

**REGULATORY PERFORMANCE MEASUREMENT PLANS AND
THE DEVELOPMENT OF COMPETITIVE LOCAL EXCHANGE
TELECOMMUNICATIONS MARKETS**

by

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ABSTRACT

We analyze performance measurement plans (PMPs) that have been implemented in the telecommunications industry to ensure that the quality of wholesale services and unbundled network elements (UNEs) are provided to competitive local exchange carriers (CLECs) in a non-discriminatory manner by incumbent local exchange carriers (ILECs) and that CLECs are afforded a meaningful opportunity to compete in the provision of local exchange services. These plans were implemented as a means of promoting local exchange competition assuming that such competition would lead to improvements in consumer welfare. We show that existing PMPs may not be consistent with the development of an efficient local exchange market and that such plans, as currently designed: (i) result in taxes and subsidies that may distort economic decision making; (ii) provide little incentive for ILECs to continue to improve wholesale service quality; (iii) and have no defined relationship to changes in consumer welfare. We provide specific recommendations for measuring performance and structuring an appropriate remedy/reward structure that will move these plans toward ones that are based on sound economic principles.

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I. EXECUTIVE SUMMARY

In this paper, we examine the economic impact of regulatory-initiated performance measurement plans (PMPs) in terms of the evolution of competition in the local exchange telecommunications market and consumer welfare. To do this, we performed a detailed assessment of a representative PMP. Based upon this analysis, we developed recommendations for improving the structure of PMPs in general so that such plans are consistent with improving consumer welfare.

The Telecommunications Act of 1996 (TA96) fundamentally changed the regulatory paradigm for telecommunications markets in the U.S. by requiring that the local exchange telecommunications marketplace be opened to competition. To achieve this objective, Congress removed the legal and regulatory barriers to entry for competitive local exchange carriers (CLECs), and directed incumbent local exchange carriers (ILECs), and the Bell Operating Companies (BOCs) in particular, to provide CLECs with access to their networks and services. Two sections of TA96 – specifically sections 251 and 271 – provided the basis for the evolution of the PMPs that have since been implemented by regulators and applied to the BOCs. Importantly, TA96 itself did not require such performance measurement systems and remedy payment plans. The PMPs in place today are largely the result of negotiations between the BOCs and government regulatory agencies including state commissions and, to a lesser extent, the FCC and the DOJ.

All of the regional BOCs (RBOCs) – BellSouth, Qwest, SBC, and Verizon – have regulatory-based PMPs in place in some or all of the states in which they operate. PMPs are currently in place in the majority of states in the U.S. In structure, PMPs typically comprise: (i) a defined number of specific performance measures, (ii) a defined set of statistical tests for evaluating actual performance, and (iii) some type of liquidated damages remedy plan.

The exact number of performance measures in each PMP varies by RBOC and by state. Qwest has the lowest number of defined measures averaging about 30 per state. The number of measures for BellSouth, Verizon, and SBC vary by state and range from about 55 to several

hundred in a given state. For SBC in the State of Texas, 104 performance measures were identified in the PMP as of August 2002. The number of measures is a moving target because negotiations between ILECs and CLECs result in adding and deleting measures. Our analysis in this paper is based on performance data in Texas over the one-year period September 2001 through August 2002. Each of these measures has associated sub-measures, market areas, and CLECs, so counting the number of performance measures at an aggregate level is almost meaningless. In Texas, the level of tracking and reporting is at the sub-measure, market area, and CLEC level. For example, tracking a single performance measure in Texas (such as the percentage of ILEC-caused missed due dates for provisioning POTS and UNE-Ps) could balloon into tracking 5,280 measures once the sub-measures, market areas, and CLECs levels are counted.

RBOCs have large systems in place and spend millions of dollars annually to simply administer PMPs on a state-by-state basis. SBC tracked approximately 480,000 measures each month in the State of Texas alone over the one-year period – September 2001 through August 2002 – that we examined (*i.e.*, 220 CLECs multiplied by 2,182 sub-measures). To cover all 13 states in which it operates, SBC employs approximately 450 people to administer PMPs and spends about \$40 million annually.

The ultimate impact of PMPs, on final retail consumers is a result of complex interactions between wholesale markets (over which regulators have a reasonable amount of control) and retail markets (over which regulators have less control). As a yardstick to measure the goal of regulatory policy, PMPs are far from straightforward. An important issue is whether the current PMPs – designed as a first step toward meeting the regulatory goal of encouraging nondiscriminatory access to promote competition in the local exchange that results in increased consumer welfare – are grounded in solid economic principles. If not, such PMPs may inhibit the development of an efficient competitive local exchange market, reduce consumer welfare, and dampen the recovery of the telecommunications sector.

Based on our analysis, we conclude that PMPs as currently designed are not based on solid economic foundations. In particular: (i) the plans are overly detailed and provide numerous

wholesale service performance indicators, (ii) the associated remedy structure is asymmetric in that it includes remedies but no rewards; (iii) the remedy/reward amounts do not reflect consumer harm or value; and (iv) all aspects of the statistical testing are not applied to all measures or to all CLECs resulting in discriminatory treatment across CLECs (*i.e.*, all CLECs may not be treated equally).

PMPs, as currently designed, can result in ILECs making remedy payments to CLECs despite providing acceptable wholesale service quality (*i.e.*, ILECs are taxed and CLECs are subsidized). Such PMP-induced taxes and/or subsidies can result in increases in the number of inefficient competitors in the local exchange market, and increases in the exit of efficient competitors. The ultimate impact will be a reduction in consumer welfare; precisely the opposite of the intended effect.

We propose five specific recommendations for improving the structure of PMPs. First, we recommend replacing the current system of numerous and highly specific performance measures with a broad-based index approach to measuring wholesale service quality, such as an index approach. When a regulatory goal is narrow, it may be appropriate to adopt pointed and specific regulatory measures. However, when the regulatory goal is broad-based (such as the case here), it is inadvisable for regulators to micro-manage firms by focusing excessively on detailed means to achieve the broad-based goal. Under an index approach, one or two wholesale service quality index values are computed, tested, and reported for each CLEC. The index approach is consistent with sound incentive regulation policy because it allows the regulated firm (*i.e.*, the ILEC) flexibility in deciding how to meet a goal. The preferred index approach is analogous to price cap regulation where the ILEC has the freedom to set relative retail prices as long as the cap is not exceeded. This is in contrast to a regulatory scheme that places a separate price ceiling on each retail service. This movement away from micro-regulation of ILEC decision making was, and still is, viewed as a major benefit of price cap regulation. The index approach also allows the ILEC to respond to varying CLEC demands for wholesale service quality, and therefore, can expand the opportunity set for CLECs seeking to compete in local exchange markets. The index approach greatly reduces the number of statistical tests and associated

statistical errors that occur when multiple measures are tested for a CLEC. Finally, the burden of associated reporting (by ILECs) and reviewing (by CLECs) of results is greatly reduced.

Second (and related to our first recommendation), if an index approach is not adopted, we strongly recommend including a Type I error adjustment mechanism in the current PMPs that applies to all measures. A Type I error occurs when an ILEC is judged to be non-compliant based on a statistical test even when it delivers the same level of service quality to its competitors as it delivers to itself (or meets the benchmark). When testing multiple performance measures for a CLEC, as is the case with PMPs, the likelihood of one or more Type I errors occurring for a given CLEC is extremely high. PMPs currently include a mechanism to account for Type I errors such as the “K table” in Texas and in many other states. The K table reduces, but does not eliminate, Type I errors. Based on simulation results in Michigan, for example, during a one-month period (*i.e.*, January 2003), SBC will make erroneous remedy payments (*i.e.*, SBC will be judged “non-compliant” even though it provided parity service to a CLEC) to 11% of the CLECs with the K table in effect and to 86% of the CLECs without the K table in effect. Hence, a mechanism to adjust for Type I errors when multiple measures are tested for a CLEC is critical to PMPs that are based on the testing of individual performance measures.

Third, regardless of whether the index approach is adopted or the testing of individual measures continues, we recommend implementing a “stopping rule” for PMPs. A troublesome aspect of these plans is the large number of performance measures for which statistical tests are performed based on fewer than 10 observations. Importantly, the Type I error adjustment mechanism is fully or partially excluded for these measures. Our concern is that, with the large number of measures that fit into this category (about 46% of the measures tested in Texas and about 56% in Michigan), the statistical testing may lead to a high percentage of erroneous test results. The consequences of this are significant: CLECs that fit this profile (which tend to be smaller niche players) are likely to be treated differently (in terms of receiving remedy payments) than other CLECs. These smaller CLECs may game the PMP system and base their business upon receipt of payments from ILECs based on statistical errors. Given the very high percentage of tests that fall into this category, we recommend implementing a “stopping rule.” Under such a rule, the measure is not tested until a pre-specified number of service requests is reached (such as 10 or

30). Then, a Z test can be used for statistical testing. If an index approach is adopted, we still recommend excluding measures in the index with fewer than 10 observations.

Fourth, we recommend incorporating symmetry into the plans. On balance, based on our analysis of the one-year period in Texas, SBC provides “super-compliant” service to CLECs much more often than it provides “non-compliant” service to CLECs. However, due to the asymmetric nature of the plans (*i.e.*, ILECs are penalized but not rewarded), SBC pays remedies to CLECs even though SBC provides outstanding service. We recommend that PMPs include a system of remedies and rewards (or credits), through which ILECs are penalized for “non-compliant” service and rewarded for “super-compliant” service. When the ILEC pays a remedy for non-compliant service, the result is that the CLEC appropriately receives a wholesale service quality discount. Likewise, when the ILEC receives a credit for providing super-compliant service, the result is that the CLEC appropriately pays a wholesale service quality premium. Such remedies or rewards could be calculated as discounts below or premiums above the regulated wholesale price.

Fifth, we strongly recommend that the actual dollar amounts of remedies and rewards be more closely aligned with the harm or value of the level of wholesale service quality provided to CLECs, and ultimately to final retail consumers. Under the current PMPs, remedies may be assigned either using a single amount for all measures (*e.g.*, as in Michigan) or using high, medium, and low remedy amounts (*e.g.*, as in Texas). We recommend that regulators consider quantifying the remedy (and reward) amounts in line with value, either based on empirical analysis or other methods. Such an approach will result in appropriate economic signals to ILECs and CLECs.

PMPs are exceptionally important in ensuring non-discriminatory access to CLECs, ensuring that ILECs do not favor their affiliated retailers or sabotage their downstream rivals, and ultimately increasing local competition so that more choices and lower prices are available to consumers. However, as in the antitrust arena, the appropriate yardstick for measuring regulatory success is the change in consumer welfare, and not the number of CLECs in the local exchange market or the increase in the CLECs’ market share. Thus, basing the design of PMPs

on a sound economic foundation is essential if PMPs are to be an effective means for promoting local exchange competition and, ultimately, for improving consumer welfare.

II. INTRODUCTION

Over the past seven years, both federal and state regulators have expended a great deal of effort implementing the Telecommunications Act of 1996 (TA96 or “the Act”). One of the primary objectives of TA96 was the introduction of competition into the local exchange telecommunications marketplace assuming that such competition would increase consumer welfare.¹ To achieve this objective, in part, the Act required incumbent local exchange carriers (ILECs) to: (i) allow competitive local exchange carriers (CLECs) to interconnect to ILEC networks, (ii) unbundle certain elements of their networks and allow CLECs to purchase unbundled network elements (UNEs),² and (iii) sell their retail telecommunications services to CLECs at a wholesale discount thereby allowing CLECs to sell these services to customers at competitive prices (resale). The Act required that the ILEC provide these services on a nondiscriminatory basis. These unbundling and network requirements were intended to allow CLECs to compete for customers without having to build their own complete networks.³ Regulators have focused their efforts on the implementation of policies to ensure that the interconnection, UNEs, and resold services that ILECs provide to CLECs are nondiscriminatory.

¹ Increasing the number of competitors in a market is not a regulatory objective in itself. The desired effects of increasing the competitiveness of a market are increases in consumer choice, product offerings, and service quality as well as a reduction of prices. These benefits contribute to improvements in consumer welfare.

² For example, ILECs are required to make the loops in their networks available for use by CLECs. A loop is a transmission line that connects a customer’s premise with the central office of the telephone company.

³ The Act anticipated three modes of CLEC competition: (1) CLECs might purchase ILEC retail services at a wholesale discount and resell these services (which is referred to as resale); (2) CLECs might purchase unbundled network elements and combine them with their own facilities (which is referred to as UNEs), or use unbundled network elements to provide an end-to-end service which is commonly referred to as UNE-platform or UNE-P; and (3) CLECs might employ their own facilities to service their customers, and simply interconnect with the ILECs. In this paper, “wholesale services” refers to the services or elements that CLECs might employ in pursuing the first two modes of operation.

A performance measurement plans (PMP)⁴ is one type of regulatory initiative that evaluates the ILEC's provision of wholesale services (*i.e.*, resale, UNE-Ps, or UNEs) to CLECs. Typically, PMPs are included in interconnection agreements between the Bell Operating Companies (BOCs) and CLECs, that have been approved by regulators as part of the process for ILECs to obtain long distance relief (*i.e.*, as part of proceedings under section 271 of TA96), or are the outcome of negotiations among various parties regarding proposed mergers.⁵ In these instances, the BOCs agreed to meet certain standards concerning their performance in wholesale markets, and also to pay remedies in cases where the standards are not met.⁶

Regulators adopted a remedy mechanism to ensure that ILECs comply with interconnection or merger agreements. As a result, the prices that ILECs charge CLECs for wholesale services are reduced when ILECs fail to meet the PMP standard (*i.e.*, the remedy is a discount off the wholesale price).⁷ By implementing such safeguards for non-discriminatory treatment of CLECs, the regulators' goal was to enhance consumer welfare by increasing the level of competition in the local exchange market. The link between increases in competition and increases in consumer welfare is based on the assumption that new competitors are efficient and do not benefit from false economic signals such as subsidies or transfer pricing. However, flaws in the design and/or implementation of PMPs could result in inefficiencies in the local exchange market. Inefficiencies occur when ILECs make remedy payments to CLECs despite providing acceptable wholesale service quality (*i.e.*, ILECs are taxed), or when CLECs receive remedy payments even when they are receiving acceptable service quality (*i.e.*, CLECs are subsidized). PMP-induced taxes and/or subsidies could result in increases in the number of inefficient

⁴ In this paper, we are addressing PMPs that are part of the regulatory process (*e.g.*, a 271 process, a merger process, or an interconnection agreement). "Performance measurement" and "performance management" are also terms that refer to systems internal to a company to measure and improve operations which is not the subject of this paper.

⁵ By 2002, as a result of mergers or buyouts, only four of the original seven regional bell operating companies (RBOCs) remained – BellSouth, Qwest, SBC, and Verizon.

⁶ Such agreements are generally referred to as PMPs or Performance Measurement and Remedy Plans. The remedies (or penalty payments) associated with these plans are in the form of "liquidated damage" payments to affected CLECs, voluntary payments to state treasuries, or both.

⁷ Throughout this paper, we use the term wholesale services to refer to either the services (*i.e.*, resale) or elements (*i.e.*, UNEs or UNE-P) provided by the ILEC that CLECs might employ in providing retail telecommunications services.

competitors in the local exchange market, and increases in the exit of efficient competitors. The ultimate impact will be a reduction in consumer welfare; precisely the opposite of the intended effect. Appropriately designed regulatory-based PMPs are particularly important in the environment of declining investment and job losses that the telecommunications industry currently faces. The recovery of the telecommunications sector will depend on a variety of fundamental economic factors; this includes regulation that stresses the promotion of economically efficient competition. Therefore, regulators must be exceptionally careful in designing and implementing PMPs.

