Use Case Report for NASPInet Data Bus and Phasor Gateway Specifications

v0.10

Contents

1. Introduction

1.1. Summary

The North American Synchro-Phasor Initiative (NASPI) is a major effort by the North American electric power industry to create a robust, widely available and secure infrastructure. NASPI's goal is to define and implement a network (NASPInet) that will interconnect electric power systems with sufficient fidelity to improve operation and safety. The "Phasor Gateway Technical Specifications for North American Synchro-Phasor Initiative Network (NASPInet)" and "Data Bus Technical Specifications for North American Synchro-Phasor Initiative Network (NASPInet)" outline NASPInet and its requirements.

NASPInet connects Phasor Gateways (PGs) and a Data Bus (DB). The gateways will integrate with the utility and monitoring center IT infrastructures. The data bus connects gateways. Once fully deployed, NASPInet could support hundreds of gateways and thousands of Phasor Measurement Units (PMUs). Total data-flow is significant; each of the thousands of PMUs typically samples data at 30 times per second. See Figure 1.

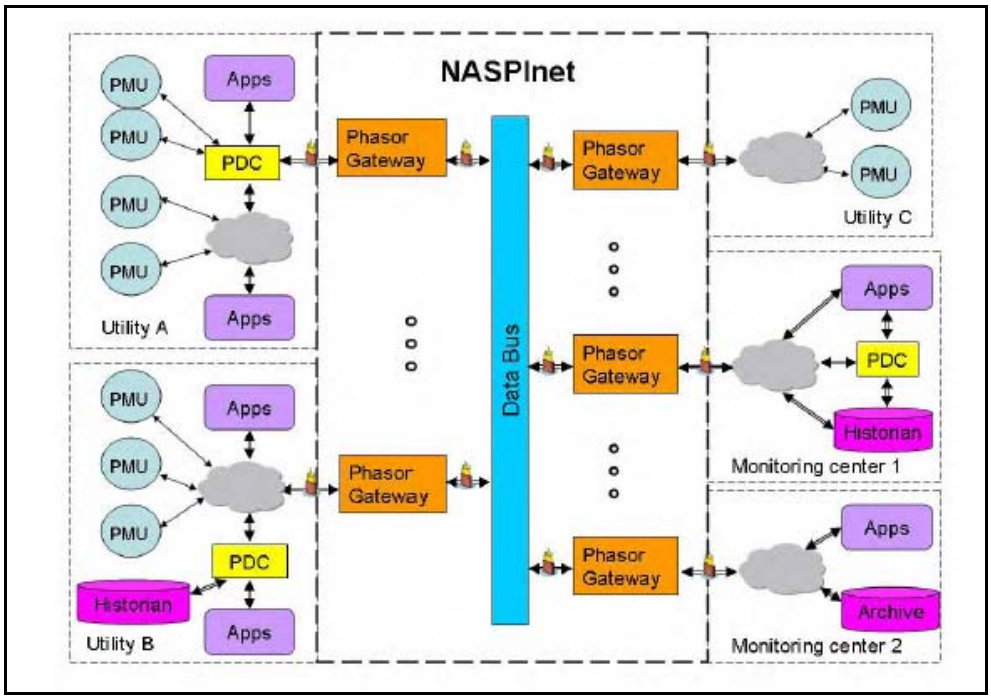

Figure 1: NASPInet Conceptual Diagram

This challenging distributed system needs a well-considered, efficient architecture. The first step is to understand the challenges; this document analyzes use cases for NASPInet. The goal is to clarify interactions so we can next define a system architecture and an efficient application programming interface (API) that meet the system's current needs and future expansion.

This document analyzes all known use cases, including securing and managing access to the network, connecting gateways to the network, discovering network participants, and accessing real-time and historical data. It covers both relevant interfaces, including the local utility or monitoring center's interaction with the gateway, and the gateway's interaction with the data bus. The analysis considers use cases in sufficient depth to reveal issues with actor communication, quality of service requirements, and architectural limits.

1.2. Goal of this Document

The goal of this document is to characterize the usage of the proposed NASPInet so that we can then create a Platform Independent Model (PIM) from this work.

This work starts from the NASPInet Data Bus specification, and extends the use-cases listed in that document. With the goal of creating a Platform Independent Model, this document does not reference some use cases from the original document since they are implementation specific (for example, the document assumes a client-server or a publish-subscribe model). In other words, this document will list the expected *behavior* of the NASPInet system, but will not define *how* to deliver the functionality.

Where possible, we will list the use cases referenced in the original document that have not been included because they were specific to an implementation.

