

Q/P MANAGEMENT GROUP, INC.

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**BellSouth Corporation
Wholesale Operations
Software Quality Assessment**

February 12, 2004

**Encore
Releases 10.3 – 14.0**

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**DECLASSIFIED
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Background

The Wholesale Operations division of BellSouth Telecommunications has embarked on an effort to gain a comprehensive understanding of the quality of their software releases being deployed. To this end Q/P Management Group has been engaged to establish quality metrics and compare the results to industry benchmarks. This project has collected software size and quality on the past nine releases in order to calculate quality rates for the BellSouth and vendor software included in the releases. The resulting quality rates were then compared to benchmark quality rates for similar size software projects. Project size is a key component of the analysis since as projects increase in size the number of potential defects also increases. In order to compare the quality of two different size projects it is necessary to normalize them to a common measure. The common measure used to normalize the projects is the size of the project in terms of function points. Therefore, the base metric for the benchmark comparison is Defects per Function Point. The Defects per Function Point metric is an industry-accepted measure of quality used by numerous telecommunication companies and government agencies.

Approach

This study evaluated the quality of BellSouth Wholesale Operations software releases from the beginning of 2002 to the present. Size and defect data were collected for the applications included in a release in order to reflect the quality of each release.

Q/P Management Group worked with BellSouth representatives to plan, schedule and perform the Software Quality benchmark activities. A major input into the benchmarking study was the release function point counts previously established for BellSouth applications being supported by Accenture. The function point counts are based on the International Function Point Users Group Counting Practices Manual Release 4.x (CPM 4.x) counting rules. Additional data collected to support this effort include:

- Line of code counts for Telcordia Technologies applications
- Line of code counts for ESI applications
- Application/Release Defects

In addition to the data provided, Q/P collected information on line of code counting standards used by the vendors and defect definitions used by BellSouth.

Project Scope

The releases involved in this Software Quality Assessment are:

- | | | |
|----------------|------------------|----------------|
| - Release 10.3 | - Release 10.3.1 | - Release 12.0 |
| - Release 10.4 | - Release 10.5 | - Release 13.0 |
| - Release 10.6 | - Release 11.0 | - Release 14.0 |

Methodology

The Software Quality Assessment that resulted from this study is based the methodology described below.

1. *Collect Function Point Size and application/release defect data* – function points provide the functional size of the software releases. Defects were collected during the 60-day period after a release was implemented. The defect counts were provided to Q/P for each release being analyzed.
2. *Establish Function Point Size Estimates for Telcordia Technologies and ESI Software* – using industry accepted techniques, convert the line of code counts provided into function point counts to establish project sizes.
3. *Establish Quality Metrics and Perform Benchmark Database Comparison* – Establish defect metrics (defects/function point) and evaluate quality in comparison to Q/P Management Group's (Q/P) benchmark database.
4. *Establish Software Quality Assessment Report* – document the process, findings and conclusions resulting from the benchmark comparisons.

These steps are explained in further detail below.

Collect Function Point Size and Application Defect Data

Q/P Management Group collected function point size data for BellSouth applications included in the releases. The function point counts were established previously as part of an ongoing BellSouth software measurement program. The function point counts are based on standards set by the International Function Point Users Group's (IFPUG) Function Point Counting Practices Manual, Release 4.x (CPM 4.x).

The International Function Point Users Group (IFPUG) is the largest software measurement organization in the world. Its mission is to be a recognized leader in promoting and encouraging the effective management of application software development and maintenance activities through the use of Function Point Analysis and other software measurement techniques. Function Point Analysis is an industry and an International Organization for Standardization (ISO) standard used to establish the size of a software application.

The primary goal of Function Point analysis is to evaluate a system's size from a business functionality point of view. To achieve this goal, the analysis is based upon the various ways users interact with software applications. From a user's perspective, a computer application assists them in doing their job by providing five (5) basic functions. Two of these capabilities address the data requirements of the business and are referred to as Internal Logical Files and External Interface Files. Three of these capabilities address the user's need to access data and are referred to as External Inputs, External Outputs and External Inquiries. The five components are counted and weighted based on low, average or high data complexity resulting in an Unadjusted Function Point count. The

Unadjusted Function Point count is then multiplied by the application's Value Adjustment Factor, which considers operational complexities. The end result of the counting process is the final Adjusted Function Point count.

