

Smart Grid RFI:

Addressing Policy and Logistical Challenges

Gay Gordon-Byrne President, TekTrakker Information Systems, LLC

5 Cranberry Court North Haledon, NJ 07508

Office: 973-949-5163 Mobile: 201-747-4022

gbyrne@tektrakker.com

We are pleased to present our recommendations on how to share and compare failure experience between utilities for all devices in order to drive improvements in grid reliability, drive better and more durable choices of smart grid equipment, and provide common standards for discussions about reliability for all stakeholders.

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Executive Summary:

Central Concept: All grids require durable and reliable equipment at every point. Design and effective implementation of smart grids requires the most reliable equipment possible, yet there are no measurement standards to facilitate comparison and validation of specifications. We intend to demonstrate for the DOE that effective sharing of failure experience by utilities is the most practical way for measuring devices within the grid for reliability. These measurements can then be used by utilities to better manage their operations, for the DOE to manage reporting about ARRA funding, and for stakeholders to have a common language for reliability discussions.

Relationship to RFI Categories:

Equipment failure rate is essential to the selection, maintenance, and lifecycle planning for all devices in these categories:

Instrumenting and Automating the Transmission and Generation System

Distribution Automation

AMI, AMR, and Associated Products

Indirectly, equipment failure rate impacts all customer-facing functions as well as the integration of distributed generation, electric vehicles, and other in-home devices.

TekTrakker® Innovation: TekTrakker has built a fully functional database of computer hardware failure rates driven by service databases. The same methodology can be adapted immediately for use by utilities to share data without the need for any additional programming or installation of any software. The resulting failure rate data is a vendor-neutral, completely independent, calculation of reliability in a standard format. All products in the grid can be monitored for failure rate in the same manner, from the oldest electro-mechanical devices to the latest PMU.

Relationship to RFI Sections:

Interaction With and Implications for Consumers

All the customer-facing side of demand response and rate design must have a core of reliable equipment. For example, if a utility were to deploy millions of defective set-back thermostats, they could anticipate a wave of customer service issues and repair issues even if the device were covered by a manufacturer warranty. In order to avoid being embroiled in excessive customer-service issues (and

backlash), all devices provided by the utility must be of the highest quality. Without measurement, no products can be compared on the basis of reliability.

Interaction with Large Commercial and Industrial Customers

Equipment stability and durability is just as applicable for C&I customers as it is for any other device in the grid. The ability to provide consolidated and standardized feedback to such accounts can only improve their ability to manage costs.

Assessing and Allocating Costs and Benefits

In order to assess and allocate costs, the total cost of ownership (TCO) over the project period must be calculated. To date, this has been a haphazard process at best. As an example, SDG&E requested that a particular meter be treated with a 15 year useful life. TURN (a consumer advocacy group) advocated a 20 year useful life. The judge split the difference and declared a 17.5 year useful life.¹ This is an absurdity since the functional useful life of the equipment is completely unknown. A judge cannot make a device more reliable by decree.

In the case of computers (similar internally to all new electronics in the smart grid), useful life of 7 years is on the high end of age. Most computers are obsolete years before they fall apart, but the rate at which they already are known to need service for part or unit failure should give everyone involved in smart grid planning pause. Within the data center environment, climate controlled and focused on high standards for uptime, the best devices are posting failure rates of about 240 months MTBF. A typical desktop computer fails at a rate of roughly 150 months MTBF. A typical laptop computer is far less reliable, with a failure rate of roughly 80 months MTBF.²

Compare the highest functioning data center devices at 240 months MTBF with typical electro-mechanical meters with a MTBF of 2400 months. These low-tech meters are ten times more durable than the most highly reliable devices in the data center. Some AMI devices already appear to be posting failure rates consistent with routers in the 240 months MTBF range.³ The full range of variation is not yet known, but anecdotal evidence suggests that AMI meters can be just as dysfunctional as using a laptop.

Using the failure rate of any device, it is possible to perform simple calculations to extrapolate the TCO for the device over the entire proposed useful life of the equipment. Variables such as cost per truck roll, warehouse management, internal customer-service and ticketing systems, and even office space and general overhead can be pulled into the calculation, if desired, into order to assess the impact of any device on the cost structure over time.

¹ SDG&E Settlement Agreement dated April 5, 2007 A.05-03-015 ALJ/DMG/h12

² TekTrakker® database of hardware failure rates, proprietary information

³ City of Tacoma, WA failure rate of 5.0% for their 50,000 unit cable modem AMI system

Benefits can then be weighed in relationship to the TCO. Stakeholders of all stripes can discuss the differences in costs and benefits at the model level. Cost overruns in one area do not blur the efficiencies and effectiveness of improvements in other areas. Questions, such as if an AMR system should be replaced by an AMI system, can be answered with an empirical foundation.

Utilities, Device Manufacturers and Energy Management Firms

Interaction between bulk power markets and utilities can also be impacted directly by device failure rates. For example continuous and reliable communications between the entities is essential for wholesale energy distribution. Deploying back office computers and communications infrastructure of these “mission critical” services can be informed by reliability data on those devices, much of which is already being monitored by TekTrakker® as part of our IT business segment.

