Multi-Tenant Meter Data Management

A Systems Approach to Hierarchical Value

FINAL REPORT | MAY 31, 2014

NRECA
A Touchstone Energy® Cooperative
CRN
Cooperative Research Network

NRECA-DOE SMART GRID DEMONSTRATION PROJECT | DE-OE0000222

Multi-Tenant Meter Data Management

A Systems Approach to Hierarchical Value

FINAL REPORT | MAY 31, 2014

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The National Rural Electric Cooperative Association

NRECA is the national service organization for more than 900 not-for-profit rural electric cooperatives and public power districts providing retail electric service to more than 42 million consumers in 47 states and whose retail sales account for approximately 12 percent of total electricity sales in the United States.

NRECA's members include consumer-owned local distribution systems — the vast majority — and 66 generation and transmission (G&T) cooperatives that supply wholesale power to their distribution cooperative owner-members. Distribution and G&T cooperatives share an obligation to serve their members by providing safe, reliable and affordable electric service.

About CRN

NRECA's Cooperative Research Network™ (CRN) manages an extensive network of organizations and partners in order to conduct collaborative research for electric cooperatives. CRN is a catalyst for innovative and practical technology solutions for emerging industry issues by leading and facilitating collaborative research with co-ops, industry, universities, labs, and federal agencies.

CRN fosters and communicates technical advances and business improvements to help electric cooperatives control costs, increase productivity, and enhance service to their consumer-members. CRN products, services and technology surveillance address strategic issues in the areas:

- Cyber Security
- Consumer Energy Solutions
- Generation & Environment
- Grid Analytics
- Next Generation Networks
- Renewables
- Resiliency
- Smart Grid

CRN research is directed by member advisors drawn from the more than 900 private, not-for-profit, consumer-owned cooperatives who are members of NRECA.

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Table of Contents

Page

Foreword ii
Introduction 1
  Research Questions 1
  Important Findings 1
NRECA Overview 2
Cooperative Background 2
Methodology 3
Detailed Results 4
  What needs does an MT-MDMS meet for each of its tenants? 4
  What are the functional and technical requirements necessary to meet those needs? 5
    Virtual Metering 5
    Central Data Warehousing 9
  What is the potential value of an MT-MDMS to the electric power industry? 9
    Secure, Real-Time Information Sharing 9
    Bidding Demand Response and Other Storage Resources into MISO 9
    Monitoring Line Losses and Power Theft 9
    Load Forecasting 10
  What are the barriers to the creation and adoption of this technology? 10
  What role did the SGDP play in accelerating the development of this technology? 11
Conclusions 11
Appendix A: Detailed Functional and Technical Requirements A-1

List of Figures

Page

Figure 1. GRE Member Cooperatives 3
Figure 2. Vertical Aggregation Sums Meters with Logical Hierarchy 6
Figure 3. Horizontal Aggregation Sums Meters with Similar Attributes 7
Figure 4. If-Then Aggregation Logic 8

List of Tables

Page

Table 1. Great River Energy's MT-MDMS project goals as described in the RFP. 4

FOREWORD

The National Rural Electric Cooperative Association (NRECA) has organized the NRECA-U.S. Department of Energy (DOE) Smart Grid Demonstration Project (DE-OE0000222) to install and study a broad range of advanced Smart Grid technologies in a demonstration that involved 23 electric cooperatives in 12 states. For purposes of evaluation, the technologies deployed have been classified into three major sub-classes, each consisting of four technology types.

Enabling Technologies:	Advanced Metering Infrastructure Meter Data Management Systems Telecommunications Supervisory Control and Data Acquisition
Demand Response:	In-Home Displays & Web Portals Demand Response Over AMI Prepaid Metering Interactive Thermal Storage
Distribution Automation:	Renewables Integration Smart Feeder Switching Advanced Volt/VAR Control Conservation Voltage Reduction

To demonstrate the value of implementing the Smart Grid, NRECA has prepared a series of single-topic studies to evaluate the merits of project activities. The study designs have been developed jointly by NRECA and DOE. This document is the final report on one of those topics.

INTRODUCTION

Cooperatives cooperate, and sometimes this means innovating to enable such cooperation. As part of the Smart Grid Demonstration Project (SGDP), Great River Energy (GRE), Lake Region Electric Cooperative (LREC), Minnesota Valley Electric Cooperative (MVEC), and National Information Solutions Cooperative (NISC) have come together to create a secure information-sharing framework that allows cooperatives within GRE's service area to cooperate, collaborate, and coordinate with more agility than previously possible. Leveraging this system, the cooperatives achieve many of the benefits and economies of scale, while also maintaining local control.

Research Questions

1. What needs does a multi-tenant meter data management system (MT-MDMS) meet for each of its tenants?
2. What are the functional and technical requirements necessary to meet those needs?
3. What is the potential value of an MT-MDMS to the broader industry (utilities, ISOs, research consortiums, owner-members)?
4. What are the barriers to the creation and adoption of this technology?
5. What role did the SGDP play in accelerating the development of this technology?

Important Findings

1. A defining feature of an MT-MDMS is the ability to aggregate data programmatically into "virtual meters" and share those data across organizations.
2. Information security—specifically, flexible, role-based access controls—is the most critical enabling feature for making an MT-MDMS viable.
3. The role-based information security framework opens the door to offering appropriate meter data access to other industry stakeholders.
4. The necessity of writing custom interfaces to other utility data systems is a significant cost and delay driver for an MT-MDMS, and it contributes to implementation delay.
5. This technology was enhanced by the DOE NRECA Smart Grid Demonstration.

NRECA OVERVIEW

NRECA received a $34 million Smart Grid Demonstration research grant from the U.S. Department of Energy (DOE). The resultant project, coordinated by NRECA's Cooperative Research Network (CRN), purchased the necessary equipment on behalf of NRECA's participating member cooperatives. Twenty-three of NRECA's member electric cooperatives embarked on a unique, nationwide demonstration project, deploying more than 250,000 smart grid components across the country to test the value of the new technologies for cooperative consumer members.

CRN and the participating electric cooperatives are evaluating the potential benefits of new technologies that could help increase operational efficiencies and improve electric service.

COOPERATIVE BACKGROUND

Great River Energy (GRE) is a not-for-profit electric cooperative owned by its 28 member cooperatives. GRE generates and transmits electricity for members located in the outer-ring suburbs of Minneapolis-St. Paul, Minnesota, up to the Arrowhead region of Minnesota and down to the farmland region in the southwestern portion of the state. Collectively, GRE's member cooperatives serve nearly 645,000 member-consumers.

The RFP discussed in this study concerns a procurement of an MDMS for GRE and two of its distribution member cooperatives: Lake Region Electric Cooperative (LREC) and Minnesota Valley Electric Cooperative (MVEC) (circled in **Figure 1**).

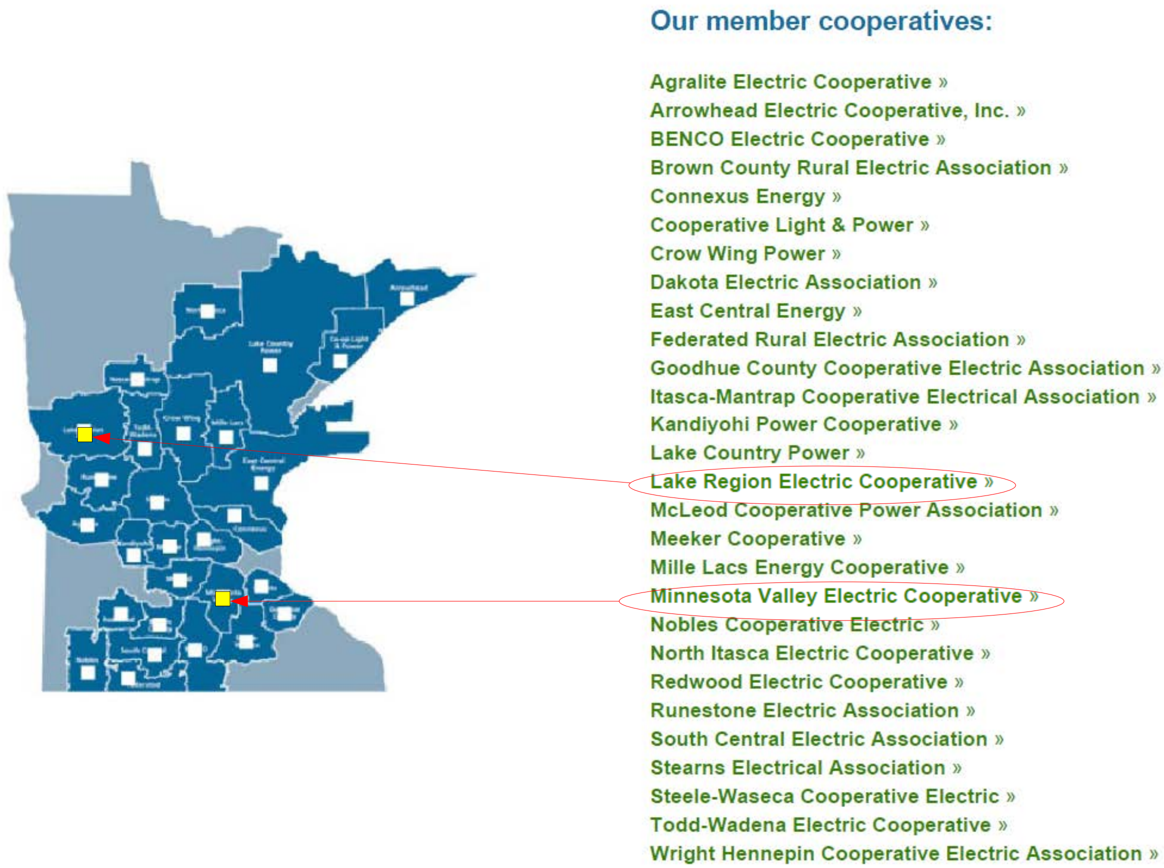


Figure 1. GRE Member Cooperatives

LREC provides retail electricity to more than 26,000 member-consumers. It has more than 31,300 advanced meter infrastructure (AMI) meters over a 3,200 square-mile service territory. Located in the west-central portion of Minnesota, LREC is a non-profit electric cooperative dedicated to providing power and opportunity to the areas it serves.