The defect data used in this assessment existed prior to the initiation of this study. This data was combined with the appropriate function point size data to calculate a Defect per Function Point metric for each release.

Establish Function Point Size Estimates for Telcordia and ESI Software

Telcordia Technologies and ESI do not collect function points on the projects they deliver to BellSouth. Therefore, line of code (LOC) data was utilized. The line of code data was converted to an estimated project function point size using a LOC to FP conversion factor (gearing factor). The conversion factors for three of the Telcordia applications were calibrated based on the LOC and function point data collected for BellSouth on Telcordia software through previous engagements. Two Telcordia applications and the ESI software were sized using LOC to function point ratios established by Q/P using a proprietary method based on acceptable industry standards that takes into account an applications language set and age. The result of this analysis provided the measure of size for all the software being evaluated. The LOC counting standards used by Telcordia and ESI were also reviewed and considered when the gearing factors were established.

Establish Quality Metrics and Perform Benchmark Database Comparison

The benchmark analysis compared BellSouth software quality against industry average and Best-in-Class statistics. The actual Defects per Function Point density by release was compared to the industry defect density to determine if BellSouth software is above, below or at industry levels of software quality.

The statistics that resulted from the quality analyses were compared to benchmarks from Q/P Management Group's database. The benchmark database is comprised of over ten thousand projects and applications from over 100 organizations. The majority of data in the database are from Fortune 500 companies based in North America. The largest industry sector represented in the database is telecommunications. Numerous Fortune 500 companies and government agencies utilize this database to benchmark software quality, productivity and cost.

The peer group selected to establish the benchmark comparisons for this study include a subset of the telecommunications companies listed below.

- SBC
- GTE
- Compaq Telcom. Solutions
- Ameritech

- Verizon
- Bell Canada
- LHS Infocell
- AT&T
- Iridium
- Sprint
- Telcordia
- Nortel

In addition to utilizing telecommunications for benchmark statistics, Q/P also selectively chose projects and applications from clients from other industry sectors. The selection was based on identifying projects of similar size and complexity to those in production at BellSouth. This data were selected from a subset of the following companies:

- Detroit Edison
- American Express
- PRC Litton
- NASD
- NIPSCO
- Blue Cross Blue Shield
- USAA Insurance
- S.W.I.F.T.
- Fleet Bank
- First Data Corp.

The benchmark database contains productivity, cost and quality statistics, including Function Points delivered per hour and Defects/Function Point on a broad range of software types including new development, enhancement projects, major releases and application maintenance. The software classifications and functions in the database include:

- | | |
|--------------------------|------------------------|
| Data Warehouses | Middle-ware |
| Tele. Services Marketing | Customer Care |
| Cellular Services | Telco Billing |
| Equipment Procurement | Plant and Facilities |
| Network Management | Credit Card Processing |
| Funds Transfers | Securities Fraud |
| ATM Networks | P.O.S. Networks |
| Human Resources | Finance and accounting |
| Telemarketing | Distribution |
| Stocks and Bonds | Account Management |
| Contract Management | Weather Forecasting |

The approach utilized in this analysis identified software releases that are comparable to the size and complexity of BellSouth – Wholesale Operations Releases. These releases were selected from the benchmark database by applying filters to the database. These filter are intended to reduce the total set of data in the database to only those releases, which provide a relevant and valid comparison. The filters are based on finding projects of comparable size, complexity, platform and development type. The filter process resulted in the average quality benchmark statistics used for comparisons throughout this report.

A second filtering process selected the top 10% of the filtered projects with highest quality rates. The result of this filtering process was the establishment of a subset of the Q/P database that was utilized to determine best-in-class benchmark quality rates.

For benchmarking purposes, Release Quality is based on the number of defects reported during the first 60 days of production and the release function point count. This is calculated by dividing the total number of defects reported against the release by the associated release function points (release defects/release function points). The defect per function point metric has been compared to software quality benchmarks that were selected from the database using the process described above. The intent behind this analysis is to determine the quality and stability of BellSouth Wholesale Operations software releases.

Establish Software Quality Assessment Report

The study results are documented in this benchmark report. The report summarizes the study findings related to software quality. In addition the report describes the study approach and methodology. Backup analysis and data are also provided as appropriate.