1.3. Organization of Use Cases

We have categorized the use cases by the physical system and the respective references to the NASPI specifications. Specifically:

- Section 2 contains that the use cases that have been **commonly** referenced by the documents "Phasor Gateway Technical Specifications for North American Synchro-Phasor Initiative Network (NASPInet)" and "Data Bus Technical Specifications for North American Synchro-Phasor Initiative Network (NASPInet)".
- Section 3 contains the use cases referenced by the documents "Phasor Gateway Technical Specifications for North American Synchro-Phasor Initiative Network (NASPInet)" and "Data Bus Technical Specifications for North American Synchro-Phasor Initiative Network (NASPInet)".

2. Common Use Case Model

2.1. Introduction

This section covers the generalized actors and use cases that are common to both the Phasor Gateway and the NASPInet Data Bus domains.

These use cases have applicability to the component suppliers for both the Phasor Gateway and the Data Bus as identified by NASPInet's Data Bus and Phasor Gateway Specifications.

2.2. Actors

An *actor* is something or someone which exists outside the system ('black box') under study and takes part in a sequence of activities in a dialogue with the system to achieve some goal. Actors may be end users, other systems, or hardware devices.

2.2.1. Relationship between Actors

2.2.2. Network Entity (abstract)

This actor generalizes all actors that connect to the Data Bus (DB) and to the local network that is linked to the Phasor Gateway.

2.2.3. Data Producer

This actor generalizes all actors that publish data.

2.2.3.1. Phasor Gateway (PG)

The Phasor Gateway is the sole access point to the DB for inter-organizational Synchro-Phasor traffic. It administers and disseminates cyber security and access rights. In addition, it monitors and maintains data integrity. The PG manages traffic format, timing compatibility and traffic priority according to the data's Service Classes.

Since the PG subscribes to the data from other endpoints and publishes the information on the NASPI Data Bus, it extends both the Data Producer and the Data Consumer actors.

For the purpose of clearly delineating the publishing and subscribing roles of the PG, we specialize this actor into S-PG (Subscribing Phasor Gateway) and P-PG (Publishing Phasor Gateway).

2.2.3.2. Phasor Data Concentrator (PDC)

A Phasor Data Concentrator correlates phasor data from a number of Phasor Measurement Units (PMUs) or PDCs and feeds it out as a single stream to other applications. The PDC correlates phasor data by time-tag to create a system-wide measurement set.

The PDC provides additional functions. It performs various quality checks on the phasor data and inserts appropriate flags into the correlated data stream. It checks disturbance flags and records files of data for analysis. It also monitors the overall measurement system and provides a number of specialized outputs, such as a direct interface to a SCADA system.

Since a PDC subscribes to the data from other applications on the network and it publishes the information on the NASPI Data Bus, it specializes both the Data Producer and the Data Consumer actors.

2.2.3.3. Intelligent Electronic Device (IED)

IEDs receive data from sensors and power equipment and can issue control commands, such as tripping circuit breakers if they sense voltage, current, frequency anomalies or raising/lowering voltage levels in order to maintain the desired level. Common types of IEDs include protective relaying devices, load tap changer controllers, circuit breaker controllers, capacitor bank switches, recloser controllers, voltage regulators, etc. Some recent IEDs are designed to support the IEC61850 standard for substation automation, which provides interoperability and advanced communications capabilities.

An IED specializes the Data Consumer actor.

2.2.3.4. Synchro-Phasor

A Phasor Measurement Unit (PMU) measures the electrical waves on an electricity grid to determine the health of the system. A phasor is a complex number that represents both the magnitude and phase angle of the sine waves found in electricity. Phasor measurements that occur at the same time are called a "Synchro-Phasor," as are the PMU devices that allow their measurement.

A PMU specializes the Data Producer actor.

2.2.3.5. Phasor Gateway Distributor

This a logical component of the PG that interfaces with the Data Bus to get streaming and historical PM data from NASPInet and distributes the data to the applications connected to the PG.

2.2.3.6. RTU

2.2.3.7. Historian

The Historian enables data archiving of SCADA systems for automation applications. It captures real-time information from various endpoints in the substation and provides open access to historical values for trending and real-time customized production reports. The Historian communicates with clients by means of the NASPI data bus.

Since the Historian subscribes to the data from other endpoints and publishes the information on the NASPI Data Bus via the PG, it specializes both the Data Producer and the Data Consumer actors.

2.2.4. Data Consumer (abstract)

This actor generalizes all actors that subscribe to data.

2.2.4.1. Phasor Gateway Ingest Service

This is a logical component of the PG that uses and interfaces with the DB services to consume streaming and historical PM data from devices (PMU, PDC, IED) connected to the PG into the DB. In other words, the DB services enable these data functions in the PG by interfacing with the PG Ingest Service component.

2.2.5. Network Data (abstract)

This abstract actor generalizes all the data that is published on the NASPI data bus and within the local networks. Not all data consumers (and producers) are created equal – different consumers subscribe to different classes of data; in practice we'll likely have consumers for each of the traffic classes (A-E).