MVEC is an electric power distributor headquartered in Jordan, Minnesota. MVEC distributes electricity to 34,000 member-owners across nine counties in Minnesota: Blue Earth, Carver, Dakota, Hennepin, Le Sueur, Rice, Scott, Sibley, and Waseca.

METHODOLOGY

This study was conducted by examining the MT-MDMS specification and the correspondence between GRE and NISC during the procurement process to determine the system requirements and identify barriers to development and adoption. This was augmented with interviews with expert staff at NISC and GRE, so as to better understand the challenges, as well as the value, of an MT-MDMS.

DETAILED RESULTS

What needs does an MT-MDMS meet for each of its tenants?

In the procurement documents for the MT-MDMS, Great River Energy described its needs for the system.

Table 1. Great River Energy's MT-MDMS project goals as described in the RFP.

Project Goals

The purpose of this project is to demonstrate if a multi-tenant demand response and meter data management architecture will provide an economical solution for creating a comprehensive next- generation demand response environment in which cooperative members and renewable resources may interact with wholesale market prices.

This project represents the collaborative effort of three companies: Minnesota Valley Electric Cooperative (distribution cooperative), Lake Region Electric Cooperative (distribution cooperative), and Great River Energy (generation and transmission (G&T) cooperative).

GRE and its member systems currently operate an industry-leading load management program. The program is managed centrally by GRE and generally utilizes one- and two-way communications to load management receivers controlling air conditioning, space heating, water heating, irrigation, commercial/industrial, and electric-thermal storage. Changes in technologies and regulations are providing an impetus to develop the next-generation load management environment. Supporting the next-generation load management environment will require gathering data at several levels across the organizations and throughout each organization. GRE desires to evaluate a meter data management system's capability to efficiently gather and represent these data in a meaningful way.

To accomplish this goal, Great River Energy will implement the following technologies:

- Multi-tenant Meter Data Management (MDM) system
- Multi-tenant Demand Response Management (DRM) system

This next-generation demand response environment will enable the following objectives to be achieved:

1. Prove a functional and economic framework for a multi-tenant DRM and MDM environment in which multiple AMI systems will be integrated into the selected MDM.
2. Prove a security framework for multi-tenant DRM and MDM environment.

The system shall:

- Support approximately 80,000 physical metering endpoints across three individual organizations and 5,000 virtual meters
- Integrate metering data from multiple AMI systems
- Perform Validation, Editing, and Estimation (VEE) on metering data
- Support Complex Billing determinants utilizing interval data
- Aggregate meter data and apply logic to adjust meter data
- Sum meter data to a common interval (totalization)
- Create event markers on end-user meters, substations, distribution cooperatives, G&Ts, or wholesale market point
- Perform Data Analytics on input data for various operational, business, and billing purposes
- Present energy consumption information to end consumers
- An objective of this deployment is to demonstrate a multi-tenant system that will provide the following capabilities:
  - Logically partition metering data for G&T and member distribution cooperatives
  - Maintain data privacy and security
  - Grant full and/or limited access to meters and their related attributes to other organization(s) utilizing role-based permissions
  - Exist as an off-premise (hosted by vendor) or on-premise (utility-hosted) solution

Of these requirements for the system, the last four are the defining characteristics of an MT-MDMS.

What are the functional and technical requirements necessary to meet those needs?

GRE developed a detailed specification for the functional and technical requirements for the Multi-Tenant Meter Data Management and Demand Response Systems, found in Appendix A of this report, along with NISC's comments on those requirements. However, now that the system has been delivered and is starting to be used, two features stand out as being particularly important in making this multi-tenant environment work: virtual metering and secure data warehousing.

Virtual Metering

The MT-MDMS allows for the definition of "virtual meters." A virtual meter is a selective aggregation or "roll up" of a subset of the meters in the system, which then may be viewed, shared, and analyzed as if they were a single physical meter. This selection need not be a static list: the virtual meter is defined programmatically, according to meter attributes in the system. Those attributes include the distribution utility, rate class, substation, and participation in a particular program (e.g., demand response).

Virtual meters can be used for vertical aggregation, to sum up the usage for a distribution cooperative.

Vertical Aggregation

Figure 2 depicts vertical aggregation needs to sum meters with logical hierarchy. The example uses a cooperative and the substations serving that cooperative's load as the logical hierarchy. Summing the substation meters serving a cooperative's load creates a virtual meter point for the cooperative.

See functional and technical requirements 17 through 25 and 43 through 44 in Appendix A.

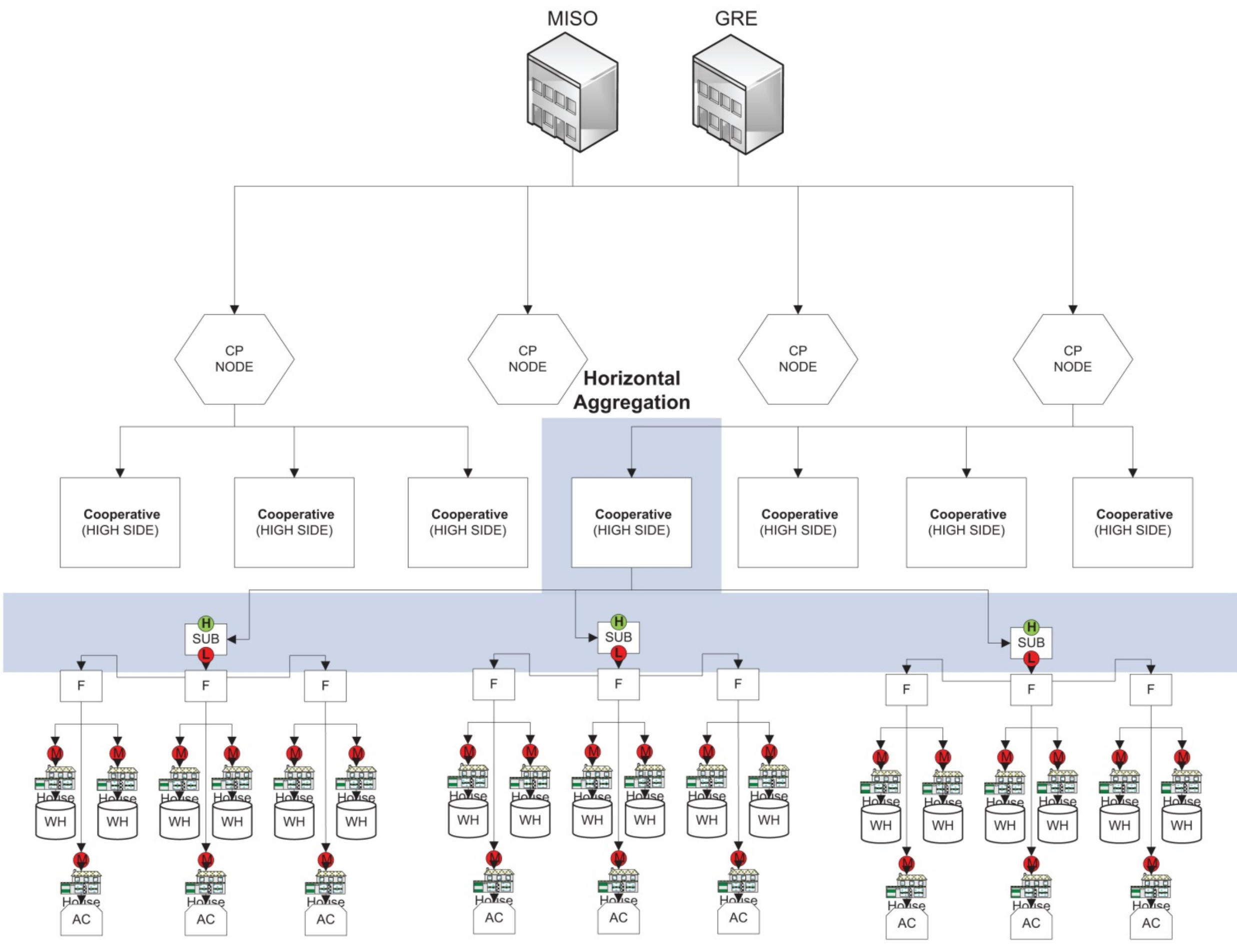


Figure 2. Vertical Aggregation Sums Meters with Logical Hierarchy

Virtual meters also can be used for horizontal aggregation, summing meters with certain attributes across utilities.

Horizontal Aggregation

Figure 3 depicts horizontal aggregation needs to sum meters with similar attributes. The example uses demand response programs as the key attribute by which to aggregate. All accounts with a controlled water heater are aggregated to a single virtual meter.

See functional and technical requirements 17 through 25 and 43 through 44 in Appendix A.