The difficulties of measuring consumer welfare or changes in consumer welfare are well-known.⁸ A straightforward way to think about measuring changes in consumer welfare in telecommunications, for example, is to determine whether the ultimate users of the service (*i.e.*, final retail consumers) are “better off” as a result of a regulatory action; that is, have consumers accrued positive net benefits (*i.e.*, the dollar value of benefits minus costs) as a result of the specific regulatory action. Accurately gauging such benefits requires information from consumers and resources to gather and compile the information for quantifying benefits.⁹

In this paper, we develop an economic argument that consumer welfare is increased when regulators: (1) apply broad-based performance measures, as opposed to the numerous detailed performance measures that currently are applied by many state commissions in monitoring the provision of wholesale service quality; (2) impose a system of incentive payments that includes both remedies and rewards; and (3) base the incentive payment amounts on the harm or value to the ultimate final consumer.¹⁰ We base our analysis on the economic premise that an efficient allocation of resources is a necessary condition for increasing and/or optimizing consumer welfare. We also assume that local exchange retail providers are competitive and efficient, and

⁸ See Chapter 1 in P. R. G. Layard and A. A. Walters, *Microeconomic Theory*, McGraw-Hill Book Company, New York, NY. 1978.

⁹ Such benefits have been quantified in other areas such as environmental benefits assessment, health benefits assessment, and the value of electric service reliability. With the availability of the internet for reaching consumers, this type of information is easier to obtain now than it was in the past.

¹⁰ In this paper, we use the terms final consumers and retail consumers interchangeably to refer to consumers of retail telecommunications services from both ILECs and CLECs.

that consumer welfare is influenced by wholesale prices and wholesale service qualities to CLECs.¹¹

In this paper, we investigate the optimal structure for such regulatory-driven PMPs, and offer recommendations for the practical implementation of such an optimal structure. In Section II, we provide an overview of the genesis of PMPs, discuss our understanding of the regulatory objectives underlying the use of these plans, and summarize the plans that are in effect in the U.S. In Section III, we describe the PMP process. This includes a discussion of the structure of the local exchange telecommunications market and the process by which regulatory-based PMPs influence consumer welfare. In Section IV, we describe the key components of a representative performance measurement plan (*i.e.*, we use the Performance Remedy Plan in the Texas 271 Interconnection Agreement (the Texas Plan),¹² and assess this plan relative to the achievement of regulatory goals. We also provide three recommendations for moving a PMP such as the Texas Plan toward one that is firmly based on sound economic principles. In Section V, we introduce the practical steps that need to be taken to implement such a PMP. Section VI concludes and identifies next steps.

III. GENESIS OF PERFORMANCE MEASUREMENT PLANS

In this section, we discuss the regulatory genesis of PMPs, the overall regulatory goals and objectives underlying the development of PMPs, and the general characteristics of these plans. In the remainder of the paper, we explore whether (or not) PMPs facilitate the likely achievement of these regulatory goals and objectives.

¹¹ Wholesale prices and service qualities affect retail prices and service qualities. In this paper, we focus solely on wholesale service quality measurement and recognize that, in the U.S., wholesale prices are set in proceedings by regulators separately from wholesale service qualities.

¹² This is a state commission-approved interconnection agreement for the State of Texas. See Attachment 17: Performance Remedy Plan and Appendices in Interconnection Agreement between Southwestern Bell Telephone, L. P. d/b/a Southwestern Bell Telephone Company and CLEC. January 15, 2002. The conclusions that we draw in this paper are based on performance data for the State of Texas obtained in November 2002 for the period September 2001 through August 2002.

A. TELECOMMUNICATIONS ACT OF 1996

TA96 fundamentally changed the regulatory paradigm for telecommunications markets in the U.S. by requiring that the local exchange telecommunications marketplace be opened to competition. To achieve this objective, Congress removed the legal and regulatory barriers to entry by CLECs, and directed ILECs, and the BOCs in particular, to provide CLECs with access to their networks and services. Two sections of the TA96 – specifically sections 251 and 271 – provided the basis for the evolution of the PMPs that have since been implemented by regulators and applied to the BOCs. The design and development of the current PMPs are largely the result of negotiations between the BOCs and various government regulatory agencies. Importantly, TA96 itself did not require such performance measurement systems and remedy payment plans.

Section 251 of TA96 required that ILECs provide CLECs with interconnection and UNEs, as well as other wholesale telecommunications services on a nondiscriminatory basis.¹³ Section 271 of TA96 provided the guidelines under which the BOCs – unquestionably the largest of the ILECs – could obtain permission from the Federal Communications Commission (FCC) to enter the long distance market, after they demonstrated that their local exchange markets had been opened to competition. The nondiscrimination requirements of section 251 were incorporated into section 271, and took on two meanings, depending on the context. First, when the BOC is providing a wholesale service to CLECs for which there is a retail analogue, nondiscrimination means that the BOC must provide wholesale services to the CLEC in substantially the same time and manner as it provides those same services to itself or an affiliate (*i.e.*, at *parity* with retail).¹⁴ Second, in cases where there is no retail equivalent (*e.g.*, OSS interface availability), then the BOC must provide wholesale services to the CLECs in a manner that provides an efficient competitor with a meaningful opportunity to compete. In the context of the PMPs, when there is no retail equivalent, the BOCs are required to provide CLECs with wholesale services at a predetermined level of performance (*i.e.*, an established benchmark).

¹³ See Federal Communications Commission, The Telecommunications Act of 1996. FCC 96-325. August 1, 1996.

¹⁴ Recall that we are using the term wholesale services to refer to either the services (*i.e.*, resale) or elements (*i.e.*, UNEs or UNE-P) provided by the ILEC that CLECs might employ in providing retail telecommunications services.

The notion of creating PMPs was first introduced in negotiations between BOCs and CLECs shortly after TA96 became law, and some of the early interconnection agreements contained PMPs.¹⁵ Subsequently, in its order approving the SBC/Ameritech merger, the FCC required a PMP as a condition of the merger approval. Shortly thereafter, in its order granting section 271 relief in New York, the FCC determined that the existence of a PMP would constitute probative evidence that the BOC would continue to meet its section 271 obligations and that its entry would be in the “public interest.” As a result, all section 271 applications approved by the FCC after New York contained some form of PMP that had been approved by a state commission. These plans involved defining performance measures, testing performance for compliance with parity or a benchmark, and defining associated remedies for non-compliance. The result of this process is that each BOC is responsible for tracking, testing, reporting, and potentially paying remedies based on PMPs that include numerous performance measures at a very detailed level and that often vary by state. For an ILEC such as SBC, for example, a PMP is in place in each of the 13 states in which it operates.¹⁶

B. REGULATORY OBJECTIVES

As a means of promoting local exchange competition assuming that such competition would increase consumer welfare, PMPs were developed to encourage ILECs to provide CLECs with nondiscriminatory access to (i) the wholesale components of the ILEC’s local exchange telecommunications network and (ii) resold retail telecommunications services.

¹⁵ For example, in October of 1999, the Public Utility Commission of Texas (PUCT) approved the Texas 271 Interconnection Agreement. The FCC approved the application in June 2000 and Southwestern Bell Telephone (SWBT) began offering interLATA long distance service to its local exchange customers in July 2000. The PUCT implemented performance measures because the PUCT wanted to ensure that parity and a meaningful opportunity to compete would be ongoing after 271 approval. The measures were the result of collaboration between SWBT, the Texas CLECs, the Department of Justice (DOJ), and PUCT staff.

¹⁶ For example, SBC operates local exchange businesses and has PMPs in place in 13 states - the Southwestern Bell region (*i.e.*, Texas, Kansas, Oklahoma, Arkansas and Missouri), the former Ameritech region (*i.e.*, Michigan, Illinois, Indiana, Ohio, and Wisconsin), California, Nevada, and Connecticut. In the State of Texas alone (1 of the 13 states), over a one-year test period between September 2001 and August 2002, SBC tracked performance for over 200 CLECs and conducted statistical tests and reported on over 100,000 performance measures. The number of underlying transactions for these tested measures was almost 5 billion.

Fundamental to microeconomics is the premise that competition can serve consumers well.¹⁷ In focusing on increasing levels of competition as a means to increase consumer welfare, regulators assumed that competitors were economically efficient. However, the benefits of competition can be lost if firms are inappropriately subsidized or taxed. Under such conditions, inefficient firms that are inappropriately subsidized may survive, and least-cost firms that are inappropriately taxed may be forced to exit the market.

This lesson in market fundamentals is important to the design of regulatory-based PMPs. If the goal of the regulators is to increase consumer welfare by facilitating economically efficient competition in the local exchange market, it is critical that distortions which might advance (and potentially sustain) inefficient competition not be introduced.¹⁸ Therefore, it is critical that PMPs be designed thoughtfully. To avoid such distortions, we recommend that PMPs be based on five underlying principles:

- The performance measures should be clear and non-repetitive, the number of measures and sub-measures should be parsimonious, and the relationship between each measure and the achievement of a competitive local exchange market should be understood.
- The testing of measures should be based upon statistically sound principles, accounting for the type of measure, the number of observations, and potential errors.
- The incentives should be symmetric,¹⁹ in that remedies are assessed when wholesale service quality below parity or benchmark levels is provided and

¹⁷ As described in most microeconomics textbooks, the market pressures associated with such competition force high-cost providers to cease production and exit the market, while the remaining providers innovate with pricing and product offerings that improve the welfare of consumers.

¹⁸ An example of this is when an ILEC is required to make an erroneous remedy payment to a CLEC due to a PMP design flaw. In this case, the CLEC is inappropriately subsidized and the ILEC is inappropriately taxed. If this occurs with some frequency (*i.e.*, such as monthly), the PMP design may result in encouraging the entry of CLECs that may not be viable businesses in the absence of the design flaw (*i.e.*, the firms are inefficient). In such a case, the PMP design results in a larger number of CLECs but actually decreases consumer welfare (rather than increasing it) because of the entry of inefficient firms. This example demonstrates why increasing consumer welfare is an appropriate regulatory goal but simply increasing the number of competitors is not an appropriate regulatory goal.

¹⁹ See *Designing Incentive Regulation for the Telecommunications Industry*, by David E. M. Sappington and Dennis L. Weisman. MIT Press and AEI Press. Cambridge, MA and Washington, DC. 1996.

rewards (or credits) are assessed when wholesale service quality above parity or benchmark levels is provided.²⁰

- Incentives (*i.e.*, remedies or rewards) should accurately reflect the wholesale service quality provided and should not occur when parity or benchmark service is provided.
- Incentive amounts for wholesale service quality performance should be tied to retail consumer harm or value demonstrated by empirical evidence.

C. GENERAL CHARACTERISTICS OF PERFORMANCE MEASUREMENT PLANS

All of the regional BOCs (“RBOCs”) - BellSouth, Qwest, SBC, and Verizon - have regulatory-based PMPs in place in some or all of the states in which they operate. PMPs are currently in place in the majority of states (over 40) in the U.S. In structure, PMPs typically comprise: (i) a defined number of specific performance measures, (ii) a defined set of statistical tests for evaluating actual performance, and (iii) some type of liquidated damages remedy plan. For some PMPs, remedy payments to the state treasury are also included. These plans are quite similar in overall design but vary in the details. In this section, we generally describe the characteristics of the plans in terms of performance measures, statistical testing, and incentive payment structure.

1. Numbers and Types of Performance Measures

A performance measure is a summary indicator (*e.g.*, a mean, a percentage, or a ratio) of the quality of a single wholesale service provided by an ILEC to a specific CLEC. Examples of performance measures include the percent of missed due dates for provisioning loops for residences or businesses; the percent of installation trouble reports for provisioning a telephone line; the mean time to restore telephone service; and the percentage of blocked calls for interconnection trunks. However, focusing on performance measures, *per se*, does not accurately portray the size of a PMP because, as described below, a single measure can balloon into thousands of measures to track, test, and report.

- A number of sub-measures are typically defined for each performance measure, corresponding to the different wholesale products provided, the type of customer,

²⁰ The wholesale provider should receive some level of incentive to provide exceptional service to CLECs; (*i.e.*, treat CLECs as another class of customer) if CLECs and retail consumers derive value from such service quality.

and other factors. Importantly, the tracking (and statistical testing and reporting) of these measures occurs at the sub-measure level rather than at the measure level. For example, in the Texas Plan, the performance measure “percent of ILEC-caused missed due dates for provisioning plain old telephone service (POTS) and UNE-Ps” (*i.e.*, measure #29) has six sub-measures. Four sub-measures that are tracked for provisioning POTS (*i.e.*, residential fieldwork, residential non-fieldwork, business fieldwork, and business non-fieldwork) and two sub-measures that are tracked for provisioning UNE-Ps (*i.e.*, fieldwork and non-fieldwork).²¹ Hence, this single measure has six sub-measures.

- In addition, in many states, specific types of performance measures (such as provisioning and maintenance measures), are tracked (and statistically tested and reported) at the market area level rather than at the state level. The Texas Plan, for example, has four defined market areas.²² So, for the single measure (*i.e.*, #29) in this example, the total number of “tracked” sub-measures for a *single* CLEC is 24 (*i.e.*, 6 sub-measures by 4 market areas).
- Finally, furthering our example, these 24 sub-measures are tracked for each CLEC. In the State of Texas, for example, 220 CLECs operated during a one-year test period between September 2001 and August 2002. Hence, tracking this single performance measure by sub-measure, market area, and CLEC has ballooned into tracking 5,280 measures.

The exact number of performance measures varies by RBOC and by state. Qwest has the lowest number of defined measures averaging about 30 per state. The number of measures for BellSouth, Verizon, and SBC vary by state and range from about 55 to several hundred in a given state. For SBC in the State of Texas, 104 performance measures are identified in the PMP.²³ As stated above, because each of these measures has associated sub-measures, market areas, and CLECs, counting the number of performance measures at an aggregate level is almost meaningless.²⁴

²¹ A UNE-P or a UNE-platform is the use of an unbundled loop and an unbundled port combined by an ILEC with no CLEC-owned facilities to provide an end-to-end service.

²² This was the number of market areas in the Texas Plan between September 2001 through August 2002. The State of Michigan, for example, also has four defined market areas.

²³ This was the number of measures in the Texas Plan during a one-year test period, September 2001 through August 2002, over which *The Brattle Group* evaluated the Texas Plan.

²⁴ Taking into account all of the sub-measures, CLECs, and market areas, PMPs track, statistically test, and report on a very large number of sub-measures each month which typically requires a dedicated staff and information technology resources. Section IV provides details on the specific numbers of measures that are tracked and tested in the Texas Plan.

The number of performance measures and the level of dis-aggregation have two significant economic consequences. First, because regulators are concerned about the provision of services on a nondiscriminatory basis for each CLEC, PMPs must have the capability to track, test, and report performance for all sub-measures and market areas by CLEC. As a result, RBOCs have large systems in place and spend millions of dollars annually to administer PMPs.²⁵

Second, PMPs do not include an economic rationale underlying the selection and priorities given to performance measures. As a result, in the current PMPs, a large number of measures are included and all are treated as being equally important. In reality, some are far more important to ILECs and CLECs than others. A system that includes more than the critical set of measures and/or treats all measures the same may send the wrong economic signals to both ILECs and CLECs.

2. Statistical Testing

In addition to defining specific performance measures, PMPs include defined test statistics for assessing whether parity and/or a meaningful opportunity to compete has been achieved by the ILEC in providing specific wholesale services to each CLEC.²⁶ These test statistics are defined by a particular statistical test and a defined confidence level and are typically applied to individual performance measures.²⁷

²⁵ As an example, SBC tracked approximately 480,000 measures each month in the State of Texas over the one-year test period (*i.e.*, 220 CLECs multiplied by 2,182 sub-measures). To cover all 13 states in which it operates, SBC employs approximately 450 people to administer PMPs and spends about \$40 million annually.

²⁶ It is difficult to measure perfectly the level of service quality that an ILEC delivers. Observed performance generally provides useful, but not perfect, information about the level of service quality delivered. This is because, even if an ILEC delivered the same level of service quality in provisioning a service 100 times, the observed provisioning times will typically vary. This is the case because factors other than service quality influence provisioning time. Therefore, even when an ILEC delivers the same level of service quality in provisioning a service, a range (or distribution) of provisioning outcomes (rather than a single outcome) will be observed due, in part, to random variation. Consequently, assessments of the relative service quality that the ILEC delivers to its competitors and to itself require the comparison of two distributions of provisioning outcomes – the distribution of outcomes that the ILEC provides to a CLEC and the distribution of outcomes that the ILEC provides to itself. Statistical hypothesis testing is used to determine whether the two distributions differ from each other.

