FLUKE networks

How to get the most out of cable test reports

Anyone who has ever seen a "PASS" in the display of a cable tester has had to deal with the "dark side" of that four-letter word: data management. In approximately ten years since the first portable cable tester was introduced, the industry has gone from virtually no test records, to an overabundance of records that can be difficult to manage. For an average job, there can be more than 419,000 data fields! After completion of a project, end users are faced with binders full of printouts, or an enormous amount of data saved to a CD. But who wants to schlep around a binder or manually peruse hundreds or thousands of test results on a CD with application software that is unfamiliar to them? With so much data, it can be difficult to see trends or spot anomalies.

Without a way to easily consolidate the information, it can leave many questions unanswered:

- Are your NEXT margins consistent or do you do better with specific components?
- Did all installers do an equally competent job?
- Were the appropriate link adapters and personality modules used for each test?
- Were the right autotests selected every time?
- You're promised 3 dB margin over the Category 5e limit. Did you always get it?

There are four principal users of field test information: installers, consultants, end users, and manufacturers – each has unique needs and interests.

Installers/contractors

Contractors are in a very competitive business. It is a constant challenge to provide an educated, trained workforce with quality products and workmanship at prices that attract business, yet allow a fair profit. Contractors are probably the heaviest users of field test tools, often using them six or seven days a week. Special concerns of this group include:

- How can I win more business?
- How can I reduce labor costs?
- Which product performs best after being installed?
- How can I get quicker warranty approval of my work from my supplier?
- Are all my installers doing similar quality terminations?

In many cases, the contractor won't be paid until after the work has been completed, the warranty approved by the manufacturer, and received by the end user. Warranty approval alone can take four weeks in some cases.

Consultants

Consultants often specify the requirements of the job, including mandatory tests and report format. In the case of premium cabling, there may be a guarantee of a certain level of NEXT margin above the limit

line, minimum guaranteed ACR (headroom), or extended frequency performance. While consultants do not use test tools as often as the other groups, they are in a very influential position, as they often dictate what must be done. Special concerns of this group include:

- Is the installed cabling performing to the level specified?
- Are results consistent?
- Did all installers do an equally competent job?
- Was everything done according to specification, i.e., correct tester, current software, appropriate test standard and link adapter, etc?
- Can I get an all-inclusive, professional-looking summary document of the installation to include with my final report?

End users

End users don't have time to check hundreds or thousands of results, but otherwise have no easy way to answer the following questions:

- Did all links pass with the promised margin?
- Were all tests valid?
- Were there any marginal links?
- Were results consistent?
- Were there any overlooked anomalies in the data?

Manufacturers

Manufacturers make and supply the cable and connecting hardware, then approve and support the warranty requirements. Their needs are different from all the others, typically requiring a more detailed analysis in order to sustain and improve product quality and efficiency. Their questions include:

- How can I reduce my cost to provide warranties?
- How does system performance change:
  - At near and far ends?
  - When installed by different contractors?
  - When installed with different components?
  - On different pairs?
  - At different frequencies?
- How can I increase confidence in warranted performance claims?
- When troubleshooting becomes necessary, how can I quickly get to the root of the problem and distinguish normal from abnormal data?

There are several alternatives to address the questions raised by installers, contractors, end users and manufacturers. These include manual review of the test data, post-processing of detailed results via analysis of Comma Separated Variable (CSV) output, and automatic analysis via special software such as Fluke Networks' LinkWare Stats.™

The traditional method is a manual review. In the field, small jobs (< 100 links) are often printed and placed in a binder. For larger jobs, the results are put on a CD in electronic form. Given the volume of data points, it is simply impractical to perform any sort of thorough analysis in a reasonable amount of time. At best, you have a hit or miss spot check of selected random reports. If you find something you can dig deeper, but if you don't, all you can do is hope everything is good.

