Closeout Testing: A Cable Centric Workforce Management Solution

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Closeout Testing Overview

The term workforce management in the cable industry covers a very broad array of topics and has different connotations for each cable operator For the past few years, there is a focus on implementing models from the utility and telecommunications industry with automated dispatch/routing and paperless work orders. These systems carry multi-million dollar price tags and ROIs that are often difficult to justify; resulting in implementations (in the cable industry) that are few and far between. Although these are key pieces in an overall workforce management strategy, there is more to workforce management in the cable industry than dispatch and work orders. Cable operators need functional applications designed specifically for the cable industry. These applications must focus on functions specific to the work required by field technicians that meet objections not only in engineering but also customer satisfaction.

Closeout testing is one such concept that is specific to the cable industry that uses technology to meet the needs of engineering and customer satisfaction. It also addresses the technicians' training needs as they manage multiple advanced services. The idea of closeout testing has hovered around the industry for quite some time but only in broken pieces with ad hoc solutions that were never complete therefore the idea has never been truly implemented.

The main goal of closeout testing is to ensure jobs (service, install etc.) are done correctly the first time and verified with quantitative test data hence reducing repeat service calls. If an operator can ensure that tests are taken for each job the test data is recorded while at the same time reconciled against the work order system, then quality standards are enforced for each job. This helps customer satisfaction levels as customer do not have to keep experiencing the same problem, resulting in high frustration. This helps engineering goals by reducing service and training costs.

Why bother with closeout testing? If implemented correctly, it is possible to achieve the following benefits:

- Reduce repeat rate – lowering repeats due to misprovisioning, improper or lack of testing
- Lower training costs by bringing automation and consistent test procedures to the instrument
- Create a system wide standard for initiating & interpreting test results. Results in standards and consistent procedures that ensure quality based on quantitative test data
- Improved productivity by automating testing tasks for provisioning \ service \ maintenance calls
- Improved customer satisfaction levels as customers do not have to keep experiencing the same problem
- Central repository for test data provides management reports, trends for data analysis, efficiency of technician and productivity

If an operator chooses to pursue the idea of closeout testing, there are four main components to address as part of the implementation. It is important that all four areas are adequately addressed. Omitting any one or more of these components, results in serious gaps rendering closeout testing ineffective.

1. Automated testing functionality in an instrument
2. Remote test data retrieval
3. A central test data repository
4. Integration to workforce management systems

The remainder of this paper analyzes these four components, the necessary requirements to consider for implementation and the benefits achieved with each component. Throughout each section, concrete examples illustrate the solution and make note of the pitfalls to avoid.

Automated Testing Functionality in an Instrument

Today's test instruments are loaded with multiple types of tests for testing everything from basic video levels to DOCSIS and VoIP services. Technicians are often confronted with too many options for choosing which test to run during their daily routine. As a result, sometimes tests are not conducted during a job or the wrong test is performed resulting in a false sense that the service is operational and the customer problem will not reoccur in the near future. As new services are implemented and test instruments continue to provide new test options, vendors must bear the responsibility to evolve technology to make the testing easier and the instruments more intelligent for the technician.

The intelligence required in the instrument is the automation of test procedures. This translates into the ability to run a 'one-button' closeout test that performs a predefined test or tests according to a predefined set of pass\fail criteria (commonly called limit plans). Although the term 'one button' is commonly used in the industry, the reality of the situation is that a single button to do all the steps involved is impractical. More practical is a degree of automation to guide the technician through the process step by step and limit the potential for user error, while still giving them the information and flexibility they need to fix problems in the field. It is also important to note, that the automation required is more than simply running a test. As this paper will explain, there are additional steps in the instrument besides conducting the test that the technician requires.

The idea of closeout testing is related to the concept of autotest that has existed for many years. But there are very distinct differences between the two and some significant limitations of the autotest concept. Autotest functionality exists in a silo, where the technician must enter the mode and run the test then the procedure is over. It only covers the test component. It is not automated to guide them through the entire process and the other steps necessary in order to complete the process. It is also not connected with the other components of closeout testing, such as back office integration. Remember the automation in the meter is only one area of a closeout test solution. Whether the instrument uses standard autotest functionality or automated closeout testing, it still must incorporate the other key areas of the solution to provide any benefits for the field workforce and business metrics.