Note: Classes of data do not make any implication on their relative priorities. For example, a class of data requiring low-latency does not necessarily imply dropping data that does not have similar latency needs. Classes of data are an indicator of what type of contract a publisher and subscriber have when exchanging data.

2.2.5.1. Class A Data

This data service class supports the needs of high-performance, feedback control applications. This class is characterized by very low latency and a fast data rate (e.g., 60 messages per second). Class A data shall be transmitted and received as quickly as possible with a high level of data availability (there shall be no data gaps). The data can be event driven or periodic.

2.2.5.2. Class B Data

This service class supports the needs of feed-forward control applications, such as state estimator enhancement. The latency requirement for Class B data is less strict than that for Class A data. High availability of the data is also required.

2.2.5.3. Class C Data

This class of data supports view-only applications such as visualization by power system operators. The tolerance for accuracy and latency for Class C data is less stringent than Class B data. The system shall enable end-user applications to retrieve data from many PMUs across a wide geographical area.

2.2.5.4. Class D Data

This service class supports the needs of post-mortem event analysis and other off-line studies. The system shall provide a high degree of data completeness and accuracy for this service class. However, latency of Class D data may be higher than Class A, B and C data since analysis of Class D data will generally be conducted offline (hours or days later) with archived data, as opposed to an online data stream.

2.2.5.5. Class E Data

Class E data primarily supports the needs for testing and Research and Development (R&D) applications. There are no guarantees on any attributes of this data class. Class E shall be given the lowest priority of all NASPInet data traffic.

2.2.6. NASPI Admin (abstract)

This actor generalizes all actors that perform administrative functions on NASPInet (PG Admin and Site Admin are not included under this actor, since they are within a utility/BA/ISO network).

2.2.6.1. PG Admin

The PG Admin manages access control for all operations related to the PG.

2.2.6.2. NASPInet Naming and Directory Service/Admin (NDS)

This is a NASPInet administrative service that registers and assigns names to devices/entities and signals available on NASPInet. It registers PGWs, PMU signals, etc. This registry is then used to support a directory service so users can find devices and signals available on NASPInet. Associated with NDS is an administrative entity.

2.2.6.3. NASPInet Security Service/Admin (SS)

This is a NAPSInet administrative service that provides key management, mediates trust establishment, enforces access control (to the network, to signals based on owner policy), etc. Access control may be enforced through distribution of appropriate cryptographic keys to authorized entities.

2.2.6.4. NASPInet Network and QoS Management Service/Admin (Replaces Instrumentation Services in the Spec) (NQMS)

This is a NASPInet administrative service that manages the Data Bus, specifically with respect to provisioning, performance and QoS.

2.3. Use Cases

2.3.1. Provide Security

2.3.1.1. Check Access Rights

NASPI Data Bus specifications have been designed with security as a top priority.

This use case encapsulates various access control-related use cases that are related to authentication and authorization. Even though security-related use cases are outside the scope of this document, we want to emphasize that in actual PG and DB systems, Cyber Security for these systems will be a significant part of the implementation.

All other use cases therefore include this use case. In this use case, the Admin verifies that the network entity has the desired security credentials to perform the operation.

1. NASPInet shall ensure that access to its resources, such as PGs and DB components/services, are highly secure, both physically and in cyber space. The security of NASPInet shall meet corresponding NERC CIP, FIPS, and other relevant cyber security standards/guidelines.
2. NASPInet shall limit data browsing capability to authorized subscribing PGs to minimize the risk of unauthorized access of the published data. Subscribers will be required to initiate the process of setting up a subscription by discovering available published data that they are allowed to access through data discovery requests, selecting the data to subscribe to, and making the formal subscription requests for the selected data.
3. Publishers shall respond to subscribers' data discovery requests and subscription requests by granting access rights to part or all of their published data based on the authenticated identities of the subscribers.

Actors

- Admin
- Network Entity

2.3.1.2. Provide Secure Data Transmission

The information assurance shall ensure the information confidentiality and integrity of the delivered data. To maintain data confidentiality between the publisher and subscribers, NASPInet shall be designed to prevent published data from being received and understood by non-subscribers.

Information integrity assurance measures shall be implemented for detecting and reporting any tampering and degradation of the exchanged data. This use case will also include preventing and detecting the spoofing of signals.

2.3.2. Manage Policies

2.3.2.1. Specify Resource (QoS) Policies

Devices and applications participating in the exchange of information over NASPInet will provide functions to configure their contract (Quality of Service) for exchanging data. The contract includes promising data transmission characteristics such as reliability, durability, transmission rates, and security. This use case also covers the following cases:

1. Specify security policies
2. Modify policies for existing subscriptions

2.3.3. Register a Signal

2.3.3.1. Create Registration

In this use case, the owner of an endpoint such as a PGW or PMU registers it with the NASPInet NDS. Similarly, signals available for sharing on NASPInet are also registered. The NDS ensures that the endpoint is authorized to participate in the NASPInet community. It then assigns it a unique ID (we assume it will be 128 bits) and establishes appropriate security context, i.e., issue keys, etc.

