Special Meeting Agenda
PUD Board of Commissioners
Tues, Feb 22, 2022 10:00 AM
Zoom
Port Townsend, WA 98368

To join online go to: https://zoom.us/my/jeffcopud. Follow the instructions to login. Meetings will open 10 minutes before they begin. TOLL FREE CALL IN #: 833-548-0282, Meeting ID# 4359992575#. Use *6 to mute or unmute. *9 to raise a hand to request to begin speaking.

Page

1. Call to Order

Per the Governor's Extended Proclamation 20-28 and in response to the COVID-19 Pandemic, Jefferson County PUD is no longer providing an in-person room for meetings of the BOC. All meetings will be held remotely via Zoom until otherwise informed by the Governor. Participant audio will be muted upon entry. Please unmute at the appropriate time to speak. If you are calling in, use **6 to mute and unmute and *9 to raise a hand to request to speak.*

2. Agenda Review

3. Presentations

3.1. AMI Vendor Selection — 3 - 129

JPUD VISION DRAFT CONTRACT 20220221 v2.pdf

Resolution 2022 XXXX Authorizing Contract for Metering 2022 02 21 v2.docx

3.2. SCADA/Substation Engineering Position — 130 - 134

Non Rep Salary table.pdf

4. Executive and Closed Sessions

4.1. Per RCW 42.30.110(4)(a) to discuss ongoing union negotiations

4.2. Per RCW 42.30.110(1)(i) to discuss with legal counsel potential litigation

5. Adjourn

AMI System Master Agreement between Jefferson County PUD and Vision Metering, LLC.

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1 AMI System Master Agreement

This AMI System Master Agreement (hereinafter "Agreement") for delivery of Advanced Metering Infrastructure ("AMI") related products and services is entered into effective February 22___, 2022 by and between Jefferson County PUD No. 1, (hereinafter referred to as "Purchaser or JPUD") whose general office is located at 310 Four Corners Port Townsend WA.98368and Vision Metering, LLC having a place of business at 7 Ross Cannon St., York, SC 29745 (hereinafter referred to as "Supplier") (individually referred to as "Party" or collectively as "Parties").

1.1 RECITALS

A. Jefferson County PUD is a Washington State Public Utility District, serving its customers in Jefferson County, Washington.

B. JPUD desires to purchase and obtain from Supplier, and Supplier desires to provide to JPUD, a LoRa Advanced Metering Infrastructure system (or "System") and associated maintenance services for the System as more fully described below.

For and in consideration of the foregoing Recitals and the mutual promises, terms, conditions and warranties, set forth herein, Purchaser and Supplier, hereby agree as follows:

2 Terms and Conditions

2.1 Term

This Agreement is effective for a period of five (5) years from the date of Final System Acceptance, as defined herein. Thereafter, this Agreement shall automatically renew from year to year (each year, a "Renewal Term"), unless terminated as follows: (i) by either Party providing prior written notice to the other Party at least sixty (60) days before expiration of the Term or a given Renewal Term; or (ii) in accordance with Section 2.33 (Termination) herein.

2.2 Definitions

The terms listed below are defined as follows:

The term "Agreement" means this Master Purchase, License and Services Agreement, including all exhibits and Statements of Work, which is by and between Purchaser and Supplier. In the event there are any conflicting provisions or requirements among the Agreement documents, the provision and requirements of the Agreement document must be enforced in the following order of descending priority:

i. Any amendment to this Agreement;
ii. The body of this Agreement;
iii. Attachment I – Scope of Work

iv. Attachment I – Schedule
v. Attachment I – AMI Requirements
vi. Attachment II – Responsibility Summary;
vii. Attachment I – Pricing Schedule and Bill of Materials;
viii. Attachment I – Integration;
ix. Attachment III – Final System Acceptance (FSAT) Plan;
x. Attachment I – Maintenance and Support Agreement;
xi. Attachment I – Software License Agreement

The term "Annual Maintenance Fee" means annual fees relating to Software, System Support, and Equipment maintenance and support Services including, but not limited to those Services described in the Maintenance and Support Agreement and priced in the Pricing Schedule and Bill of Materials sections of Attachment I.

The term "Available Meter Locations" means a meter that is accessible at a customer's or consumer's meter location and physically accessible by the installation crew.

The term "Collector" means Supplier two-way radio collector that transmits data between the Meters/Modules, and the data center.

The term "Coverage Commitment" shall mean reaching ninety-nine percent (99%) of the installed base of active Meters/Modules and Endpoints via on-request read twenty four (24) hours per day and seven (7) days a week in all weather conditions, excluding non-reporting Meters/Modules and Endpoints found to be in failure due to Purchaser-side problems not caused by and outside of the control of Supplier (such as meter tampering, a damaged Meter or Endpoint, or a damaged transformer, or other Purchaser-related or non-AMI related problem), and except for a Force Majeure event. 100% of Meters/Modules and Endpoints must be read within a rolling three-day billing cycle and in the same three-days 99.% of all interval reads are obtained.

The term "Coverage Commitment Term" shall mean five (5) years from the date that ninety percent (90%) of the Meters/Modules and Endpoints required by this Agreement have been installed and have associated with the System.

The term "Delivery Date(s)" means (i) for Equipment, the date on which such Equipment is delivered in accordance with Section 2.27 (Transportation and Risk of Loss); and (ii) for Software, the earlier of the date on which Purchaser downloads the Software, or thirty days after the Supplier makes the Software available to Purchaser for electronic download.

The term "Endpoint" means a sensory-type device, including, but not limited to, electric meter, water meter, gas meter, distribution automation (DA) device, and/or load control switch, that is equipped with an AMI module or cellular module.

The term "Equipment" means Network Equipment, Meters/Modules, Collectors, Endpoints, Repeaters, and/or hardware that Purchaser purchases from Supplier.

The "Equipment Warranty Period" shall mean Three (3) years from the Delivery Date of the Equipment

The term "Field Tools" means Supplier proprietary tools to be used in the field, including but not limited to software and handheld devices.

The term "Final System Acceptance" means that Purchaser has at the completion of Full Deployment, accepted the Work provided by Supplier after Purchaser has performed a Final System Acceptance Test.

The term "Firmware" means Software embedded in and provided with the Equipment.

The term "Meter/Module" means a device that measures the supply of electricity, comprised of a meter and an AMI module or cellular module, and provided by Purchaser to Purchaser's consumers. Note that the Purchaser will provide Supplier purchase order for an integrated Meter/Module (single part number) that will be supplied by the Supplier.

The term "Network Association" means the event in which a Meter/Module or Endpoint takes to establish its initial registration with the Collector and AMI system and is exchanging data and information available to the user on the AMI software platform.

The term "Network Equipment" means the Collectors, Routers, and radios that are in these devices for radio frequency (RF) that are, or will be, under this Agreement physically deployed in Purchaser's service territory. The term does not include the System backhaul, the network operations center, any system Equipment that is not located in Purchaser service territory, Meters/Modules, or any aspect or component of the System components that is not used by Purchaser.

The term "Network Reconnection Time" means the period of time for a Meter/Module, Endpoint, or Equipment to reconnect to the Collector and AMI System after a period of network stress caused by events such as; power outages, loss of communications at the Collector or Endpoint, resulting in no connection or communication or transmit and receiving of data or information.

The term "Project Manager" shall mean Purchaser or Purchaser's designate, acting as agent and consultant to Purchaser on matters relating to this Agreement. As a representative of Purchaser, the designate would be acting only on Purchaser's behalf and has no responsibility to Supplier to direct, oversee, or supervise any of the Work to be performed and delivered by Supplier under this Agreement.

The term "Purchaser" refers to Jefferson County PUD No. 1.

The term "Specifications" shall mean any requirements for any product contained in the documentation and Attachments, specifically, but not limited to, Attachment I.

The term "Software" means computer application and programs in any form that Purchaser licenses from Supplier.

The term "Services" means project management services, training, project delivery services, commissioning services, and/or other services described in Attachment I Scope of Work and Pricing Schedule and Bill of Material, and Attachment II Responsibility Matrix.

The term "Subcontractor" refers to a person, persons, partnership, association, company, or corporation engaged by Supplier to furnish any portion of the Work, as defined below, to Supplier.

The term "Supplier" in this Agreement refers to Tantalus Systems Inc, a Canadian corporation with USA headquarters in Raleigh North Carolina.

The term "System" means the integrated, installed system providing AMI to Purchaser, comprised of the Supplier's Equipment, Firmware, Field Tools, Software, and any other components as may be necessary to complete the Agreement as herein defined, to include (but not limited to) Collectors, Endpoints, Meters/Modules, Network Equipment, Routers, and Take-Out Points, as herein defined, whether or not fully detailed on drawings (if any) or listed in detail in this Agreement.

The phrase AMI "Take-Out Point" shall mean the location at the end of Supplier's AMI transport System. Third-party or commercial communications equipment coordinated by Purchaser will be required to transport the AMI data from the Take-Out Point to Purchaser's data center.

The "System Warranty Period" shall mean five (5) years from the successful completion of Final System Acceptance Test (FSAT).

The term "Work" includes any and all parts of such design, site preparation, construction, installation, documentation, training, transportation, and testing and the furnishing of all labor and/or other services (including the services of all trades), methods, training, documentation, materials, Software, Firmware, hardware, Equipment, Meters/Modules, Endpoints, and facilities, transportation, and other services as may be necessary for Supplier to complete the System and to meet obligations under this Agreement as herein defined, whether or not listed in detail in this Agreement.

The address of Purchaser's Principal Office is:

Jefferson County PUD No. 1

310 Four Corners Rd

Port Townsend WA 98368

2.3 Cost

The Parties have agreed upon pricing for the System and the Work as set forth in Attachment I, Pricing Schedule and Bill of Material and as otherwise described herein.

All System, Annual Maintenance Fee, Endpoint, and Equipment prices shall be fixed from the date of the first purchase order through **December 31, 2025**. After **January 1, 2026** Supplier may adjust any Equipment line items annually by an amount not to exceed the then current Consumer Price Index ("CPI"). The CPI will be obtained from U.S. Bureau of Labor Statistics (www.bls.gov/cpi) and is designated as of the June-to-June twelve-month percentage change to the CPI – Urban Consumers, All Cities Average, All Items ("CPI-U"). The pricing after any CPI increase must not exceed the Suppliers then-current price.

2.4 Taxes

The Purchaser will be responsible for all Local, State and Federal taxes.

2.5 General Scope of AMI System to be Purchased

Supplier shall provide Purchaser with a System that achieves Advanced Metering Infrastructure ("AMI") access to all of Purchaser's electric Meters/Modules within Purchaser's service territory based on the information provided by the Purchaser.

The responsibilities of Supplier and functionality of its AMI System shall also be comprised of all commitments made in this Agreement, including but not limited to, the Requirements and the Responsibility Matrix (Attachment II), and all materials including product specifications attached hereto as Attachment(s) below.

2.6 Entire Agreement

This Agreement and the attachments and documents attached hereto or referenced herein and hereby expressly incorporated by this reference, when fully executed by both Supplier and Purchaser, shall be deemed to include the entire Agreement between the Parties and shall supersede all other previous and contemporaneous understandings, commitments or representations, whether oral or written, and all subsequent oral agreements concerning the subject matter hereof. Neither Supplier nor Purchaser shall claim any modification resulting from any representation or promise made at any time, by an officer, agent, the Consultant, or employee of any Purchaser or by any other person. Each Party acknowledges that the other Party has not made any representations other than those that are contained herein.

2.7 General Statement of Responsibility of Supplier

Supplier shall perform the Work in accordance with the terms of this Agreement. The obligation of Supplier shall be deemed to carry with it the obligation to incur all items of necessary expense to perform the Work.

Supplier shall have complete and undivided responsibility for complying with the Agreement, including sole discretion for the means by which the Work is to be performed. Without any qualification of such undivided responsibility, Supplier shall have the right to enter into such subcontracts, purchase orders, and other commitments with third parties for the performance of any part of the Work, as may, in Supplier's opinion, be advantageous or necessary for the proper and expeditious or economical prosecution of the Work. Notwithstanding the foregoing, Supplier shall remain primarily responsible for completion of the Work, provision of the System and performance of the Subcontractors. Supplier shall ensure that all Subcontractors agree to, comply with, and follow the terms and conditions of this Agreement. Supplier shall provide written advance notice to Purchaser of all subcontractors. Supplier may not assign this Agreement or any of its duties or responsibilities herein.

2.8 Independent Contractor

The relationship between Purchaser and Supplier shall be that of contracting party to independent contractor. Accordingly, subject to the specific terms of the Agreement, neither Party shall have any general right to prescribe the means by which the other Party shall meet its obligations under the Agreement. This Agreement is not intended to create, nor shall it be construed to create any partnership, joint venture, employment or agency relationship between Supplier and Purchaser, nor shall either Party have any right, power, or authority to enter into any agreement or undertaking for, or act on behalf of, or to act as or be an agent or representative of, or to otherwise bind, the other Party. No Party shall be liable for the payment or performance of any debts, obligations, or liabilities of the other Party, unless expressly assumed in writing herein or otherwise. Each Party retains full control over the employment, direction, compensation and discharge of its employees, and will be solely responsible for all compensation of such employees, including social security, withholding and worker's compensation responsibilities.

2.9 Purchaser Review and Approval

Unless otherwise agreed to by express written statement in the Agreement, Purchaser's review and/or approval of the specifications, drawings, and related documents developed by Supplier as part of its proposal to the Purchaser or pursuant to this Agreement shall in no way or manner relieve or lessen Supplier's responsibility under this Agreement for the professional quality, technical accuracy, and completeness of such documents.

2.10 Supplier Representations

In order to induce Purchaser to enter into this Agreement, Supplier makes the following representations and warranties:

1. Supplier has examined and carefully studied this Agreement, including all Attachments hereto and information provided by JPUD

2. Supplier is fully qualified to complete the Work in accordance with the terms of this Agreement within the time specified;

3. Supplier, its employees, agents and any subcontractors have all licenses, permits, qualifications, and approvals that are legally required to practice their respective professions in the State of Washington and to complete the Work in accordance with the terms of this Agreement.

4. Supplier is familiar with and is in compliance with all federal, state, and local statutes, laws, rules, and regulations including but not limited to OSHA, NEC, and NESC, and any regulations that may affect cost, progress, completion and performance of the Work.

5. There are no complaints, claims, suits, actions, mediations, arbitrations or proceedings or investigations pending or, to the knowledge of Supplier, threatened against or affecting Supplier that would, if adversely determined, have a material adverse effect on Supplier's

ability to perform its obligations hereunder, or on the validity or enforceability of this Agreement.

2.11 Change-Orders

Changes to the System to be provided under this Agreement, the Work, the sums to be paid, or the time permitted for performance of the Work under this Agreement can only be made by a written change-order signed by duly authorized representatives of both Purchaser and Supplier following the procedure and requirements described below. No other verbal or written communication or action or failure to act on the part of Purchaser or any of Purchaser's representatives including its consultants, can substitute for a written change-order signed by a duly authorized representative of Purchaser.

The change-order shall identify all affected items in the Agreement including technical matters (i.e., functions, performance, reliability, etc.), cost, schedule, process and all other factors affected including reference to contract terms. Only items specifically identified in a written change-order as modified are affected.

Purchaser may request a change by providing a written change-order as described above to Supplier in writing. Supplier agrees it will make all reasonable efforts to meet the request for a change in the Work, but in no event shall be later than ten (10) business days, and shall promptly respond regarding its ability to meet the request.

Supplier may request a change by providing a written change-order as described above to Purchaser in writing. Supplier must secure prior Purchaser approval for all change orders. Purchaser shall respond within ten (10) business days to either accept or deny the change-order as written, provided that if no response is made, Purchaser's silence shall be deemed a denial of the change-order.

If the terms of a change-order are agreed to, the requesting Party shall provide two executed copies to the other Party for signature. The Party accepting the request shall sign both copies and return one original copy of the signed change-order to the requesting Party.

When invoicing for change-order items, Supplier shall reference the change-order and itemize it separately.

2.12 Right to Use Accepted System

Purchaser shall have all rights to use the installed system from first installation until retirement.

2.13 Defective Work and System (Warranty)

Notwithstanding the acceptance of the System by the Purchaser or the provision of any certificate with respect to delivery or acceptance of the System, the following warranties shall apply:

A. Equipment Warranty. During the Equipment Warranty Period (see definition), Supplier warrants that the Equipment furnished to Purchaser under this Agreement and all

components thereof will comply with the Specifications and will be: (1) of new manufacture upon Delivery, (2) free from defects in design, workmanship and materials, (3) conveyed to Purchaser with good and merchantable title, free and clear of all security interests, liens, encumbrances or claims of subcontractors and third party suppliers, and (4) fully tested in accordance with the Specifications. This warranty does not cover Equipment in poor operating condition due to: (a) changes made to the Equipment by Purchaser, without Supplier's prior consent; (b) use with third party software, hardware or firmware that Supplier has not provided to Purchaser or approved in writing for use with Equipment; (c) Purchaser's misuse, abuse, negligence, or failure to install, test, handle or operate the Equipment in accordance with its specifications; (d) a Force Majeure event. Supplier will repair Equipment damaged by any of the foregoing items (a) to (d) above only upon Purchaser's payment of costs to repair or replace such damaged Equipment.

B. System Warranty. Supplier warrants that the System will perform in accordance with Documentation and this Agreement including, but not limited to, the Specifications set forth in any System supporting documentation. This System Warranty only covers problems reported to Supplier in writing during such System Warranty Period. In the event of a breach of the foregoing System Warranty, in addition to Supplier's other obligations under this Agreement, Supplier will, at its sole expense, repair, modify, or adjust the System to make it conform to the foregoing System Warranty.

C. Intellectual Property (IP) Warranty. Supplier warrants that the sale, use, or incorporation into manufactured products of all machines, parts, components, services, devices, material and rights furnished or licensed hereunder which are not of Purchaser's design, composition or manufacture shall be free from any patent, copyright, trademark, or other proprietary rights for the payment of any license fee or royalty to others by Purchaser. Supplier shall be liable for, defend and save Purchaser harmless from any loss, damage, or expense whatsoever, including but not limited all costs of defense by counsel selected by Purchaser, that Purchaser may suffer from Supplier's breach of any of these warranties in accordance with Section 2.26 (Indemnification) of this Agreement.

D. Compliance with Laws. The Supplier warrants that the Work and the System, upon delivery and when operated in accordance with the Documentation, will comply with and will have been produced, processed, delivered, and sold in conformity with all applicable federal, state, and local laws and administrative regulations and orders.

For any Equipment under warranty that does not comply with the warranties herein, Supplier shall pay all costs and expenses of repair or replacement, including correction of cause of defect and return shipping to Purchaser's site. The decision whether to repair or replace will be made with the concurrence of Purchaser and the repair or replacement will be scheduled consistent with Purchaser's operating requirements so as to minimize loss of production or use of the Equipment or of any plant or equipment of which the Equipment is a part. Repaired or replaced Equipment must be made from new parts.

All warranties for any repaired or replaced Equipment will be six (6) months from the date of re-delivery of the repaired or replaced Equipment, or for the duration of the remaining Equipment

Warranty Period, whichever is longer. The warranty for new Equipment placed into service due to a warranty claim shall be the same as the Equipment Warranty Period.

2.14 System Life Expectancy

Supplier represents and warrants that the Work, System and Equipment purchased from Supplier shall be supported for a minimum of fifteen (15) years from the date of First Installation said term being the Life Expectancy, through Supplier making available for purchase products and services that are compatible with those purchased under this Agreement for the first five (5) years Supplier shall make available spare parts for all Equipment purchased or provided under this Agreement and corrections for any Software purchased or provided under this Agreement during the Life Expectancy of the System. After the first five (5) years following Final System Acceptance, the Supplier shall take commercially reasonable steps to make available for purchase maintenance service, additional equipment and spare parts for all equipment ordered under this Contract, and corrections for any software ordered for the life expectancy of the System. In the event Supplier's business changes such that it no longer manufactures the equipment or spare parts, Supplier shall offer equivalent and backwards compatible next generation products. In the event System support is terminated by Supplier during the term of the Life Expectancy, other than for Force Majeure, Purchaser shall receive compensation pro-rated based on the initial cost of the contracted goods and services as set forth in Section 2.32 (Liquidated Damages and Remedies), and the Purchaser shall, at its option and at no cost be free to terminate the Agreement.

2.15 Deployment Plan

The deployment will occur at the Purchasers discretion. Purchaser desires to purchase gateways, meters, and head end software at their convenience and deploy on their schedule. An equipment forecast will be provided by Purchaser which will be a part of the deployment plan.

2.16 Payment to Supplier

Supplier will issue invoices to Purchaser for all amounts owed to Supplier hereunder. Invoices: (i) for Work and Services will be issued upon completion of the Work or Service; and (ii) for the Equipment shall be issued upon delivery.

Invoicing and payment shall be commensurate with retainage as shown in the table below and the Pricing Schedule set forth in Attachment I. Written authorization shall be required from Purchaser before Services commence.

Purchaser will review, approve, and pay each undisputed invoice within thirty (30) days of receiving such invoice and other documents required hereunder. Supplier may collect a late fee of no more than one and one-half percent (1.5%) of the unpaid amount of an undisputed invoice if not paid in the thirty (30) day period.

After delivery and inspection at destination, Purchaser will be responsible for any loss, theft, physical damage, or abuse that affects the operation of the System and occurs while System is in the control of Purchaser.

Notwithstanding any provision in this Agreement to the contrary, Purchaser may withhold any or all payment or payments for Work done to the extent of protecting Purchaser against loss on account of:

- Defective workmanship and materials;
- Failure of Supplier to make payments promptly to Subcontractors or Suppliers for material or labor;
- Damages to structures or property caused by a Supplier Party; and
- Other specified reasons set forth in this Agreement.

Unless otherwise provided for in the Agreement, all prices for Work and Equipment are firm and fixed.

Purchaser reserves the right to refuse or return at Supplier's risk and expense shipments made in advance of required schedules, or to defer payment on advance deliveries until scheduled delivery dates.

As a condition of payment, Supplier shall provide to Purchaser a Lien Waiver for the labor and material covered by said payment. If said payment included labor and supplies by a subcontractor, Supplier shall obtain a Lien Waiver from the subcontractor and provide to Purchaser within three business days of receipt of the payment. In the event the Supplier does not provide a Lien Waiver from an applicable subcontractor, the Supplier shall defend, indemnify and hold harmless Purchaser, for any and all expenses and costs, incurred due to the subcontractor filing a lien or claim against Purchaser.

2.17 Equipment Forecasts

Within sixty (60) days after the Effective Date of this Agreement, Purchaser shall supply to Supplier a written forecast of total anticipated Supplier Equipment needs by month. Any changes to the Equipment forecast should also be furnished to Supplier.

2.18 Purchase Orders

Purchases shall be authorized by Purchaser's issuance of a written Purchase Order ("Purchase Order") to Supplier by mail, facsimile communication or electronic mail. Supplier may accept Purchaser's Purchase Order by signing it, acknowledging it, using facsimile or electronic mail, or by delivering the System Component that Purchaser ordered. Notwithstanding any other provision herein, Purchaser's Purchase Order will be accepted solely for purposes of establishing the items and quantities ordered and the desired shipment dates and shipment method. Purchaser's desired shipment dates shall take into account Supplier's current lead times at the time of the Purchase Order. Lead times will be provided to Purchaser by a Supplier representative and are defined as the cycle time from acknowledgement of Purchase Order to fulfillment of Purchase Order. It is

acknowledged by the Parties that all instruments and documents issued or delivered pursuant to this Agreement, including any and all Purchase Orders, Purchase Order acceptance, Purchase Order acknowledgements, invoices and other instruments ("Purchase Order Documents") shall incorporate by reference the terms and conditions of this Agreement, irrespective of whether any such Purchase Order Document expressly references this Agreement, and shall be subject to the terms and conditions contained in this Agreement. In the event of a conflict as between the terms and conditions of any and all Purchase Order Documents and this Agreement, this Agreement controls. Any terms and conditions contained in a Purchase Order Document now or hereafter delivered by a Party pursuant to this Agreement other than quantities, service description and other required details and shipping instructions, will not apply and each Party hereby waives and rejects all such terms and conditions.

2.18.1 Cancellation and Modifications

Purchaser may, without penalty, cancel or reduce a Purchase Order for Equipment on written notice to Supplier no later than sixteen (16) weeks prior to scheduled delivery of the order. If Purchaser cancels or modifies an Equipment order within sixteen (16) weeks prior to delivery, such Equipment order may be subject to reasonable cancellation charges. Notwithstanding the foregoing, cancellation charges do not apply to cancellations by Purchaser of Purchase Orders for Software or Services.

2.19 Coverage and Performance Commitment

Supplier agrees to satisfy the Coverage Commitment as defined herein for the duration of the Coverage Commitment Term.

Regardless of the number of towers or Collectors described in the Pricing Schedule (Attachment I), Supplier must achieve the Coverage Commitment. In the event the Coverage Commitment is not met, the costs of additional equipment, including additional Collectors, repeaters, base stations, higher towers/poles, etc., will be the responsibility of Supplier. It is understood that towers, poles and other structures selected to mount gateways will be at least 60' (sixty feet) high or higher. Every effort and accommodation will be made, where reasonable, to mount the Network Equipment at or above the 60' height. Such as maximizing existing mounting locations and terrain (height above ground level) advantages, through the Supplier's recommendations and final approval of the Purchaser.

Supplier certifies that the network as quoted and deployed under this Agreement will:

A. Meet the Coverage Commitment term and meet the requirements listed in the Coverage Commitment listed in Section 2.2

B. Network Association and Network Reconnection Time: Network association time represents the time it takes for a device to establish its initial registration. Once the stress is removed from the local area network, 95% of electric meters that were Available Meters prior to the event will reconnect within 120 minutes assuming the stress was less than 8 hours in duration.

C. Read Success Rate. Customer will be able to achieve a minimum 99% percent daily read for each electric meter by 8 a.m. each day, and 100 percent over any three consecutive day billing window. For a requested read of one (1) electric meter, a return read rate of equal to or less than 30 seconds and for a requested read of up to 100 meters, a return read rate of 99% within 45 seconds or less.

D. Remote Connect/Disconnect. It is expected that the individual electric meters with remote connect/disconnect capability will action a remote disconnect request with no major system events (such as a major power outage) occur during this duration. Reconnect functionality will be the same. For any reconnect and disconnect the return time to complete either action will be within 30 to 45 seconds or less.

After Purchaser has completed any required network optimization at least 97 percent of Available Meter Locations and in a condition to allow a new meter install (socket condition, etc.) Supplier shall configure the network to support:

A. 100 percent of single-phase meters reporting 15-minute interval data and 10 percent of the single-phase meters reporting 15-minute voltage information.

B. 20 percent of all socket based polyphase meters reporting 15-minute interval data and 10 percent of the socket based polyphase meters reporting 15-minute voltage information

C. 10 percent of all transformer based polyphase meters reporting 5-minute interval data at with the remaining meters (90 percent) reporting 15-minute data. In addition, 10 percent of the transformer based polyphase meters need to report 5-minute voltage information.

After 10 days of operation, at least 97 percent of all interval reads and voltage reports shall be obtained within the above interval recording cycles. All interval data must be reported within 4 hours of the recorded interval.

2.20 Major Endpoint Failure

If in the first five (5) years following the Effective Date, a major failure occurs with the Endpoints provided by Supplier (with "major" being defined as one percent (1%) of the installed base within any rolling twelve (12) month period), Supplier shall provide Purchaser replacement Endpoints as needed at no cost and pay for shipping.

Endpoint failures will be tracked by Purchaser and reported to Supplier on a mutually agreed schedule.

2.21 Endpoint Failure upon Installation

For Endpoint failures and defects, including but not limited to, zero consumption and non-association discovered within 24 hours of installation of that Endpoint during Full-Deployment and during any warranty period, other than failures due to Purchaser-side problems not caused by and outside of the control of Supplier (such as meter tampering, a damaged Meter or Endpoint, or

a damaged transformer), and except for a Force Majeure event, Supplier shall remedy or repair the failure or defect within fourteen (14) days after notice from Purchaser as stated in Section 2.13 [Defective Work and System (Warranty)] and Supplier shall provide Purchaser replacement Endpoints as needed at no cost and pay for shipping.

2.22 Tests and Inspections

The Equipment furnished pursuant to the Specifications in Attachment I shall be in compliance with all of the standard commercial inspections and tests normally performed by Supplier and its Subcontractors or other suppliers in the industry. Supplier shall furnish Purchaser with such certified information and test certificates as are normally made available to customers of Supplier's manufacturing divisions and subsidiaries and other manufacturers of equipment specified within. Purchaser or its agent has the right to witness all factory and/or site tests and inspections. Purchaser shall not be required to accept any Equipment until the Equipment has undergone and successfully met such tests and inspections.

2.23 Applicable Laws and Courts

Supplier will comply with all applicable federal, state, and local statutes, laws, rules, codes, and regulations.

This Agreement will be governed by and construed and enforced in accordance with the laws of the State of Washington without regard to its conflicts of law principles. Venue of any legal proceedings arising from or concerning this Agreement shall be in the Superior Court of Jefferson County, Washington.

2.24 Insurance

As additional security for Purchaser and as separate obligation of Supplier not in conjunction with any other provisions of this Agreement, Supplier agrees to carry and maintain during the term of this Agreement and all warranty periods occurrence-based liability insurance with coverages and limits of liability not less than those shown herein. Each of Supplier's subcontractors of any tier, if any, shall also provide and maintain during the term of their respective agreements the insurance coverages specified as follows, with limits of liability determined appropriate by Supplier. In the event work is performed by a subcontractor, Supplier shall be primarily responsible for any liability arising directly or indirectly out of the Services performed that is not otherwise covered by any subcontractor's insurance. All such insurance shall be primary with respect to any other insurance or self-insurance programs afforded to or maintained by or for the benefit of Purchaser and shall not require the exhaustion of any other coverage.

Supplier shall procure at its expense, and maintain, and shall require all of its subcontractors, if any, to procure and maintain in full force during the full term of this Agreement, insurance policies, from an insurer, or insurers, licensed to do business in the State of Washington possessing a Best's policyholder's rating of A- or better and a financial rating of less than VIII and reasonably acceptable to Purchaser where the work hereunder is to be performed. Each of such policies shall

be in such form and issued by such insurer as shall be satisfactory to Purchaser; and the said policies shall provide insurance of the type and, at a minimum, in the amounts below indicated:

1. Workers' Compensation Insurance and Employer's Liability coverage, with limits as required by applicable law covering all of Supplier's employees, or any individual who may be deemed Supplier's employee, who perform any obligations relating to or under this Agreement as per the laws of the State of Washington. Workers' compensation insurance is required, and no "alternative" forms of insurance shall be permitted.

2. Employers Liability Insurance with limits of not less than $1,000,000 per occurrence and $1,000,000 per disease/each employee.

3. Commercial General Liability Insurance under an occurrence policy form insuring the indemnity agreements set forth in this Agreement with a combined single limit of not less than $1,000,000 per occurrence and $2,000,000 in the aggregate, including endorsements for Premises/Operations, Personal Injury Liability, Products/Completed Operations, Blanket Contractual Liability assumed in the Agreement, including indemnification liability, and Completed Operations Coverage (minimum 2 years past completion of the Work). The policy must be endorsed to provide that aggregates limits apply on a per project basis. Coverage shall also be included for any construction or work on or within 50 feet of a railroad.

4. Business Automobile Liability Insurance covering liability arising out of any auto (owned, hired and non-owned) with a combined single limit of at least $2,000,000 per person and $2,000,000 each occurrence.

5. Umbrella Insurance (Excess Liability) with minimum limits of $5,000,000 per occurrence.

Additional Insured: All policies, including any provided by subcontractors of any tier, if any, except for Workers' Compensation/Employers Liability, Professional Liability shall name, by policy endorsement, Purchaser as an additional insured. The Supplier shall forward evidence of insurance and copies of the additional insured endorsements of each Subcontractor of every tier prior to commencement of work by the Subcontractor.

Waiver of Subrogation: Supplier hereby waives all rights of subrogation against Purchaser and its respective commissioners, officers, members, employees, agents and insurers, and all policies of insurance (except Professional Liability and Pollution Liability) provided for above shall contain a provision and/or endorsement stating that the insurance carriers and underwriters waive all rights of subrogation in favor of Purchaser and its respective commissioners, officers, members, employees, agents and insurers.

Primary & Non-Contributory: Purchaser and Supplier intend that the Supplier shall ensure that all policies purchased and/or maintained in accordance with this section will protect Purchaser and Supplier, and will be primary and non-contributory with any other coverage elsewhere afforded or available to Purchaser, as well as provide primary coverage for all losses and damages caused by the perils covered thereby related to or arising out of the Work, and shall not require the exhaustion of any other coverage.

Severability & Cross Liability: The policies shall also include standard severability provisions that state each insured is provided coverage as though a separate policy had been issued to each, except with respects to limits of insurance. The policies shall not contain a cross liability or a cross-suit exclusion that prevent Purchaser from asserting claims against the Supplier or any other Insured under the policies.

Proof of Insurance and Replacement: The insurance required hereunder shall be maintained in effect during the entire duration of this Agreement. Certificates of Insurance meeting the requirements set forth herein shall be delivered to Purchaser prior to the commencement of the Work. Replacement certificates of insurance evidencing continuation of such coverage shall be furnished to Purchaser prior to the expiration of the current policies. Each copy or certificate shall contain a valid provision or endorsement that the policy may not be canceled, terminated, changed or modified without giving thirty (30) days written advance notice thereof to Purchaser. Purchaser's receipt of or failure to object to any insurance certificates or policies submitted by Supplier or its subcontractors does not release or diminish in any manner the liability or obligations of Supplier or its subcontractors or constitute a waiver of any of the insurance requirements under this Agreement. Should Supplier or any subcontractor at any time neglect, refuse to provide or cancel the insurance required herein, such failure shall constitute a default under this Agreement, and Purchaser shall have the right to terminate this Agreement and/or pursue any remedy available at law.

2.25 Settlement Preferred

Purchaser and Supplier will attempt to settle any claim or controversy arising from this Agreement (except for a claim relating to intellectual property) through consultation and negotiation in good faith and a spirit of mutual cooperation. It is anticipated that the respective Project Managers will confer and attempt to settle a dispute when appropriate before escalating the dispute to appropriate higher-level managers of the Parties, if necessary. Unresolved disputes may either be litigated or, with the mutual consent of the Parties, arbitrated on such terms and conditions as the Parties may mutually agree.

2.26 Indemnification

1. Supplier shall indemnify, defend and hold harmless Purchaser, Purchaser's officers, Commissioners, partners, employees, consultants, contractors, and agents from and against and in respect to any and all claims, actions, suits, proceedings, demands, assessments, judgments, costs, losses, damages, fines, penalties, fees, and any expense whatsoever and fees (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of personal injury, death, sickness, disease, violation of any federal, state, or local law, rule, or regulation, unauthorized disclosure of Confidential Information, infringement of any third party intellectual property right by any software, intellectual property, equipment, materials, supplies, installation methods used in the Work or the System or the use thereof by Purchaser, and any damage to tangible or intangible property, including the loss of use thereof, hereinafter referred to as "Liabilities" to the extent that such Liabilities were caused in whole or in part by the acts, errors, or omissions of any Supplier, its agents, employees, Subcontractors or others

for whom Supplier is responsible, arising out of, in connection with, or as a result of the performance and furnishings of the Work or other services performed by any Supplier Party for or on behalf of Purchaser. Nothing herein shall be construed as making Supplier liable for any injury, death, loss, damage or destruction caused by any negligence of Purchaser. After mutual negotiation of the parties, the Supplier waives immunity as to the Purchaser and its employees and agents only under title 51 RCW, "Industrial Insurance."