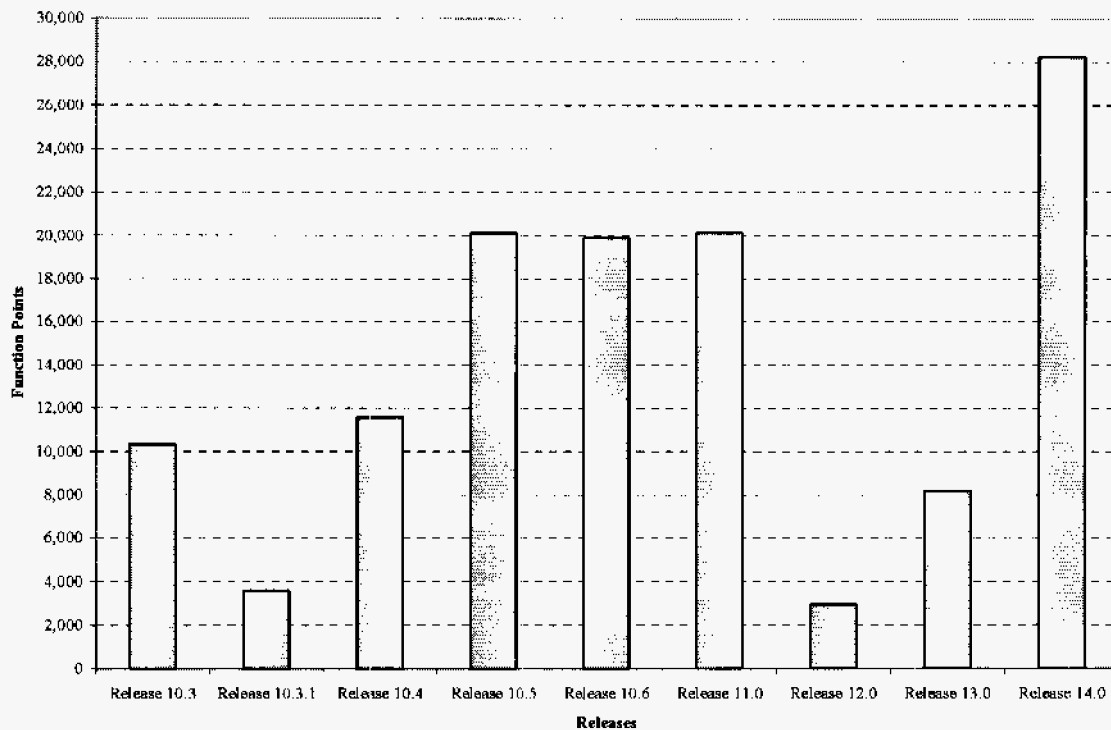
Findings

The following documents the findings resulting from the analysis of the data collected during the Software Quality Assessment study.

Software Quality Analysis

The following chart depicts the function point sizes of the Wholesale Operations Releases. The solid bar represents the function point size. Release 10.3, 10.4, 10.5, 10.6, 11.0, 12.0, 13.0 and 14.0 are major releases, Release 10.3.1 is a mini-release. (Note: The summarized data supporting the following analysis can be found in Appendix A of this report.)