²⁷ The exception is the Verizon PMP in New York State. See Performance Assurance Plan, Verizon New York, Inc. January 2003.

Under most plans, each individual performance measure is statistically tested using either parity or a benchmark standard.²⁸ The specific statistical test may vary depending on whether the performance measure is a mean, a proportion, or a rate. For example, a Z test is typically used to test the difference between two means for parity service and a Z test is also used in some states to test whether a benchmark value has been achieved. In some states Fisher's Exact test is used to test proportions and rates while in other states a Z test is used. Most states use permutation tests when testing measures with small numbers of service requests.²⁹

Based on our review of plans currently in place for BellSouth, Qwest, SBC, and Verizon, most of the existing performance plans are based (primarily) on statistical testing of individual performance measures (*i.e.*, one-by-one testing of measures) as described above. A notable exception is the Verizon plan in the State of New York which utilizes an index of performance measures in five categories that correspond to modes that CLECs use to enter the local exchange market.³⁰ Each of these indexes includes performance measures that are critical to that particular mode of entry.

The confidence levels for the statistical tests (*i.e.*, 1.0 minus the significance level or error rate) vary across plans.³¹ In some states, levels are set at 95 percent for certain types of measures

²⁸ Under the parity standard, the service that SBC provides to a CLEC is (statistically) compared to the service that SBC provides to its retail arm. That is, the two distributions are compared and tested to determine whether they are different. Under the benchmark standard, the service that SBC provides to a CLEC is (statistically) compared to a benchmark.

²⁹ Typically a permutation test is used when the number of service requests from a CLEC in a given measurement period (typically a month) is less than 30. This is a frequent occurrence. For example, in the State of Texas, over a one-year test period between September 2001 and August 2002, about 62 percent of the statistical tests were performed for measures with 30 or fewer service requests. More remarkably, about 46 percent of the statistical tests were performed for measures with fewer than 10 service requests. Likewise, in Michigan (where statistical tests are performed for parity measures only), 71 percent of the statistical tests on parity measures were performed for measures with fewer than 30 service requests over a three-month period between November 2002 and January 2003. Again, and even more remarkably, about 56 percent of the statistical tests were performed for measures with fewer than 10 service requests.

³⁰ See the "Mode of Entry" measurements method in the Performance Assurance Plan, Verizon New York, Inc. January 2003.

³¹ The chosen confidence level defines the significance level or the likelihood of a Type I error. If a statistical test is defined with 95% confidence, then the likelihood of a Type I error is 5%. For a parity test of two "means" or averages for a single performance measure, this results in the following. If we drew an infinite number of samples from the two populations (*i.e.*, the ILEC population and the CLEC population)

(e.g., BellSouth) or 95 percent for all measures (e.g., SBC in Texas and Michigan). In California, confidence levels vary based on sample size, aggregate results across all CLECs, and repeated failures.³² For Verizon in New York State, Z scores are converted into performance scores and minimum and maximum thresholds are set. The Verizon plan also incorporates a three month view of performance; performance scores for a given month can change based on performance in the following two months.³³

Statistical testing is accompanied by the possibilities of Type I and Type II errors.³⁴ Typically, an increase in a Type I error will result in a decrease in a Type II error. A Type I error is, by definition, the significance level defined for the test. Hence, because the significance levels vary in some states, the probability of Type I errors also varies. As a result of the large number of statistical tests performed for each CLEC and the increased probability of one or more Type I errors in the case of multiple tests, many plans include a correction for this increased likelihood of one or more Type I errors.³⁵ For example, in several of the states in which SBC operates, a “K table” is included to correct for the Type I error problem resulting from multiple comparisons (*i.e.*, multiple statistical tests for one CLEC) in the PMPs. The purpose of the K table is to reduce toward 5 percent (but not eliminate) the likelihood of one or more Type I errors when

and examined the difference between the two sample means, then 5% of the time we would get observed differences in the sample means that would lead to an incorrect conclusion that the ILEC has failed the parity test when, in fact, it has not failed the test. This incorrect conclusion is the Type I error.

³² See Decision 02-03-023, Opinion on the Performance Incentives Plan for Pacific Bell Telephone Company and Appendices A through K. Before the Public Utilities Commission of the State of California. March 6, 2002.

³³ See Performance Assurance Plan, Verizon New York Inc. January 2003.

³⁴ A Type I error occurs when an ILEC is judged to be non-compliant when it is, in fact, compliant. A Type II error occurs when an ILEC is judged to be compliant when it is, in fact, non-compliant. For a discussion of the costs of Type I and Type II errors, see Jan Kmenta, Chapter 5, Section 5-1, Elements of Econometrics. MacMillan Publishing Company, New York, NY. 1971.

³⁵ In the case of multiple statistical tests, if each test has a significance level of 0.05 (*i.e.*, 5%), then the combined probability of at least one Type I error is much greater than 0.05 and increases as the number of tests increases. For example, for 10 tests with a significance level of 0.05, the probability of at least one Type I error is less than or equal to 0.50 (allowing for mutually exclusive tests). To correct for this, a Bonferroni correction or some other mechanism to account for Type I errors in the case of multiple comparisons is typically used. See George W. Snedecor and William G. Cochran, Statistical Methods, Eighth Edition, Iowa State University Press. 1989. pps 115-117.

multiple statistical tests are performed.³⁶ The K table includes a specified number of measures which are “forgiven” due to Type I errors (*i.e.*, when SBC is judged to be non-compliant when it is, in fact, compliant) as well as the specific Z value to use in conducting the tests. The plans applied to Qwest include a table with varying critical Z values depending on the number of performance measures tested for a CLEC,³⁷ and the plans applied to BellSouth include an approach for balancing Type I and Type II errors.³⁸

3. Incentive Payment Structure

Incentive payment structure refers to (i) the types of incentives and (ii) the incentive amount. PMPs with a symmetric incentive payment structure would include two types of incentives: remedies for failure to provide nondiscriminatory access to CLECs (*i.e.*, non-compliance) and rewards for exceeding compliance targets. In practice, no PMPs have a symmetric incentive structure; PMPs include remedy provisions only. These are often referred to as “remedy payments” or “performance penalties.” Remedies are applied when an ILEC is judged to be non-compliant on a particular performance measure for a CLEC. Remedies take the form of liquidated damages or bill credits and are sometimes designed in a two-tiered fashion. Tier 1 remedies follow a particular schedule tied to a performance measure and the number of consecutive failures and are payable directly to the CLECs. Tier 2 remedies typically are paid directly to the state treasury after some number of consecutive failures on individual measures or are based on overall performance to CLECs. None of the PMPs that we are aware of include a

³⁶ Notice that the likelihood of one or more Type I errors can be very high when multiple tests are performed as is the case for PMPs. As a simple example, suppose that SBC delivers parity service to a CLEC on 10 measures in a given month. The Texas Plan is designed so that the probability of a Type I error on each measure is 5 percent (given parity performance). In this setting, the probability that a Type I error will occur on one or more of the measures tested may be as high as 0.50 (equal to 0.05×10) or 50 percent. Thus, even though the probability of a Type I error on an individual performance measure is 5 percent, the probability that one or more Type I errors will occur when 10 measures are tested can be as high as 50 percent (this means that a CLEC with only 10 measures has a very high chance of getting a remedy payment even when SBC provides parity service). The K table noted in the text reduces toward 5 percent (but does not eliminate) the probability that SBC will be required to make payments to a CLEC despite providing parity service to the CLEC.

³⁷ Qwest Post Entry Performance Plan Final Collaborative Summary. May 30, 2001.

³⁸ See, for example: (1) BellSouth Florida Plan, Self-Effectuating Enforcement Mechanism Administrative Plan. AJV PM Affidavit Exhibit PM-20. Version 2.6; and (2) BellSouth Alabama Plan. Self-Effectuating Enforcement Mechanism Administrative Plan. Alabama Exhibit PM-19. Interim – Version 1-5.

reward component to be credited to the ILEC for exceeding performance targets or providing exceedingly high performance to CLECs.

The amount of the remedy payment in the PMPs reviewed appears to be an arbitrary value (*e.g.*, in Michigan, the remedy payment amount is the same value for every single measure and in Texas the remedy payment amount takes on one of three values), rather than a value related to retail consumer harm. This is a serious limitation of the current plans.

In the next section, prior to providing an assessment of a specific PMP, we provide a general description of the PMP process and how it influences consumer welfare.

IV. THE PMP PROCESS

In this section, we introduce the process through which PMPs influence consumer welfare. Similar to many regulatory initiatives, the path through which an initiative influences marketplace behavior may be indirect and time-lagged. Therefore, a discussion of the process through which PMPs affect consumer welfare is important. We begin with a discussion of the concept of consumer welfare. Next, we describe the structure of the local exchange telecommunications market. We conclude with a discussion of how regulatory-based PMPs ultimately influence consumer welfare.

A. CONSUMER WELFARE

The critical starting point for designing a PMP is the regulator's objective of maximizing the welfare of retail consumers. The welfare of retail consumers is the relevant regulatory objective for at least two reasons.³⁹ First, TA96, the legislation that led to the creation of PMPs, adopts this objective. Its Preamble not only makes clear the consumer welfare goal in terms of service quality but underscores the role of competition in achieving the goal:

³⁹ Profits earned by all firms are included in a measure of total welfare since they will find their way into household income and in that way boost consumer welfare.

“To promote competition and reduce regulation in order to secure *lower prices* and *higher quality* of services for American telecommunications consumers ...”
(emphasis added)

Second, the consumer welfare objective enjoys considerable support in U.S. antitrust practice. It is widely agreed that enforcement of antitrust laws should be judged by their effectiveness in promoting the interests of retail consumers. The well-worn mantra is that: “antitrust laws protect competition, not competitors.” TA96 and antitrust enforcement share the view that competition is a means of promoting consumer welfare and not an end in itself. PMPs are a *means* of promoting local exchange competition. However, the ultimate yardstick for measuring success is the change in consumer welfare, and not the number of CLECs in the local exchange market or the increase in the CLECs’ market share.

In local exchange markets, regulators recognize that the quality of wholesale services is an important determinant of retail competition. Accordingly, regulators have pressed for PMPs that penalize ILECs who favor their affiliated retailer or who “sabotage” their downstream rivals. While the implications of such asymmetric treatment frequently are not spelled out, the presumption is that consumers will be harmed if similar competitors are treated differently.^{40,41}

When adopting a consumer welfare objective, the regulator’s problem is to maximize consumer welfare constrained by equilibrium in wholesale and retail markets.⁴² However, achieving

⁴⁰ It should be noted that downstream retailers can differ in subtle ways, and these differences may justify asymmetric treatment by the ILEC wholesale provider. Retailers’ choices about which technologies to adopt and which retail services to market lead to different derived demands for wholesale service qualities. Efficient unregulated markets will recognize these differences in the transactions that take place between wholesaler and retailers.

⁴¹ Regulatory rules may also be the source of discriminatory treatment of firms. This can occur when the rules result in inappropriate subsidies to CLECs.

⁴² An alternative approach to the design of PMPs would be to characterize a social optimum for wholesale and retail markets, and then devise a procedure that induces firms to move toward that outcome in an iterative fashion. By analogy, “Ramsey prices” solve the problem of maximizing social welfare when a multi-product monopolist satisfies demands. The challenge is to induce a monopolist to set those prices voluntarily. Under certain conditions, there are iterative mechanisms that encourage a regulated firm to adopt Ramsey prices. See Vogelsang and Finsinger, “A Regulatory Adjustment Process for Optimal Pricing by Multiproduct Monopoly Firms,” *Bell Journal of Economics*, Vol 10 (1), Spring 1979, pp.157-171. and David E. M. Sappington, “Strategic Firm Behavior Under a Dynamic Regulatory Adjustment Process,” *The Bell Journal of Economics*, Vol. 11 (1), Spring 1980, pp. 360-372. Those mechanisms share

improvements in consumer welfare is not necessarily a straight-forward task because the ultimate effect on consumers is a result of complex interactions between wholesale markets (over which regulators have a reasonable amount of control) and retail markets (over which regulators have less control).

B. WHOLESALE AND RETAIL MARKET STRUCTURES

Delivery of local exchange service to an end-use consumer frequently involves the participation of wholesale and retail providers. We assume a single, integrated provider of wholesale network services and retail services (*i.e.*, the ILEC). We further assume that the ILEC provides wholesale services⁴³ to all retailers (*i.e.*, the CLECs as well as the ILEC's retail division).⁴⁴ The ILEC's retail division depends on the same network services as those provided to the CLECs. To keep the discussion simple, we assume each retailer provides a single retail service though the quality of each service may vary across retailers. Label the single ILEC retailer as $k = 0$, and assume there are K CLECs labeled $k = 1, \dots, K$.⁴⁵ Further, label the wholesale services as $j = 1, \dots, J$.

As discussed earlier, PMPs are designed to measure the quality of wholesale services provided by the ILEC because wholesale service quality affects retail prices, retail service qualities, and (ultimately) consumer welfare. However, retail service quality is not entirely determined by wholesale quality. The retailer's actions as well as randomness also affect retail service quality. Likewise, wholesale service quality cannot be controlled perfectly by the ILEC. Both the ILEC's actions as well as randomness affect wholesale service quality.^{46,47}

features with the better-known "price cap schemes" used to regulate electric power utilities and local exchange companies. The difficulty in this case is that there is no well accepted model of how wholesale and retail quality variation affect consumer welfare in telecommunications markets and the incentives that will move firms to the optimum.

⁴³ As defined earlier, wholesale services refer to either services or unbundled network elements that CLECs might employ in providing retail services (*e.g.*, a local loop is an unbundled network element).

⁴⁴ We use the term "retailers" to refer to both the CLECs and the ILEC's retail operations, and assume that the market is composed of efficient providers.

⁴⁵ In a more general formulation of the PMP design problem, we would allow for an arbitrary number of CLECs.

⁴⁶ To illustrate, consider the time taken to provision a local loop. If the ILEC provisions a large number of loops that are seemingly identical, observed provisioning times will nevertheless vary. This is the case because factors other than service quality influence realized provisioning time. Relevant factors that are

Realized wholesale quality is denoted by v_{jk} ; the realized quality of wholesale service j provided to retailer k by the ILEC. Retail quality is denoted z_{jk} . Retail service quality depends on the realized quality of wholesale services purchased by a retailer (v_{jk}) and the associated efforts (e_{jk}) of individual retailers.⁴⁸ We include e_{jk} because, by devoting effort, CLECs have an opportunity to mitigate some of the possible disadvantage that might arise from non-compliant ILEC wholesale service quality by making material contributions to the quality of their own retail services.

C. ROLE OF PMPs IN LOCAL EXCHANGE MARKETS

We summarize the PMP process in the flowchart in Figure 1. The process starts with the regulation of wholesale prices and qualities, and ends with retail consumer purchase decisions which affect consumer welfare. Specifically, the process includes six steps:

1. Regulators set the price for each wholesale service provided by the ILEC to the CLECs and also set a PMP which includes a remedy structure.
2. The ILEC devotes resources to ensure delivery of wholesale services (to CLECs and to its retail divisions) at acceptable levels of quality.