2. Purchaser agrees that it will give prompt written notice to Supplier of any Liabilities asserted against Supplier for which Purchaser believes Supplier is responsible for indemnification, in whole or in part. Upon receipt of such written notice, Supplier shall defend at its own expense, with either counsel of its choosing, but reasonably acceptable to Purchaser, or Purchaser's selected counsel, any suit, claim or action brought against any Purchaser Party based upon such Liabilities.

3. Supplier agrees that it maintains Insurance ("Insurance") for purposes of insuring against loss as a result of Liabilities caused in whole or in part Supplier; such insurance coverage is acknowledged to comply with the requirements as designated in Section 2.24 (Insurance). Supplier understands and agrees and further warrants and represents to Purchaser that, notwithstanding any other provision to the contrary herein contained, Supplier's Liability for any and all losses, whether to Purchaser or to third parties, resulting from any Liabilities caused in whole or in part by Supplier's negligence shall not be limited to the amount of any insurance proceeds payable to or on behalf of Supplier under such Insurance, and Supplier agrees to immediately indemnify and hold Purchaser harmless for any and all such Liability in excess of such insurance proceeds. Supplier shall furnish written proof of such insurance upon execution of this Agreement, and at least annually to Purchaser with Purchaser as additional named insured.

4. Hazardous Materials Indemnification. To the fullest extent permitted by law, Supplier shall indemnify, defend and hold harmless Purchaser from and against all claims, losses, damages, liabilities and expenses (including attorneys' fees), arising out of or resulting from hazardous materials brought onto any site, or from negligent handling of an existing hazardous condition, by Supplier or any subcontractor or their respective employees or agents or anyone else acting under their direction and control or on their behalf in connection with performance of the work or during any curative action under any warranty

2.27 Transportation and Risk of Loss

1. Supplier shall be responsible for the proper packaging of equipment, materials, items and components of the System and Work provided or purchased hereunder and shall exercise every precaution to adequately protect all shipments against damage in transit. The method of transportation and routing shall be at the option of Supplier for delivery to the destination designated by Purchaser. Shipping will be F.O.B. York, SC prepaid and added to the invoice. Purchaser shall be responsible for correcting and collecting for any damage or loss while the equipment, items, components or materials it ships are in transit, prior to receipt of the equipment or materials at Purchaser's designated destination, and while any such equipment, items, components or materials are in control of any Supplier Party.

2. All material and workmanship shall be subject to inspection and testing at reasonable times and places by Purchaser before, during, and after performance and delivery. If any loss of or damage to the Work or System or component thereof occurs prior to delivery to Purchaser, Purchaser may require that Supplier promptly make all repairs or replacements at no cost to Purchaser as necessary to place the Work and System in the condition required by this Agreement.

3. Purchaser's failure to inspect or test does not relieve Supplier of any responsibility to perform according to the terms of this Agreement. Acceptance of the System and Work comprised of goods by Purchaser shall not constitute acceptance as to latent or hidden defects not subject to discovery upon reasonable inspection or testing.

4. Supplier shall notify Purchaser in writing when any material, equipment, item or component is ready for shipment. One (1) copy of the notice of shipment covering all items shipped shall be issued by Supplier and forwarded to Purchaser's office. In addition to the preceding, a complete packing list of every individual item in each box, crate, or other shipping enclosure shall be sent to Purchaser with a duplicate enclosed with each box, crate or other shipping container.

2.28 Confidential and Proprietary Information

The following language shall supersede any prior Non-Disclosure Agreement (a.k.a., "Confidentiality Agreement") entered into by the Parties relating to this AMI System and/or Work upon the execution of this Agreement:

In the course of performing the Work covered by this Agreement, both Parties may disclose certain confidential and proprietary information to the other. Confidential or proprietary information must be of such a nature that it would reasonably be concluded to be of a confidential nature or be clearly marked as confidential or proprietary and may include but is not limited to all data, materials, products, technology, computer programs, designs, drawings, specifications, manuals, business plans and information, marketing plans, financial information, and customer information (including names, addresses, email addresses, telephone numbers, and personal financial information) ("Confidential Information"). Both Parties agree to maintain the confidential and proprietary nature of this information, along with any information developed under this Agreement, and shall disclose it only to its officers, directors, agents, suppliers, consultants, or employees with a specific need to know in the performance of this Agreement. Neither Party shall publish, distribute or disclose the existence or subject matter of Confidential Information to any third party without prior written consent of the Party providing Confidential Information. Confidential Information shall not include material which: (i) at the time of disclosure is in the public domain or which, after disclosure, becomes part of the public domain by publication or otherwise; or (ii) is information which Purchaser can show was in its possession at the time of disclosure and was not acquired directly or indirectly from Supplier; or (iii) is information received by Purchaser from a third entity having legal right to transmit the same.

Each Party may disclose the other Party's Confidential Information if and to the extent that such disclosure is required by applicable law or legal process, provided that the receiving Party shall, prior to making such a disclosure, use commercially reasonable efforts to notify the disclosing

Party of such requirements (as allowed by law) to afford the disclosing Party the opportunity to seek, at the disclosing Party's sole cost and expense, a protective order or other remedy. Supplier acknowledges that Purchaser is a municipal entity subject to the Washington State Public Disclosure Act, RCW 42.56.

Upon request, either Party shall return to the other Party any Confidential Information given to it by the other Party, except that information provided by Supplier to Purchaser for the operation and use of the Work or provisioning the System made part of this Agreement, shall remain with Purchaser as long as Purchaser continues to have the associated software licenses. The Party returning Confidential Information shall destroy or provide to the other Party any documents or other media it created that contains Confidential Information. The Party returning Confidential Information shall certify in writing that such documents or other media it created are destroyed if such is requested.

Disclosure of Confidential Information beyond what is outlined above shall be approved in writing by the other Party in advance of such disclosure.

2.29 Safety and Compliance with Codes and Other Laws

Supplier shall at all times be solely responsible for complying with all applicable federal, state, and local laws, ordinances, regulations, and codes in connection with the Work, including those relating to the safety of all persons and property. This shall include obtaining all licenses and permits required for the Work. Supplier understands that the obligations of the Parties hereunder are subject to the applicable regulations and orders of governmental agencies having jurisdiction in the matters.

Should at any point Supplier find any unsafe or hazardous areas or conditions, Supplier will immediately report the said condition to Purchaser.

No obligations shall be imposed upon Purchaser, Purchaser's officers, directors, partners, employees, consultants, and agents to review or supervise Supplier's compliance with any safety measures, laws, ordinances, regulations, or codes. Supplier is solely responsible for its acts, errors, and omissions and the acts, errors, and omissions of any Subcontractor, of any Supplier or of any other individual or entity performing any of the Work.

2.30 Time is of the Essence

Time is of the essence and shall remain a material element of this Agreement, and no acts of Purchaser, including without limitation, modifications of this Agreement or acceptance of late deliveries, shall constitute waiver of this provision. SUPPLIER SHALL BE LIABLE AND SOLELY RESPONSIBLE FOR ANY AND ALL CLAIMS OR DIRECT DAMAGES PURCHASER MAY INCUR DUE TO SUPPLIER'S FAILURE TO PROVIDE TIMELY PERFORMANCE WITH THIS AGREEMENT. Purchaser also reserves the right to refuse or return at Supplier's risk and expense shipments made in advance of required schedules, or to defer payment on advance deliveries until scheduled delivery dates. Supplier shall notify Purchaser in writing immediately of any actual or potential delay to the performance of this Agreement and such notice shall include a revised schedule and shall not constitute a waiver to Purchaser's rights

and remedies hereunder. Every effort will be made by the Supplier to deliver equipment on time, however, conditions due to the pandemic can cause delays beyond the Supplier's control. Leniency will be granted by the purchaser to the Supplier if adequate information supporting conditions beyond the control of the Supplier support the delays.

2.31 No Implied Waiver

Either Party's failure to insist upon strict performance by the other Party of any of the terms of this Agreement shall not be construed as a waiver of terms of this Agreement. No waiver shall be deemed a continuing waiver or waiver in respect of any subsequent breach or default, either of a similar or dissimilar nature, unless expressly so stated in writing by a duly authorized representative of the waiving Party.

2.32 Liquidated Damages and Remedies

A. Right to Cure. If default shall be made by the Supplier or any Supplier Party in the performance of any of the terms of this Agreement, Purchaser, without in any manner limiting its legal and equitable remedies in the circumstances may provide to Supplier a written notice requiring Supplier to cause such default to be corrected forthwith. Unless within ten (10) days after the provision of such notice to Supplier such default shall be corrected or arrangements for the correction thereof satisfactory to Purchaser shall be made by the Supplier, Purchaser shall be entitled to any right or remedy available herein or existing at law or in equity including termination of this Agreement

B. Liquidated Damages for Performance Delays. Time is of the essence with respect to the observance of the terms and conditions of this Agreement. Purchaser shall have the right to assess Liquidated Damages for Supplier's delay in performing the Work as follows upon written notice to Supplier and the expiration of the ten (10) day period set forth in paragraph A above if any of the following occurs:

1. If the Supplier neglects, refuses or fails to complete Full Deployment and the FSAT, within the time herein agreed upon, after giving effect to extensions of time, if any, herein provided or affirmatively accepted in writing by Purchaser, then, in that event and in view of the difficulty of estimating with exactness damages caused by such delay, Purchaser shall have the right to assess liquidated damages of three thousand dollars ($3,000), plus five hundred dollars ($500) per each calendar day the Supplier is late in completing performance until such time as Full Deployment and FSAT are completed or Purchaser elects to terminate this Agreement, but not to exceed fifty percent (50%) of the amounts paid and payable for the Full Deployment. Every effort will be made by the Supplier to deliver equipment on time, however, conditions due to the pandemic can cause delays beyond the Suppliers control. Leniency will be granted by the Purchaser to the Supplier if adequate information supporting conditions beyond the control of the Supplier support the delays.

2. If the Supplier neglects, refuses or fails to timely provide replacement Products pursuant to Section 2.14 (System Life Expectancy), Supplier shall be assessed

$20,000 for each month the Supplier is delayed in providing replacement products until such time as the replacement products are provided or Purchaser elects to terminate this Agreement, but not to exceed $600,000. Every effort will be made by the Supplier to deliver equipment on time, however, conditions due to the pandemic can cause delays beyond the supplier's control. Leniency will be granted by the Purchaser to the Supplier if adequate information supporting conditions beyond the control of the supplier support the delays.

If Supplier otherwise neglects, refuses or fails to meet its obligations under Section 2.14 (System Life Expectancy), then, in that event and in view of the difficulty of estimating with exactness damages caused by such default, Purchaser shall have the right to assess Liquidated Damages in the amount paid by Purchaser to Supplier to the date of default.

Any assessment of Liquidated Damages may be deducted by Purchaser from any payment then due or which may become due and payable to Supplier. If the amount due and to become due from Purchaser to the Supplier is insufficient to pay in full any such Liquidated Damages, Supplier shall pay to Purchaser the amount necessary to affect such payment in full.

C. **Cumulative Remedies**: Every right or remedy herein conferred upon or reserved to Purchaser shall be cumulative, shall be in addition to every right and remedy now or hereafter existing at law or in equity or by statute and the pursuit of any right or remedy shall not be construed as an election: Provided, however, that the provisions of subsection (B), above, shall be the exclusive measure of damages for failure by the Supplier to meet the specific obligations described in subsection (B) within the time or for the duration of time herein agreed upon.

2.33 Termination

Purchaser may terminate this Agreement with or without cause, in whole or in part, at any time by written notice to Supplier. In such an event, Purchaser shall pay Supplier for any outstanding undisputed invoices and for all actual labor and material costs incurred prior to such termination notice in accordance with Attachment I less salvage value, unless termination is for cause such as non-performance or default by Supplier.

Upon receipt of a notice of termination of some or all of the System, Supplier shall discontinue the provisioning of the System and make every effort to cancel all subcontracts, orders and other agreements, or portions thereof that involve the terminated System. If Purchaser specifically requests, Supplier shall attempt to transfer subcontracts to Purchaser. Purchaser shall not be liable for any damage to any subcontractor in case of termination.

Supplier will also make every effort to preserve the terminated portion of the System regardless of location, assist with inventory of the terminated System, identify outstanding orders and subcontracts, and as requested by Purchaser, transfer the System and title to the System to Purchaser. Purchaser may decline title to any portion of the System.

Supplier shall not be entitled to damages resulting from termination of any Work or provisioning of the System, including loss of anticipated revenue or costs such as idle personnel or equipment.

If the Supplier defaults in the performance of the Work, the Purchaser may at its option, finish the Work by any method possible, including contracting with another supplier.

2.34 Extension to Successors and Assigns

Each and all of the covenants, obligations and agreements contained in this Agreement shall extend to and be binding upon the successors and assigns of the parties hereto.

2.35 Expenses and Fees

In the event of a default under this agreement, if the non-defaulting Party resorts to legal proceedings of any kind to resolve a dispute or to enforce or protect their rights under this agreement, the non-defaulting Party will be entitled to recover, upon demand, from the defaulting Party all reasonable out-of-pocket expenses, including Legal Costs, incurred by the non-defaulting Party relating to said legal proceedings for resolution of a dispute or enforcement or protection of rights under this Agreement, including but not limited to, costs of collection. "Legal Costs" means the reasonable out-of-pocket expenses related to the cost of legal proceedings incurred by it, including legal fees.

Neither party shall be liable to the other for any compensation in excess of that expressly set forth in this Agreement or otherwise agreed to in writing by the parties, including but not limited to lost profits, lost opportunity, unrecovered start-up costs, preparatory, settlement or discontinuation costs or damages, or consequential or other indirect damages, as a result of the termination of a portion or all of this Agreement.

2.36 Intellectual Property Infringement

Supplier shall indemnify, defend and hold harmless Purchaser, Purchaser's officers, directors, partners, employees, consultants, and agents from and against and in respect to any and all claims, actions, suits, proceedings, demands, assessments, judgments, expenses, costs, losses and damages and fees (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising from any and all claims, suits, and proceedings for the infringement of any third party intellectual property right by any software, intellectual property, equipment, materials, supplies, or installation methods used in the Work or the System or the use thereof by Purchaser. The Supplier shall, at its own cost (and Purchaser agrees to permit Supplier to do so with counsel reasonably acceptable to Purchaser), defend any suits, which may be instituted by any Party against the Purchaser for alleged infringement of intellectual property rights relating to the Supplier's performance hereunder.

In the event that any Work, the System, or use of any Work or the System is delayed due to any claim, suit, or proceeding relating to patent infringement, the Supplier shall make every reasonable effort to quickly remedy the situation, at its own cost, so Work and provision of the System can

proceed and be used as desired. This includes but is not limited to obtaining any necessary license arrangements and finding alternatives acceptable to the Purchaser.

2.37 Legal Notices

Any legal notice required or permitted by this Agreement or given in connection with it shall be in writing and shall be given to the appropriate Party by personal delivery, certified mail, or other recognized delivery service that confirms delivery. All notices required, permitted, or desired to be given hereunder shall be deemed duly given and effective (i) when received after being sent by confirmed facsimile transmission or delivered by hand or (ii) five (5) days after being deposited with the United States Postal Service, properly addressed, sent by registered or certified mail, return receipt requested, postage prepaid. Any Party may change its address for the purpose of this Paragraph by giving written notice of such change to the other Parties in the manner provided in this Paragraph.

Legal notices to Purchaser shall be sent to:

Jefferson County PUD No. 1
310 Four Corners Rd
Port Townsend WA 98368

Legal notices to Supplier shall be sent to:

Randy H. Austin
Vision Metering, LLC
7 Ross Cannon St.
York, SC 29745

2.38 No Construction Against Drafter

This Agreement has been negotiated and prepared by Purchaser and Supplier and the Parties' respective attorneys and, should any provision of this Agreement require judicial interpretation, the court interpreting or construing such provision shall not apply the rule of construction that a document is to be construed more strictly against one Party.

2.39 Force Majeure

Neither Purchaser nor Supplier shall be considered in default in the performance of its obligations under this Agreement to the extent that the performance of its obligations is prevented or delayed by any cause beyond the Party's control, including without limitation: acts of God; acts or omissions of governmental authorities; acts of public enemy; wars; blockades; riots; civil disturbances; floods; hurricanes; tornadoes; pandemics; and any other similar events, acts, or conditions (individually and collectively referred to as "Force Majeure").

In the event that Supplier considers Supplier's performance is prevented or delayed by a cause beyond its control, Supplier shall inform Purchaser in writing within five (5) days after Supplier

knows or by reasonable diligence should know of the event causing or likely to impact Supplier's performance. Every effort will be made by the supplier to deliver equipment on time, however, conditions due to the pandemic can cause delays beyond the supplier's control. Leniency will be granted by the purchaser to the Supplier if adequate information supporting conditions beyond the control of the Supplier support the delays.

2.40 Conflict

Except as the Parties may otherwise explicitly agree, pursuant to the terms of this Agreement pertaining to any changes to the Work or amendments to this Agreement, the following rules of conflict shall apply:

1. In the event of a conflict between this Agreement and the terms or conditions of any attachments to this Agreement, the terms and conditions of this Agreement shall control.

2. In the event of a conflict between this Agreement and a purchase order and/or commitment, including any specifications attached thereto, this Agreement shall control.

In the event of an ambiguity in the specifications, drawings, or other requirements of this Agreement, Supplier must, before proceeding, consult Purchaser whose written interpretation shall be final.

2.41 Severability

Any provision or part of this Agreement held to be void or unenforceable under any law or regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon Purchaser and Supplier who agree that this Agreement shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision, provided that such stricken clause is not material to the performance of this Agreement and neither Party is aggrieved by the omission of such clause or the reformation of this Agreement.

2.42 Amendment

Notwithstanding the requirements for change-orders described above, this Agreement may not be changed, amended, modified or released or discharged, in whole or in part, except by an instrument in writing referred to as an amendment to this Agreement signed by authorized representatives of both Parties hereto.

2.43 Section Titles

The section and subsection names in this Agreement are only provided for convenience. In no way do the section and subsection names restrict the applicability of the requirements to the topic area given in the section or subsection name. For example, it is possible requirements under a section labeled "hardware" could actually include software requirements unrelated to the section or subsection title. Furthermore, it is possible that requirements listed under a particular section or

subsection name are not all the requirements for that topic within this Agreement, as requirements on that topic may be listed in other sections, subsections or Exhibits.

2.44 Survival

The rights and obligations of the Parties under this Agreement that would by their nature survive the expiration or termination of this Agreement, including but not limited to those pertaining to further assurances, confidentiality, applicable laws and courts, safety and compliance with codes and other laws, warranty, indemnification, insurance, limitations of liability, and severability shall survive the expiration or termination of this Agreement.

In witness whereof, the Parties have, by their duly authorized representatives, executed this Agreement on the date(s) indicated below.

Jefferson County PUD	**Vision Metering, LLC**
By:_____	By:_____
Print Name:_____	Print Name:_____
Title: _____	Title: _____
Date:_____	Date:_____

Attachments

It is hereby mutually agreed by the Parties that the following list documents are to be included as part of this Agreement and herein incorporated by reference for all purposes.

Attachment I: Full Vision Response to RFP

Scope of Work:	Pages 17-18
Schedule:	Page 5
AMI Requirement:	Pages 13-17
Integration:	Pages 1, 13, 50
Pricing Schedule/Bill of Materials:	Pages 19-20
Maintenance and Support Agreement:	Page 21
Software License Agreement	Pages 34-38

Attachment II: Responsibility Summary (From JPUD RFP #2021-008 Section 4.2, Page 5)

Attachment III: Final System Acceptance (FSAT) Plan

ATTACHMENT I

Vision Response to RFP

Scope of Work:
Pages 17-18

Schedule:
Page 5

AMI Requirement:
Pages 13-17

Integration:
Pages 1, 13, 50

Pricing Schedule/Bill of Materials:
Pages 19-20

Maintenance and Support Agreement:
Page 21

Software License Agreement:
Pages 34-38

AMI Proposal for: Jefferson County PUD

Vision Metering is a Veteran and Women Owned Business

The Only Open & Future Proof AMI/IoT System

Vision Metering, LLC, 7 Ross Cannon St., York, SC 29745 803-628-0035 www.visionmetering.com
Proposal prepared by Randy H. Austin, President 704-609-8801

December 7, 2021

Anette Johnson
Jefferson County PUD
310 Four Corners Road
Port Townsend, WA 98368

RE: Metering System Upgrade Project

Dear Anette,

Vision Metering is pleased to propose the Only Open and Future Proof AMI System for your Electric and Water AMI project. LoRa/LoRaWan is an Internet of Things (IoT) system in which AMI functions superbly. Vision Metering has been in business for more than 30 years and is the one of the last meter manufacturers still producing meters in the U.S. We are a Veteran/Women owned business and doing business in many countries.

LoRa stands for Long Range and has up to 20 miles communication between the gateway and connected devices. Our system operating at Ferry County PUD in Republic, WA is representative of what LoRa can do in challenging terrain. The LoRa Alliance is a standards based point to point/multipoint system comprised of more than 500 companies that participate in standards development. LoRa has been available since 2012 and has grown to billions of connected devices around the world and has become the de-facto communications system in Europe. New devices are being added to this IoT system daily with virtually every vertical participating in LoRa's expansion.

Vision Metering started producing electronic meters in 2008 and has offered AMR/AMI systems since 2010. While we produce our own AMI systems, we have also worked with Verizon, NexGrid, Delta Energy, and Itron/SSN to install their modules in our meters. We also produce 4G/Cat M1 modem meters and have over 160,000 modem meters in the field. Our first AMI system was installed in the Philippines in 2012 which we call HawkEye. It is an extraordinary system using our Data on Demand technology. It helps developing countries minimize theft of energy while offering all the benefits of AMI including remote service disconnect. We have this system operating in many countries - the U.S., The Philippines, Ecuador, Honduras, Dominican Republic, Canada and Mexico. We can also read electric and water ERT's with our system. Water ERT's have to be 100W or greater.

Vision Metering is currently working on a Load Control System in conjunction with Star-Energy in Alexandria, MN. Star-Energy is owned by 7 Electric Cooperatives which all have Load Control. We are developing a system to retrofit existing systems and a new approach using devices communicating via LoRa within the home.

Vision currently integrates to NISC at Bayfield Electric Coop and Ontonagon REA and Star Energy. We are using MultiSpeak 4.1 in these cases to integrate into all NISC's systems. We also have the capability to integrate into any other system using MultiSpeak including IPKeys, mPower, ESRI and others. While we have not integrated into Survalent yet, we are committed to do so at no additional charge to Jefferson County PUD.

Vision Metering and LoRaWAN are an excellent solution for Jefferson County PUD for short and long term goals. The openness of the system will provide the future proof solution necessary for you to be successful today and years to come.

Sincerely,

Randy H. Austin

Randy H. Austin
President

Vision Metering, LLC, 7 Ross Cannon St., York, SC 29745 803-628-0035 www.visionmetering.com

Table of Contents – Jefferson County PUD

EXECUTIVE SUMMARY

Vision Metering is proud to present our leading-edge solution for your AMI project. Our LoRaWan system is an industry disruptive, Advanced Metering Infrastructure (AMI) system that will perform seamlessly for JEFFERSON COUNTY PUD. We can implement and support your project, with nonproprietary IoT technology we've pioneered over the years. A LoRa system will not just supersede the specific needs of JEFFERSON COUNTY PUD, but it will provide an open pathway to IoT without the common obligatory contracts that keep you handcuffed to one vendor.

It is important to note that our EndSight Software can read LoRa meters and Cat M1 Modem meters. The Cat M1 modem meters are 4G/5G compatible and use the sidebands of the G's. They are data only modems and use very little data. There is no additional charge with using our system to support LoRa or

Our proposed system leverages next generation Internet-of-Things (IoT) technology using LoRaWAN network communications in the Vision EndSight software. Vision's electric meters and forthcoming Load Control System all communicate flawlessly using LoRaWAN. Demand management, distribution network devices, load control and monitoring devices are all available with LoRa. EndSight interfaces into NISC via multispeak for all NISC products. This integration is operating at Bayfield Electric Coop, Ontonagon REA and Star Energy.

LoRa's Open-architecture solution represents the most forward-thinking AMI and communication system available today. This positions Jefferson County PUD for the future while offering the lowest-cost solution. With a LoRa system, Jefferson County PUD will be able to manage and control other system devices such as streetlights, transformer temperature monitoring, load control devices, pole tilt monitoring, cut-out monitoring, capacitor control, and any other functions which can be monitored or controlled independently or in concert with LoRa. Vision is also looking to the future with some SCADA capabilities in late 2022. You can leverage your LoRa network to assist customers with other types of monitoring such as propane tanks, water meter reading, natural gas metering, garbage dumpsters, parking meters, life alert monitors and pet monitoring.

Vision was founded on the idea that change and disruption drives innovation and competition within the utility industry. Today's widespread adoption of IoT devices (LoRa) and new communication technologies are driving the next paradigm shift in energy and are the bedrock of innovation. Vision is committed to keeping LoRaWan an open system allowing the customer to work with vendors that provide the best devices at the most advantageous prices.

LoRa/LoRaWAN systems break the chains that otherwise commit customers to single vendors for decades.

Being Handcuffed to a AMI vendor for 15 to 20 years is unthinkable. Expand your opportunities in the Internet of Things (IoT) with an AMI system totally open to all vendors.

Business Relationship

Vision Metering has a rich 30 year history of providing our customers with the Best Customer Experience possible. We believe that the customer should be able to contact the factory directly at any time without going through a distributor or manufacturers representative. When you order equipment and services or contract for a system, you will deal directly with the factory. Vision has a support staff to solve any issues immediately. When you call the factory, your call will be answered by a real person during normal working hours, no phone tree to maneuver.

The culture of customer service prevails at all levels of the Company. The relationship with our customers is of utmost importance and you will never be nickeled or dimed with nonsense. We desire our customers do business with us because they want to, not because they have to.

LoRa

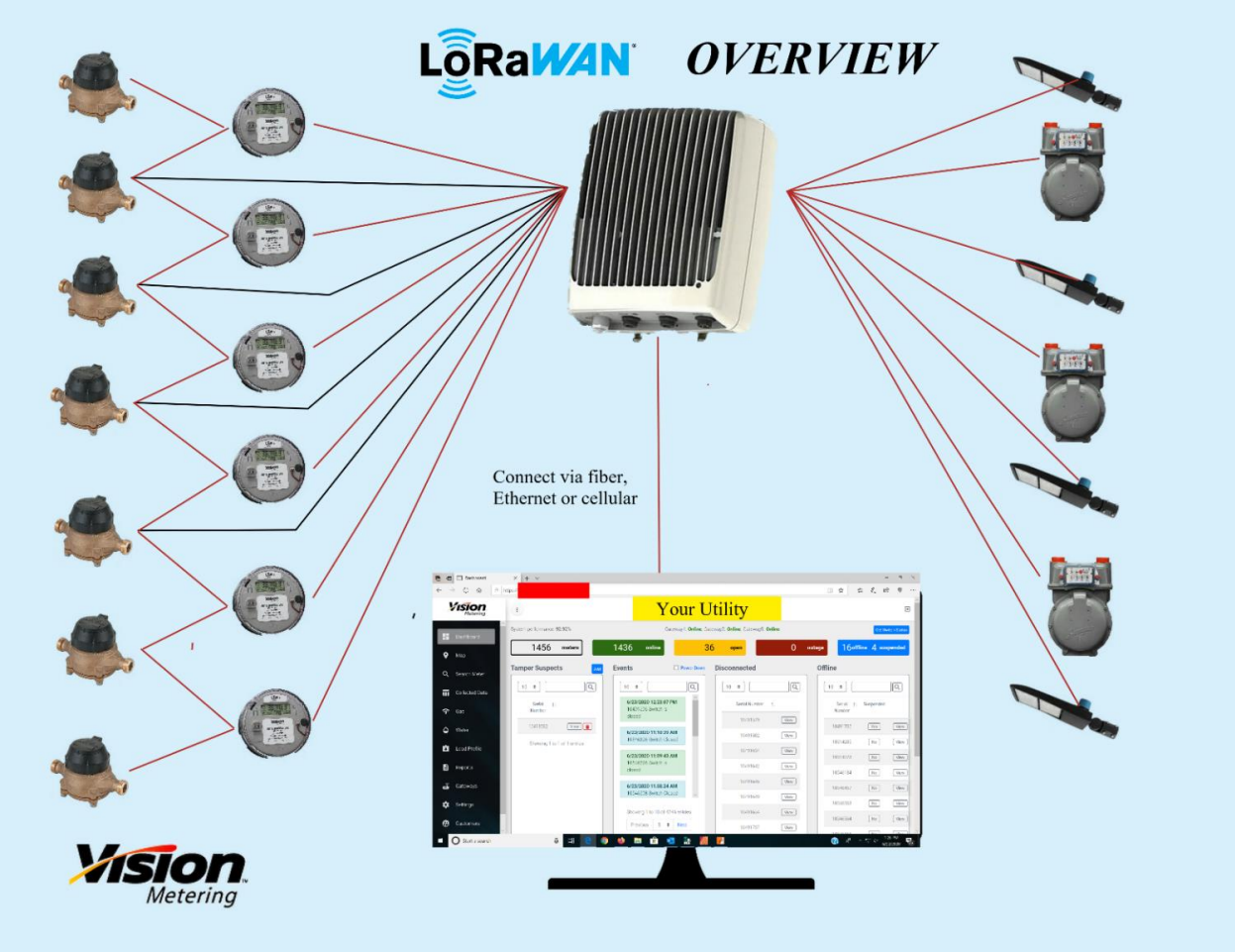
Our proposed solution offers a world class Long Range (LoRa) IoT system. Unlike Mesh Systems, LoRa is a point-to-point or a point to multipoint system. It is capable of communicating up to 20 miles with electric meters and other end devices such as gas and water meter modules. LoRa technology has advanced significantly since 2012 primarily due to more than 500 companies that have dedicated themselves to making it the most robust open IoT system in the world. It is a standards-based system with alliance members contributing to the development of LoRa standards. LoRa is a low-cost system requiring minimal infrastructure and features an open architecture that supports end devices, gateways, and Head-End systems. See more at www.lora-alliance.org.

LoRa communications achieves its long range (20 miles) with a link budget of small data packets, slower communication speeds (380 ms) and 1 watt of power. The Vision LoRa system operates with a maximum of 41 bytes and transmission speeds of less than 400 ms. The packets can be designed to provide information most desired for the type of installation. Residential and commercial meters are using the 41 byte package and are configurable to contain virtually every desired value and load profile, voltage Sag & Swell and alarms being transmitted in separate packets. A typical transmission from every meter includes Delivered and Received KWh, KWd, KVARh Delivered, KVAR, Volts and Amps for all three phases, Power Factor, Frequency and Meter Temperature, RSSI and SNR. Other values can be added at will. Additionally, four channels of Load Profile with 4 15 minute intervals for each channel gets transmitted 3 times per hour, thus triplicating the load profile data. Data includes KWh Delivered and Received, KVARh Delivered & Received. Every meter also transmit midnight reads which can be used for detailed system analysis and trueing up purchased vs sold energy.

Data is transmitted in packets which are secure from transmission to reception in both directions. A full explanation of LoRa security is in this summary. There are a total of 134 values available in the meter which can be loaded into packets and transmitted as often as every 1 minute. The firmware in the LoRa module, meter and meter settings can be upgraded over the air. A typical firmware upgrade will take between 15 and 20 hours. Since LoRa works with small packets, the 41 byte packets used in our system can be transmitted every 2 seconds via downlink from the gateway to the meters. Thus it takes about 5 hours to get a full image. The full image is transmitted 3 times to ensure all meters get all fragments.

The standard benefits of LoRa are:

1. Minimal infrastructure – about 10% of the infrastructure as compared to a mesh system.
2. Monthly charges for connectivity reduced substantially because of less gateways.
3. Long range communications, up to 20 miles when gateways mounted at 100 feet.
4. Supports multi-vendor end devices, gateways and Head-End systems.
5. Significant reduction in cost to own and operate.
6. Option to use an externally managed system through Machine Q, Senet or Everynet.
7. No interdependency on other devices to communicate.
8. No dependence on one vendor. The utility can choose vendors for any segment of the system.
9. End devices will continue to reduce in price as more companies adopt LoRa standards.
10. Meter security includes Standard 128 AES encryption from meter to Head-End.
11. Quicker installation due to minimal infrastructure.
12. Vision Cat M1 modem meters can be used for Bellwether and hard to reach locations.
13. Midnight reads on all electric meters.
14. Firmware over the air upgrade of the radio, meter and meter configuration



All Vision electric meters are equipped as outlined below at no additional charge. We only sell meters with all features and functions enabled.

The ST/XT family of meters is designed to run the same firmware on all forms of meters. Therefore, all Vision Meters are full featured as shown above no extra charge for any feature or function except pulses or RS485 communications. Vision meters meet requirements set forth by UL with regard to design, materials and components however, only some are actually UL approved.

The Standard XT meter platform is typically offered when standard features are required. The XT can be equipped with Vision's Data on Demand, Landis + Gyr Airpoint and Nexgrid'sAMI technology. It is also used for LoRa an all It is offered in all forms and can be equipped with a 200 amp switch in Forms 1S, 2S & 12/25S.

For JEFFERSON COUNTY PUD, we have specified Twelve (12) Tektelic Mega 64 channel gateways mounted in various locations on JEFFERSON COUNTY PUD's system. The propagation study indicates the entire system can be done with 8 gateways. Because of the terrain, we are hedging our bets and specifying 12. These gateways each have the capability of handling 12,000,000 messages per day. With your system of approximately 35,000 devices (6,020,000 messages), you can expect to use less than 10% of each gateway's capability. These calculations are based on electric meters transmitting 7 times per hour plus one midnight read. Any Load Control devices on the system will be negligible in terms of network traffic.

As JEFFERSON COUNTY PUD is considered a First Responder, you have the choice of using either ethernet connected gateways or cellular modems. First Net is a first responder system offered by all the mobile carriers. Using the cellular system, data should cost around $40 per month per gateway. You also have the capability to use any fiber and/or TCP/IP connection for connectivity to the gateways.

The connectivity you choose will be predicated on what communications means are available.

Vision AMI Experience

Vision started producing meters in 2008 and built the first Data on Demand (DOD) AMR system for Duke Energy which was delivered in April of 2010. Expanding on the DOD system Vision built an AMI system called HawkEye which is primarily used in developing countries to minimize theft of energy. This system went into production in 2012 and is still being produced today. In 2013 Vision started producing modem meters and currently has over 160,000 modem meters throughout the U.S., Canada and Puerto Rico. Vision has one of the most advanced modem meters in the industry utilizing the "G's" Cat M1 which co-exists with 4G, 5G, etc. Vision installs Verizon GridWide modules in their meters for various customers and also works with NexGrid to install their modules in Vision meters.

All of the experience with AMR/AMI has led Vision to develop an AMI system using LoRa communications. LoRa is the most proficient communication system ever developed for the IoT space.

