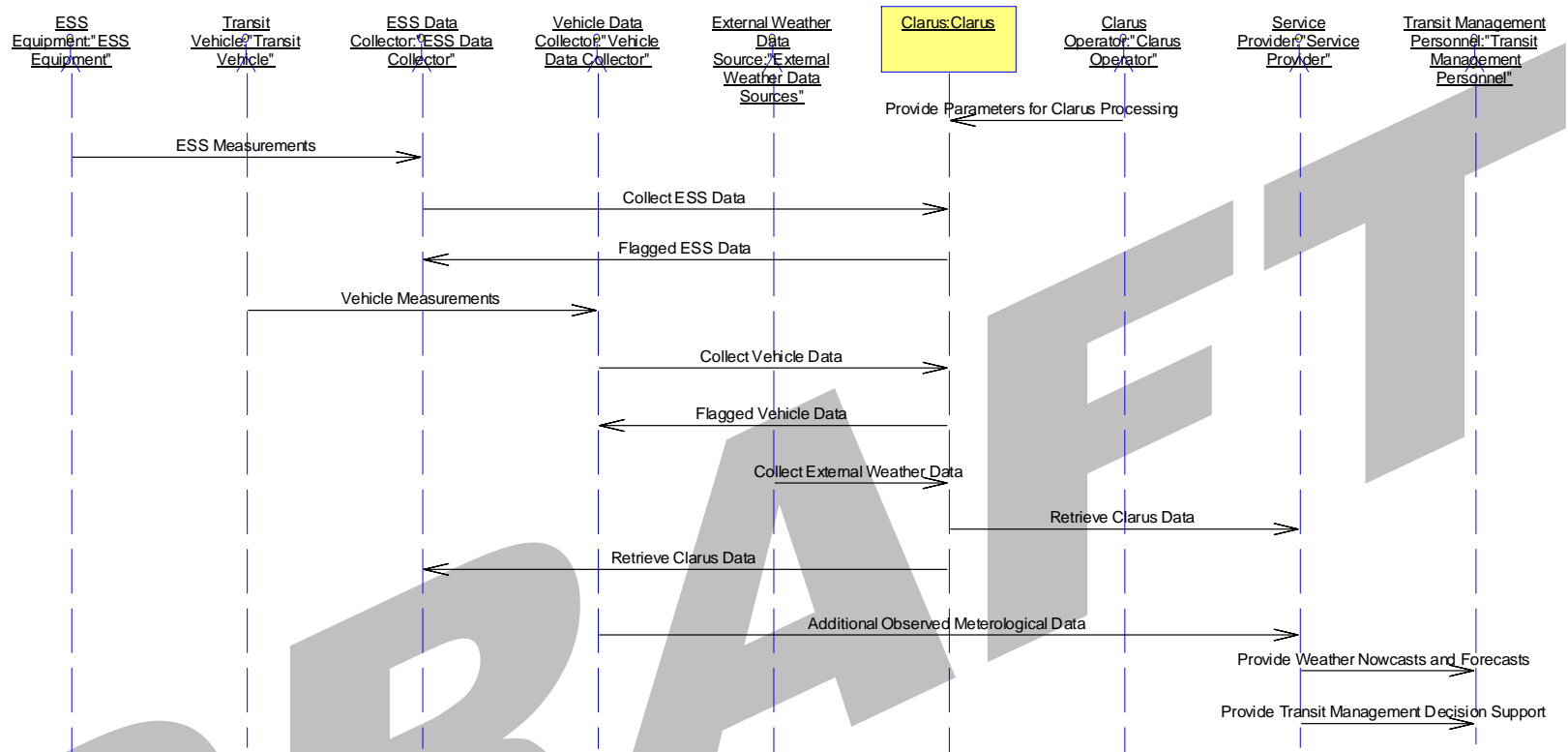


Figure 8. Clarus Transit Management Sequence Diagram

Scenario E - LOCAL EMERGENCY AND DISASTER MANAGEMENT FUNCTION

The Clarus initiative is driven by the needs of the customers of the various service providers and these needs or interests are incorporated into a use case analysis. The formal Clarus system includes data acquisition, data integration, quality control, and service provider interface

The economy of the city of Pisgah depends upon the success of Enthalpy Explosives, a manufacturer of fireworks and explosive devices. Although half the city works for Enthalpy, it is a standing joke that Enthalpy is a disaster waiting to happen. No one is more aware of this than Karen Phore, manager of the Pisgah Emergency and Disaster Management Authority (PEDMA). Karen has worked extensively with Pisgah and the state to assure that PEDMA has access to the data from the array of **Environmental Sensor Stations (ESS)** owned and maintained by these agencies. She has also worked with Weather Flows, a local **weather service provider**, to jointly develop a dispersion model that can interface with the emergency management deployment plan run by PEDMA. Karen is pleased that the new national **Clarus** weather system promises to integrate both of these sources while providing quality-controlled data to the city and state providers. Karen has worked diligently to coordinate the efforts of agencies from all sectors of the city in preparation for a potential disaster.

To assure that the PEDMA plan will work effectively, the City of Pisgah plans a disaster demonstration project for an unannounced time tomorrow. Nearly all government facilities, hospitals, medical support facilities, transportation services, and other emergency resources will participate. A report will be issued following ...

components. Responses to local emergency or disaster situations may be significantly impacted by weather-related conditions. Local support services rendered by members of the service provider community become an important part of the agency's decision process. Service providers acquire quality-controlled Clarus data and integrate it with data from other sources (e.g., observed meteorological data from other public and private sources, numerical weather prediction model data, road condition reports, and camera imagery) to produce consumer products. Observed data from Clarus enhances and complements the observed data set acquired from the national and private weather observation networks creating a refined analysis of existing conditions. Service providers integrate observations from all available sources into a composite presentation of each key parameter. They then enhance the presentation by adding analyzed fields using color gradations to represent small ranges of values in the total spectrum of observed values.