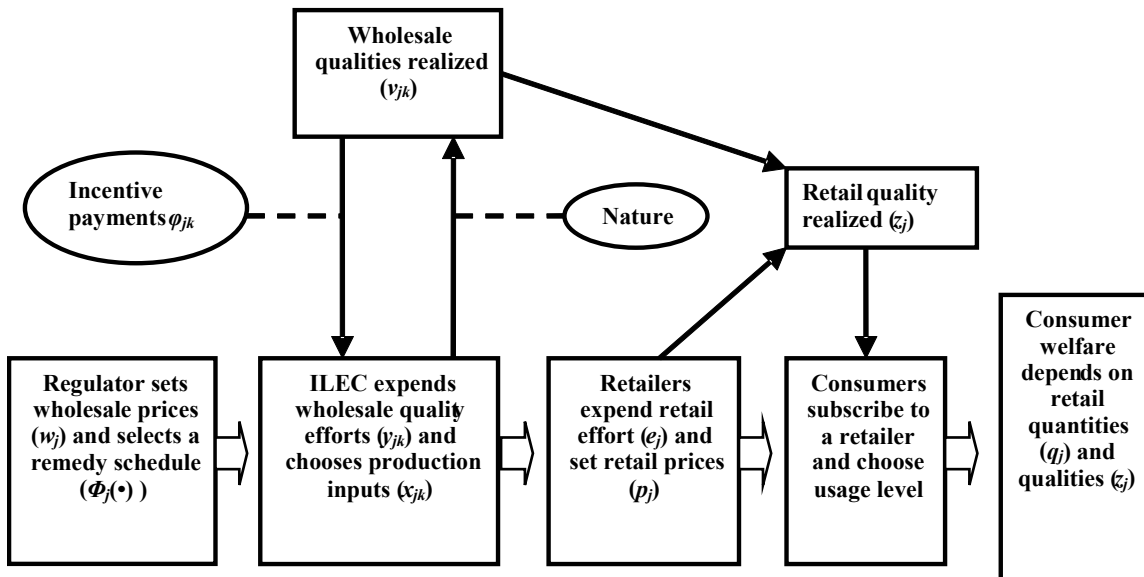
difficult or impossible for an ILEC to anticipate or control include unavoidable equipment failures, an unanticipated dramatic increase in provisioning requests, or even adverse weather conditions. Therefore, even when an ILEC delivers the same level of service quality in provisioning a loop, a range (or distribution) of outcomes (rather than a single outcome) will be observed.

⁴⁷ In our formulation of the PMP design problem, we do not allow for retailers to affect the realized quality of wholesale services. However, in reality, the quality of an ILEC's wholesale service quality may be affected by the retailer. For example, if a CLEC is not punctual in making meeting times or if it supplies inaccurate technical information, the quality of the ILEC's wholesale service may be affected.

⁴⁸ We deliberately separate the wholesale service quality provision from the production of wholesale and retail quantities. A retailer's individual choice of quality effort (e_{jk}) affects retail quality but does not alter the quantity produced (say q_k). The quantity produced is determined completely by the retailers' choice of wholesale input quantities (x_{jk}) according to a standard production function (e.g., $q_k = F_k(x_{1k}, \dots, x_{jk})$). For example, suppose that a CLEC requests local loops from an ILEC to use with that CLEC's own local switches. The quality of wholesale services would depend, among other factors, on the design and reliability of the line card installed by the ILEC. Nevertheless, the quantity of local loops is likely to be constant regardless of the quality of the line card.

3. The quality of wholesale service is realized by retailers (as service requests are made). Quality is influenced (but not completely determined) by the ILEC's expenditure on the service.
4. Regulators assess ILEC remedy payments based on the remedy structure and on the wholesale quality actually realized.
5. Retailers choose retail quality efforts that, together with wholesale qualities, determine retail qualities; retailers then set their retail prices to maximize profit.
6. Consumers make purchase decisions based on retail prices and qualities.

Figure 1: PMP Flowchart



In this process, we assume that consumers are retail price and quality takers, and are perfectly informed. Consumers maximize “utility” (or welfare) which results in a final demand for each retailer’s service as a function of that retailer’s prices and qualities. Consumer demand for an individual retailer’s services also depends on the prices and qualities of rival CLECs, as these

rivals offer close substitutes. Market demand for each retailer's services is simply the sum of all consumer demands.

Retailers compete by setting retail prices and choosing quality efforts. The outcome of this competition is a Nash equilibrium, which exists when each competitor sets its price and quality in order to maximize its profit,⁴⁹ taking as given all of its rivals' price and quality effort decisions. Ordinarily, if retail quality improves for one retailer, it increases that retailer's demand and profit (due to increased sales and/or higher prices), and reduces the demand and profit of its rivals. The solution to each retailers' profit maximization problem (where profits include all relevant incentive payments) defines a set of equilibrium retail prices and quality efforts $\{p_k^*, e_{jk}^*\}$. This generates each retailer's demand for wholesale services provided by the ILEC. When summed up across retailers, this is the derived market demand for each wholesale service provided by the ILEC.

Regulators influence consumer welfare by ensuring non-discriminatory access and facilitating the delivery of wholesale service qualities at levels that would be demanded in a competitive market. This can be accomplished through an appropriately designed PMP. The challenge to regulators is to select a remedy structure that maximizes expected, aggregate consumer welfare.⁵⁰ This means that the regulator has to find the remedy structure that results in equilibrium retail prices and retail and wholesale service qualities that maximize expected consumer welfare.⁵¹

A remedy structure associates an "incentive payment" by the ILEC with observed wholesale service qualities, v_{jk} , for the complete set of J wholesale services and for each of the $K + I$

⁴⁹ A retailer's profit is the difference between its revenues and costs, and includes any incentive payments paid to the CLEC by the ILEC (or in the case of rewards, CLEC payments made to the ILEC).

⁵⁰ We use expected aggregate consumer welfare because the remedy schedule is chosen before wholesale quality is known. We form a measure of aggregate consumer welfare by weighting all consumers equally.

⁵¹ For simplicity, assume a remedy structure that is linear in performance measures. This may not be a serious limitation since, at least locally, a linear remedy approximates a more general schedule—though the degree of accuracy of the approximation depends on specific conditions.

retailers (recall that the ILEC retailer is defined as $k = 0$).^{52,53} Under a symmetric remedy structure, remedy payments are made (by the ILEC) when the average quality of the wholesale service supplied to the ILEC's retail division is judged to be better than the average quality supplied to a CLEC and reward payments are received (by the ILEC) when the average quality of the wholesale service supplied to a CLEC is judged to be better than the average quality supplied to the ILEC's retail division.

So far, we have described incentive payments based on the average quality provided of a specific wholesale service. Most (but not all) PMPs use this approach. As described in the next section, an alternative approach is a remedy structure where the incentive payment depends on an index of wholesale service quality (see, for example, Performance Assurance Plan, Verizon New York, Inc. January 2003). In addition, we have described a symmetric incentive structure that includes both remedies and rewards. Existing PMPs are asymmetric in that they include remedies but not rewards. As described in the next section, the asymmetry of PMPs has economic consequences.

In summary, regulatory-based PMPs ultimately influence consumer welfare. However, the path for doing so is complex, in part due to the nature of the local exchange market structure. An important issue is whether the current PMPs (designed as a first step toward meeting the regulatory goal of encouraging nondiscriminatory access to promote competition in the local exchange that results in increased consumer welfare) are grounded in solid economic principles. If not, taking subsequent steps to modify these plans is a crucial for the telecommunications industry.

In the next section, as an illustrative example, we provide an overview and specific assessment of SBC's Performance Remedy Plan in the State of Texas based on one year of performance

⁵² An incentive payment by the ILEC to its affiliated retailer is a wash, unless the ILEC retailer operates as a separate profit center, in which case such payments could have an effect on the bottom line operation of that division.

⁵³ We assume that the regulator can observe the realized wholesale service quality without error, and that the qualities are "verifiable," meaning that if a disagreement should arise over a value, an impartial third party (e.g., a court) could verify the true value.

data, September 2001 through August 2002.⁵⁴ We conclude with opportunities for moving toward a plan that is more firmly based on sound economic principles.⁵⁵

V. OVERVIEW AND ASSESSMENT OF THE TEXAS PLAN

In this section, we provide an overview and assessment of SBC's Performance Remedy Plan in the State of Texas (*i.e.*, the Texas Plan) based on one year of performance data, September 2001 through August 2002. The Texas Plan was one of the earliest PMPs and serves as a model for plans in other states where SBC operates. Also, PMPs that are in effect for other RBOCs have many of the same features as the Texas Plan. Therefore, we believe that an assessment of the Texas Plan will highlight the problems associated with PMPs in general and inform discussion concerning the modifications of such plans to support regulatory goals.

A. THE TEXAS PERFORMANCE PLAN

In the State of Texas, the Public Utility Commission of Texas (PUCT) voted to support Southwestern Bell Telephone's⁵⁶ (SWBT's) section 271 application in October 1999. Subsequently, the FCC approved SBC's section 271 application for Texas in June 2000 and SWBT began offering interLATA long distance service to its local exchange customers in July 2000. The PUCT implemented performance measures to ensure that CLECs would be provided wholesale services at parity and be given a meaningful opportunity to compete. The measures tracked performance in the following areas: (1) pre-ordering, (2) ordering, (3) provisioning, (4) maintenance, (5) interconnection, (6) collocation, (7) coordinated conversions, (8) billing, (9)

⁵⁴ As stated earlier, these data were obtained in November 2002 and provide a one-year snapshot of performance in Texas between September 2001 and August 2002. It is our understanding that performance data are sometimes updated and modified. However, to avoid a moving target, we have not updated or modified our database.

⁵⁵ See Attachment 17: Performance Remedy Plan and Appendices in Interconnection Agreement between Southwestern Bell Telephone, L. P. d/b/a Southwestern Bell Telephone Company and CLEC. January 15, 2002. This plan originally was due to expire in October 2003 but has been extended into the early part of 2004.

⁵⁶ SWBT is an SBC operating telephone company in Texas. We also refer to SWBT as SBC throughout this paper.

database accuracy, and other areas.⁵⁷ These performance measures are reviewed every six months by SBC, CLECs who receive wholesale services from SBC, and the PUCT staff to ensure that they adequately measure SBC's provision of wholesale telecommunication service to CLECs.⁵⁸

The Texas Performance Remedy Plan (*i.e.*, the Texas Plan) includes defined performance measures, the statistical tests that are applied to these measures, and the remedy structure for unacceptable performance. The Texas Plan includes both parity and benchmark performance measures. Parity performance measures compare the service that SBC provides to a CLEC with the service it provides to its own retail customers. In contrast, benchmark measures compare the service that SBC provides to a CLEC with a specified standard typically because SBC does not provide this service to itself. For example, the benchmark values for performance measures related to local number portability are based on industry specified guidelines.

The PUCT adopted a remedy structure in the Texas Plan, in an effort to deter SBC from not fulfilling its obligation to provide CLECs with nondiscriminatory interconnection, and access to UNEs and resold services. The Texas Plan requires SBC to make payments in the form of "liquidated damages" to affected CLECs, and "assessments" to the Texas State Treasury, depending upon the violation, the type of performance measure, and the frequency. The Texas Plan does not include any provision that credits SBC for better than parity or benchmark performance; that is, there is no reward (in the form of a credit, for example) to SBC if SBC exceeds the performance targets set by the PUCT.

As noted previously, remedy payments follow a two-tiered structure. Tier 1 measures are "customer affecting" and paid directly to the CLECs each month if SBC fails to provide parity or benchmark service on a particular measure. Tier 2 measures are "competition affecting" and are

⁵⁷ Some performance measures are statewide and some are tracked and tested in each of the four market areas in Texas where SWBT operates: (1) Houston, (2) Dallas/Fort Worth, (3) Central and West Texas, and (4) South Texas.

⁵⁸ The regulatory goal of the Texas Performance Remedy Plan was to provide sufficient incentives for SWBT to provide high level wholesale service to CLECs and disincentives for SWBT to engage in anti-competitive behavior after obtaining 271 relief.

paid directly to the Texas State Treasury if SBC fails to provide parity or benchmark service on a set of measures for three consecutive months. Payment amounts are classified as low, medium, or high based on the assumed impact on the CLECs and competition. As part of the Texas Plan, SBC is required to file monthly performance measurement reports that provide the results for all performance measures for each CLEC.⁵⁹ The term of the current Texas Plan originally expired on October 13, 2003 but has been extended through early 2004.⁶⁰

The Texas Plan has been and continues to be widely replicated as part of a standard interconnection agreement in other states, including Kansas, Oklahoma, Arkansas, and Missouri, where the FCC has approved SBC's applications for section 271 relief. The Texas Plan also serves as a model for PMPs in the former Ameritech states (*i.e.*, Illinois, Indiana, Michigan, Ohio, and Wisconsin), which are now part of SBC.

The current Texas Plan has mushroomed into a very large performance tracking, testing, and reporting system that has the following characteristics:⁶¹

- At an aggregate level, 104 performance measures are currently tracked in Texas. However, this aggregate number of measures does not paint an accurate picture of the extent of the performance measurement system.
- Taking into account both paying and non-paying measures, the disaggregation to sub-measures, and the four market area disaggregation (for many measures), the number of performance sub-measures that potentially could be tracked for a single CLEC in Texas (*i.e.*, the number in the Texas Plan) is 2,182. Of these, 1,286 (about 60 percent) are paying measures and 896 are non-paying measures.⁶²

⁵⁹ As described later in this section, the tracking of the measures, the performance testing, and the reporting of the performance results in Texas alone is a very large undertaking that requires devoted staff.

⁶⁰ See Report to the 78th Texas Legislature, "Scope of Competition in Telecommunications Markets of Texas." January 2003. Page 40

⁶¹ This summary is based on performance and remedy data that *Brattle* received in November 2002 from SBC for a one-year test period in Texas, September 2001 through August 2002. Occasionally performance and remedy data are updated and re-stated. However, any restatements beyond November 2002 are not included in our analysis.

⁶² Note that both paying and non-paying measures are tracked but only paying measures are subject to remedies. Non-paying measures may be new measures in a diagnostic period or measures that the ILEC or the CLECs want to monitor.

- The number of performance sub-measures in the Texas Plan designated parity or benchmark is 1,963. Of these, about one-third are parity measures (36 percent) and two-thirds are benchmark measures (64 percent).
- SBC tracked performance for 220 CLECs over the one-year test period. Of these, SBC tracked performance on paying performance measures for 171 CLECs.
- Taking into account statewide measures, market area measures, and company measures, SBC statistically tested over 100,000 performance sub-measures that were subject to potential remedies (*i.e.*, paying measures) over the one-year test period, September 2001 through August 2002. As noted above, many more measures are tracked and reported but are not subject to remedies
- A performance measure is a summary indicator (such as an average or a percentage) of the quality of a specific wholesale service provided. The total number of service requests or transactions associated with any type of performance measure (*i.e.*, paying or non-paying) over the one-year period was 13.4 *billion!* (specifically, 13,383,576,137). The number of transactions for paying measures was 4,873,408,071, or 36.4 percent of all transactions.

B. SBC'S PERFORMANCE UNDER THE TEXAS PLAN

Despite the voluminous nature of the Texas Plan, based on our analysis of the one-year test period, SBC managed to provide an exceedingly high level of performance to CLECs and often provided “super-compliant” service to CLECs.⁶³ Taking into account both benchmark and parity paying measures (*i.e.*, measures subject to remedies), SBC was about 6 times more likely to provide super-compliant service than non-compliant service to CLECs.⁶⁴ Examining only parity paying measures, SBC was about 2.3 times more likely to provide super-compliant service than non-compliant service to CLECs. Finally, of the 4.9 billion transactions that occurred on paying measures, SBC made remedy payments on only 0.01 percent of the transactions over the one-year test period. In other words, for those performance sub-measures where SBC is subject

⁶³ Wholesale service quality can fall into one of three categories: compliant, non-compliant, or super-compliant. Compliant service occurs when the service that SBC provides to the CLEC is (statistically) not significantly different than the service SBC provides to its own retail customers or to its own retail arm (or not significantly different from the benchmark). Non-compliant service occurs when the service that SBC provides to the CLEC is (statistically) significantly worse than the service that SBC provides to its own retail arm or (statistically) significantly worse than the benchmark. We define super-compliant service as the opposite of non-compliant service. Super-compliant service occurs when the service that SBC provides to the CLEC is (statistically) significantly better than the service that SBC provides to its own retail arm or (statistically) significantly better than the benchmark. Super-compliant service is not measured under the current Texas Plan.

⁶⁴ *Ibid.*

to potential remedy payments, SBC either met or exceeded parity or the benchmark standard 99.99% of the time, and “failed” on only 1 in 10,000 opportunities.

C. ASSESSMENT OF THE TEXAS PLAN

As discussed above, the Texas Plan was the first plan applied to SBC and served as a model for plans in the other states where SBC operates.⁶⁵ Also, performance plans that are in effect for other RBOCs have many of the same features as the Texas Plan (*e.g.*, the New York State plan for Verizon). We believe that an assessment of the Texas Plan will allow us to identify issues associated with PMPs in general, and will serve to inform discussion concerning the maintenance of the current set of PMPs or modifications of these plans to support overarching regulatory goals.

