Background

Since the early 2000s, the USDOT has funded various efforts to explore the potential of connected vehicle technology. The first of these to demonstrate at real scale was the Vehicle Infrastructure Initiative (VII), which demonstrated DSRC-based probe data generation and traveler advisory message delivery, and suggested the viability of initial V2I use cases. (this occurred in parallel with various CAMP activities that demonstrated V2V safety applications).

Subsequently, an effort was undertaken to more formally define the “glue” components necessary to implement connected vehicle technology. This effort resulted in three significant deliverables describing the “Core System.” Much of the work performed by that team was eventually incorporated into CVRIA, HARTS and ARC-IT. However since this work progressed to the point of defining a system architecture as opposed to a reference architecture, it may be worthwhile to revisit some of the particular artifacts generated in that work.

VII and the Core System work determined that publish-subscribe was a necessary component of any connected vehicle implementation of significant scale.

**References**

Key information was extracted from the following documents:

1. Core System Concept of Operations (ConOps), October 24, 2011.
2. Core System System Requirements Specification (SyRS), September 6, 2011.
3. Core System System Architecture Document (SAD), Ocrober 14, 2011

**Requirements**

System Needs aka top level system requirements for the Core System. These were filtered into Support services in CVRIA/HARTS/ARC-IT and are relevant to DDS solutions:

1. **Data Request:** The Core System needs to provide a mechanism for data consumers to request data that is produced by data providers. This is a single request for a subscription to a certain type of data, and subsequent modification of the request to change data types or subscription parameters. Parameters include data frequency, type and location of where the data was generated. This enables the distribution of anonymously-provided data to interested data consumers, without requiring them to enter into a relationship with data providers. Request formats need to provide data consumers with the ability to differentiate and receive only the types of data they requested. For example this includes data type, geographic range, frequency and sampling rate. This request method supports a wide variety of user needs, from planners requesting all traffic data all the time, to traveler information services requesting a subset of traffic data, to weather information services only interested in windshield wiper status for vehicles in a specific area.
2. **Data Provision:** The Core System needs to supply information to data providers enabling them to transmit data to interested data consumers. At a minimum, data characteristics need to include type, frequency and location where data was generated, so that users that have requested data (see need data request) can differentiate between available data. This need enables data providers to direct the data they create to data consumers, and serves as the provider-side corollary to the data request need. This supports a variety of applications, including those focused on the center provision of data to users. It also serves as the answer to the System User’s question of “I have data, how do I provide it and to whom?”
3. **Data Forward:** The Core System needs to provide a mechanism to distribute data that is produced by a System User acting as a data provider and requested by another System User. The Core System needs to provide this distribution mechanism, rather than relying on individual provider-consumer relationships, because multiple consumers may want access to the same data. By having the Core System distribute the data, System Users are relieved of the need to transmit the data multiple times. Also, some data that may be critical to the proper functioning of mandatory applications, such as data supporting geo-location of users (position corrections), time base data and roadway geometry data, all of which likely comes from a single source and needs to be distributed to large numbers of System Users. Additionally, System Users may interact over resource-constrained communication links, so Core-provided data redistribution reduces the potential load on those links.
4. **Geographic Broadcast:** The Core System needs to provide the information necessary for System Users who wish to communicate with a group of System Users in a specific area to do so. This capability enables System Users to target those in a specific area for information they wish to distribute without having to send individual messages to each recipient. Examples of applications that might use this include Amber Alerts, traffic information, and air quality alerts.

Two additional levels of requirements were defined in the Core System Requirements document. These are placed at the end of the document because they are a little challenging to parse given all the embedded references and also because the content of the Core SAD is likely more relevant.

**Data Distribution System Architecture**

Subsequent analysis in the Core ConOps and System Architecture documents describe a Data Distribution Subsystem. The header references were kept intact so the source material can be more easily referenced. Note that the architecture specification for the Core is not the same as was used for CVRIA/HARTS/ARC-IT. Most of the information relevant to ISO 23255 is contained in the Functional and Information views. Structure of the Functional is similar to the HARTS functional, but diagrams are included. The Information View gets closer to a data model than HARTS does, though it is still not nearly as detailed as necessary for interface definition.

**4.2.1.3.3 Data Distribution**

Data Distribution (DD) maintains a directory of System Users that want data and facilitates the delivery of that data to those users. It supports two distribution mechanisms:

• Source-to-Points: The data provider communicates data directly to data consumers. In this case, no data is sent to the Core System.

• Publish-Subscribe: The data provider communicates data to the Core, which forwards it to all us-ers that are subscribed to receive the data.

Data Distribution maintains a registry of which data subscribers get what data, according to the criteria defined above. Data Distribution does not store or buffer data beyond that which is necessary to complete publish-subscribe actions. If a given data subscriber is unable to receive data that it has subscribed to because of a communications or other system failure, the data may be lost.

Data Distribution repackages data it receives from data providers, stripping away the source header in-formation while maintaining the message payload. It then sends the repackaged payload data to subscribers of that data.