Long Term Issues: Managing a Grid with High Penetration of New Technologies

The axiom, coined by Lord Kelvin, “One cannot manage what one cannot measure” is fully applicable for this question. Measurement of reliability is at the foundation of running a stable grid. Introduction of electronic technology at key places in the grid can facilitate the benefits of smart grid applications, but if that equipment fails, the designers must be prepared to avoid outages due to component failure, as well as plan for the inevitable repair including repair of redundant fail-safe systems.

Reliability and Cyber-Security

Cyber-Security issues such as we have seen with the Siemens – SCADA worm indicate that many cyber-security issues are equipment specific. It may be possible to measure incidents at the equipment level if there is data to drive the associations. This is a potential enhanced use of our methodology.

Managing Transitions and Overall Questions

Measuring reliability of existing (legacy) infrastructure is fundamental to planning any improvements. A Baseline of reliability of all devices to the model level is necessary to evaluate all the questions posed in this section. The status quo of reliability of today’s devices is not known. There are no standards for describing or evaluating equipment already in use. Failures are defined differently within different departments within the same organization. There is no commonality for discussions internally or externally. In order to move forward, all utilities must first organize their infrastructure reporting so that they know what they have deployed to the model level. Cost elements from various departments can then be added to determine costs to support the current infrastructure to the model level.

Model level understanding is essential to allocating costs. It is not useful to view an O&M budget as a single cost. The activities to make field repairs are spread across a wide variety of equipment. Until the equipment portfolio can be associated with repair costs, it is impossible to break down the changes in costs due to changes in any element of the infrastructure.

General Discussion of Failure and Failure Rate

Reliability Measurement : For purposes of this RFI, we focus entirely on the hardware reliability measurement side of smart grid implementation and challenges. Reliability measurement, our goal, comes in the form of Mean Time Between Failure (MTBF). MTBF is at the heart of many activities in utility operations, including operations and maintenance, planning, finance, customer service and consumer education. Our focus is entirely on creating actionable metrics, from which other utility and policy activities can be informed.

Grid and Device Reliability: We believe that device reliability is a fundamental requirement for building a cost effective and high reliable grid. Much is discussed about grid reliability, but little is measured at the device level, without which no grid can be reliable. For many in the industry, it is a surprise that such information is lacking. The reason is that so much has changed so quickly that traditional measurements are too slow to be useful, and the information gap is so large that a different approach is necessary.

Why Devices? Every grid is only as reliable as its weakest link. Consider the example of an AMI meter deployment. Not only is the meter replaced, but an entirely new infrastructure is added to manage the data backhaul, each element of which has its own failure rate. Within any segment of the infrastructure, a single point of failure can have enormous and unexpected consequences. There is no cure except to prevent failure at every juncture by focusing on the reliability of every device.

Collaboration is Key: If utilities and organizations band together at this pivotal time, they can glean the results of hundreds and possibly thousands of other deployments in advance of making the full investment of time and money. Coordinating reporting from multiple utilities into a database of failure experience will quickly result in a practical database of failure rate – expressed as Mean Time Between Failure (MTBF).

Each utility testing a different set of equipment, or the same set of equipment in a different environment, adds to the knowledge base. There is no wasted data. Regardless of the weather, software, or interface, the quality of the equipment as designed and manufactured must be documented and understood before additional layers of complexity are introduced.

Early stage evaluation of failure rate is essential to pin-point weak products, and just as effective at locating solid ones. Moving into a full-scale production environment with a defective product suite is pure folly. The ideal time to evaluate products is during test and pilot work. Even for installed systems, weakness or poor performance must be removed quickly, or the entire goal of cost effective and efficient operation can be lost, perhaps permanently, if there is sufficient regulatory and consumer backlash.

Reliability - Measured by Mean Time Between Failure (MTBF)

Essential Role for MTBF: We believe that providing ongoing measurement of the reliability of any or all of the devices involved favorably impacts every aspect of smart grid planning and execution. Any utility can use measurement of failure rate (MTBF) to make continuous improvements. The DOE can use the same methodology with ARRA recipients to monitor the effectiveness of their funded projects.

Within the Utility

Planning & Design: Armed with MTBF data of installed products and platforms, planners can select new products that will improve on the reliability of earlier products with a constant goal of improving grid reliability. Planners can take immediate steps to cull the weakest (those with the worst performance) from the grid in order to directly reduce risk of future failures, reduce direct costs of managing failure, and in so doing reduce operational costs. The same data can be used to plan logically for product replacements, address the unknown issues of product lifecycle, and make the most of fully depreciated assets.

Operations & Maintenance: Failure rate data immediately provides details on the future repair needs of the equipment. Managers can project needs for parts and spares not just initially, but over the full lifecycle of equipment. The same information allows O&M managers to project needs for repair teams and appropriate training.

Customer Service: The proliferation of electronic devices with higher failure rates than current equipment is going to greatly increase demands on customer-facing applications such as call centers. MTBF data both informs the variety and volume of calls that a utility should anticipate, but also can be part of the training program for known problems. If, for example, a customer calls regarding a meter issue – the call center can be prepared to ask all the right questions to quickly eliminate, or indicate, a hardware issue.

Commercial & Industrial Users: C&I users have already deployed many elements of the Smart Grid for themselves, but they can always benefit from learning about available improvements in equipment and stability. Use of MTBF data for business and industry can drive reliability improvements in all sectors by providing tools for analysis and comparison. Every product in use in the C&I environment can be monitored for reliability in exactly the same way as for other assets.