Actors

- NDS Admin, SS Admin
- PG Admin
- Phasor Gateway Ingest Service
- Phasor Gateway Distributor
- PMU
- PDC
- IED
- Historian

Specializes Use Case

- Manage Discovery

2.3.3.2. Modify Registration

This use case notifies the admin that some information pertinent to the endpoint participating in the NASPInet community has changed.

Specializes Use Case

- Manage Discovery

2.3.3.3. Remove Registration

This use case notifies the Admin hat the endpoint participating in the NASPInet community is no longer connected.

Specializes Use Case

- Manage Discovery

2.3.3.4. Register PG with Data Bus

This use case enables the PG Admin to register a PG with the DB, i.e., with NDS. A PG must register before it can publish or subscribe to data on the DB and NASPInet.

2.3.3.5. Update PG Registration

The PG administrator shall be able to update the registration of a previously registered PG to accurately inform NASPInet about changes in the PG's functionalities and capabilities.

2.3.3.6. Remove PG Registration

This use case will enable the PG Administrator to remove a registered PG from NASPInet at any time.

2.3.3.7. Register Historical Data Source

This use case will enable historical data sources (HDS) to register themselves on the DB in order to publish their data to NASPInet via a PG. Any HDS that supplies data to NASPInet subscribers shall be registered through the HDS owner's PG.

This use case covers both automatic and interactive registrations.

2.3.3.8. Update Historical Data Source

The PG shall include an administration function to allow the update of changes in the configuration and/or available historical data-points of an existing registered HDS device or system that is currently publishing historical data to the NASPInet. For example, it shall be possible to add or delete HDS stored data-points, resulting in the PG supplying more or fewer historical data-points to the NASPInet.

2.3.3.9. Remove Historical Data Source

This use case allows one or more registered and communicating HDS devices to be taken off-line in a planned and orderly manner for various reasons, such as testing, software upgrade, or other maintenance activities. No historical data shall be published from HDS systems/devices that are off-line.

2.3.3.10. Register Real-Time Streaming Data Source with PG

All real-time, streaming data sources (RT-SDS) that will serve as streaming data sources through the NASPInet Data Bus must be connected to and registered with a PG that is registered with NASPInet. This use case does NOT depend on the PG being registered first with the DB.

This use case covers all the requirements for both interactive and automatic registrations.

2.3.3.11. Update Real-Time Streaming Data Source with PG

The PG shall include an administration function to change the configuration of an existing registered RT-SDS device or system that is currently publishing streaming data to the NASPInet. For example, it shall be possible to update the registration of a Phasor Data Concentrator (PDC) when PMUs are added or removed from the PDC, resulting in the PDC supplying more or fewer signals to the NASPInet.

2.3.3.12. Remove Real-Time Streaming Data Source from PG

The system shall allow one or more registered and communicating RT-SDS devices to be taken offline in a planned and orderly manner for various reasons, such as testing, firmware upgrade, or other maintenance activities. No real-time streaming data will be published from phasor measurement devices that are offline.

2.3.4. Subscribe to a Signal

2.3.4.1. Manage Discovery

Discovery is the process in which network endpoints—PG, PMU, IED, RTU, other applications on different nodes—find out about each other. Manage Discovery is an abstract use case that is extended and specialized by Register, Modify, and Disconnect use cases.

1. NASPInet shall provide a Name & Directory Service (NDS) for its publish/subscribe mechanism, uniquely identifying each and every registered signal across the entire NASPInet. The NASPInet NDS shall also support PG registration and PG discovery for all PGs connected to the NASPInet DB. The NASPInet NDS shall be provided through DB NDS and PG device-management functionality.
2. The NASPInet NDS shall enable publishers to register devices/applications and the associated signals for data publishing before their data can be published to NASPInet.
3. The NASPInet NDS shall enable subscribers to discover any accessible data that they could select and subscribe to.
4. NASPInet shall provide means for setting up subscriptions between a publisher and a subscriber for its publish/subscribe mechanism. The means shall include accessible signal discovery, subscription request, and subscription setup mechanisms.
5. NASPInet shall enable the system-wide registry of Phasor Gateways, Phasor Measurement Units, Phasor Data Concentrators, and IED devices and their associated signals as well as the services, components, processes and other entities required by the Phasor Gateway and/or Data Bus components.
6. NASPInet shall enable unique identification of any registered signal across the entire NASPInet on an individual signal basis.
7. NASPInet shall enable discovery of accessible devices/applications/signals.
8. NASPInet shall allow the concurrent use of different naming conventions in different utility networks. The naming convention will be uniform on the DB side of NASPInet.
9. NASPInet shall provide a basis for resource management, subscription management, and traffic management.