Data Distribution also provides information to System Users that enables those users to communicate with a group of System Users, by maintaining information regarding available communications methods, coverage areas, addresses and performance characteristics for geo-cast communications.

Associated Information Objects:

• Data Acceptance Info: This is the response to the Data Provision Request.

• Data Provision Request: This includes the type of data to be provided, source type and area over which the System User will provide data.

• Data Subscription Confirmation Info: This is a response to the Data Subscription Re-quest, describing the exact parameters of the System User’s subscription.

• Data Subscription Redirect Info: This is a response to the Data Subscription Request, rejecting the subscription.

• Data Subscription Request: This is the request to subscribe to data.

• Direct Data Distribution Info: This is data describing 3rd parties that accept data that the Core does not accept.

• Field Node Configuration Information: This specifies the location, IP address, commu-nications range, bandwidth and constraints for use of Field Node Infrastructure.

• Geo-Cast Message: This is a message that the System User wishes to distribute over a specific area, either once or repeatedly over a period of time.

• Other Core Acceptance Info: This is the response to the Data Provision Request, sent when the Core does not accept the data the System User wishes to provide.

• Provided Data: This is data received from System User Data Providers intended for the publish/subscribe engine.

• Repackaged, Addressed Data: This is data repackaged to match a specific subscriber’s subscription criteria. This is data that was originally provided by other System Users (Da-ta, above) that has been selected based on subscription criteria.

**4.2.2 Functional View – Data Distribution**

**4.2.2.1 Introduction**

This view explores the Core System’s Data Distribution functionality. System Users provide data, other System Users subscribe to data; the Core matches those providers and consumers without requiring them to enter into a relationship with the other.

This view includes several optional functions: data aggregation, data parsing and data sampling. The extent to which these are included in a Core System is dependent on the services that a Core System Deployer wishes to deploy, and constrained by the available resources. These functions are processing intensive; their implementation may require a significantly greater capital investment. A Deployer may wish to provide these services because they can significantly reduce the size of the data stream sent to subscribers. This reduction in recurring communications costs may balance the processing investment for some deployments. Such an analysis depends on the costs of hardware used to operate Core SEOs, the scope of the Core System and costs of available communications. Analysis of these trade-offs is recommended for all Core System Deployers.

**4.2.2.2 Concerns Addressed by this View**

|  |  |
| --- | --- |
| Interfaces | How difficult is it to develop applications that use Core System interfaces? |
| Interfaces | How flexible are Core System data distribution interfaces? |
| Interfaces | How does the Core System enable control of the services it provides? |
| Functionality | How does the Core System monitor the services it provides? |
| Functionality | How does the Core System function internally? |
| Functionality | How do the Core System’s components work together? |
| Functionality | How does the Core System transition between operational modes? |
| Security | What functional elements are involved in the detection of misbehavior by System Users, and what roles do those entities have? |
| Security | How does the Core System maintain the integrity of information provided to it by System Users? |
| Appropriateness | Does the Core System meet all of the needs defined in the ConOps? |
| Appropriateness | Does the Core System meet all of the functional requirements defined in the SyRS? |
| Evolvability | How easily can the Core’s functionality be expanded to cover new needs if they arise? |
| Evolvability | Does the functionality of the Core scale to support foreseeable demands from System Users? |

**4.2.2.3 Object Definitions and Roles**

**4.2.2.3.1 Actors**

**4.2.2.3.1.1 System User**

This actor represents a System User, including Center, Mobile and Field.

**4.2.2.3.2 Special Functional Objects**

These special objects interact with various other functions to perform operations on messages sent or received. The last maintains some common information that is used by many other functions. They are not shown interacting on the view description diagram for the sake of clarity.

4.2.2.3.2.1 Decrypt Messages Received Encrypted

This function accepts an encrypted message intended for the Core System and decrypts it using the Core’s private key.

4.2.2.3.2.2 Encrypt Messages

This function encrypts a message using the public key of the intended recipient.

4.2.2.3.2.3 Sign Messages

This function attaches the Core System’s digital signature to a message by encrypting a hash of the message content with the Core’s private key.

4.2.2.3.2.4 Verify Authenticity of Received Messages

This function verifies that the message is not a duplicate, has a valid digital signature, that it meets formatting rules and that its contents are within prescribed limits for the message type.

**4.2.2.3.3 Aggregate Data**

This Optional Functional Object receives data from the Parse Data and/or Repackage Data functions, and aggregates messages or data elements as appropriate, before passing such aggregations to the Sample Data function. If this function is not implemented, all messages simply pass through it to the Sample Da-ta function.

Associated Information Objects:

• Aggregated Data is the aggregated, parsed, and repackaged data, provided to the Sam-ple Data function.

• Parsed Data is an individual parsed data object received from the Parse Data function.

• Repackaged Data is composed of groups of same-type data, received from the Repack-age Data function.