Local emergency and disaster management operations focus on quick mobilization of resources. They may also require an immediate, highly localized assessment of the transport of hazardous materials within the atmosphere around and disseminating from a disaster site. Inclement weather affects the mobilization plan in different ways depending upon the character of the weather situation. In winter situations weather impacts road conditions and the subsequent effect on the mobilization plan is dependent upon the maintenance actions taken by local maintenance agencies. In disaster situations, the airborne movement of noxious, lethal, or hazardous materials or gases is often dependent upon weather conditions in the area of the disaster and the effect of the event on these meteorological factors. The determination of safety zones around the disaster needs to be defined as soon as possible after the event. In addition, the evacuation or movement of affected parties needs to be implemented quickly. The response scenario becomes a dynamic process if the source of hazardous materials persists and weather conditions change.

Support for emergency and disaster management functions by Clarus is enhanced by weather-, pavement-, and environmental-related data collected from diverse sources owned and/or operated by surface transportation organizations. Although emergency and disaster management authorities are not typically owners of transportation weather data collection systems, they benefit from the data collected by other agencies within their area of operation. The process to provide support for these emergency management agencies requires that data from these local weather and pavement information systems be transferred at routine intervals to one or more data fusion centers to form the Clarus database. The data collection process checks the raw, incoming data for obvious anomalies. After all of the data are merged, the Clarus system performs a quality assurance evaluation at routine intervals to flag data anomalies. The quality-controlled data are stored in the Clarus database and become available to a group of users designated as Service Providers. These are the private and public organizations that have a need for the observed Clarus data. The Clarus system returns the quality-controlled data to the provider agencies with indicators of potential data anomalies within their data set. These system owners also maintain and update the metadata that defines the characteristics of each site and each reported parameter at that site. This quality control feedback is part of a process to assure a dynamic metadata characterization.

Service providers extract data, as needed, from the Clarus system. They receive quality-controlled data and associated metadata information for the specified data request. Service Providers then integrate the Clarus data with other pertinent weather and non-weather data to produce specific products and services that respond to the needs of the maintenance community such as pavement treatment actions. These products and services are distributed to the maintenance user following accepted procedures that satisfy their particular needs.

Step-by-Step Flow of Activities for Local Emergency and Disaster Management Function

The information that follows provides a step-by-step flow of activities that depicts a general scenario for a local emergency and disaster management function. Each successive heading and set of bullets constitutes the next stage of activities with a general flow of time increasing as the list progresses. The entity responsible for each is noted on the line before each set of bullets.

ESS MEASUREMENT – TRANSPORTATION AGENCY (AUTONOMOUS ENTITY)

- Weather and pavement values measured at field Environmental Sensor Station (ESS)
- Weather and pavement values stored in field ESS as current report
- Aggregated weather and pavement values stored in field ESS as a series of reports

ESS COLLECTION– TRANSPORTATION AGENCY (AUTONOMOUS ENTITY)

- ESS Data Collector polls ESSs and transfers new stored reports from each ESS
- ESS Data Collector stores reports in a database

VEHICLE COLLECTION – PUBLIC SAFETY AGENCY (AUTONOMOUS ENTITY)

- Emergency Vehicles detect and store weather and emergency operations information as a function of time and location
- Vehicle Data Collector uploads the data from the vehicle at specified intervals or drop points and stores the aggregated vehicle-based weather in an operational database

CONSOLIDATION - CLARUS

- Clarus server directly collects data from the ESS Data Collector and the Vehicle Data Collectors
- Collection process performs quality control checks on incoming data and flags obvious errors
- Clarus server stores the data with quality control flags
- Clarus server accepts and stores External Weather data for quality assurance check
- Data from multiple sites is sorted into data sets having common date, time and location reference

QUALITY ASSURANCE CHECK - CLARUS

- External Weather data is compared with Clarus data for the purpose of data validation and quality assurance processing
- Quality assurance check is run on the time and location sorted data
- Observations deviating from expected values by a specified amount are flagged as potential errors
- Clarus stores the error flags with the data
- Clarus sends notification to the data provider when suspect data occur

DATA TRANSFER - CLARUS

- Data in the Clarus database are acquired by public and private members of the Service Provider community based on timeframe and location

DATA INTEGRATION – SERVICE PROVIDER

- The Service Providers collect, store, and consolidate the Clarus data with observed meteorological data from various other sources
- The Service Providers acquire forecast guidance products to complement the observed data
- Observed data are consolidated and composed into presentations showing the data from various sites displayed on a GIS background
- The observed and forecasted data are composed into weather forecast products
- The forecasts are organized into text and graphical presentations

DATA TRANSFORMATION – SERVICE PROVIDER

- Meteorological data are run through a pavement condition model that transforms the weather forecast components into projections of pavement temperatures and road conditions
- Pavement conditions are computed for segments of a given highway having relatively uniform physical and environmental characteristics
- Computed pavement temperatures and road conditions are organized into tabular and graphical representations of current and forecasted pavement conditions

EMERGENCY AND DISASTER MANAGEMENT DECISION SUPPORT – SERVICE PROVIDER

- The observed weather and pavement conditions are coupled with reported maintenance actions to assess the current condition of the road surface for numerous representative points along a segment of highway
- Observed and forecasted weather conditions serve as input into a dispersion model that simulates the flow of air the local environmental factors

- Using the forecasted weather conditions, the surface transportation weather service provider's pavement condition model or MDSS (Maintenance Decision Support System) assesses the anticipated pavement conditions assuming no maintenance
- MDSS also assesses the anticipated pavement conditions based upon input from highway crews and their expected route timing.
- These observations and projections are composed into value-added deliverables and stored for distribution to the end users.

EMERGENCY AND DISASTER MANAGEMENT ACTIVITIES – PRODUCT CONSUMER

- Weather and road condition advisory information is acquired from service providers
- Decisions are made on the impact of the projected weather and pavement conditions on the response timing of emergency vehicles within the local area
- Response times are adjusted to accommodate for the impact of the weather, road conditions, and traffic flow and integrated into an emergency management deployment system
- Output from the dispersion model feed into the emergency management deployment system which provides guidance on the appropriate deployment of available resources and possible evacuation and response plans associated with the disaster event

Use Case and Sequence Diagrams

The Use Case and Sequence Diagrams based on the above functionality are depicted below in Figure 9 and Figure 10.