Deployment Experience and Schedule

Most utilities are unsettled when it comes to deploying an AMI system since many systems deployed are mesh. Mesh systems require a lot of infrastructure and coordination to deploy. LoRa is not like mesh because the infrastructure is minimal. The gateways are easily managed by the LoRa network and EndSight, and the ongoing maintenance, which from a user's perspective is almost zero. The only serviceable part of the gateway system is the back-up battery in the POE to support the gateway.

Deploying meters and end devices is easy. Electric meters are plug and play, plug them in and walk away. There is no field programming required.

LoRa is a very simple system to install and operate. Vision will preprogram all devices to minimize the work in the field. The LoRa stack is programmed to specific utility requirements to achieve maximum benefit to the user. More data is provided than required by the utility.

The ongoing maintenance fees are very reasonable. $0.10 per device per month. This maintenance fee is for hosting the data on AWS and managing EndSight with upgrades when available. We can also install the system locally if desired.

Mobile Apps are available for Apple and Android which are provided to the utility's customers free of charge. These Apps provide the customer with up-to date information about their usage and when prepaid it deployed, they will keep the customer updated with how much energy they have left. There is also a load limiting feature which allows the utility to limit consumption whenever power cannot be turned off.

Lead time on parts and sub-assemblies are very long and Vision does not carry much inventory. Typical lead time on some parts is 26 to32 weeks. Planning to deploy large quantities should be about 24 weeks in the future to begin receiving meters and MIUs. Small numbers of meters and MIUs can be shipped in 4 to 6 weeks to start system implementation. It typically takes about 2 days to set up the EndSight Software and gateways usually take 6 to 8 weeks to deliver. While waiting for the bulk of meters and MIUs, the utility can get the system set up and training can occur utilizing a small number of meters and MIU's which are shipped for trial purposes.

Load Control

There are two forms of Load Control. The conventional system employs a controller with communications and wires running throughout the house to control various devices. The other form is load limiting. Every Vision meter has load limiting as an integral part of its operation. Load Limiting allows the user to limit one, many or all meters to control the amount of current each member can use. If you set the limit to 30 amps, every member will have to control their load to be under 30 amps or will be disconnected for 5 minutes before being reconnected. This process will continue until the customer has reduced their load or the load limiting has been turned off.

The other load control is typical in most installations where individual devices are controlled like water heaters and air conditioners/heat pumps. This requires wiring throughout the house or building to incorporate the control. This process is expensive and often times requires a permit from the local authorities.

Vision's load control, currently under development, has a completely different approach. Vision intends to use LoRa radios in the control devices to create another LoRa network within the home. All load control activity will then be directed by the meter, thus eliminating a need for an additional communications device. Instead of a box with relays, Vision will build individual load control devices that have solid state switches installed that require very little control voltage (roughly 15 – 20 ma). Each device will have a power line carrier module that communicates with the meter and takes its commands from the meter. It won't matter if you are controlling the line voltage or the control voltage. All devices will have a 30 amp solid state relay that can be put inline with the existing appliance. The Load Profile in the meter will be able to determine if the device was actually controlled. See more in the Load Control Section.

Business Relationship

Vision Metering is all about customer service and the relationship with our customers and their experience with our products and systems. Since our systems are reliable and easy to use, there are very few situations that could cause friction between the customer and Vision. Vision's relationship with all of it customers is pleasant, accommodating and looks to its customers to help make the overall system better and easier to use. Customization which can be utilized over all platforms is encouraged as others may want the same features being requested. Changes typically happen quickly and are deployed during non-working hours. Basically, we listen and respond and the whole Company is focused on making happy customers.

Future Proof

Technology is advancing at warp speed and predicting future technologies would be an impossible task. Having a robust open technology system like LoRa serves to project longevity well into the future. Mesh systems are inadequate for the future as they are proprietary and do not have an open and available protocol which is public. You can only buy devices which are approved from your vendor. LoRa's open architecture allows you to buy from other providers or develop your own Head End system to achieve your desired results. Amazon Web Server will soon have a LoRa network available, which will allow users to manage any devices desired by the customer without having to have multiple networks and funnel data through a single vendor's system.

Vision Metering is a Veteran and Women Owned Business.

AMI Experience

Vision Metering has been producing AMI systems since 2012. Our first system was Data on Demand which is the basis for HawkEye. It was first deployed in early 2013. The system uses Vision's data-gates to collect data from 50 meters located inside an aluminum box and mounted on a pole. The data-gate communicates with fifty meters simultaneously and then communicates with our EndSight Head End via long range IP radio's. The system was designed to collect data and control disconnect switches in the meter. Today, there are over 65,000 units with more deployed every year.

The HawkEye system is capable of providing KWh delivered & received, KW, KVARh, KVAR, Volts & Amps on both phases, Power Factor and Meter temperature. Data is transmitted every 15 minutes flawlessly.

LoRa/LoRaWAN is by far the most exciting and results oriented system available anywhere in the world. It is a Long Range radio system capable of communicating up to 20 miles when the gateway is mounted around 100' in the air. A LoRaWAN system requires about 10% of the infrastructure that a typical mesh system requires. This saves significant financial and personnel resources during the installation and throughout the service life of the system.

Vision has over 50,000 deployed in various parts of the world with a backlog of over 100,000 meters. Vision has a solution for Electric, Water, Gas & Streetlight. Soon load control and capacitor controls will be added to the mix. Vision's AMI system is expandable into many different verticals with equipment already available.

LoRa is a relatively new technology, having only been commercialized in 2012 and primarily in Europe. It is now taking the world by storm and is expected to exceed 20 billion devices deployed by 2025.

Vision has been producing Modem meters since 2013. First with 3G, then with 4G and now with Cat M1. In total, more than 160,000 modem meters have been deployed in almost every state and Puerto Rico. Our modem meters use the ANSI C-12.19 tables and can communicate with Itron's MV-90 system, Trilliant/Primestone Primeread system, Also NOC and Vision's EndSight software. Meters can also be interrogated using Vision's 2020 software on an individual meter basis. These meters have very stable communications and can be used on any carrier with a Hologram SIM and on Verizon & T-Mobile using their carrier SIMS.

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verizon

nexgrid

Vision also sells meters for various communications device manufacturers like Verizon, NexGrid, Delta Global Communications. These companies use our meters with their communications modules. To date, there are over 100,000 of these meters deployed.

Vision has also produced hundreds of thousands AMR meters using Landis + Gyr's Airpoint modules. All the above along with the non communicating meters, Vision has produce well over 1,000,000 meters

12/2021

Corporate Info & Background

Vision Metering started as Austin International, Inc in June 1991. As a supplier of refurbished, surplus and remanufactured equipment, Austin International, Inc. was successful in creating a significant market worldwide. Throughout the first twenty years of business, the Company migrated more toward the metering, so in 2011 a decision was made to concentrate on metering and less on Distribution, Transmission and Generation equipment. In January 2011, Austin International, Inc changed its name and corporate structure to Vision Metering, LLC. Everything remained the same during this transition including the location and corporate management.

In 2008, Vision Metering started producing its own electronic meter which was used primarily for AMR as it contained a L+G Airpoint, (similar to Itron ERT). The first AMI system was produced in 2012 for the Aboitiz Power Company in the Philippines called HawkEye. This system is still in operation today and delivers data to the head end every 15 minutes and provides Aboitiz with the ability to turn customers on and off remotely. It also helps Aboitiz reduce non-technical losses in that it is extremely difficult for non-Aboitiz personnel to tamper with the meters.

Vision Metering has always been a green company in that most surplus, used and remanufactured equipment that came through its doors was refurbished and sold for the original purpose for which it was intended. Even the cardboard is recycled. In 2017, 813 KW of solar was installed on the building, thus reducing the Company's electric bill by 70%.

Corporate Headquarters located at 7 Ross Cannon St., York, SC 29745

www.visionmetering.com Phone: 803-628-0035

Tax ID:	27-3960535	Randy H. Austin	President & 85% Owner
Duns Number	966517406	Debbie D. Ruth	Executive VP & 15% Owner
Bank	South State Bank	Thomas Neebling	Vice President New Equipment
	Rock Hill, SC	Tony Recinella	VP Test Equipment
Accountants	Burkett, Burkett & Burkett	Darren Campbell	Comptroller
	Rock Hill, SC		
Company Structure	Limited Liability Company		

Vision Metering, LLC is a Veteran and Woman owned business.

No current Lawsuits, Claims or Judgements
No Failed Contracts or incomplete projects
Over 70% of business comes from new meter production
Financially Stable and Profitable

12/2021

LoRaWAN™

LoRaWAN™ SECURITY

FULL END–TO–END ENCRYPTION FOR IoT APPLICATION PROVIDERS

A WHITE PAPER PREPARED FOR THE LoRa ALLIANCE™

BY GEMALTO, ACTILITY AND SEMTECH

February 2017

LoRa Alliance™
Wide Area Networks for IoT

INTRODUCTION

LoRaWAN™ is a Low Power Wide Area Network (LPWAN) protocol that supports low-cost, mobile, and secure bi-directional communication for Internet of Things (IoT), machine-to-machine (M2M), smart city, and industrial applications. The LoRaWAN protocol is optimized for low power consumption and is designed to support large networks with millions of devices. Innovative LoRaWAN features include support for redundant operation, geolocation, low-cost, and low-power applications. Devices can even run on energy harvesting technologies enabling the mobility and ease of use of IoT.

As security is a fundamental need in all of the aforementioned applications, it has been designed into the LoRaWAN specification from the very beginning. However, the topic of security encompasses multiple properties and, in particular, the cryptographic mechanisms used to implement security in LoRaWAN deserve careful explanation. This whitepaper aims to present the security of the current LoRaWAN specification. First, we will present the security properties embodied in the LoRaWAN specifications, then details of its implementation and finally some explanations about LoRaWAN security design.

PROPERTIES OF LoRaWAN™ SECURITY

LoRaWAN security is designed to fit the general LoRaWAN design criteria: low power consumption, low implementation complexity, low cost and high scalability. As devices are deployed in the field for long periods of time (years), security must be future-proof. The LoRaWAN security design adheres to state-of-the-art principles: use of standard, well-vetted algorithms, and end-to-end security. Later, we describe the fundamental properties that are supported in LoRaWAN security: mutual authentication, integrity protection and confidentiality.

Mutual authentication is established between a LoRaWAN end-device and the LoRaWAN network as part of the network join procedure. This ensures that only genuine and authorized devices will be joined to genuine and authentic networks.

LoRaWAN MAC and application messaging are origin authenticated, integrity protected, replay protected, and encrypted. This protection, combined with mutual authentication, ensures that network traffic has not been altered, is coming from a legitimate device, is not comprehensible to eavesdroppers and has not been captured and replayed by rogue actors.

LoRaWAN security further implements end-to-end encryption for application payloads exchanged between the end-devices and application servers. LoRaWAN is one of the few IoT networks implementing end-to-end encryption. In some traditional cellular networks, the traffic is encrypted over the air interface, but it is transported as plain text in the operator's core network. Consequently, end users are burdened by selecting, deploying and managing an additional security layer (generally implemented by some type of VPN or application layer encryption security such as TLS).

This approach is not suited in LPWANs where over-the-top security layers add considerable additional power consumption, complexity and cost.

SECURITY IMPLEMENTATION

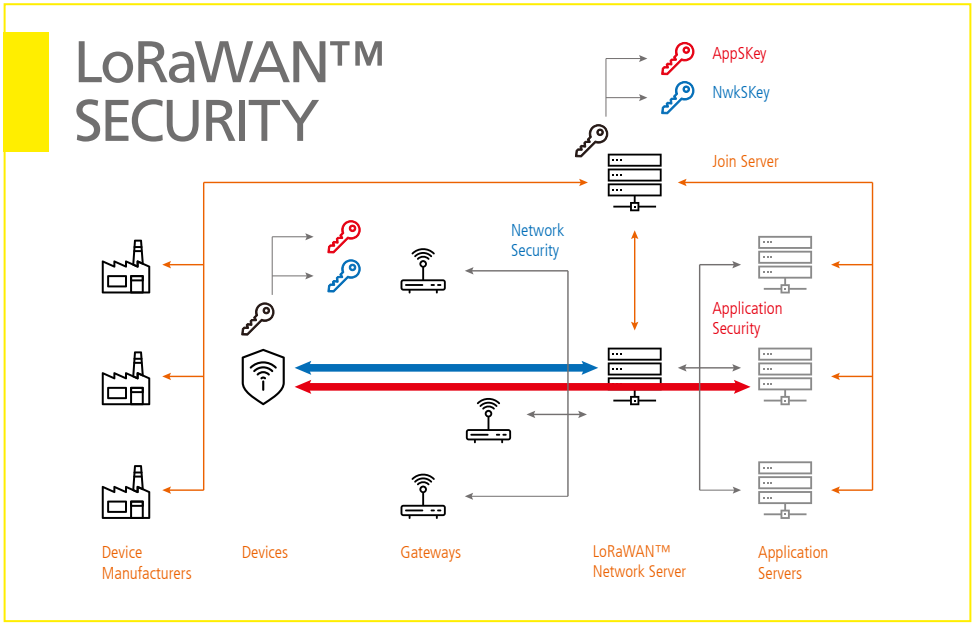
The security mechanisms mentioned previously rely on the well-tested and standardized AES[1] cryptographic algorithms. These algorithms have been analysed by the cryptographic community for many years, are NIST approved and widely adopted as a best security practice for constrained nodes and networks. LoRaWAN security uses the AES cryptographic primitive combined with several modes of operation: CMAC[2] for integrity protection and CTR[3] for encryption. Each LoRaWAN device is personalized with a unique 128 bit AES key (called AppKey) and a globally unique identifier (EUI-64-based DevEUI), both of which are used during the device authentication process. Allocation of EUI-64 identifiers require the assignor to have an Organizationally Unique Identifier (OUI) from the IEEE Registration Authority. Similarly, LoRaWAN networks are identified by a 24-bit globally unique identifier assigned by the LoRa Alliance™.

SECURING APPLICATION PAYLOADS

LoRaWAN™ application payloads are always encrypted end-to-end between the end-device and the application server. Integrity protection is provided in a hop-by-hop nature: one hop over the air through the integrity protection provided by LoRaWAN protocol and the other hop between the network and application server by using secure transport solutions such as HTTPS and VPNs.

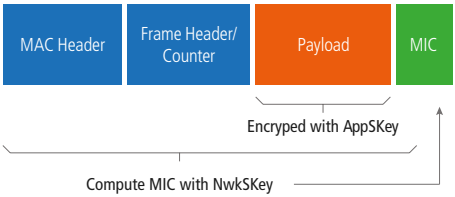
MUTUAL AUTHENTICATION

The Over-the-Air Activation (a.k.a. Join Procedure) proves that both the end device and the network have the knowledge of the AppKey. This proof is made by computing an AES-CMAC[4] (using the AppKey) on the device's join request and by the backend receiver. Two session keys are then derived, one for providing integrity protection and encryption of the LoRaWAN MAC commands and application payload (the NwkSKey), and one for end-to-end encryption of application payload (the AppSKey). The NwkSKey is distributed to the LoRaWAN network in order to prove/verify the packets authenticity and integrity. The AppSKey is distributed to the application server in order to encrypt/decrypt the application payload. AppKey and AppSKey can be hidden from the network operator so that it is not able to decrypt the application payloads.



DATA INTEGRITY AND CONFIDENTIALITY PROTECTION

All LoRaWAN traffic is protected using the two session keys. Each payload is encrypted by AES-CTR and carries a frame counter (to avoid packet replay) and a Message Integrity Code (MIC) computed with AES-CMAC (to avoid packet tampering). See beside the structure of a LoRaWAN packet and its protection:



SECURITY FACTS AND FALLACIES

PHYSICAL SECURITY OF A LoRaWAN™ DEVICE

AppKey and the derived session keys are persistently stored on a LoRa Alliance™ device and their protection depends on the device physical security. If the device is subject to physical threats, keys can be protected in tamper resistant storage (a.k.a. Secure Element), where they will be extremely difficult to extract.

CRYPTOGRAPHY

Some sources claim that LoRaWAN™ cryptography only uses XOR and not AES. In fact, as already mentioned, AES is used in the standardised CTR mode which makes use of XOR crypto operations (as many other modes like CBC[5]). This strengthens the AES algorithm by using a unique AES key for each block cipher.

SESSION KEY DISTRIBUTION

As AppSKey and NwkSKey are generated from the same AppKey, one could argue that if the LoRaWAN operator has the AppKey, it is able to derive the AppSKey and hence to decrypt the traffic. In order to avoid this situation, the server managing the AppKey storage, mutual authentication and key derivation can be run by an entity outside the control of the operator. In order to give operators additional flexibility, a future release of the LoRaWAN specification (1.1) defines two independent master keys: one for the network (NwkKey) and one for the applications (AppKey).

BACKEND INTERFACES SECURITY

The backend interfaces involve control and data signaling among network and application servers. HTTPS and VPN technologies are used for securing the communication among these critical infrastructure elements, much the same way done in any other telecom systems.

IMPLEMENTATION AND DEPLOYMENT SECURITY

The LoRa Alliance works towards ensuring its protocol and architecture specifications are secure, while recognizing that the overall security of the solution also depends on the specific implementation and deployment. Implementation security issues need to be taken up by the relevant manufacturers and deployment issues need to be taken up by the relevant network operators. These two types of issues are not specific to the LoRaWAN technology and usually equally applicable to any radio technology implemented on the same platforms/networks.

AS SHOWN IN THIS PAPER, THE LoRaWAN™ SPECIFICATION HAS BEEN DESIGNED FROM THE ONSET WITH SECURITY AS AN ESSENTIAL ASPECT, PROVIDING STATE-OF-THE-ART SECURITY PROPERTIES FOR THE NEED OF HIGHLY-SCALABLE LOW POWER IOT NETWORKS. UNLIKE MANY OTHER IOT TECHNOLOGIES, IT ALREADY OFFERS DEDICATED END-TO-END ENCRYPTION TO APPLICATION PROVIDERS.

LoRa Alliance™

LoRaWAN™ Specification, v1.0.2, July 2016
LoRa Alliance™: **www.lora-alliance.org**
media@lora-alliance.org

[1] AES - Advanced Encryption Standard. It is a public encryption algorithm based on symmetric secret keys, allowing message encryption and authentication. [2] CMAC - Cipher-based Message Authentication Code. [3] CTR - Counter Mode Encryption. It is a mode of operation of AES algorithm relying on a counter to encrypt streams of data. [4] AES-CMAC - Cipher-based Message Authentication Code using AES encryption algorithm to provide message integrity and authenticity. [5] CBC is a mode of operation of AES algorithm relying on an initialization vector and the previous data block to encrypt streams of data.

4.2.1.2. **Meter Data Management System**

Vision does not offer an MDMS system but can interface with any system including IPKeys, mPower, NISC etc. We do not charge for integrating into these MDM systems.

4.3. **Electric Meter and AMI Requirements**

The successful bidder shall supply all meters described in this specification and an Advanced Metering Infrastructure System (AMI) that is fully and completely compatible with the supplied meters.

The AMI system must interface with the PUD Survalent SCADA system, NISC customer information meter reading system that may include additional future customer information system modules.

The AMI system will provide near real time data to the PUD office for power and water consumption measured by each of the respective meters in the system hourly. The AMI system should also be capable of transporting data from third party devices for use by the Survalent SCADA System.

The Vendor must provide, and integrate all required information technology network hardware and software. The primary hardware and software are to be suggested by the Vendor and may be located at the PUD Irondale electric service center communications room with PUD approval.

All Software licenses shall be provided in the PUD's name.

The minimum AMI System requirements are outlined below. This list is not intended to limit innovative solutions and other options that meet or exceed the PUD requirements.

4.3.1. **Electric Meter Requirements**

The following types of meters shall be provided:

- Residential Meters with remote disconnect: Form 2S CL200 240V, or approved equal
  Comply All Vision Meters are Bi-Directional and provide Demand, Reactive, 12 Channels of Load Profile, TOU, Four Quadrant Metering, Voltage Sag & Swell, Net Metering, and Event Log.
- Small Business Meters: Form 2S Demand CL320 240V, Form 2S Demand CL200 240V, and Form4S Demand CL20 120 to 480V, Form 12S Demand CL 200 120V, or approved equal
  Comply All Vision Meters are Bi-Directional and provide Demand, Reactive, 12 Channels of Load Profile, TOU, Four Quadrant Metering, Voltage Sag & Swell, Net Metering, and Event Log.
- Large Business/Commercial: Form 9S (8S) Demand CL20 120 to 480V, and Form 16S (15S, 14S)Demand CL200 120 to 480V, or approved equal
  Comply All Vision Meters are Bi-Directional and provide Demand, Reactive, 12 Channels of Load Profile, TOU, Four Quadrant Metering, Voltage Sag & Swell, Net Metering, and Event Log.
- Bidirectional Meters (for small distributed generation): Form 2S Net CL200 240V and Form 9S (8S) Meter CL 20 120 to 480V, or approved equal
  Comply All Vision Meters are Bi-Directional and provide Demand, Reactive, 12 Channels of Load Profile, TOU, Four Quadrant Metering, Voltage Sag & Swell, Net Metering, and Event
- Network Meters Form 12S CL200 120V, or equal
  Comply All Vision Meters are Bi-Directional and provide Demand, Reactive, 12 Channels of Load Profile, TOU, Four Quadrant Metering, Voltage Sag & Swell, Net Metering, and Event Log.
- Residential Network Meters with remote disconnect: Form 12S CL200 120V, or approved equal
  Comply All Vision Meters are Bi-Directional and provide Demand, Reactive, 12 Channels of Load Profile, TOU, Four Quadrant Metering, Voltage Sag & Swell, Net Metering, and Event Log.

4.3.1.1. **Compatibility**

All new meters shall have the AMI Module installed as a factory component.

Comply

.

All new meters shall be fully compatible with the AMI specifications as stated below.

4.3.1.2. **Functionality**

The following list is a set of minimum requirements for the meters used for the AMI system. This list is not intended to limit innovative solutions and options that meet or exceed the PUD requirements.

- All AMI Systems shall maintain time synchronization for all meters, nodes, and other devices connected to the network.
  Comply
- Programable broadcast time setting.
  All meters transmit every 15 minutes and data can be requested anytime.
- All AMI meters shall provide time-stamp capabilities.
  Comply
- All AMI meters shall be uniquely identified in the network.
  Identified by Meter Serial Number, Module DEVEUI (mac address)
- All alarm, fatal and nonfatal errors, and consumption information shall be "pushed" as events occur or consumption periods end from the AMI module to the AMI server.
  Comply
- All residential electric meters shall be capable of reporting meter reads hourly.
  ALL meters, singlephase and polyphase report every 15 minutes. Every packet includes KWh delivered and received, KW, KVARh, KVAR, Volts and Amps on all three phases, Power Factor, Meter Temperature, RSSI and SNR.
- All commercial electric AMI meters shall be capable of reporting meter reads every 15 minutes.
  ALL meters, singlephase and polyphase report every 15 minutes. Every packet includes KWh delivered and received, KW, KVARh, KVAR, Volts and Amps on all three phases, Power Factor, Meter Temperature, RSSI and SNR.
- All AMI meters shall have the ability to monitor and report voltage in a time frame that allows the utility to respond proactively to the information.
  Voltage is reported every 15 minutes. Sag & Swell events are transmitted when they occur.
- All meters shall have remote programming capability, including firmware updates.
  The meters firmware and meter settings are all programmable over the air.
- All meters shall be able configurable for time of use (TOU), critical peak pricing (CPP) and real-time clock.
  Comply
- All meters shall be capable of two-way communications.
  Comply using LoRa and LoRaWAN.
- All meters shall support outage detection, restoration and reporting.
  Comply
- All residential meters shall support tamper detection.
  All residential meters have tamper switches installed and have magnetic shielding on the CT's to prevent tampering with a magnet. Our meters also monitor the current on both phases so tampering can be detected by loss of current reporting on a phase that has been jumpered.
- All commercial meters shall have a minimum of 45 days of data storage capability (4 channels

15 minute intervals).
Four channels of load profile data at 15 minutes will have 101 days of storage.

- All meters shall have near real-time on demand reading capability.
  Our meters store data that can be transmitted via LoRa every 3 minutes. The absolute oldest data will be as much as 3 minutes old.
- All meters shall provide near real-time voltage quality data (outage alarms, restoration notices, and voltage alarms) to support system operations, and other distribution system applications.
  Voltage is a part of every packet which is transmitted every 15 minutes. Sag and Swell are reported immediately.
- Remote disconnect meters must report disconnect status.
  Comply
- All meters shall have consistent accuracy throughout the 20-year expected life of the meter of at least 0.5%.
  Meters are built for 20 year life and typically maintain the 0.2% accuracy throughout the life.
- All meters to have compatibility and optional Power Quality functions available that can be communicated to the PUD electric SCADA system.
  We only have power quality for voltage.
- All meters shall have a power outage carryover feature (battery or super capacitor).
  We do not use batteries in our meters. Super Capacitors support outage notification, last gasp.
- All meters shall be solid state digital.
  Comply
- All meters to have upgradeability for advanced features.
  Comply
- All demand meters shall be configurable for rolling 5-minute interval data (T=15 or T=60).
  Comply
- All Meters shall have a Bidirectional metering feature option.
  Included in all meters.
- All meters shall have field communication and reconfiguration capability.
  Communication can be established via the optical port on the meter and our 2020 software.
- All Meters shall include Hot Socket detection
  Meter temperature is continually monitored and reported every 15 minutes.
- Any special tools, communication hardware, or software required for field communication and configuration of the meter shall be supplied to the PUD.
  2020 software is provided free of charge.

4.3.1.3. **Data to Transmit**

The meters shall have the functionality and ability to transmit the data elements listed below. The Bidder shall indicate to the PUD at the time of the bid if there are additional costs or fees above and beyond the cost included in the bid for specific data elements on the list below. The PUD shall then select the data elements to include prior to the awarding of the contract.

ALL Vision Meters come fully loaded with all features and functions. You pay nothing for any features available in the meter.

1. Consumption View for Single Phase Meters Comply
   a. Meter ID:
   b. Meter Type:
   c. Product:
   d. Disconnect Status:
   e. Meter Form:
2. Consumption Information Comply
   a. kWh:
   b. kW:
   c. kVAh:
   d. kVA:
3. VQM
   a. Last VQM Time: Comply
   b. Last Min Voltage: Comply
   c. Last Max Voltage: Comply
   d. Events: Comply
   e. Last Outage: Comply
   f. Last Sag: Comply
   g. Last Swell: Comply
   h. Date/Time: Comply
   i. Blink Count: We handle this differently based on blink time.
   j. Last Blink Count:
   k. Number of Blinks:
   l. Minimum Voltage: Comply
   m. Maximum Voltage: Comply
   n. VQM Status Reports per interval:
4. For Poly-phase meters Comply
   a. Meter ID:
   b. Meter Type:
   c. Product:
   d. Firmware Version:
   e. Meter Form
5. Transformer Comply
   a. CT Ratio: if programed into meter
   b. Transformer Ratio: if programed into meter

c. PT Ratio: if programed into meter
d. Installed Switches: We do not use softs witches. Everything is included.
e. Device Selected:
f. Device Type:
Assoc. Status: Associated
g. Service Status: In Service

6. Consumption Readings Comply with all
   a. Last Read kWh:
   b. Last Read kVAh:
   c. Last Read kVARh:
   d. Voltage Readings
   e. Last Read Time:
   f. Last Read Volts A: Volts
   g. Last Read Volts B: Volts
   h. Last Read Volts C: Volts
   i. Current Readings
   j. Last Read Time:
   k. Last Read Current A: Amps
   l. Last Read Current B: Amps
   m. Last Read Current C: Amps
7. Power Quality
   a. Last Read Time: Comply
   b. Power Factor: Comply
   c. Line Frequency (Hz): Comply
   d. Voltage Harmonic Content Do not have
   e. Voltage Sag/Swell Qualification Period: (all phases) Comply
   f. Volts Phase A Comply
   g. Volts Phase B Comply
   h. Volts Phase C Comply
   i. Sag Voltage: Volts Comply
   j. Swell Voltage: Volts Comply
   k. Monitor Sag/Swell On/Off Always on
   l. Outage Monitoring Comply
   m. Phase A Outage Qualification Period: (1 – 10 sec.) Settable from 1 second to 60 seconds.
   n. Phase B Outage Qualification Period: (1 – 255 sec.) Settable from 1 second to 60 seconds.
   o. Phase C Outage Qualification Period: (1 - 255 sec.) Settable from 1 second to 60 seconds.
8. Peaks
   a. Peak kW: Comply with all
   b. Peak Time:
   c. Coincident kVA:
   d. Reset Time:
   e. Coincident kVAR:
   f. Peak kVA:
   g. Peak Time:
   h. Coincident kW:
   i. Reset Time:
   j. Coincident kVAR:
   k. Peak kVAR:
   l. Peak Time:
   m. Coincident kW:
   n. Reset Time:
   o. Coincident kVA:

4.4. **Project Scope and Expectations**

The PUD goal is to deploy an AMI system covering 99.4% of the metered endpoints in the PUD service territory. The existing meters will be replaced with a solid state electronic meter designed to communicate with an AMI system capable of supporting the features discussed in this RFP. More than one communication technology may be necessary to meet geographic, population density, and availability constraints. Interoperability, therefore is going to be a key consideration in this project and

in the selection of the AMI and MDMS systems.

Our EndSight Software is designed to operate with LoRa and our Cat M1 Modem Meters. If an area is not available with LoRa, then modem meters can be used if wireless service is available on any network.

7.1. Proposal Cost Sheet A

JEFFERSON PUD METERING SYSTEM UPGRADE PROJECT
REQUEST FOR PROPOSALS FOR
METERS AND ADVANCED METERING INFRASTRUCTURE (AMI)

Proposal of Vision Metering, LLC, (hereinafter called "VENDOR"), organized and existing under the laws of the State of South Carolina, doing business as Vision Metering, LLC. To Jefferson PUD(hereinafter called "OWNER").

In compliance with the Request for Proposals for Meters and Advanced Metering Infrastructure (AMI), VENDOR hereby proposes to perform all WORK for the supply of the required meters and the supply, installation, startup of the AMI component in strict accordance with the RFP all documents in The Request for Proposals for Meters and Advanced Metering Infrastructure (AMI), within the time set forth therein, and at the lump sum price stated below.

By submission of this PROPOSAL, each VENDOR certifies that their PROPOSAL has been arrived at independently, without consultation, communication, or agreement as to any matter relating to this PROPOSAL with any other VENDOR or with any competitor.

The undersigned VENDOR, having examined and determined the scope of the Request for Proposals for Meters and Advanced Metering Infrastructure (AMI) including RFP Documents, hereby proposes to perform the work described for the following unit cost amounts. Unit costs will be summed to a total project cost that will be used for evaluation of the RFP.

The digital signature of Randy H. Austin is valid throughout this document.

Randy H. Austin
December 7, 2021

Proposal Cost Sheet A

	Meas. & Pmt. Reference	Item	Quantity	Unit	Unit Price	Amount
2	16400SP	Residential Meter W/Remote Disconnect Form #2S CL200 240V	17750	EA	111.00	1,970,250
3	16400SP	Small Business Meter – Form #2S Demand CL320 240V	500	EA	125.00	62,500
4	16400SP	Small Business Meter – Form #2S Demand CL200 240V	500	EA	111.00	55,500
5	16400SP	Small Business Meter – Form #4S Demand CL20 120-480V	400	EA	135.00	54,000
	16400Sp	Small Business Meter – Form #12S Demand CL200 120V w/Disconnect switch	100	EA	135.00	13,500
6	16400SP	Large Business Meter - Form #9S (8S) Demand CL20 120 -480V	80	EA	175.00	14,000
7	16400SP	Large Business Meter – Form 16S (15S, 14S) Demand CL200 120-480V	150	EA	175.00	26,250
8	16400SP	Residential 12S CL200 120V 480V	200	EA	145.00	29,000
9	16400SP	Bidirectional Meter – Form #2S meter CL200 240V w/disconnect switch	250	EA	111.00	27,750
10	16400SP	Bidirectional Meter – Form #9S (8S) meter CL20 120-480V	20	EA	175.00	4,000
11	16400SP	AMI Network Infrastructure:	1	LS	None Required	
11a	16400SP	Local System (servers, software, installation, etcetera) No Server Hardware Included. Software Only	1	LS	10,000	10,000
11b	16400SP	Field Collection Devices (number to be determined by vendor)	30	EA	4,200	126,000
11c	16400SP	Other Infrastructure	1	LS	None Required	
11d	16400SP	Deduct for removal of Water Meter Reading Requirement	1	LS		
					Total	2,392,750

Respectfully Submitted:

Signature: *Randy H. Austin*

Vendor: Vision Metering, LLC

Date: December 7, 2021

7.2. Proposal COST SHEET B

JEFFERSON PUD METERING SYSTEM UPGRADE PROJECT
REQUEST FOR PROPOSALS FOR
ANNUAL TECHNICAL SUPPORT & HOSTING SERVICES

Proposal of Vision Metering, LLC (hereinafter called "VENDOR"),organized and existing under the laws of the State of South Carolina, doing business as Vision Metering, LLC To Jefferson PUD (hereinafter called "OWNER").

In compliance with the Request for Proposals for meters and Advanced Metering Infrastructure (AMI), VENDOR hereby proposes to provide technical support and data hosting services in the form of a renewable annual agreement in strict accordance with all documents in The Request for Bids for Meters and Advanced Metering Infrastructure (AMI), within the time set forth therein, and at the annual price stated below.

By submission of this PROPOSAL, each VENDOR certifies that their PROPOSAL has been arrived at independently, without consultation, communication, or agreement as to any matter relating to this PROPOSAL with any other VENDOR or with any competitor.

The undersigned VENDOR, having examined and determined the scope of the Request for Proposals for Meters and Advanced Metering Infrastructure (AMI) including RFP Documents, hereby proposes to perform the work described for the following annual amounts.