• Subscription Details is received from the Data Subscription Catalog function. It includes the subscriber’s contact information, the data it is subscribed to and details about aggre-gation and sampling that should be applied to that data.

**4.2.2.3.4 Check User Permission**

This object accepts a System User ID or Operator ID, along with a type of operation that the user is at-tempting to access, and responds with whether or not the user is permitted that action.

Associated Information Objects:

• Provider ID, function is the identity or type of the System User data provider (which could be anonymous), which is sent to the Check User Permission function to verify whether the System User is permitted a given function.

• Operator ID, function is the identity of the operator, which is sent to the Check User Permission function to verify whether the operator is permitted a given function.

• Permission is the response from the Check User Permission function describing whether or not the User (System User, Core or Operator, depending on the original request) is permitted this action.

**4.2.2.3.5 Data Acceptance Catalog**

This data store maintains a catalog of data types and sources that are used by the Core’s Data Distribu-tion subsystem. It also maintains a list of the data types it does not accept but some other facility does. It allows changes to the catalog to update existing and add new data types, sources and combinations of types and sources. This function responds to queries about data types telling whether or not that type/source combination is accepted for data distribution. It also analyzes its data distribution coverage area, time, and source/type combinations against those reported by other Cores to determine if there are any overlaps (where multiple Cores provide the same services in the same area) or conflicts (where Cores provide different and conflicting information for the same area, for instance if one Core says that a given data type must go to external sink A, but another Core says that it accepts that data type).

Associated Information Objects:

• Data Acceptance Query is a request for information about the data types accepted by the Core. Includes the type of data to be provided, source type and location.

• Data Acceptance Info is a response to a Data Acceptance Query received from Receive Data from System Users. It indicates whether the data requested to be published is dis-tributed by the Core, and if not includes information describing a 3rd party facility that does accept the data, if such a facility exists. Includes the type of data to be provided, source type and location.

• Data Type and Source Request is a query sent to the Data Subscription Catalog to de-termine if a given data type/source combination is currently being used. This includes the types of data and their source or source type.

• Existing Acceptance and/or Changes is the response to the Data Type and Source Re-quest query. It specifies whether the data type/source in question is already being distrib-uted or if not, that such distribution has been added.

• Data Acceptance Details is information describing what data (source/type, time, cover-age area) the Core accepts, sent to the Provide Operator Interface to DD function.

**4.2.2.3.6 Data Subscription Catalog**

This data store maintains a catalog of data types and sources and the System Users that want to receive that data. It may allow specification of aggregation period and sampling rate for each System User. Al-lowable sampling rates and aggregation specifications may be restricted based on configuration and per-formance of this subsystem. Allows changes to the catalog to update existing and add new subscribers and responds to queries about data subscribers and their subscriptions.

Associated Information Objects:

• Data Type and Source Request is a query received from the Data Acceptance Catalog to determine if a given data type/source combination is currently being used. This in-cludes the types of data and their source or source type.

• Data Types and Sources is received from the Parse Data and Repackage Data functions. It asks whether a given type of data from a given type of source is used by any data sub-scription.

• Existing Acceptance and/or Changes is the response to the Data Type and Source Re-quest query from the Data Acceptance Catalog. It specifies whether the data type/source in question is already being distributed or if not, that such distribution has been added.

• Data Acceptance or Discard includes disposition for each data type/source combination included in Data Types and Sources. Possible dispositions are accept or discard. Within accept, this could include parse, aggregate and/or sample.

• Subscription Details is sent to the Match Data to Data Subscribers, Aggregate Data and Sample Data functions. It includes the subscriber’s contact information, the data it is sub-scribed to and details about aggregation and sampling that should be applied to that data.

**4.2.2.3.7 Geo-cast Device Catalog**

This data store keeps track of the information necessary for System Users to perform geo-casting. This includes locations, addresses, and ranges of devices that accept geo-cast messages.

Associated Information Objects:

• Geo-cast Addresses provides the IP addresses of the devices in the geo-cast area speci-fied by the Geo-Cast Area Specification query, sent to the Match Data to Data Subscrib-ers function.

• Geo-cast Area Specification is a query received from Match Data to Data Subscribers. It specifies an area that a message must be distributed over.

**4.2.2.3.8 Geo-cast Message Log**

This data store logs geo-cast messages.

Associated Information Objects:

• Geo-cast Message comes from the Manage Geo-cast Messages function. It includes the geo-cast message as well as information describing the desired distribution area and time over which the distribution should be made.

**4.2.2.3.9 Manage Geo-cast Messages**

This object accepts geo-cast messages from the Receive Data from System Users function. It then estab-lishes a schedule for geo-cast message publication and regularly provides messages to the Match Data to Data Subscribers function.

Associated Information Objects:

• Geo-cast Message comes from Receive Data from System Users. It includes information describing the desired distribution area and time over which the distribution should be made.

• Repackaged Geo-cast is a reformatted geo-cast message including location specification, provided to the Match Data to Data Subscribers and Geo-Cast Message Log functions.