Procurement: The typical procurement process within utilities has been bulk buys of commodity products based on price point. This is a useful way to buy no-tech equipment such as wire, but a very poor way to buy electronics. Specifications can be very variable, and responses to specifications in bids are difficult to compare without introducing reliability as a criteria. Using MTBF data, buyers can make

calculations of the difference in cost between products based on the total cost of ownership and not just initial cost. Vendors will be able to justify quality using MTBF data, and buyers will have functional tools for considering innovative products.

Finance: One of the largest problems in building smart grid business cases today is the issue of depreciation. Legacy assets had useful lives of 30 or 40 years and could be depreciated for twenty years. Most electronics in commercial use outside of utilities have useful lives of five years or less, with most depreciation taken at three years. Converging short-term useful life of technology assets with demands for decades long useful life for a rate design is a massive problem. MTBF data does not resolve the problem, but informs the discussion so that depreciation schedules can be logical.

Technology: MTBF when monitored over time provides the basis for planning upgrades and replacements based on the problems of the device, not the depreciation schedule. EPRI's recent whitepaper about ⁴accuracy of electronic meters stated that there is a "bathtub curve" for product lifecycle, but the chart is notably devoid of units. MTBF data would fill in the chart with units – so that changes in the failure rate over time would result in the ability to decide when, and if, a product was likely to become a problem if spikes in failure rate were visible.

Outside the Utility

Rates & Regulators: Regulators have already expressed serious concern over the business case for smart grid when it comes to new and untested technologies. Several of the key issues in the recent BGE vs. Maryland PSC ⁵were equipment related, as the cost-benefit analysis was very weak on the subject of the true costs to the ratepayer. MTBF and a serious commitment to make decisions based on Total Cost of Ownership (TCO) will be of immediate value to any discussions or presentations to regulators. MTBF data should be included in every discussion and will do much to advance the quality of the rate cases.

Consumers & Advocates: To the degree that Utilities can make better business cases, and provide consumers with more solid evidence of performance instead of modeling, consumers can be allies instead of enemies. It is important for consumers and advocacy groups to trust the data. Utilities are not trusted (case in point that PG&E had to hire a consultant to prove "accuracy"⁶), just as vendors are not trusted. Conspiracy theories are always nurtured by lack of data and questionable sources.

Government: Numerous government agencies, from municipalities operating utilities, to federal agencies, are all concerned with building viable and cost-effective smart grids. Utilities seeking to coordinate work with any agency are better informed and prepared to answer questions about the

⁴ EPRI Whitepaper May 2010 " Accuracy of Digital Electricity Meters pg 4.

⁵ BGE vs Maryland PSC – Press and AMI List Serve Discussions

⁶ The Structure Group reports back to PG&E (San Francisco Business Times Sept 2, 2010)

equipment using MTBF data. Unless grid elements can be confidently deployed, projects will continue to be delayed. Several recent cases support this reluctance to invest without further proof of concept.⁷

The risk of backlash against government can also be mitigated by even handed and independent data collection. Just as vendors are mistrusted – so too are politicians. Any taint of political payoff can destroy consumer confidence. The best protection against political backlash is to support product and vendor selection based on empirical evidence of quality.

Vendors: Vendors are not unwilling to have reliability data shared, they are only frightened if it turns out their products are not as good as those of their competitors. This is a two-edged sword. They cannot brag about how wonderful their products are without being exposed to an evaluation of quality. Based on experience from a similarly structured product⁸ which allowed computer mainframe equipment to be compared on the basis of reliability, monitoring of reliability will touch off a vendor scramble to improve reliability at a rapid rate. Only vendors with no intention of improving their products need fear being measured. This is a win for the industry at all levels.

Consultants & Systems Integrators: These groups have been very supportive of TekTrakker® as a much-needed data backbone for providing value to their clients. The information void as currently exists regarding reliability is a frightening situation for any consultant or integrator. Programs with poor results will immediately reflect poorly on the advisors. Every organization committed to keeping a good reputation will prefer to have metrics behind their recommendations.

⁷ HECO July 2010

⁸ R+ (Reliability Plus) begun in 1972 was used by the GSA for federal contracting standards by 1974 and continued until the mid 1990s. The GSA refused to allow agencies to buy equipment that was not within 80% of the then-current R+ figures for the device type.

Alternative Sources for Reliability Data

Vendor Data: The primary existing resource for reliability statistics is vendor information. This is no longer a suitable resource due to the proliferation of new products with little or no installation history. Vendors, even when in control of the repair and warranty data, do not have enough history or enough detail on the asset deployment to make these calculations efficiently and reliably. The issue is mathematical. Anyone calculating MTBF must have control over both the asset quantity of deployed assets, as well as control of the failures associated with only deployed assets. The nature of the distribution channel where large volumes of equipment are shipped without being installed illustrates the asset quantity dilemma. Statistics from vendors are therefore less valuable than user-driven data.

Bench Testing: Most statistics provided by vendors are originally the result of bench testing and small scale (beta test) deployment data. The limitations of bench testing are in the variables that can be tested, the duration of the test, and the missing interactions with the outside world. Further, when dealing with highly reliable equipment, such as equipment designed to last 20-30 years in the field, it can take extremely large quantities of devices to mimic the effects of time. A single device with a failure rate of 2400 months (a legacy meter) would not be expected to deliver a failure rate result without thousands of asset months of history. As a practical matter, most bench testing does not capture sufficient quantity, time, attachments or environmental variables to begin to match field experience.