In addition to the testing component, there are three general areas to also consider for the necessary automation in the instrument. Within each area there are specific details and each operator may choose to vary the steps based on their procedures and philosophy but the following main areas should be covered.

1. Naming structure – it is important to 'tag' or name the file with the test data according to a consistent and logical structure. Instruments must have some file structure to support this. Common designators are customer or account numbers as that is the easiest way to correlate to the work order system for the creation of management level reports. A common pitfall is the lack of a consistent naming policy, resulting in each technician creating their own naming structure. This makes it nearly impossible to mine test data.
2. Results display – clearly display the summary status of the test results to the technician (pass\fail) while allowing them the ability to view test details and vary test location in order to troubleshoot problems.
3. Close the loop – it is important to automate all the steps for completing the closeout test in a single mode in an instrument. If a technician needs to maneuver to different modes and sections in the instrument in order to complete all the steps, the risk of error increases. It is more time consuming and confusing for a technician, which also reduces the likelihood that they will embrace this concept whether it is a corporate edict or not. The automation must 'close the loop' on the process in a few simple steps in one mode in the instrument.

The automation is fairly consistent across users so the same concept can be implemented for all technicians. The factor that varies is the type of test. Different technicians can be required to conduct different tests. This will also vary across operators. For example, some operators want technicians to conduct DOCSIS testing at a home even though the customer is only subscribing to basic video. They want technicians to test and repair the plant if there is a problem while they are there. In addition the type of DOCSIS testing may vary from basic ranging and registration tests to more advanced packet loss testing. The process of conducting a closeout test and steps involved is most likely to stay the same, with the type of test as the only variable.

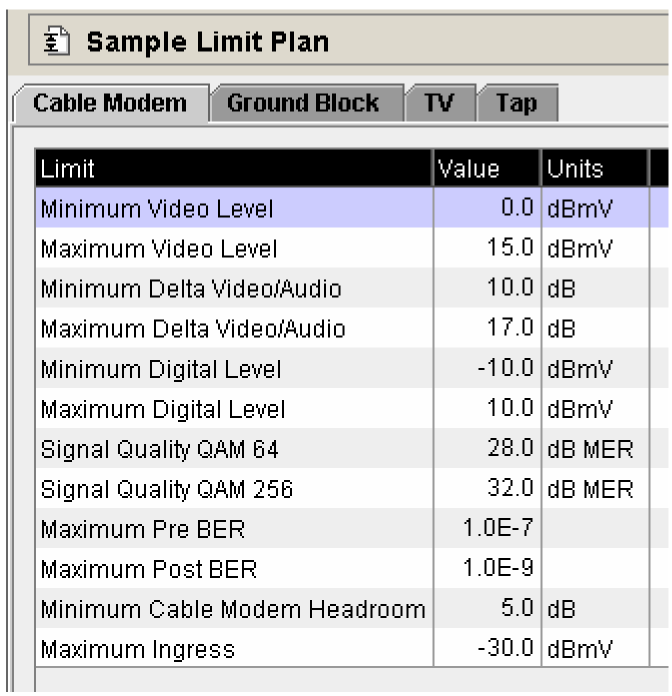
Automation in instruments is one of the key areas of closeout testing. In conjunction with this, and often overlooked, is the configuration of the test parameters associated with the closeout test. It is strongly recommend that these are controlled from a central location using a software package. The entire goal of closeout testing is to create a clear and consistent procedure that everyone adheres to across the system and is verified by quantitative test data. It is important that every technician adhere to the same standards. The use of a central software tool keeps control and consistency at a central location. It also prevents technicians from attempting to change settings in the instrument in order to pass the closeout test and give a false sense of achievement. This philosophy should apply to any setting in the instrument that a technician may try to change in order to manipulate the test, i.e. data and time stamp.

When considering central control of certain parameters, there are two main areas related to closeout testing:

1. The parameters of the limit plans
2. Definition of the closeout test

❶ The parameters of the limit plan

Allowing technicians to create and edit limit plans in the instrument provides a loophole around the successful completion of the closeout test. It would be possible to alter the limit plans in order to pass any test. However it is necessary to allow the technician to select the limit plan associated with the particular test location such as the tap or ground block. If it is deemed necessary that the test will always be conducted at the same location, you could eliminate this flexibility from the instrument and lock the closeout test to a particular limit plan location. This is usually not encouraged as it limits the technician's ability to run tests at different locations in order to troubleshoot and isolate problems.