**4.2.2.3.10 Match Data to Data Subscribers**

This object examines repackaged data and geo-cast messages to determine what data and messages go to which subscribers. Adds subscriber destination information and passes matched, sampled and aggregat-ed data to be distributed.

Associated Information Objects:

• Data Ready to be Matched is the aggregated, parsed, sampled and repackaged data, re-ceived from the Sample Data function.

• Reformatted Data with Destinations is the Data Ready to be Matched with the IP ad-dresses of subscribers to the data attached.

• Repackaged Geo-cast is a reformatted geo-cast message including location specification, received from the Manage Geo-cast Messages function.

• Geo-cast Addresses is the response to the Geo-cast Area Specification query that in-cludes the IP addresses of the area specified in the query.

• Geo-cast Area Specification is a query sent to the Geo-cast Catalog that includes an area specification.

• Subscription Details is received from the Data Subscription Catalog function. It includes the subscriber’s contact information, the data it is subscribed to and details about aggre-gation and sampling that should be applied to that data.

**4.2.2.3.11 Misbehavior Reports Log**

This object maintains the misbehavior reports received by the Core, including those submitted by System Users, and those from other Cores and those generated by internal Core monitoring processes. It accepts queries on those reports and provides the reports matching that query to requesting functions.

Associated Information Objects:

• Suspicious Data is Provided Data that does not pass the permission check. It is received from the Receive Data from System Users function.

• Suspicious Geo-Cast is a Geo-Cast Message that does not pass the permission check. It is received from the Receive Data from System Users function.

**4.2.2.3.12 Modify DD Operational State**

This object is the enabling function that allows the Operator to instruct various functions of Data Distri-bution to change the way they operate; this can include adding or deleting instantiations of an object or by commanding functions to enter into a different state or mode.

**4.2.2.3.13 Parse Data**

This Optional Functional Object receives data from Receive Data from System Users and parses it for individual data objects that are required to satisfy data subscriptions. Some data objects could be subject to parsing and others not; so the Repackage Data function is still required even if this object is imple-mented.

Associated Information Objects:

• Provided Data comes from the Receive Data from System Users Function. Data that is not subject to parsing is passed to the Repackage Data function. If the Parse Data func-tion is not implemented, all Provided Data is passed to the Repackage Data function.

• Repackaged Data is composed of groups of same-type data, send to the Match Data to Data Subscribers function.

• Data Types and Sources is sent to the Data Subscription Catalog. This includes the types of data and their source or source type.

• Data Acceptance or Discard includes disposition for each data type/source combination included in Data Types and Sources. Possible dispositions are accept or discard. Within accept, this could include parse, aggregate and/or sample.

• Parsed Data is an individual parsed data object provided to the Aggregate Data func-tion.

**4.2.2.3.14 Provide Data to Subscribing System Users**

This object receives blocks of same type/source packaged data with destination information attached. It also buffers data packages intended for the same destination and sends those as larger messages.

Associated Information Objects:

• Repackaged, Addressed Data is the packaged data on subscribed data types sent to da-ta subscribers.

• Reformatted Data w/Destinations is the aggregated, parsed, sampled and repackaged data with a list of IP addresses that are to receive that data.

**4.2.2.3.15 Provide Operator Interface to DD**

This object provides an interface to the Operator, allowing him access to User Data Subscription, data acceptance and geographic broadcast functions. The Operator interface also allows control changes to the operational mode of Data Distribution functions.

Associated Information Objects:

• Data Acceptance Details is information describing what data (source/type, time, cover-age area) the Core accepts, received from the Data Acceptance Catalog.

• Operator ID, function is the identity of the Operator attempting a data subscription or data acceptance modification, sent to the Check User Permission function to verify whether the System User is permitted the given function.

• Permission is received from the Check User Permissions function in response to the Op-erator ID, function message. This includes whether or not the Operator is permitted the function requested.

**4.2.2.3.16 Receive Data from System Users**

This object acquires data and geo-cast distribution requests from System Users. It queries the Check Us-er Permissions function to determine if the System User is permitted to send the data or geo-cast that the System User provides. It only forwards data and geo-cast requests if those data and requests are permit-ted. Data and requests that are not permitted are noted as misbehavior reports.

Associated Information Objects:

• Geo-cast Message comes from System Users. It includes information describing the de-sired distribution area and time over which the distribution should be made. It is provided to the Manage Geo-cast Messages function if it passes the permission check.

• Provided Data comes from System Users and is distributed to the Parse Data function if it passes the permission check.

• Provider ID, function is the identity or type of the System User data provider (which could be anonymous), which is sent to the Check User Permission function to verify whether the System User is permitted a given function.

• Permission is the response from the Check User Permission function describing whether or not the User (System User, Core or Operator, depending on the original request) is permitted this action.

• Data Acceptance Info is received from the Data Acceptance Catalog and sent to a Sys-tem User that provides data that the Core does not accept. It includes information de-scribing a 3rd party facility that does accept the data, if such a facility exists. Includes the type of data to be provided, source type and location.