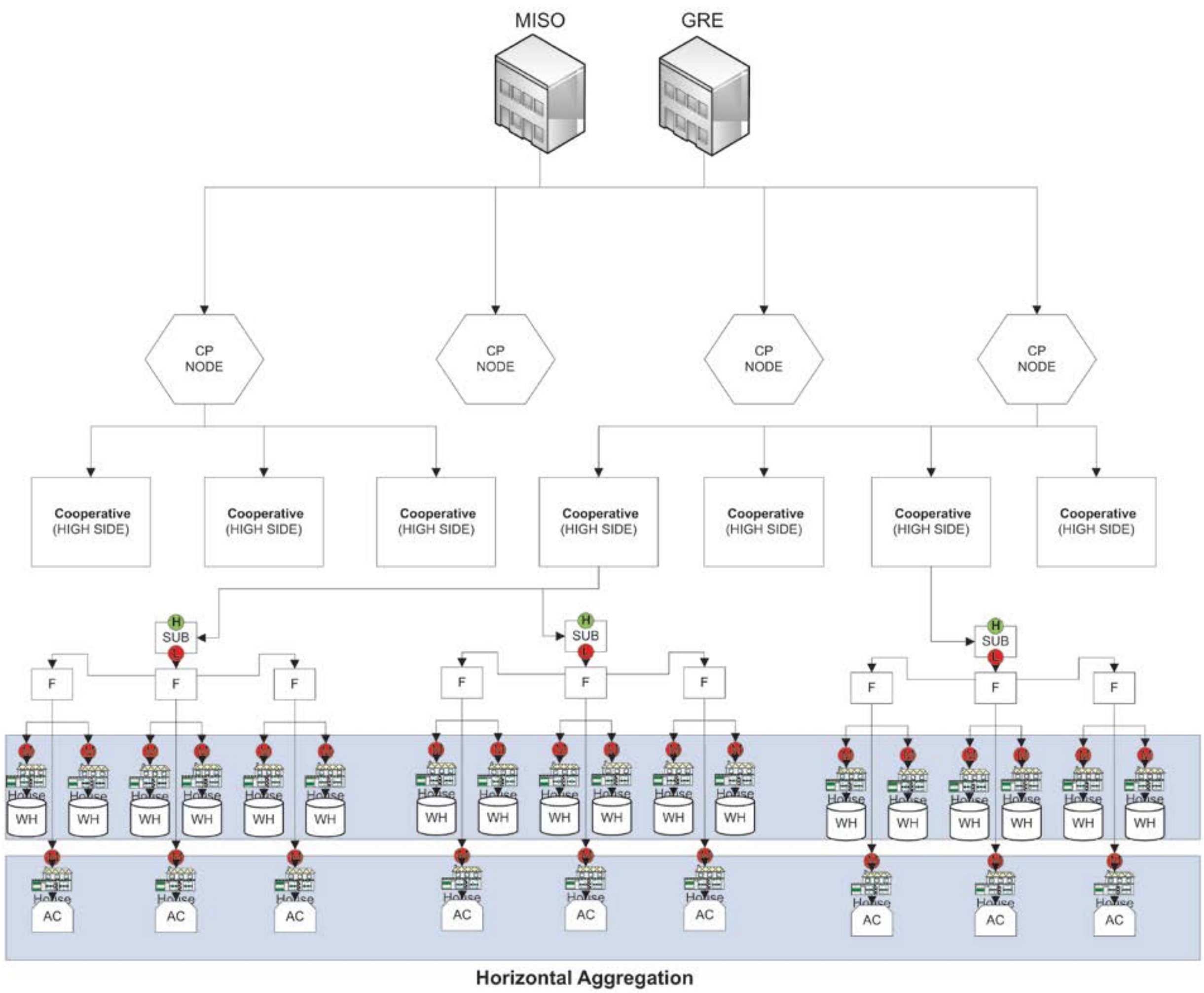


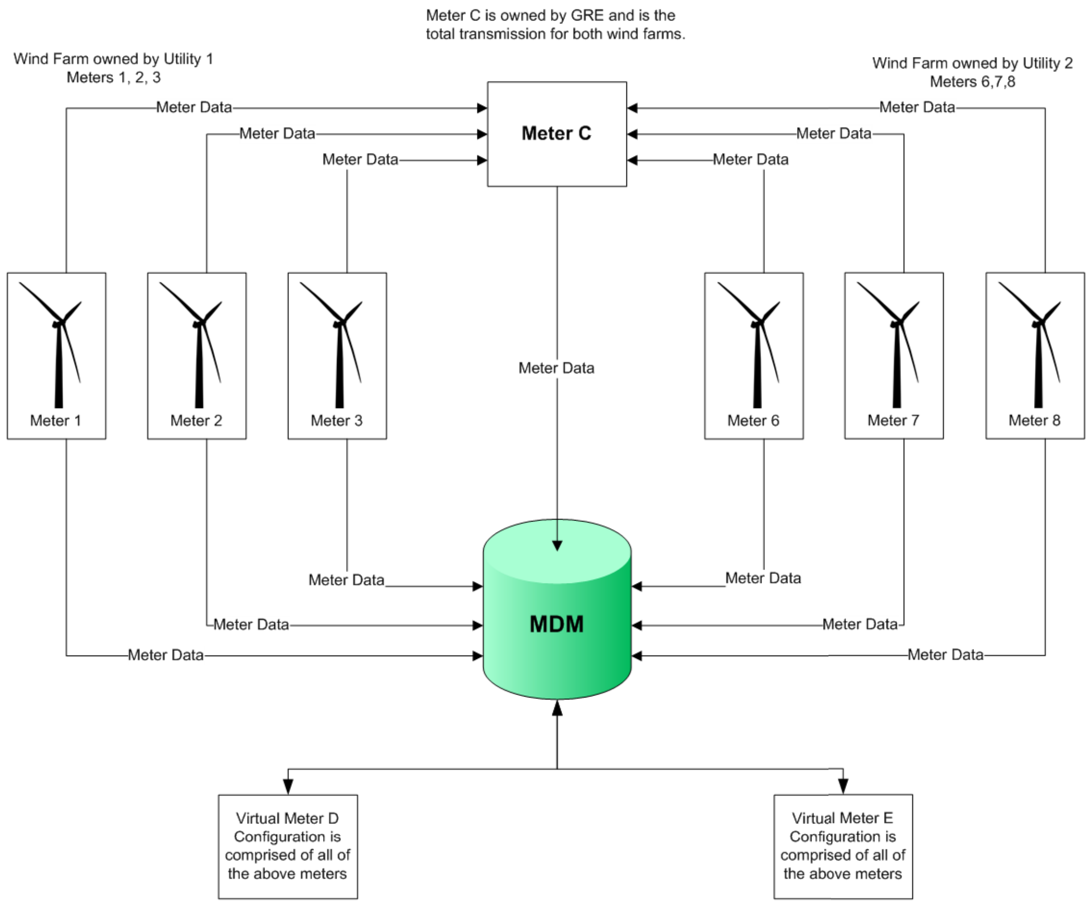
Figure 3. Horizontal Aggregation Sums Meters with Similar Attributes

These virtual meter definitions also can be used to conduct calculations on both real and virtual meters with math functions.

If-Then Aggregation Logic

Figure 4 provides an example of one of the types of aggregation the MT-MDMS provides.

See functional and technical requirement 23 in Appendix A.



Aggregation Logic Needed

If sum(meters(1+2+3+6+7+8)) + Meter C = 0 then
    Virtual Meter D = 0
    Virtual Meter E = 0

Else If sum(meters(1+2+3+6+7+8)) = 0 AND Meter C > 0 then
    Virtual Meter D = Meter C * .5
    Virtual Meter E = Meter C * .5

Else
    Virtual Meter D = Meter C / sum(meters (1+2+3+6+7+8)) * sum(meters (1+2+3))
    Virtual Meter E = Meter C / sum(meters (1+2+3+6+7+8)0 * sum(meters (6+7+8))

Figure 4. If-Then Aggregation Logic

Central Data Warehousing

NISC hosts the data for the MT-MDMS in a single database. The system logically separates the data by utility. Each utility owns its data and establishes the permissions pertaining to them. For instance, authorized personnel at a distribution co-op may choose to make one of their meters available for read-only access by GRE, the G&T. Within an organization, access is granted to personnel inhabiting a given role pertaining to the granularity of a meter.

This system is a flexible framework for applying the principle of "least privilege" to meter data. This means that it is oriented toward granting each user of the system the smallest amount of access necessary to conduct the duties assigned to his or her "role" in the system (i.e., his or her job). Colloquially speaking, meter data are shared on a "need-to-know" basis.

The security of a role-based access control system can only be as good as the security of its host. The security of NISC's hosted database was verified by GRE's information security specialists, who were permitted to run penetration tests against NISC's cloud-based hosting solution.

What is the potential value of an MT-MDMS to the electric power industry?

Secure, Real-Time Information Sharing

GRE staff emphasize the synergy between centralized data hosting and virtual metering in allowing them to share information effectively without jeopardizing the privacy of their members: virtual meters provide a way to share complicated aggregates of meter data in real time without divulging the underlying data from which the virtual meter was derived, while the shared hosting environment allows data to be shared without duplication.

Before this system was available, staff at GRE and its distribution cooperatives were aware of ways in which it would be useful to share meter data but in many cases they did not do so because of the time intensity of the processes to exchange data. Centralized hosting of the database reduces the time needed to share data. Previously, this entailed each cooperative tabulating meter data manually as a batch process and sharing the results via email. With virtual metering, intricate tabulations for a given cooperative's data can be defined as a virtual meter, which is always up to date and available to those personnel who need the sums—but not the addends—of those tabulations.

Bidding Demand Response and Other Storage Resources into MISO

The MT-MDMS was conceived to support dispatch, accounting, and measurement and verification of demand response resources spread across different distribution utilities. Previously, all of these tasks were performed manually. Dispatch was conducted via day-ahead emails. Accounting was conducted through time-consuming monthly batch submissions. Under the new system, dispatch is conducted via the multi-tenant demand response system, and data are collected automatically via virtual meters at every participating distribution cooperative. These virtual meters pertaining to the various demand response and storage assets on its system allow GRE to verify the efficacy of these resources in reducing demand and demonstrate it to the Midcontinent Independent System Operator (MISO).

Monitoring Line Losses and Power Theft

This system makes it easy to track system losses all of the time by defining a "losses" virtual meter as the hourly aggregate of load meters subtracted from the substation meters serving those loads. A "losses" meter then can be monitored for fluctuations that would strongly imply power theft.

Load Forecasting

The MT-MDMS can be used to better forecast future loads by allowing more nuanced and intuitive analysis of the differing consumption patterns among ratepayers or groups of ratepayers.

What are the barriers to the creation and adoption of this technology?

A few key barriers existed to the development and adoption of this technology. First and foremost, MT-MDM and DRM systems did not exist before GRE and NISC created them. There were also financial impediments to the acquisition or development of such a system even at a time when the need for such a system was known. Industry education was a third factor—at the beginning of this project, NISC had limited experience with the G&T side of the utility business. According to GRE, this education process was very successful, and the finished product not only met its specifications but exceeded its own vision as to the power and usability of the graphical user interface. DOE solved these three problems by reducing the financial risks involved in the development effort and contributing to the urgency needed to get the project from ideation to fruition by providing funds through the SGDP.

The other impediment to the development of this technology was the insufficiency of existing interoperability standards to support the effort. MultiSpeak was deemed to be the most applicable standard available and was a part of the system specification. However, MultiSpeak currently is missing some of the features that were found to be vital to this effort. GRE engineers asserted that the MultiSpeak methods for demand response programs lacked the features necessary to support GRE's need to start and stop whole programs.

What role did the SGDP play in accelerating the development of this technology?

As stated previously, DOE removed three out of the four impediments to the development of this technology by providing grant funds through the Smart Grid Demonstration grant.

