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Pricing Access to Incumbent Telecommunications Networks:
The Law and Economics of *Verizon* v. *FCC*

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This paper is part of a work-in-progress that examines both the legal and economic dimensions of the FCC's regulations governing the prices that incumbent local telephone companies can charge competitors for use of the incumbents' network facilities. These regulations are known as the "TELRIC" rules, where TELRIC is short for "total element long run incremental cost." Those rules are currently pending review by the United States Supreme Court on claims that the rules (1) fail to provide constitutionally adequate compensation to the incumbent firms for their costs of providing network access, and (2) are inefficient and administratively irrational. The paper from which this shorter paper is drawn examines both the legal claims and the associated economic questions. The portion that follows focuses more narrowly on how the FCC's TELRIC pricing rules work, and explains conditions under which they would or would not compensate incumbent firms for their costs and reasonably satisfy conflicting efficiency considerations. This paper argues that the TELRIC pricing rules do not necessarily confiscate the past investments of incumbent telephone companies, but that under the interpretation that has governed application of the rules to date, the regulations will both undercompensate the incumbents and lead to inefficient entry and investment decisions on a forward-looking basis. This paper then suggests two possible ways to apply the rules that avoid these problems and examines which of theses two alternatives is economically preferable.

INTRODUCTION

In the opening session of its 2001 term, the United States Supreme Court will hear the case of

Verizon v. *FCC*. This will be the first case in years in which the Court directly examines a pricing regulation. The particular rule at issue was promulgated by the Federal Communications Commission in 1996 pursuant to the Telecommunications Act of 1996. The Act required incumbent local exchange carriers ("ILECs") to open their networks for use by new entrants into the local telephone business, and to do so at rates based on "cost." The FCC adopted a regulation limiting the price incumbents could charge for access to a network facility to the forward-looking, long-run, incremental cost of purchasing, operating, and maintaining that facility. The Commission termed its regulatory pricing approach "TELRIC," standing for total element long-run incremental cost. That rule has been challenged by the incumbent companies both as violating the Fifth Amendment's Taking Clause and as being administratively irrational, arbitrary, and capricious. The petitioners allege that TELRIC unconstitutionally confiscates past, but as yet unrecovered investment in their networks, and will continue to undercompensate them for investments they make in their networks in the future. The result, petitioners argue, is a taking of their property and an inefficient policy that undermines the 1996 Act's objectives.

This paper will examine the FCC's TELRIC regulation in light of the constitutional and administrative challenges before the Court in *Verizon* v. *FCC*. It concludes that TELRIC as applied to date under the FCC's rules does not necessarily confiscate the incumbents' historical investments, but that it does systematically undercompensate the incumbents in a forward-looking basis and will provide inefficient entry incentives for new firms as well as inefficient investment incentives for incumbent carriers. The paper finds, however, that there are ways to revise the TELRIC approach such that it stays true to the Commission's objectives while providing reasonably efficient incentives for incumbents and new entrants alike.

This paper is organized as follows: the first section provides a background discussion of the 1996 Act and the FCC's TELRIC rules. Part two examines the mechanics of TELRIC and analyzes both the compensation and efficiency consequences of TELRIC regulation as interpreted by the Commission, and then discusses possible improvements to that rule. Section three concludes.

I. THE 1996 ACT AND ITS IMPLEMENTATION

The Telecommunications Act of 1996 radically revised prior law in the United States by

eliminating state-imposed barriers to local exchange competition and by requiring existing local exchange carriers to cooperate with potential competitive entrants. The goal of the Act was clear: to facilitate, to the extent possible given the economics of the industry, competition in the "local loop"–the part of the telephone network that connects directly to individual end-users.

The simplest, yet in historical context most significant, provisions of the Act are those that make it legally possible for new entrants—usually called "competitive local exchange carriers" or CLECs—to build their own competing local telephone networks and to enter into competition with incumbent carriers. Competitors who choose to build their own infrastructure are known as facilities-based competitors. The provisions most relevant to their efforts are section 253(a), which preempts state and local laws that create barriers to entry into the local exchange markets, and sections 251(a) and 251(c), which require rival local exchange carriers to exchange traffic with entrants such that customers on any one telephone network can communicate with customers on every other network. Note the important consequences of these provisions. Section 253 stops state regulators from protecting particular local exchange carriers, as states had done since the 1920's. In most jurisdictions in the U.S., even a firm that built its own, state-of-art network would have been unable until passage of the 1996 Act to enter into competition with the incumbent franchise monopoly. The interconnection provisions of §251, meanwhile, stop those incumbent carriers from using their larger network externalities[1] to foreclose rivalry. Refusal by the existing local exchange carrier to interconnect with a rival's system would mean that customers of the new firm would be unable to call, or receive calls from, anyone not on the new network—a result that would effectively eliminate the new firm's business prospects, even if it were to build the best possible rival network.[2]