• Data Acceptance Query is a request for information concerning all the data types the Core accepts. Includes the type of data to be provided, source type and location.

• Suspicious Data is Provided Data that does not pass the permission check. It is provided to the Misbehavior Reports Log.

• Suspicious Geo-Cast is a Geo-Cast Message that does not pass the permission check. It is provided to the Misbehavior Reports Log.

**4.2.2.3.17 Repackage Data**

This object queries the Data Subscription Catalog to determine what data has subscribers. Of that data with subscribers, it strips source header from each message, groups messages according to type and pro-vides those message groups to the Aggregate Data function.

Associated Information Objects:

• Provided Data comes from the Receive Data from System Users Function.

• Repackaged Data is composed of groups of same-type data, send to the Aggregate Data function.

• Data Types and Sources is sent to the Data Subscription Catalog. This includes the types of data and their source or source type.

• Data Acceptance or Discard includes disposition for each data type/source combination included in Data Types and Sources. Possible dispositions are accept or discard. Within accept, this could include parse, aggregate and/or sample.

**4.2.2.3.18 Sample Data**

This Optional Functional Object receives data from the Aggregate Data function, and samples messages or data elements as appropriate, before passing such sampled data to the Match Data to Data Subscribers function. If this function is not implemented, all messages simply pass through it to the Match Data to Data Subscribers function.

. Associated Information Objects:

• Aggregated Data is the aggregated parsed and repackaged data, received from the Ag-gregate Data function.

• Data Ready to be Matched is the aggregated, parsed, sampled and repackaged data, provided to the Match Data to Data Subscribers function.

• Repackaged Data is composed of groups of same-type data, received from the Repack-age Data function.

• Subscription Details is received from the Data Subscription Catalog function. It includes the subscriber’s contact information, the data it is subscribed to and details about aggre-gation and sampling that should be applied to that data.

**4.2.2.4 View Description**

This view addresses the functions required to implement, monitor and control the Core System’s data distribution function, including geo-casting and publish/subscribe-based distribution of data. Establish-ment and maintenance of System User subscriptions are covered under a separate view, Functional View – User Configuration.

This view includes three optional functional objects: Parse Data, Sample Data and Aggregate Data. Data Distribution can still be implemented without these functions; they are classed as optional because their implementation requires substantial effort.

The system accepts data with the Receive Data from System Users function, and passes all data meeting permissions requirements to the Parse Data function. If the Parse Data function does not exist, data is passed to the Repackage Data function. Either way, data is made anonymous by one of these functions, either by having individual elements extracted by Parse Data or having the sender’s header information removed by Repackage Data. Data that does not meet the permissions checks initiated by Receive Data from System Users is reported to the Misbehavior Reports Log for later analysis.

Data passes through the Parse Data, Repackage Data, Sample Data and/or Aggregate Data functions, depending on what is implemented by the Core and what subscriptions the Core has. Subscriptions dic-tate what amount of sampling and aggregation are required, so if no subscribers request those functions, then those functions are essentially pass-through.

Data passing through the publish/subscribe engine is passed through the following functions in order:

Receive Data from System Users -> Parse Data / Repackage Data -> Aggregate Data -> Sample Data -> Match Data to Data Subscribers -> Provide Data to Subscribing System Users

Data is not modified under any circumstances. Data may be aggregated, in which case new information is created from existing data.

Data that is provided for a geo-cast that passes the permission check is passed through the following functions in order:

Receive Data from System Users -> Manage Geo-Cast Messages -> Match Data to Data Sub-scribers -> Provide Data to Subscribing System Users

Geo-cast messages are held by the Manage Geo-Cast Messages function and sent when their message envelope indicates they should be sent. Geo-cast messages may be resent periodically, so this function may maintain a copy of the message and periodically resend it, until the message’s send time is passed.

Note that geo-cast messages and other data, regardless of source, all enter the Core System at the same logical point. This is to enable flexibility with regard to the eventual distribution of data. It may also simplify the development of applications that use the Data Distribution features of the Core, as they will have to support only one interface. The exact specification of the interfaces provided by Receive Data from System Users and Provide Data from System Users will be a task for subsequent design. These in-terfaces should use commercially available protocols that can be accessed from all supported communica-tions media (see the Communications Viewpoint).

Additional interfaces could always be added by adding a new input function, and then tying that into the Parse Data or Repackage Data function. Similarly, additional functionality could be added by insert-ing new functions into the data flows defined here. For instance, if it was decided that certain data should be subject to limit checking, a Limit Checking function could be added between Parse Data and Aggregate Data without substantially re-architecting the system, though related Connectivity and In-formation Views would have to be considered.

This diagram depicts the Data Distribution functional view. Details of the functions (ovals), information (rectangles), data stores, (cylinders), interfaces (dashed lines or arrows), and actors (stick figures) are described in the preceding text.