CONCLUSIONS

Multi-tenant systems are those that serve many constituents with a common resource. Multi-tenancy is currently a busy area of research in computer security because of the ascendency of the cloud computing model, in which a given physical server might well be asked to host virtual machines from private entities with orthogonal or competing interests. This is a challenging problem because a multi-tenant system typically is asked to provide a high quality of service to all constituents while also maintaining a high degree of isolation between entities sharing that common, finite resource. These are somewhat competing goals, as has been demonstrated by the use of timing attacks on cloud services to infer what other services are running on the same physical server: such attacks present subtle quality-of-service issues (specifically, latency in acquiring computing resources) that originate from the shared and finite nature of the resource. However, whereas a given cloud-based server might have dozens of individual constituents in need of high-quality service and isolation, electric feeders may have thousands.

Electric grids are the ultimate multi-tenant systems because they provide uniform service and a high degree of isolation to nearly every member of society. The primary method for accomplishing this is the low-source impedance of the electric supply: Ohm’s law shows that, all else being equal, the voltage in a home must drop when a neighbor turns on his or her television. Yet it is unusual for this change in a neighbor’s load impedance to cause a noticeable change in the quality of our electric service. The voltage change originating from a neighbor’s decreased load impedance is insignificant to our appliances, and even to our eyes: voltage “flicker”—variations in voltage that affect the brightness of electric lighting—is rare. The electric supply is a very low-impedance voltage source, and any load impedance sufficiently low to threaten the quality of service of other tenants of an appropriately maintained electric system is termed a “fault” and isolated from the rest of the system by fault protection devices (e.g., reclosers, circuit breakers, fuses, etc.). The low-impedance voltage source that provides a uniform voltage to owner-members regardless of their load is possible because our electric grids historically have been designed for projected future worst-case peak load conditions. In the transmission and distribution areas, this has meant sizing conductors, transformers, and other current-carrying assets much larger than necessary to meet typical loads. This implies that the capacity factor on typical distribution and transmission assets is low.

This peak-driven capacity planning has made the American electric grid a miraculous multi-tenant system-of-systems that has served nearly every member of society with a high quality of service, effective isolation from other tenants, and a century of declining energy costs. However, given the rapidly increasing price of conductors, the development of affordable distributed generation technologies, and the lack of market incentives around operating transmission and distribution assets since deregulation, building and maintaining electric systems in this way is becoming more expensive. Thus, there is considerable incentive to use and manage existing generation, distribution, and transmission assets more efficiently to hold down costs. Using and managing assets more efficiently requires knowledge of where inefficiencies in the system lie and an understanding of which techniques can be used to mitigate them. This pressing market need for advanced analytics and agile grid management is giving rise to a more agile, more data-driven grid.

Meter data management systems increasingly are becoming the "corpus callosum" of the data-driven grid—the nerve center that provides information services to many of the data systems in a utility. This is because the bulk of the data-enabling innovation in asset management, system planning, operations, and consumer programs in many systems originates with meters at the substations and the loads. While load meters historically have been used exclusively for monthly energy metering, electric meters increasingly are becoming powerful sensor packages that can report voltage, power factor, connection status, and complex load impedance in near-real-time. The MDMS is tasked with verification, validation, and analysis of meter data, and interfacing with other systems that rely on the data. Typically, these other systems are owned or leased by a single utility. However, the data and information contained in an MDMS have uses across organizational boundaries.

As part of the Smart Grid Demonstration grant, GRE specified an MDMS that reflected the multi-tenant nature of the electric grid—an MT-MDMS—that would provide a high level of service to and appropriate isolation between GRE and its constituent distribution utilities. This specification was issued as an RFP (per the rules of the DOE contract) to five vendors of meter data management systems. In the bidding process, GRE discovered that there was no such MT-MDMS on the market. NISC was selected as the vendor to provide the MT-MDMS. As is common with novel technology, there have been unforeseen implementation challenges. In this report, we have examined the system requirements for an MT-MDMS and the benefits this system is bringing to GRE and its constituent members, and discussed some of the challenges encountered while endeavoring to meet those requirements.

APPENDIX A: DETAILED FUNCTIONAL AND TECHNICAL REQUIREMENTS

MDMS Functional and Technical Requirements
Great River Energy

This document contains a list of your co-op's functional and technical specifications or requirements. Please respond "yes" or "no" in the appropriate space below, depending on whether your system is in compliance with the specification. In all cases, provide a brief commentary describing how your system complies or does not comply. If your system is in partial compliance, please provide an explanation and, if appropriate, offer an alternative.

		Supplier Response	
#	Requirement Description	Yes/No/ Partial/Exception	Comments
	Physical Meter Configuration		
1	The system may integrate with the provisioning to head-end system(s), DRM, and CIS, etc. for the addition/modification of meter configuration attributes.	Yes	MultiSpeak is used for meter asset modifications. There is also an interface for exchanging large amounts of usage data with the demand response management systems (DRMS).
2	The system shall provide the ability to disable and enable a meter and/or meter data from coming into the MDMS and its related processing	Partial	The meters can be moved to groups that have VEE processing turned off. There is not currently a way to keep the data from coming into the MDMS completely. NISC is willing to explore this business need with GRE and add something to the roadmap if necessary.
3	The system shall provide version history and audit trail for meter configuration attributes as modifications occur.	Yes	There is an audit trail for changes to the meter records. There are some of these configuration items that must be considered point-in-time change. For example, if the meter is receiving hourly data for a few weeks and then is changed back to receive only a daily reading, the MDMS will track when these interval changes occurred.
4	The system shall provide the ability to accept meter interval changes.	Yes	The system is designed to accept changes in the length of intervals. For example, if a meter collects 60-minute intervals and then changes to 15-minute intervals in the middle of the month, MDMS will accept this without any changes being made in MDMS.
5	The system shall provide the ability to handle meter data across meter changes occurring during the billing period, including meter changes reported to MDMS after meter readings are reported to MDMS.	Yes	Meter changes are accepted via MultiSpeak.
6	The system shall provide the ability to manually create or import meter configurations.	Exception	NISC is working through the design/development for manually maintaining meter asset information for certain groupings of meters.
7	The system shall provide the following meter attributes: meter ID, description, physical/electrical locations, totalization interval, active/inactive dates, etc.	Yes	These data are retrieved and stored in MDMS. In most cases, these data are provided by the CIS or Meter Asset system to MDMS via MultiSpeak.

#	Requirement Description	Supplier Response: Yes/No/ Partial/Exception	Supplier Response: Comments
8	The system may provide the ability to customize meter attributes.	Partial	NISC needs to know more specifics about what kind of customization would be needed. As mentioned, there are design/development projects in place to create and maintain meter asset information for certain groupings of meters within MDMS.
9	The system shall provide the ability to prime the MDM prior to go-live by receiving and loading all the pertinent core data from the designated master utility system(s), including data for meters and other devices, such as end-use consumer, premise, account, billing cycle, connectivity, module, etc.	Yes	NISC's MDMS uses a sync process (via MultiSpeak) to receive all of the meter asset, necessary customer, and location information.
10	The system shall provide the ability to synchronize with the designated master utility system(s) to keep data aligned for meter and devices, such as end-use consumer, premise, account, billing cycle, connectivity, module, etc.	Yes	The system uses MultiSpeak to keep the meter and necessary customer and location information in sync.
11	The system shall provide the ability to detect any inconsistencies that may occur in data being synchronized with other systems as a result of the synchronization processes.	Partial	There are logs in the MDMS that will track if data were sent via MultiSpeak but were not successfully accepted. There are still business challenges that NISC continues to address around this topic. We use MultiSpeak to sync the data, but there are times that the MultiSpeak does not get sent from the master system or areas where MultiSpeak does not accommodate certain data elements. In the case of sites using NISC's iVUE, we have started a process that would do a direct database compare behind the scenes to verify that the MultiSpeak methods are keeping the data in sync. We are still exploring what kind of options may be available for non-iVUE sites. The MDMS can re-synchronize data in the event that they become out of sync. This feature also depends on the capabilities of the integrating system in question.
	VEE Rule Configuration		
12	The system shall support the creation and modification of custom VEE rules and the ability to group rules into rule sets.	Yes	The VEE rules can be modified and applied to groups of meters differently. There is some limited ability to use Java scripting for customer logic. The VEE set-up screen supports the standard VEE rules defined by Edison Electric Institute.
13	The system shall provide the ability to apply different VEE rules and rule sets based on meter attributes.	Yes	VEE Groups within MDMS allow the utility to configure VEE rules differently by groups of meters. These groups can be defined by characteristics like meter type, rate, revenue class, service use type, etc.

		Supplier Response	
#	Requirement Description	Yes/No/ Partial/Exception	Comments
14	The system shall provide the ability for VEE rules to be configurable with the ability to define the actions for each validation failure and have parameters that allow thresholds to be configured.	Yes	These are configured by VEE group and each rule can be turned on/off, action taken, and thresholds changed. For example, there are rations for when a Spike check may occur or, by VEE group, how many consecutive zeros are considered a failure.
15	The system shall provide industry standard validation checks for interval and register data.	Yes	NISC's MDMS uses standard VEE rules for both Interval and Register (cumulative) data. These can be configured by VEE group.
16	The system shall provide version history and audit trail for VEE rules as modifications occur.	Yes	The raw data, estimated data, and edited data are all stored in MDMS to provide a full audit of what happened to each interval.
	Virtual Meter Configuration		
17	The system shall have the ability to group multiple meter points into a virtual meter and have the capability to apply logic to adjust meter data. A virtual meter is the sum of 1 to many physical and/or virtual meters with or without adjustment logic applied. See Figures 6, 7, and 8 in the RFP.	Yes	Roadmap item spanning 4th Quarter 2011 & 1st Quarter 2012.
18	The system shall provide version and audit history of virtual meter configuration as modifications occur.	Yes	Roadmap item spanning 4th Quarter 2011 & 1st Quarter 2012.
19	The system shall have the ability to enable/disable a physical or virtual meter comprised within a virtual meter.	Yes	Roadmap item spanning 4th Quarter 2011 & 1st Quarter 2012.
20	The system shall store adjustment factors for each meter (physical or virtual) within the virtual meter. Adjustment factors are used when aggregating meter data.	Yes	Roadmap item spanning 4th Quarter 2011 & 1st Quarter 2012.
21	The system shall provide the ability to disable and enable a virtual meter configuration and its related processing.	Yes	Roadmap item spanning 4th Quarter 2011 & 1st Quarter 2012.
22	The system shall store totalization intervals for a virtual meter. A virtual meter can have multiple intervals and must be stored separately.	Yes	Roadmap item spanning 4th Quarter 2011 & 1st Quarter 2012.
23	The system shall provide the ability to set up “if/then logic” for aggregating virtual meters. See Figure 8 in the RFP.	Partial	Roadmap item for the 1st half of 2012. Our plan is to build in some "if/ then logic," but NISC cannot commit to the standard "if/then logic" being able to support every scenario possible. Custom logic may be necessary for some situations.
24	The system may provide drill-through capabilities to view virtual meter composition.	Yes	Roadmap item spanning 4th Quarter 2011 & 1st Quarter 2012.
25	The system shall provide the ability to dynamically add physical meters to virtual meters based on attributes. As a	Partial	Roadmap item spanning 4th Quarter 2011 & 1st Quarter 2012. We need to work with GRE to clarify its objectives and requirements on what