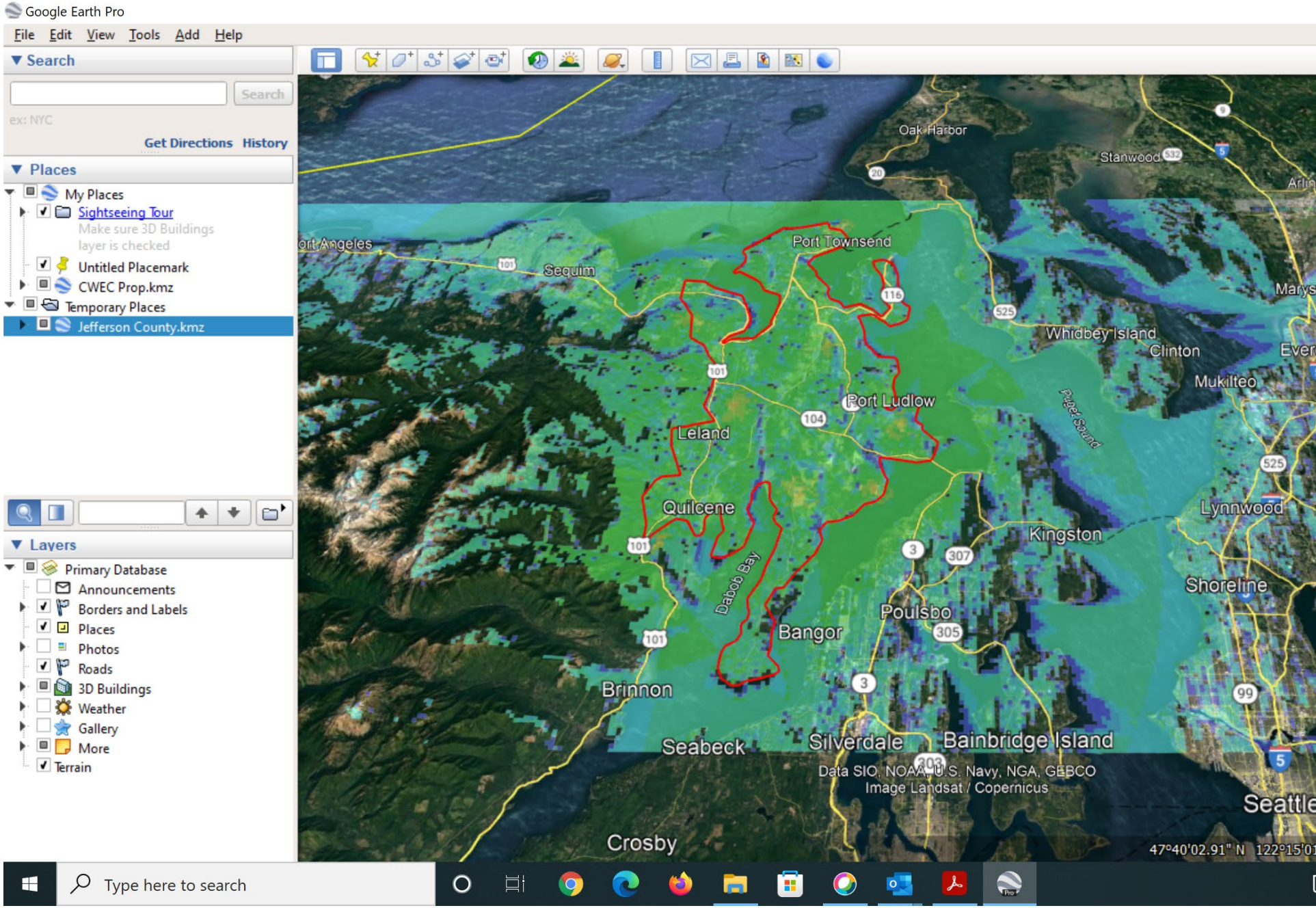
No.	Meas. & Pmt. Reference	Item	Quantity	Unit	Unit Price	Amount
12	16400SP	Annual AMI System Support	18,450	Yearly	1.20	22,140
13	16400SP	Off Site AMI Systems Processing and Maintenance	1	Yearly		
14	16400SP	Deduct for removal of Water Meter Reading Support	1	Yearly		

Respectfully Submitted:

Signature: *Randy H. Austin*

Vendor: Vision Metering, LLC

Date: December 7, 2021


Google Earth Pro
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Search
Search
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Get Directions History
Places
My Places
Sightseeing Tour
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Untitled Placemark
CWEC Prop.kmz
Temporary Places
Jefferson County.kmz
Layers
Primary Database
Announcements
Borders and Labels
Places
Photos
Roads
3D Buildings
Weather
Gallery
More
Terrain
Oak Harbor
Stanwood
Port Townsend
Sequim
Whidbey Island
Clinton
Mukilteo
Port Ludlow
Leland
Quilcene
Dabob Bay
Kingston
Lynnwood
Shoreline
Poulsbo
Bangor
Brinnon
Seabeck
Silverdale
Bainbridge Island
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
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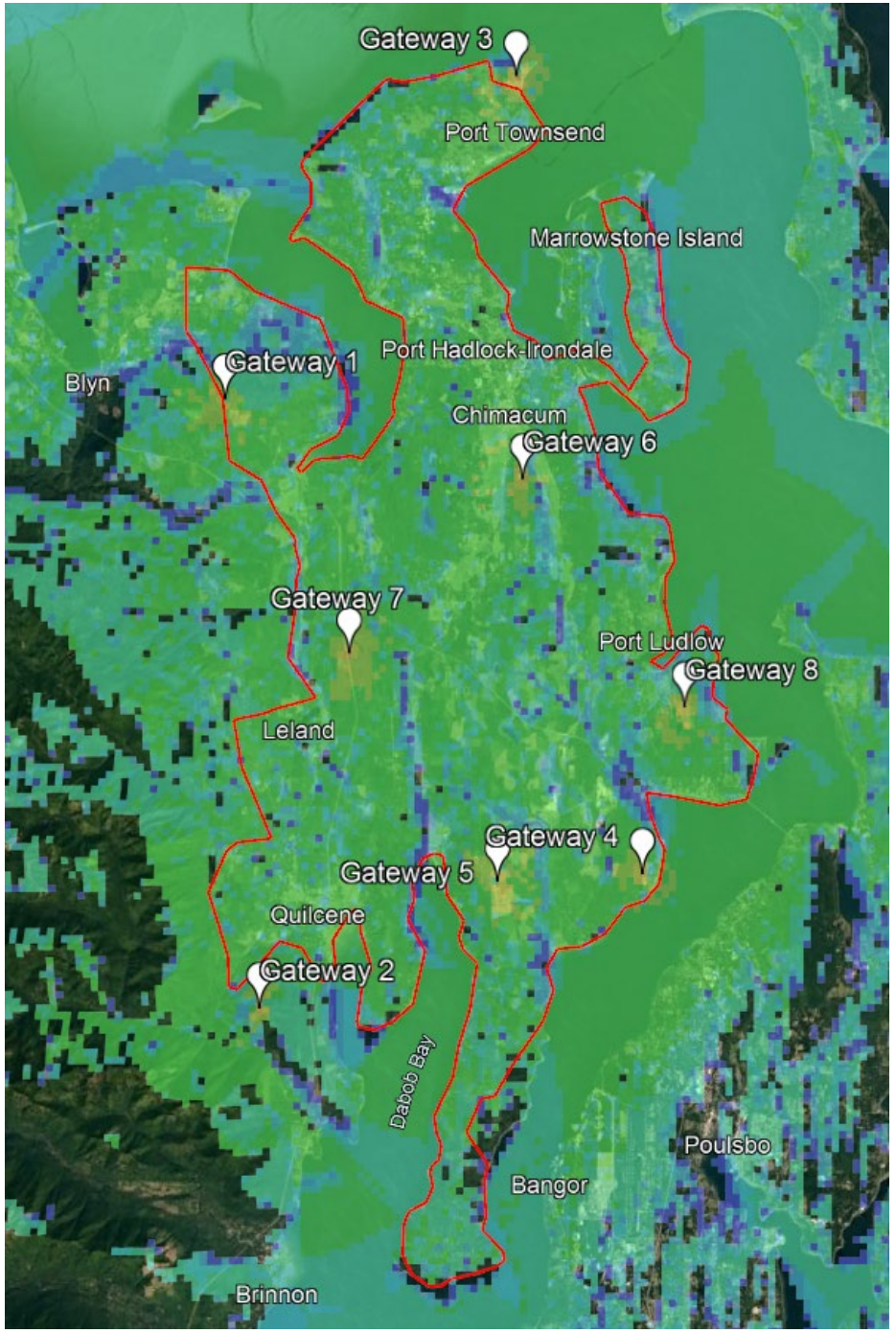
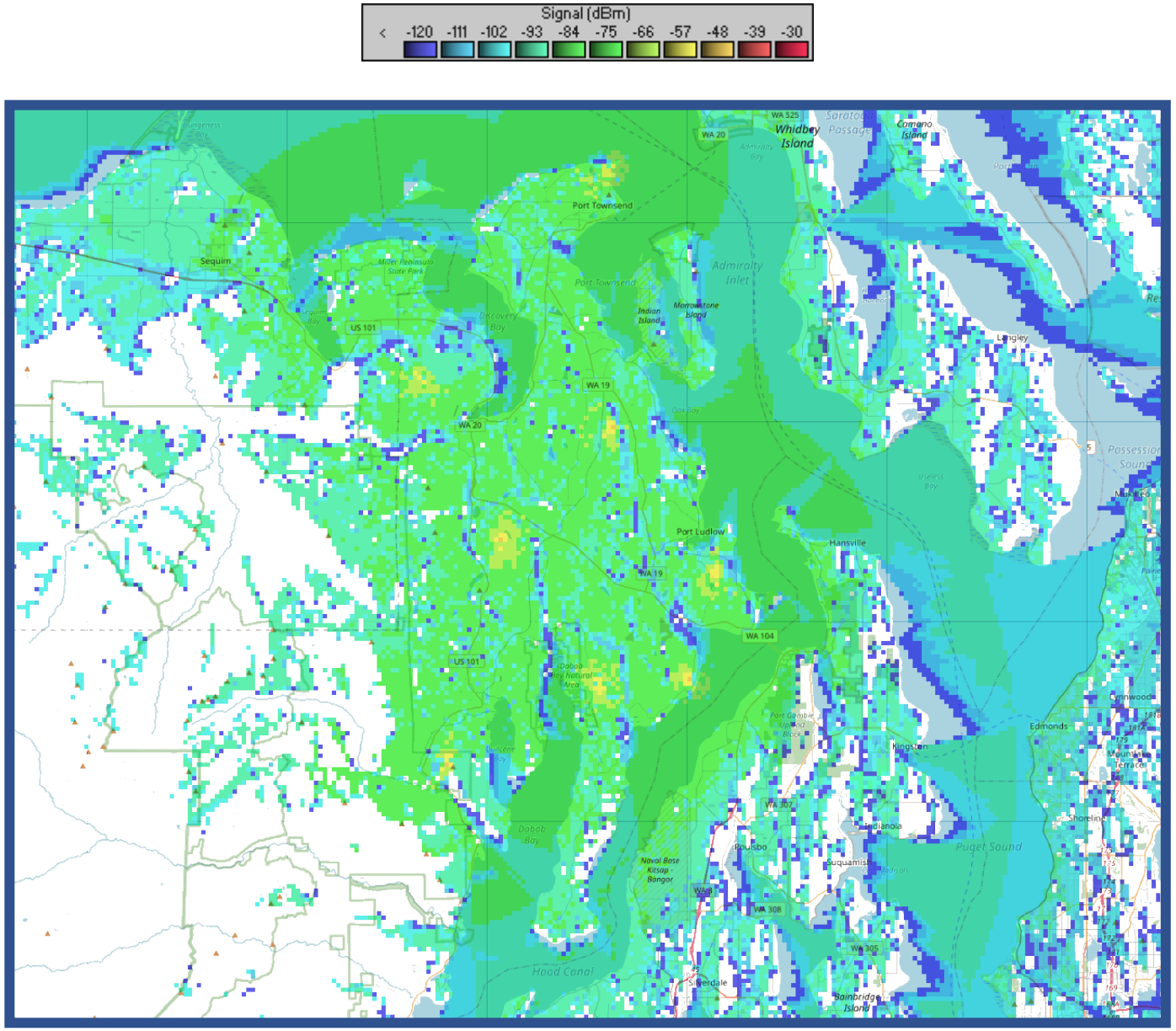
Jefferson County Propagation Study



Propagation Study Parameters

The propagation study is based on 30dBm TX power with 8dB gain antennas placed with expected heights of 100ft.



Gateway Suggestions:

Due to the terrain of the service area, 8 gateways are recommended to provide coverage.

Potential gateway placement priorities infrastructure then height.

Gateway names are based on estimated rankings of coverage they provide.

Proposed Gateway	Latitude	Longitude	Location Description	Estimated Height (feet)
Gateway 1	48° 0'57.19"N	122°55'38.18"W	2080ft Summit full of towers	100
Gateway 2	47°47'18.76"N	122°54'23.89"W	2800ft Summit	100
Gateway 3	48° 8'18.80"N	122°45'55.19"W	Fort Worden State Park	100
Gateway 4	47°50'18.24"N	122°41'38.71"W	Seattle Drive	100
Gateway 5	47°50'7.89"N	122°46'30.48"W	Toandos Road	100
Gateway 6	47°59'11.84"N	122°45'40.73"W	Tower off NF-1161	100
Gateway 7	47°55'16.23"N	122°51'29.79"W	Tower off Tarboo Lake Road	100
Gateway 8	47°54'3.58"N	122°40'14.07"W	Tower off Watson Road	100

Reference Information

Presque Isle Electric & Gas Electric Coop
Onoway MI

Description of Project: LoRa AMI deployment
Completion Date: Currently Underway Electric & Gas
Contact Person: Wesley Repke 800-423-6634 X 1044
Email address: wrepke@pieg.com

Ferry County PUD, WA
Republic, WA

Description of Project: LoRa AMI deployment

Completion date: Currently underway Electric
Contact Person: Steve VanSlyke 509-775-3325
Email address: svanslyke@fcpud.com

Bayfield Electric Cooperative
Iron River, WI

Description of Project: LoRa AMI Deployment – Electric Only
Contact Person: Jake Hipshire
Telephone: 715-372-4287
Email: jake.hipsher@bayfieldelectric.com

Ontonagon Electric Cooperative
Ontonagon, MI

Description of Project LoRa AMI Deployment – Electric only
Contact Person: Debbie Miles
Contact Email: debbie@ontorea.com
Phone: 906-884-4151

City of Mountain View
Mountain View, MO

Description of Project: LoRa AMI Deployment
Completion Date: Fully Deployed 3/2020
Contact Person: Morgan Schowengerdt
Telephone: 417-934-2601
Email address: mvcityutil@centurytel.net

City of Morganton, NC

Description of Project: LoRa AMI Deployment
Completion Date: Currently Underway
Contact Person: Brooks Kirby Telephone: 828-443-1054 Fax: 828-438-2672Email address: Bkirby@ci.morganton.nc.us

Also Energy
Boulder, CO

Description of Project: Cat-M1 modem meters
Contact Person: Robert Schaefer, P.E.
Telephone: 720-316-1171
Email address: rjs@alsoenergy.com

Visayan Electric Co.

Description of Project: Hawk Eye/LoRaContact
Person: Anton Perdecis Telephone: 011-
63917-630-4151
Email address: Anton.perdecis@aboitiz.com

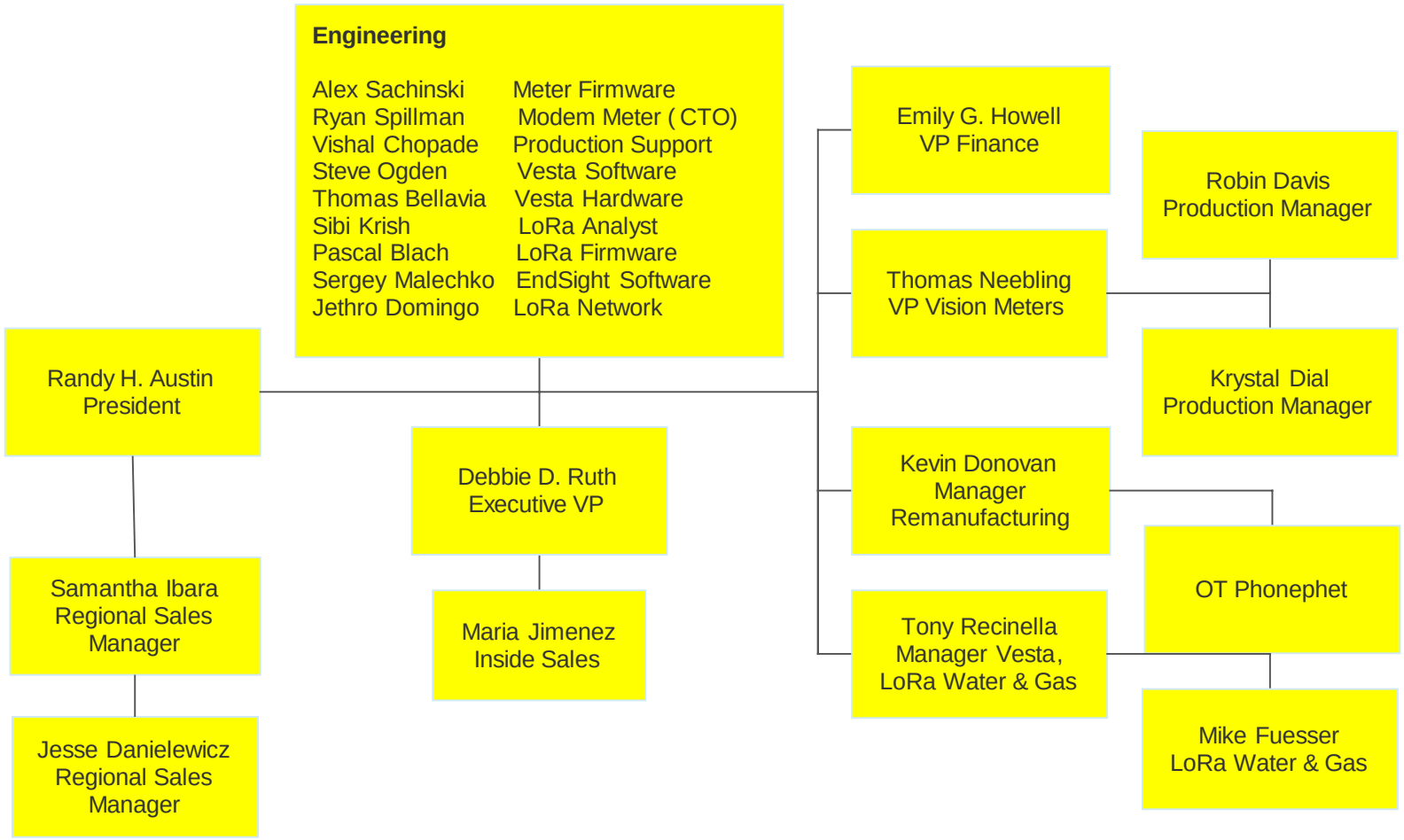
City of Concord, NC

Description of Project: Nexgrid Contact
Person: Chris Greene
Telephone: 704-920-5316
Email address: GreeneC@concordnc.gov
Only supplied meters for Nexgrid deployment

City of Kinston, NC

Description of Project: Nexgrid
Contact Person: Steve Miller
Telephone: 252-939-3285
Email address: Steve.Miller@ci.kinston.nc.us
Only supplied meters for Nexgrid deployment

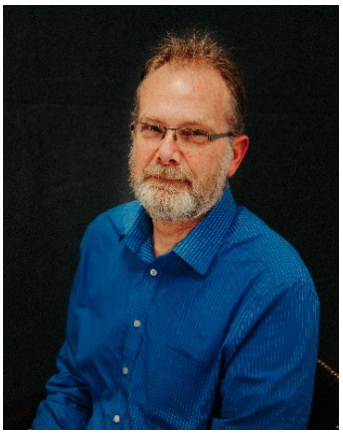
Organizational Chart



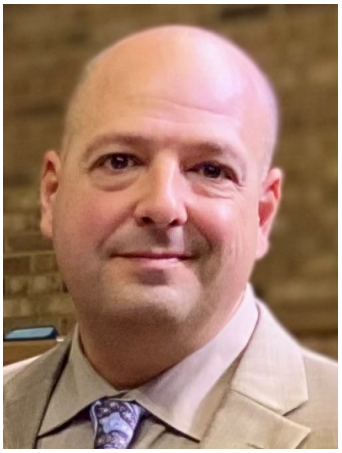
Randy Austin, President – Started his career in the US Navy as an Electricians Mate with 8 years of service. While in the Navy he earned his Associates Degree at the University of Maryland. The remainder if his education has been OJT. After the Navy he joined Ekstrom Industries in Michigan. Then in 1982 he moved south and worked for Process Systems which was subsequently acquired by Siemens. He then started in Aptech in 1986 with two partners and sold it in 1991. Immediately thereafter he started Austin International which became Vision Metering in 2011. In 1999 he bought parts of Aptech back and merged their product line in with Austin International. Randy has led Austin International/Vision Metering for 29 years. Randy has been the driving force behind most product and service developments since the Company started.

Debra Ruth, Vice President - Joined Austin International, now Vision Metering in 1992 to manage and oversee all aspects of the office. The role progressed into direct sales and maintaining customer accounts, in conjunction to coordinating the shipments to ensure all orders were processed in a timely manner. Now with over 28 years of experience in the metering industry my daily role continues to cover a wide array of different tasks such as but not limited to: manage personal and payroll, oversee daily activities in the front office, maintaining domestic & international shipping, supporting sales team, ensuring inventory is accurately recorded & replenished, as well as various other projects necessary to ensure that Vision Metering operates efficiently and successfully.

Darren Campbell, Controller – Joined Vision Metering in 2021 as the Company's Comptroller. Darren has worked in the financial and health care industry for over 30 years and brings a breadth of experience in the accounting and financial area. He is replacing our previous VP of Finance who spent 25 years in the position.



Thomas Neebling, VP of Operations - Joined Austin International in 2011 and began overseeing the daily operations of the Gas Lab. In 2013 he began overseeing the operations of the Vision Electric Meters. With over 9 years of Metering Experience his role as the VP of Operations covers but is not limited to: gathering and prioritizing product and customer requirements, defining the product concept, while directing the engineering, sales, production, and quality control to ensure revenue and customer satisfaction goals are met.

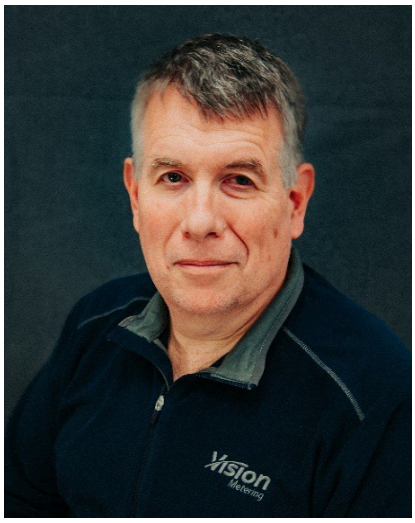


Anthony Recinella, Product Manager - Joined Austin International as a Mechanical Designer and managed projects within multiple departments. Led engineering team to implement mechanical design aspects for new electrical devices while maintaining support for legacy products. With more than 12 years of experience, as the current Product Manager he covers an array of tasks such as but no limited to: manage and improve all aspects of the Vesta test board with focus on maximizing profitability and market share. Creating and implementing ECN procedures and supplemental controls to add traceability, transparency, and accountability. Most recently he has worked with engineering to create the LoRa gas and water module for Vision Metering's AMI solution.

Sergey Malechko, Software Engineer - Joined Austin International in 2010 with a background in database design, and desktop/web applications. Experience with OOP, C#, XML, JSON, JS, JQuery, AJAX, HTML, CSS, MS SQL, MQTT, Git. In my position as the Software Engineer for Vision Metering, he has worked on various projects including but not limited to: software for operating electrical meters, interfacing software with hardware of the complex using MQTT, Modbus, usb, comport connection, API server development, web access to the data, and building reports. He developed the Endsight software used for Vision Metering's LoRa AMI system and continues to implement new features on a regular basis to meet the specific needs of our customers.

Sibi Chakravarthy Navaneetha Krishnan, Electronics Engineer – Joined Vision Metering in 2017. He has helped to manage and cultivate Vision Metering's AMI solution using LoRa. Coordinating with Firmware Engineers and software developers to create a system that is used by utilities for electric, water, and gas. Tasks performed are listed but not limited to: Perform the FCC pre compliance testing for LoRa products and measurements using spectrum analyzer, Maintain Firmware release packages, formatting data packets, Manage Head End system that comprises of Dashboard and reports for customer billing, Programming the data collector and modem with Network configuration keys, packet delays, OTAA activation protocols, Designing a super capacitor charging circuit that can provide backup power to transmit power outage packets, PCB designing using orCAD pcb designer and Documenting Bills of Materials (BOM).

Jethro Domingo, Junior IOT Engineer - Joined Vision Metering in 2017 as a Junior IOT Engineer with a background in IT. He handles and maintains network servers locally and, in the cloud (AWS) which we use for IOT purposes to read and send data from /to electric meters using LoRa technology. He also handles testing for LoRa modems, as well as some minor programming for LoRa communications and ERP development using c# and Xaml**.**

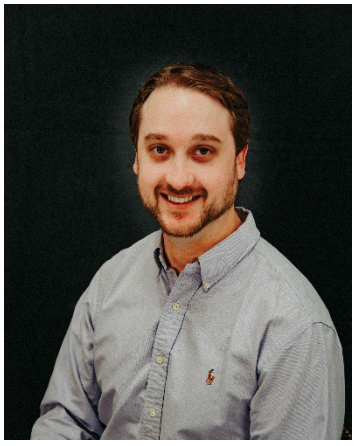


Thomas Bellavia, Electronics Engineer – Joined Vision Metering in 2020 Designing firmware and software for Vesta Testboard. Experience programming proprietary software solutions. Produced and analyzed customer requirements and performed requirements-based testing functions to clear designs for release. Practical embedded software development experience with the following processors: ARM7, 8052, x86, MIPS and XScale. Software coding toolsets used include the following: Eclipse/Andoid SDK, Windriver Multi, MS Embedded Visual Studio, MS Platform Builder, Keil, GNU and Borland C/C++ IDE. Mastered the following programming languages and technologies: ANSI C/C++/C#, Java, Assembler, MS Visual C++, MS Visual Basic, Python and TCL script, HTML, Active Server Pages, LAMP, XML, JavaScript, VBScript, Windows Scripting Host. PC board design and layout experience using Cadence Orcad 17.4 to produce production level electronics. Electronics laboratory experience involving prototyping circuitry, data logging and environmental screening of new designs. Fluent in the operation of test equipment such as logic analyzers, multi-channel digital storage oscilloscopes, PC based Intel, Atmel and ST Arm real time in-circuit emulators and various IC device programmers.

Ryan Spillman, Chief Technology Officer – Joined Vision Metering in 2016 and is Involved with every engineering project in one way or another. He write's firmware in C. He also writes software primarily in C# .net. Ryan also oversees and defines test procedures based on industry standards. For the Vesta testboard he has worked on Embedded C Firmware Development On Bare Metal, Self-Tunning PI Control, Serial and SPI drivers, Calibration Algorithms, Digital and Analog circuit development and debugging. For the CatM1 Meter he works on Embedded C Firmware Development on FreeRTOS, Serial and SPI Drivers, Developed Communication Protocol for Reading Meters OTA, FOTA for Both Meter and Modem, Board Level Testing Firmware and Software (C# .net), Digital and Analog circuit development and debugging. For Lora he works on Embedded C Firmware Development On Bare Metal, Board Level Testing Firmware and Software (C# .net), Digital and Analog circuit development and debugging.

Alexandre Sachinksi, Senior Software Engineer – Joined Vision Metering in 2011 to design firmware for smart electrical meters in conformity with ANSI standards. He esigns firmware for communication modules CatM1, Lora and Modbus and bootloader firmware for utilized devices. He also directs a team of technicians on testing methodology, priorities, and deadlines, allocating resources as needed. Alex also collaborates with marketing to identify new products and features. He develops and maintains firmware for Teridian/Maxim metering chips, STM32L4 and PIC18 controllers and peripheral chips: Flash, EEPROMs, ADC/DAC, modems, and power amplifiers; Designed and supports C++/C# applications to read meters data. He uses IDEs: Eclipse based, Visual Studio, MPLab, and source control systems: git, Mercurial, CVS, bug tracking systems Bitbucket and Redmine.

Alex Skidmore, Regional Sales Manager – Joined Vision Metering in 2021 as a Regional Sales Manager covering 16 states. Alex is a graduate of Pfeiffer University in Charlotte, NC. He majored in Sports Management and subsequently held sales positions primarily in the Wind Industry. Alex comes to Vision with a great attitude and a desire to excel in the Utility Industry. He is a customer focused individual and will provide his customers with great customer service.



Jesse Danielewicz, Regional Sales Manager - Joined Vision Metering in 2020 with experience as a Financial Analyst/Asset manager which I have been able to utilize in my current role as a Regional Sales Manager. My daily tasks in this role are the following but not limited to: visiting Electrical Coops and Municipals, creating relationships with the utilities and ensuring customer satisfaction, presenting our AMI solution using LoRa, demonstrating our Endsight software, attending conferences and displaying our various products, constructing proposals for utilities based on their needs, accurately recording orders and programming specifications, as well training utilities on functionalities of our software.

Bill Roberts – Regional Sales Manager joined Vision Metering in 2021 as a Regional Sales Manager and cover 23 states across the United states. With more than 17 years of sales and management experience, he understands the importance of establishing and maintaining customer relationships. As a Regional Sales manager he performs the following but not limited to: visiting Electrical Coops and Municipals in 16 states, creating relationships with the utilities and ensuring customer satisfaction, presenting our AMI solution using LoRa, demonstrating our Endsight software, attending conferences and displaying our various products, constructing proposals for utilities based on their needs, accurately recording orders and programming specifications, as well training utilities on functionalities of our software.

are.

7 Ross Cannon Street
York, SC 29745-1341
803.628.0035 t
803.628.0282 f
www.visionmetering.com

Warranty Policy

Vision Metering, LLC warrants Vision Meters for 2 years. We will repair or replace any defective equipment due to materials or workmanship during the warranty period. The Warranty starts from the date of Invoice.

This warranty excludes any expense for removal or reinstallation of any defective goods and any other incidental, consequential, or punitive damages incurred by the buyer or buyer's customer and shall not apply where goods have been subject to acts of God, misuse, abuse, neglect, accident, improper application or have been repaired or substantially altered by others.

Shipping and Handling: Vision Metering will not pay for inbound shipping transportation or insurance charges or accept any responsibility for laws and ordinances from inbound transit. Vision Metering will pay for outbound shipping, transportation, and insurance charges for all items under warranty but will not assume responsibility for loss and/or damage by the outbound freight carrier. If the return shipment appears damaged, retain the original boxes and packing material for inspection by the carrier. *Contact your carrier immediately***.**

This limited warranty is the only warranty made by Vision Metering, LLC and is expressly in lieu of all other warranties expressed and implied, including any warranties of merchantability and fitness for a particular purpose. This warranty does not include any installed third party communications modules or firmware contained within the Vision Electric meter. No Statement, conduct or description by Vision Metering, LLC or its representative in addition to this Limited Warranty shall constitute a warranty.

2/6/2020

SOFTWARE AS A SERVICE AGREEMENT

This SOFTWARE AS A SERVICE AGREEMENT (the "Agreement") is dated this 15th day of February, 2021 (the "Execution Date").

LICENSEE	VENDOR
	Vision Metering, LLC 7 Ross Cannon St. York, SC 29745
("the Licensee")	("the Vendor")

BACKGROUND

A. The Licensee is of the opinion that the Vendor has the necessary qualifications, experience and abilities to provide services to the Licensee.
B. The Vendor is agreeable to providing such services to the Licensee on the terms and conditions set out in this Agreement.

SERVICES PROVIDED

1. The Licensee hereby agrees to engage the Vendor to provide the Licensee the following services (the "Services"):
    - Collect data from electric meters, gas and water modules

2. The Services will also include any other tasks which the Parties may agree on. The Vendor hereby agrees to provide such Services to the Licensee.

TERM OF AGREEMENT

3. The term of this Agreement (the "Term") will begin on the date of this Agreement and will remain in full force indefinitely until terminated as provided in this Agreement.
4. In the even that either Party wished to terminate this Agreement, that Party will be required to provide 10 days written notice to the other Party.
5. In the even that either Party breaches a material provision under this Agreement, the non-defaulting Party may terminate this Agreement immediately and require the defaulting Party to indemnify the non-defaulting Party against all reasonable damages.
6. This Agreement may be terminated at any time by mutual agreement of the Parties.
7. Except as otherwise provided in this Agreement, the obligations of the Vendor will end upon the termination of this Agreement.

PERFORMANCE

8. The Parties agree to do everything necessary to ensure that the terms of this Agreement take effect.

CURRENCY

9. Except as otherwise provided in this Agreement, all monetary amounts referred to in this Agreement are in USD (US Dollars).

COMPENSATION

10. The Vendor will charge the Licensee for the Services at the rate of $1.20 per year per endpoint. (the “Compensation”).
11. The Licensee will be invoiced on a monthly basis at a rate of $0.10 per meter per month.
12. Invoices submitted by the Vendor to the Licensee are due within 30 days of receipt.
13. The Vendor will not be reimbursed for any expenses incurred in connection with providing the Services of this Agreement.

CONFIDENTIALITY

14. Confidential information (the “Confidential Information”) refers to any data or information relating to the business of the Licensee which would reasonably be considered to be proprietary to the Licensee including, but not limited to, accounting records, business processes, and Licensee records and that is not generally known in the industry of the Licensee and where the release of that Confidential Information could reasonably be expected to cause harm to the Licensee.
15. The Vendor agrees that they will not disclose, divulge, reveal, report or use, for any purpose, any Confidential Information which the Vendor has obtained, except as authorized by the Licensee or as required by Law. The obligations of confidentiality will apply during the Term and will survive indefinitely upon termination of this Agreement.
16. All written and oral information and material disclosed or provided by the Licensee to the Vendor under this Agreement is Confidential Information regardless of whether it was provided before or after the date of this Agreement or how it was provided to the Vendor.

OWNERSHIP OF INTELLECTUAL PROPERTY

17. All intellectual property and related material (the “Intellectual Property”) that is developed or produced under this Agreement, will be the property of the Vendor. The Licensee is granted a non-exclusive limited-use license of this Intellectual Property.
18. Title, copyright, intellectual property rights and distribution rights of the Intellectual Property remain exclusively with the Vendor.

RETURN OF PROPERTY

19. Upon the expiration or termination of this Agreement, the Vendor will return to the Licensee any property, documentation, records, or Confidential Information which is the property of the Licensee.

CAPACITY/INDEPENDENT VENDOR

20. In providing the Services under this Agreement it is expressly agreed that the Vendor is acting as an independent contractor and not as an employee. The Vendor and the Licensee acknowledge that this Agreement does not create a partnership or joint venture between them and is exclusively a contract for service. The Licensee is not required to pay, or make any contributions

to, any social security, local, state or federal tax, unemployment compensation, workers' compensation, insurance premium, profit-sharing, pension or any other employee benefit for the Vendor during the Term. The Vendor is responsible for paying, and complying with reporting requirements for, all local, state and federal taxes related to payments made to the Vendor under this Agreement.

RIGHT OF SUBSTITUTION

21. Except as otherwise provided in this Agreement, the Vendor may, at the Vendor's absolute discretion, engage a third party sub-contractor to perform some or all of the obligations of the Vendor under this Agreement and the Licensee will not hire or engage any third parties to assist with the provision of Services.
22. In the event that the Vendor hires as a sub-contractor:
    - the Vendor will pay the sub-contractor for its services and the Compensation will remain payable by the Licensee to the Vendor.
    - for the purposes of the indemnification clause of this Agreement, the sub-contractor is an agent of the Vendor.

AUTONOMY

23. Except as otherwise provided in this Agreement, the Vendor will have full control over working time, methods, and decision making in relation to provision of the Services in accordance with the Agreement. The Vendor will work autonomously and not at the direction of the Licensee. However, the Vendor will be responsive to the reasonable needs and concerns of the Licensee.

EQUIPMENT

24. Except as otherwise provided in this Agreement, the Vendor will provide at the Vendor's own expense, any and all tools, machinery, equipment, raw materials, supplies, workwear and any other items or parts necessary to deliver the Services in accordance with the Agreement.