In assessing the plan, we asked whether the implementation of the Texas Plan is likely to increase consumer welfare in Texas. We did not attempt, however, to model and/or quantify the change in consumer welfare.⁶⁶ Instead, our assessment was based on whether the Texas Plan provides the appropriate signals and incentives to CLECs and ILECs to advance the development of an efficient competitive local exchange market.⁶⁷ Specifically, we looked at whether the plan resulted in accurate economic signals to ILECs and CLECs by:

- Assessing the specific measures applied in the plan, and asking whether the measures provide *meaningful indicators* that reflect factors the ILEC can control;
- Assessing whether the plan provides the *appropriate incentives* for the ILEC to provide access on a nondiscriminatory basis, as well as incentives for the ILEC to

⁶⁵ Many of the states in which SBC operates – Southwestern Bell states and the former Ameritech states – have similar plans to Texas. However, it is not feasible to analyze all of these plans due to the sheer size of the databases. Hence, in the ensuing discussion, we focus our analysis on Texas, since plans in many states are modeled after the Texas Plan. However, when necessary to make a point, we also refer to the Michigan plan (which provides an example of a plan in a former Ameritech state).

⁶⁶ It is well known that consumer welfare is very difficult to measure. One way to measure a change in consumer welfare in the context of local exchange markets is to define two states of the world such as before and after a regulatory change, such as the implementation of PMPs for wholesale services, and measure the change in net benefits to consumers as a result of changes in local telecommunications retail services provided and associated prices. We did not attempt this.

⁶⁷ Economic efficiency refers to an efficient allocation of resources, so that no one (*i.e.*, ILECs, CLECs, or final retail consumers) can be made better off without making someone else worse off.

continually improve the quality of its wholesale services;⁶⁸ and, whether remedies or rewards accurately reflect the costs and benefits of non-compliant or super-compliant performance, respectively. Inappropriate remedies and/or rewards can distort market signals and inadvertently tax or subsidize ILECs or CLECs;

- Assessing the *accuracy of the statistical tests* the plan employs to measure whether nondiscriminatory service has been provided; that is, the extent to which remedies or rewards are assessed erroneously or based on a CLEC characteristic rather than the quality of wholesale service delivery. Inaccuracies in remedies, for example, can inadvertently tax or penalize ILECs, and subsidize CLECs.

1. Meaningful Indicators

As described above, the Texas Plan is very detailed and includes numerous performance measures. For instance, over the one-year test period, SBC statistically tested 103,129 performance measures in the State of Texas. Each month, 2,182 individual performance measures are tracked and potentially measured for each CLEC in Texas. This level of disaggregation strongly suggests that ILEC performance is micro-managed.

When regulatory goals are very specific, it may be appropriate to focus performance measures on equally specific activities.⁶⁹ However, when regulatory goals are broad-based – which is the case in the use of PMPs to encourage access on a nondiscriminatory basis and ultimately to promote competition in the local exchange that results in an improvement in consumer welfare – it is inadvisable to micro-manage the firm by focusing excessively on particular means to achieve the goal. Doing so can compel the regulated firm to focus its efforts unduly on particular activities, even though those activities are not the best means for achieving the ultimate goal. Furthermore, it can engender a specific kind of CLEC entry designed to take advantage of the particular focus. That is, it can encourage gaming and/or entry of inefficient providers.

⁶⁸ Recall that we are using the term “wholesale services” to refer to the ILEC’s provision of wholesale services and/or unbundled network elements.

⁶⁹ See, for example, Chapters 5 and 6 in *Designing Incentive Regulation for the Telecommunications Industry*, by David E. M. Sappington and Dennis L. Weisman. MIT Press and AEI Press. Cambridge, MA and Washington, DC. 1996

A broader approach can better induce the regulated firm to employ its superior knowledge of its business environment to achieve regulatory goals.⁷⁰ To illustrate this general point, suppose the ultimate goal set by a regulator is for the regulated firm to decrease production costs. The regulator could specify the particular means by which the firm must reduce its costs, but the regulated firm itself typically is in the best position to decide how best to reduce these costs. In such a case, the regulator should reward the firm for securing cost reductions however that firm may choose to do so (within the constraints of lawful actions and without diminishing its quality of service), rather than specifying the particular steps that the firm must take to reduce costs.

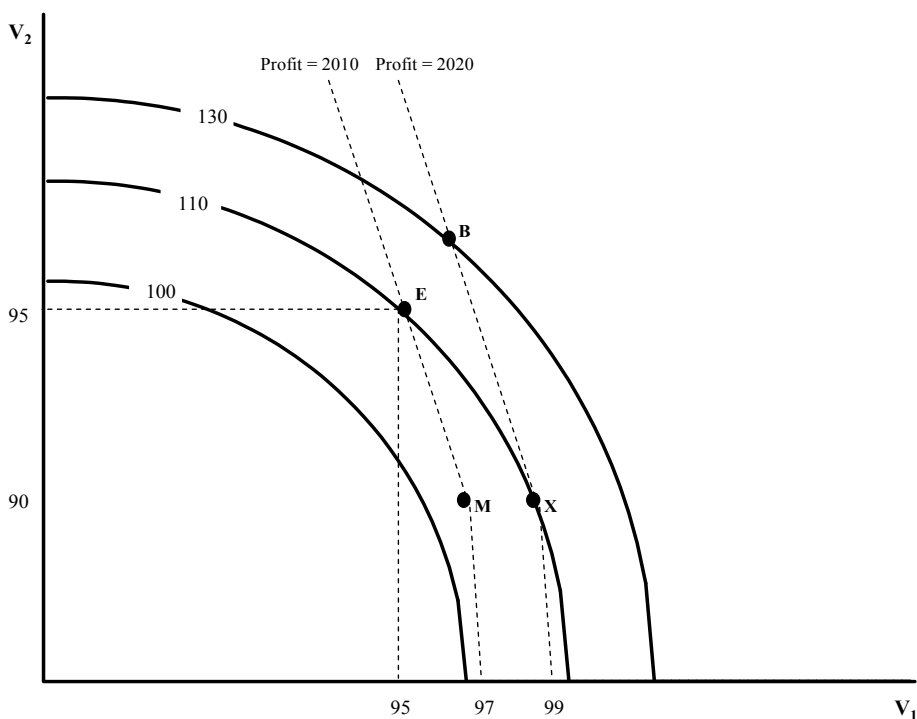
More specifically, consider the simple example illustrated in Figure 2 where the ILEC provides two wholesale service qualities, V_1 and V_2 , to the CLECs. Assume that these services have benchmark values of 95 percent in the performance measurement plan (*e.g.*, a benchmark value of 95 percent typically means that the ILEC must complete the activity being measured within the specified time interval 95 percent of the time.) For example, for the performance measure, “installations completed within the customer requested due date” in the Texas Plan, orders for the installation of 1-10 BRI loops must be completed within 4 business days 95 percent of the time. If SBC provides this service 100 times, then it must complete the BRI loop installation in 4 or fewer days for least 95 orders (or service requests) to meet the benchmark.

Figure 2 shows three ILEC production possibility frontiers that represent different quality combinations of V_1 and V_2 that can be produced with resource expenditures of \$100, \$110, and \$130, respectively.⁷¹ Figure 2 also shows two iso-profit curves representing profit levels of 2,010 and 2,020 to the CLECs. Along any iso-profit curve, any mix of V_1 and V_2 will provide the same profit to the CLECs.

⁷⁰ *Ibid.*

⁷¹ This example is based on a retail service example in Sanford V. Berg and John G. Lynch, Jr., The Measurement and Encouragement of Telephone Service Quality. *Telecommunications Policy*, April 1992.

Figure 2. Relative Valuations of Quality Dimensions V_1 and V_2



At point E, CLECs value V_1 more than V_2 as indicated by the slope of the iso-profit curve (*i.e.*, CLECs are just as well off at point M as at point E when V_1 is equal to 97 and V_2 is equal to 90). Note that, for the same resource expenditure (*i.e.*, \$110), higher benefits (*i.e.*, profits to the CLECs in this example) will be obtained at point X than point E. However, under the current PMPs, ILECs are encouraged to provide service at point E or to the northeast of point E. A regulatory incentive system that allows an ILEC to adjust its mix of V_1 and V_2 to respond to CLEC relative value and provide services at point X provides an improvement in CLEC profit.⁷² Thus, CLEC profitability (and presumably consumer welfare) may be increased when ILECs are able to respond to CLEC demands, as opposed to following the behavior prescribed by regulators. Although calibrating specific benchmarks for each CLEC (based on relative values of different services) is theoretically possible, it is not practical or reasonable to implement.

⁷² For this example, we assume that CLEC demand for wholesale service quantities and qualities is influenced by consumer demand for retail services and qualities so that an increase in CLEC profits increases consumer welfare.

Hence, a broader-based regulatory performance measurement plan, such as an index approach (which reflects overall business processes and focuses on overall wholesale service quality rather than relying on individual measures) is one method for achieving the flexibility that will allow an ILEC to adjust its mix of wholesale service qualities in response to a CLEC's (and ultimately final retail consumers) relative value.

There is a second and equally important reason why attempting to micro-manage ILEC performance by measuring a large number of performance measures individually may be dangerous. Micro-management may produce unintended consequences. That is, although regulators may intend for the combination of the various ILEC performance incentives to yield an efficient competitive local exchange market, the economic impact of the underlying activity being measured (*i.e.*, the provision of wholesale service quality) on local exchange competition and ultimately on retail consumer welfare is highly complex.

To our knowledge, to-date there has been no economic analysis of the impact of “poor” performance (*i.e.*, performance that does not meet the parity or the prescribed benchmark) on a CLECs’ ability to compete and ultimately on consumer welfare. Rather, the underlying assumption is that such “poor” performance affects CLECs individually and affects competition (and ultimately consumer welfare) in general. However, it is highly unlikely that each activity being measured affects CLECs’ ability to compete or retail consumer welfare in an identical or near-identical way. Yet, this assumption of uniform response is precisely what the present Texas Plan presumes.⁷³ Thus, the present plan may tax the ILEC unnecessarily and/or subsidize CLECs unduly, and thereby distort key economic decisions. For example, considering Figure 2 again, assume the ILEC provides wholesale quality of V_1 equal to 97 and V_2 equal to 90 at point M. If the performance plan requires the ILEC to provide a mix of wholesale quality at point E (95 of V_1 and 95 of V_2), then the ILEC will be unnecessarily taxed for failing to meet the

⁷³ The Texas Plan presumes that failure to meet a performance measure (despite the different dimensions that define a measure) has three possible dollar values as reflected by the low, medium, and high remedy amounts in the plan and that each measure is equally important in terms of statistical significance levels for hypothesis testing. In some states, such as Michigan, all remedy amounts are set at a single level. In other states, such as California, significance levels vary. But, in California for example, the variation is related to sample sizes and repeated failures rather than to the importance of the measure.

standard (and the CLEC will be subsidized) even though the CLEC is just as well off at V_1 equal to 97 and V_2 equal to 90.

A third problem with the use of such a micro-managed approach to performance is that it may fail to aid the ILEC in determining where and how to improve its service delivery in response to CLEC demands. In our view, under a highly-specific plan, the ILEC becomes focused on meeting the performance measurement objective (*i.e.*, achieving parity or meeting the benchmark), rather than focusing on providing wholesale service qualities in response to CLEC demands. This, in turn, affects the CLEC's ability to compete and ultimately retail consumer welfare.

Finally, we can find no basis in economics for the use of multiple individual performance measures; such an approach does not identify how these individual measures are related to the overall business processes of the CLECs or to retail consumer welfare. An economics-based approach would account for how the provision of wholesale services to CLECs influences the retail services and qualities offered by CLECs, and ultimately retail consumers.

Consistent with the basic principle for the design of sound incentive regulation policy (*i.e.*, of allowing the regulated firm flexibility in deciding how to meet a goal), we recommend that the current Texas Plan and similar PMPs, which focus on targeted individual performance measures, be replaced with an index-based plan that is broadly-based to include the underlying business processes and the underlying technology of delivering wholesale service quality. By doing so, regulators can harness the superior knowledge of industry participants to achieve regulatory goals. First, replacing individual measures with an index that captures the underlying business processes will give the ILEC flexibility in making wholesale service quality decisions in response to different CLEC demands. Secondly, such an index also gives the ILEC more discretion to act on its private information. Finally, the index approach can expand the opportunity set for CLECs seeking to compete in local exchange markets. When the performance index reflects the underlying business process and the technology of providing

wholesale services, it enables different CLEC business models than were otherwise available.⁷⁴ Ultimately the expanded CLEC opportunity set will result in a wider array of choices for retail consumers

2. Appropriate Incentives

PMPs, such as the Texas Plan, should provide incentives that: (1) penalize the ILEC for providing discriminatory access to CLECs, and (2) reward the ILEC for improving its provision of wholesale services to CLECs on an ongoing basis. The Texas Plan provides incentives to avoid discriminatory service (*i.e.*, the incentive is the “remedy” payment) but does not provide any explicit incentives or “rewards” when SBC improves the quality of wholesale services or delivers superior quality service.⁷⁵ Therefore, the current system does a poor job of encouraging improvements in wholesale service quality over time.

Super-compliant behavior on the part of an ILEC (*i.e.*, provision of service at levels statistically significantly above parity or the benchmark that is specified by the performance measurement plan) may be highly valuable to a CLEC (and presumably to retail consumers). However, regardless of how highly CLECs may value super-compliant ILEC behavior, ILECs will have little incentive to undertake such behavior because they perceive no incremental reward for doing so – beyond avoidance of the payment of a remedy. Consequently, failure to reward super-compliant behavior can harm CLECs substantially (and presumably retail consumers) in the sense that they do not receive the better wholesale service quality which they value.⁷⁶

Three aspects of the Texas Plan’s system of incentives are troublesome. First, the current performance remedy structure (which provides no “rewards”) is asymmetric and, as such, inconsistent with the regulatory goal of encouraging competitive local exchange markets. Second, the specific remedy amounts included in the Texas Plan, and similar plans, do not

⁷⁴ It may not be straightforward to identify the relevant (and parsimonious set of) wholesale services for the index. Doing so likely will require the guidance of a group of technically knowledgeable individuals in telecommunications.

⁷⁵ All of SBC’s PMPs include remedies but no rewards. To our knowledge, there are no PMPs that include rewards, currently.

⁷⁶ This assumes that CLECs cannot purchase superior wholesale service qualities from an ILEC.

appear to be based upon any empirically based analysis of the costs associated with poor performance to affected CLECs or to retail consumers. Likewise, these PMPs do not attempt to identify a reward amount based upon an empirical analysis of the value associated with super-compliant performance; all rewards are set at zero. A sound remedy and reward structure should reflect the values and costs to ILECs, CLECs, and ultimately to retail consumers associated with different levels of wholesale service quality provision.⁷⁷ Determining such values and costs with any level of precision may be a challenging exercise – because it will require information from ILECs, CLECs, and/or consumers that may be regarded as confidential or difficult to obtain. Nevertheless some level of determination should be undertaken so that remedy amounts are more in line with economic consequences.

To address these first two issues, consistent with the principles of sound incentive regulation policy, we recommend that the “incentive” structure in the Texas Plan and similar plans be replaced with (i) a symmetric incentive structure that incorporates both remedies and rewards, and (ii) incentive amounts that reflect both the harm and the value (*i.e.*, economic value) of specific wholesale performance to retail consumers.^{78,79}

Third, incentive payment amounts should not be independent of regulated prices for wholesale services. The ultimate price that the CLEC pays for a wholesale service is a combination of the regulated price plus or minus the remedy or reward for the wholesale service quality. For example, a CLEC that receives inferior wholesale service quality would pay a price that is discounted below the regulated price; this “discount” (*i.e.*, the remedy amount) should be a percentage of the regulated price. Likewise, a CLEC that receives superior wholesale service quality would pay a premium above the regulated price; this “premium” (*i.e.*, the reward amount)

⁷⁷ Somewhat surprisingly, the current Michigan Performance Remedy Plan incorporates a single remedy amount for all performance measures. This assumes that the economic consequences are exactly the same for all measures.