		Supplier Response	
#	Requirement Description	Yes/No/ Partial/Exception	Comments
	meter is added/updated/removed to/from the MDMS, it is automatically modified in the virtual meters in which it resides.		would be automatically updated as opposed to items needing manual updates.
	Meter Data		
26	The system shall provide the ability to support integration from multiple metering data sources, such as Aclara, MV-90, etc.	Yes	Currently supports integration with seven AMI vendors and also supports one of the MV-90 formats. The roadmap includes support for additional MV-90 formats.
27	The system shall ensure that data arriving to be stored in the MDMS does not come from a disabled meter; e.g., if a meter is deactivated in the MDM, the system should not process meter data from the AMI system.	Exception	The MDMS does receive data from the AMI system even if the meter is supposed to be inactive. This is done so we can report possible energy theft.
28	The system shall provide the ability to manually import data files when integrations are not available.	No	Historically, if the AMI integration is not currently supported by NISC but the AMI vendor is one that other utilities will also be using, then NISC will write an interface to receive the usage data from this vendor. However, we are willing to discuss this item further to learn more about what the business need is and what situation would occur when a standard integration could not be built.
29	The system shall provide the ability to prime the MDMS prior to go-live by receiving and loading all the pertinent core data from the designated master utility system(s), including data for meters and other devices, such as end-use consumer, premise, account, billing cycle, connectivity, module, etc.	Yes	The MDMS instance is synched to both the AMI system, CIS, etc. systems prior to going live. This allows the implementation team to analyze the data, make recommendations, and also use them for training and exploring by the utility.
30	The system shall provide the ability to synchronize with the designated master utility system(s) to keep data aligned for meter and devices, such as end-use consumer, premise, account, billing cycle, connectivity, module, etc.	Yes	The data are kept in sync with the various systems via MultiSpeak.
31	The system shall provide the ability to detect any inconsistencies that may occur in data being synchronized with other systems as a result of the synchronization processes.	Partial	There are logs in the MDMS that will track if data were sent via MultiSpeak but were not successfully accepted. There are still business challenges that NISC continues to address around this topic. We use MultiSpeak to sync the data but there are times that the MultiSpeak does not get sent from the master system or areas where MultiSpeak does not accommodate certain data elements. In the case of sites using NISC's iVUE, we have started a process that would do a direct database compare behind the scenes to verify that the MultiSpeak methods are keeping the data in sync. We are still exploring what kind of options

		Supplier Response	
#	**Requirement Description**	**Yes/No/ Partial/Exception**	**Comments**
			may be available for non-iVUE sites. The MDMS can re-synchronize data in the event they become out of sync. This feature also depends on the capabilities of the integrating system in question.
32	The system shall provide the ability to collect data from non-meter sources, including end-use consumer premise equipment and Home Area Networks.	Partial	We can support the collection of the interval data using any of the NISC- supported formats, including CMEP, MultiSpeak, etc. Given that some of these devices may not be managed by the utility, other interfaces will be required to manage the life cycle of the assets.
	Validation, Editing, Estimation Process		
33	The system shall provide a real time or batch process for VEE.	Yes	The VEE is a real-time process. As soon as data are loaded to MDMS, the VEE process will automatically start.
34	The system shall provide versioning of data as it initially passes through VEE and as data is recollected and passed through VEE.	Yes	The usage data are stored and available for display in their raw, estimated, and manually edited forms.
35	The system shall provide the ability to override data exceptions.	Yes	Manual editing is available if the user has the appropriate security settings.
Validation			
36	The system shall validate all received meter data. The frequency shall be configurable based on the source of the data.	Yes	The NISC MDMS is designed to accept meter data as many times throughout the day as needed. The validation process occurs as soon as data are imported into the database.
Estimation			
37	The system should be able to re-interrogate the meter if data is not initially collected.	Yes	The system can accept and replace missing/estimated data if the AMI system is able to retrieve and resend the data. There are exceptions that are taken into account (has the account already billed, are the data being resent the same as the original data received).
38	The system shall be able to estimate any missing or invalid data minimally, on a daily basis for all meters, to ensure complete data sets.	Yes	The VEE process will automatically estimate missing data based on how the VEE rules are configured by the utility.
39	The system shall be able to estimate missing and invalid data using historical, linear interpolation, or class load profile data.	Yes	Historical and linear estimation are currently available, and there are settings in the VEE configuration that allow the utility to control when these methods are used. Class Load Profile has been designed and is on the Roadmap for 1st quarter 2012.
Editing			
40	The system shall provide a user interface and tool set for editing interval and register reads	Yes	The VEE editing screens allow the user the ability to manually edit data. There are user security settings to control who is able to edit the data.
	Totalization Process		
41	The system shall support the ability to	Yes	The usage graph currently totalizes all intervals to

		Supplier Response	
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	sum meter data to a common interval using the Totalization Interval (e.g., hourly).		the hourly level for display to the customers. The actual interval can still be seen in the VEE portal. There is also a dashboard chart that totalizes the usage for reporting purposes. NISC plans to do other things with totalization as it relates to virtual metering and other complex billing determinants.
42	Totalization shall happen as soon as data has passed the VEE process.	Yes	Currently, the totalization of the intervals is done on the fly and the "totalized" usage is not actually stored in the database. Some of this will change as the virtual meter project is completed. This totalization does and will occur after the VEE process.
Virtual Meter Aggregation Process			
43	The system shall provide the ability to aggregate meter data and apply logic to adjust meter data as the VEE process is completed. See Figures 6, 7, and 8 in the RFP.	Yes	The virtual metering calculations, processes, and reports are in various stages of design/development but are being added to the product and will be available for GRE (see comments in questions 33–40).
44	Virtual meter aggregation shall happen as soon as data has passed the VEE or totalization process if applicable.	Yes	Once the virtual metering project is completed, this will be calculated after the VEE and totalization process and will actually be stored in the database. (Currently, all "virtual" metering data are calculated on the fly.)
Events			
45	The system shall provide the ability to create event markers on end-user meters, substations, distribution cooperatives, G&T, or wholesale market points.	Partial	Energy Markers (Event Markers) can be created by the utility or the end customer, or imported from other systems. Currently, the Event markers are at the individual meter level. The roadmap includes virtual metering and data aggregation, which would open the event marker up to additional levels. It is also possible for Lockheed Martin's DRMS system to create Event Markers for the start and stop times of a DR event.
46	Events may or may not be repeatable.	Partial	Need additional clarification.
47	Events must have a type and time dimension.	Yes	The Event Markers can be for a specific date/time or a date/time range. Currently, the markers are not divided into "types" or groups, but NISC will build this "type" classification into the product.
48	Events may need to be applied retroactively or for the future.	Yes	Energy Markers can be applied to prior, current, or future dates.
49	Some may come from external source (e.g., DRM, Billing System).	Yes	Event Markers can be imported. For example, the DRMS module for NISC's MDMS has the ability to create Energy Markers and send them to MDMS.
50	The system shall provide the ability for a user to define which organizations, roles, and users events are visible (e.g., end-user consumer can see a DR event	Yes	The Event Markers created by the utility can be configured as visible for the end customer or visible only by the utility. Currently, events created by a customer are viewable to the

#	Requirement Description	Supplier Response: Yes/No/ Partial/Exception	Supplier Response: Comments
	invoked by a G&T or distribution cooperative, G&T and distribution cooperative cannot see a consumer-defined event like a vacation).		individual utility of which they are a member. We do have an existing enhancement request to allow end customers to indicate if they want the utility to see the Event Marker.
51	The system shall provide the ability to see events at the physical or virtual meter level and track through delivery system whether it is relational.	Partial	The Event Markers can be seen at the physical meter level; once the virtual meter development is completed, they could also be stored at the virtual level. There is not currently a relational track throughout the delivery system, but NISC is willing to work through this requirement with GRE and get it on the product roadmap.
52	The system may provide the ability for end-use consumers to create events.	Yes	Consumers can create their own Energy Markers.
	Presentment – Web Interface/Portal		
53	The system may provide the ability for secure end-use consumer login to view their accounts.	Yes	The MDMS comes with a customer presentment tool called Usage & Billing Analysis. With NISC's new SmartHub system, these data can also be available to a customer via a Smartphone app.
54	The system may provide a secure end-use consumer login for bill presentment and payment and integrate to 3rd party payment provider.	Exception	The MDMS does provide a web presentment tool, integrated with NISC's Customer Self-Service tools, which support payments and bill presentment. Both Minnesota Valley and Lake Region use NISC Customer Self-Service. The Usage & Billing Analysis can also be integrated with other e-bill and payment vendors using single-sign-on standards.
55	The system may provide the ability for the end-use consumer to view Bill-to-Date information available from the CIS.	Yes	The Usage & Billing Analysis does allow the user to see historical usage and some high-level billing information, along with unbilled usage. NISC continues to build out this tool to include more and more cost-related features.
56	The system may provide the ability for the end-use consumer to graphically view power consumption.	Yes	The Usage & Bill Analysis allows the utility to see monthly, daily, and hourly usage. The temperature information is also displayed on this graph.
57	The system may provide energy efficiency and conservation educational tools.	Partial	The Usage & Bill Analysis allows the consumer to create energy markers. NISC is currently working on baseline and weather normalization calculations to allow the consumer to conduct analysis on these events. NISC is also exploring linking various software platforms that present efficiency and conservation education into the web presentment.
58	The system may provide the ability for the end-use consumer to create “What if” scenarios for selecting an alternative rate plan.	Yes	NISC is currently developing a Billing Comparison tool, which is planned for release in late 2011 or early 2012.