NO EXCLUSIVITY

25. The Parties acknowledge that this Agreement is non-exclusive and that either Party will be free, during and after the Term, to engage or contract with third parties for the provision of services similar to the Services.

NOTICE

26. All notices, requests, demands or other communications required or permitted by the terms of this Agreement will be given in writing and delivered to the Parties at the following addresses:
    a. Bayfield Electric Cooperative
    68460 District St., Iron River, WI 54847

    b. Vision Metering, LLC
    7 Ross Cannon St., York, SC 29745

    or to such other address as either Party may from time to time notify the other, and will be deemed to be properly delivered (a) immediately upon being served personally, (b) two days after

being deposited with the postal service if served by registered mail, or (c) the following day after being deposited with an overnight courier.

INDEMNIFICATION

27. Except to the extent paid in settlement from any applicable insurance policies, and to the extent permitted by applicable law, each Party agrees to indemnify and hold harmless the other Party, and its respective directors, shareholders, affiliates, officers, agents, employees, and permitted successors and assigns against any and all claims, losses, damages, liabilities, penalties, punitive damages, expenses, reasonable legal fees and costs of any kind or amount whatsoever, which result from or arise out of any act or omission of the indemnifying party, its respective directors, shareholders, affiliates, officers, agents, employees, and permitted successors and assigns that occurs in connection with this Agreement. This indemnification will survive the termination of this Agreement.

MODIFICATION OF AGREEMENT

28. Any amendment or modification of this Agreement or additional obligation assumed by either Party in connection with this Agreement will only be binding if evidenced in writing signed by each Party or an authorized representative of each Party.

TIME OF THE ESSENCE

29. Time is of the essence of this Agreement. No extension or variation of this Agreement will operate as a waiver of this provision.

ASSIGNMENT

30. The Vendor will not voluntarily, or by operation of law, assign or otherwise transfer its obligations under this Agreement without the prior written consent of the Licensee.

ENTIRE AGREEMENT

31. It is agreed that there is no representation, warranty, collateral agreement or condition affecting this Agreement except as expressly provided in this Agreement.

ENUREMENT

32. This Agreement will enure to the benefit of and be binding on the Parties and their respective heirs, executors, administrators and permitted successors and assigns.

TITLES/HEADINGS

33. Headings are inserted for the convenience of the Parties only and are not to be considered when interpreting this Agreement.

GENDER

34. Words in the singular mean and include the plural and vice versa. Words in the masculine mean and include the feminine and vice versa.

GOVERNING LAW

35. This Agreement will be governed by and construed in accordance with the laws of the State of South Carolina.

SEVERABILITY

36. In the event that any of the provisions of this Agreement are held to be invalid and unenforceable in whole or in part, all other provisions will nevertheless continue to be valid and enforceable with the invalid or unenforceable parts severed from the remainder of this Agreement.

WAIVER

37. The waiver by either Party of a breach, default, delay or omission of any of the provisions of this Agreement by the other Party will not be construed as a waiver of any subsequent breach of the same or other provisions.

IN WITNESS WHEREOF the Parties have duly affixed their signatures under hand and seal on this 15th day of February, 2021.

Lewis County PUD

Per:_____(Seal)

Officer's

Name:_____

Vision Metering, LLC

Per:_____(Seal)

Officer's

Name:_____

Vision Metering

LoRaWAN®

A veteran and woman owned business.

LoRaWAN is the ONLY Future Proof, Low Cost, OPEN AMI system for Electric, Water and Gas operating in the Internet of Things

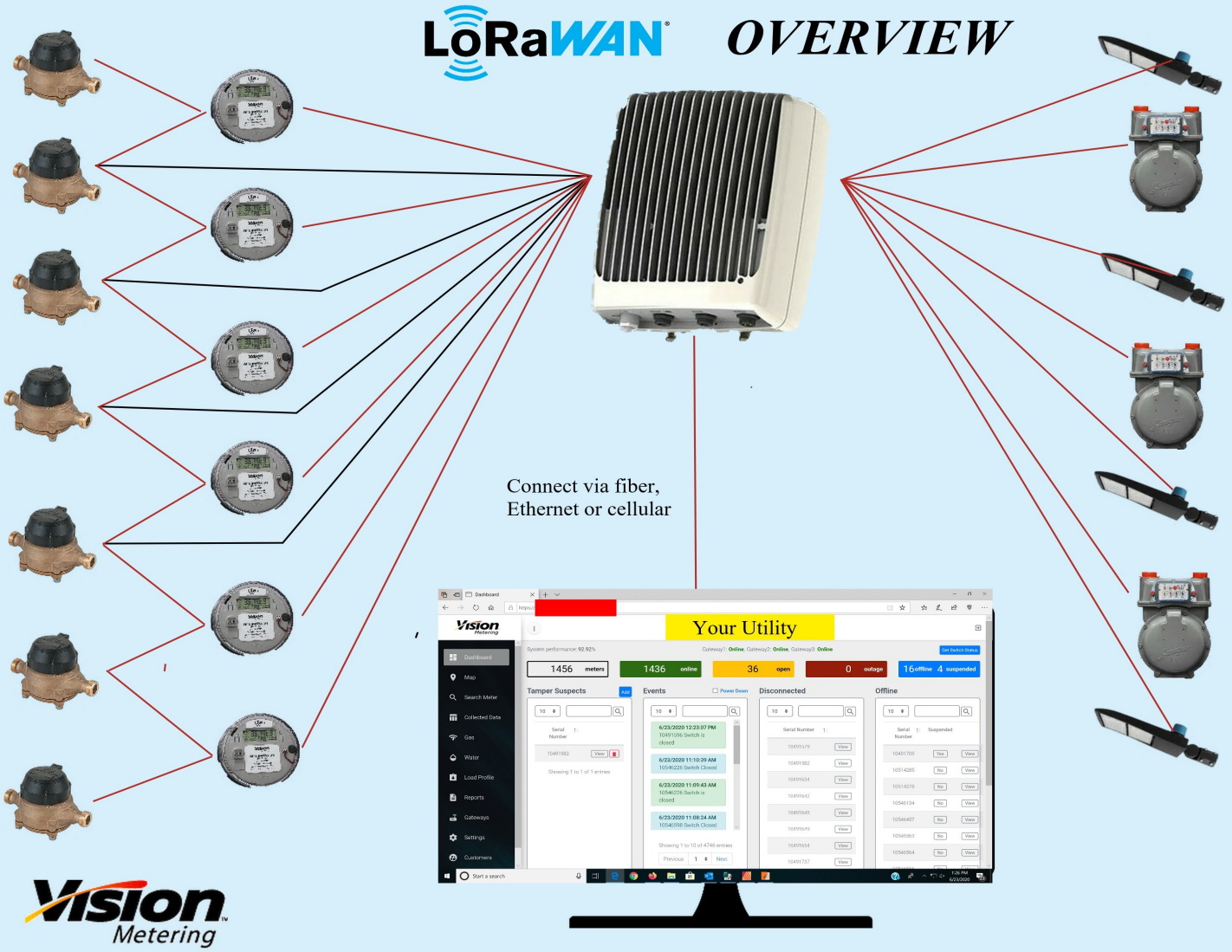
LoRa AMI System

A very robust and flexible solid state meter with all functionality included at no extra charge. Assembled in the US with production since 2008.

- Forms 1S, 2S, 12/25S available with 200 amp switch.
- All meter forms are available.
- Switches for Class 320 available in 2021.
- Accuracy better than 0.2%.
- Last Gasp capacitors good for 20+ seconds.
- 400 Event Log.
- Time of Use.
- 12 Channels of Load Profile.
- Net Metering.
- 4 Quadrant Metering.
- Reactive & Demand.
- All LoRa meters are time synced at midnight and immediately after a power outage.
- Alerts and Alarms
- 32 digit security key
- Available with Cat M1 Modems on Verizon & Sprint.
- 2020 programming software available with purchase of meters.
- 2 Year warranty on meters
- ANSI C12.20, C12.18 & C12.19 Compliant

LoRa is the most Phenomenal AMI System Available

- **Communicate with end devices up to 20 miles away.**
- Completely open system - multiple vendors for every aspect.
- Standards based system controlled by the LoRa Alliance.
- Lowest cost infrastructure.
- Point to point/multipoint system (no mesh).
- Complete Plug & Play system. Very little prep work required.
- LoRa Security system uses AES 128 for end to end encryption.
- One page Dashboards to display systems health of Electric, Water and Gas
- Mapping System to show all meters location based on Electric, Water and Gas
- Data packets can be transmitted in intervals from 1 minute to 1 hour. Each packet can contain 13 to 14 variables and typically KWh delivered & received, KW, KVArh, KVAr, Volts and Amps on all three phases, Power Factor, Meter Temperature and Frequency.
- 2 + channels of load profile are transmitted every 20 minutes and generally include 15 minute KWh and KVArh.
- Current limiting feature is available to control customer usage during cold weather.
- Prepaid options available in EndSight or third party software.
- Net Metering options include Delivered, Received, Delivered + Received (Secure) and Delivered - Received (Net)
- Demand can be manually or automatically reset from the Head End system based on Cycle Day
- Voltage Sag & Swell events programmable for magnitude and duration.
- Security and Theft of service notifications.
- Water Dashboard shows meters which have the number of meters online, meters not reported within 24 hours, Tamper suspects, Leaking and reverse flow.
- Gas Dashboard shows meters which have not reported within 24 hours, the number of meters online and the number of meters off-line.
- Gas Modules available for American, Rockwell/Sensus, Itron flat face and slant face and National.
- Water MIU functions with any water meter that has either a serial output using the Sensus UI 1203 or pulses.



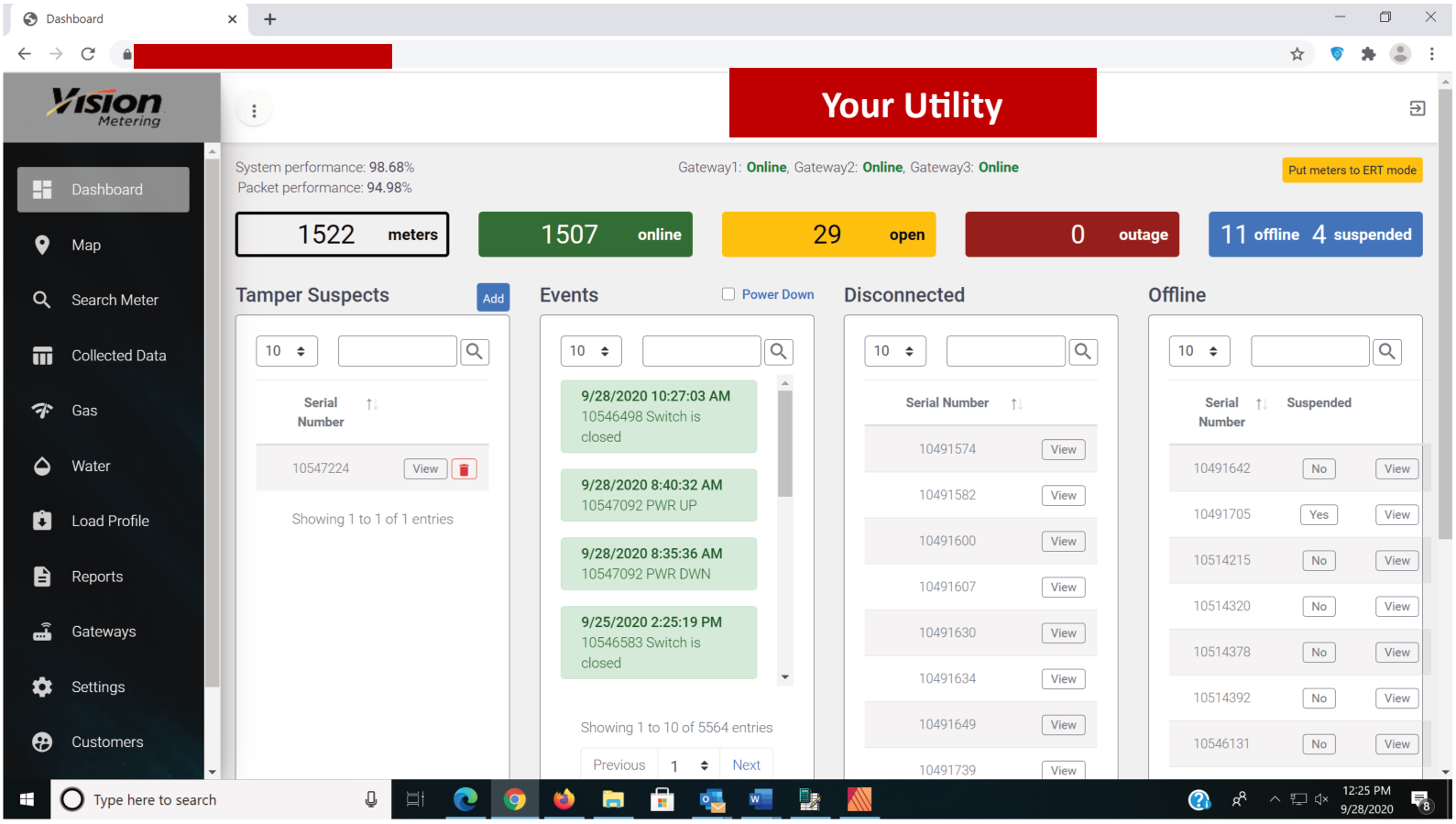
LoRa is a long range Internet of Things (IoT) system designed for the ever expanding IoT. It is an open system that allows anyone to manufacture devices which can communicate over a LoRaWAN network. The openness removes the hand-cuffs that restricts companies to a particular vendor. With LoRa, utilities can design their system to facilitate communicating with electric, water and gas meters all on the same network. Other devices like street light controllers, transformer temperature monitoring, load control devices and demand management system can all coexist within LoRa.

LoRa is designed for low power, long range applications which are well suited for AMI. It operates in the 900 Mhz ISM bands but the technology allows its signals to transmit above the noise in these bands. Vision's system transmits a maximum of 42 bytes at just under 400 ms using 1 watt of power (30dbm) radios. LoRa allows meters and other devices to communicate up to 20 miles.

The LoRa Alliance is comprised of over 500 companies all working in concert to develop the absolute best IoT system in the World. The technology deployed by LoRa is second to none and creates independence for its users. There are no monthly fees to the LoRa Alliance associated with data and no restrictions on the amount of data you can accumulate.

LoRa is scalable to the size of your requirement. You can choose from 8 to 64 channel gateways and can receive up to 12,000,000 messages per day with a 64 channel gateway. Gateways are available from several manufacturers.

Any system other than LoRa will handcuff you to a single vendor for 15 to 20 years. LoRa allows you to competitively source meters, infrastructure and software from the best and most competitive sources.



ENDSIGHT CAPABILITIES

- Simple Dashboard providing system health and operation at a glance.
- Open and Close switches
- Location map showing all meters and their current state, online, offline, power outage and switch status
- Outage Management System by distribution transformer and feeder
- Reporting Capabilities with more than 16 reports as well as the ability to custom design a report.
- Custom API for interfacing with billing software including MultiSpeak connectivity
- California Electric Metering Protocol available
- Transformer Loading Tools
- Dashboards for Electric, Water and Gas
- View collected data as received
- Outage and Alarm Notification sent by email or test as they occur
- Load Profile available on all meters and included at no additional charge
- Search database for devices by Account Number, Meter Serial Number and Address
- Power over Ethernet (PoE) monitoring
- Every packet delivered to the system includes KWh delivered and received, KW, KVARh, KVAR, volts and amps on all three phases, power factor, frequency and meter temperature.

Water Module with LoRa®

Vision Metering has incorporated LoRa® technology into its Water Metering Unit (MIU). The MIU is a battery operated device utilizing a D Cell 3.6 volt battery. It is encased in a glass filled injection molded polyamide package and then potted to ensure that water cannot infiltrate the package. The antenna is mounted in the cap and also potted to prevent water damage. The Vision MIU uses the same opening as the Sensus module.

MIU and Water Meter Combination

The LoRa radio is a Class B transceiver which will transmit between 100 mw and 1 watt (30 db). It has transmission range of approximately 5 + miles provided the gateways are mounted above 60' or higher. It can transmit on any LoRaWan system provided the system has the appropriate App Keys and DEVEUI. These credentials are provided with every MIU.

The MIU can read any meter with a Sensus® UI-1203 output protocol and can provide any data which the meter can produce. The MIU has successfully connected to Zenner, Badger, Neptune, Kamstrup, Honeywell, Master Meter and Mueller water meters. The MIU can be connected using Nicor connectors or crimp connectors at the user's discretion.


Water MIU installed in a plastic cover

The battery is capable of powering the MIU for 20 years if the module is transmitting 4 times per day (every 6 hours). If a greater frequency of transmissions are required, the battery will support 6 transmissions per day thus providing 15 years of battery life. There is a voltage monitor on the battery and it will send an alarm over the air if the battery voltage drops below 3.2 volts.

The MIUs come from the factory preprogrammed and are ready to install right out of the box. When shipped the MIUs will be transmitting every 6 hours and not stop until the battery is drained. When installing, it is necessary to put the MIU in instantaneous transmit mode with the use of a magnet. Each swipe of the magnet will cause an instant transmission so the installer can check the communication.


Magnet rebooting MIU to transmit immediately

Ordering Information

VMW-2-Badger	*These MIUs come without connectors. The wires between the meter and MIU will have to be spliced with outdoor connectors which are included.*
VMW-2-Honywell	
VMW-2-Mueller	
VMW-2-Neptune	
VMW-2-Sensus	
VMW-2-Zenner	

VMW-2NC-Badger	*These MIUs will have Nicor Connectors installed.*
VMW-2NC-Honeywell	
VMW-2NC-Mueller	
VMW-2NC-Neptune	
VMW-2NC-Sensus	
VMW-2NC-Zenner	

XT METERS

Reliable & Flexible

The XT family of meters is designed to run the same firmware on all meters. Therefore the functionality among all types is similar. There are differences between PCB hardware which makes each of them unique. All Vision meters meet requirements set forth by UL with regard to design, materials and components.

The **Standard XT** meter platform is typically offered when standard features are required. The XT can be equipped with Vision's Data on Demand, Landis + Gyr Airpoint and Nexgrid's AMI technology. It is offered in all forms and can be equipped with a 200 amp switch in Forms 1S, 2S & 12/25S.

The **XT-L** is the Standard XT with a 4G LTE or Cat M-1 modem designed for multiple networks. Communications with the **XT-L** can be accomplished with Itron's MV-90, Vision's EndSight or 20/20 software and PrimeStone PrimeReadThe **XT-L** can be sold with or without UL approval.

Some customers require their meters to be UL approved especially in non-utility applications. Our **XT-UL** platform has all the same features as the standard XT and some enhancements in the power supply. UL approval is only on 2S, 12S & 16S.

The **XT-E** is an enhanced version of our **XT** platform designed specifically for Verizon Grid Wide Utility Solutions. It has an enhanced power supply and additional circuitry for power failure. All switching circuits for the disconnect switch(s) are on the main board.

COMMUNICATIONS OPTIONS

Vision Metering

LTE Cat M-1

LoRa

Evolution LTE 4G

NBIoT LTE

Data on Demand

Landis + Gyr Airpoint

verizon

Grid Wide Intelligent Energy

nexgrid
novative smart grid so utions

Displayable Values

ENERGY VALUES
KWh Delivered Total
KVARh Delivered
KVAh Delivered
KWh Delivered Phase A
KWh Delivered Phase B
KWh Delivered Phase C
KWh Received Total
KVARh Received Total
KVAh Received
KWh Received Phase A
KWh Received Phase B
KWh Received Phase C
Quadrant 1 KWh
Quadrant 2 KWh
Quadrant 3 KWh
Quadrant 4 KWh
Quadrant 1 KVARh
Quadrant 2 KVARh
Quadrant 3 KVARh
Quadrant 4 KVARh

DEMAND
Max KW Demand
Max KVA Demand
Max KVAr Demand
Cumulative Demand
Continuously Cumulative Demand Reset Date
Date, Max KW Demand
Date, Max KVA Demand
Date, Max KVAr

Time of Use

KWh Rate A
KWh Rate B
KWh Rate C
KWh Rate D

Cumulative Demand
Continuously Cumulative Demand

Demand KW Rate A
Demand KW Rate B
Demand KW Rate C
Demand KW Rate D

Volts, Amps & PF

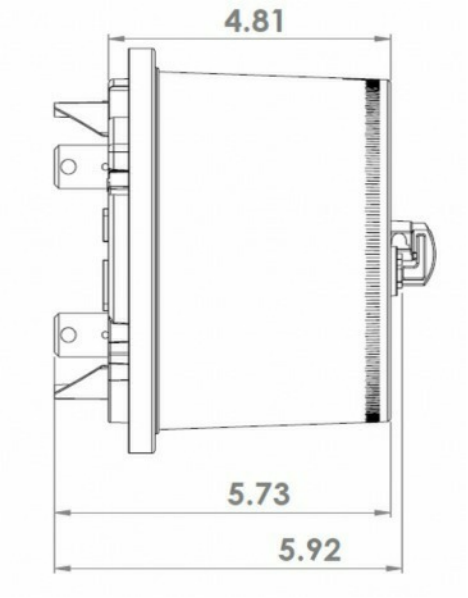
Voltage RMS Phase A
Voltage RMS PhaseB
Voltage RMS Phase C

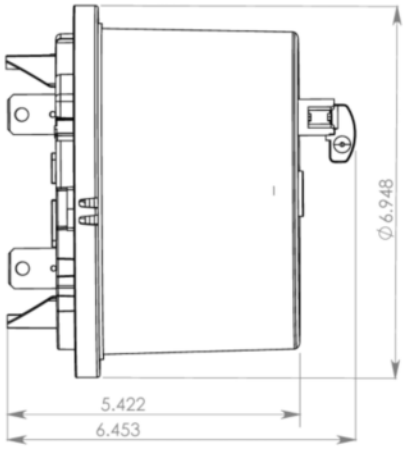
Current RMS Phase A
Current RMS Phase B
Current RMS Phase C

Phase Angle Phase A
Phase Angle Phase B
Phase Angle Phase C

Power Factor Phase A
Power Factor Phase B
Power Factor Phase C
Total Power Factor

XT-E Dimensions





Standard XT, XT-L, XT-UL

LCD Display Layout

Example 9S with Data on Demand

9	N	9	J	1	P

Meter Form	Volts/Class	Platform	Communications	Options	Cover Type
1 Form 1S	A 120V/100A	1 Vision LT	A None	1 None	D Demand
2 Form 2S	B 120V/200A	2 Vision ST	B HP Airpoint Radio	2 200 A Switch	N None
3 Form 3S	C 120V/320A	3 Vision XT	C Pulsed Output FM C	3 Ext Antenna	P Polycarbonate
4 Form 4S	D 120V/20A	4 Vision XT AMI	D Pulsed Output FM A	4 Switch & Ant	L Lexan SLX
5 Form 5S	E 240V/200A	5 Vision ST AMI	E RS-485	5 Potential Link	
6 Form 6S	F 240V/320A	7 LT Shielded	F RF/Pulse FM C	6 Switch w/link	
9 Form 9S	G 240V/20A	8 ST Shielded	G RF/Pulse FM A	7 Ant w/link	
R Form 10S	H 480V/200A	9 XT Shielded	H RF/RS-485	8 Sw/Ant/link	
P Form 11S	J 480V/320A	S XT-E	I Verizon Gridwide	9 100A Switch	
M Form 12S	K 480V/20A	U XT-UL	J Data on Demand	0 TSTM Xformer	
N Form 25S	L 120-480V/200A		K LTE Modem	C Pulse Form C	
Z Form 16S	M 120-480V/320A	Switch Meters 4,5 or U only	N Nexgrid	D Dual Pulse	
C Form 2SM	N 120-480V/20A		T 3 Airpoints		
T Form 32S	P 120-480V/100A		W 5 Airpoints		
P Form 36S			U Cat M-1		
F Form 45S					

GENERAL XT SPECIFICATIONS

- ANSI C12.18, C12.19, C12.20, & C37.90.1 Compliant
- Utilizes Magnetically Shielded Current Transformer(s) for Current Measurement
- 120 480 VAC Input Voltage
- LCD Display is soldered to the board
- 12 Channels of Load Profile,
- Time of Use
- Demand, KW & KVAR
- Reactive Metering
- Four Quadrant Metering
- Event Log
- Delivered, Received and Net Metering
- Alternate Mode with programmable display values
- Accuracy Class +/0.2%
- Shipped with Accuracy better than +/0.15%
- Designed for 20 Year Life
- Battery options for Display, Ram, and Clock
- Continuous Instantaneous KW
- Uses Vision 20/20 Software for Programming (included with the purchase of meters at no charge)
- 50/60 Hz +/5%
- Utilizes Maxim Teridian Technology
- 100 & 200 Amp Switch Option
- 30 Digit User Defined Security Key
- 40 to +85 Degree C Operation
- 5 to 95% Relative Humidity
- Functions with Itron's MV90 System.
- Code Numbers assignable to Display Values
- All plastic materials meet or exceeds UL Requirements

XT-E ADDITIONAL SPECIFICATIONS

- Power supply capable of 10 watts @ 4 volts
- Switching circuits for high current switches on main PCB
- Zero crossing circuit for power outage detection

EVOLUTION LTE ADDITIONAL SPECS

- AES 256 Security with Certificate Handling
- Meter/Modem Power Consumption 3.6 watts idling, 6 watts at maximum transmitting
- Designed for multiple wireless systems.

All XT Vision Meters Include

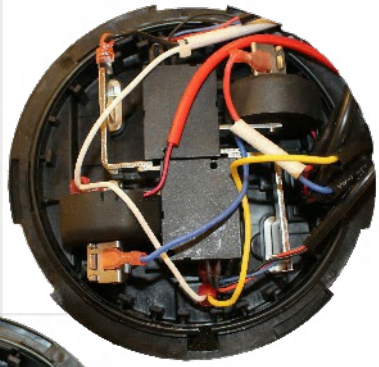
Time of Use
KW & KVAR Demand
Continuously Cumulative Demand
12 Channels of Load Profile
Net Metering
Reactive Metering
Four Quadrant Metering
Event Log
Power Quality

No Extra Charge for Any Features

100 Amp Form 16S Switch

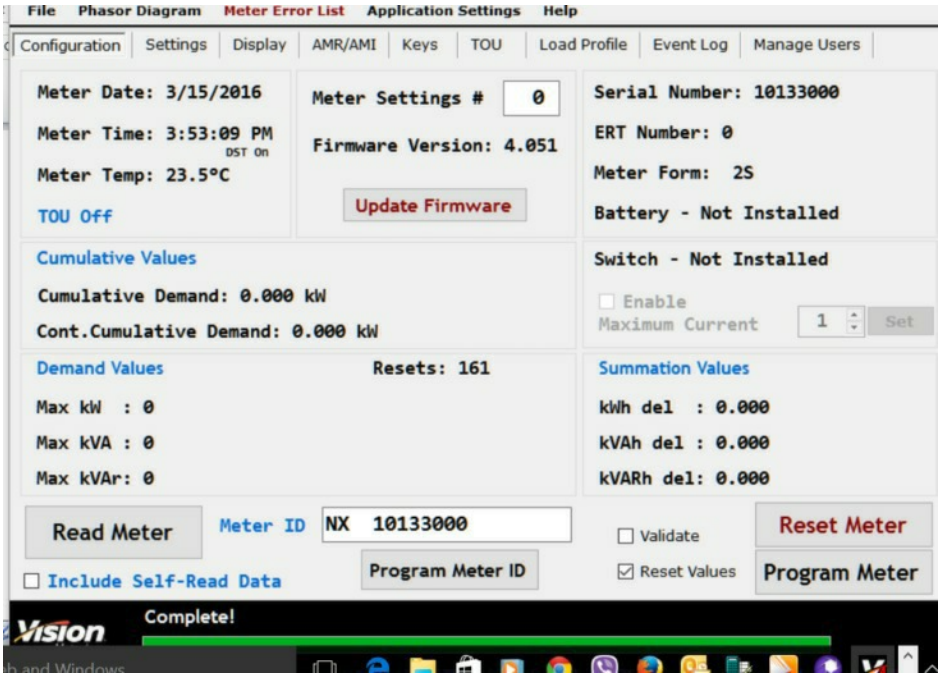
200 Amp Form 2S or 12S Switch

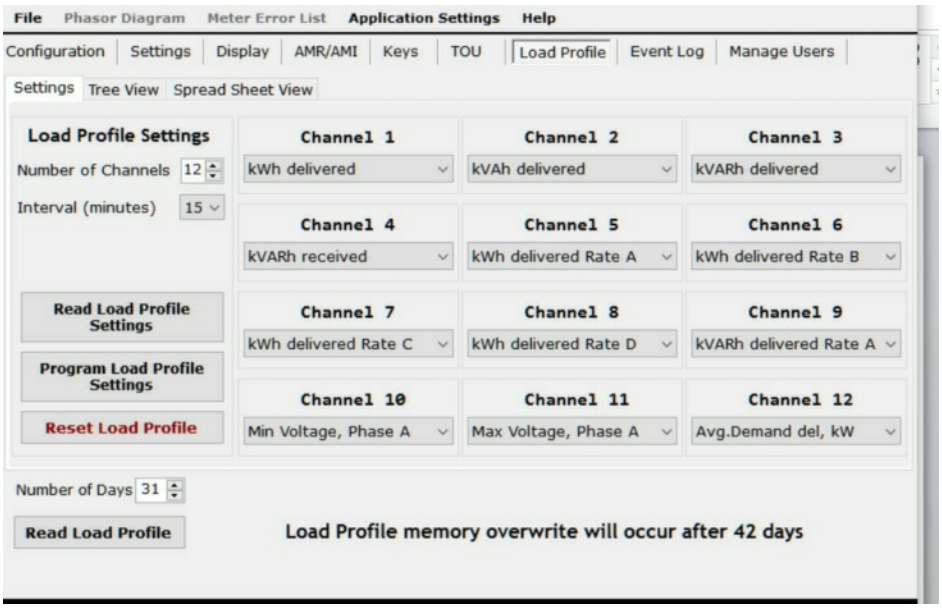
100 Amp Form 2S or 12S Switch

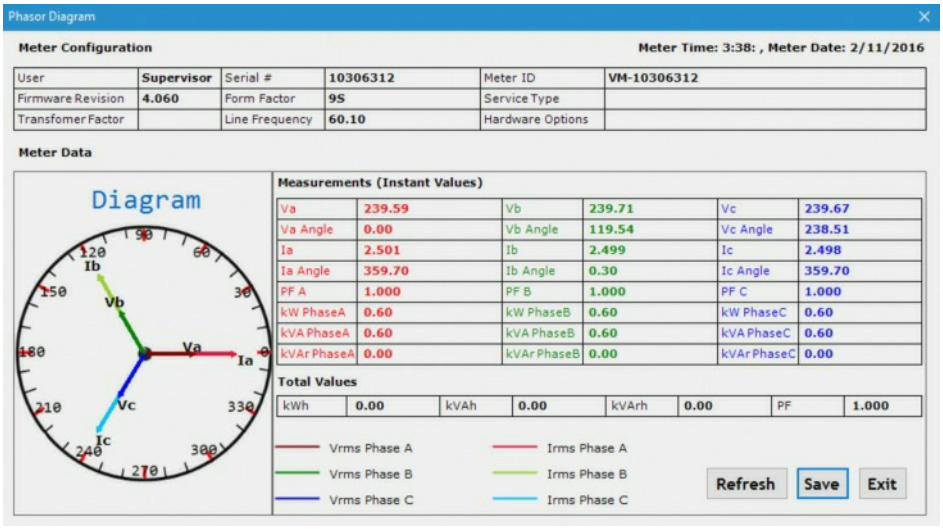


100 Amp Form 1S Switch

2020 Programming Software







Vision 2020 Software is capable of programming all variables in the meter. Time of Use, Demand, 12 channels of Load Profile, Net Metering, Reactive and Four Quadrant Metering are programmable. Demand can be programmed for block, rolling, cumulative and continuously cumulative. Programs can be developed and stored under a specific Meter Settings #.

2020 is very intuitive and flows easily from screen to screen. All Vision Meters are supplied with everything included. The meter is only sold in one configuration “LOADED”. Thus all functions in 2020 are available to be programmed.

2020 will run on Windows XP, 7, 8 & 10. Security is an integral part of 2020 with tasks selectable by the administrator for all users. Security between 2020 and the meter is also programmable by the administrator.

2020 is also used to communicate with Vision’s XT-L LTE modem meters via the Internet.

When communicating with any XT meter it is possible to view the Phasor diagram while on site. The Phasor diagram will provide the voltage and current on all phases along with real and reactive power including the phase angle. It will also show the meter’s serial number, form and version of firmware.

2020 is an ideal tool to read and store Load Profile Date. Data can be collected via the optical port, LTE modem or via the optional RS-485 port. Load Profile can also be read via Itron’s MV-90 System.

CAT M1 MODEM METER

ACHIEVE LOWER COSTS OF OWNERSHIP AND LOWER DATA RATES WITH CAT M1 MODEM

FINALLY, A LOW COST SOLUTION FOR MODEM METERS

Vision Metering is proud to introduce a low cost solution for using the public wireless systems to meter residential, commercial and industrial customers. The LTE Cat M1 modem is data only making it significantly less expensive than 4G LTE modems. It is the perfect choice for Machine to Machine (M2M) communications.

Cat M1 modems cost about 50% less to produce versus the 4G LTE modem, thus reducing the cost of a typical meter equipped with a modem. Data rates are also decreasing and are less for Cat M1 versus 4G LTE since it does not stream video or audio.

Cat M1 is currently available on both Verizon and AT&T nationwide. It was developed to achieve longer transmission distances and reduce the overall costs. Since it is strictly data, one antenna is used to transmit and receive. This makes the data rate slower than a typical 3G or 4G

The Cat M1 Modem Meter uses the XT-UL meter platform with UL listings coming soon for 2S, 12S & 16S meters. This is the same meter platform currently being used on the 3G and 4G modem meters..