Sampling and Modeling: Sampling is used appropriately for work on determining accuracy of meters, but has no role in calculating MTBF of a population. These are different views of different aspects of grid devices. Accuracy can be sampled, but reliability needs a different methodology. MTBF of a population of devices is the statistical “gold” standard for engineers. Our product is deliberately designed to calculate MTBF of a population and associated comparisons using Standard Deviation calculations of the population. Advanced econometric modeling can be performed using MTBF data for additional purposes. TekTrakker® performs no modeling.

Surveys, Conferences and other Anecdotal Sources: Utilities have long known that MTBF is a valuable metric to be shared. The problem has been one of coordination and standardization. When a survey is performed, the survey designers have to plan ahead which specific data points they require, and then send the participants into their systems to cull the responses. This always introduces a variety of problems, the largest of which is compliance. A poorly designed survey can easily confuse the participants, and the results can easily be disappointing. The challenges of conforming data are daunting and as a result many projects seeking to tap user experience have not been executed.

TekTrakker® Approach

Innovation: Our critical innovation is to use existing asset management and service databases within utilities to drive our external database of hardware failure rates. The reasoning is simple:

- Sharing data regarding thousands of different devices and millions of assets is a herculean task impossible without using a database structure and existing electronic files.
- Sharing data from multiple users requires an intermediate step to conform descriptions into a standard so that they can be tabulated.
- Data delivered directly from utilities eliminates the inherent lack of trust in using vendor-generated statistics and covers all products in use, not just those of one vendor.
- An industry-wide view of products can be driven with a higher level of confidence using an external database than any individual effort, regardless of the size of the utility.

In our development phase, having attempted to work with other data sources, we determined that the only potential data source to drive industry-wide statistics was to leverage existing service databases, including those built by end users or under contracts from service providers. This has worked where other efforts have failed. We have avoided the problems of vendor influence, avoided having to install monitoring software, and avoided having end users invest in re-programming to be able to interface with TekTrakker®.

Data Quality: Our external approach has yielded other significant benefits. First, we can control data quality directly. Many files are presented to us with implausible or impossible asset descriptions. Our first pass at the data results in an error report which is returned to the participant. The error report is then used as a road map for asset database clean-up. Reporting in the break-fix service database is ideal for driving the failure side of the equation because the data is created by the service technician first hand. Downstream efforts to manipulate service/repair data can easily introduce unwanted bias – particularly where such data is parsed to avoid blame.

Standards: Second, we consolidate and standardize descriptions in a way that provides a different view of reliability even for those very large utilities already doing some internal reporting. For example, it is clear that SGD&E⁹ is monitoring their environment very closely for failure rate. Other large utilities are undoubtedly doing the same, but the standards they may be using can be totally different. Thus a 4.0% failure rate at one utility is not at all comparable to any other report of a 4.0% failure rate. Our set of standards, when applied to all data, results in the ability to compare failure rate consistently.

Leveraging Small Datasets: Pilot and small-scale deployments are excellent drivers to the database. Where the tendency of statisticians is to think of only very large quantities of equipment as being needed for an effective “sample”, we are not sampling. MTBF of a population is not modeling and therefore even a small volume of assets, when treated identically as to failure, can yield viable results.

⁹ SDG&E Settlement Agreement dated April 5, 2007 A.05-03-015 ALJ/DMG/h12

The key is totally standard treatment. Since we control the raw data, we sort and select for the same problems in the same way across all datasets. MTBF builds quickly with a few users reporting the same device for a few months. A single user with 1,000 of “model ABC” will generate 12,000 asset months of reporting in a single year of use. If another user has 2,000 of the same device for 8 months – their 16,000 asset months of history combines to reflect 28,000 asset months in the database. In this manner, each new report combines the shared experience to build an industry-wide view more quickly and with greater statistical validity than other approaches.

Database Organization

Taxonomy: TekTrakker organizes products into logical relationships so that users can quickly locate products of interest. Each product is assigned a Category (Meters are a Category), then a Function (AMI Meters are a Function), and Series (usually a marketing designation) and then Model. Within the model, all variables of configuration are rolled up so that small differences in parts between sub-models do not make the resulting data excessively granular. There are nuances for each model to be considered, and much work is done to assure that the resulting data is suitable for that particular product set.

MTBF (POP): TekTrakker is deliberately designed to measure the MTBF of a population of devices. This allows us to deal with data of variable quality at the most basic level. MTBF of a population is regarded as the “gold standard” of reliability as no modeling or extrapolation is performed. If superior data detail is provided, it is captured for later use. The foundational statistic is MTBF, from which we add any known details such as failure type, part type, or even part number.

We are often asked if the sample sizes we use are “statistically significant”. This is not our approach. We provide all the background data, including the entire volume of assets months of reporting and the specific details of all failure reports on a rolling 12-month average. Users are expected to use their judgment as to the wisdom of making decisions on any given data volume size of data, and encouraged to take advantage of the part level details to make inferences appropriate to their environment. Not all configurations are identical and many products may have failure profiles unique to certain components.

STDEV: TekTrakker automatically calculates the standard deviation of the MTBF of products both in comparison to each other and of each utility to all other utilities. This is a form of continuous benchmark allowing all participants to evaluate their systems in context. Without a universe of “normal”, utilities cannot detect if their products themselves are problematic, or if they have unique environmental or other problems.