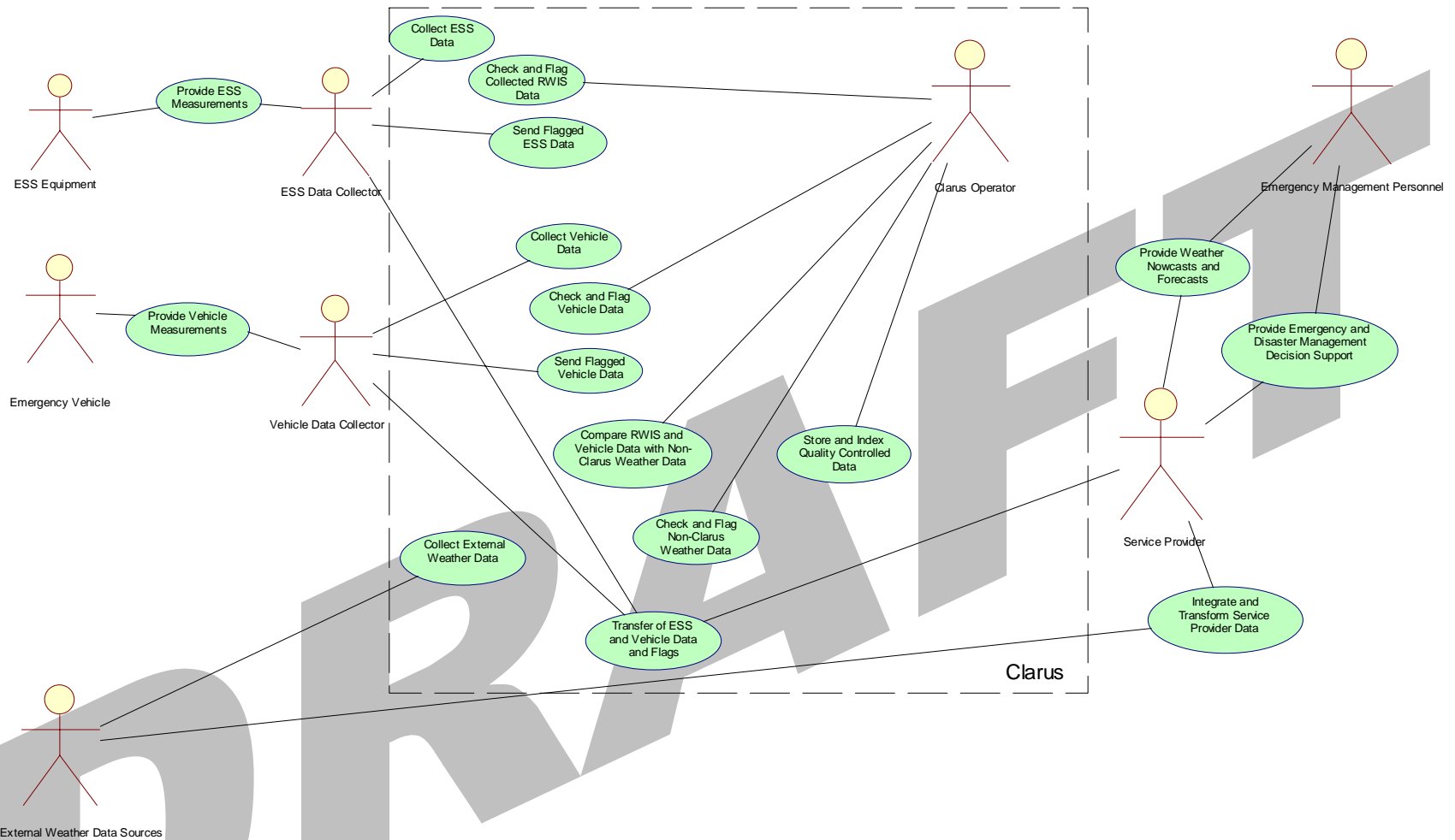


Figure 9. Clarus Local Emergency and Disaster Management Use Case Diagram

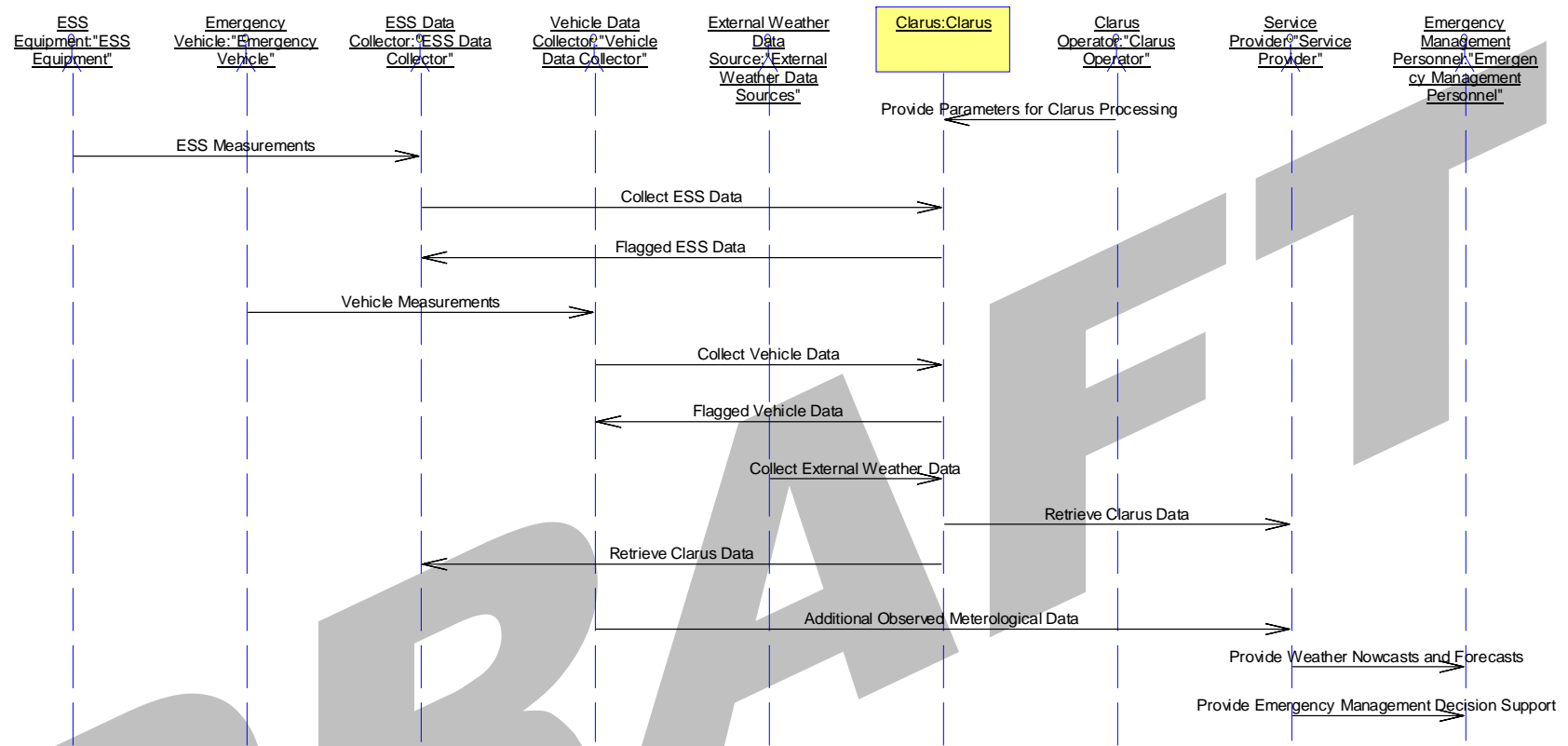


Figure 10. Clarus Local Emergency and Disaster Management Sequence Diagram

Scenario F – RAILROAD CARRIER OPERATIONS FUNCTION

The Clarus initiative is driven by the needs of the customers of the various service providers and these needs or interests are incorporated into a use case analysis. The formal Clarus system includes data acquisition, data integration, quality control, and service provider interface

As an engineer with Rogers Railroad, Jimmie is always on the watch for changing weather conditions that could jeopardize his schedule and the safety of the freight he hauls between Albuquerque and Nashville. As his unit train is passing through the Texas Panhandle late on a summer afternoon, dispatch contacts him with a severe thunderstorm alert. Jimmie doesn't realize that Rogers Railroad now subscribes to a **weather service provider** that relies on the national **Clarus** weather system. The thunderstorm alert indicates that a strong microburst associated with a rapidly developing thunderstorm will pass across his path fifteen miles ahead of his location at the same time he is projected to be at that location.

components. For the railroad industry, value-added products created by members of the service provider community become an essential part of decision support for planning and daily operations. Service providers acquire quality-controlled Clarus data and integrate it with data from other sources (e.g., observed meteorological data from other public and private sources, numerical weather prediction model data, road condition reports, and camera imagery) to produce consumer products. Observed data from Clarus enhance and complement the observed data set acquired from the national and private weather observation networks creating a refined analysis of existing conditions. Service providers integrate all observation sources into a composite presentation of each key parameter and further enhance the presentation by adding analyzed fields using color gradations to represent small ranges of values in the total spectrum of observed values.

Railroad operation decision-making relies upon the availability of timely current and forecasted weather information along thousands of miles of rail line across the nation that experience extreme weather conditions ranging from violent thunderstorms to bitter cold air temperatures. Safeguarding the movement of freight and passengers requires knowledge of weather events that can result in derailment due to high winds to the buckling of track due to extreme temperatures. The preparation of the appropriate weather information requires the use of a broad range of weather information to formulate how weather conditions will evolve over an entire rail network along with site-specific information relating transient weather conditions that result in isolated, yet severe, weather conditions along the railroad right of way.

Service providers extract data, as needed, from the Clarus system. They receive quality-controlled data and associated metadata information for the specified data request. Service Providers then integrate the Clarus data with other pertinent weather and non-weather data to produce specific products and services that respond to the needs of rail operations. These products and services are distributed to the rail operations users following accepted procedures that satisfy their particular needs.