An alternative to manual review is post-processing of detailed CSV data. Most cable record management software provides an option to export all data fields associated with each test record in CSV format:

```
"Cable ID","Tester Type","Main
   S/N", ...,"ATTN Margin",
   "Attenuation","A[02]-A",
 "DSP-4300","7350022",....,
     20.6,10.1, ...,etc.
```

Each test record appears as one line or row of output. While CSV might be difficult to read by humans, it is fairly easy to process with standard applications, such as spreadsheets or internally developed software. Using this approach, analysis beyond pass/fail can be provided to address the needs of the various field test information users:

- Contractors can determine if the installer has used the required tester configuration across all tested links
- Consultants analyze non-TIA information (e.g., insertion loss analysis over actual length)
- Manufacturers can monitor long-term averages in factory sampling
- End users can check average and worst case margins for key measurements

Despite being able to gain valuable insight from CSV analysis, there are significant issues as well. The explosion of stored data has caused the number of fields to exceed the maximum number of fields that standard spreadsheet applications can import (255). Applications such as Fluke Networks' LinkWare allow some level of programmability to select the fields to be exported. However, if all fields were required, multiple exports and analysis of multiple files would be required to obtain all information of interest, further complicating the process.

Another potential issue is that CSV data fields can change (e.g., new fields added) with new versions of test software or standards requirements. These changes can have an impact on the output format. This forces the processes and software developed by the user to be modified accordingly. What was working one day might not with the next update to the test equipment. CSV is also open to editing errors and tampering. Once the data has been exported in a text format such as CSV, it is very easy to inadvertently or intentionally modify the results, so data integrity becomes a concern.

With new automated records analysis programs like Fluke Networks' LinkWare Stats, there is now a much simpler and more powerful way to analyze and manage your test data, without the drawbacks of CSV output. LinkWare Stats can summarize the performance of a 10,000-link network on a single sheet of paper. It can provide several views of the data that quickly point out performance parameters and configuration discrepancies across an entire installation (see **Figure 1** on the next page).

In addition to overall summary information, viewing data across the entire range of stored results can yield useful information. One tool used to summarize test data is the histogram, where the number of records are shown on the Y-axis and the margin for the test of interest is on the X-axis. In **Figure 2**, you can see the distribution of NEXT margin. Note that it follows a normal distribution curve, as would be expected with consistent products and termination practices. A few links where the margin is less than 1 dB are shown in yellow. Any failing links would be shown in red.

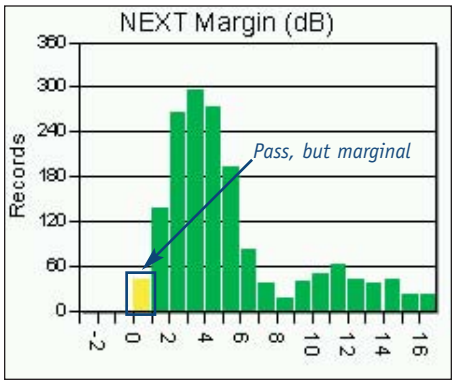


Figure 2: NEXT margin histogram – normal distribution

In **Figure 3**, we see an example where the results are shifted or skewed to the right. The average margin is clearly much better at this site, suggesting higher quality cabling.

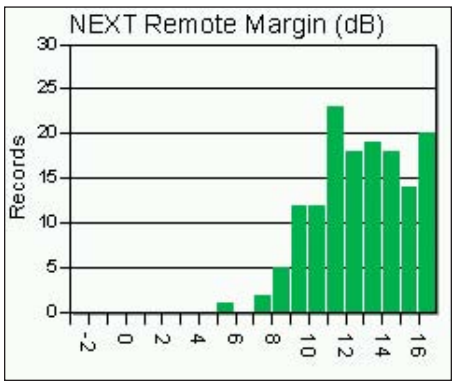


Figure 3: NEXT margin histogram – better than average margins

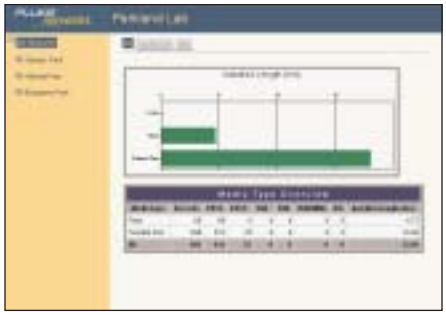


Figure 1: LinkWare Stats summary reports

Figure 4 shows evidence of inconsistent termination practices, given that we know the same cabling and connecting hardware were used throughout the site. This would be a flag to look at NEXT margin by installer or location (floor, building, etc.), and could represent a training opportunity.