10. NASPInet shall be based on metadata storage and retrieval systems to provide flexible and expandable metadata storage and retrieval capabilities. The number of fields and the size of each field of a metadata record and the total storage capacity shall all be adjustable and expandable.
11. NASPInet shall provide unique IDs for each and every registered item. The ID shall be a 128-bit random number.
12. NASPInet shall work in concert with NASPInet Security Service and PG Security Component to enable registered PGs to discover accessible signals by sending request to DB. NDS shall authenticate a requesting PG's identity, granting access rights by source data owners, and provide accessible signal information to requesting PGs.
13. NASPInet shall not provide general browsing of all registered signals to minimize the risk of unauthorized access to registered signals, regardless whether the request is from registered PGs or unknown/unauthorized devices/applications.
14. The NASPInet naming convention may include PG-OWNER's existing naming convention, NASPInet global naming convention (to be developed), and other naming conventions.

Actors

- Historian
- Intelligent Electronic Device (IED)
- NASPI Data Bus
- Network Entities
- Phasor Data Collector (PDC)
- Phasor Gateway (PG)
- Phasor Measurement Unit (PMU)

Included Use Cases

- Check Access Rights

2.3.4.2. Match Producers and Consumers

This use case enables endpoints to subscribe to available data streams.

This use case assumes that all end points on the NASPInet will be uniquely identified by using a 128-bit ID.

Specializes Use Case

- Manage Data Flow

2.3.4.3. Subscribe to Historical Data

This use case enables the S-PG to allow an authorized user or application to request a block of historical data from a P-PG via the DB.

SYS-16. Historical data shall be delivered through NASPInet only on a one-publisher-to-one-subscriber basis. NASPInet shall deliver the historical data to subscribers as a self-sufficient data block, including appropriate configuration information of

the data (measurement devices, measured items, time period, data points, data format, etc.). NASPInet shall transport the historical data in a format that can be output by the data source as is – i.e., it will be up to the requesting application to transform and load the data.

2.3.4.4. Unsubscribe from Historical Data

The P-PG or the S-PG shall be able to cancel a request for historical data at any time.

2.3.4.5. Subscribe Streaming Data Sources

1. NASPInet shall support the real-time streaming data exchange on a real-time basis, which typically must meet very strict QoS requirements for each class of real-time streaming data. The real-time streaming data shall, at a minimum, be able to be delivered on a frame-by-frame basis.
2. The real-time streaming data may be subscribed to in both one-publisher-to-one-subscriber and one-publisher-to-many-subscribers scenarios. NASPInet shall be able to deliver real-time streaming data in both scenarios.

2.3.4.6. Subscribe to a Real-Time Data Stream

This use case will enable the S-PG and S-PG administrator to subscribe to real-time data streams that are available to it from NASPInet publishers (P-PGs). The S-PG and S-PG administrator shall first use the browse function to discover the available signals and obtain detailed information about the available signals.

This use case covers both subscribing to and receiving real-time data streams.

2.3.4.7. Unsubscribe to a Real-Time Data Stream

This use case covers both stopping and unsubscribing from the real-time data stream

Both S-PG and P-PG shall be able to terminate an RT data subscription. This procedure assumes there is already a data subscription in place between the two PGs.

2.3.4.8. Manage Registration of Signal with PG

PG-18. The PG shall provide GUIs and functions for registering devices/applications with this PG that are external to NASPInet, such as PMUs, PDCs, phasor applications, etc., either manually by the PG administrator or automatically by responding to a device/application's registration request.

PG-19. The PG shall provide GUIs and functions for the PG administrator to setup the PG for automatic external devices/applications registration (such as assign/setup device/application ID, enter key information of a device/application for authentication, etc.), so that it will be able to respond to a device/application's registration request directly.

PG-20. The PG shall provide GUIs and functions for updating device/application's registration information with this PG for registered devices/applications interactively by PG administrator. Registration information update shall include the status update of external device/application, such as from "online" to "offline."

PG-21. The PG shall provide functions for updating a device/application's registration information with this PG for registered devices/applications automatically by responding to device/application's registration request. The registration information update shall include the status update of the external device/application, such as from "online" to "offline." The PG shall provide GUIs and functions to allow PG administrators to configure the automated registration updating function.

PG-22. The PG shall provide GUIs and functions that allow the PG Administrator to interactively cancel a device/application's registration with this PG, for any registered device/application. Cancellation shall be used for removing a device/application that is permanently out of service.

PG-23. Register device/application with DB manually: PG shall provide GUIs and functions for registering a device/application with DB NDS that have been registered with this PG manually by PG administrator upon the completion of device/application's registration with this PG. The registration process shall include sending a registration request to the DB NDS, supplying registration metadata to DB NDS, receiving and storing the assigned device/application ID and signals IDs for the device/application, and confirming the successful completion of the registration process.