Step-by-Step Flow of Activities for Railroad Carrier Operations Function

The information that follows provides a step-by-step flow of activities that depicts a general scenario for a railroad operations management function. Each successive heading and set of bullets constitutes the next stage of activities with a general flow of time increasing as the list progresses. The entity responsible for each is noted on the line before each set of bullets.

ESS MEASUREMENT – TRANSPORTATION AGENCY (AUTONOMOUS ENTITY)

- Weather and rail values measured in field Environmental Sensor Station (ESS)
- Weather and rail values stored in field ESS as current report
- Aggregated weather and rail values stored in field ESS as a series of reports

ESS COLLECTION– TRANSPORTATION AGENCY (AUTONOMOUS ENTITY)

- ESS Data Collector polls ESSs and transfers new stored reports in stored series from each ESS
- ESS Data Collector stores reports in database

CONSOLIDATION - CLARUS

- Clarus server directly collects data from the ESS Data Collector and Vehicle Data Collector
- Collection process performs quality control checks on incoming data and flags obvious errors
- Clarus server stores the data with quality control flags
- Clarus server accepts and stores External Weather data for quality assurance check
- Data from multiple sites is sorted into data sets having common date, time and location reference

QUALITY ASSURANCE CHECK - CLARUS

- External Weather data is compared with Clarus data for the purpose of data validation and quality assurance processing
- Quality assurance check is run on the time- and location-sorted data
- Observations deviating from expected values by a specified amount are flagged as potential errors
- Clarus stores the error flags with the data
- Clarus sends notification to the data provider when suspect data occur

DATA TRANSFER - CLARUS

- Data in the Clarus database are acquired by public and private members of the Service Provider community based on timeframe and location

DATA INTEGRATION – SERVICE PROVIDER

- The Service Providers collect, store, and consolidate the Clarus data with observed meteorological data from various other sources
- The Service Providers acquire forecast guidance products to complement the observed data
- Observed data are consolidated and composed into presentations showing the data from various sites displayed on a GIS background
- The observed and forecasted data are composed into route-specific weather forecast and rail condition products

DATA TRANSFORMATION – SERVICE PROVIDER

- Weather condition and forecast data for specific railroad segments are stored in a database on information delivery systems ready for access.
- Rail conditions are computed for segments of a given geographical region and are stored along with the weather condition and forecast information

RAILROAD OPERATIONS DECISION SUPPORT – SERVICE PROVIDER

- The observed weather and conditions are coupled with railroad actions to assess the current condition of the railroad network.
- Using the forecasted weather conditions, the Decision Support System assesses the anticipated impacts to rail traffic and recommends routing guidance and/or actions to mitigate short-term threats
- These observations and projections are composed into value-added deliverables and stored for distribution to the end users.