A more complicated set of provisions in the1996 Act attempt to facilitate entry by firms that would not or could not build complete local telephone networks of their own but that would, if

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[1]A network externality can arise when a product or service is one whose value to any individual consumer increases with the number of other consumers who use the product or service. The telephone network is a classic example: it becomes more valuable to each subscriber as the number of people connected to the network increases and, hence, so too does the number of people the individual subscriber can call.

[2] If the new entrant were able to gain a majority of subscribers, network effects would start to work in its favor. But getting to that point without interconnection would be difficult.

allowed, compete with rival local exchange carriers by providing some services and infrastructure on their own while purchasing other inputs from rivals. These provisions thus attempt to foster entry by forcing incumbent carriers to make their services and infrastructure available to competitors at regulated rates. The two pertinent statutory provisions are those for resale of incumbent services[3] and for "unbundling" of incumbent network facilities. The paper focuses on the latter and, more specifically, addresses the pricing rules that apply to network unbundling.

Section 251(c)(3) of the 1996 Act entitles competitive local exchange carriers ("CLECs") to purchase access, at regulated rates, to particular components of an incumbent's existing telephone network. The Act refers to these components as unbundled "network elements" (or "UNEs") and permits new entrants to use such elements to provide local telephone service without incurring the up-front costs of building an entire new network. Section 251(c)(3) requires incumbent local exchange carriers "to provide, to any requesting telecommunications carrier for the provision of a telecommunications service, nondiscriminatory access to network elements on an unbundled basis at any technically feasible point on rates that are just, reasonable, and nondiscriminatory . . .." In other words, the existing local telephone companies had to make parts of their networks available to new entrants seeking to provide competing service. Thus, the incumbents' switches (the computers that route telephone calls), transport lines, customer loops (the lines connecting individual customers to the network) and other facilities must be accessible on "reasonable" terms to new entrants into the local telephone market. The ready legal analogy to the unbundling rules is the "essential facilities" doctrine in U.S. antitrust law.

Section 251 posed two key questions for regulators: (1) which network elements should an incumbent firm have to unbundle and (2) at what prices? On August 8, 1996, the Federal Communications Commission issued a massive order establishing regulations to implement the local competition provisions of the Telecommunications Act of 1996.[4] The Order (the "First Report and Order") addressed both the required scope of network unbundling and the price terms on which it

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[3]Under sections 251(b)(1) and 251(c)(4), a CLEC has the right to purchase (at regulated wholesale rates) telecommunications services from a rival and then resell those services directly to consumers under the CLEC's own name.

[4]In Re Implementation of the Local Competition Provisions of the Telecommunications Act of 1996, First Report and Order, 11 FCC Rcd. 15499 (1996).

would occur. The scope of unbundling is not relevant to this paper, although it is worth noting by way of background that the FCC modestly reduced[5] its original list of unbundled elements after the ILECs successfully challenged that list in the Supreme Court.[6] What is relevant here is what the Commission said about pricing, to which we now turn.

A. The FCC's Pricing Rule for Network Unbundling

When the Commission turned to the question of pricing for unbundled network elements in the First Report and Order, it adopted a pricing scheme that it called TELRIC. In the FCC's own words:

> [T]he Commission concludes that the state commissions should set arbitrated rates for interconnection and access to unbundled elements pursuant to a forward-looking economic cost pricing methodology. The Commission concludes that the prices that new entrants pay for interconnection and unbundled elements should be based on the local telephone companies' Total Service Long Run Incremental Cost of a particular network element, which the Commission calls "Total Element Long-Run Incremental Cost" (TELRIC), plus a reasonable share of forward-looking joint and common costs. States will determine, among other things, the appropriate risk-adjusted cost of capital and depreciation rates.[7]

In its *First Report and Order*, the FCC explained that forward-looking methodologies, like TELRIC, consider the costs that a carrier would incur in the future for providing access to network elements based on optimal network investment starting today. The forward-looking nature of TELRIC raises a question of *which* network elements should factor into the TELRIC calculation. Should costs be based on the most efficient network that could be built from scratch today with the best available current technology? Or, should costs reflect efficient use of the ILEC's existing network infrastructures? Or, should costs be calculated assuming some forward-looking configuration to which the network is predicted to evolve from its current configuration? The FCC chose an approach in which it tried to base element prices on efficient technology while recognizing that rational carriers

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[5]In Re Implementation of the Local Competition Provisions of the Telecommunications Act of 1996, Third Report and Order, 15 FCC Rcd. 3696 (1999).