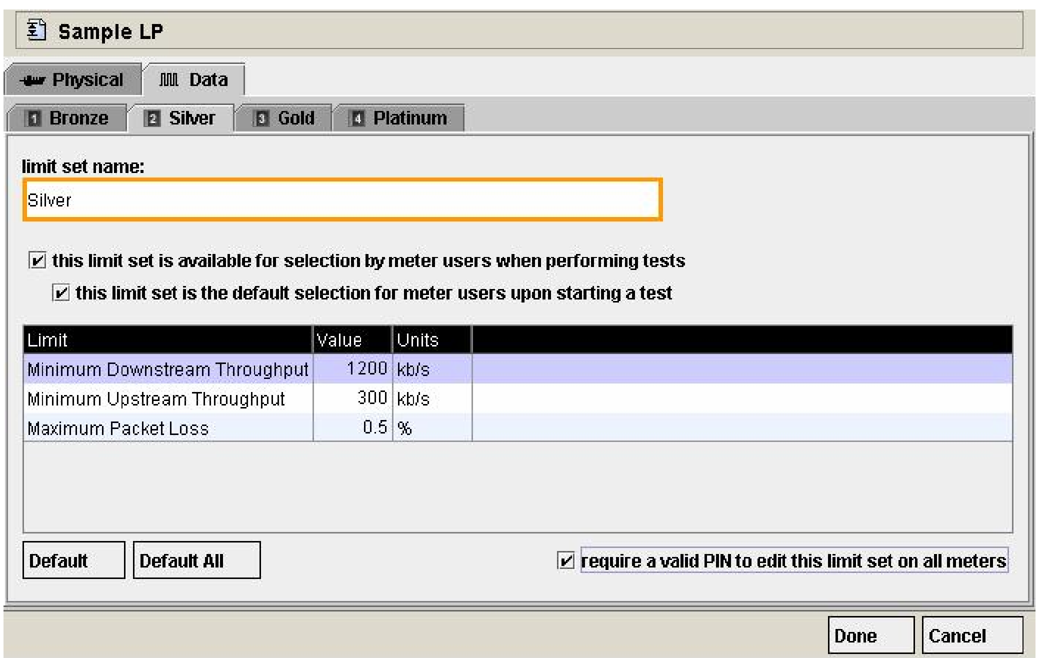
Limit	Value	Units
Minimum Video Level	0.0	dBmV
Maximum Video Level	15.0	dBmV
Minimum Delta Video/Audio	10.0	dB
Maximum Delta Video/Audio	17.0	dB
Minimum Digital Level	-10.0	dBmV
Maximum Digital Level	10.0	dBmV
Signal Quality QAM 64	28.0	dB MER
Signal Quality QAM 256	32.0	dB MER
Maximum Pre BER	1.0E-7	
Maximum Post BER	1.0E-9	
Minimum Cable Modem Headroom	5.0	dB
Maximum Ingress	-30.0	dBmV

Figure 1: Physical Limit Plan for Cable Modem

For each test that is available for the closeout test process, a limit plan is required to support it. Without implementing limit plans, there are no pass\fail criteria for technicians and it is near impossible to quantifiably judge the success of the test. For each type of closeout test it is necessary to maintain a limit plans associated with the test. Figure 1 and 2 illustrate two examples of limit plans, for standard levels and DOCSIS services respectively. It is important to make the limit plan universal for all technicians so they are using the same evaluation criteria. If it is absolutely necessary to allow technicians to alter limit plans in the field, then it can be accomplished by protecting limit plans with a PIN number that allows the technician to alter the limit plan if they have the correct PIN.

A common pitfall with limit plans and closeout testing occurs when the tests are conducted with no limit plan. This results in indeterminate (no pass or fail) test results, and makes it impossible to verify the closeout test. The test should always be conducted with a limit plan.