RAILROAD OPERATIONS MANAGEMENT ACTIVITIES – PRODUCT CONSUMER

- Weather and rail condition advisory information is acquired from service providers
- Decisions are made on the impact of the projected conditions on the schedules of train routing and rail schedules
- Schedules are adjusted to accommodate for the impact of the weather, rail conditions, and train traffic
- Revised schedules are computed and made available to rail system users
- Follow decision support advisories to maintain effective right of way control.

Use Case and Sequence Diagrams

The Use Case and Sequence Diagrams based on the above functionality are depicted below in Figure 11 and Figure 12.

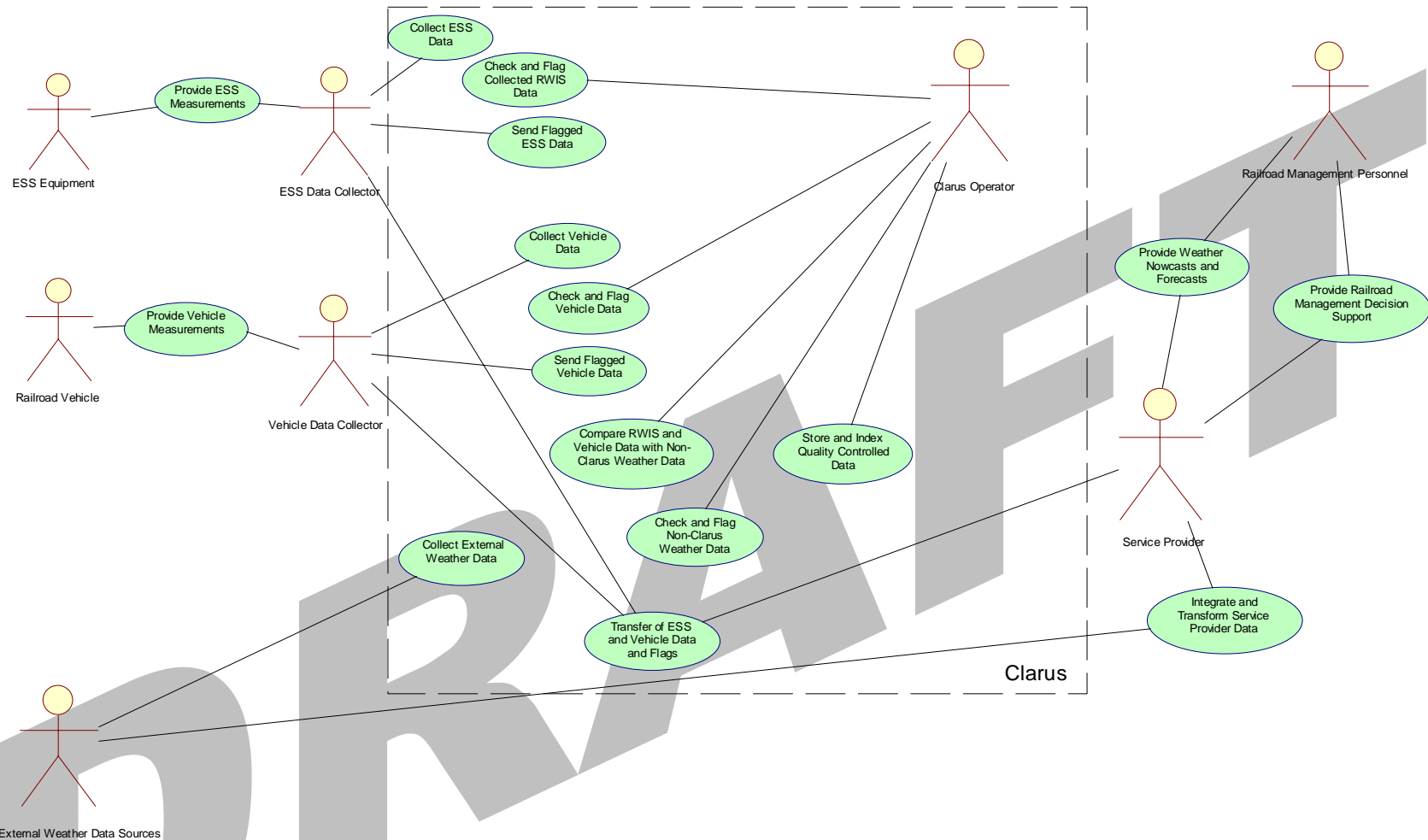


Figure 11. Clarus Railroad Carrier Operations Use Case Diagram

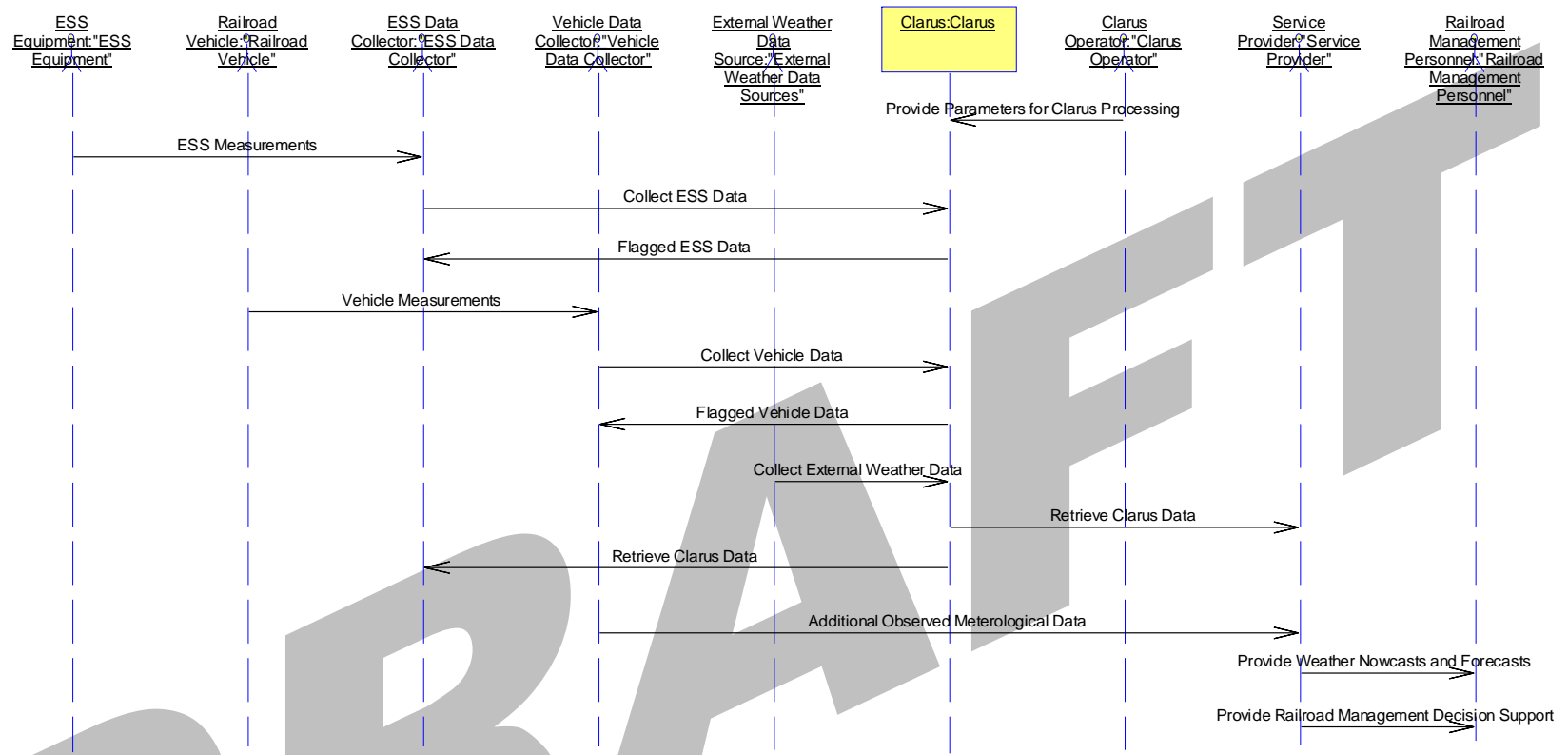


Figure 12. Clarus Railroad Carrier Operations Sequence Diagram

Scenario G: COMMERCIAL VEHICLE OPERATION FUNCTIONS

The Clarus initiative is driven by the needs of the customers of the various service providers and these needs or interests are incorporated into a use case analysis. The formal Clarus system

With the high price of diesel fuel, Commercial Express is on the verge of bankruptcy. Joe Hardy, the fleet operations manager, must convince his management that his idea to partner with the Route's R Us **weather service provider** can save the company millions. Route's R Us is touting its partnership with the national **Clarus** system in claiming that they can reduce weather-related routing and scheduling problems by 50%. Joe knows that a detailed picture of national weather conditions for his long haul trucks is the only way to go. Route's R Us has a pitch that seems reasonable, a nationwide merging of available **environmental data from vehicles** coupled with regional **ESS** data and other **external weather data**. After the presentation, Management gives Joe the chance to prove his idea in a pilot project. All Joe now needs is some significant weather event for his convoy of commercial vehicles heading out of Wichita, KS.

Being the middle of August in the middle of the country, Joe didn't have to wait very long for a severe weather alert to be issued for a tornado that has reportedly set down about 20 miles ahead of the convoy's path. Joe is now relying on his **weather service provider** to make good on its promises...