[6]AT&T Corporation v. Iowa Utilities Board, 525 U.S. 366 (1999).

[7]First Report and Order at ¶ 29.

do not completely reconfigure their networks every time a new technological breakthrough occurs. Pursuant to section 252(d)(1), the FCC promulgated 47 C.F.R. §51.505 entitled "Forward-looking economic cost." That regulation states in part that "the total element long-run incremental cost of an element should be measured based on the use of the most efficient telecommunications technology currently available and the lowest cost network configuration, given the existing location of the incumbent LEC's wire centers." 47 C.F.R. §51.505(b)(1).

The regulation just cited offers some guidance, but raises some perplexing questions. While the provision tells us that the TELRIC calculation should not be based on a completely hypothetical network (the cost model for a network must at least assume the actual locations of the network's central offices, which is where switches are located and typically where a customer's individual line connects to the rest of the network through a switch), it is not precise about what "use of the most efficient telecommunications technology available" means. A strong reading of the language suggests that an incumbent must be assumed to have the most advanced switch, loop, and other network technology in place at every point in its network. Thus, even if the incumbent in fact has an older switch in place, its costs will be modeled as if that switch had been replaced by the latest available model. An alternative reading is that the ILEC will be assumed to have incorporated the best available technology where efficient to do so, but not at every point in its network because in many cases it would not yet be cost effective to do so. In that case the cost model for TELRIC would incorporate a mix of existing and new facilities.

In the end, there is still debate over how §51.505(b)(1) should be applied. But the Commission itself and many state regulatory agencies have adopted the stronger reading and, with the strong support of new entrants, adopted a model that assumed the best available technology had been completely deployed throughout incumbent networks (the "full replacement" assumption). The arguments supporting that assumption have usually emphasized that the incumbent monopolies should not be able to charge new entrants more for unbundled network elements than a competitive telecommunications firm would charge and, the argument goes, a competitive firm would have to deploy the most efficient technology or else be pushed out of the market. This paper will address that argument later in the context of assessing the efficiency consequences of the full replacement assumption. But we turn first to a discussion of what legal and economic considerations may have led the FCC to adopt its TELRIC rule.

B. The Objectives of TELRIC

Why did the FCC adopt TELRIC? It appears to have done so to compromise among several conflicting considerations that come into play in setting regulated prices for network inputs. First, the FCC could not completely ignore the issue of just compensation for the ILECs, not just for reasons of general fairness, but because the U.S. Constitution imposes some such requirements as well through the Takings Clause of the Fifth Amendment. The FCC knew that incumbents would argue that the regulated price must be high enough so as to allow the recovery not just of its marginal costs, but also of some fair proportion of its fixed costs. Too low a price would inevitably spark complaints from ILECs that the regulation imposes an unfair burden and perhaps even causes an unconstitutional "taking" of their property.

Second, UNE prices will affect an ILEC's future incentives to innovate. If an ILEC knows that its facilities will be offered to rivals at regulated rates and, moreover, thinks that those rates will be too low for the ILEC to recover its risk-adjusted costs, then the ILEC might be reluctant in the future to invest in new network technologies. This is particularly troubling if we think that, because of their years of experience and considerable resources, incumbents are particularly well-situated to engage in innovation.

Third, UNE prices raise short-term efficiency concerns. If a competitor must pay a price above marginal cost, it may inefficiently under-consume access to network elements. If the regulated price exceeds marginal cost, firms willing to pay more than marginal cost but less than the regulated price will not purchase access. Conversely, prices below marginal cost might lead to over-consumption by competitors of the incumbents' network facilities.