ALL CAT M1 MODEM METERS INCLUDE:

Time of Use

KW, KVAR & KVA Demand

Continuously Cumulative Demand

12 Channels of Load Profile

Net Metering

Reactive Metering

Four Quadrant Metering

400 Entry Event Log

Cat M1 modem currently certified on Verizon

Modem also functions on AT&T but not certified

Available in All Metering Forms

2S & 12S Meters available with 200 Amp Switch

Cat M1 Meters can be read with MV-90, PrimeStone, Vision 2020 and Vision EndSight

Visible LEDs indicate Modem's Operation

Green - Blinking Heartbeat one second on/off

Blue - Connected to Network

Red/Orange - Error trying to Connect

GENERAL XT SPECIFICATIONS

- ANSI C12.18, C12.19, C12.20, & C37.90.1 Compliant
- Magnetically Shielded Current Transformers for Current Measurement (Optional)
- 120 - 480 VAC operatioin
- LCD Display is soldered to the board
- 12 Channels of Load Profile
- Time of Use
- Demand, KW, KVAR & KVA
- Reactive Metering
- Four Quadrant Metering
- 400 Events in the Event Log
- Delivered, Received and Net Metering
- Alternate Mode with programmable display values
- Accuracy Class +/-0.2%
- Shipped with Accuracy better than +/-0.15%
- Designed for 20 Year Life
- Battery options for Display, Ram, and Clock
- Continuous Instantaneous KW
- Uses Vision 20/20 Software for Programming (included with the purchase of meters at no charge)
- 50/60 Hz +/-5%
- Utilizes Maxim Teridian Technology
- 200 Amp Disconnect Switch Option
- 30 Digit User Defined Security Key
- -40 to +85 Degree C Operation
- 5 to 95% Relative Humidity
- Functions with Itron's MV90 System.
- Code Numbers assignable to Display Values
- All plastic materials meet or exceeds UL Requirements

ORDERING INFORMATION

FM 2S	2LUU1P No Switch
FM 2S Switch	2LUU2P
FM 3S	3NUU1P
FM 4S	4NUU1P
FM 5S	5NUU1P
FM 9S	9NUU1P
FM 12S	MLUU1P No Switch
FM 12S Switch	MLUU2P
FM 16S	ZLUU1P

COMMUNICATES WITH:

Itron™ MV-90

Primestone Primeread

Locus NOC

Vision EndSight

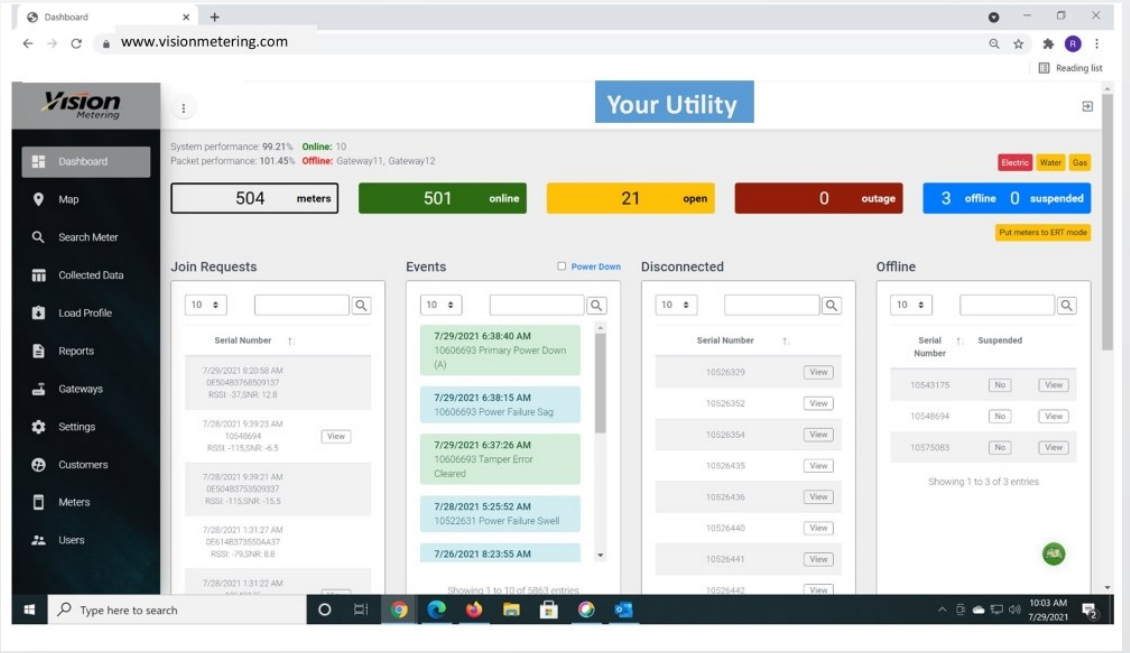
Vision 2020

U-BLOX CHIPSET CHARACTERISTICS:

Vision Metering's Cat M1 modem uses the U-Blox Sara 410 chipset.

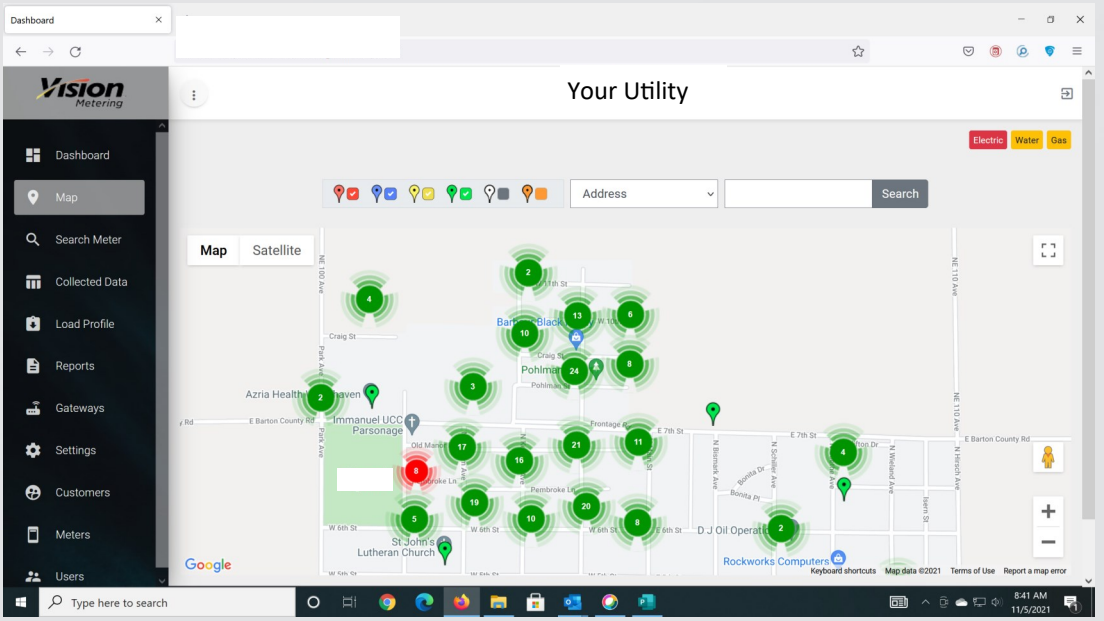
- Global configurability with single hardware version
- Flexible mode selection as LTE Cat M1, LTE Cat NB1, EGPRS – only/preferred
- Critical firmware updates delivered via uFOTA with LWM2M
- Low power consumption
- Extended range in buildings, basements, and with NB1, underground
- Easy migration between U-Blox 2G, 3G and 4G modules
- Cat M1/NB1 deployed bands 2, 3, 4, 5, 8, 12, 13, 20, 26, 28 and 39 in M1 only

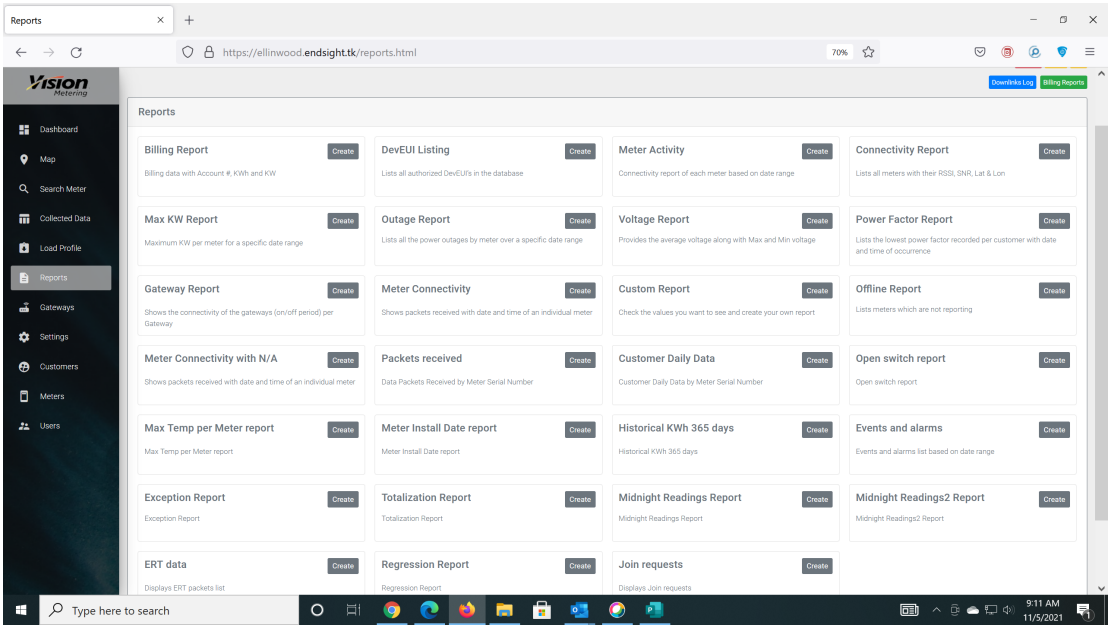
EndSight Cloud



Endsight Cloud is provided as a Software as a Service (SaaS) Platform and hosted in the AWS cloud. The Dashboard above gives a visual indication of the system's health at a glance. It performs as an Electric, Gas, Water and Streetlight platform. The system uses a MS SQL Server database and is hosted in three different server locations throughout the AWS system. With EndSight Cloud, you can monitor every device on your system with 5 or 15 minute data, open and close switches, poll meter data, perform Demand Resets and put meters into Load Limiting mode. The system is very easy to use and is intuitive for the user to follow. EndSight is integrated into many Billing Systems like NISC, SEDC, TylerTech and many others. EndSight can be integrated into any billing system.

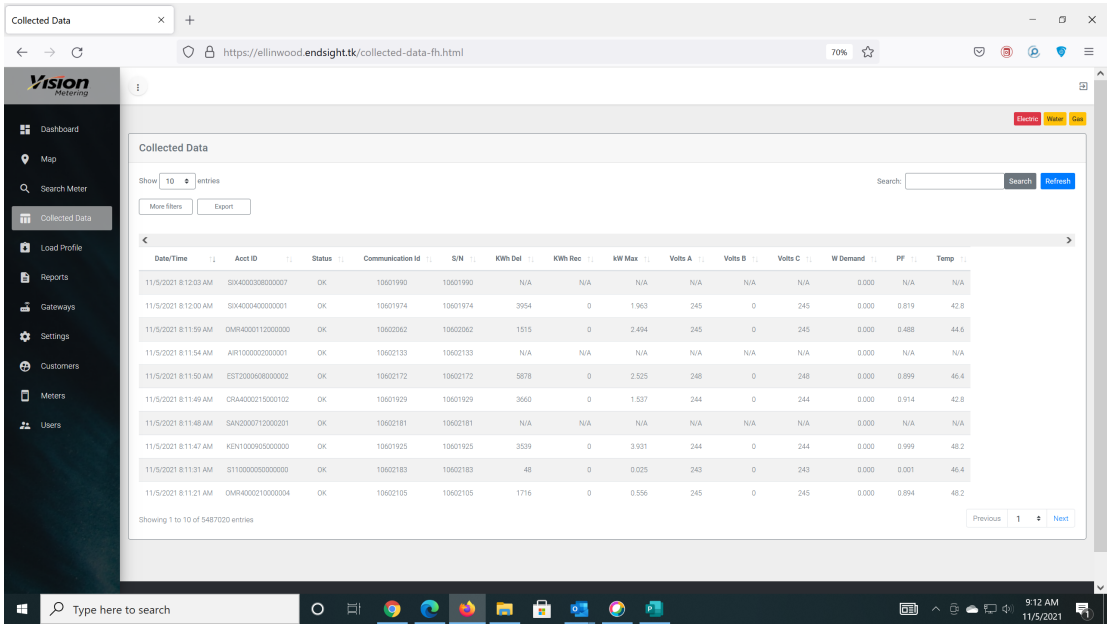
The map below shows all meters on the system. If green, they are communicating regularly. If yellow the switch is open. If Blue the meter is not communicating, and if red there is a power outage. It serves as a visual Outage Management System. You can click on any pin and get the meter's location and move directly to the meter details page.



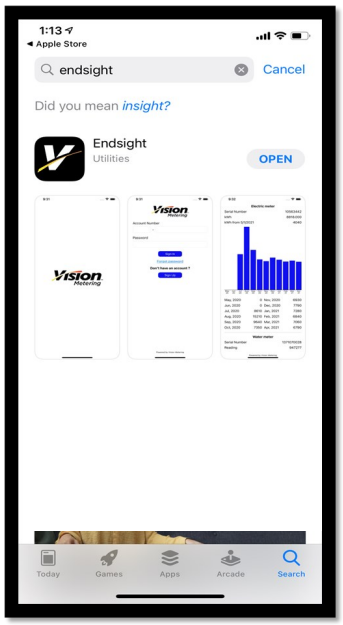


There are many canned reports that allow the presentation of data. Reports can be added as requested and data presented in a way for customers to easily follow.

There are reports that allow you to present data to a customer complaining of a high bill that shows how much energy is being used every day.



The Collected Data screen shows data as it is being collected from each individual meter. You can sort this data based on individual meters and see the history of collected data for the last six months.



Utility Apps are available for Apple and Android via their app stores that can be given to individual customers to show consumption history and almost real time consumption. The data can be delayed by as much as 15 minutes as the meters only report every 15 minutes. The Apps will be configured with the utility's logo and pricing information can be displayed if desired by the utility. Data can be displayed for Electric, Gas & Water.

Sentry 250 POE

Power over Ethernet

Sentry 250 with meter socket

The Sentry 250 is a Power Over Ethernet / Battery back up for gateways and other devices requiring power from the Ethernet port. It was specifically designed to work with Electric, Water and Gas AMI systems.

The Sentry 250 is available with or without a meter socket. Inserting a meter provides an indication to the head end system that power has been lost. A 6 amp circuit breaker is included for safety.

A 55 Amp hour battery will provide up to 24 hours of back up depending on the application and the amount of power the end device is using.

The Sentry 250 can be powered from either 120 or 240 volts AC. It can provide up to 36 watts to the end device and is a POE ++. If more power is required, a 55 watt POE++ can be installed for an additional charge.

The power supply is capable of providing 100 watts for power the POE and battery charger. Upon power failure the power supply will switch from line power to battery back up and the communications module in the meter will notify the head end system.

Any AMI systems meter will function with the Sentry 250. The main reason for using a meter is to let the head end know that a power outage has occurred at the gateway site.

Specifications:

Input Power	90 - 264 Volts
Battery	12 Volts 55 Amp hour
Battery Charger Output	13.6 Volts 2.5 Amps
POE ++ Output	36 Watts @ 48 Volts
Enclosure	Powder coated Aluminum Nema 3R
Meter Socket	Round 125 Amp

KONA Mega IoT Gateway

High Capacity LoRaWAN™ Gateway for Wide Area Deployments

TEKTELIC's KONA Mega IoT Gateway provides network operators with a carrier grade product for the deployment of LoRaWAN™ Internet of Things networks. The Gateway enables massive scalability in a compact form factor by supporting up to 12 million messages per day.

It is ideal for public and private network operators that require Full Duplex, multiple Rx and Tx Channels, cost effective and reliable LoRaWAN™ gateways to maximise their network investment for years to come.

Product Differentiators:

- High availability carrier grade design with support of in-service configuration and software updates.
- Environmentally hardened aluminium enclosure fully tested to withstand extreme temperature conditions.
- Full duplex operation making all receive and transmit channels available simultaneously.
- Excellent isolation between the Tx and Rx bands as well as out of band rejection of Cellular and Paging networks.
- Day-One scalability with support of up to 12 million received messages per day.
- Easy to deploy supporting different backhaul and power options.
- Fully integrated with the broader eco-system of LoRa™ network servers and sensors.

Key Features

- **Frequency Duplex 72 Rx / 4 Tx**
- **Dual Antenna Support for Rx Diversity**
- **Double Simultaneous Tx Channels**
- **High Linearity LNA/Receiver**
- **Integrated Bandpass Filter**
- **Precise Newtork Synchronization (GPS)**
- **Integrated GPS Holdover**
- **1 Watt (30 dBm) Tx Power**
- **Geolocalization Support**
- **Hardened Carrier Grade Enclosure**
- **Integrated Cellular 3G/4G Modem**
- **Copper and Optical Ethernet Backhaul**
- **Rated IP67 Enclosure**
- **NA 915 ISM Band**

TEKTELIC communications

WWW.TEKTELIC.COM +1.403.338.6900 INFO@TEKTELIC.COM

KONA Mega IoT Gateway

High Capacity LoRaWAN Gateway for Wide Area Deployments

Technical and Functional System Specifications

Mechanical Parameters

MTBF	450,000 hours
DC POwer Consumption	< 40 W
Operational Temperature	-40°C to +55°C
Operational Humidity	10% to 100% Condensing
Ingress Protection	IP67
Size	222.2 x 267.6 x 101 mm
Weight	5 kg
Volume	5.5 L

Interfaces

Ethernet Backhaul	RJ-45
GPS	N-Type
Cellular Backhaul (3G/4G)	N-Type (Optional)
Hybrid Optical and DC Power	Harting Hybrid (Optional)
LoRa Antenna (2 ports)	N-Type (2nd Port Optional)
Power	-48VDC or PoE++ (802.3bt)

Regulatory Compliance

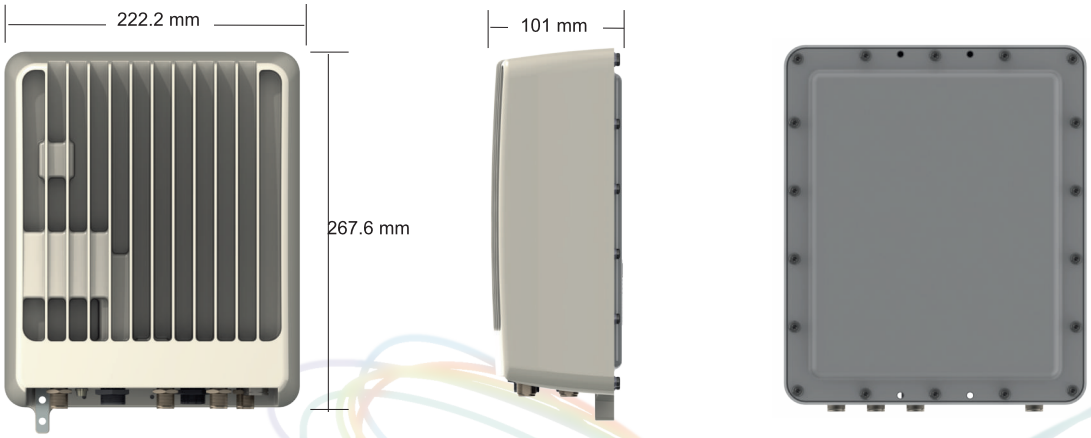
Safety	UL 60950-1 (US/C)
Environmental	ETSI EN 300 019-2-1, 300 019-2-2 ETSI EN 300 019-2-3, 300 019-2-4
Regulatory	FCC Part 15.247, 109, 209

LoRa Radio Parameters

ISM NA Band	902 - 915 MHz (Rx) 923 - 928 MHz (Tx)
Tx Power	2 x 1W (2 x 30 dBm)
Rx Sensitivity	-142 dBm (SF12, 293 bits/sec)
Rx Noise Figure	3.5 dB
Rx Linearity	-10 dBm
Rx Dynamic Range	70 dB Analog, 100+ dB Digital
Tx to Rx Isolation	75 dB

Software and Management

Tools	Access Control List managment
	3G/4G Parameter Configuration
	System Health Monitor
	Flight Recorder
	Radio Configuration and Control
	Remote Software Upgrade
	Active and Passive image management
	Factory image provisioning
Networking	DHCPv4 client
	TFTP server
	HTTP server
	Firewall and Access Lists



Specifications subject to change without notice.

TEKTELIC Communications is a premier supplier of best-in-class LoRaWAN™ IoT Gateways, Sensors, and custom applications. These elements combined provide a powerful end-to-end solution that can be easily, quickly, and cost effectively deployed to address the most demanding IoT challenges.

For more information please visit www.tektelic.com

TEKTELIC communications

LoRa Alliance Member

2018 Product & Services Line Card

Vision Metering, LLC., Formerly Austin International, Inc. has been in business since 1991. The company has recycled more than $375M in used and remanufactured equipment. As a green company every opportunity is seized to reduce its carbon footprint as evidenced by its sales and 813 KW of solar power on the roof. Vision Metering has developed an extensive product line of electronic meters, test equipment, and accessories, all focused on electric utility metering.

Shown with optional wedge to improve ergonomics.

Why not buy test equipment from a company that uses what they sell?

Optional A Base Adapter

VESTA is advancing the realm of electricity meter testing. This test board can be operated with a scanner and your finger. The touch screen display allows the user to test any form of meter with a variety of pulsed pick ups.

TOUCH THE FUTURE

with VESTA

Vision Metering, LLC, 7 Ross Cannon St., York, SC 29745 803-628-0035 www.visionmetering.com

Sentry Products

Sentry 410 Optical Probe

Low-cost USB optical probe for reading and programming solid state electric meters. Available in both 6' and 9' lengths.

6' Sentry 410	**Item# ST-VM-SENTRY 410-6**
9' Sentry 410	**Item# ST-VM-SENTRY 410-9**

Sentry 950 Handheld

Lightweight, affordable handheld for reading and troubleshooting Itron 900 MHZ radio modules for electric, gas, and water meters. The Sentry 950 features an industrial touch screen and is capable of reading Itron ERTs, SCM/SCM+ messages, Cellnet modules and Vision's Data on Demand radio.

Sentry 950	**Item# ST-VM-SENTRY 950**

Sentry Isolation Relays

Complete line of solid state and conventional mercury isolation relays and totalizers. Models available include the Sentry 30E with one input and three outputs up to the Sentry 70 with three inputs and six outputs.

Sentry 30E	**Item# ST-VM-SENTRY 30E**
Sentry 50	**Item# ST-VM-SENTRY 50**
Sentry 70, 2 Inputs, 4 outputs	**Item# ST-VM-SENTRY 70-2/4**
Sentry 70, 3 Inputs, 6 outputs	**Item# ST-VM-SENTRY 70-3/6**

Sentry 30E

Sentry 50

Sentry 70

Sentry K-Base Adapters

Vision's patented K-Base adapters are designed to handle the full rated current of the existing meter socket so that there is no derating of service. All three adapters are manufactured to the highest standards and continually provide accuracy better than 0.15%. The internal CTs are encapsulated in the polycarbonate housing and are rated to provide linear accuracy throughout the entire current range.

2K to 3S, 200:5	**Item# AD-VM-2K-3S-200**
2K to 3S, 400:5	**Item# AD-VM-2K-3S-400**
12K to 5S, 200:5	**Item# AD-VM-12K-5S-200**
12K to 5S, 400:5	**Item# AD-VM-12K-5S-400**
16K to 9S, 200:5	**Item# AD-VM-16K-9S-200**
16K to 9S, 400:5	**Item# AD-VM-16K-9S-400**
16K to 9S, 400:5 KYZ	**Item# AD-VM-16K-9S-400-KYZ**

16K to 9S

2K to 3S

12K to 5S

Sentry 7000 Meter Base Washer

Stainless steel meter washer with replaceable rotating brush. The Sentry 7000 uses clean water, no need for detergent, and is designed to wash roughly 800 meters per 8 hour shift. The brushes last approximately 30,000 meters.

Sentry 7000	**Item# ST-VM-S7000-METER WASHER**
Replacement Brush	**Item# ST-VM-S7000-BRUSH**

Vision Meter Platforms

ST Meter Platform

The ST meter family provides solid sate accuracy with the proven reliability of current transformers for reliability and long life. ST meters are available with a range of communication options. Available in forms: 1S, 2S, 3S, 4S, 12S and 25S.

XT Meter Platform

Vision Metering's flagship electric meter platform. Available with host of AMI communication options.

XT-L Meter Platform

The XT-L (Evolution LTE) is the Standard XT with a 4G LTE modem designed for multiple networks. Communications with the XT-L can be accomplished with Itron's MV-90, Vision's EndSight or 20/20 software. The XT-L can be sold with or without UL approval for forms: 2S (without switch), 12S, and 16S.

XT-E Meter Platform

The XT-E is an enhanced version of our XT Platform designed specifically for 3rd party AMI vendors. It has an enhanced power supply and additional circuitry for power failure. All switching circuits for the disconnect switch are on the main board.

Vision Meter Platforms Include:

- 12 Channels Load Profile
- Bi-Directional Metering
- Reactive Metering
- Demand
  (Not Available in ST Meters)
- Time of Use
- Net Metering
- 5 HP Airpoint Radios

Irrigation Meter

Vision Metering worked with TSTM to securely mount their transformer inside the meter to effectively create a stable meter for irrigation wells. Available in 12S and 16S.

All Vision Meters are class 0.2% accuracy.

Programming Software

Vision 2020 Programming Software

The 20/20 Software is made available to every end user of Vision Meters. 20/20 will run on Windows XP, 7, 8 and 10, and is capable of programming all variables in the meter. 20/20 is an ideal tool to read and store Load Profile Data. Data can be collected via the optical port, LTE modem, or via the optional RS-485 port. Load Profile can also be read via Itron's MV-90 System.

Gas & Electric Meter Services

Vision Metering Services

Vision Metering began providing meter testing services over 26 years ago. Since then we have grown to become the largest meter testing facility in the United States. As the metering industry continues to evolve, new testing demands are placed on utility meter labs. Manpower reductions and OEM budget shrinkages can lead to many utilities throwing away perfectly good meters due to lack of resources to perform testing and repairs.

Vision Metering offers a number of different meter testing programs aimed to ease your meter testing workload. Our highly trained workforce is standing by to help any meter testing needs from a few hundred meters to tens of thousands Contact us today and let us develop a custom tailored testing program that meets all of YOUR testing needs.

Call now to see how we can help you.

Gas Services Include:

- Diaphragm Meter Repairs (Level 1 - Level 4)
- Rotary Meter Repairs (Basic and Enhanced)
- Remanufactured Meters (American/Rockwell/Itron, 250 cfh- 1000 cfh)
- ERT Battery Replacement
- AMI Integration

Electric Services Include:

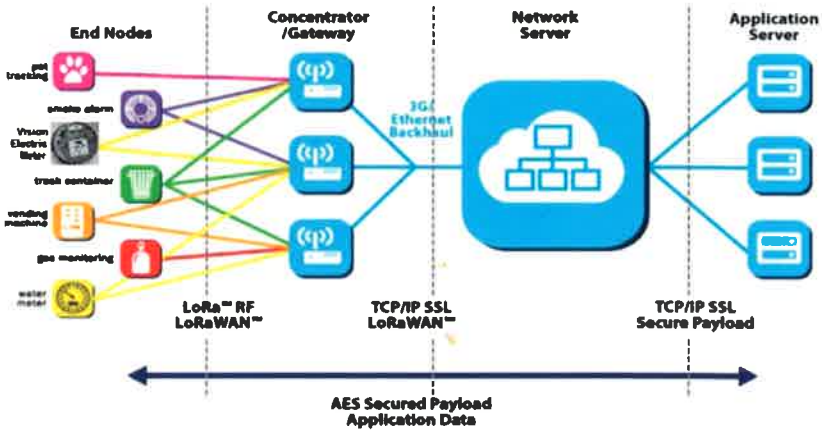
- Meter Testing
- Retirement Testing
- Acceptance Testing
- AMI Communication Testing
- RMA Processing
- Certified Smart Meter Destruction
- AMI Integration
- Overflow Testing
- Partial Outsourcing
- Full Outsourcing

Communication Solutions

AMI

LoRA

LoRa is a low power, wide area network (LPWAN) designed for the Internet of Things (IoT). It is open source, allowing you to customize the equipment as needed and eliminating the need for long term contracts. LoRa stands for "Long Range" because of its ability to connect and communicate with devices over great distances, up to 20 miles. The low power usage allows a battery to keep an endpoint device connected for many years without replacement. In the US LoRa operates in the 900 MHz ISM bands. The technology is proven, utilizing AES 128 encrypted security from end to end. User data is embedded in the LoRa stack (data packet.) Network architecture is typically laid out in a star-of-stars topology in which gateways are a transparent bridge relaying messages between end-devices and a central network server in the backend. LoRa radios are ideally suited for electric, gas, and water meter reading as they are well suited for creating an Advanced Metering Infrastructure (AMI). Cheap to install and cheap to run, LoRa is the future of smart metering.



Ask about our Trial Package

Includes:

- Single phase and polyphase meters equipped with LoRa modules and all functionality enabled. (Remote disconnects available for FM2S and FM12S meters)
- Gateway/Collector with either ethernet/fiber or 4G LTE Modem for back haul to head-end system
- Endsight Software with laptop for head-end data storage and export to billing system

4G LTE Modem Meters

Vision's Modem Meter provides a robust AMI solution utilizing Verizon's network to connect meters directly to EndSight or another head-end system using a developers kit. There is also a TIM for Itron's MV-90 and Primestone's PrimeRead system. Available in all forms and as a UL listed device for forms: 2S (without switch), 12S, and 16S.

LTE Cat M1

A next-stage modem developed for more efficient transmission of data only in wide area networks. Designed for Connecting Internet of Things (IoT) and Machine-to-Machine (M2M) devices, it lowers the data rate cost by eliminating unnecessary voice and video capability on Verizon's network.

AMR

Data On Demand

Designed for smaller utilities and sub-metering installations, Data-On-Demand offers one-way communication from the meter to the head-end system. All meter forms can be connected through DataGate collectors that then send readings to EndSight. It is a cost-effective AMR solution that is perfect for RV parks, apartment complexes, college campuses, and marinas.

Head-End System

EndSight

EndSight is a powerful yet easy to use head-end system that stores and reports meter data collected from meters equipped with either an AMI or AMR communication module. EndSight works with Vision meters utilizing LoRa, LTE Modem, or Data-On-Demand. Data from EndSight can be exported to Excel and other spreadsheets.

Additional communication solutions include: Verizon Grid Wide, NexGrid, and Landis & Gyr ZMP 59.

Accessories

Collapsible Meter Crate:

Innovative new design for transporting meters to and from the meter lab. Four position stackable meter crate securely stores and protects meters while in use, then collapses flat for convenient storage and shipping.

4 Position Crate **Item# ST-VM-MC-4POS**

Electric Meter Covers

Full line of polycarbonate covers are constructed of UV stabilized high molecular weight, engineered thermoplastics that have exceptionally high impact strength over a wide temperature range.

Cover , GE I-210	**Item#ST-VM–PCG-210-B**
Cover, Landis + Gyr Focus	**Item#ST-VM-PC-XLP-F**
Cover, Vision LT + ST	**Item#ST-VM-PC-VISION**
Cover, GE kV Family	**Item#ST-VM-PCG**
Cover, Extra Low Profile Single Phase	**Item#ST-VM-PC-XLP**
Cover, 3 Phase, High-Profile	**Item#ST-VM-PC-FM 12-16**
Cover, Low Profile, Single Phase	**Item#ST-VM-PCLP**
Cover, Blank Out	**Item#ST-VM-PAL NO.2**
Cover, Blank Out, Unbladed	**Item#ST-VM-PAL NO.3**

Electric Meter Sealing Rings

Complete line of sealing rings including slip lock, screw type, and lever type.

Slip Lock	**Item# ST-VM-SSSR**
Screw Type	**Item# ST-VM-SSSR-ST**
Lever Type	**Item# ST-VM-SSSR-LEVER**

Electric Replacement Meter Batteries

3.6V lithium batteries for solid state meters, manufactured by Xeno.

Battery **Item# ST-VM-XL-050F**

Electric Meter Rack

Seventy position meter rack for lab meter storage. Constructed from powder coated aluminum with replaceable casters.

70 Pos. Rack **Item# ST-VM-MR70P**

Electric Meter Lamps

Decorative meter lamp designed with vintage, American made electric meters. Available with oak, cherry, or mahogany base, includes shade. Perfect for retirements and longevity awards.

Oak Base	**Item# ST-VM-LAMP-OAK**
Cherry Base	**Item# ST-VM-LAMP-CHERRY**
Mahogany Base	**Item# ST-VM-LAMP-MAHOGANY**

Meter Sockets

Round Meter Sockets, rated for 100 Ampere. Includes a slip lock seal ring.

4 Terminal, two 1" Hub Openings	**Item# ST-VM-MS4TH1**
5 Terminal, two 1" Hub Openings	**Item# ST-VM-MS5TH1**
5 Terminal, two 1" Hub Openings w/ Bypass	**Item# ST-VM-MS5TH1-BP**
6 Terminal, two 1" Hub Openings	**Item# ST-VM-MS6TH1**
6 Terminal, two 1" Hub Openings w/ Bypass	**Item# ST-VM-MS6TH1-BP**

MS4TH1

MS5TH1

MS6TH1

Gas Meter Indexes

New replacement direct read indexes for American AC-250 and AL-425 meters and Sensus 275 and 400 series meters. All indexes are available in TC and Non-TC.

Vision, AC250/425, TC, Direct Read	**Item# GM-VM-INDEX-AC250TC-DIR**
Vision, AC250/425, Non TC, Direct Read	**Item# GM-VM-INDEX-AC250NTC-DIR**
Vision, R250, TC, Pointer Register	**Item# GM-VM-INDEX-R250TC-PTR**
Vision R250, Non-TC, Pointer Register	**Item# GM-VM-INDEX-R250NTC-PTR**
Vision, R400, TC, Pointer Register	**Item# GM-VM-INDEX-R400TC-PTR**
Vision R400, Non-TC, Pointer Register	**Item# GM-VM-INDEX-R400NTC-PTR**

WHY LoRaWAN® IS THE CONNECTIVITY PLATFORM FOR SMART CITY APPLICATIONS

MAY 2020

INTRODUCTION

We live in a rapidly urbanizing world, in which two-thirds of the population will live in cities by 2050, adding another 2.5 billion city-dwellers to the current just over 4 billion urban residents[1].

Smart cities are the ultimate in interconnected, intelligent infrastructure, with services, devices and systems linked that encompass simple inputs such as sensors on waste bins or controls for streetlighting to complex citizen services composed of multiple systems integrating with each other to enable smart transportation or connected vehicles.

The connection of infrastructure and services in a city includes buildings, businesses and municipal assets, and operates alongside smart buildings, smart vehicles and smart utilities. The common goal is to make money, save money or achieve compliance. Often, it's all three.

As in all complex technological deployments, smart cities rely on an ecosystem of developers, equipment makers and service providers to provide the various pieces of the smart city architecture. This ecosystem looks very similar for all digitally transformed sectors, not just smart cities.

The equation is composed of hardware, software, connectivity and data processing capability. There are sensors and actuators to measure variables and then react to them. For example, for turning a light off at dawn, there is software to define that decision, and to aid management of devices, there are radio access networks to connect devices according to their needs and ensure connectivity is ubiquitously available at an appropriate cost. There are also data visualisation and analytics tools to derive actionable insights from the data that is collected and communicated.

Individual endpoints differ from vertical to vertical as they perform different and sector-specific tasks, but the infrastructure of the network and the data handling is largely the same, providing a vast base of development and engineering resources. Thankfully, it's not necessary to reinvent the wheel every time you look to connect a new endpoint device. The connectivity needs of an air conditioner are similar to those of a streetlight, although the data transmitted and the frequency of that transmission might be very different.

This is not to suggest that smart cities do not have specific requirements when it comes to infrastructure. They're clearly different from a smart agriculture environment, for example, which has far fewer applications to support, fewer constraints in terms of dense urban topology, and involves fewer stakeholders to integrate across the ecosystem.

Smart cities are complex in terms of the number of different services, applications and endpoints involved; they have challenging wireless network propagation characteristics, such as needs for in-building and underground network coverage; they involve multiple vendors and types of users;

and involve integration of third parties into the smart city infrastructure securely. In addition, many of these are public projects that fall under financial and regulatory scrutiny, so the focus is not only on achieving commercial goals but on delivering societal benefits for citizens.