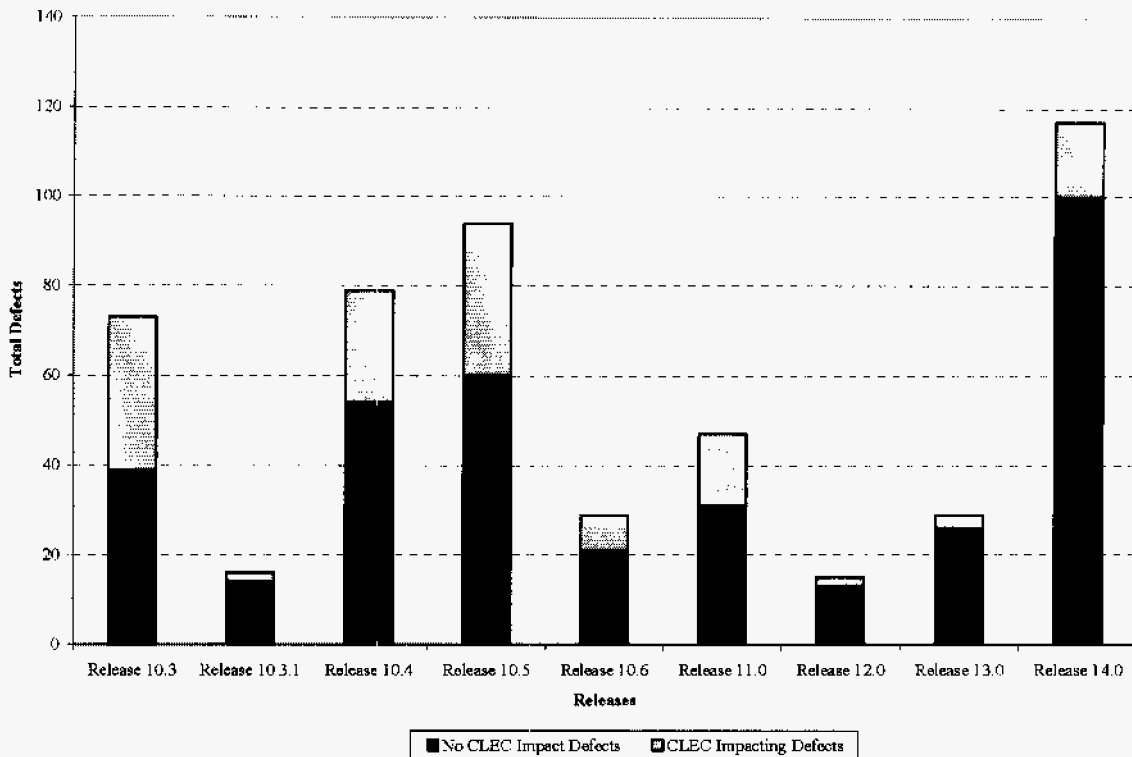
Chart 1 – Release Function Point Size



The chart above shows that the major releases have varied significantly in size over the analysis period. Release 14.0 represents the largest release contained in this software quality assessment report.

The following chart depicts the number of defects reported against the releases. The black portion of the bar represents defects that did not impact the Competitive Local Exchange Carriers (CLECs), the gray portion of the bar indicates the defects that impacted CLECs. There have been a total of 499 defects reported for these releases. Of the reported defects, 141 impacted CLECs.

Chart 2 – Release Defects by Type



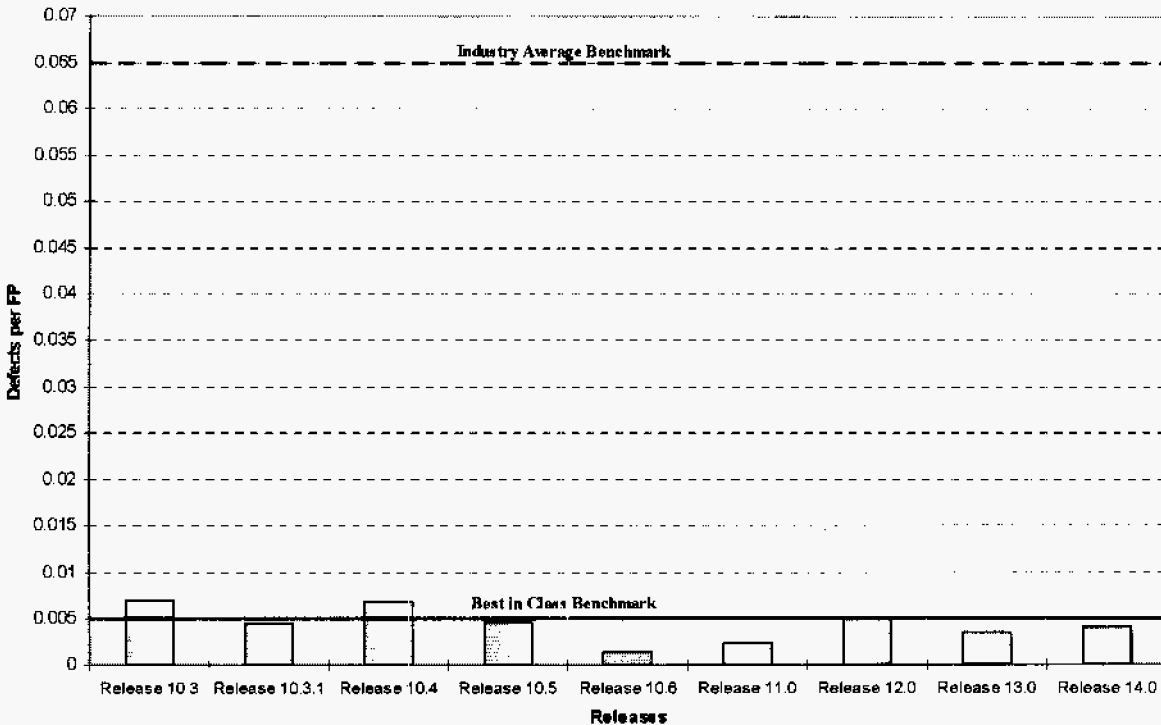
Comparing the two charts above it can be seen that the size of Release 10.5 is nearly twice the size of Release 10.3 (Release 10.3 = 10,313 FPs, Release 10.5 = 20,108 FPs). However the number of defects reported against Release 10.5 is only 30% greater than those reported against Release 10.3 (Release 10.3 = 73 Defects, Release 10.5 = 94 Defects). Release 10.6, which is also twice the size of Release 10.3, reported 60% less defects than Release 10.3 (Release 10.6 = 19,887 FPs and 29 Defects). Release 11.0 is similar in size to Release 10.6 (Release 10.6 = 19,887 FPs, Release 11.0 = 20,126 FPs) but it had 62% more defects than Release 10.6 (Release 10.6 = 29 Defects, Release 11.0 = 47 Defects). Release 12.0 is smaller than all of the other major releases (2,926 function points). Release 12.0 also had significantly fewer defects (15 defects) than the other major releases. Release 13.0 had the same number of defects as Release 10.6 (29 defects), however Release 13 is only 41% as large as Release 10.6 (Release 10.6 = 19,877 FPs, Release 13 = 8,175). Additional analysis indicates that Release 13 had fewer CLEC impacting defects (Release 10.6 = 8 CLEC defects, Release 13 = 3 CLEC defects). Release 14.0 is 40% larger than the largest release previously included in this analysis,