Failure Cause: Most data showing cause in the IT environment identifies the failed part. Much detail is lost when equipment is swapped out rather than repaired. We expect this will be the case with smart grid products as well, particularly low-cost assets. Users should expect that cause is going to be work in progress as utilities may have to improve their systems in order to capture cause.

Data Points

Essential Data: Calculations of MTBF are made on three essential points – quantity, failures, and time. In order to calculate MTBF, utilities must provide monthly a current list of deployed assets by model (or summary quantity), and a list of resolved failures. TekTrakker works from these most basic reports to standardize descriptions, associate products with the correct part of the taxonomy, and resolve failures so that they associate properly with each model.

Time: MTBF expressed in months is the most practical measurement for IT products because the lifecycle of technology products and associated service contracts is usually discussed in months. Monthly changes are sufficiently granular to reveal trends, whereas annual changes will blur the results of dynamic changes in the types of devices deployed. If this is not agreed, we can easily adjust the calculations and reporting headers to use hours, days, or years, but the reporting will have to be consistent for the entire project.

Failures: TekTrakker uses a “warm hands” standard for determining the nature of the failure. If a part or system has to be touched by a person, then the problem is assigned as a hardware failure. If a device can be rebooted or just comes back by itself, these are not hardware failures. We also remove failures due to external factors, such as vandalism or tree limbs. Having a common standard of hardware failure allows products to be compared consistently without software variables or external influences. There may be nuances of certain devices where additional failure types need to be captured, such a microcode failure. These can be addressed and included.

Recommended Data Sources

Assets in Use: Every utility knows the deployed quantities for meters because they must have this information in order to bill a customer. Other product types may have their asset quantities maintained in other departments or for other purposes – such as a fixed asset inventory for depreciation, or a SCADA systems manager keeping records to manage the grid. The point is that every utility already has this data and no process changes or reprogramming is needed to collect it.

Legacy Products: There are some potential issues with tracking legacy products in current use. Many of our discussions with T&D managers reveal that such items as transformers, lightning arrestors, reclosers, etc. are bought in bulk on a generic basis and cannot be associated with a known manufacturer. It will only be possible to track the overall failure rate of the product category until more details are routinely captured.

Failures: We know that utilities keep track of device failures even if they do not perform root cause analysis. Every truck roll has a workorder. Every meter shop knows how many meters were pulled for replacement due to failure, vandalism, or regulatory testing. Regardless of the record keeping, so long

as an excel spreadsheet or flat file can be produced with a chronological list of problems, TekTrakker will organize the failures to associate them with the device inventory on a monthly basis.

Deliverables

Web Access: Access to the database is online 24 x 7 with downloadable reporting to excel or access. Each participant sees the MTBF of each device they report always shown in comparison to all others reporting on the same device. Depending on the view selected, the user can see their product performance vis-à-vis their peers, or the products vis-à-vis comparable products. Views always show the details of quantity of assets and failures so that scale can be considered.

Organization Options: Reporting “tree” options are available to allow reporting flexibility based on the needs of the utility or group of utilities. Tree structures can be used to make sub-groups, subsidiary/division access, or even physical location reporting available.

Baselines: Every data set accepted into the database automatically produces a baseline of failure rate for each and every device for each individual utility. This baseline view of current failure rate directly supports the ARRA reporting requirement. Any utility can benefit similarly is an essential first step in all planning. It is impossible to improve on reliability without first measuring the status quo.

Benchmarks: Comparisons between products and between users are automatic features of our system. Any user logged in will always see their products in comparison to others. Depending on the view selected, the comparisons (benchmarks) compare products to each other, or the utility in comparison to its peers using the same product. There is no additional effort needed to create a benchmark.

Trend Analysis: We designed TekTrakker to record all data on a monthly basis so that historical trends could be charted. We anticipate using this function to monitor products over long periods of time for changes in MTBF, perhaps indicating a problem of aging. It would also answer the question of when, and if, a product lifecycle really includes a “bathtub curve”.

Unfair Influence: The question of “gaming” failure data has been considered. Our position is that utilities are providing their own data, and if they knowingly game their own data, it will show in the MTBF comparison to peers for that utility. If false data is reported for a new product, others may buy the illusion of a superior product but upon deployment, the true failure rate of the device will be reported and the results will show a significant difference. Effective manipulation of MTBF for the benefit of a particular manufacturer or product cannot be done without the collusion of many users and therefore seems unlikely under these circumstances.

Build or Buy?

Given enough effort, our methodology can probably be replicated, but would be “reinventing the wheel” without improving efficiency, lowering costs, or delivering greater value. We believe that the immediate availability of our fully functional solution, combined with tested techniques to manage large volume of divergent data give competitors little incentive to launch a competitive project.