HOW LoRaWAN® CAN BE AN ENABLER OF SMART CITIES

Smart cities depend on connectivity that is ubiquitously available indoors and outdoors, even with the ability for signals to reach underground locations. This ubiquity is vital to connect all the disparate endpoints of a smart city—don't forget a smart city is a complex ecosystem, not a simple point-to-point connection of a single type of device with a centralized computing function.

Smart cities connect waste bins, streetlights, public transport, traffic, cleaning, environmental and many other systems, all of which require secure, available, cost-effective connectivity. Unlike other IoT application areas, smart cities by definition have a clearly defined geographical area, making them ideal for private networks. LoRaWAN can be an ideal solution for these—at much lower cost and with greater ease of deployment than cellular networks.

As always, it's a case of selecting the appropriate technology for the appropriate application, and different technologies can be complementary to each other. For example, licensed spectrum technologies—the cellular networks—typically offer a quality of service based on an OpEx business model, while unlicensed technologies have fewer regulations and lower associated costs. However, there are no capex guarantees with owning a private network, and there is no opex business model flexibility.

This variance comes before we even get into the applications that networks support, and it needs to address the specific topology of a city, the population and building density, the capacity that already exists as well as fundamentals, such as whether the GDP of a population can support the cost of the service being provided. Different network types have different strengths and weaknesses, and often the decision is not an either/or question. Multiple types of connectivity can be selected to provide the best option across the different dynamics.

When it comes to the apps themselves, LoRaWAN won't be suitable for the low-latency demands of autonomous vehicles, but it's perfect for tracking buses, managing streetlighting, streamlining waste collections and numerous other applications detailed in the use cases section below.

A key strength of LoRaWAN is its ability to support large numbers of devices per gateway. Depending on the policy applied and the time allowed on the network per device per day, more than 1,000 devices can be supported. For simple applications, like a waste bin signalling that it's full, this is ideal and, coupled with the range of LoRaWAN—which is measured in miles—it's easy to see how LoRaWAN could enable many thousands of low bandwidth smart city devices cost effectively and securely.

Of similar importance is that this is not a high bandwidth industry. The asset only needs to communicate its location in order to be tracked and, even advanced applications, such as cold chain transport, only need to transmit small amounts of data about the temperature of the product being shipped. Therefore, relatively low bandwidth and low latency connectivity are ideal.

A further strength is that LoRaWAN devices typically have very long battery life, making them ideal for long-term deployments. Use cases such as streetlighting, air quality sensors, bin emptying and many others can all have long deployment-lives without the need for battery maintenance. This saves on the overall cost of the solution.

Smart cities by their nature are busy, fast-moving environments subject to extremes of temperature, weather and the general rough and tumble of city life. LoRaWAN offers robust performance, so it can continue to operate in most extreme situations, in spite of, e.g., shock impacts or vibration.

Finally, among the low-power network options, only LoRaWAN has the mature ecosystem and out-of-the-box availability to support the wide range of smart city use cases, as illustrated below. No other technology has anything like the scale and depth of its developer ecosystem coupled with the ease of deployment that LoRaWAN delivers. It therefore has a substantial and clearly defined position alongside cellular and other alternatives in connecting smart cities.

USE CASES

By their nature, smart cities represent a highly dense environment that accommodates a vast array of applications and services. Below, many of the potential smart city use cases are listed, and it is important to recognize that many of these have low bandwidth requirements and only infrequent needs to communicate. This relatively low level of network demand fits well with the capabilities of LoRaWAN. Other apps with demands for high bandwidth and low latency may be better served by cellular alternatives.

However, applications providers and city authorities do not need to agree to long contracts with cellular providers or establish individual networks for each of the low bandwidth, infrequent use cases. Instead, they can own a private LoRaWAN over which they can run many of the applications listed below.

City authorities need information to be able to plan for future demand for their services and to ensure the safety and improved quality of life for citizens. LoRaWAN-enabled sensors can collect and communicate critical data in areas, such as temperature, humidity, air quality, vibration and noise.

Examples of these include monitoring temperature to decide whether to salt roads in winter; monitoring nitrogen oxide levels to plan for reduction in the environmental impact of traffic; monitoring of humidity to fight damp within buildings; and monitoring for excess noise levels. All of this data can be collected and acted upon, and additional sensors, such as ones embedded in roads, can provide information on the salt level on a particular road and thereby eliminate wasted re-salting.

Other examples of monitoring include sensors on waste bins to alert when a bin is becoming full, so it can be emptied when required, rather than as part of a weekly routine in which some bins are overflowing and others are barely used. In addition, soil sensors can be used to determine when public parks or sports grounds require irrigation, and rainfall sensors can be used to trigger flood defenses or emergency support for citizens.

Much of the data collected can be analyzed alongside historical data to enable trend analysis and predictive action to be taken, thereby increasing efficiency and improving citizens' lives.

However, smart cities are not only about the collection of data. Activation of functions is also required. Examples of this include the control and maintenance of streetlighting,

management of smart parking, and security-related applications such as building surveillance, and access control and monitoring.

Having the deep indoor coverage of LoRaWAN across a city using a network that is owned by the city means new applications can be added and served extremely cost effectively, adding further to the business case for rolling out LoRaWAN.

EXAMPLES

As explained above, there is a wide portfolio of smart city applications that can be readily supported by citywide LoRaWAN coverage. Many of these make the business case for LoRaWAN alone; however, many other applications can also be supported at the same time. In addition, other applications may need to access cellular infrastructure to support their QoS, latency or throughout needs.

SMART PARKING

A European city has rolled out a smart parking system to reduce the time spent by drivers searching for spaces and the environmental impact of circulating traffic that is looking to park. By being able to inform drivers of the nearest available space, the city is able to increase revenue through targeted revenue and reduce illegal parking and instances where paid-for parking time is exceeded.

This initiative, which involves placing sensors in each bay and communicating their status over LoRaWAN also ties into city initiatives to encourage electric vehicle use. The city knows more about user habits and therefore can install charging points where they are most needed. In future, it is expected that the data gathered will enable the city to perform more effective parking management for busy locations.

WASTE MANAGEMENT

The task of emptying garbage bins has traditionally been performed by city operatives driving round in trucks to empty bins. This is inefficient, because some bins do not need emptying as often as others, and some bins need to be emptied more frequently. One city has radically increased the capacity of its bins by creating large underfloor containers for the storage of waste and recycling. This infrastructure requires emptying less often than small traditional bins, and has already saved the city 50% of its disposal trips.

The system relies on LoRaWAN's below-ground capacity to monitor underfloor waste storage capacity, and to communicate when it is nearing the time to be emptied. The city passes the savings directly on to the citizen in the form of reduced local taxation.

LEISURE FACILITY MANAGEMENT

A Swiss city has deployed swimming pool sensors at its pools to inform users of the temperatures of its pools. The city also benefits because its workers do not need to manually measure temperature and pH of the water. The temperature data is provided for citizens via displays at pool entrances and by the city's app.

AN1200.22
LoRa™ Modulation Basics

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1 Introduction

LoRa is a proprietary spread spectrum modulation scheme that is derivative of Chirp Spread Spectrum modulation (CSS) and which trades data rate for sensitivity within a fixed channel bandwidth. It implements a variable data rate, utilizing orthogonal spreading factors, which allows the system designer to trade data rate for range or power, so as to optimize network performance in a constant bandwidth.

LoRa is a PHY layer implementation and is agnostic with to higher-layer implementations. This allows LoRa to coexist and interoperate with existing network architectures.

This application note explains some of the basic concepts of LoRa modulation and the advantages that this modulation scheme can provide when deploying both fixed and mobile low-power real-world communications networks.

2 Acronyms

BT	Bandwidth Time Product
CEPT ECC	Conférence Européenne des administrations des Postes et des Télécommunications - Electronics Communications Committee
CSMA	Carrier Sense Multiple Access
CSMA-CA	Carrier Sense Multiple Access with Collision Avoidance
CSS	Chirp Spread Spectrum
dB	Decibel
E_b/N_O	Energy per bit to noise-power spectral density ratio (normalized Signal-to-Noise Ratio)
ETSI	European Telecommunications Standards Institute
DSSS	Direct Sequence Spread Spectrum
FSK	Frequency Shift Keying
IEEE	Institute of Electrical and Electronic Engineers, Inc
LBT	Listen Before Transmit
LoRa™	Semtech's Long-Range modulation
LTE	Long-term Evolution
M-LMS	Multilateration Location and Monitoring Service
NPSTC	National Public Safety Telecommunications Council
OFCOM	Independent Regulator and Competition Authority for the UK Communications Industries
O-QPSK	Offset Quadrature Phase-Shift Keying
PHY	Physical Layer
SNR	Signal-to-Noise Ratio

3 Spread Spectrum Communications

3.1 Shannon – Hartley Theorem

No discussion on spread spectrum techniques would be complete without a brief recap of the Shannon – Hartley Theorem.

In information theory, the Shannon–Hartley theorem states the maximum rate at which information can be transmitted over a communications channel of a specified bandwidth in the presence of noise.

The theorem establishes Shannon's channel capacity for a communication link and defines the maximum data rate (information) that can be transmitted within a specified bandwidth in the presence of noise interference:

$$C = B * \log_2\left(1 + \frac{S}{N}\right) \qquad \text{Equation 1}$$

Where:

C = channel capacity (bit/s)
B = channel bandwidth (Hz)
S = average received signal power (Watts)
N = average noise or interference power (Watts)
S/N = signal to noise ratio (SNR) expressed as a linear power ratio

By rearranging Equation 1 from log base 2 to the natural log, e, and by noting that $\ln = \log_e$ we can manipulate the equation as follows:

$$\frac{C}{B} = 1.433 * \frac{S}{N} \qquad \text{Equation 2}$$

For spread spectrum applications the signal to noise ratio is small, since the signal power is often below the noise floor. Assuming a noise level such that S/N << 1, Equation 2 can be re-written as:

$$\frac{C}{B} \approx \frac{S}{N}$$

Or:

$$\frac{N}{S} \approx \frac{B}{C} \qquad \text{Equation 3}$$

From equation 3 it can be seen that to transmit error free information in a channel of fixed noise-to-signal ratio, only the transmitted signal bandwidth need be increased.

3.2 Spread-Spectrum Principles

As has been noted above, by increasing the bandwidth of the signal we can compensate for the degradation of the signal-to-noise (or noise-to-signal) ratio of a radio channel.

In traditional Direct Sequence Spread Spectrum (DSSS) systems, the carrier phase of the transmitter changes in accordance with a code sequence. This process is generally achieved by multiplying the wanted data signal with a spreading code, also known as a chip sequence. The chip sequence occurs at a much faster rate than the data signal and thus spreads the signal bandwidth beyond the original bandwidth occupied by just the original signal. Note that the term chip is used to distinguish the shorter coded bits from the longer un-coded bits of the information signal.

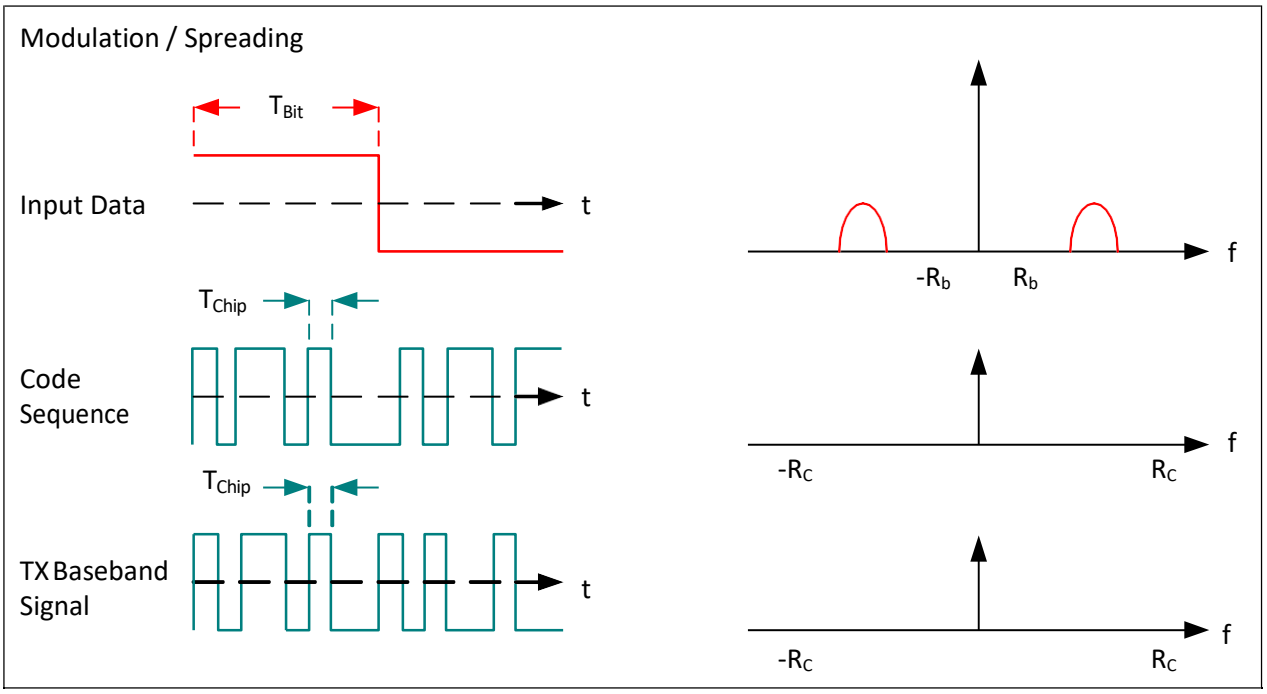


Figure 1: Modulation / Spreading Process

At the receiver, the wanted data signal is recovered by re-multiplying with a locally generated replica of the spreading sequence. This multiplication process in the receiver effectively compresses the spread signal back to its original un-spread bandwidth, as illustrated below in
Figure 2. It should be noted that the same chip sequence or code must be used in the receiver as in the transmitter to correctly recover the information.

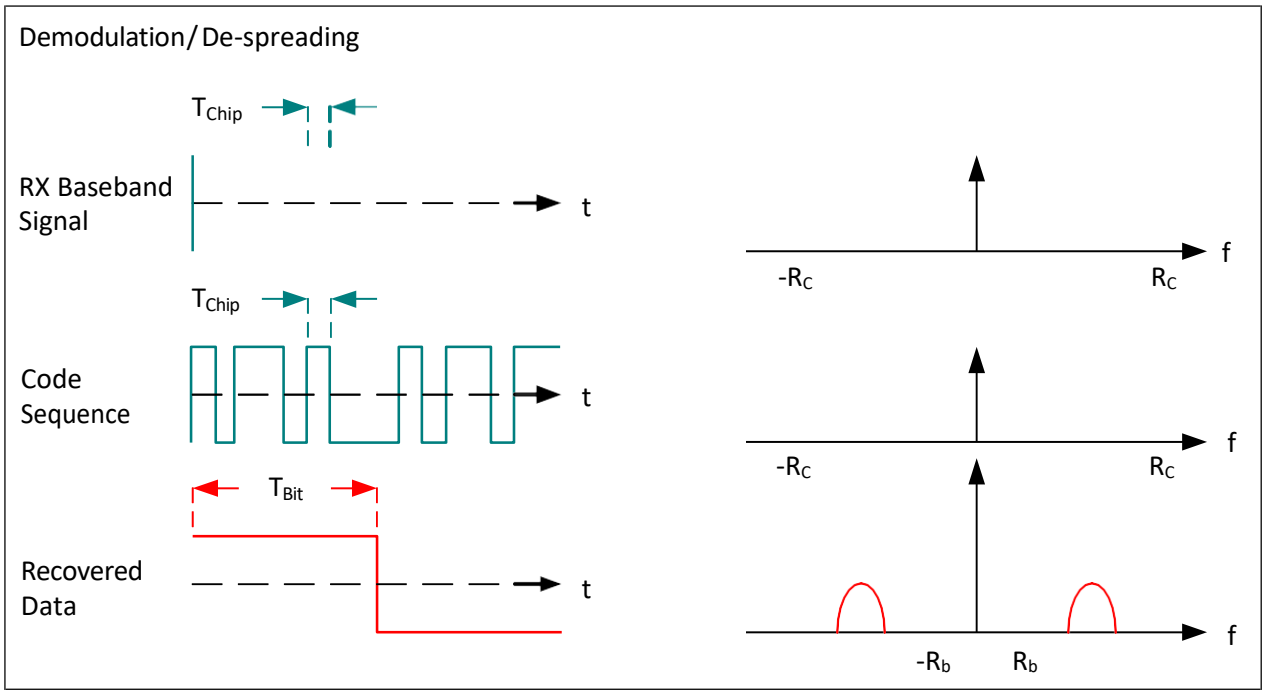


Figure 2: Demodulation / De-spreading Process

The amount of spreading, for direct sequence, is dependent on the ratio of "chips per bit" - the ratio of the chip sequence to the wanted data rate, is referred to as the processing gain (G_p), commonly expressed in dB.

$$= 10 * \log(-)_{b}$$

Where:

R_C = chip rate (Chips/second)
R_b = bit-rate (bits/second

As well as providing inherent processing gain for the wanted transmission (which enables the receiver to correctly recover the data signal even when the SNR of the channel is a negative value); interfering signals are also reduced by the process gain of the receiver. These are spread beyond the desired information bandwidth and can be easily removed by filtering.

DSSS is widely used in data communication applications. However, challenges exist for low-cost or power-constrained devices and networks.

Often, as is the case with GPS or the DSSS PHY of IEEE Standard 802.15.4k, the system will require a highly accurate and expensive reference clock source. In addition, the longer the spreading code or sequence, the longer the time required by the receiver to perform a correlation over the entire length of

the code sequence, or by either searching sequentially through code sequences or implementing multiple correlators in parallel

This is especially of concern for power-constrained devices that cannot be “always-on” and thus need to repeatedly and rapidly synchronize.

3.3 Chirp Spread Spectrum

Chirp Spread Spectrum was developed for radar applications in the 1940’s. Traditionally used in a number of military and secure communications applications; over the past twenty years this modulation technique has seen increased adoption in a number of data communications applications due to its relatively low transmission power requirements and inherent robustness from channel degradation mechanisms such as multipath, fading, Doppler and in-band jamming interferers.

A CSS PHY was adopted by the IEEE for the Low-Rate Wireless Personal Area Networks (LR-WPANs) standard 802.15.4 for applications requiring longer range and mobility than that achievable with the O-QPSK DSSS PHY mode.

4 LoRa Spread Spectrum

Semtech’s LoRa modulation addresses all of the issues associated with DSSS systems to provide a low-cost, low-power, yet above all robust alternative to the traditional spread-spectrum communications techniques [1], [2].

In LoRa modulation the spreading of the spectrum is achieved by generating a chirp signal that continuously varies in frequency. An advantage of this method is that timing and frequency offsets between transmitter and receiver are equivalent, greatly reducing the complexity of the receiver design. The frequency bandwidth of this chirp is equivalent to the spectral bandwidth of the signal.

The wanted data signal is chipped at a higher data rate and modulated onto the chirp signal.

The relationship between the wanted data bit rate, symbol rate and chip rate for LoRa modulation can be expressed as follows:

We can define the modulation bit rate, R_b, as:

$$R_b = SF * \frac{}{\overline{BW}} \text{ bits/sec}$$

Where:

SF = spreading factor (7..12)
BW = modulation bandwidth (Hz)

Now define the symbol period, T_S, as:

$$T_s = \frac{2}{BW} \text{secs}$$

Thus, symbol rate, R_S, is the reciprocal of T_S:

$$R_s = \frac{1}{T_s} = \frac{BW}{2} \text{symbols/sec}$$

Finally we can define the chip rate, R_C, as:

$$R_c = R_s * 2^{SF} \text{ chips/sec}$$

As can be seen this provides the datasheet definition: *"…one chip is sent per second per Hz of bandwidth…"* as can be seen below:

$$R_c = R_s * 2^{SF}$$

$$R_c = \frac{BW}{2} * 2^{SF} \text{chips/sec}$$

LoRa modulation also includes a variable error correction scheme that improves the robustness of the transmitted signal at the expense of redundancy.

Thus we can define the nominal bit rate of the data signal as:

$$R_b = SF * \frac{\frac{CR}{4}}{\frac{BW}{2^{SF}}}$$

Where:

SF = spreading factor (7..12)
CR = code rate (1..4)
BW = modulation bandwidth (Hz)

If we define rate code, such that:

$$\text{Rate Code} = \frac{4}{4+c}$$

We can rewrite nominal the bit rate as:

$$R_b = SF * \frac{\text{rate code}}{\frac{BW}{2^{SF}}} \text{bits/sec}$$

4.1 Key Properties of LoRa Modulation

4.1.1 Bandwidth Scalable

LoRa modulation is both bandwidth and frequency scalable. It can be used for both narrowband frequency hopping and wideband direct sequence applications. Unlike existing narrowband or wideband modulation schemes, LoRa can be easily adapted for either mode of operation with only a few simple configuration register changes.

4.1.2 Constant Envelope / Low-Power

Similar to FSK, LoRa is a constant envelope modulation scheme which means that the same low-cost and low-power high-efficiency PA stages can be re-used without modification. In addition, due to the processing gain associated with LoRa, the output power of the transmitter can be reduced compared to a conventional FSK link while maintaining the same or better link budget.

4.1.3 High Robustness

Due to the high BT product (BT > 1) and their asynchronous nature a LoRa signal is very resistant to both in-band and out-of-band interference mechanisms. Since the LoRa symbol period can be longer than the typical short-duration burst of fast-hopping FHSS systems, it provides for excellent immunity to pulsed AM interference mechanisms; typical receiver out-of-channel selectivity figures of 90 dB and co-channel rejection of better than 20 dB can be obtained. This compares to typically 50 dB for adjacent and alternate channel rejection, and -6 dB co-channel rejection for FSK modulation.

4.1.4 Multipath / fading Resistant

The chirp pulse is relatively broadband and thus LoRa offers immunity to multipath and fading, making it ideal for use in urban and suburban environments, where both mechanisms dominate.

4.1.5 Doppler Resistant

Doppler shift causes a small frequency shift in the LoRa pulse which introduces a relatively negligible shift in the time axis of the baseband signal. This frequency offset tolerance mitigates the requirement for tight tolerance reference clock sources. LoRa is ideal for mobile data communications links such as wireless tire-pressure monitoring systems, drive-by applications such as toll booth and mobile tag readers, and trackside communications for railroad infrastructure.

4.1.6 Long Range Capability

For a fixed output power and throughput, the link budget of LoRa exceeds that of conventional FSK. When taken into conjunction with the proven robustness to interference and fading mechanisms, this improvement in link budget can readily translate to x4 and beyond enhancement in range.

4.1.7 Enhanced Network Capacity

Semtech LoRa modulation employs orthogonal spreading factors which enables multiple spread signals to be transmitted at the same time and on the same channel without minimal degradation the RX

sensitivity. Modulated signals at different spreading factors appear as noise to the target receiver and can be treated as such.

4.1.8 Ranging / Localization

An inherent property of LoRa is the ability to linearly discriminate between frequency and time errors. LoRa is the ideal modulation for radar applications and is thus ideally suited for ranging and localization applications such as real-time location services.

4.2 FSK vs. LoRa Sensitivity Comparison

The principle of increasing the wanted signal bandwidth to transmit error free data over longer distance (i.e. in the presence of an increasing noise-to-signal ratio) is a fundamental principal of spread-spectrum communications and can be visualized by comparing the sensitivity of LoRa vs. a competitive landscape of FSK transceivers available as illustrated in Figure 3, below:

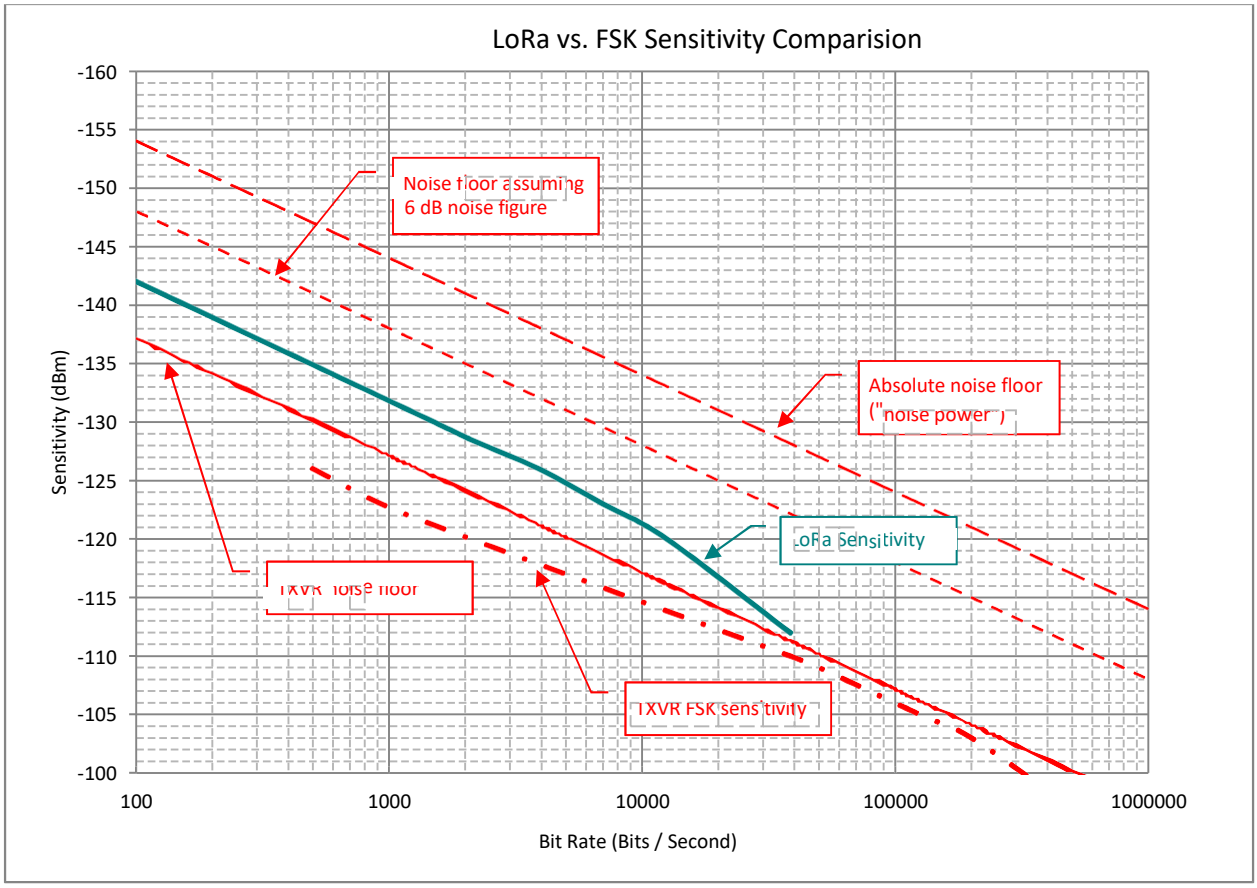


Figure 3: Comparison of LoRa and FSK Sensitivity

The theoretical absolute noise floor ("noise power") at room temperature assumes from Equation 1 that the channel capacity is 1 bit per Hz of bandwidth (the required SNR is thus 0 dB) and can be calculated from:

$$\text{Noise Floor} = 10 * \log k * T * * 1000\ m$$

Where:

Noise Floor = equivalent noise power (dBm)
K = Boltzmann's Constant (~1.38 *10^{-23})
T = 293 kelvin ("room temperature")
B = channel bandwidth (Hz)
1000 = scaling factor from Watts to milli-Watts

This can be simplified as:

$$\text{Noise Floor} = -174 + 10 * \log \qquad m$$

Where:

-174 = 10 * $\log_{10}$ (k * T * 1000) as defined above
B = channel bandwidth (Hz) as before

TXVR noise floor indicates a close approximation to the noise floor of the current generation of sub-GHz FSK transceiver devices currently available and again is calculated from:

$$\text{TXVR Noise Floor} = -174 + \quad * 1.5 + D_{SN} + NF \qquad m$$

Where:

B*1.5 = Idealised channel bandwidth for GFSK modulation (Hz)
D_{SNR} = Required demodulator E_b/N_0 for coherent FSK (~ 10 dB)
NF = Receiver architecture noise figure (6 dB)

Compare the theoretical noise floor to typical sensitivity figures obtained from the datasheets of current generation FSK transceiver devices. It can be shown that at low data rates, specified sensitivity diverges from the theoretical RX noise floor due to the increase channel (filter) bandwidth required to compensate for expected frequency errors between the transmitter and target receiver.

Sub-GHz LoRa sensitivity is as per the specification in both the SX1272 and SX1276 datasheets [3], [4] and takes into account the typical 6 dB noise figure of the receiver architecture.

The E_b/N_0 of LoRa offers typically 10 dB improvement over that for GFSK and thus it can be seen that LoRa offers a significant sensitivity improvement over FSK. It should be noted that if the noise figure is added to the absolute noise floor plot, the sensitivity achievable with LoRa modulation is within 6 dB of the relative noise floor.

5 Considerations for Wireless Communications

5.1 Wireless Network

5.1.1 Star Network Topology

A star network is the most common form of network topology for power constrained end-point nodes and is relatively simple to implement. Typically a central coordinator or concentrator acts as the conduit for all network traffic. All network transmissions are routed via the central coordinator.

A star-network topology helps minimize the amount of network traffic. For a network that is not link-constrained only 3 devices and two links are involved in any communications between two nodes. In addition nodes are isolated from one another and provides for ease of replacing nodes. Centralization allows for inspection of all network traffic at a single point.

A disadvantage of this topology is that failure of the coordinator will disable all network communications

5.1.2 Mesh Network Topology

In a mesh network data propagates through the network via every node. Mesh networks can be considered flooding, whereby each node relays the same message regardless of the end destination or routing, whereby the method propagates along a path to its destination. Networks typically employ look-up tables or are self-routing.

Advantages of a mesh networks are the ability to “self-heal” and reconfigure themselves in the event of a loss of connectivity to a node or group of nodes.

A disadvantage of this topology is the relatively increased complexity over traditional star networks and an increase in network traffic due to the inherent in-built redundancy of the network. In addition the increased traffic that each node has to handle means that mesh networks are typically implemented in circumstances where the nodes are not power constrained.

5.2 Multipath Propagation Mechanisms

Multipath [5], [6], [7] is the propagation phenomenon that results in the transmitted radio signal reaching the receiver by two or more paths. Multipath mechanisms include reflection from objects such as building, mountains, large bodies of water, atmospheric ducting, ionospheric reflection and refraction. It should be noted that these mechanisms can give rise to both constructive and destructive interference. This later case causes fading to be observed

Multipath gives rise to small-scale fading effects:

- Rapid changes in signal strength over a small travelled distance or time interval
- Frequency drift and bandwidth spread effects caused by Doppler shifts on each multipath signal

Multipath fading mechanisms can be considered as flat or frequency-selective fading.

In the case of flat fading, the bandwidth of the propagation channel is greater than that of the transmitted signal. In this case, while the spectral properties of the signal are unaltered at reception, the amplitude of the signal fluctuates with time due to changes in the gain of the channel caused by multipath. Narrow-band FSK systems attempt to mitigate for the effects of flat-fading by implementing spectral diversity techniques such as frequency hopping.

Frequency-selective fading is said to occur when the bandwidth of the propagation channel is less than that of the transmitted signal. It can be seen that the flat-fading case is most common for narrowband FSK modulation; although for high-data rate wideband and FSK modulation inter-symbol interference can be introduced by multipath delay spreading causing distortion of the demodulated signal. To overcome frequency-selective fading, high-data rate FSK systems may implement multi-level (or m-ary) modulation to reduce the transmitted signal bandwidth. Multi-level FSK requires both more complicated receiver architecture to successfully demodulate the transmitted signal and a higher SNR than two-level FSK.

In addition to multipath fading, Doppler fading mechanisms may also need to be considered in the case of mobile communication.

As has been noted, the relatively broadband nature and high BT of LoRa provides for excellent immunity to multipath and fading mechanisms.

5.3 Link Budget

The link budget of a wireless system or network is a measure of all the gains and losses from the transmitter, through the propagation channel, to the target receiver. These gains and losses include system gains and losses associated with the antenna, matching networks, etc. as well as losses associated propagation channel itself (either though modelling or measured data).

Typically randomly varying channel mechanisms such as multipath and Doppler fading are taken into account by factoring additional margin depending on the anticipated severity.

The link budget of a network wireless link can be expressed as:

$$P_X \quad m = P_{TX} \quad m + {}_{SYSTEM} \quad - L_{SYSTEM} \quad - l_{CHANNEL} \text{---------- } M$$

Where:

P_{RX} = the expected power incident at the receiver
P_{TX} = the transmitted power
G_{SYSTEM} = system gains such as those associated with directional antennas, etc.
L_{SYSTEM} = losses associated with the system such as feed-lines, antennas (in the case of electrical short antennas associated with many remote devices), etc.
$L_{CHANNEL}$ = losses due to the propagation channel, either calculated via a wide range of channel models or from empirical data
M = fading margin, again either calculated or from empirical data

A communications channel is said to be link limited when the losses associated with the channel cause the incident power level at the receiver to be below that required to meet the SNR requirement of the receiver for correct demodulation of the received data.

5.4 Interference Limited Links

In practice, operating in license-exempt spectrum provides for no quality of service guarantee (as opposed to licensed operation, whereby the network operator has paid a fee for exclusive access to the spectrum being used) and a device operating in license-exempt spectrum is likely to be interference rather than link-budget limited.

A typical scenario may see several co-located networks attempting to access the same frequency space at the same time. While there are a number of collision mitigation mechanisms that can be implemented, either through regulation (such as LBT or transmitter duty-cycle limits) or through voluntary mechanisms such as CSMA / CSMA-CA, by the nature of dynamic interference mechanisms a channel assessment at the transmitter may not necessarily coincide with the channel conditions at the target device and the transmission may be blocked.

To avoid interference mechanisms, narrowband systems often implement frequency agility (or frequency hopping) to avoid repeated operation on the same channel or frequency. As has been noted, this frequency agility is also used by narrowband systems to mitigate for multipath propagation properties.

However, the pseudo-random nature of the hop sequence employed (as is typically required by regulation) can lead to a loss of a packet and subsequent channel synchronization due to either the transmitter or target receiver jumping to an already occupied channel or having another transmitting device hop to that frequency during a wanted transmission.

The requirement to frequency hop also leads to an increase in packet redundancy. While modern narrowband receivers typically require only a short preamble sequence for synchronization there will be a requirement to retransmit a message header so that the receiver can be assured that the received broadcast is intended. In addition, most frequency hopping systems only remain on a channel for a few milliseconds so as to minimize the probability of the channel becoming blocked by another unwanted

transmission, thus in the case of a low data rate narrowband transmission the message overhead increases still further.

Any loss of synchronization between transmitter and receiver will require the devices to undergo a period of re-discovery and synchronization.

5.5 Network Coexistence

Traditionally narrowband FSK signals have traded upon their frequency agility and ability to “punch through” wideband spread-spectrum signals (which are traditionally limited by power spectral density limits and thus transmit at a lower power than narrowband signals) as is illustrated below in Figure 4.