PG-24. Register device/application with DB automatically: The PG shall provide functions for automatically registering a device/application with the DB NDS that have been registered with this PG by initiating the DB NDS registration process immediately upon the completion of device/application's registration with this PG. The registration process shall include sending a registration request to the DB NDS, supplying registration metadata to the DB NDS, receiving and storing assigned device/application ID and signals IDs for the device/application, and confirming the successful completion of the registration process. The PG shall provide GUIs and functions for PG administrators to configure the automated functions for registering a device/application with the DB.

PG-25. Update device/application registration with DB manually: The PG shall provide GUIs and functions for updating a device/application's registration with the DB NDS that have been manually registered with the DB NDS by the PG administrator. The updating process shall include sending updating a request to the DB NDS, supplying updated registration metadata to the DB NDS, receiving and storing updated device/application ID and signal IDs for the device/application, and confirming the successful completion of the registration updating process. The registration information update shall include the status update of the external device/application, such as from "online" to "offline."

PG-26. Update device/application registration with DB automatically: The PG shall provide GUIs and functions for updating a device/application's registration with the DB NDS that have been automatically registered with the DB NDS by initiating the corresponding updating process immediately upon the completion of the device/application's updating with this PG. The updating process shall include sending updating a request to the DB NDS, supplying updated registration metadata to the DB NDS, receiving and storing updated device/application ID and signal IDs for the device/application, and confirming

the successful completion of the registration updating process. The registration information update shall include the status update of the external device/application, such as from "online" to "offline." The PG shall provide GUIs and functions for PG administrators to configure the automated functions for updating a device/application's registration with the DB.

PG-27. Cancel device/application registration with DB manually: The PG shall provide GUIs and functions for canceling a device/application's registration with the DB NDS that have been manually registered with the DB NDS by the PG administrator. The canceling process shall include sending canceling a request to the DB NDS, confirming its intention to cancel the registration to the DB NDS, and acknowledging the receipt of the DB NDS' confirmation of the registration cancellation. Cancellation shall be used for removing a device/application that is permanently out of service.

PG-28. The PG shall provide secure, local storage for storing the registration metadata for devices/applications registered with this PG. The stored metadata shall include if the device/application has been registered with the DB NDS, and the assigned device/application ID and signal IDs if the device/application is already registered with the DB NDS.

PG-29. The PG shall provide functions for logging the status of devices/applications it has registered.

PG-30. The PG shall provide functions for automatically sending the device/application's status to the DB NDS for devices/applications registered with the DB NDS each time a status change occurs.

PG-31. The PG shall provide a function to respond to a DB's status query for any device/application that is registered with the DB NDS with its current status.

2.3.5. Exchange a Signal

2.3.5.1. Provide QoS Conformance

This use case alerts the administrator when the endpoints that are participating in a data exchange fail to conform to the use case.

2.3.5.2. Manage Data Flow

This abstract use case enables endpoints to manage connections to available data streams (*e.g.*, create, modify, or delete them). It is ensures that the endpoint has the security credentials to subscribe to the data stream.

1. The data flows shall support both one-to-one and one-to-many subscription scenarios.
2. NASPInet shall support the simultaneous data exchange of multiple subscriptions with different data service classes; each has its own QoS requirements. NASPInet shall guarantee the data exchange of each subscription meeting its QoS requirements under normal operating conditions, while facilitating the data exchange of multiple subscriptions with different data service classes through network traffic management.

3. NASPInet shall implement QoS assurance based on the NASPInet resource management mechanism. This mechanism shall include resource condition monitoring, resource usage monitoring, QoS performance monitoring, QoS provisioning, and traffic management. NASPInet resources include PGs, DB components/services, and NASPInet data network components.
4. NASPInet shall provide a QoS provisioning mechanism during the new subscription setup process. This mechanism shall enable NASPInet to determine, once setup, if the QoS requirements of the new subscription could be satisfied based on the resource status, resource usage, and QoS performance of existing subscriptions and external publishing sources.
5. NASPInet shall provide a traffic management mechanism for QoS assurance under both normal and abnormal system conditions based on the traffic prioritization of different data service classes. NASPInet shall support data delivery based on the priority traffic-levels, i.e. higher-priority traffic shall always be delivered/processed before lower-priority ones.
6. NASPInet shall provide a means for setting the desired priorities of different types of traffic, such as the priorities for different classes of data services, subscription requests/responses messages, network management traffic, control signals, etc.
7. The traffic management shall also provide a means for setting NASPInet traffic-management policies for dealing with various normal and abnormal system conditions. NASPInet shall be able to control the traffic based on the traffic-management policies, resource availability, resource usage levels, and actual QoS performance measurement.

Actors

- Phasor Gateway Ingest Service
- Phasor Gateway Distributor
- PMU
- PDC
- IED
- Historian

Depends on Use Case

- Manage Discovery - Data connections can only be established among participants that have already been discovered.