⁷⁸ As mentioned earlier, identifying such values and harms may be difficult and will likely require further study.

⁷⁹ To ensure the delivery of appropriate wholesale service quality levels, rewards for exceeding particularly challenging benchmarks may need to be more substantial than rewards for exceeding more moderate benchmarks. See *Designing Incentive Regulation for the Telecommunications Industry*, by David E. M. Sappington and Dennis L. Weisman. MIT Press and AEI Press. Cambridge, MA and Washington, DC. 1996.

should also be a percentage of the regulated price. In each case, if discounts and premiums are appropriately set, the two parties are compensated appropriately. The ILEC paying a remedy is equivalent to the CLEC receiving a wholesale service quality discount. Likewise, the CLEC paying a premium for superior wholesale service quality is equivalent to the ILEC receiving a reward. It is important to note that the discount or the premium (and therefore the remedy and reward amounts) should be tied to the regulated wholesale service price.⁸⁰

In summary, we recommend developing an appropriate incentive structure for PMPs that has the following characteristics: (1) incentives that are symmetric, (2) incentive amounts that are based on economic harm and value to CLECs and final retail consumers, and (3) incentive amounts that are not independent of regulated wholesale service prices.

3. Accurate Statistical Testing

In designing a performance measurement plan that seeks to ensure “healthy competition” but where no absolute service quality standard exists, parity is an appropriate standard. Hence, in the Texas Plan and similar plans, the relevant standard often is defined as the level of service quality that SBC provides to its own retail customers. In cases where SBC provides a wholesale service that it does not provide to itself, a benchmark standard is established. The level of service quality that SBC provides on a particular performance dimension is deemed to be acceptable if SBC delivers to its competitors either the same level of service quality that it delivers to itself or a higher level or service quality (or a level of service quality that meets or exceeds the specified benchmark standard). In contrast, SBC’s performance is deemed unacceptable if the quality that SBC delivers to its competitors is less than the quality it delivers to itself (or if SBC does not meet the benchmark). Remedies are imposed on SBC when the level of service quality is “judged” to be below the level it delivers to itself (or below the benchmark) based on a statistical test.

⁸⁰ This may not be straightforward since regulated prices for wholesale services (*i.e.*, either elements or wholesale services) vary depending on whether TELRIC prices or wholesale discounts are in effect.

In reality, the level of service quality delivered is a distribution, not a single number. For a given measure, SBC might deliver a service to itself thousands or tens of thousands of times and it might deliver that same service to a CLEC a few times or hundreds of times. Hence, for parity measures, two distributions – a distribution of ILEC service delivered to itself and a distribution of ILEC service delivered to a CLEC – are compared. These distributions are defined by a mean and a variance.

The Texas Plan and similar plans provide statistical tests for testing compliance, based on a Z test and a provision to adjust for the likelihood of one or more Type I errors when a large number of measures are tested for a CLEC (called the “K Table”).⁸¹ Just as it is difficult to specify “ideal” service quality, it is difficult to measure perfectly the level of service quality that SBC delivers. To illustrate this, consider the time taken to provision a loop. Even when SBC delivers the same level of service quality in provisioning a loop for a CLEC, the actual time to provide this service will vary because factors other than service quality influence provisioning time. These include both exogenous factors outside of SBC’s control and errors in measuring observed performance. Exogenous factors, for example, may include equipment failure, fieldwork delays due to traffic conditions, adverse weather conditions, or service technician truck break-downs. Therefore, even when SBC delivers the same level of service quality in providing a service to its retail customers as to a CLEC, a range or distribution of provisioning outcomes rather than a single outcome typically will be observed. Consequently, assessments of the relative service quality that SBC delivers to its competitors and to itself require the comparison of two distributions of provisioning outcomes – the distribution of outcomes that SBC provides to its competitors and the distribution of outcomes that SBC provides to itself. Statistical hypothesis testing is used to determine whether the two distributions differ from each other.

Under hypothesis testing, a threshold performance differential is specified. This threshold performance differential is calculated to provide reasonable confidence that SBC will not be

⁸¹ A modified Z test is used in the Texas Plan. For a mean-based performance measure, this test statistic is the difference between the ILEC mean and the CLEC mean divided by the standard error of the difference. However, only the ILEC variance is used in computing the standard error. The value of this test statistic is then compared to a critical Z value (based on the K table) to determine whether the ILEC is providing nondiscriminatory service on that measure to a specific CLEC.

“judged” non-compliant, if SBC truly delivers the same service quality to itself and its competitors. Of course, reasonable confidence is not absolute certainty, and there is a reasonable possibility that SBC will be judged non-compliant even when it delivers the same level of service quality to its competitors and to itself. This is referred to as a Type I error.⁸² The Texas Plan and similar plans admit the possibility that SBC will be judged non-compliant (*i.e.*, to have delivered lower quality service to its competitors than to itself) even when SBC delivers the same level of service quality to its competitors and to itself. In other words, the Texas Plan admits to the occurrence of Type I errors.

Without the K table, the Texas Plan admits a 5 percent chance of a Type I error on each measure. However, a 5 percent chance of a Type I error on each measure makes it very likely that some Type I error will occur when multiple measures are tested for a CLEC. For example, if there is a 5 percent chance of a Type I error on each of ten performance measures, the chance that at least one Type I error will occur when the ten measures are statistically tested may be as high as 50 percent.⁸³ More generally, for each CLEC, the probability that at least one Type I error occurs when SBC provides parity service can be as high as the product of the number of measures tested for the CLEC and 5 percent, up to a maximum of 100 percent.⁸⁴ The Texas Plan includes a K table to correct this problem. The K table reduces toward 5 percent (but does not eliminate) the likelihood that one or more Type I errors will occur when multiple measures are tested for a CLEC and there is a 5 percent chance of a Type I error on each measure.⁸⁵

⁸² A Type I error occurs when SBC is judged to be non-compliant when, in fact, SBC delivers to its competitors the same level or a better level of service quality than it delivers to itself.

⁸³ This is the upper bound and allows for mutually exclusive tests. In general, the Bonferroni inequality states that the probability of at least one failure in “n” tests is less than or equal to the sum of the significance values of the individual tests. In the Texas Plan, significance values (p) are set at 0.05 for all tests so the probability of at least one failure is less than or equal to (n*p). For a more extensive explanation of Type I errors for multiple tests, see George W. Snedecor and William G. Cochran, *Statistical Methods*, Eighth Edition, Iowa University Press. 1989. pp. 115:117.

⁸⁴ Under the Texas plan, between September 2001 and August 2002, over 100,000 measures were tested for 171 CLECs (*i.e.*, about 49 measures per CLEC per month, on average). When such a large number of statistical tests are performed, many Type I errors are likely to occur.

⁸⁵ When performing multiple hypothesis tests it is important to determine the correct error rate (level of significance). This is because the error rate for several hypothesis tests combined is larger than the error rate for one individual test. Multiple comparison procedures take into account and properly control for the effect of multiple tests. The K table is one such procedure.

The K table provides a very important function in the Texas Plan and similar plans. Without the K table, or a mechanism like it to account for multiple comparisons, the Texas Plan will produce more inaccurate results, thereby obligating SBC to making payments to a CLEC even when it provides parity service. In the Texas Plan, even with the K table, the extent of the reduction in the likelihood of Type I errors varies with the number of measures that are tested. For each grouping of measures in the K table (*e.g.*, the group of 10 to 19 measures or the group of 20 to 29 measures), the likelihood of one or more Type I errors occurring increases as the number of measures (within the group) increases.⁸⁶ To the extent that such errors are not eliminated, the performance measurement plan imposes a tax on SBC and also treats CLECs unequally. Some CLECs may be treated better than others, because they are more likely to receive a remedy payment from SBC in error (*i.e.*, one that is due to a Type I error) simply based on their size. In this regard, the Texas Plan is providing unequal treatment of CLECs

Despite the importance of the K table and its inclusion to address (but not eliminate) Type I errors, the Texas Plan still suffers a significant statistical testing flaw. The K table does not apply to all measures⁸⁷ and measures with fewer than 10 transactions are subject to K table forgiveness only under special circumstances.⁸⁸ Thus, CLECs which fit this profile, meaning either that the CLEC requests specific wholesale services not subject to the K table or that all (or most) of the performance measures applicable to that CLEC have fewer than 10 transactions, are likely to receive more erroneous remedy payments (but not necessarily more dollars) than other

⁸⁶ For example, in the Texas Plan, when the number of measures analyzed in a given month (for a CLEC) is 20, the probability of at least one Type I error (judging SBC to be non-compliant when SBC is, in fact, compliant) even after K table forgiveness is about 5 percent. When the number of measures is 29, the probability that at least one Type I error will occur even after K table forgiveness increases to almost 12 percent. Likewise, for CLECs with 10 measures in a given month, the probability of at least one Type I error even after K table forgiveness is about 5 percent. When the number of measures is 19, the probability that at least one Type I error will occur even after K table forgiveness increases to about 15 percent.

⁸⁷ Specific individual performance measures are not subject to the K table after two consecutive failures to meet the parity or benchmark standard; these are referred to as critical measures in the Texas Plan. These specific measures comprise the overwhelming percentage of remedy dollars incurred by SBC.

⁸⁸ Over the one-year period, September 2001 through August 2002, about 46 percent of the performance measures in Texas that were statistically tested and subject to remedy payments had fewer than 10 transactions. K table exemptions do not apply to these measures unless all performance measures with 10 or more transactions have already been forgiven.

CLECs. In this regard, the specific operating mode of the Texas Plan itself does not meet the PUCT's regulatory goal of nondiscriminatory treatment.

Another troublesome aspect of the statistical testing is the large number of performance measures for which tests are based on fewer than 10 observations or transactions (*i.e.*, service requests). As noted earlier, over a one-year period in Texas, 46 percent of the statistical tests performed were for measures with fewer than 10 transactions for a CLEC, and an additional 16 percent were for measures with between 10 and 30 transactions. This is not unique to Texas. Over a three-month period in Michigan, 56 percent of the statistical tests performed were for parity measures with fewer than 10 transactions for a CLEC, and an additional 15 percent were for measures with between 10 and 29 transactions.⁸⁹ The business rules in both states call for a permutation test when the number of transactions for a measure is less than 30.⁹⁰ The test described is actually a modified permutation test because it uses a random sample of all possible combinations of the ILEC and CLEC data for a given measure rather than all possible combinations.⁹¹

Our concern is that, with the large number of measures tested with fewer than 10 service requests (about half of all measures tested!), the statistical testing may lead to a high percentage of

⁸⁹ In Michigan, statistical tests apply only to parity measures. Recently, the Michigan Public Service Commission (MPSC) voted to eliminate the use of the K table (see MPSC Order Denying Rehearing, Case No. U-11830. *In the matter of SBC Ameritech Michigan's submission on performance measures, reporting, and benchmarks, pursuant to the October 2, 1998 order in Case No. U-11654.*). This results in a very high likelihood (much higher than 5 percent as discussed earlier) that SBC will pay "remedies" to a CLEC when SBC is, in fact, providing compliant performance. Recall that with the K table in place, the likelihood that SBC will pay at least one erroneous remedy payment to each CLEC is reduced toward 5 percent.

⁹⁰ Our understanding is that the permutation test is currently in place in Michigan and is planned for implementation in Texas.

⁹¹ In an exact permutation test, the statistic of interest is calculated for all possible combinations of the two original data sets (in this case, the ILEC data and the CLEC data for that measure). The permutation test described for Texas and Michigan is modified in that it uses a random sample of all possible combinations of an unspecified sample size T. This is repeated 10 times, a p-value is estimated based on the rank of the observed test statistic and an average p-value is computed. The Z value corresponding to the average p-value is compared to the critical Z value from the K table. A superior alternative to the 10 repetitions is to increase the sample to size 2xT. The p-value based on 2xT combinations will provide a better estimate of p than the average of 10 p values based on T combinations.

erroneous test results because the K table (for the most part) does not apply.⁹² If so, CLECs that fit this profile are likely to be treated differently than other CLECs. Given the very high percentage of tests that fall into this category, we recommend implementing a “stopping rule” as an alternative to performing a modified permutation test every month on every measure with fewer than 30 service requests. Under such a rule, the data are pooled over multiple months until a pre-specified number of service requests is reached (such as 30). Then, a Z test can be used for statistical testing.

In summary, the K table does an excellent but imperfect job of eliminating erroneous remedy payments in Texas. Furthermore, the K table is not in effect for all wholesale services. Finally, the statistical testing of so many measures with very small numbers of transactions (*i.e.*, fewer than 10) is problematic. As discussed earlier in this section, we generally recommend that the current Texas Plan and similar plans (*i.e.*, based on testing of individual performance measures) be replaced with a broad-based plan that uses an index approach to measure performance. Such a plan would greatly reduce, but not entirely eliminate, the problems that the K table is designed to address. We also recommend postponing the testing of measures with fewer than 10 transactions during a month, until a sufficient number is reached.

D. OPPORTUNITIES FOR IMPROVEMENT

We recognize how difficult it is to design a comprehensive, principled performance measurement plan. We also assume that the plans that have been designed to-date were intended as a first step in developing final PMPs that are firmly grounded in solid economic principles. Taking such a first step is, of course, necessary and commendable. However, it is important to recognize that subsequent steps are crucial to ensure the healthy and timely development of a telecommunications industry that best serves the interests of consumers

Our assessment of the Texas Plan has identified several key shortcomings which can be eliminated by making design modifications. Based on our assessment, we provide three specific

⁹² On a more practical note, going through the effort of a permutation test for such small numbers of transactions seems almost absurd when waiting an extra month (or so) to perform the test is a feasible and practical alternative.

recommendations for measuring performance and structuring an appropriate remedy/reward system that will: (i) move the Texas Plan (and similar plans) toward one that is more firmly based on sound economic principles and (ii) eliminate many of the problems with the current plan.

- First, the Texas Plan and similar plans will be more effective in meeting the overarching regulatory goals of non-discriminatory access for CLECs and a meaningful opportunity to compete in local exchange markets by replacing the current overly-detailed individual measures-based PMP with an index approach that is *broadly-based* to include the underlying business processes and the underlying technology of delivering wholesale service quality.⁹³
- Second, the Texas Plan and similar plans should adopt a more symmetric incentive structure that incorporates both remedies and rewards. Such a structure will encourage ILECs to: (1) provide access to CLECs on a nondiscriminatory basis, and (2) improve the quality of their wholesale services or provide super-compliant performance to meet CLEC demands.
- Third, the Texas Plan and similar plans should base wholesale quality incentive payments (both the remedies and rewards) on empirical evidence of the economic costs and benefits to CLECs and retail consumers. Further, these payments should not be independent of regulated wholesale service prices; in other words, CLECs should receive discounts for “low” quality and pay “premiums” for high quality wholesale service to the extent that this matters to retail consumers.

These recommendations for a broad-based, symmetric, and value-based incentive plan represent a “next step” in the evolution of PMPs. We believe that adoption of these recommendations will align the Texas Plan and similar plans with sound economic principles, and move the plan closer to one with solid economic foundations. However, if it is not possible to implement a broad-based index and statistical testing of individual performance measures continues, we recommend that: (i) the K table be in effect for all performance measures, and (ii) the testing of measures

⁹³ Note that by developing a broad-based PMP, many of the statistical issues associated with the individual measures-based plan either vanish or decrease in importance. If a broad-based plan is not adopted, then we recommend consistent statistical testing and that the K table be in effect for all of the performance measures (so that the Type I error problem is consistently addressed). This is currently not the case under the Texas Plan where many measures are not subject to the K table. We also recommend an implementing an optimal stopping rules so that measures with very small numbers of transactions are not tested until a sufficient number is reached. We also recommend implementing a “stopping rule” for testing.

with fewer than 10 transactions (during a month) be postponed until a sufficient number (such as 30) is reached. We discuss the practical implications of our recommendations next.

VI. PRACTICAL IMPLICATIONS FOR PERFORMANCE MEASUREMENT

In this section, we provide practical and actionable steps to implement a broad-based performance index of wholesale service quality, a remedy structure that is symmetric, and incentive payment amounts that are based on changes in consumer welfare.