Figure 2: Data Limit Plan

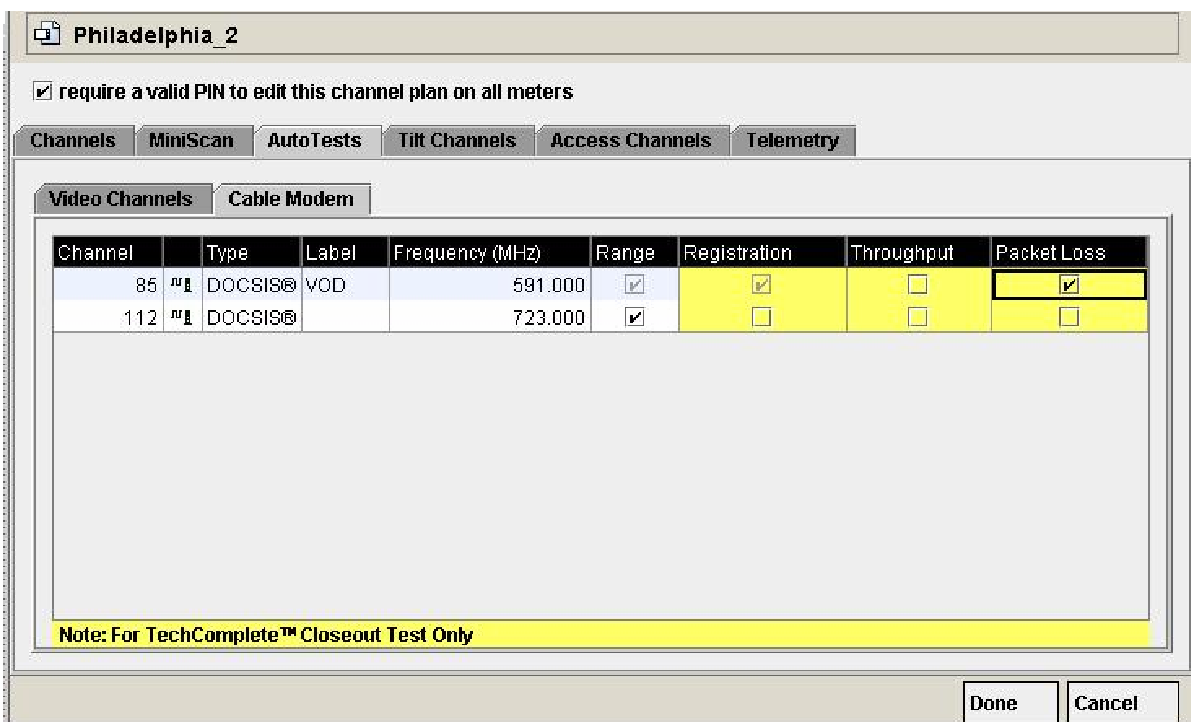


❷ Definition of the closeout test

The second area is the definition of the closeout test. Each operator will have their own set of requirements for conducting a closeout test. Different groups, such as installers or service technicians, may require different closeout tests as they are assigned different responsibilities. Although the automation and process all technicians follow will most likely be the same, the tests they conduct will most likely vary.

The choice of which closeout test is conducted should not be left up to the technician. Once again, this should be created, managed and controlled from a central location. Theoretically any test in an instrument should be available as a closeout test as long as it is practical for the technician to run that test. Figure 3 displays an example of configuring the closeout test associated with DOCSIS services. Whichever tests are implemented as part of the closeout process, it is necessary to define these and apply them to designated groups. Similar to the limit plans, if it is necessary to alter the closeout test definition, a PIN can be used and only provided in the rare case it is required.

Figure 3: DOCSIS Closeout test Definition



Remote Test Data Retrieval

The second critical area for closeout testing is the ability to remotely retrieve test results from an instrument in an efficient manner. Once the test results are taken and recorded, the technician must have the communication capability to send the results to a central database from the test instrument, whether it is a remote location or within the operator's office\network. It is impractical to require a technician to physically return to a central location where a computer resides and transfer the data to a database. Past history has demonstrated the challenge with this task as well as the lack of compliance.

The remote communication must make it very simple and fast for technicians to send test data back frequently, ensuring all test data is recorded at a central location. Test data represents a wealth of information if it is centrally stored and intelligently mined for reporting purposes. The problem with too many existing procedures results in large gaps and discrepancies in test data. Data may be taken but not saved or taken but with no limit plans, or taken but not centrally stored, or all named according to a technician's unique naming philosophy. Manually recording of test data on paper work orders also contributes to this problem. In order for test data to be valuable, a separate test database must be created, not the work force management system (this topic is discussed in further detail in the next section).