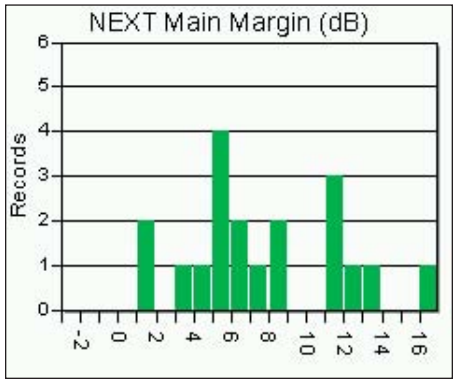


Figure 4: NEXT margin histogram – inconsistent margins

It is also useful to drill down and understand performance of each measurement at the local and remote ends of the cable, by pair or pair combination, and by frequency. **Figure 5** plots the worst-case return loss margin by frequency. We see that most of the worst-case return loss results occurred at high frequencies (>350 results occur between 225 and 250 MHz). This suggests to an expert that the connector, as opposed to cable performance, affected the return loss margin of this sample.

One of the perplexing issues surrounding managing data is the issue of the "false pass." A "false pass" occurs when some invalid set of conditions conspire to make the result pass, when it really shouldn't have. One example is using a Category 5 basic link test configuration (adapters, test standard, etc.) on a Category 5e permanent link installation. To detect these conditions, it is useful to summarize results by tester, software version, link adapter, and so on. This permits inspection of the test configuration to ensure that all conditions were legitimate for the specified requirements. **Figure 6** (next page) provides a LinkWare Stats example that indicates a number of problems: incorrect testers used, out-of-date software versions, incorrect link adapters,

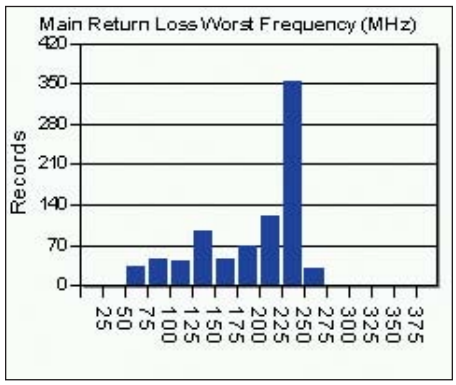


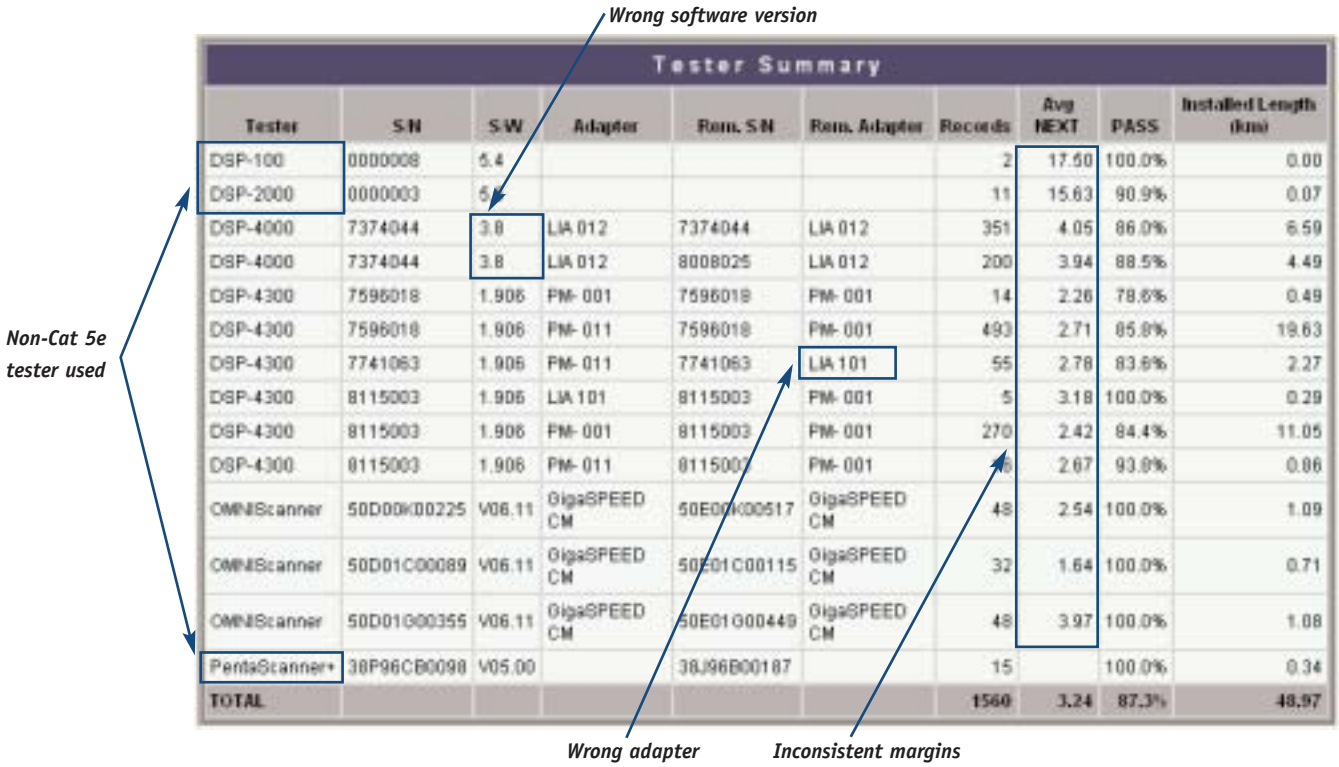
Figure 5: Return loss margin by frequency histogram