includes data acquisition, data integration, quality control, and service provider interface components. The management of commercial vehicle fleets may be significantly impacted by weather-related conditions. Service providers acquire quality-controlled Clarus data and integrate it with data from other sources (e.g., observed meteorological data from other public and private sources, numerical weather prediction model data, road condition reports, and camera imagery) to produce consumer products. Observed data from Clarus enhances and complements the observed data set acquired from the national and private weather observation networks creating a refined analysis of existing conditions. Service providers integrate observations from all available sources, including commercial vehicles, into a composite presentation of each key parameter. They then enhance the presentation by adding analyzed

fields using color gradations to represent small ranges of values in the total spectrum of observed values.

Fleet management of commercial vehicles revolves around scheduling and it is essential that all components of the inter-modal transportation scheme reach each designated location at specified times. Commercial vehicle operators depend upon this scheduling consistency. However, inclement weather affects different components of the inter-modal system in different ways, thus it becomes important to know specifically what the type and intensity of weather is expected and how this weather scenario is likely to impact the performance of the fleet. Winter storm conditions tend to disrupt commercial vehicles the most because of their wind profile and weight, thus significant attention needs to be placed on pavement conditions and its impact on commercial vehicles.

Support for commercial vehicle fleet management functions by Clarus involves weather-, pavement-, and commercial vehicle-related data collected from diverse sources owned and/or operated by surface transportation organizations. Commercial vehicle fleet management can provide vehicle-based environment data collection systems or provide services within jurisdictions that maintain collection systems for other transportation requirements. The data from these systems are transferred at routine intervals to one or more data fusion centers to

form the Clarus database. The data collection process checks the raw, incoming data for obvious anomalies. After all of the data are merged, the Clarus system performs a quality assurance evaluation at routine intervals to flag data anomalies. The quality-controlled data are stored in the Clarus database and become available to the private and public organizations, Service Providers, that have a need for the observed Clarus data. The Clarus system returns the quality-controlled data to the provider agencies with indicators of potential data anomalies within their data set. These system owners also maintain and update the metadata database that defines the characteristics of each site and each reported parameter at that site. This quality control feedback is part of a process to assure a dynamic metadata characterization.