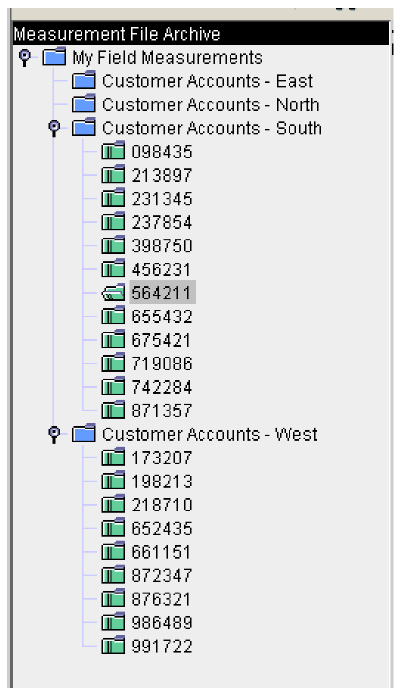
The most ideal way to retrieve the test data as it is recorded is via the existing RF DOCSIS channel. This eliminates the need for technicians to return to an office to download test data. With the development of 2-way cable systems, operators are in a very unique position to use their own cable plant for communication. This is one of the biggest obstacles in the telecommunication industry for Closeout testing. The DOCSIS communication utilizes an existing paid-for and maintained system and helps avoid sporadic and costly wireless data coverage. In addition, technicians can send it over the two-way plant at their convenience, even from their own home. A second alternative is via the customer's Ethernet network. This is not as convenient as the RF plant but still provides an easy communication mechanism once the technician is on the Ethernet network. The last and least desirable alternative is to tether the instrument via a cable directly to a PC. Solutions relying on this communication method will find it difficult to successfully implement a Closeout testing solution. It requires too much time by technicians resulting in sporadic results and an incomplete database that does not represent the entire operator's network.

Whichever communication method is utilized it is important to try and instill this as consistent behavior in technicians, which is defined as at least once per day. Keeping a complete and up to date test database is the base for all further integrations.

Central Test Data Repository

As previously stated, test data from technicians represents a wealth of information if it is managed and mined correctly. For the purpose of this solution, we are focused on the measurement data taken by field technicians at different points throughout the network. There are other sources of test data from many other systems that are valuable as well. However, closeout testing is focused as a field technician management solution.

Figure 4: Test Data Tree Structure



One of the main problems with past solutions, in conjunction with the difficultly in retrieving test data, is the sporadic population of a test database or the use or separate test databases within a single system. The central coordination and management of test data in one database is critical to closeout testing. The single database is based on a system level basis rather than a national basis. Enterprise solutions (for national coverage) can layer on top of individual system databases if necessary. The client user at an enterprise level will have different needs than supervisors or managers at a system level; therefore it is not necessary to create one massive database that all systems nationwide would connect to. This can also create management issues as well. They should be managed locally with data extracted to an enterprise solution based on individual customer preferences and their requirements.

With these goals in mind, the following factors must be addressed for the central test data repository:

- There must be an intelligent user interface that allows users to logically organize the test data and search or query the database. This is important as it allows users to sort through the data in an efficient manner. If an advanced query engine is used then organization of the data can be eliminated. The most common solution is a tree structure similar to Windows Explorer that can have multiple layers. An example of this is displayed in Figure 4. The structure must also support a naming convention for organizing the test data. There are many different possibilities for naming conventions within the structure and each operator must decide what will work with their processes.

This allows data to be shared easily amongst technicians and found quickly. If a repeat service call does arise, it is easy to find the past test data if it is saved according to customer\account number. Another common naming scheme is by physical location, whether that is a node, drop street address etc. This makes it possible to look for test history according to common elements. However this is more difficult as creation of the tree structure usually must work in conjunction with mapping and\or design systems unless it is created manually.

- The central repository must consist of a database that stores all the individual test files technicians take in the field. It must allow supervisors or managers to review individual test files when the need arises.

- In the bullet point above, it is stressed that the central database allows supervisors or managers to review individual test files. However, it is entirely impractical to review every individual test files for large numbers of technicians. Higher level management reports are required that allow users to look for trends and highlight any potential problem areas. If these management reports indicate a problem, then supervisors can drill down into the individual test files. These reports will be described in the integration to workforce management system section below.

- Cable operators need 'out of the box' reports that provide immediate benefit and do not require custom system integration projects. This is the nature of solutions in the cable industry. More solutions need to focus on specific applications that provide immediate benefits with minimal integration efforts. Too often are massive integration projects embarked upon with questionable benefits for the end users and lengthy implementation schedules. Focus should be on a core base of reports along with the flexibility to meet custom requirements.