and inconsistent NEXT margins. Without a summary facility such as this, the likelihood that you would find such problems manually going through hundreds of pages of data is extremely remote.

As cables, connectors, and test equipment have advanced, so has the need to process ever increasing amounts of data. This trend is likely to continue. Standards committees are currently considering new performance and test requirements for cabling systems of the future. The data storage requirement for the installation of cabling can be overwhelming. Automated solutions such as LinkWare Stats provide a new way to examine the data. By statistically examining the test results for an entire job to produce an easy to understand view of that data, the burden is lessened while avoiding the pitfalls of post-processed CSV data. Contractors, consultants, end users, and manufacturers all have unique needs, but automated statistical analysis packages can tap into the "hidden" information in the data to ensure the proper use of test equipment and gain the necessary insights into cabling performance and installation practices.

See what LinkWare Stats can do with your data

A free demo version of LinkWare Stats is included with every copy of LinkWare. You can download LinkWare free from our web site at **www.flukenetworks.com/linkwarestats**. Take a test drive and see LinkWare Stats for yourself – using data from your own cable plant.



Tester Summary

Tester	S/N	S/W	Adapter	Rem. S/N	Rem. Adapter	Records	Avg NEXT	PASS	Installed Length (km)
DSP-100	0000008	5.4				2	17.50	100.0%	0.00
DSP-2000	0000003	5				11	15.63	90.9%	0.07
DSP-4000	7374044	3.8	LIA 012	7374044	LIA 012	351	4.05	86.0%	6.59
DSP-4000	7374044	3.8	LIA 012	8008025	LIA 012	200	3.94	88.5%	4.49
DSP-4300	7596018	1.906	PM-001	7596018	PM-001	14	2.26	78.6%	0.49
DSP-4300	7596018	1.906	PM-011	7596018	PM-001	493	2.71	85.8%	19.63
DSP-4300	7741063	1.906	PM-011	7741063	LIA 101	55	2.78	83.6%	2.27
DSP-4300	8115003	1.906	LIA 101	8115003	PM-001	5	3.18	100.0%	0.29
DSP-4300	8115003	1.906	PM-001	8115003	PM-001	270	2.42	84.4%	11.05
DSP-4300	8115003	1.906	PM-011	8115003	PM-001	6	2.67	93.8%	0.86
OMNIScanner	50D00K00225	V06.11	GigaSPEED CM	50E00K00517	GigaSPEED CM	48	2.54	100.0%	1.09
OMNIScanner	50D01C00089	V06.11	GigaSPEED CM	50E01C00115	GigaSPEED CM	32	1.64	100.0%	0.71
OMNIScanner	50D01G00355	V06.11	GigaSPEED CM	50E01G00449	GigaSPEED CM	48	3.97	100.0%	1.08
PentaScanner+	38P96CB0098	V05.00		38J96B00187		15		100.0%	0.34
TOTAL						1560	3.24	87.3%	48.97

Figure 6: Tester Summary reveals inconsistencies