- TekTrakker is already an efficient and demonstrable solution to problem of sharing and collaborating on field experience of failure to the model series level. Building an alternative will take years and cost millions. Delays in reporting will thwart, rather than improve, the current lack of knowledge about smart grid products. By the time the DOE could bid, award, and fund a database build effort, many thousands of projects will have already begun and the opportunity to capture and leverage that data lost.
- Our innovation remains in the details of how to execute merging MTBF data from disparate datasets. The concept is simple but the execution is excruciating. Anyone that has attempted to compare two data sets referring to the same device will appreciate that each description, each manufacturer name, and each failure event has to be diligently standardized or the data cannot be compared. Building the database is structurally easy. Getting the data into the database is the critical functional challenge which we have resolved and continue to improve.
- Much comparison is possible between electronic devices already in use and being monitored by TekTrakker and related devices in Smart Grids. For example, a SCADA system is comparable to commercially available servers – only the housings are different. Wireless networks, hubs, routers, switches in business have similar innards to externally mounted communications grids. Laptops and tablets share considerable design basics with AMI meters. Our experience with technology products, and the issues already common with technology devices design and manufacturing give us an immediate understanding of the challenges.
- TekTrakker is totally independent of all vendors and vendor influences. We have no interest in the outcome of any pilots or projects, including intellectual pride. We are not aligned with any think tanks, consumer groups, or systems integrators. We have no political interests behind us. We have no axe to grind for or against any ideas. We live entirely in the realm of measurement.
- TekTrakker is wholly woman-owned, woman-run.

Building a Collaborative Database Using TekTrakker®

TekTrakker has been working with utilities and utility trade groups to build participation in our collaborative efforts to monitor failure rate for utilities. Building a collaborative database requires collaboration – thus our focus on harnessing the power of existing groups. There are number of roles which the DOE could take in support of building a collaborative database powered by TekTrakker.

ARRA Reporting: The DOE has a specific need to coordinate reporting from ARRA recipients. (A complete discussion of the specific impacts we identified within the ARRA RFP process follows in Attachment A.) Without a set of standards, such as those which would be managed and enforced by TekTrakker, the resulting analytics for reporting back to Congress are going to be exceedingly difficult. Driving a database of hardware failure rates through TekTrakker will perform two important functions:

- Standardize ARRA reporting on equipment elements and monitor them over time for use by the DOE and its stakeholder organizations as required by the Act.
- Feed the same metrics into a database for use by ARRA recipients and other stakeholders to use when dealing with issues of equipment reliability, useful life, and total cost of ownership.

DOE as Catalyst and Leader: The DOE can both act in its own interest for purposes of managing the performance of ARRA funding, and also as a catalyst for a broader and inherently more valuable database. This has the potential to demonstrate world-wide leadership regardless of politics. Smart Grid programs worldwide can use the same database, and allow comparison of products and methodologies across the planet. Innovation in the Smart Grid can happen anywhere, and the value of the design and quality of execution made visible from a very early stage.

DOE can Demand Cooperation: Under commercial circumstances, TekTrakker can cajole, but not compel data delivery even from its most committed clients. The DOE has the advantage of the ability to require specific reporting from within its ARRA recipients – an ideal “hammer” with which to cause a functional database to be built.

Once in place – the ability to demonstrate a functional database will allow “marketing” of the function to voluntary users. Whether advocated by alliances with groups such as EPRI, CRN, APPA, or other industry groups, or individually, this is still marketing. Many will share data willingly once the DOE has blessed the concept. We have met with hundreds of utilities that are interested in joining TekTrakker – if only there were a database already in place.

Urgency: This is a pivotal moment in time where the entire industry is experimenting with smart grid products. Some of these experiments are going to have negative results – which in the world of science are still important results. Without sharing and comparing all opportunities and approaches at this early stage, the science will be lost and marketing will take over. There will be winners and losers in this enormous marketing and technological battle. History tells us that the winners will not always be the best products. For example, the Sony Betamax vs the VCR ended badly for technology.

Discussion Points: TekTrakker can organize access according to the needs of the sponsoring group. Such groups should consider some of the following issues: Who should be allowed to access the database? Is the information to be made public? Who controls the dissemination of data? Which stakeholders should have access, and how?

Privacy: TekTrakker has designed anonymity into the product structure. We suggest the DOE and any interested consortiums or groups consider multiple levels of privacy when organizing any approach to collaborate between utilities. TekTrakker is capable of executing any level of privacy.

Future - Expansion of ideas: As mentioned in the summary regarding cyber security, there is potential to use TekTrakker to include events associated with cyber attacks. The limitations for TekTrakker are always data sources, not math. Similarly, the same techniques can be used to monitor dropped communications, or even measure different forms of repair issues such as microcode or firmware updates.

Company Background

TekTrakker was inspired by an operating system software product named R+ (Reliability Plus) from the 1970's. The product measured reliability of mainframe hardware at a point in time when computing was in its infancy and new designs and new applications were being implemented at a rapid pace. Business was just beginning to automate, hardware was very expensive, and no one knew what to buy. The situation is very analogous to the transformation now underway in the utility industry.

Measuring reliability immediately allowed users to compare equipment. There were enormous and unexpected differences between products and many products did not stand the test of time. Reliability became a competitive point between vendors, and both products and service teams were evaluated using R+ as the data backbone for nearly 30 years. R+ was eventually discontinued because the only product that could be monitored was the mainframe.

The challenge in building TekTrakker has been bring this proven reliability measurement functionality to technology products without the need for an operating system software link. Because we focused on external data drivers, we built our methodology without any specific technology link. We have always been able to track any product with a model number.

Due diligence has confirmed that comparable issues of failure rate exist within the utility industry, and that our methodology was entirely suitable for use without modification.