- In conjunction with 'out of the box' style reports, the central repository should support the generation of custom reports based on individual operator's needs as well as integration to other back office systems. Test data may be integrated into other operation support systems (OSS) or combined with other databases of information for custom reports. This requires the central repository to be an open relational database.

Across the industry there is a great deal of discussion regarding the integration of test data to the workforce management system for inclusion of test data on work orders. This topic rises as most operators are trying to achieve the goal of providing historical test data to field technicians on demand. Most work orders currently maintain fields for recording signal levels or other basic information. But because these fields are manually populated by the technician rather than the field test instrument, their value is suspect. There is definite value to record test data on work orders. However, there is no need to require an additional step for technicians to perform in the field when this process can be automated in the back office. There is no need to complicate the technician's job even further. The tendency is to place the burden on the technician to do tasks that can be automated without any of their intervention or time. If a truly central test database is created with an open database structure then this is much easier done in the back office between the two systems.

The next logical question to ask is why have two different systems for test data and work orders? Remember there are more than just signal levels when considering test data. Multiple types of test files in conjunction with the instrument management functions are usually best served in separate systems. The users or the system are often different as well. Requiring two separate client interfaces. Data can and should be shared between the two but it is extremely difficult to integrate into a single system.

The goal of providing historical test data to field technicians can be accomplished through work orders, although the amount of test data can be a bit overwhelming. The next logical progression of closeout testing once the process is in place and the data is consistently recorded, is to extend the availability of historical test data directly to the field technician. There are many possible options for this extension which will not be covered in this paper. You can not reach this level until a closeout testing 'type' solution is implemented. But once it exists, technicians can be provided an interactive interface directly to the central repository where they can request and receive historical data! This has a myriad of benefits and is very empowering for the field workforce.

Integration to Workforce Management Systems

So far the discussion of this paper focuses on the process in the test instrument, the individual test files and their database. The last component to complete the solution is integration to the workforce management (or billing) system that contains the work orders. Although there is some debate on how to best integrate to the work force management system and to what extent, it is fairly accepted that some integration is required in order to provide the most benefits.

The most visible benefit from integration is in the management level reports that summarize all of the individual test files. Remember, the goal is for software to provide higher level management reports for supervisors to look for trends and problem areas. This should aggregate test data and provide views at different aggregation points. The following aggregation points are recommended on a system level:

- Individual technician
- Supervisor – all technicians that report to a particular supervisor
- Manager – all supervisors that report to a particular manager
- System – all managers in the system

The management level reports are grouped in the integration to work force management system section because without one or the other their value greatly diminishes. The goal of these reports is to help supervisors ensure technicians are taking the closeout tests for each work order (or job), they are passing (or failing), and that they are adhering to predefined quality standards. By using reports to look for these trends, it eliminates the need for supervisors to look at microscopic detail associated with each technician. It can also help identify training issues with the workforce. For example, maybe a technician needs more training on the technology and interpreting the test results so they can fix the problem. Maybe they do not understand how to use their test instrument so they do not use it at all. All of this translates back into a reduction of repeat rates and higher customer satisfaction levels. Repeat rates decrease because it is possible to ensure that technicians are taking tests in the field, doing the work to fix the problem for each job, adhering to consistent quality standards and all the work is completed before they leave.

So why is it necessary to integrate to the billing or work order system? It is necessary as it provides a correlation that is imperative to understanding the number of tests that passed relative to the number of jobs that required a test. Without this correlation, reports are misleading and inaccurate. In addition the goal is also to prevent managers from looking through thousands of individual test files for trends or problem areas. An example of this report and its importance is represented in Figure 5. This is an example of a management level report on a supervisor level (displays all technicians for a supervisor over a user specified time period). While looking at the line corresponding to technician number 568, it shows a 100% test pass rate which on first glance would be very good. However, by viewing the tests ran column, this technician only took tests on 38% of their jobs, indicating that the correct work may not have been completed for that job and a repeat service call may be required. This quickly flags the work for review by a supervisor and they may choose to investigate further into the test database. Without integration to the billing system, a supervisor is unable to make this comparison and an accurate portrayal of the field workforce is impossible. They would only see the tests passed results and receive a very false level of compliance. This same example can be extended on the different aggregation points, i.e. for all supervisors in a manager or across the entire system.