Service providers extract data, as needed, from the Clarus system. They receive quality-controlled data and associated metadata information for the specified data request. Service Providers then integrate the Clarus data with other pertinent weather and non-weather data to produce specific products and services that respond to the needs of the maintenance community such as pavement treatment actions. These products and services are distributed to the maintenance user following accepted procedures that satisfy their particular needs.

Step-by-Step Flow of Activities for Commercial Vehicle Operation Function

The information that follows provides a step-by-step flow of activities that depicts a general scenario as to how a commercial vehicle operations function would occur. Each successive heading and set of bullets constitutes the next stage of activities with a general flow of time increasing as the list progresses. The entity responsible for each is noted on the line before each set of bullets.

ESS MEASUREMENT – TRANSPORTATION AGENCY (AUTONOMOUS ENTITY)

- Weather and pavement values measured at field Environmental Sensor Stations (ESS)
- Weather and pavement values stored in field ESSs as current report
- Aggregated weather and pavement values stored in field ESS as a series of reports

ESS COLLECTION– TRANSPORTATION AGENCY (AUTONOMOUS ENTITY)

- ESS Data Collector polls ESSs and transfers new stored reports from each ESS
- ESS Data Collector stores reports in a database

VEHICLE COLLECTION – COMMERCIAL VEHICLE OPERATIONS (AUTONOMOUS ENTITY)

- Commercial Vehicles detect and store weather and commercial vehicle operations information as a function of time and location
- The Vehicle Data Collector uploads the data from the commercial vehicle at specified intervals, or drop points, and stores the aggregated vehicle-based weather and operations data in an operational database

CONSOLIDATION - CLARUS

- Clarus server directly collects data from the ESS Data Collector and the Vehicle Data Collectors
- Collection process performs quality control checks on incoming data and flags obvious errors
- Clarus server stores the data with quality control flags
- Clarus server accepts and stores External Weather data for quality assurance check

- Data from multiple sites is sorted into data sets having common date, time and location reference

QUALITY ASSURANCE CHECK - CLARUS

- External Weather data is compared with Clarus data for the purpose of data validation and quality assurance processing
- Quality assurance check is run on the time- and location-sorted data
- Observations deviating from expected values by a specified amount are flagged as potential errors
- Clarus stores the error flags with the data
- Clarus sends notification to the data provider when suspect data occur

DATA TRANSFER - CLARUS

- Data in the Clarus database are acquired by public and private members of the Service Provider community based on timeframe and location

DATA INTEGRATION – SERVICE PROVIDER

- The Service Providers collect, store, and consolidate the Clarus data with observed meteorological data from various other sources
- The Service Providers acquire forecast guidance products to complement the observed data
- Observed data are consolidated and composed into presentations showing the data from various sites displayed on a GIS background
- The observed and forecasted data are composed into weather forecast products
- The forecasts are organized into text and graphical presentations

DATA TRANSFORMATION – SERVICE PROVIDER

- Meteorological data are run through a pavement condition model that transforms the weather forecast components into projections of pavement temperatures and road conditions
- Pavement conditions are computed for segments of a given highway having relatively uniform physical and environmental characteristics
- Computed pavement temperatures and road conditions are organized into tabular and graphical representations of current and forecasted pavement conditions

COMMERCIAL VEHICLE DECISION SUPPORT – SERVICE PROVIDER

- The observed weather and pavement conditions are coupled with reported maintenance actions to assess the current condition of the road surface for numerous representative points along a segment of highway
- Using the forecasted weather conditions, the Maintenance Decision Support System (MDSS) assesses the anticipated pavement conditions assuming no maintenance
- MDSS also assesses the anticipated pavement conditions based upon input from highway crews and their expected route timing.
- These observations and projections are composed into value-added deliverables and stored for distribution to the end users.

COMMERCIAL VEHICLE OPERATIONS MANAGEMENT ACTIVITIES – PRODUCT CONSUMER

- Weather and road condition advisory information is acquired from Service Providers

- Decisions are made on impact of the projected conditions on the schedules of commercial vehicles within the fleet
- Schedules are adjusted to accommodate for the impact of the weather, road conditions, and traffic flow
- Revised schedules are computed and made available to commercial vehicle operators

Use Case and Sequence Diagrams

The Use Case and Sequence Diagrams based on the above functionality are depicted below in Figure 13 and Figure 14.