Included Use Cases

- Check Access Rights

2.3.5.3. Browse Historical Data Sources

This use case will enable its user/application/subscriber to initiate a browse to determine the availability of historical data available via NASPInet.

2.3.5.4. Browse Streaming Data Sources

This use case enables a user/application/subscriber to browse the NDS regarding the active, registered RT-SDS devices/systems on NASPInet to determine what streaming data is available for access. Only subscribing PGs (S-PG) currently registered with the NASPInet DB NDS shall be able to browse the NDS regarding active, real-time, streaming data sources. The S-PG shall be able to use the data obtained via the browsing process to select the proper signals for subscription.

The use case is a generalization of the following two cases:

- Interactive browsing of P-PGs for Available RT-SDS Signals
- Automated browsing of P-PGs for Available RT-SDS Signals

2.3.5.5. Pause Receipt of Historical Data

When historical data is being transmitted from a P-PG to an S-PG, either the PG or the DB shall be able to pause the receipt of data.

2.3.5.6. Resume Receipt of Historical Data

After the transmission of historical data has been paused during transfer from a P-PG to an S-PG, the S-PG (or DB) shall be able to resume the data transmission.

2.3.6. Monitor a Network

2.3.6.1. Monitor NASPInet

1. NASPInet resource-condition monitoring shall provide both real-time and historical resource-condition information for each resource, including logging, reporting and alarming. NASPInet resource condition monitoring shall be able to detect and report any failure and out-of-service conditions for any of its resources.
2. NASPInet resource-usage monitoring shall provide both real-time and historical resource-usage information on each resource through resource-usage tracking, logging, reporting and alarming. The resource-usage tracking shall include all resources that are involved in the data-delivery chain, from data entering NASPInet to data leaving NASPInet.
3. The resource-usage information tracked, logged and reported shall include, but not be limited to, detailed loading information (instant, peak, and average) of each resource, for each class of the data services.
4. NASPInet resource-usage monitoring shall allow setting of alarm thresholds and generate alarms whenever tracked usage exceeds the threshold(s).
5. NASPInet QoS-performance monitoring shall enable end-to-end QoS-performance monitoring on a per subscription basis. NASPInet QoS-performance monitoring shall provide both real-time and historical QoS information on a per subscription basis through measurement, logging, reporting and alarming.

6. NASPInet shall also provide statistical QoS information for the entire NASPInet, using the logged per-subscription QoS information. The QoS information to be measured and logged shall include, but not be limited to, latency (maximum and average), successful delivery rate, etc.
7. NASPInet shall provide accurate timing-references for measuring the delivery latency for each subscription. NASPInet QoS-performance monitoring shall also include the QoS-performance monitoring of incoming data from registered, publishing PGs.
8. For auditing purposes, NASPInet shall log all user activities (e.g., access requests and the outcome of each request), system-administration activities (e.g., data-source registration and connection, a PG's DB access-requests and outcome), data subscription-related activities (e.g., subscription requests and outcome), QoS alerts, cyber-security alerts, application errors, etc. Each record shall be time-stamped and securely stored.
9. The PG shall allow the PG administrator to generate reports from the log or export data from the log to a common data-format, such as Excel.
10. The DB components shall allow their administrators to generate reports from the log or export data from the log to a common data-format, such as Excel.
11. NASPInet shall maintain accurate audit trails of all NASPInet activities, such as user activities, system administration activities, and data subscription and delivery activities.

2.3.6.2. Detect IT Failures

Networking and IT failures can happen for many reasons: network failures, ACK storms, bugs, cyber attacks, peak loads, etc. Just as the grid needs to be monitored for failures, the NASPInet DB will provide capability that can infer some of the common issues associated with distributed systems, including, but not limited to:

- Detecting slow producers & consumers
- Detecting faulty NIC cards (retransmissions, etc.)
- Detecting ACK storms
- Detecting incompatible system organization
- Detecting issues related to system resource usage
- Integrating with third-party products to detect cyber attacks

2.3.6.3. React to Link Failure

It is not possible to recover in time to from all types of IT failures. For some failures, such as subsets of cyber attacks, system resource usage, and ACK storms, it is possible to detect these events sufficiently in advance to prevent the entire system from getting compromised. This could involve isolating the offending nodes, correcting the contracts between publishers and subscribers, or sending real-time alerts to operators.

2.3.6.4. Provide PG status

PG-16. The PG shall provide a function to respond to a DB status query with its current status.

PG-17. The PG shall provide functions to log its interactions with other PGs and DB components/services. Logged information shall be stored locally and securely. Logged information shall not be editable by anyone, including the PG administrator, but shall be able to be copied and exported by the PG administrator.