		Supplier Response	
#	Requirement Description	Yes/No/ Partial/Exception	Comments
59	The system may provide the ability for the end-use consumer to request a change in service.	Yes	NISC's E-Bill/Customer Self-Service (CSS) tool allows the user to request a change of service. The MDMS presentment tool integrates with NISC E-Bill/CSS. For sites not using NISC E-Bill/CSS, this feature would be dependent on their vendors' E-Bill/CSS. Both Minnesota Valley and Lake Region already use NISC's E-Bill/CSS tool.
60	The system may provide the ability for password recovery/self-service.	Yes	This is part of the E-Bill/CSS system that both Minnesota Valley and Lake Region use.
Complex Billing			
61	The system shall support the following billing methodologies:		
62	Time-of-Use Billing (TOU)	Yes	The MDMS supports framing/binning of interval data into TOU buckets. These can then be passed to CIS for billing.
63	Critical Peak Pricing (CPP)	Yes	The MDMS supports framing/binning for interval data for CPP rates. The utility is able to identify at any time which days and hours will be CPP, and there are also admin settings to limit the number of CPP events allowed in a year, and the months that a CPP event can occur.
64	Peak Time Rebate (PTR)	No	NISC's current focus on Dynamic Rates is Day-Ahead Real-Time Pricing, which is scheduled for release in the Spring of 2012. The next dynamic rate on the Roadmap would be Peak Time Rebate, currently scheduled sometime in late 2012.
65	The system shall include a calendar interface for configuring and scheduling complex billing methodologies.	Yes	The Dynamic Pricing options in MDMS have a calendar to allow the utility to easily define time frames.
66	The system may provide the capability to calculate meter-specific baselines for peak time rebates and demand response measurement and verification.	Partial	The DRMS module that integrates with NISC's MDMS performs baseline calculations used in M&V for demand response. NISC is also currently working on the development of baseline calculations and weather normalizations to be used in energy comparisons on MDMS. This will also be used for PTRs once we start that development for PTR sometime next year.
Reports/Data Analytics			
67	The system shall provide the ability to schedule reports for delivery.	Yes	Reporting functions can be scheduled in the dashboard module. Typically, utilities will activate this feature when their AMI import files are known to import at a specific time.
68	The system shall provide the ability to deliver and export report data in multiple formats, such as MS Excel, CSV, HTML, PDF, etc.	Yes	The data from MDMS can be exported to Excel or in a CSV format. There are also APIs, which allow a utility to extract data from MDMS.
69	The system shall provide the ability to create and save ad hoc reports.	No	The MDMS system has standard charts/reports that can be processed. These reports can have filters applied to them to narrow or alter the

#	Requirement Description	Supplier Response: Yes/No/ Partial/Exception	Supplier Response: Comments
			results. The data are also available via APIs if they need to be exported. NISC is exploring a community library of "custom" reports, as well as some basic query-building-type reports. Our preferred approach is to work with the utilities on their reporting needs and build as many reports as possible into the standard product.
70	The system shall provide the ability to support reporting functions without adverse impact on the transactional processing of the MDMS.	Yes	Data that are exported from the primary storage cluster can be used to feed all reports, so performance issues are rarely encountered.
71	The system shall provide the ability to generate point-in-time and trend performance reports for each meter-read collection system.	Yes	The MDMS dashboard allows for filtering based on a variety of attributes that allow the utility to filter by collection system as well as meter type. Abilities in this area depend on the integration implementation into the asset management system.
72	The system shall provide the ability to create and maintain algorithms used for data analytics.	Yes	Scripting functionality exists in the MDMS, which allows custom reports to be written against the reporting engine.
73	Line Losses	Yes	Roadmap item for the 1st half of 2012.
74	Transformer loading analysis	Yes	Roadmap item for the 1st half of 2012.
75	Measurement and verification of DR events	Exception	NISC's MDMS has an optional DRMS module that will use the usage data stored in MDMS compared to the customer baseline usages for calculating M&V on DR events. The DRMS system can also update MDMS with markers for when an event started and stopped. NISC is currently working on some baseline and weather regression models that will allow consumers to do basic M&V for their accounts. This could be used for various types of Event Markers on the customer's account.
76	Revenue Protection (e.g., a premise that does not have an active end-use consumer is consuming any energy, or some energy above a threshold. Identify that the reverse energy flow is allowed for those meters which are in net metering mode, however, to avoid false indicators).	Yes	The MDMS Dashboard has a report called Unauthorized Usage.
77	The system shall provide the capability to profile end-use consumer meter data over a period of time and compare to other end-use consumers with like attributes.	No	This is being evaluated for a Roadmap item for several different purposes. The most common is for customer presentment, so customers can compare themselves to other like customers.
78	The MDMS database model shall be open, allowing organizations to create and save their own reports.	Exception	Above and beyond the standard reports, NISC's MDMS has APIs available for extracting any level of data from the MDMS.
79	The system shall provide reports that integrate with weather station system to use sky/temperature information.	Partial	NISC's MDMS pulls weather data for every weather station in the US. These data are then linked to the usage graphs for each individual

		Supplier Response	
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			location/meter in MDMS. Currently these data are not included in any other reports, but NISC is willing to have additional discussions about this to determine what the business need may be.
80	The system may provide reports to calculate Wet Bulb Temperature.	No	NISC is willing to work with GRE on defining this business need and determining the requirements and impact.
	Interoperability		
81	**Standards:** Supplier shall indicate which standards the proposed products and systems conform with, and how the system implements recommended best practices. A criterion for evaluation of the proposals will be a demonstrated knowledge of evolving open standards that will affect the MDM system and how those ongoing developments will impact the current project. The response to this section should demonstrate an understanding on the part of the Supplier that a key goal of the project is to demonstrate the ability of MultiSpeak® to provide a significant portion of the interoperability required by the MDM system.		The MDMS supports both MultiSpeak and International Electrotechnical Commission (IEC)-based message formats, depending on the nature of the data being moved. In some cases, due to IO constraints, SOAP messages are avoided while instead using streamable REST-based services. This significantly decreases node IO requirements, decreases bandwidth requirements, and increases performance. These factors help keep costing down while using a consistent data model across specifications. NISC's MDMS currently uses MultiSpeak for pulling data such as customer information and meter asset and location information. We also support both MultiSpeak and CMEP for receiving interval data from AMI vendors. We currently use a version of 3.X and are evaluating 4.1. As MultiSpeak continues to change and grow, the MDMS will adapt to meet these new available options. NISC maintains very close contact with MultiSpeak and participates in all of the meetings. We have a long history in our other applications, such as CIS, OMS, GIS, etc. for using many different MultiSpeak methods with various vendors.
82	**Required Hardware or Software:** In addition to identifying the hardware and software that will be supplied by Supplier, the Supplier shall describe any additional required hardware or software that will be needed for the fully integrated operation of the AMI system but that it does not intend to supply. For example, if middleware or an integration server to provide enhanced messaging or application functionality is required in order to achieve full functionality, these should be specifically identified.		The MDMS is a hosted cloud environment, so all hardware is purchased and maintained by NISC Operational Staff. There are no direct charges to the utility for hardware. There are no underlying software licenses for the utilities to purchase; the entire Cooperative Cloud is open source based. These two attributes were specifically designed to ensure the long-term visibility and cost effectiveness of the MDMS. During Implementation, an MDM proxy may need to be installed on the utilities' networks. This will help facilitate the communication between the enterprise systems and the cloud. This can be installed on an existing Windows-based machine at the utility.
83	**Interoperability with Different MultiSpeak Versions:** The AMI		Although this questions references "the AMI system provided by the Supplier"….we believe

#	Requirement Description	Supplier Response: Yes/No/ Partial/Exception	Supplier Response: Comments
	system provided by Supplier shall interface with a number of enterprise application systems; each may have a different version of MultiSpeak-compatible interfaces. Please explain how Supplier will implement interfaces that support a number of different versions of MultiSpeak and specifically how the AMI application will interface simultaneously with a number of other applications that support several different versions of MultiSpeak.		it means to indicate how the MDMS provided by the supplier will support multiple versions on MultiSpeak. Currently, our MultiSpeak configuration allows us to indicate which version of MultiSpeak is being used. This is not just set at the utility level, but at the integration level at a utility, so an OMS integration may be on a different version than the CIS integration.
84	**Interfaces with Current Enterprise Software Applications:** As a minimum, the MDM system must integrate with all indicated "current" enterprise software applications (as listed in the RFP) via MultiSpeak Version 3.0 or later. Preference will be given to vendors that provide integration which is in compliance with the requirements of MultiSpeak Version 4.1 or later. See Appendices A and B for resources on the requirements of MultiSpeak Version 4.1.		NISC currently supports the following MultiSpeak methods for integration with CIS. "CancelDisconnectedStatus," "CancelUsageMonitoring," "InitiateUsageMonitoring," "InitiateDisconnectedStatus," "MeterChangedNotification," "MeterAddNotification," "MeterExchangeNotification," "MeterInstalledNotification," "MeterRemoveNotification," "MeterRetireNotification," "ServiceLocationChangedNotification," "CustomerChangedNotification," "PingURL," "GetMethods" getAllCustomers getAllMeters – assumed to be electric meters only getAllServiceLocations – assumed to be electric service locations only getDomainMembers "meter.utilityInfo.substationCode" "serviceLocation.revenueClass" "meter.extensions.rateSchedule" "meter.extensions.electricUseCd" "meter.meterType" "serviceLocation.district" "serviceLocation.boardDist" "serviceLocation.franchiseDist" "serviceLocation.schoolDist" "serviceLocation.taxDist" "serviceLocation.linemanServiceArea" "serviceLocation.servStatus" "serviceLocation.cityCode" "serviceLocation.county" NISC has not interfaced with Daffron directly but we are dedicated to working with it on interoperability testing for the above MultiSpeak methods. The location information could be