Figure 4 9: Functional View – Data Distribution

**Appendix: Requirements**

|  |  |
| --- | --- |
| ***3.1.1.2*** | ***Data Distribution Requirements*** |
| 3.1.1.2.1 | A Core System shall receive the 4.5.1.2.2.5 Data Subscription Request from Data Subscribers. |
| 3.1.1.2.2 | A Core System shall send the 4.5.1.2.2.3 Data Subscription Confirmation Info response to a Data Subscriber upon request. |
| 3.1.1.2.3 | A Core System shall use the contents of the 4.5.1.2.2.5 Data Subscription Request to update the contents in the 4.2.2.3.6 Data Subscription Catalog. |
| 3.1.1.2.4 | A Core System shall accept the 4.5.1.2.2.2 Data Provision Request a Data Provider. |
| 3.1.1.2.5 | A Core System shall transmit the 4.5.1.2.2.1 Data Acceptance Info response to a Data Provider upon request. |
| 3.1.1.2.6 | A Core System shall use the contents of the 4.5.1.2.2.2 Data Provision Request to update the contents in the 4.2.2.3.5 Data Acceptance Catalog. |
| 3.1.1.2.7 | A Core System shall accept the 4.5.1.2.2.8 Geo-Cast Message from System Users. |
| 3.1.1.2.8 | A Core System shall use the contents of the 4.5.1.2.2.8 Geo-Cast Message to update the contents in the 4.2.2.2.8 Geo-cast Message Log. |
| 3.1.1.2.9 | A Core System shall accept the 4.5.1.2.2.7 Field Node Configuration Information request from System Users. |
| 3.1.1.2.10 | A Core System shall use the contents of the 4.5.1.2.2.7 Field Node Configuration Information to update the contents in the 4.2.2.3.7 Geo-cast Device Catalog. |
| 3.1.1.2.11 | A Core System shall send the 4.5.1.2.2.11 Repackaged, Addressed Data to a Data Subscribers upon request. |

**3.2.2 Data Distribution Subsystem**

The Data Distribution Subsystem maintains a directory of System Users that want data and facilitates the delivery of that data to those users. It supports multiple distribution mechanisms, including:

• Source-to-Points: The data provider communicates data directly to data consumers. In this case no data is sent to the Core System, however the Core is involved to check System User Permissions and to provide addressing services through those subsystems

• Publish-Subscribe: The data provider communicates data to the Data Distribution subsystem, which forwards it to all users that are subscribed to receive the data.

Data Distribution allows data consumers to specify (and change the specification of) data they wish to receive using criteria including:

• Data type

• Data quality characteristics

• Data format requirements

• Geographic area

• Sampling rate

• Minimum and maximum frequency of data forwarding

Data Distribution maintains a registry of which data consumers get what data according to the criteria defined above. Data Distribution Publish-Subscribe does not store or buffer data beyond that which is necessary to complete publish-subscribe actions. If a given data consumer is unable to receive data that it has subscribed to because of a communications or other system failure, the data in question may be lost. The degree to which data distribution buffering accommodates connectivity failures will be up to the Core System deployment. Some Cores may offer “temporary storage” in this fashion.

Data Distribution repackages data it receives from data providers, stripping away the source header information while maintaining the message payload. It then sends the repackaged payload data to subscribers of that data.

Data Distribution will also maintain source-to-points information. With this option, the data consumer will connect directly to the data provider with the address supplied by the Data Distribution subsystem. When connected, the data provider sends the data directly to each consumer bypassing the Core System.

Data Distribution does not share or exchange data with other Core Systems. System Users that want data from multiple Cores need to subscribe to each Core.

**3.2.2.1 Functional Requirements**

3.2.2.1.1 Data Subscription Processing

3.2.2.1.1.1 The Data Distribution Subsystem shall receive the 4.5.1.2.2.5 Data Subscription Request from Data Subscribers.

3.2.2.1.1.2 Upon receiving a 4.5.1.2.2.5 Data Subscription Request from a Data Subscriber, the Data Distribution Subsystem shall ensure that its contents meet the acceptance criteria for all of its data objects.

3.2.2.1.1.3 Upon receiving a valid 4.5.1.2.2.5 Data Subscription Request from a Data Subscriber, the Data Distribution Subsystem shall send the 4.5.1.2.2.3 Data Subscription Confirmation Info response to that Data Subscriber.

3.2.2.1.1.4 Upon receiving a valid 4.5.1.2.2.5 Data Subscription Request from a Data Subscriber, the Data Distribution Subsystem shall use its contents to update the contents in the 4.2.2.3.6 Data Subscription Catalog.

3.2.2.1.1.5 Upon receiving a 4.5.1.2.2.5 Data Subscription Request from a Data Subscriber that does not meet the acceptance criteria, the Data Distribution Subsystem shall send the 4.5.1.2.2.4 Data Subscription Redirect Info response to that Data Subscriber.