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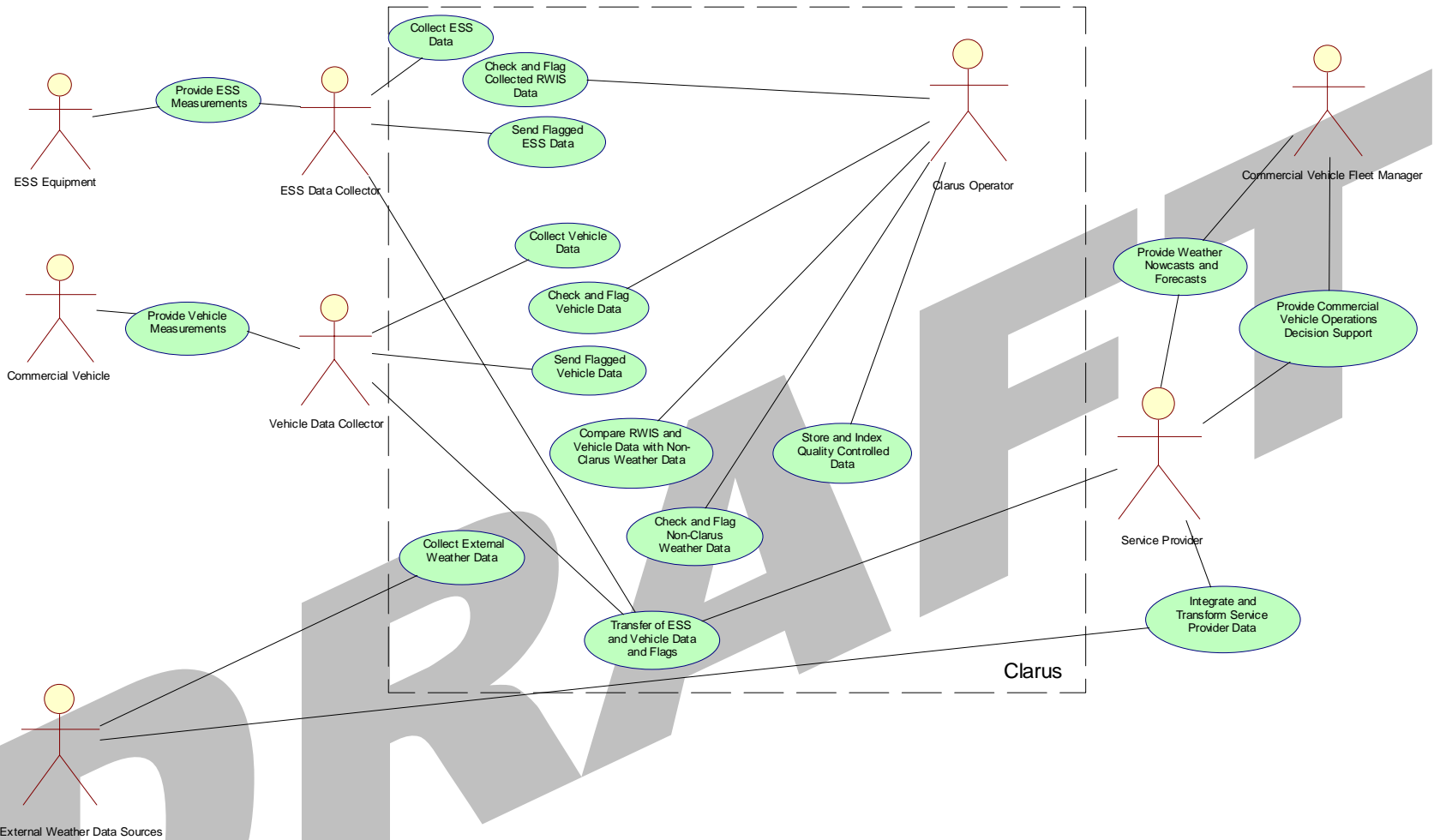


Figure 13. Clarus Commercial Vehicle Operation Use Case Diagram

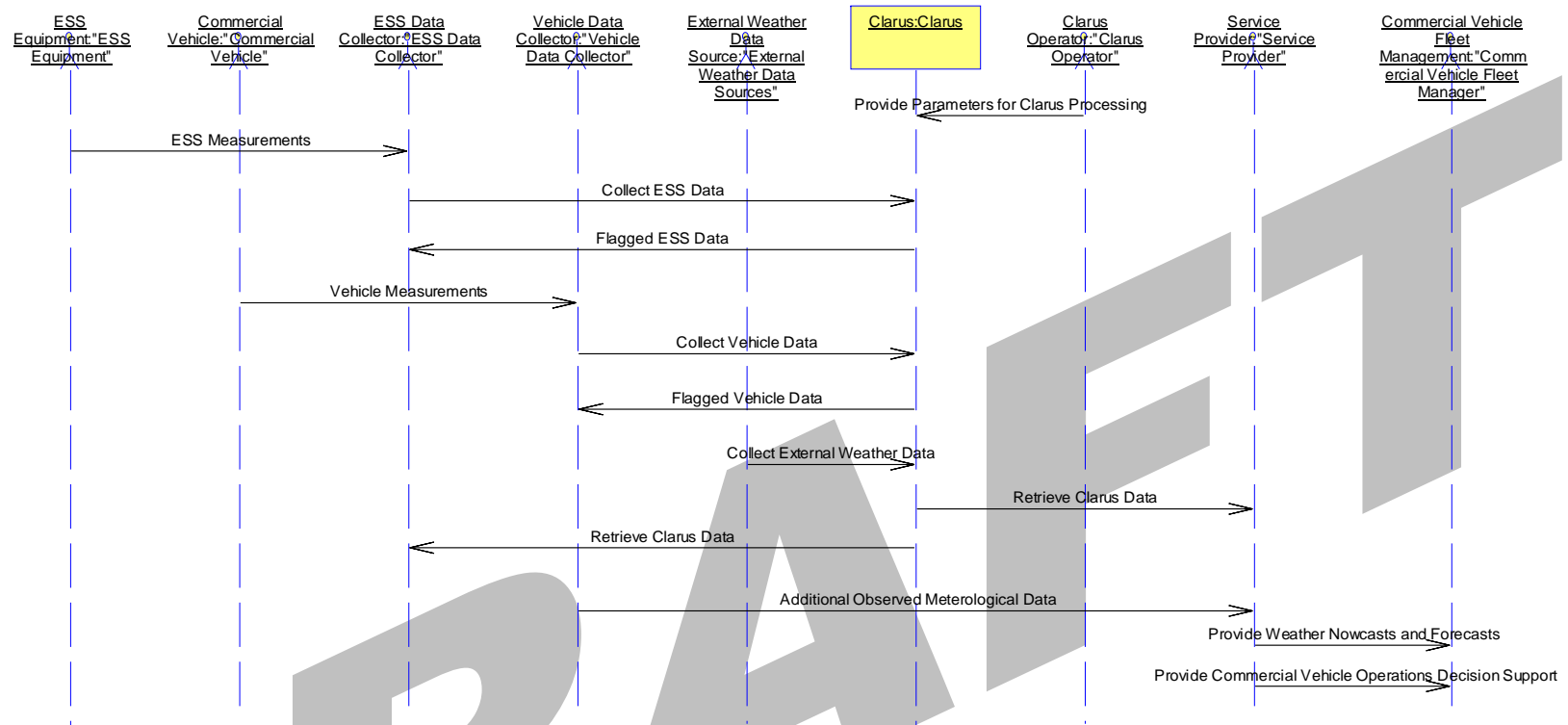


Figure 14. Clarus Commercial Vehicle Operation Sequence Diagram