2.3.6.5. Adaptable Network

1. NASPInet shall be able to tolerate certain levels of system degradation, such as a single component failure, and shall provide an emergency traffic-management mechanism to sustain the best level of data exchange under degraded system conditions.
2. NASPInet shall be flexible and expandable to support a gradual system expansion in a phased implementation approach.
3. It is highly desirable that NASPInet is designed and implemented in an architecture framework that would provide for additional synchro-phasor data service-classes in the future.
4. It is also highly desirable that NASPInet is designed and implemented in an architecture framework that would support non-synchro-phasor data exchange and non-synchro-phasor data service-classes in the future, such as fault-record data, non-electrical data (weather forecast data, video streams, etc.), through its publish/subscribe mechanism.
5. The design and implementation of NASPInet shall provide the flexibility and expandability needed to support incremental deployment.
6. The design and implementation of the DB shall allow it to gradually increase the capacities of its various components and services to support a gradually increasing number of PGs connected to it, the publishing devices (e.g., PMUs, PDCs) connected to publishing PGs, and the subscribing devices/applications connected to subscribing PGs.
7. The design and implementation of the PG shall facilitate customization and configuration to support different data publishing and subscription capabilities of each PG.
8. The design and implementation of the PG shall allow expansion from initial limited data publishing and subscription capabilities to the full capabilities described in these specifications.
9. The design and implementation of the PG shall enable the increase of the processing capacity for each class of data that it supports when needed.
10. The NASPInet WAN design and implementation shall support incremental growth in the NAPSInet deployment process.

2.3.7. Interoperate

2.3.7.1. Exchange Signals Across Different Networks and Applications

Producers and Consumers will be able to exchange signals across subnets with different characteristics. The interoperability will include exchanging data across:

- Ethernet, ATM, WiMax
- UDP, TCP, STCP
- Wire protocols (RTPS, X37.118…)
- Message formats (61850, C37.118, GOOSE, DDS, ..)
- Operating Systems
- Programming Languages (C, C++, Java, .NET, Python, Perl)

3. Mapping to NASPInet Specifications

Use Case	Specification Number
Check Access Rights	SYS-7,17,18,48-50,DB-143-152,PG-211-221
Provide Secure Data Transmission	SYS-24,25,51,54-58,71,DB-142,153-154,PG-222-226
Prevent and Detect spoofing of signals	PG-10-14,205-210
Adaptable Network	SYS-6,8,11,12,63-68,74,DB-75-77,80
Create Registration	SYS-3,DB-10-15,19-31
Modify Registration	SYS-88-96
Remove Registration	SYS-97-102
Register PG with Data Bus	SYS-77-87,PG-9
Update PG Registration	SYS-88-96,PG-15
Remove PG Registration	SYS-97-102
Register Historical Data Source	SYS-144-163
Update Historical Data Source	SYS-164-177
Remove Historical Data Source	SYS-178-184
Register a Real-Time Streaming Data Source with PG	SYS-103-120
Update a Real-Time Streaming Data Source with PG	SYS-121-136
Remove a Real-Time Streaming Data Source from PG	SYS-137-143

Use Case	Specification Number
Manage Discovery	SYS-19-22,26-35
Match Producers and Consumers	SYS-3
Subscribe to Historical Data	SYS-16,258-271
Unsubscribe from Historical Data	SYS-291-298
Subscribe Streaming Data Sources	SYS-13,14
Subscribe to a Real-Time Data Stream	SYS-13,14,201-215
Unsubscribe Real-Time Data Stream	SYS-216-241
Manage Registration of Signal with PG	PG-18-31
Provide QoS Conformance	SYS-5,DB-81
Manage Data Flow	SYS-2,4,36,44-47,DB-32-74
Browse Historical Data Sources	SYS-242-257
Browse Streaming Data Sources	SYS-185-200
Pause Receipt of Historical Data	SYS-272-283
Resume Receipt of Historical Data	SYS-284-290
Monitor NASPInet	SYS-37-43,52-53,59-62,75,DB-155
Monitor and Detect policy violations	PG-130-164
Collect data for post-event	PG-227-234
React to link failure	PG-198-204
Provide PG status	PG-16-17
Manage PG users	PG-32-41

4. Revision History

Author	Date	Comments
supreet@rti.com	Sept 28, 2009	Created
supreet@rti.com	Sept 30, 2009	Incorporated feedback from rick@rti.com
supreet@rti.com	Oct 1, 2009	Incorporated feedback from daveanderson@wsu.edu
supreet@rti.com	Oct 2, 2009	Incorporated feedback from david.mckinnon@pnl.gov
supreet@rti.com	Nov 15 – Dec 6, 2009	Collected, in series of meetings, feedback from Dave Bakken, Dave Anderson, John Gillerman, David McKinnon, Kris Koellner, Matt Donnelly
rbobba@illinois.edu	Jan 10 2010	Added more details on NASPInet admin actors getting them inline with the spec.
supreet@rti.com	Jan 28, 2010	Incorporated feedback from johng@sisconet.com. Incorporated feedback from the use-case meeting held on Dec 22, 2009