(Release 14.0 = 28,205 FPs vs. Release 11.0 = 20,126 FPs). Release 14.0 had more defects than any other release included in this assessment, (117 defects). However only 15% of the defects reported in Release 14.0 impacted the CLECs (17 CLEC related defects). Release 10.3.1 is a mini release that contains significantly fewer function points than a major release.

Release Quality is measured by calculating the total number of defects resulting from a Release during the 60 day period following its implementation and dividing these totals by the total number of function points delivered in the Release (release defects/function points). This ratio is compared to benchmark statistics for similar projects. The definition used by BellSouth to classify defects was reviewed and it was determined to be consistent with the definition used by Q/P to classify defects in the benchmark database.

The following analysis represents the defect per function point analysis for defects impacting CLECs and BellSouth Users. The gray bars represent the total defects per release function points. The industry average benchmark is indicated by the upper dashed line (-----). The lower solid line (_____) indicates the industry Best-in-Class benchmark.

Chart 3 – Release Quality (Defects/Function Point)



When compared to quality benchmarks, the quality of Wholesale Operations software releases is significantly better than industry average. All releases are at or very close to the Best-in-Class quality benchmark with the exception of Release 10.6 and 11.0, which are both significantly better than the Best-in-Class benchmark.

Conclusions

The Software Quality Assessment described above indicates that the quality of Wholesale Operations software releases is very good when compared to industry benchmarks.

- Software Releases 10.3 – 10.5 and Release 12.0, 13.0 and 14.0 are rated at Best-in-Class quality levels.
- Release 10.6 and Release 11.0 are rated as having significantly better quality than the Best-in-Class benchmark.
- Seven out of the nine releases (78%) included in this analysis had Best-in-Class or better than Best-in-Class quality.
- The majority of the defects reported had no impact on the CLECs.

Appendix A – Size and Quality Summary Data

The following chart contains the summary data used in this analysis.

Table 1 – Release Size and Defect Data

Release	Total Defects	Total FPs	Defects/FP	No CLEC Impact Defects	CLEC Impacting Defects
Release 10.3	73	10,313	0.00708	39	34
Release 10.3.1	16	3,569	0.00448	14	2
Release 10.4	79	11,576	0.00682	54	25
Release 10.5	94	20,108	0.00467	60	34
Release 10.6	29	19,887	0.00146	21	8
Release 11.0	47	20,126	0.00234	31	16
Release 12.0	15	2,926	0.00513	13	2
Release 13.0	29	8,175	0.00355	26	3
Release 14.0	117	28,255	0.00414	100	17
Industry Average Benchmark			0.0650		
Best-in-Class Benchmark			0.0050		