Figure 5: Management Report on a Supervisor Level

		Number	Tests Ran		Tests Passed	
Tech ID	Total Jobs	Require Test	Number	%	#	%
128	13	11	11	100%	11	100%
334	11	11	11	100%	11	100%
451	12	8	7	88%	6	86%
567	8	8	8	100%	7	88%
568	9	8	3	38%	3	100%
569	15	11	11	100%	11	100%
702	12	12	11	92%	11	100%
801	4	4	4	100%	4	100%
803	16	12	12	100%	8	67%
880	18	14	13	93%	13	100%
Total	118	99	91	92%	85	93%

The integration to a workforce management system becomes very critical when discussing management level reports and truly closes the loop for the closeout testing. Figure 5 only illustrates one example of these reports and the possibilities are endless when considering the wealth of information in a central test database. However, without integration to the workforce management system the last component of the solution is not implemented and Closeout testing is not truly achieved. For this type of functionality a real time interface to the workforce management system is not required, hence decreasing the complexity of the solution. Simple daily batch reports can provide the required functionality.

Solution Challenges

Implementation of closeout testing is not without its challenges. In each section obstacles are highlighted relative to the individual component. But there are some general obstacles that an operator can experience with implementation of closeout testing. Although the concept sounds fairly basic, usually the change in process for technicians is very dramatic. There are exceptions to this based on the individual system's existing methods and procedures; however this is the exception and not the norm. Therefore, the acceptance and training of the field workforce is the biggest challenge. This translates into challenges on two fronts. First, ingraining into their daily routine that a closeout test must be run for every single job and follow the procedure according to the process defined. Second, consistently (defined as daily) communicating back to the central repository.

Technician acceptance issues arise because in the beginning running this test will take more time per job. In a world where time is money and they are always being pressed to do more jobs quicker, this is a hard mold to break. The closeout test may be more than they do currently and force more steps into their typical job routine. But over time as they become more familiar with the process, they will become more efficient completing the process and more intelligent on fixing the issues. The small increase in time in the beginning is dramatically compensated in the savings of eliminating a repeat service call. Most operators would rather spend and extra five minutes on a call running some tests than sending another truck back two weeks later. In order to overcome this challenge, it is imperative that the supervisors convince technicians that this process can benefit them and that spending an extra five minutes on a job will not be penalized! In order to persuade technicians on the value of the system, supervisors should stress the consistency that they will derive from the process, the automation that will walk them through the process, the test results and how to interpret them to help them find and repair problems quicker.

Another common challenge is the consistent use of the management level reports to encourage technician compliance. Some operators fall into the trap that once they have a process everyone will follow it consistently. And since in the past there was no way to really track processes, compliance often went unchecked. But with management level reports this is now possible. But still, a common mistake it that management ends once the automated methods and procedures are deployed to the technicians. Although a process may be implemented and technicians are supposed to follow it, there is no substitution for proactively managing the workforce. All the reports and information in the world can not force anyone to follow procedures or correct their mistakes. They can only highlight problem areas and create a flag when a potential issue arises. It is still up to managers to use the available information. Automation can only go so far. It is important to remember that automation combined with personal management is one of the keys for this to succeed. This often goes overlooked and in the end the solution can appear to be counter productive.

Overall the solution needs commitment from all levels of the organization to succeed from technicians, and supervisors to technical operations directors etc. Without system wide commitment, there is sporadic use, holes in the central database and the solution does not provide the intended benefit.

Conclusion

Closeout testing can have a dramatic effect on the efficiency of the field workforce and reduction in repeat service calls. It is important for each operator to set up clear testing criteria along with consistent procedures. Closeout testing is the only way to offer the automation required to achieve this goal. Any procedures that require manual intervention and do not address the four key areas described, results in disjointed solutions that will not achieve the end goal. This becomes frustrating to all owners, especially the mobile field workforce.

But with a successful implementation, it is possible to achieve the following benefits and dramatically impact business:

- Reduce repeat rate – lowering repeats due to misprovisioning or improper testing
- Lower training costs by bringing automation and consistent test procedures to the instrument
- Create a system wide standard for initiating & interpreting test results. Results in standards and consistent procedures that ensure quality based on quantitative test data
- Improved productivity by automating testing tasks for provisioning \ service \ maintenance calls
- Improved customer satisfaction levels as customers do not have to keep experiencing the same problem
- Central repository for test data provides management reports, trends for data analysis, efficiency of technician and productivity