The index approach that we propose measures the difference between the wholesale quality that an ILEC provides to CLECs and the quality that it provides to itself (*i.e.*, to its own retail arm)⁹⁴ but, unlike the individual measures approach, several performance dimensions are included in a single index.⁹⁵ Replacing individual measures with an index that is aligned with the underlying business processes and technology of providing wholesale services will give the ILEC flexibility in making wholesale service quality decisions and discretion to act on its own private information. The index approach will also allow for varying CLEC demands and different CLEC business models than were otherwise available in local exchange markets.

Allowing the ILEC flexibility in deciding how to meet a goal is consistent with the basic principles for the design of sound incentive regulation policy, and consistent with and similar to the price cap approach (or price cap mechanism, PCM) that some regulators have applied to ILECs.⁹⁶ Given state regulators' experience with price cap mechanisms, they will likely be comfortable with implementation of a PMP based on an index of wholesale service quality.

⁹⁴ This is the parity standard. When an ILEC does not provide a service to its retail arm, a benchmark standard is employed instead.

⁹⁵ Index approaches are not new to telecommunications. For an example of an index approach for wholesale service quality, see the "Performance Assurance Plan," Verizon New York, Inc. January 2003. Berg and Lynch provide another example of the development of an index for measuring the quality of telecommunications retail services. Sanford V. Berg and John G. Lynch, Jr., "The Measurement and Encouragement of Telephone Service Quality." *Telecommunications Policy*, April 1992.

⁹⁶ Under a PCM, instead of regulators setting prices on individual services, ILECs set prices to stay under an *overall* price cap. For an overview of price cap regulation, see Chapter 7, "Price Regulation" by David E. M. Sappington. In *Handbook of Telecommunications Economics*, Vol. 1. Edited by M. E. Cave, S. K. Majumdar, and I. Volegsang, Elsevier Science Publishers 2002; and Chapter 3 in *Designing Incentive*

Additional benefits of the index approach are that: high performance on one dimension can offset low performance on another; the number of statistical tests is greatly reduced; the associated extremely high likelihood that one or more Type I errors will occur when multiple measures are tested for a CLEC resulting in erroneous remedy payments by the ILEC is greatly reduced;⁹⁷ rewards as well as remedies are readily incorporated; and the burden to both ILECs in reporting results and CLECs in reviewing results is reduced.

In providing guidelines for implementing the index approach for measuring performance, we propose the development of an index for each CLEC mode-of-market entry – resale, UNE-P, and UNE-L.⁹⁸ Each index is significantly broader than the individual performance measures on which most of the state plans are based currently. Although we provide illustrative indexes in this paper based on Texas, we recommend that the specific indexes be defined by a panel of experts representing ILECs and CLECs.

The development and implementation of performance indexes is a four step process:

- 1) specify the performance index(es);
- 2) determine the weights for each performance measure in the performance index(es);
- 3) compute the performance index(es); and

Regulation for the Telecommunications Industry, by David E. M. Sappington and Dennis L. Weisman. MIT Press and AEI Press. Cambridge, MA and Washington, DC. 1996.

⁹⁷ As described later in this section, the index approach that we recommend results in a maximum of 14 statistical tests for any one CLEC – two indexes are specified at the state level only and three indexes are specified at four market area levels. Assuming the same significance level for testing as under the current Texas Plan (*i.e.*, 5 percent), reducing the number of tests to a maximum of 14 greatly reduces the likelihood that one or more Type I errors will occur (the K table currently reduces but does not eliminate this error). If a single index were ultimately adopted, for example, the Type I error problem associated with performing multiple tests would be eliminated completely and only a Type I error for a single test would remain.

⁹⁸ TA96 anticipated the following modes of CLEC competition: (1) CLECs might purchase ILEC retail services at a wholesale discount and resell these services (in a process known as resale); (2) CLECs might purchase unbundled network elements and combine them with their own facilities (UNE-L); (3) CLECs might purchase unbundled network elements to provide an end-to-end service which is commonly referred to as the UNE-platform or UNE-P; and (4) CLECs might employ only their own facilities to serve their customers (facilities-based). This paper focuses on the three modes of competition that require CLECs to purchase wholesale services from the ILEC.

- 4) impose the prescribed remedies and rewards.

A. SPECIFYING THE PERFORMANCE INDEXES

The first step in developing performance index(es) has two components: identifying the categories of measures and identifying the specific measures. For the first component, we recommend that a panel of experts determine which categories of performance measures to include in a performance index for each CLEC market mode-of-entry (*i.e.*, resale, UNE-P, and UNE-L) based upon business processes that are meaningful to both CLECs and the ILEC.⁹⁹ This group will need to be technically expert, since the issues associated with wholesale service quality have technical bases. By way of example, we again use the Texas Plan, which currently contains fourteen categories of performance measures. Subject to the input of technical experts, we recommend using five categories of wholesale services: (1) Pre-ordering/Ordering; (2) Provisioning; (3) Maintenance; (4) Interconnection; and (5) Billing. We selected these five because their overall definitions are well known, and they represent critical functionalities required by CLECs in providing local exchange service.

Specifically, we recommend creating a single index for each of three CLEC modes of entry because the types of wholesale services procured by the CLEC will ultimately influence consumer welfare.^{100,101,102} CLECs in the resale or UNE-P modes-of-entry rely entirely on the

⁹⁹ Discussions concerning business processes are included in a variety of books and articles. Over the past two decades, business process definition and business process mapping has received considerable attention, and are critical components of business process reengineering, process improvement, and total quality management. This paper does not refer to the performance measurement and management techniques developed as part of these operational improvement methods, we refer to similar notions of business processes.

¹⁰⁰ As defined earlier, the three modes of CLEC market entry that require wholesale services are resale; UNE-P; and UNE-L. These modes either require different wholesale services and/or the wholesale services are priced differently. As of early 2003, approximately 65 percent of CLEC lines in the U.S. were in the UNE-P entry mode, 23% were in the UNE-L entry mode, and only 12% were in the resale entry mode (see UBS Warburg, Wireline Postgame Analysis 3.0, May 14, 2003).

¹⁰¹ Some have argued for identifying DSL as a separate mode-of-entry as in the Verizon Plan in NY State. However, we do not agree. If a CLEC is requesting only DSL services, then only performance measures related to DSL services will be in that CLEC's performance index. If a CLEC is requesting DSL services as well as other services, then performance measures for all of the wholesale services requested will be included in that CLEC's index which is appropriate. In our view, and consistent with our recommendation for broad-based measures, mode-of-entry is the determining factor, not the type of service requested.

ILEC's facilities to provide retail services through resold services or through fully recombined sets of ILEC unbundled network elements (*i.e.*, the UNE-Platform or UNE-P). CLECs in the UNE-L mode-of-entry rely on their own network switches and on ILEC loops (*i.e.*, the "last mile" component of the network) in providing retail services.^{103,104} It is important to note that a final group of CLECs serve retail customers using entirely their own facilities (*i.e.*, their own switches and loops). These "facility-based" CLECs are not purchasing wholesale services from ILECs and therefore are excluded from our performance measurement discussion.¹⁰⁵

In instances where a CLEC uses a combination of their own switches, ILEC loops, and the ILEC network in providing retail services (*i.e.*, where the CLEC is operating in multiple modes of entry), we recommend creating an index for each entry mode. This will result in the creation of more than one index for some CLECs.

The second component of specifying the index is to identify the specific performance measures associated with each wholesale service quality index. To illustrate the composition of an index, we developed indexes based on existing performance measures in the Texas Plan.¹⁰⁶ In

¹⁰² Recall that we are using the term wholesale services to refer to either the services (*i.e.*, resale) or elements (*i.e.*, UNEs or UNE-P) provided by the ILEC that CLECs might employ in providing retail telecommunications services.

¹⁰³ Different modes of entry will likely have different implications for consumer welfare for the following reason. A resale or UNE-P CLEC, completely dependent on the ILEC network, is likely to provide fewer innovative retail services than CLECs that rely on their own facilities in part (*i.e.*, UNE CLECs) or entirely (*i.e.*, facilities-based CLECs).

¹⁰⁴ UNE-L CLECs require interconnection with the ILEC whereas Resale and UNE-P CLECs do not require interconnection (*per se*) because the ILEC is supplying the entire wholesale service.

¹⁰⁵ Facilities-based CLEC lines are not insignificant. According to the FCC Local Telephone Competition: Status as of December 31, 2002 report (Industry Analysis and Technology Division, Wireline Competition Bureau, June 2003), as of December 2002 approximately 26 percent of CLEC lines were facility-based (*i.e.*, CLEC owned). This percentage decreased from 33 percent in December, 1999. Facilities-based CLECs require no services from the ILEC.

¹⁰⁶ As stated earlier, we recommend that an expert panel develop a definitive list of performance measures for each index. For illustration, in this paper, we asked SBC to identify the appropriate measures for each index based on their expertise.

principle, every performance dimension that affects final wholesale service quality for a specific entry mode should be included in the index for that mode.¹⁰⁷

Table 1 provides a listing of the performance measures that comprise each index by CLEC mode-of-entry. The performance measures included in each index vary somewhat by entry mode. As an illustrative example, we use the “provisioning-related” measures in the index. As shown in Table 1, three individual performance measures (*i.e.*, wholesale service quality dimensions) make up the provisioning-related measures in the index for the “Resale” CLECs and “UNE-P” CLECs (*i.e.*, performance measures 29, 32, 35). However, for “UNE” CLECs, a different subset of performance measures are included (*i.e.*, 58, 59, 62, and 114.1-115.2 combined) for the provisioning-related measures in the index.¹⁰⁸

In constructing each measure within the index and in computing and testing the index, it is useful to note the differences between our approach and the current Texas Plan. The most important differences are the following:

- Under the current Texas Plan, some types of performance measures are measured at the market area level and some are measured at the state level. In moving to the index approach, we compute a single statewide index for each CLEC mode-of-entry.¹⁰⁹
- We normalize each sub-measure by computing a percent difference. The Texas plan does not include this. The exact method for normalizing is described later in this section.
- We aggregate sub-measures to the measure level by computing a transaction-weighted average of the associated (normalized) sub-measures. The exact method for aggregating to the measure level is described later in this section. This is not

¹⁰⁷ Not all of the measures in the current Texas Plan are assigned to one of the proposed indexes; we are not proposing that the numerous performance measures associated with the current plan simply be re-assigned to an index.

¹⁰⁸ Note that in specifying these performance measures, we are not eliminating the associated sub-measures. The sub-measures are still tracked but their values are now aggregated into a single performance measure. This is described later in this section. In the Texas Plan, although the performance measures are the same for Resale and UNE-P CLECs, the sub-measures are different.

¹⁰⁹ Hence, for a CLEC operating in one market entry mode, one performance index will be computed each month. For a CLEC operating in multiple market entry modes, up to three indexes could be computed each month.

necessary under the current Texas Plan because each sub-measure is evaluated independently.

- In computing the index (in contrast to the current Texas Plan), we transform the measures so that higher values indicate higher quality of service to the CLEC. This is described later in this section
- To evaluate the overall quality of wholesale services provided, we statistically test whether the value of the index is significantly greater than or less than zero. This is in contrast to the current Texas Plan where each sub-measure is individually tested.

B. DETERMINING THE IMPORTANCE WEIGHTS FOR EACH INDEX

Calculating the indexes requires developing weights for each of the performance measures that make up each index. The weights signify the importance of that particular performance dimension of wholesale quality to retail service quality and ultimately to consumer welfare. For the Resale and UNE-P mode of entry indexes, 13 performance measures are included so 13 relative weights (which sum to 100 percent) must be developed. For the UNE-L index, 24 performance measures are included. Each weight can be interpreted as the contribution of that particular performance measure of wholesale service quality to overall consumer welfare (for that particular wholesale quality mode-of-entry index).¹¹⁰ We believe that it is entirely appropriate for a panel of experts (*i.e.*, experts representing ILECs and CLECs) to develop the set of wholesale service quality weights for each performance measure in each index.

For this paper, we use illustrative weights for the performance dimensions of each index which we apply to the example included in this section. We assume a single index-specific set of weights for each CLEC mode-of-entry within a particular state. Table 1 presents the weights by performance measure expressed in percentage terms.¹¹¹ For each index, the weights sum to 100 percent. For example, consider the performance measures that comprise the performance index for “UNE-L” CLECs. Notice that “mean time to restore a UNE” is the most important performance dimension (*i.e.*, the associated weight is 17% or 0.17) and, as a group, the

¹¹⁰ As discussed previously, consumer welfare is dependent, in part, on demand for retail telecommunications services which is a function of retailer’s prices and qualities. Given consumer demand, retailers compete by setting retail prices and choosing quality efforts.

¹¹¹ We asked wholesale performance experts at SBC to provide the illustrative set of weights in Table 1.

billing/databases measures are the least important performance measures (*i.e.*, the largest weight is 2% or 0.02).

Our discussion of the index assumes that the measures within an index are independent; we recommend that each index be specified so that its individual components are independent. If, however, the measures within an index are not independent, then the relationships between the different measures will have to be specified.

C. DEFINING AND COMPUTING THE INDEX

The UNE-L index (*ULI*), for example, can be calculated for each CLEC k as a combination of the weights (b_j) and the service quality dimensions (v_{jk}) or performance measures shown in Table 1. In the index, each service quality dimension or performance measure is expressed as the difference between the wholesale service quality that the ILEC provides to a CLEC and the service that the ILEC provides to itself (when the ILEC does not provide the service, a benchmark standard is established). Each dimension is weighted based on its importance to overall wholesale service quality. Therefore, the wholesale service quality index for each entry mode is a weighted average of the differences in wholesale service quality provided to a CLEC relative to the service the ILEC provides to itself or a benchmark.

Prior to computing the index, several steps are required so that all service quality dimensions are in similar units, move in the same direction, and are on the same scale. In addition, in order to compute the index at the measure level (rather than at the sub-measure level), sub-measures are aggregated to the measure level. These steps are described below.

1. Normalizing the Measures

All of the performance measures are not on the same scale so it is necessary to normalize each measure prior to computing the actual index. One method for doing this is to compute a percentage difference for each performance measure included in the index. However, note that if

“normally distributed” performance measures are a goal,¹¹² it is likely to be necessary to transform the performance measures prior to the percentage difference normalization.¹¹³ The computed percentage difference (using either the original measure or a transformed measure) is a deviation from the ILEC’s performance to itself (or to the benchmark standard). To show this, define the following terms:

\bar{v}_{jk} = the average service quality that the ILEC provides to CLEC k for performance measure j.

\bar{v}_{j0} = the average service quality that the ILEC (e.g., SBC) provides to itself for performance measure j (or alternatively, the appropriate benchmark standard).

In contrast to the Texas Plan, each percentage difference is constructed so that positive values indicate higher quality of service to the CLEC.¹¹⁴ Whether the performance measures are means or percentages, the percent difference is calculated as follows:¹¹⁵

$$\frac{\bar{v}_{jk} - \bar{v}_{j0}}{\bar{v}_{j0}}$$

¹¹² Normally distributed measures come closer to meeting the underlying assumptions of classical statistical tests such as the Z test.

¹¹³ For example, if percentage-based measures are clustered around zero or one, an arc sin transformation may be appropriate to spread out the distribution. Likewise, a log transformation of the individual observations making up average-based measures may be necessary to obtain a distribution of measures that is closer to normal.

¹¹⁴ The technique for transforming sub-measures so that higher values indicate better performance is somewhat different for percentage-based (or rate-based) measures than for average-based measures. For percentage-based or rate-based measures with sub-measures, if required, the sub-measure is transformed so that higher values indicate better performance by subtracting the value from 1.0 (e.g., a performance value of 3% (i.e., 0.03) and a benchmark of 5% for a specific measure would be transformed to a performance value of 97% and a benchmark of 95%). After the transformation, the percent difference is calculated at the sub-measure level. If the percentage-based measure has no sub-measures and requires a transformation, the measure is transformed prior to the percent difference calculation. For average-based measures, the percent difference is calculated at the sub-measure level and multiplied by -1 if a change in direction is required so that higher values indicated better performance.