Attachment A – Provided to Several Vendors and Utilities Planning Proposals under the Second Round of ARRA Funding (cancelled).

Smart Grid Investment Grant Program

Funding Opportunity Number: DE-FOA-0000058

TekTrakker Manages the Measurement, Metrics, and Reporting Requirements in FOA

Applicants for funding under the FOA are challenged by the DOE to include plans for how projects will be evaluated against their pre-SmartGrid environment (baseline), how they will continually monitor and report on SmartGrid improvements, and how they will quantify cost savings within the areas of operations and maintenance. The metrics for all of these requirements easily and inexpensively performed by TekTrakker's newly available Utility Data Cooperatives.

Elements in the FOA where TekTrakker has direct applicability are highlighted in YELLOW and the narrative of how TekTrakker manages these points are in BLUE text below.

Under Section B 3 Management Plan

Submitted Project Plans are required to include a section on the technical approach to address potential risks (technical, financial, regulatory, or institutional) that may impact the successful completion of work or impede the schedule. The technical approach to addressing project risks should include:

- A summary of the potential risks and a description of the potential impacts on project tasks and schedule.

- A summary of the strategies to be employed to address or mitigate the risks.

Equipment / Device failure is a serious risk to all SmartGrid deployments. Recent experience with pilot deployments already confirms a wide variety of unanticipated problems, from failures of binding meters to the correct wireless address, to outright recalls of installed equipment. Continuous monitoring of the failure rate of equipment is the only way to measure impacts and avoid potential risks – particularly technically unsound equipment and the resulting negative financial impact of replacement or excessive maintenance and support costs.

Under Section B 4 Technical Approach to Enabling Smart Grid Functions

How the project plans to assess operational performance of the smart grid technologies, tools, and techniques and use the results of that assessment to optimize the way electricity is generated, delivered, or used and enable or enhance smart grid functions and help to achieve the purpose and goals of the SGIG.

TekTrakker is constantly measuring the operational performance of all equipment reported. Any physical device deployed in large quantities can be monitored. This includes AMI, Communications, T&D, Back office, as well as in-home devices.

Pg 24 Section B 5 Technical Approach to Interoperability and Cyber Security

Submitted Project Plans are required to include a section on the technical approach to addressing interoperability with respect to the integration of smart grid devices covering the application of procedures and practices involving interface identification, specification, testing, and lifecycle management. The technical approach to addressing interoperability should include:

Testing prior to deployment catches a significant percentage of failure issues but can never replace field experience for true evaluation of equipment/device quality. Lifecycle management is best done using field experience MTBF data – the ideal application for TekTrakker. The MTBF derived from field experience is the “Gold Standard” for statistical analysis and should be used wherever possible in lieu of

extrapolated. sampling, surveys, or bench testing. Vendor claims of reliability are easily validated using TekTrakker.

- A summary of the information exchange interfaces for communicating automation devices and systems (i.e., their points of connection with other elements of the system).
- A summary of how the project will provide openly available and proprietary aspects of the interface specifications, and how existing (legacy) communicating devices or systems will be integrated into the project.
- A summary of how the project will address response to failure and device upgrade scenarios, such that overall system impact is mitigated.

TekTrakker monitors device failures. A SmartGrid is only as reliable and stable as its weakest link. TekTrakker reporting identifies all areas of weakness which feeds directly into improving operations in order to minimize disruption. Reporting from TekTrakker is used to identify products with unsuitable performance. Reporting compares the performance of that device to all others reported deployed which in turn helps to determine root cause of failure. Upgrades can then be planned logically.

Pg 26 Section B 6 Project Costs and Benefits

It is an important DOE goal to analyze costs and benefits of SGIG projects in the most complete and comprehensive manner possible. In developing their Project Plans, applicants should be aware that this analysis will require that projects provide a baseline set of conditions using a control group or other means so that appropriate estimates can be made of project costs and benefits in comparison with before- and after-, or without- and with- the installation of smart grid technologies, tools, and techniques. For example, data would be collected for a period of time before and after the smart grid technologies, tools, techniques are installed and activated.

DOE welcomes a narrative addressing methods and approaches for conducting cost-benefit analysis, including ideas on the types, formats, and availability of data needed for the analysis.

Baseline reporting is an automatic function of TekTrakker. The moment that equipment is reported, TekTrakker automatically stores historical information so that trend analysis can be performed. TekTrakker reporting is flexible and can be easily downloaded for further analysis, formatting, and graphical presentations of any type.

Continued... pg 26 and 27

The goal of the CBA methodology is to provide a means to consistently calculate the economic value that each project provides. Examples of benefits that DOE would like to examine include:

- Lower electricity costs to consumers from flatter load curves that result from smart meter applications and changes in consumer behavior in response to tariffs that provide incentive to use less electricity during peak hours;
- Lower transmission and distribution (T&D) losses from an optimized T&D network and from having generation closer to load (distributed generation);
- Lower operations and maintenance costs from reduced need for O&M activity and from lower equipment failure rates;

O&M costs can be directly calculated (and projected) from data reported to TekTrakker. Each physical service event is categorized, summarized, and standardized so that all participants can see the specific failure causes, resolutions, and quantity of repairs. All that remains for the utility is to mathematically calculate the cost of each type of repair and compare the total to the pre-project baseline of O&M costs.