		Supplier Response	
#	Requirement Description	Yes/No/ Partial/Exception	Comments
			coming from a CIS or GIS system. Other GIS integration being explored by NISC is the ability to export metering events to the GIS maps. The GIS integration may not be available at the projected live date of July 1, 2012; further discussions would be needed about what AEC would like to accomplish with an integration to GIS.
85	**MultiSpeak Interoperability Testing:** Supplier shall provide a MultiSpeak-certified interoperability test report on all interfaces with other applications that are supplied with the system provided in response to this request for proposals. Supplier shall prepare an interoperability test assertions document in the format adopted by the MultiSpeak Initiative, describing the business processes being supported, and showing all web service methods supported by the systems under test. When tested and certified by an approved MultiSpeak testing laboratory, this interoperability assertion shall become the certified test report.		Many of the integration items in focus for Minnesota Valley and Lake Region are between NISC's MDMS and NISC iVUE systems. We do not currently have an interoperability testing document for the integration back into our own applications. NISC does have testing documents for the integration between our CIS and OMS systems and some of the other vendors mentioned in this RFP. These are available for review on MultiSpeak's website (www.MultiSpeak.org). There are some vendors on the list for which NISC does not currently have a testing document for this integration. However, we are committed to working with each of these vendors to implement and test the MultiSpeak interfaces that are available and applicable to GRE's project. Listed below are the current MultiSpeak methods being used with MDMS: "CancelDisconnectedStatus," "CancelUsageMonitoring," "InitiateUsageMonitoring," "InitiateDisconnectedStatus," "MeterChangedNotification," "MeterAddNotification," "MeterExchangeNotification," "MeterInstalledNotification," "MeterRemoveNotification," "MeterRetireNotification," "ServiceLocationChangedNotification," "CustomerChangedNotification," "PingURL," "GetMethods" getAllCustomers getAllMeters – assumed to be electric meters only getAllServiceLocations – assumed to be electric service locations only (not as important) getDomainMembers "meter.utilityInfo.substationCode" "serviceLocation.revenueClass" "meter.extensions.rateSchedule" "meter.extensions.electricUseCd" "meter.meterType" "serviceLocation.district"

#	Requirement Description	Supplier Response: Yes/No/ Partial/Exception	Supplier Response: Comments
			"serviceLocation.boardDist" "serviceLocation.franchiseDist" "serviceLocation.schoolDist" "serviceLocation.taxDist" "serviceLocation.linemanServiceArea" "serviceLocation.servStatus" "serviceLocation.cityCode" "serviceLocation.county"
86	Required Exhibits. Supplier shall provide Exhibits I–V as described in the RFP document.		See Attached documents labeled Exhibits I– V.
	Integrations		
87	The system may provide the ability to interface with back-office systems like CIS, OMS, AMS, WFMS, and others using the International Electrotechnical Commission's (IEC) Standard 61968 Part 9.	Partial	NISC's MDMS does provide interfaces to various back-office systems such as CIS and OMS. The asset information is also available via MultiSpeak and, for most distribution utilities, comes from the CIS system. These interfaces are built using MultiSpeak. There is also pre-built integration with NISC's Service Order system for creating service order requests for things such as meter exchanges, check meter read, etc. For other interfaces, NISC is willing to discuss the business need and create interfaces using MultiSpeak standards as necessary.
88	The system shall provide a standard integration for meter configuration and meter data from the following sources:		
89	Aclara Power Line TWACS	Yes	NISC's MDMS has been installed at 15 Aclara sites already.
90	Itron MV-90	Yes	NISC supports some of the MV-90 interfaces but has plans to build out more.
91	OSI Monarch	Exception	NISC's MDMS does not currently integrate with the OSI Monarch SCADA system. However, there are plans in place to build interfaces and specific reporting options into MDMS for SCADA. NISC would like to work with GRE on the detailed requirements for this and get the item on our 2012 roadmap.
92	DRM System (TBD)	Yes	NISC's MDMS is integrated with Lockheed Martin's DRMS (SEELoad).
93	The system shall provide a standard integration to send and receive events from the following sources		
94	DRM System (TBD)	Yes	NISC MDM's is integrated with the Lockheed Martin DRMS (SEELoad).
95	NISC CIS	Yes	There are many different integration points between MDMS and NISC's iVUE CIS application. Most of these are via MultiSpeak, but there are also some APIs for service order information, as well as billing history information.

		Supplier Response	
#	**Requirement Description**	**Yes/No/ Partial/Exception**	**Comments**
96	Milsoft DisSPatch	Exception	The MDMS has not been integrated with Milsoft DisSPatch yet, but NISC will pursue a MultiSpeak interface for receiving OMS events.
97	The system shall provide the ability to integrate with external systems to send and/or receive any of the following data:		
98	Physical meter configuration	Yes	MultiSpeak is currently used to meter asset information.
99	Virtual meter configuration	Exception	Virtual metering is a current development project.
100	Physical meter data	Yes	The meter data are imported from the AMI systems and are available for export to CIS and other systems.
101	Virtual meter data	Exception	Virtual metering is currently being developed but once completed, it will be available for exporting.
102	Totalized physical meter data	Yes	Totalized meter data will be available for export. Currently, we use some totalize logic for TOU and CPP accounts. This usage is being exported to CIS currently. We also have a Meter Totalization report, which will have an Export to Excel button. More functionality will be available as we complete the virtual metering project.
103	Totalized virtual meter data	Yes	Totalized meter data will be available for export. Currently, we use some totalize logic for TOU and CPP accounts. This usage is being exported to CIS currently. We also have a Meter Totalization report, which will have an Export to Excel button. More functionality will be available as we complete the virtual metering project.
104	Events	Yes	The MDMS currently can receive event data from DRMS or CIS systems.
105	Demand response	Yes	MDMS is integrated with SEELoad DRMS for usage data to be used for M&V during a DR event. MDMS will also receive DR events from SEEload to indicate when a DR event started and stopped.
106	Outage	Partial	The MDMS will integrate with OMS to receive outage events but does not currently send information to the OMS system.
107	End-use consumer defined (e.g., consumer creates a vacation event to monitor usage while on vacation).	Yes	There are usage notifications in the Usage & Billing Analysis tool that an end consumer can turn on.
108	Financial (CPP, TOU, Dynamic Pricing)	Yes	TOU and CPP information is exported to CIS.
109	VEE (e.g. integrate with an external system to notify an estimation occurred for a meter)	No	NISC would like to talk to GRE about this item and learn more about the business need and requirements.
110	The system shall provide an interface to manage integrations.	Yes	Security controls can activate and deactivate integration points by user/vendor on the fly.

		Supplier Response	
#	Requirement Description	Yes/No/ Partial/Exception	Comments
111	The system shall provide the ability for reports to integrate with weather services, to incorporate weather data from sources such as: WSI EnergyCast PowerTrader.	Yes	NISC's MDMS is already integrated with NOAA for pulling in weather data; however, NISC will provide the ability to receive weather data from other sources.
113	The system parsing the data arriving in the MDMS should make use of all the appropriate data validation and exception handling techniques.	Yes	Several functions are in place allowing the MDMS to pre-process files looking for common AMI-Export mistakes to make sure the data are ready for actual VEE. Administrators can configure this pre-processor to suit their needs, by AMI vendor. When pre-processor exceptions are encountered, an email is generated to the administrator(s) and a UI is in place to help the user resolve the issue without having to rely on intervention by NISC.
114	Data arriving to be stored in the MDMS is syntactically and semantically valid.	Yes	Several functions are in place allowing the MDMS to pre-process files looking for common AMI-Export mistakes to make sure the data are ready for actual VEE. Administrators can configure this pre-processor to suit their needs, by AMI vendor. When pre-processor exceptions are encountered, an email is generated to the administrator(s) and a UI is in place to help the user resolve the issue without having to rely on intervention by NISC.
115	Cleanse data stored in the MDMS from all private information.	Exception	To answer this fully, we will need a more detailed definition of "private information." The MDMS does not store phone numbers, social security numbers, etc., but we do store name, service address, and detailed usage information.
116	The system shall gracefully handle denial of service attempts from integration sources.	Yes	NISC has not had any issues with Denial of Service attacks due to the large amount of computing power available in the cloud environment. External integration sources are constantly monitored; should they generate an unexpected attack and NISC deems the load a threat to the system, we can activate firewall measures to circumvent the issue.
117	The system may provide the ability to communicate with, obtain data from, and control meters and Home Area Network (HAN) devices using International Electrotechnical Commission's (IEC) Common Information Model (CIM) 61968 Part 9 messaging standards.	Yes	If the devices are already contained in the asset management system, the MDMS can support most 61958 Part 9 measurements. Control functions are not currently supported. There is an enhancement in the MDMS roadmap that will not allow asset management controlled devices also to be accepted, maintained, and controlled natively in the MDMS.
	Exception Handling		
118	The system shall provide the ability to generate meaningful error codes and error messages that can be used to help facilitate debugging system and end-	Yes	All application-level exceptions are logged and categorized in real time to alert engineering staff of potential runtime issues in the MDMS. This allows our staff to be proactive with bug fixes

		Supplier Response	
#	Requirement Description	Yes/No/ Partial/Exception	Comments
	user problems.		and support. Due to the fully distributed/cloud nature of the MDMS, most issues can be resolved on the fly, with no application downtime.
119	The system shall provide the ability to monitor, report, and issue alarms for individual processes, group processes, and work or data flows within the system to ensure reliable operation.	Yes	Back-end processes have inherent failover support in the event a process aborts due to hardware or application failure.
	Multi-Tenant		
120	The system shall be able to logically partition the metering data for a G&T and member distribution cooperatives and maintain data privacy and security.	Yes	Because of the nature of the NISC Private Cloud, all data are stored only once and can be shared across the entire application platform. This assumes that the distribution utility has given explicit permission to the G&T to use its data.
121	The system shall provide the ability to prohibit G&T operational personnel from accessing detailed end-use consumer information.	Partial	This is an existing enhancement. Features in the MDMS, whether through the UI or web services, are locked down by function, not by interface. This method ensures that personnel have specific views and restricted edit capabilities only, depending on security settings.
122	The system shall provide the ability to delegate application administration tasks to each organization.	Yes	Each distribution utility and the G&T individually, have firm control of the sharing of information across the system. The MDMS employs Active Directory-style permissions models for users, roles, groups, and domains.
123	The system shall provide the ability for an individual organization to grant full and/or limited access to meters and their related attributes to other organization(s), utilizing roles-based permissions.	Yes	Because of the function-oriented security model, the NISC MDMS can consistently limit the viewing and editing of data throughout the system.
124	The system shall provide the ability to define access to the application modules and data to users of the system in a role-based manner within and across organizations.	Yes	
	Security		
125	The MDMS shall be designed and implemented using security-aware SDLC.	Yes	
126	The MDMS has passed a security penetration test by a qualified third party	Exception	We perform the PenTest on the MDM environment.
127	The system shall allow a System Administrator to perform database management and maintenance for the entire system.	Yes	