¹¹⁵ This assumes that the ILEC service to its own retailer is the “optimal” value of wholesale service provision (note that existing PMPs make this assumption). Calculating a difference is consistent with a linear index and the weights are now interpreted as a marginal change in consumer welfare relative to a percentage change in the deviation from the optimal level of wholesale service provision.

The UNE-L index for CLEC k (ULI_k) can now be expressed as a weighted sum of the average percent differences of all the service quality dimensions in that index:

$$ULI_k = \sum_j b_j \frac{\ddot{v}_{jk} - \ddot{v}_{j0}}{\ddot{v}_{j0}}.$$

The proposed normalization results in an index centered on zero for each performance measure, so that a value of zero indicates that SBC is providing *the same service* quality to the CLEC that it is providing to itself (or the benchmark) for that service quality dimension; a value greater than zero indicates that SBC is providing *better service* quality to the CLEC than it is providing to itself (or the benchmark); and a negative value indicates that SBC is providing *worse service* quality to the CLEC than it is providing to itself (or the benchmark). The statistical test for non-compliance is then whether: $ULI_k < 0$. Likewise, the statistical test for super-compliance is whether: $ULI_k > 0$.

2. Aggregating Sub-Measures to Measures

To construct the percent difference for each measure within the index, we compute a transaction-weighted average of the associated normalized sub-measures. For example, performance measure 29 in the Texas Plan (*i.e.*, percent SWBT caused missed due dates) has six sub-measures associated with it.¹¹⁶ To aggregate these sub-measures to the measure level, we multiply each normalized sub-measure (*i.e.*, the percent difference calculated for each sub-measure) by the proportion of total service requests or orders represented by that sub-measure.¹¹⁷ This results in a percent difference for the measure that has incorporated all of the information from the sub-measures.

¹¹⁶ The sub-measures associated with measure 29 (“percent SWBT caused missed due dates for provisioning plain old telephone service (POTS) or UNE-P”) for the “resale” index are: residential fieldwork for POTS; residential no field work for POTS; business fieldwork for POTS; and business no fieldwork for POTS. The sub-measures associated with measure 29 for the “UNE-P” index are: UNE combination fieldwork and UNE combination no fieldwork.

¹¹⁷ For example, assume that, in a given month, performance measure 29 has the following order breakdown for a Resale CLEC: residential fieldwork for POTS represents 0.15 of the orders; residential no field work for POTS represents 0.35 of the orders; business fieldwork for POTS represents 0.20 of the orders; and business no fieldwork for POTS represents 0.30 of the orders. These proportions (based on orders in a month) are multiplied by the sub-measure percent difference to aggregate the sub-measures to the measure level.

D. IMPOSING REMEDIES AND REWARDS

The values for remedies and rewards should be directly tied to the value of each index (*i.e.*, the degree of non-compliant or super-compliant performance), the associated number of transactions, and the costs and benefits to retail consumers. We have not conducted an analysis of the appropriate remedy or reward values associated with each index as part of this paper.¹¹⁸ However, as indicated previously, an optimal remedy structure where the remedy and reward amounts are based on both costs and benefits to retail consumers is a critical component of a PMP.

1. Remedy and Reward Amounts

Developing estimates of remedy and reward amounts from the consumer perspective is critically important. The preferred way to do this is to empirically estimate the dollar value that retail consumers place on different levels of wholesale service quality (*i.e.*, their willingness to pay (WTP) for wholesale quality levels).¹¹⁹ However, because wholesale services are not delivered directly to retail consumers, developing these WTP estimates requires several steps. We recommend the following approach:

- First, develop a mapping of the relationship between wholesale service qualities and retail services provided to consumers. For example, the Florida Public Service Commission (FPSC) evaluates local telephone companies based on 38 (retail) performance standards related to dial tone delay, call completions, repair service, and other areas.¹²⁰ The National Association of Regulatory Utility Commissions (NARUC) recommends a similar set of (retail) service quality standards for local telephone companies.¹²¹ Hence, as a first step, the wholesale

¹¹⁸ As discussed in prior sections, appropriate remedy and reward values should be related to final consumer costs and benefits associated with changes in wholesale service quality. In addition, these values are likely to depend (to some extent) on regulated wholesale prices.

¹¹⁹ As discussed earlier, the ILEC delivers wholesale service quality to the CLECs; this wholesale quality is taken as an input by CLECs when providing retail quality and service to retail consumers. Consumer welfare is then dependent, in part, on retail service choices.

¹²⁰ These retail performance measures are described in Sanford V. Berg and John G. Lynch, Jr., “The measurement and encouragement of telephone service quality.” Telecommunications Policy, April 1992.

¹²¹ NARUC has developed performance-based standards for evaluating the quality of telephone service provided by telephone utilities. The current version, the Model Telecommunications Service Rules includes technical standards for installation of service, operator handled calls, network call completions, transmission and noise, and customer trouble reports. See “Telephone Service Quality Handbook,” National Association of Regulatory Utility Commissioners, March 1992.

service quality index presented in Table 1 has to be mapped to an accepted set of retail service quality measures such as those recommended by NARUC.

- Second, the quantitative relationship between wholesale service quality levels and retail service qualities has to be established. For example, if the wholesale index is 5% below parity, how does this translate into retail service qualities or if the wholesale index is 2% above parity, how does translate into retail service qualities.¹²²
- Finally, for the defined set of retail service qualities, retail consumer value (or willingness to pay) for different retail service quality levels has to be empirically established.¹²³ Berg and Lynch argue that asking experts to make trade-offs (reflecting consumer interests) between different levels of retail “performance” is preferable to asking consumers since such experts may be more aware of the consequences of changes to overall retail performance.¹²⁴ Alternatively, we believe that trade-off exercises to elicit willingness to pay directly from consumers have been successful in other areas (such as health quality and environmental quality, for example) and could be successful here. Without further investigation, it is not possible to make an a priori recommendation as to the preferred respondents for this final step.

2. Calculating Remedies and Rewards

As described earlier, a performance index with a value greater than or equal to zero indicates that SBC is providing the same or higher quality service to CLECs relative to itself or relative to a benchmark. Under a symmetric remedy structure that provides both rewards and remedies, we would compute “reward” payments for the ILEC for those indexes that are significantly greater than zero based on a statistical test. Likewise, for those indexes that are significantly less than zero based on a statistical test, we would compute “remedy” payments for the CLECs. Note that the current Texas Plan is asymmetric in that it imposes remedies but no rewards; no computation of rewards is required under this plan.

One complication in using an index is identifying a unit of measurement. We recommend using lines in service at the end of the month as the unit of measurement for the Resale, UNE-P, and

¹²² This requires estimates of how a percentage change in the index of wholesale service quality affects retail service quality. We recommend that such estimates be developed by telecommunications experts.

¹²³ Ultimately, we are interested in how wholesale quality affects consumer welfare; however, as described earlier, the relationship is complex.

¹²⁴ Sanford V. Berg and John G. Lynch, Jr., “The measurement and encouragement of telephone service quality.” Telecommunications Policy, April 1992.

UNE-L indexes. However, note that for the UNE-L index, because interconnection is included in the index, lines in service may not be entirely appropriate.^{125, 126}

The actual value of each index is a measure of non-compliant or super-compliant performance. We use this value to compute remedy or reward amounts. As an illustration, assume that hypothetical CLEC “A” is in two entry modes: UNE-P and UNE-L. Based on wholesale services provided to hypothetical CLEC “A,” the value for the UNE-P index is -0.17 and the value for the UNE-L index is 0.02.¹²⁷ Rewards or remedies are calculated for each index as follows:

- Recall that the index is computed in percent difference terms. Therefore, a value of -0.17 for the UNE-P index indicates performance that is 17 percent below the standard. A statistical test is used to determine whether the index value is significantly less than zero.¹²⁸ If so, this indicates non-compliant ILEC performance and requires a remedy calculation.
- A value of 0.02 for the UNE-L index indicates performance that is 2 percent above the standard. A statistical test is used to determine whether the index value is significantly greater than zero. If so, this indicates super-compliant ILEC performance and requires a reward calculation.¹²⁹
- Based on the statistical tests, assume that (i) the UNE-P index is significantly less than zero (*i.e.*, indicating non-compliant performance) and therefore a remedy calculation is required, and that (ii) the UNE-L index is not significantly greater than zero (*i.e.*, indicating compliant service but not super-compliant service) and therefore, a reward calculation is not necessary. If the index were *significantly* greater than zero, a reward (or credit) calculation would apply.

To calculate remedies for CLEC “A,” we use the number of lines at the end of the month (assumed to be 100) and a yet to be determined remedy level for the UNE-P index (denoted as

¹²⁵ Minutes-of-use is a more appropriate unit of measurement for interconnection services than number of lines.

¹²⁶ Note that this problem may vanish if performance measures are defined initially as components of an index with a pre-defined metric (such as number of lines at the end of the month).

¹²⁷ Recall that negative values indicate lower performance and positive values indicate higher performance.

¹²⁸ The appropriate statistical test will depend on how the overall index is ultimately specified and the approach for determining statistical significance.

¹²⁹ *Ibid.*

\$X), and the UNE-P index value (-0.17 in our example). The total remedy amount (indicated by the negative sign on the index value) to be paid to CLEC “A” is the following:

$$-0.17 * 100 * \$X = \text{Remedy Amount}$$

This is a very straightforward approach for computing rewards and remedies. Only a “remedy” amount is computed in this example. However, in the case of “rewards” to an ILEC, an acceptable approach might be to provide credits to the ILEC (rather than payments) to offset future remedies.

Estimating remedy and reward amounts (*i.e.*, incentive payments) in the context of PMPs that are related to consumer harm is critically important. In particular, imposing an appropriate remedy for low quality service will send the correct price signal and provide the ILEC with an incentive to improve quality. Likewise, imposing an appropriate reward for high quality service will send the correct price signal and provide an incentive for the ILEC to continue to improve quality. By appropriate incentive payments, we mean those that are consistent with consumer values and harms. For retail telecommunications service quality, Lynch, ET al have shown a high degree of agreement among regulators, ILECs, and retail telecommunications customers (*i.e.*, retail consumers) about the importance of different dimensions of service quality.¹³⁰ If this is so, then it may not be too difficult to take the next step and relate the wholesale levels of service quality to retail service quality and determine, ultimately, how this affects retail consumers. Such an approach, perhaps involving ILECs, CLECs, consumers, and regulators is ultimately required to develop appropriate incentive-based payment amounts.

VII. ADVANTAGES OF MODIFYING EXISTING PMPS

We believe that our proposed modifications to existing PMPs have several advantages. First, and perhaps most importantly, the index approach incorporates weights that are based on the relative importance of each wholesale service quality dimension to overall consumer welfare.

¹³⁰ J. G. Lynch, Jr., T. E. Buzas, and S. V. Berg, “Regulatory Measurement and Evaluation of Telephone Service Quality.” *Management Science*, Vol. 40, No. 2. February 1999. pp 169-194.

This means that every performance measure is not treated equally (as is the case under the Texas Plan) and that the weights account for the varying “importance” of each measure to retail consumers. In particular, the weights reflect the benefit (or cost) to retail consumers of a marginal improvement (or reduction) in wholesale performance. Second, high performance on one dimension of the wholesale quality index can offset low performance on another. Therefore, the ILEC gets “credit” for high performance but only to the extent that this “high” performance is valued by retail consumers. Third, under an index approach, a symmetric incentive structure (including both rewards and remedies) is accommodated (and is straightforward). Fourth, consistent with incentive regulation, the index approach allows the ILEC to manage the provision of wholesale service quality and flexibility to act on its own private information. Specifically, the ILEC can allocate resources to deliver wholesale service quality consistent with the value of those services to CLECs and consumers. Ultimately, this expands the opportunity set for CLECs and enables different CLEC business models which may benefit consumers. Fifth, the use of an index results in a great reduction in the number of statistical tests. Related to this, the index reduces the extremely high likelihood that one or more Type I errors will occur when multiple measures are tested for a CLEC (such errors result in erroneous remedy payments by the ILEC to the CLEC).¹³¹ A final advantage (to *ILECs* and CLECs, respectively) is the smaller burden of associated reporting and reviewing of results.

VIII. NEXT STEPS

We currently have much of the information to begin to modify existing PMPs based on two of our three recommendations – replacing individual performance measures with an index approach and incorporating rewards as well as remedies into the remedy structure. However, little information is available to implement our third recommendation, linking remedy and reward values to retail consumer costs and benefits. In addition, an approach for developing these values in the context of PMPs is not well understood. A crucial next step is developing the missing link between incentive payment amounts and consumer welfare.

¹³¹ Note that if a single index is computed for each CLEC, the Type I error problem associated with performing multiple tests is eliminated completely and only a Type I error for a single test remains.

In summary, the modifications we propose to existing PMPs will take us several steps toward a plan that is based on sound economic principles. In particular, the proposed PMP design:

- Reduces the number of performance measures to a critical set;
- Incorporates a broad-based index approach to measuring overall wholesale service quality rather than micro-managing individual performance sub-measures.
- Accommodates sound and appropriate statistical testing;
- Makes it much less likely that an ILEC will pay remedies when it provides parity service (resulting in a subsidy to a CLEC and a tax to the ILEC). This is due to the great reduction in the likelihood that one or more Type I errors will occur;
- Includes rewards as well as remedies, thereby creating incentives to improve quality beyond current levels; and
- Demonstrates why remedy amounts should be based on “economic harm” to retail consumers.

Table 1: Mode of Entry Index for Resale, UNE-P, and UNE-L CLECs

		Mode of Entry		
		Resale	UNE-P	UNE-L
PreOrder/Order Measures		Weights		
PM 4	OSS interface availability	4.0%	4.0%	3.0%
PM 5/5.2	Percent firm order confirmations (FOCs) returned on time/within X days	1.0%	1.0%	1.0%
PM 7.1	Percent mechanized completion notifications available within one day or work completion	3.0%	3.0%	2.0%
PM 10/10.1	Percent mechanized/manual rejects	1.0%	1.0%	1.0%
PM 12.2	Percent mechanized line loss notifications returned	2.0%	2.0%	2.0%
Provisioning Measures				
PM 29	Percent SWBT caused missed due dates	25.0%	25.0%	-
PM 32	Avg. delay days for SWBT caused missed due dates	6.0%	6.0%	-
PM 35	Percent POTS/UNE-P trouble report within 10 days of installation	10.0%	10.0%	-
PM 58	Percent SWBT caused missed due dates (UNEs)	-	-	14.0%
PM 59	Percent intallation (trouble) reports within 30 days of installation (UNEs)	-	-	7.0%
PM 62	Avg. delay days for SWBT caused missed due dates (UNEs)	-	-	5.0%
PM 114.1/115.2	CHC/FDT LNP with loop provisioning interval. Percent with CHC/FDT with loop lines combined average	-	-	9.0%
Maintenance Measures				
PM 37.1	Trouble report rate net of installation and repeat reports	8.0%	8.0%	-
PM 39	Mean time to restore	21.0%	21.0%	-
PM 41	Percent repeat reports	12.0%	12.0%	-
PM 65.1	Trouble report rate net of installation and repeat reports (UNEs)	-	-	7.0%
PM 67	Mean time to restore (UNEs)	-	-	17.0%
PM 69	Percent repeat reports (UNEs)	-	-	11.0%
Interconnection Measures				
PM 70	Percentage of trunk blockage	-	-	5.0%
PM 73	Percentage of installations completed within the customer rquested due date	-	-	2.0%
PM 76	Avg. trunk restoration interval - interconnection trunks	-	-	2.0%
PM 107	Percentage missed collocation due dates	-	-	4.0%
PM 108	Avg. delay days for SWBT missed due dates	-	-	1.0%
PM 109	Percent of requests processed within the tariffed timelines	-	-	1.0%
Billing/Databases Measures				
PM 1.2	Accuracy of loop makeup information provided for DSL orders	-	-	1.0%
PM 16	Percent of accurate usage records transmitted	3.0%	3.0%	0.0%
PM 17.1	Service order posting	4.0%	4.0%	2.0%
PM 104	Average time required to update 911 database	-	-	1.0%
PM 110	Percent of updates completed into the DA database within 72 hours	-	-	1.0%
PM 113	Percent of electronic updates that flow through DSR process w/o manual intervention	-	-	1.0%
Total:		100%	100%	100%