Attachment B – Sample Analytics to Support Reliability and Cost-Effectiveness

Failure rate of equipment directly informs both appropriate use as well as cost-effectiveness. Failure rate, as measured by Mean Time Between Failure (MTBF) is the ideal statistic to drive analysis of any element of the smart grid, and the same simple figure can be shared easily by all stakeholders from the most technical engineer to the consumer. MTBF calculations can be used to drive more complex calculations and models using the same raw data without duplicate effort.

Emerging Technologies: No one knows if any of the devices contemplated for use in these complex environments are durable enough for the job. Since grid reliability depends on the reliable interaction of many new items, the grid will only be as reliable as the weakest part in the system.

Utilities can begin monitoring reliability from the first device deployed by sharing total deployed quantity and total failures reported with TekTrakker. A month with no failures is still important information. A picture of MTBF builds quickly as more devices are added to the deployed list, and failures begin to be reported. Devices that may report thousands of asset months without a known failure are clearly superior to those which report a failure against a few hundreds asset-months of history.

Driving Tighter Cost Structures:

Rate reimbursement structures of the past have padded utilities from needing to operate like businesses. This means that much unnecessary cost is imbedded and accepted. Reliability measurement can be used to drive tighter cost structures when the variables of quality can be identified.

Infant Mortality: There is a widespread assumption that infant mortality is acceptable. We reject that this should be the case. Dealing with failures to due infant mortality is a completely unnecessary cost. Manufacturers have the ability through quality control testing to deliver only fully functional products. Those manufacturers that skip this process will quickly be revealed through vastly higher failure rates. Users should expect to be able to deploy products immediately, or to begin their unique imaging and binding activities without concern that the equipment itself is already failed.

Bathtub Curve: Absent infant mortality – there should not be a bathtub curve. Products of high quality will work well immediately, with no unusual failure rates for “burn-in”. In the IT industry, there is no bathtub curve as infant mortality has been driven out of the production of products with the exception of travel damage. (Poor packaging will cause a percentage of devices to arrive DOA – another indication of poor quality). New models enter the field without modification and are retired at end of useful life, or before end of useful life, and rarely in response to massive changes in failure rate. We have not yet

seen enough history to determine the failure curve for any equipment, but the assumption that the shape will be a bathtub has not been proven.

Cost Effectiveness: Failure rate reflects the operations & maintenance needs to support any given device. Each failed unit must be repaired on a timely basis and cannot be left for another roll-out. If, as used by NARUC¹⁰, an average truck roll has a cost of \$ 275, then the overall costs to support devices can be quickly calculated. Using an industry average of 0.5% for old meters, and 5.% failure rate for AMI meters, the following calculation quickly shows the impact of equipment failure rate on the cost side of any planning.

1 Million Legacy Meters - ½ of 1% (0.5% failure rate) = 5,000 truck rolls per year

Annual O&M Support Costs: \$ 1,375,000

1 Million AMI Meters - 5.0% failure rate = 50,000 truck rolls per year

Annual O&M Support Costs: \$ 13,750,000

Net Increase in costs: \$ 12,375,000

Similarly, the ongoing repair needs for any project can be better calculated using baseline data. For example, even using vendor provided data on a solar project, we were able to calculate the repair needs of every component for both the duration of the rollout as well as over the planned useful life. Adjustments can be made against the projections once the equipment is installed, and if interested, vendors held to reliability specifications they themselves have agreed.

¹⁰ NARUC December 2009 Critical Infrastructure Committee Chicago, IL. Our own analysis supports a far higher cost per truck-roll over of \$400 because we include labor and investments outside of the O&M department such as those for customer-service call centers, ticketing and help desk systems.

Attachment C – Sample Screen Shot – Transformer Function Mock Up



- [+] Meter C&I
- [+] Meter Residential
- [-] T&D
 - [-] Transformers
 - Dry Type Vented
 - Dry Type Non-Ventilated
 - Dry Type, Encapsulated, Encl**
 - Dry type, Encapsulated Core & Coil
 - Control Power
 - Distribution
 - Secondary Substations
 - [+] Breakers
 - [+] Substations
 - [+] Capacitors
 - [+] Meters
 - [+] Relays
 - [+] Switches
 - [+] ATS
- [+] Substation
- [+] Communications
- [+] HAN

SCREEN LAYOUT EXAMPLE - DATA FOR ILLUSTRATION ONLY

SEARCH EXPORT DATA USER GUIDE CONTACT US LOGOUT

T&D> TRANSFORMERS> DRY TYPE ENCAPSULATED, ENCL/ MTBF 1205 MO							
MFR	Series	Model	ABC E&G		ALL MEMBERS		STD DEVIATION
			Reported	MTBF	Reported	MTBF	
GE	Single Phase	QB	2250	1265 mo	2250	1265 mo	0
GE	Single Phase	QMS	325	0	325	0	No Reports
GE	Three Phase	QMS3	7535	890 mo	39985	997 mo	4.8
SIEMENS	GEAFOL	Converter	0		245906	1880 mo	No Reports
SIEMENS	GEAFOL	Cast Resin	4226	745 mo	13509	599 mo	22.2
OLSUN	OLSUN	US150Bx-x	422	525 mo	1804	499 mo	2.9
OLSUN	OLSUN	US225Bx-x	0		450982	2123 mo	No Reports
OLSUN	OLSUN	US250Bx-x	0		99198	998 mo	No Reports