		Supplier Response	
#	Requirement Description	Yes/No/ Partial/Exception	Comments
128	The on-premise system shall integrate with 3rd party authentication authorization and accounting systems like Active Directory, RSA, Safeword, etc.	No	NISC iVUE admin is utilized across NISC Private Cloud apps.
129	The off-premise solution shall integrate with multiple federated authentication services.	Partial	The MDMS is currently switching over to an OpenID 2.0-based implementation that allows better compatibility with multiple back-end security providers, as well as allowing additional applications to have capabilities for Single Sign On between applications. Currently, Active Directory and iVUE Admin security directories are supported.
130	The system shall support password-based authentication with strong password security policies, such as: configurable password history field, minimum password length, minimum password complexity, account lockout, and password expiration. (If federated authentication, this is not required.)	Yes	NISC iVUE admin is utilized across NISC Private Cloud apps.
131	The system shall provide the ability to require entry of the old password when attempting to change a password.	Yes	
132	The system shall provide the ability to encrypt or hash passwords at rest in a database or directory.	Yes	
133	The system shall provide the ability to log and audit all application and database accesses throughout the system, capturing user names, timestamps, success/failure of transactions, source IP addresses, and transaction descriptions, as appropriate.	Yes	
134	The system shall provide the ability to perform an automatic log-off of a user after a configurable time frame of inactivity.	Yes	Session timeouts exist.
135	The system shall provide the ability to support a session kill on a browse away or browser close (for browser- based interfaces).	No	
Architecture			
136	**Physical Environments**		
137	The system shall support the ability to logically and/or physically isolate non-production environments from production environments to ensure that activity or problems in non-production environments will not adversely affect the production environment.	Yes	Development and test environments are completely separate from production. The production environment exists only at our hosting facilities.

		Supplier Response	
#	Requirement Description	Yes/No/ Partial/Exception	Comments
138	**Development:** To be used if actual development of applications used to enhance the MDMS solution are needed.	Exception	Development happens on NISC development servers on NISC's corporate LAN, separate from the production environment.
139	**Test/Stage:** System used for testing purposes. It allows new releases of the MDMS software and integrations to be fully tested in the utility environment before being put into production.	Exception	Initial testing of a new release of MDMS is done in NISC's test/QA environment. Once the software is ready for beta, it is installed in our production MDMS cloud, where it can be beta tested with a small number of customers. The cloud environment very easily allows a quick upgrade of all customers or beta testing for a small group, as it can support multiple versions at once.
140	**Production:** System that is online and used for all operational activities.	Yes	The production MDMS cloud exists only at our hosting facilities, away from NISC's test/QA environments. The MDMS cloud environment allows for multiple versions of the MDMS software to be deployed at one time.
141	**Disaster Recovery:** This environment is the backup of the production environment. It is used to take the place of the production system should a failure occur.	Yes	The MDMS is designed on a distributed and redundant cloud architecture. Any single node failure is handled automatically and does not affect application availability. Three copies of the MDMS data are maintained across datastore nodes in the local cluster for redundancy. The distributed nature of this architecture can be extended to cover more than one location for location redundancy. NISC is planning on extending the cloud to another location in the future, which will add extra capacity and act as a disaster recovery site. Currently, data are exported from the database on a nightly basis to a SAN, where they are replicated to an off-site location over a dedicated fiber link.
142	The system may have the ability to migrate changes across environments.	Yes	The MSMS software changes will migrate from development, test, beta, and then production, based on defined release schedules.
	Database		
143	The system may provide a data warehouse or data mart.	Exception	NISC's MDMS is in a cloud architecture, which allows multiple utilities to have data stored on the same system. These data are stored in a way that keeps them separate for each utility but still allows a utility to share data with other entities. The resources of the hardware are then shared across all entities within the cloud.
144	The system may provide ETL tools to support for loading data into a separate data warehouse.	Partial	There are APIs and exports available for exporting the data. The concept of data marts is not built into MDMS.
	Resources and Management Issues		
145	The system shall provide the ability to be backed up on a scheduled basis.	Yes	Three copies of the MDMS data are maintained across datastore nodes in the local cluster for redundancy. Data are exported from the

		Supplier Response	
#	Requirement Description	Yes/No/ Partial/Exception	Comments
			datastore on a nightly basis to a SAN, where they are replicated to an off-site location over a dedicated fiber link.
146	The technical infrastructure shall be designed to support hot backups, with no loss of system availability or unacceptable degradation of performance.	Yes	Three copies of the MDMS data are maintained across datastore nodes in the local cluster for redundancy. Data are exported from the datastore on a nightly basis to a SAN, where they are replicated to an off-site location over a dedicated fiber link. The MDMS system is available during these processes.
147	The system shall provide an administrative console for performing system maintenance.	Exception	The system is a hosted cloud application; all system monitoring and maintenance is done by the service provider.
148	The system shall provide disaster recovery abilities.	Yes	The MDMS is designed on a distributed and redundant cloud architecture. Three copies of the MDMS data are maintained across datastore nodes in the local cluster for redundancy. This distributed nature of this architecture can be extended to cover more than one location for location redundancy. NISC is planning on extending the cloud to another location soon. Currently data are exported from the database on a nightly basis to a SAN where they are replicated to an off-site location over a dedicated fiber link.
149	The technical infrastructure shall be designed to support failover to a disaster recovery environment with no loss of data and with a maximum downtime of 2 hours.	Partial	The MDMS is designed on a distributed and redundant cloud architecture. Any single node failure is handled automatically and does not affect application availability. Three copies of the MDMS data are maintained across datastore nodes in the local cluster for redundancy. This distributed nature of this architecture can be extended to cover more than one location for location redundancy. NISC is planning on extending the cloud to another location in the future, which will add extra capacity and act as a disaster recovery site. Currently, data are exported from the database on a nightly basis to a SAN where they are replicated to an off-site location over a dedicated fiber link.
150	The system shall provide the ability for horizontal or vertical scalability to improve performance and/or process additional load.	Yes	The MDMS is designed on a distributed and redundant cloud architecture. This architecture allows for near linear scalability as cloud nodes are added. The cloud architecture even allows scalability across data centers at multiple locations.
151	The system shall be fault tolerant and withstand a single failure of either hardware or software.	Yes	The MDMS is designed on a distributed and redundant cloud architecture. Any single node failure is handled automatically and does not affect application availability. Three copies of the MDMS data are maintained across datastore nodes in the local cluster for redundancy. This

#	Requirement Description	Supplier Response: Yes/No/ Partial/Exception	Supplier Response: Comments
			distributed nature of this architecture can be extended to cover more than one location for location redundancy.
152	The system shall provide the ability to apply patches and upgrades with little or no system downtime required.	Yes	Once the software is ready for beta, it is installed in our production MDMS cloud, where it can be beta tested with a small number of customers. The cloud environment very easily allows for a quick upgrade of all customers or beta testing for a small group, as it can support multiple versions at once. These upgrades are done with very little or no downtime for the MDMS.
Performance			
153	The MDMS shall not be the limiting capability in the display or distribution of data. Consequently, the time to complete validation of all meter data (intervals and registers) and estimation of missing data (assume 5% missing) should be consistent with the overall AMI requirements to collect and process meter data.	Yes	The distributed computing nature of the NISC MDMS allows it to process data very efficiently at all levels of the system. This system was designed to yield industry-leading performance, while a variety of processes are running concurrently, such as imports, VEE, reporting, consumer presentation, web services, and employee-facing UI tools.
154	Interval data supplied to the system shall be processed through a Validation, Editing, and Estimation (VEE) engine when received from the head-end metering system.	Yes	The VEE process will automatically start as soon as the data are received from the AMI system.
155	The system shall be able to support 5-/10-/15-/60-minute interval metering data.	Yes	The NISC MDMS supports all IEC meter measurements down to the millisecond.
156	The technical infrastructure shall be designed and built to achieve an availability of 99.5% or greater.	Yes	Every component in our cloud environment has on-the-fly failure and restoration capabilities. Most upgrades and updates can be done on the fly with no downtime.
157	All processes shall be made available after unplanned system downtime within 1 working day.	Yes	To date the NISC MDMS has not been down for more than one working day.
158	The system shall be able to support approximately 80,000 physical metering endpoints across 3 individual organizations and 5,000 virtual meters.	Yes	There are existing sites using NISC MDMS that are importing hourly intervals for more than 160,000 meters per day.
159	The technical infrastructure shall be designed to ensure sufficient performance and scalability to meet the demonstration project requirements with an additional margin of 25%.	Yes	Due to the current size of the NISC Private Cloud and its elastic nature, we have the ability to reconfigure and add resources on the fly to ensure performance. The NISC Private Cloud and the MDMS both have a series of valves and controls in place in the event resources become scarce and we need to prioritize.
160	The system shall be capable of supporting 1,000,000 endpoints across 29 (GRE plus 28 members)	Yes	We currently support more than 1 million meters at nearly 4 billion readings. The system has been designed from the beginning to scale well

		Supplier Response	
#	Requirement Description	Yes/No/ Partial/Exception	Comments
	organizations for a full deployment.		outside of our entire customer base of more than 450 utilities. We have no known limits at this point in time.
Implementation Support and Training			
161	The vendor shall provide project management, solution architecture, and integration development to implement the system at the utility.	Yes	NISC's MDMS Implementation team will assign a project manager to facilitate the implementation, solution architecture, and necessary integration development.
162	The vendor shall provide up-front and ongoing classroom and hands-on training for both System Administrators and End Users	Yes	The standard proposal for NISC MDMS includes training via WebEx sessions during the implementation process. However, on-site training can be included at additional cost (time and material). NISC continues to provide training via WebEx session as new releases of the MDMS are made available. These releases occur about every 8 to 10 weeks.
163	The vendor shall provide a pre-defined method for the installation, configuration, and validation of the MDMS.	Yes	NISC's MDMS Implementation team uses a SILC to define the steps of the implementation process from beginning to end. This includes configuration, validation, and training.
164	The vendor shall provide 24x7 support for critical issues.	Yes	NISC's normal business hours are 7:30 AM to 5:30 PM Central Time. There are support staff that carry cell phones from 5:30 PM to 7:30 AM every day for any critical issues.