3.2.2.1.1.6 Upon receiving a 4.5.1.2.2.5 Data Subscription Request from a Data Subscriber for 3rd parties that accept the data that the Core determines as invalid, the Data Distribution Subsystem shall send the4.5.1.2.2.6 Direct Data Distribution Info response to that Data Subscriber.

3.2.2.1.1.7 If a 4.5.1.2.2.5 Data Subscription Request from a Data Subscriber contains a data item that the Data Distribution Subsystem determines as invalid, the Data Distribution Subsystem shall exclude that data item from its update of the 4.2.2.3.6 Data Subscription Catalog.

**3.2.2.1.2 Data Provision Processing**

3.2.2.1.2.1 The Data Distribution Subsystem shall accept the 4.5.1.2.2.2 Data Provision Request from a Data Provider.

3.2.2.1.2.2 Upon accepting a 4.5.1.2.2.2 Data Provision Request from a Data Provider, the Data Distribution Subsystem shall ensure that its contents meet the acceptance criteria for all of its data objects.

3.2.2.1.2.3 Upon accepting a valid 4.5.1.2.2.2 Data Provision Request from a Data Provider, the Data Distribution Subsystem shall transmit the 4.5.1.2.2.1 Data Acceptance Info response to that Data Provider.

3.2.2.1.2.4 Upon accepting a valid 4.5.1.2.2.2 Data Provision Request from a Data Provider, the Data Distribution Subsystem shall use its contents to update the contents in the 4.2.2.3.5 Data Acceptance Catalog.

3.2.2.1.2.5 Upon accepting a 4.5.1.2.2.2 Data Provision Request from a Data Provider that does not meet the acceptance criteria, the Data Distribution Subsystem shall transmit the 4.5.1.2.2.9 Other Core Acceptance Info response to that Data Provider.

3.2.2.1.2.6 If a 4.5.1.2.2.2 Data Provision Request from a Data Provider contains a data item that the Data Distribution Subsystem determines as invalid, the Data Distribution Subsystem shall exclude that data item from its update of the 4.2.2.3.5 Data Acceptance Catalog.

3.2.2.1.2.7 The Data Distribution Subsystem shall accept the 4.5.1.2.2.7 Field Node Configuration Information request from System Users.

3.2.2.1.2.8 Upon accepting a 4.5.1.2.2.7 Field Node Configuration Information request from a System User, the Data Distribution Subsystem shall ensure that its contents meet the acceptance criteria for all of its data objects.

3.2.2.1.2.9 Upon receiving 4.5.1.2.2.10 Provided Data from System Users, the Data Distribution Subsystem shall ensure that its contents meet the acceptance criteria for all of its data objects.

3.2.2.1.2.10 Upon accepting a 4.5.1.2.2.10 Provided Data from a System User, the Data Distribution Subsystem shall ensure that its contents meet the acceptance criteria for all of its data objects.

3.2.2.1.2.11 Upon receiving valid 4.5.1.2.2.10 Provided Data from a System User that require repackaging, the Data Distribution Subsystem shall send the 4.5.1.2.2.11 Repackaged, Addressed Data to Data Subscribers.

3.2.2.1.2.12 The Data Distribution Subsystem shall send the 4.5.2.2.5.2 Operator ID, function to the User Permissions Subsystem.

3.2.2.1.2.13 The Data Distribution Subsystem shall send the 4.5.2.2.5.4 Provider ID, function to the User Permissions Subsystem.

3.2.2.1.2.14 The Data Distribution Subsystem shall send a 4.5.2.2.1.1 Core Config Info to the Core2Core Subsystem.

3.2.2.1.2.15 The Data Distribution Subsystem shall send a 4.5.2.2.1.2 Config Info for Other Cores to the Core2Core Subsystem.

3.2.2.1.2.16 The Data Distribution Subsystem shall send a 4.5.2.2.1.3 Data to be Backed Up to the Core2Core Subsystem.

3.2.2.1.2.17 The Data Distribution Subsystem shall receive the 4.5.2.2.7.3 Permission response from the User Permissions Subsystem.

3.2.2.1.2.18 The Data Distribution Subsystem shall receive the 4.5.2.2.7.1 Restore Data from the Core2Core Subsystem.

3.2.2.1.2.19 The Data Distribution Subsystem shall receive the Locally Encrypted Message from the User Trust Subsystem.

3.2.2.1.2.20 The Data Distribution Subsystem shall send the 4.5.2.2.3.9 Suspicious Data to the Misbehavior Management Subsystem (for System User misbehavior) to update the contents in the 4.2.2.3.11 Misbehavior Reports Log.

3.2.2.1.2.21 The Data Distribution Subsystem shall send the Suspicious Data Provision Request to the Misbehavior Management Subsystem (for Data Provider misbehavior) to update the contents in the 4.2.4.3.15 Misbehavior Reports Log.

3.2.2.1.2.22 The Data Distribution Subsystem shall send the Suspicious Data Subscription Request to the Misbehavior Management Subsystem (for Data Subscriber misbehavior) to update the contents in the 4.2.4.3.15 Misbehavior Reports Log.