However recent changes in to the measurement guidance procedures allowed by the FCC [8] in the United States now permit wideband spread-spectrum devices to transmit at significantly higher output power levels while still complying with power spectral density limits.

Taking advantage of this latest guidance a wideband LoRa modulated signal of 500 kHz 6 dB bandwidth can transmit up to typically +27 dBm, close to the +30 dBm permitted for narrowband modulation, as illustrated in Figure 5, without any channel dwell time restrictions.

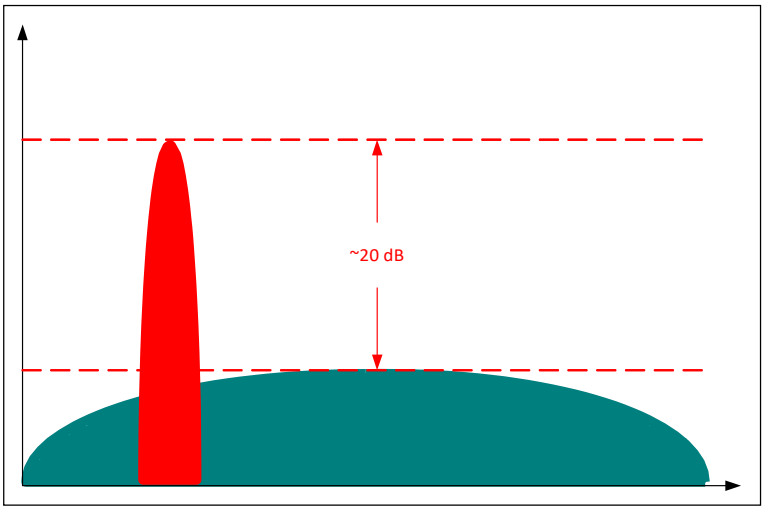


Figure 4: Traditional Narrowband Signal vs. Wideband Interferer

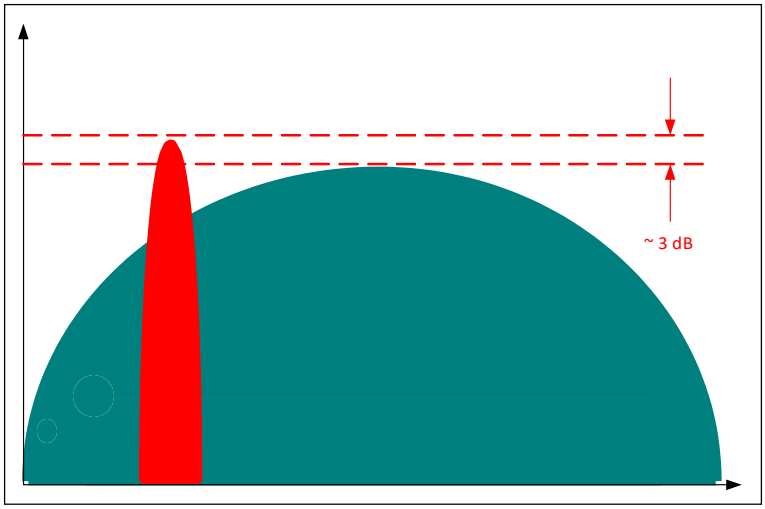


Figure 5: Narrowband Signal vs. Wideband Interferer

As has been noted, with spread spectrum modulation, the impact of interfering signals is reduced by the process gain that is inherent to the modulation. These interfering signals are spread beyond the desired information bandwidth and can be easily removed by filtering.

With narrowband modulation, interfering signals are not spread by the demodulation process. As can be seen from Figure 5, a wideband interferer will block the narrowband transmission, causing the packet to be lost.

There have been many studies into the impact of dissimilar modulation and co-located networks. In Europe, 4G-LTE has been allocated frequency spectrum vacated by analog terrestrial TV and extends to 862 MHz. Studies by both OFCOM [9] and the ECC [10] have shown that significant interference may be expected. In addition, studies by both industry associations and notified bodies [11] show that license-exempt radios deployed for SmartGrid applications co-located within 25 m (75') of LTE mobile units may expect to experience significant packet loss.

In the United States, studies have also shown [12] that the deployment of new Multilateration Location and Monitoring Service (M-LMS) services in the upper-third of the 902 – 928 MHz band could render up to 4 MHz and beyond of spectrum unsuitable for tower-based narrowband devices, such as those deployed as SmartGrid concentrators and network coordinators. Indeed, the ambient noise level "seen" by a tower based device can have significant impact upon the realizable link budget.

In addition, the future deployment of wideband systems, such as the sub-GHz IEEE standard 802.11ah (which supports channel bandwidths from 1 MHz to 16 MHz) could have significant impact on the license-exempt spectrum.

Wideband modulation systems are also subject to the same interference conditions. However, a wideband modulation signal that is co-located with a second wideband signal of different spreading factor or sequence will appear as noise to the target receiver and be treated as such.

Since the on-air duration of a wideband signal can be much longer than that of frequency-hopping narrowband signals we can expect that multiple narrowband signals may well be incident with the wideband modulation, as illustrated below in Figure 6.

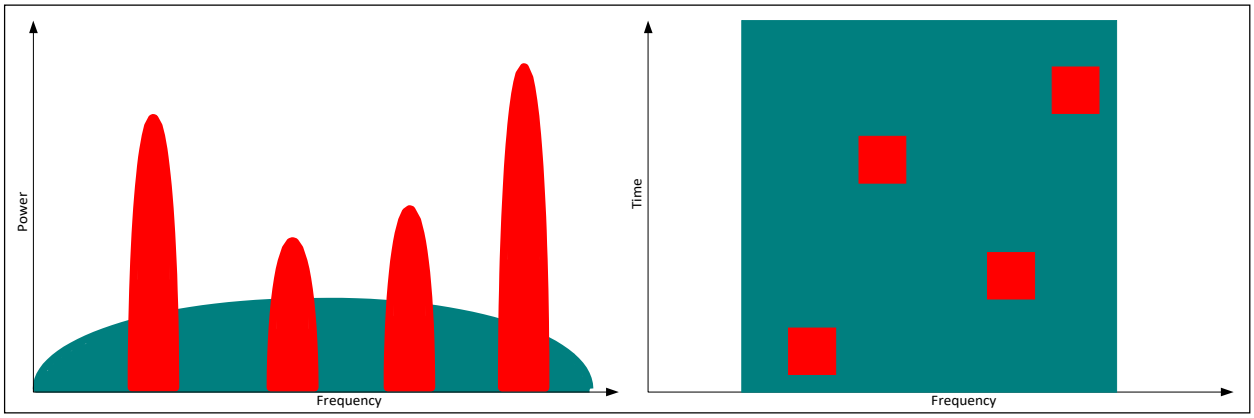


Figure 6: Wideband Signal vs. Narrowband Interferer

We note that four narrowband signals are incident upon the wideband signal. However, the duration of the narrowband signals are such that in the time domain the interference period is short with respect to the wideband signal.

Due to the redundancy associate with wideband spread-spectrum modulation (recall that each bit of data is spread of many chips), the modulation is quite resilient to the interference mechanism that appears as bursty short duration pulses. A typical application scenario is illustrated below in Figure 7.

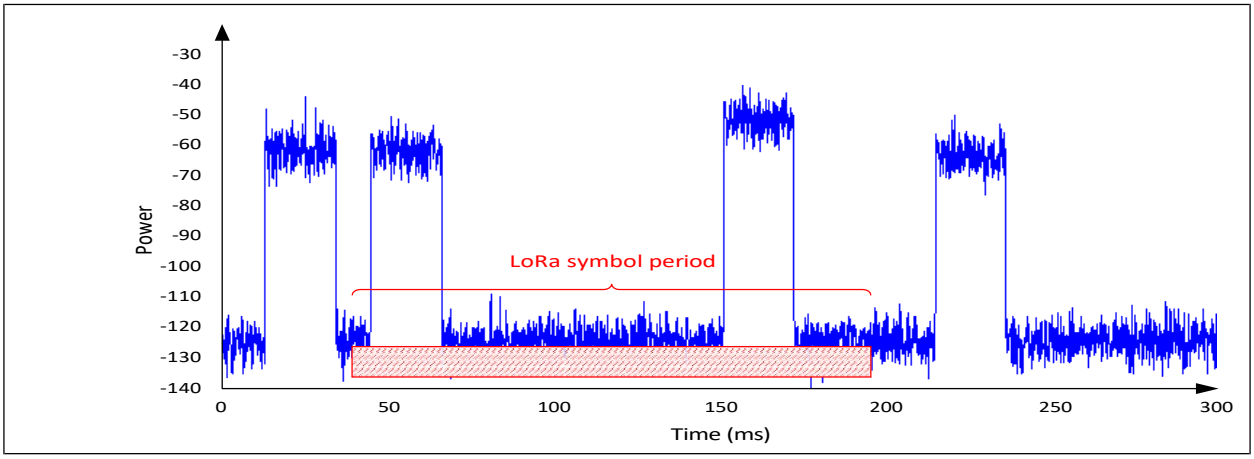


Figure 7: Example of Burst Interference

Semtech's LoRa modulation, for example, can tolerate burst interference mechanisms of arbitrary power levels for up to 30% of the symbol length with less than 6 dB sensitivity degradation.

As an example of the robustness of LoRa in the presence of frequency hopping spread-spectrum interference, we can consider the case of an FSK receiver and LoRa receiver of comparable channel bandwidths co-located with an IEEE Standard 802.15.4g transmission which is hopping on a 200 kHz channel raster, as illustrated below in Figure 8:

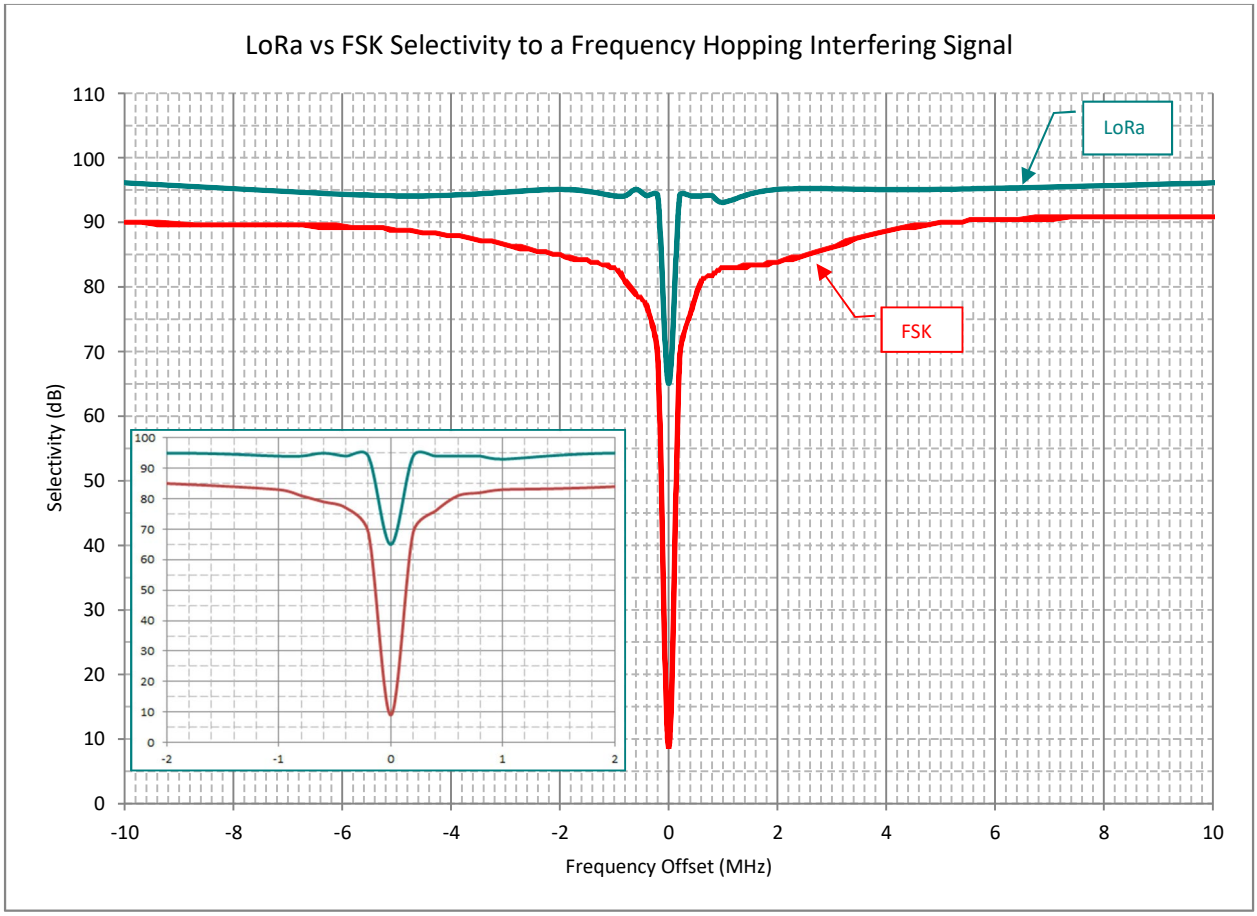
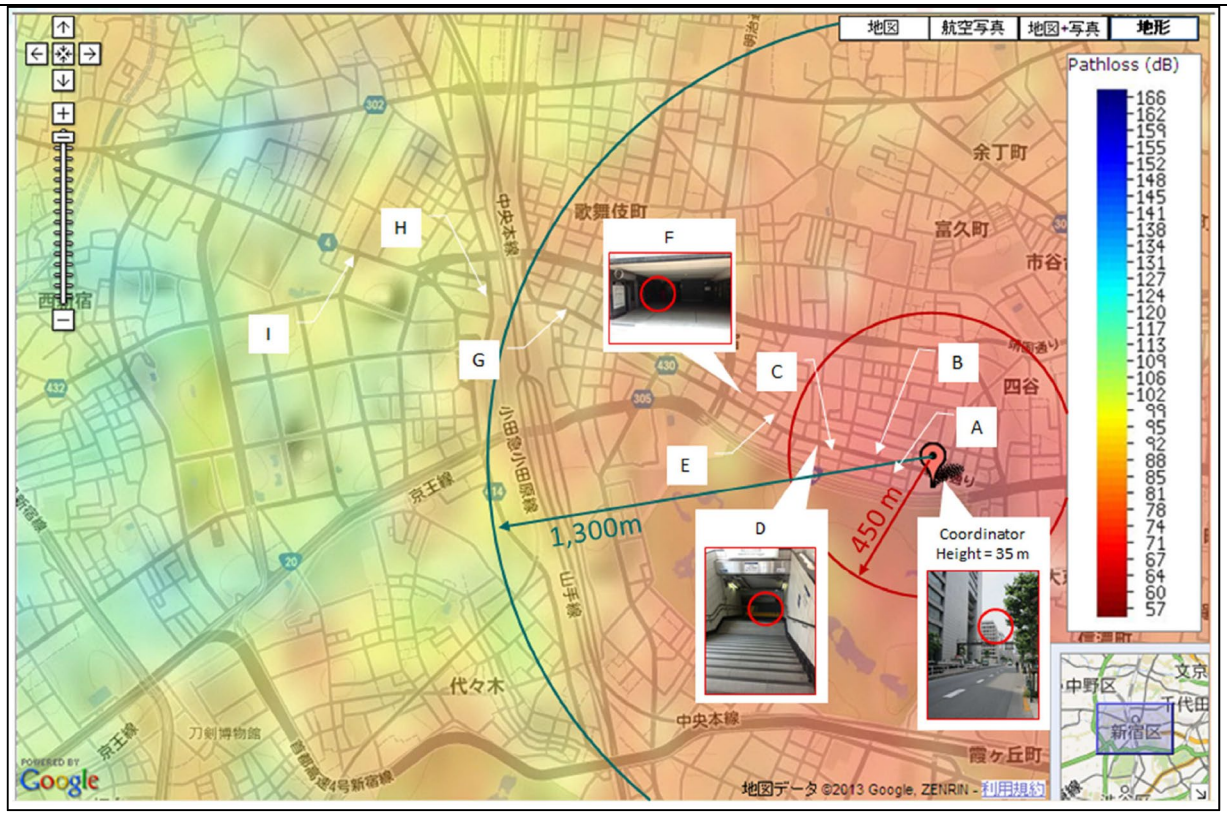


Figure 8: LoRa vs FSK Selectivity in the vicinity of an AM interfering Signal

We observe in the case of an adjacent or alternate channel interferer (at ±200 kHz and ±400 kHz, respectively – see inset) that LoRa offers between 15 and 20 dB increased immunity to the unwanted interferer and approximately 10 dB for frequency offsets in excess of 5 MHz (typically, beyond 1 MHz offset, receiver linearity at the expense of current consumption and independent of modulation, dominates).

5.6 Network Trial

An example of the relative performance of LoRa modulation compared to narrowband FSK in a challenging urban environment, we consider data obtained in Shinjuku (Tokyo Metropolis), Japan.



Ref. #	Distance (m)	2-FSK: 4.8 kb/s		LoRa: 125 kHz BW, SF = 8 (3.125 kb/s)	
		Rssi (dBm)	PER (%)	Rssi (dBm)	PER (%)
A	80	-97	0	-91	0
B	150	-100	0	-102	0
C	280	-112	1	-114	0
D	330	-	100	-124	10
E	480	-118	8	-120	0
F	560	-	100	-121	0
G	1180	-	100	-112	0
H	1350	-	100	-126	10
I	1750	-	100	-127	100

Figure 9: Shinjuku Urban Range Test

In the above example, both Semtech's LoRa solution vs. a narrowband FSK solution from a leading silicon vendor were set to transmit a short payload at a nominal output power of +13 dBm. As can be observed in Figure 9, for this challenging urban environment the achievable range of the Semtech LoRa solution is typically three times that of FSK.

6 Network Planning Example

6.1 Capacity

One of the misconceptions concerning the use of spread spectrum wideband modulation is that it is somehow spectral inefficient compared to narrowband modulation. However, consider the case of a narrowband system operating in a virtual channel of 125 kHz bandwidth.

If we assume the case of 12 narrowband FSK channels transmitting at an equivalent bit rate of 1.2 kb/s, then we can calculate the total theoretical channel capacity as:

$$\text{Capacity}_{\text{FsK}} = 12 * 1.2 \text{ kb/s} = 14.4\text{k b/s}$$

If we now consider the same available spectrum deployed as a single 125 kHz LoRa channel, and taking advantage of the orthogonal spreading factors, the equivalent capacity of the channel is now:

$$\text{Capacity}_{\text{Lo a}} = 1 * \text{SF12} + \text{SF11} + \text{SF10} + \text{SF9} + \text{SF8} + \text{SF7} + \text{SF6}$$

$$= 1 * 293 + 537 + 976 + 1757 + 3125 + 5468 + 9375 \text{ b/s}$$

$$= 21.531 \text{ kb/s}$$

Thus it can be seen that deploying LoRa modulation provides for a total channel capacity of 21.5 kb/s. This is an increase in channel capacity of nearly 50% compared to FSK.

6.2 Link Budget

If we now consider the link budget that can be obtained for each modulation scheme and using the example above and assume a sensitivity of -122 dBm that is specified for a conventional FSK transceiver, and compare against that obtainable using LoRa; for a fixed transmitter output power we observe the following link budget delta as tabulated in Table 1, below.

Mode	Equivalent bit rate (kb/s)	Sensitivity (dBm)	Δ (dB)
FSK	1.2	-122	-
LoRa SF = 12	0.293	-137	+15
LoRa SF = 11	0.537	-134.5	+12.5
LoRa SF = 10	0.976	-132	+10
LoRa SF = 9	1757	-129	+7
LoRa SF = 8	3125	-126	+4
LoRa SF = 7	5468	-123	+1
LoRa SF = 6	9375	-118	-3

Table 1: Link Budget Comparison for Narrowband FSK

Thus we observe that even when transmitting at greater than 4 times the equivalent data rate, LoRa modulation offers similar sensitivity to a conventional FSK system. When the data rate is approximately equivalent the improvement with LoRa is between 7 and 10 dB.

If we consider our channel capacity scenario above, we can see with an equivalent link budget, LoRa can actually transmit a data packet in a quarter of the time required for the FSK system.

Thus assuming a simple TDD or time division multiplexing of the radio channel, LoRa can communication with x4 the number of devices as the FSK system.

6.3 Throughput Optimization

For a wireless network it can be expected that propagation loss increases with distance from the network coordinator. For narrowband systems this may require additional nodes to be located in a mesh network topology (with increased network complexity and redundancy) or the addition of repeaters for a star network topology to ensure that every device in the network is covered. Unfortunately, the costs associated with installing a repeater can run to between x100 and x1000 the cost of the hardware.

LoRa can minimize this cost by taking advantage of the property that signals with a different spreading factor or sequence will appear as noise at the target receiver. Nodes that are closest to the network coordinator, where path loss allows for transmission at a higher data rate can transmit at the maximum data rate available; as path loss increases with distance the data throughput can be throttled back by increasing the spreading factor or reducing spreading bandwidth

6.3.1 Multi-PHY Mode Networks

For still higher data rates it can be noted that Semtech's SX127x family of low-power transceiver devices provide for multiple PHY mode operation. Where channel conditions allow, higher data rate FSK modulation can also be employed. As propagation loss increases, LoRa modulation of differing bandwidth and spreading factors can be employed, each transmission tailored to the channel conditions to ensure sufficient link margin. Unlike FSK, LoRa transmissions of differing modulation bandwidth and spreading factors can co-exist.

For dynamic network conditions it is noted that Semtech's radios can be easily and remotely configured over-the-air.

7 Conclusions

Semtech's LoRa modulation is a simple PHY layer implementation that provides significant link budget improvement over conventional narrowband modulation. In addition the enhanced robustness and selectivity provided by the spread spectrum modulation enables greater transmission distance to be obtained, even in harsh, challenging environments.

LoRa modulation uses orthogonal spreading factors. This enables multiple packets of differing spreading factors to be in the same channel concurrently, significantly improving network efficiency and throughput.

Semtech's family of multi-PHY mode transceivers allow for LoRa to coexist and interoperate with existing legacy network deployments.

8 References:

[1]. Semtech Application Note AN1200.13, "SX1272/3/6/7/8: LoRa Modem Designer's Guide" (http://www.semtech.com/images/datasheet/LoraDesignGuide_STD.pdf)

[2]. Semtech Application Note AN1200.17, "SX1272/3/6/7/8: LoRa Energy Consumption Design" (http://www.semtech.com/images/datasheet/LoraLowEnergyDesign_STD.pdf)

[3]. SX1272 Datasheet (http://www.semtech.com/apps/filedown/down.php?file=sx1272.pdf)

[4]. SX1276 Datasheet (http://www.semtech.com/apps/filedown/down.php?file=sx1276.pdf)

[5]. Rappaport, "Wireless Communications Principals and Practices," (Prentice-Hall)

[6]. Xiong, "Digital Modulation Techniques, 2nd ed.," (Artech House)

[7]. Siwak, Bahreini, "Radiowave Propagation and Antennas, " (Artech House)

[8]. FCC Office of Engineering and Technology Laboratory Division "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247" (https://apps.fcc.gov/oetcf/kdb/forms/FTSSearchResultPage.cfm?switch=P&id=21124)

[9]. OFCOM, "Use of Short Range Devices alongside mobile broadband services operating in the 800MHz band"

[10]. CEPT ECC Report 207, Adjacent band co-existence of SRDs in the band 863-870 MHz in light of the LTE usage below 862 MHz

[11]. ERA Technology, "Investigation on the receiver characteristics of SRD equipment in the 863-870 MHz band"

[12]. NPSTC, "Public Safety Related Spectrum Issues in the 902-928 MHz Band"

ATTACHMENT II

Responsibility Summary

The PUD is working on a project that will bring fiber to the home in the Quilcene and Discovery Bay areas. Options that will utilize this fiber are encouraged.

3.4. PUD Verizon Private Network

The PUD is deploying a Verizon Private Network to serve the SCADA system that may be used for data transmission by a Vendor.

3.5. PUD Customer Information System and Meter Reading Interface System

The PUD's Customer Information System, Meter Reading/Billing Interface System, Geographic Information System, and Outage Management System are components of its National Information Solutions Cooperative (NISC) software. The AMI system shall interface with the PUD NISC software. Details and NISC contact information are available to Vendors upon request. MultiSpeak interfaces are acceptable.

4. Scope of Products and Services

The following section defines the scope of products and services required for the procurement, installation, and implementation of the AMI System, which will be carried out in several phases as described in Section 4.4.

4.1. Nondisclosure Agreement

As a condition of the RFP, the PUD requires Vendor acceptance of the Nondisclosure Agreement (NDA) to gain any confidential information required by the Vendor to prepare a responsible proposal and bid sheet.

4.2. Installation and Integration Requirements

4.2.1. General Installation and Integration Responsibilities

The selected Vendor will provide the PUD with the required meters for installation by the PUD, or a PUD contractor. Due to the availability of funds and personnel, this period could extend over a two to three year period.

The selected Vendor shall coordinate with the PUD to develop a detailed implementation plan and schedule. The schedule should include any required outages and interruption to customer service and provide a description of the implications to the Electric or Water System functionality.

It is envisioned that the PUD will install all of the new meters in a regional approach, requiring the collection system to be designed to expand coincidentally or preceding the regional meter installations.

The Vendor shall be responsible for all other equipment required for the AMI system. The Vendor may propose an approach, utilizing the PUD equipment, crews, or PUD employed and approved Contractors, for field installation of devices that require mounting locations throughout the PUD System. In all cases the work shall be done only with the approval of the PUD.

4.2.1.1. Site Surveys

The Vendors may survey the PUD service area, information technology facilities and fiber optic network for use in preparing their Proposal and Bid Documents. If desired, the Vendor may conduct a RF propagation field study. GIS drawings are available upon request, once the NDA has been executed.

ATTACHMENT III.

Final System Acceptance Test Plan

(FSAT)

Certify Meter Read Success Rate.

1. Minimum 99% percent daily read for each electric meter by 8 a.m. each day
2. 99.9% billing reads over three consecutive billing cycles.
3. Return read rate of equal to or less than 45 seconds and for a requested read of up to 100 meters,
4. Return read rate of 99% within 60 seconds or less.
5. Selected meter values available to NISC on request within 60 seconds
6. Remote Connect/Disconnect return time to complete either action will be within 60 seconds.

Certify Network Success Rate.

1. Network availability 99.9% daily

Certify NISC interface

1. Billing reads 99.9% downloaded into NISC over three consecutive day billing window
2. MDMS interface completed

Certify Gateway Success rate

1. Minimum 99% percent daily uptime
2. Return read rate of equal to or less than 45 seconds and for a requested read of up to 100 meters,
3. Remote Connect/Disconnect return time to complete either action will be within 45 seconds.

Certify SCADA Interface

1. Selected meter values available to Survalent minimum every hour
2. Selected meter values available to Survalent on request within 1 minute

PUBLIC UTILITY DISTRICT NO.1
OF
JEFFERSON COUNTY

RESOLUTION NO. 2022- XXXX--

A RESOLUTION of the Board of Commissioners of Public Utility District No. 1 of Jefferson County, Washington (JPUD), approving a Contract with Vision Metering, LLC for a District Meter Replacement Program.

WHEREAS, JPUD has been evaluating the need to replace its meters throughout the District ; and

WHEREAS, JPUD has retained FCS Group to assist it in evaluating the cost, technology and need for replacing customer meters throughout its service territory; and

WHEREAS, FCS presented a Meter Replacement Plan for consideration by JPUD on April 22, 2021 and provided a full review and business case analysis to the Board of Commissioners on July 6, 2021; and

WHERAS, FCS Group and JPUD staff presented a Meter Replacement Study to the Citizens Advisory Board on May 10, 2021 and presented a business case plan to a joint meeting of the Board of Commissioners and the Citizens Advisory Board on August 9, 2021; and

WHEREAS, JPUD issued a Request for Proposal (RFP) on November 3, 2022, and has subsequently evaluated all responsive proposals and determined that Vision Metering, LLC has the most responsive bid; and

WHERAS, JPUD has negotiated a contract agreement with Vision Metering, LLC, and recommends to the Board of Commissioners that JPUD enter into the proposed contract agreement attached to this Resolution as Exhibit No. 1 and incorporated herein by this reference.

NOW, THEREFORE, BE IT RESOLVED by the Board of Commissioners of Public Utility District No. 1 of Jefferson County, Washington incorporates the Recitals listed above as if fully set forth herein, and that based upon the full review and analysis presented to JPUD it hereby authorizes its General Manager to execute a contract agreement with Vision Metering, LLC on similar terms and conditions as provided in Exhibit A.

ADOPTED at a regular meeting of the Board of Commissioners of Public Utility District No. 1 of Jefferson County, this 22nd day of February, 2022.

_____

Kenneth Collins, President

_____

Jeff Randall, Vice President

_____

Secretary, Dan Toepper

Exhibit "A"

Updated as of 8/2/2019 - Additional titles 2/22/2022

Titles and Bi-weekly Salary Ranges for Non-Represented Employees as of June, 2019

Title		Mid-pt.	Low	Mid	High
Executive Assistant/Records		40%			
	Bi-weekly		$2,357	$3,300	$4,620
	Hourly		$29.46	$41.25	$57.75
	Annual		$61,286	$85,800	$120,120
Human Resources Manager		30%			
	Bi-weekly		$2,300	$4,000	$4,300
	Hourly		$28.75	$49.61	$53.75
	Annual		$80,000	$104,000	$135,200
Human Resources Coordinator		40%			
	Bi-weekly		$2,357	$3,300	$4,620
	Hourly		$29.46	$41.25	$57.75
	Annual		$61,286	$85,800	$120,120
Communications Coordinator		40%			
	Bi-weekly		$2,143	$3,000	$4,200
	Hourly		$26.79	$37.50	$52.50
	Annual		$55,714	$78,000	$109,200
Records Management Coordinator		40%			
	Bi-weekly		$2,143	$3,000	$4,200
	Hourly		$26.79	$37.50	$52.50
	Annual		$55,714	$78,000	$109,200
Financial Services Coordinator		40%			
	Bi-weekly		$2,143	$3,000	$4,200
	Hourly		$26.79	$37.50	$52.50
	Annual		$55,714	$78,000	$109,200
Financial Services Manager I		40%			
	Bi-weekly		$2,143	$3,000	$4,200
	Hourly		$26.79	$37.50	$52.50
	Annual		$55,714	$78,000	$109,200
Financial Services Manager II		40%			

	Bi-weekly	$2,887	$4,042	$5,658
	Hourly	$36.09	$50.52	$70.73
	Annual	$75,060	$105,084	$147,117
Financial Services Manager III	40%			
	Bi-weekly	$3,631	$5,083	$7,117
	Hourly	$45.39	$63.54	$88.96
	Annual	$94,405	$132,167	$185,033
Finance Director	40%			
	Bi-weekly	$5,083	$6,100	$7,320
	Hourly	$63.54	$76.25	$76.25
	Annual	$132,167	$158,600	$190,320
Controller/Accountant	40%			
	Bi-weekly	$2,500	$3,500	$4,900
	Hourly	$31.25	$43.75	$61.25
	Annual	$65,000	$91,000	$127,400
Accounting Specialist	40%			
	Bi-weekly	$2,143	$3,000	$4,200
	Hourly	$26.79	$37.50	$52.50
	Annual	$55,714	$78,000	$109,200
Customer Service Manager	30%			
	Bi-weekly	$2,300	$3,500	$4,300
	Hourly	$28.75	$43.75	$53.75
	Annual	$70,000	$91,000	$118,300
Information Technology Manager	30%			
	Bi-weekly	$2,300	$3,500	$4,300
	Hourly	$28.75	$43.75	$53.75
	Annual	$70,000	$91,000	$118,300
Info Technology Support Technician	40%			
	Bi-weekly	$1,714	$2,400	$3,360
	Hourly	$21.43	$30.00	$42.00
	Annual	$44,571	$62,400	$87,360
Water Resource Manager	30%			
	Bi-weekly	$2,769	$3,600	$4,680

	Hourly		$34.62	$45.00	$58.50
	Annual		$72,000	$93,600	$121,680
Energy Efficiency Specialist		40%			
	Bi-weekly		$1,786	$2,500	$3,500
	Hourly		$22.32	$31.25	$43.75
	Annual		$46,429	$65,000	$91,000
Staking Engineer		40%			
	Bi-weekly		$2,286	$3,200	$4,480
	Hourly		$28.57	$40.00	$56.00
	Annual		$59,429	$83,200	$116,480
Senior Electrical Engineer		30%			
	Bi-weekly		$3,846	$5,000	$6,500
	Hourly		$48.08	$62.50	$81.25
	Annual		$100,000	$130,000	$169,000
Electrical Operations Superintendent		30%			
	Bi-weekly		$3,846	$5,000	$6,500
	Hourly		$48.08	$62.50	$81.25
	Annual		$100,000	$130,000	$169,000
Operations Manager		30%			
	Bi-weekly		$3,846	$5,000	$6,500
	Hourly		$48.08	$62.50	$81.25
	Annual		$100,000	$130,000	$169,000
Water Operations Director		20%			
	Bi-weekly		$4,583	$5,500	$6,600
	Hourly		$57.29	$68.75	$82.50
	Annual		$119,167	$143,000	$171,600
GIS Dispatching		40%			
	Bi-weekly		$2,143	$3,000	$4,200
	Hourly		$26.79	$37.50	$52.50
	Annual		$55,714	$78,000	$109,200
Operations Assistant		40%			
	Bi-weekly		$2,357	$3,300	$4,620
	Hourly		$29.46	$41.25	$57.75

	Annual		$61,286	$85,800	$120,120
Special Projects		40%			
	Bi-weekly		$2,214	$3,100	$4,340
	Hourly		$27.68	$38.75	$54.25
	Annual		$57,571	$80,600	$112,840
Service Director		20%			
	Bi-weekly		$5,000	$6,000	$7,200
	Hourly		$62.50	$75.00	$90.00
	Annual		$130,000	$156,000	$187,200
Power Director		20%			
	Bi-weekly		$5,000	$6,000	$7,200
	Hourly		$62.50	$75.00	$90.00
	Annual		$130,000	$156,000	$187,200
Broadband Manager		30%			
	Bi-weekly		$2,300	$3,500	$4,300
	Hourly		$28.75	$43.75	$53.75
	Annual		$70,000	$91,000	$118,300
Projects Manager		20%			
	Bi-weekly		$2,300	$3,500	$4,300
	Hourly		$28.75	$43.75	$53.75
	Annual		$70,000	$91,000	$118,300
Contracts Specialist		30%			
	Bi-weekly		$2,357	$3,300	$4,620
	Hourly		$29.46	$41.25	$57.75
	Annual		$61,286	$85,800	$120,120
Administrative Assistant					
	Bi-weekly		$2,357	$3,300	$4,620
	Hourly		$29.46	$41.25	$57.75
	Annual		$61,286	$85,800	$120,120
Network Engineer					
	Bi-weekly		$3,461.53	$4,423.07	$5,384.61
	Hourly		$43.26	$55.28	$67.30
	Annual		$90,000	$115,000	$140,000

Digital Communications Specialist				
	Bi-weekly	$2,028	$2,360	$2,692
	Hourly	$25.35	$29.50	$33.65
	Annual	$52,744	$61,372	$70,000
SCADA/Engineer II				
	Bi-weekly	$3,462	$4,423	$5,384.61
	Hourly	$43.26	$55.28	$67.30
	Annual	$90,000	$115,000	$140,000