**3.2.2.1.3 Data Repackaging/Aggregation**

3.2.2.1.3.1 The Data Distribution Subsystem shall aggregate provisional data (i.e., Aggregated Data) by repackaging relevant information to be transmitted to a Data Subscriber.

3.2.2.1.3.2 The Data Distribution Subsystem shall provide parsing of provisional data (i.e., Aggregated Data) by repackaging a subset of data to be transmitted to a Data Subscriber.

3.2.2.1.3.3 The Data Distribution Subsystem shall provide sampling of provisional data (i.e., Aggregated Data) by repackaging a sample set of data to be transmitted to a Data Subscriber.

**3.2.2.1.4 Geocasting Service (GCS)**

3.2.2.1.4.1 The Data Distribution Subsystem shall accept the 4.5.1.2.2.8 Geo-Cast Message from System Users.

3.2.2.1.4.2 Upon accepting a 4.5.1.2.2.8 Geo-Cast Message from a System User, the Data Distribution Subsystem shall ensure that its contents meet the acceptance criteria for all of its data objects.

3.2.2.1.4.3 Upon accepting a valid 4.5.1.2.2.8 Geo-Cast Message from a System User, the Data Distribution Subsystem shall use its contents to update the contents in the 4.2.2.2.8 Geo-cast Message Log.

3.2.2.1.4.4 If a 4.5.1.2.2.8 Geo-Cast Message from a System User contains a data item that the Data Distribution Subsystem determines as invalid, the Data Distribution Subsystem shall exclude that data item from its update of the 4.2.2.2.8 Geo-cast Message Log.

3.2.2.1.4.5 The Data Distribution Subsystem shall receive the 4.5.2.2.2.1 Geo-cast Info Changes from the Misbehavior Management Subsystem using its contents to update the contents in the 4.2.2.3.7 Geo-cast Device Catalog.

3.2.2.1.4.6 Upon accepting a valid 4.5.1.2.2.7 Field Node Configuration Information request from a System User, the Data Distribution Subsystem shall use its contents to update the 4.5.2.2.2.1 Geo-cast Info Changes contents in the 4.2.2.3.7 Geo-cast Device Catalog.

3.2.2.1.4.7 If a 4.5.1.2.2.7 Field Node Configuration Information request from a System User contains a data item that the Data Distribution Subsystem determines as invalid, the Data Distribution Subsystem shall exclude that data item from its update of the 4.2.2.3.7 Geo-cast Device Catalog.

3.2.2.1.4.8 The Data Distribution Subsystem shall send the 4.5.2.2.3.11 Suspicious Geo-Cast to the Misbehavior Management Subsystem (for System User Geo-cast misbehavior) using its contents to update the contents in the 4.2.2.3.11 Misbehavior Reports Log.

**3.2.2.1.5 Time Requirements**

3.2.2.1.5.1 The Data Distribution Subsystem shall receive the 4.5.2.2.7.2 Time Local Form from the Time Synchronization Subsystem.

**3.2.2.1.6 State/Mode/Status Requirements**

3.2.2.1.6.1 The Data Distribution Subsystem shall accept an Operational Changes message from a privilege System Operator.

3.2.2.1.6.2 The Data Distribution Subsystem shall update its State Changes to the 4.2.5.3.4 Event Log.

3.2.2.1.6.3 The Data Distribution Subsystem shall update its Actions to the 4.2.5.3.4 Event Log.

3.2.2.1.6.4 The Data Distribution Subsystem shall update its Anomalies to the 4.2.5.3.4 Event Log.

3.2.2.1.6.5 When in Restricted Mode, the Data Distribution Subsystem shall prioritize the 4.5.1.2.2.5 Data Subscription Request from a Data Subscriber.

3.2.2.1.6.6 When in Restricted Mode, the Data Distribution Subsystem shall prioritize the 4.5.1.2.2.2 Data Provision Request from a Data Provider.

3.2.2.1.6.7 When operating in Maintenance Mode, the Data Distribution Subsystem shall not accept the 4.5.1.2.2.8 Geo-Cast Message from System Users.

3.2.2.1.6.8 When operating in Maintenance Mode, the Data Distribution Subsystem shall not accept the 4.5.1.2.2.5 Data Subscription Request from a Data Subscriber.

3.2.2.1.6.9 When operating in Standby State, the Data Distribution Subsystem shall not accept the 4.5.1.2.2.2 Data Provision Request from a Data Provider.

3.2.2.1.6.10 When operating in Standby State, the Data Distribution Subsystem shall not accept the 4.5.1.2.2.5 Data Subscription Request from a Data Subscriber.

**3.2.2.2 External Interface Requirements**

3.2.2.2.1 The Data Distribution Subsystem shall enable a privileged System Operator to update the contents of the Data Distribution Configuration data store.

3.2.2.2.2 The Data Distribution Subsystem shall enable a privileged System Operator to update the contents of the Configure Data Distribution.