Finally, the FCC had to consider competitors' incentives to invest in developing network technology of their own. If ILECs' equipment is available at bargain basement prices, CLECs will be less likely to venture into the business of developing new equipment. This might not matter if we believe that ILECs will handle all necessary innovation; but, to whatever extent we want CLECs to innovate, this is a significant concern. Conversely, if ILEC equipment is priced too high, CLECs might build their own infrastructure even in cases where society would prefer that the CLEC just share the existing equipment. CLECs would be building not because the new infrastructure was cost-justified, but instead because the regulated price was so artificially high that the CLEC would rather build than

pay the regulated rate. (Of course, in this situation the ILEC might voluntarily lower its asking price and in that way avoid the inefficient build-around.)

The reason it is so difficult to price unbundled network elements is that it is difficult to write a rule that simultaneously responds to all four of the above concerns. Allow the incumbent to recover some of its up-front investment by charging more than marginal cost, and the network element may be underused from the perspective of static, allocative efficiency. But force the incumbent to charge marginal cost and not only must the incumbent absorb a significant loss, but in the future incumbent firms will hesitate to invest in new technologies while new entrants never internalize the full costs of market entry.

Faced with these competing considerations, the FCC chose what looks like a rule that sacrifices some degree of allocative efficiency in order to compensate the ILECs for efficient investment. Under the Commission's TELRIC regulations, the price an entrant pays for access to an incumbent's network element reflects the ILEC's marginal (or average variable) costs *plus* (1) a proportional share of most other, non-marginal costs associated with the relevant network element and (2) the possibility of a reasonable return on investment. To be more specific, were an incumbent to install a new switch today, under TELRIC that incumbent would be allowed to charge CLECs a price for access that would include (1) any costs directly attributable to the CLECs' use (marginal costs); (2) a proportional share of the depreciation in the switch's value from use over time; (3) a proportional share of overhead costs associated with switch use (personnel costs, billing costs, and so on); and (4) a share of the risk-adjusted cost of the capital invested in the switch (either interest paid or the foregone returns on alternative investments). TELRIC thus seems to establish prices that are above marginal cost—indeed, prices that allow ILECs to recover all of the costs associated with any particular network element.

Two aspects of the Commission's TELRIC rule complicate this simple logic, however. First, the FCC decided that, when calculating rates under TELRIC, it would not consider the "embedded costs" of facilities put in place before the Act. These embedded costs include any portion of the fixed costs of building the network that the incumbent had not yet recovered through its service prices. Thus, for network equipment already in place when Congress passed the 1996 Act, not all costs will necessarily be recovered under TELRIC, because some historical costs–costs that were perhaps efficiently incurred but remain unrecovered–would be stranded.

Second, the FCC decided that TELRIC should adjust over time to reflect the most efficient technology at any point in time. As discussed, the Commission ruled that "the total element long-run incremental cost of an element should be measured based on the use of the most efficient telecommunications technology currently available and the lowest cost network configuration, given the existing location of the incumbent LEC's wire centers." 47 C.F.R. §51.505(b)(1). So even the price of access to new, cutting-edge equipment will decline after that equipment is installed if technology changes. The Commission's rule therefore appears to require UNE prices that will reflect the real costs of an incumbent LEC's actual network only when, if ever, that network happens momentarily to be the most hypothetically efficient network that could be built.

In response to a challenge by the ILECs to TELRIC, the United States Court of Appeals for the Eighth Circuit rejected the FCC's efficient-network rule on the following grounds:

> [B]asing the allowable charges for the use of an ILEC's existing facilities and equipment (either through interconnection or the leasing of unbundled network elements) on what the costs would be if the ILEC provided the most efficient technology and in the most efficient configuration available today utilizing its existing wire center locations violates the plain meaning of the Act. It is clear from the language of the statute that Congress intended the rates to be "based on the cost ... *of providing the interconnection or network element,*"§252(d)(1)(A)(i) (emphasis added), not on the cost some imaginary carrier would incur by providing the newest, most efficient, and least cost substitute for the actual item or element which will be furnished by the existing ILEC pursuant to Congress's mandate for sharing. Congress was dealing with reality, not fantasizing about what might be. The reality is that Congress knew it was requiring the existing ILECs to share their existing facilities and equipment with new competitors as one of its chosen methods to bring competition to local telephone service, and it expressly said that the ILECs' costs of providing *those* facilities and *that* equipment were to be recoverable by just and reasonable rates. Congress did not expect a new competitor to pay rates for a "reconstructed local network," *First Report and Order* ¶685, but for the existing local network it would be using in an attempt to compete.

The Court of Appeals stayed its order, however, pending review of its decision by the United States Supreme Court. The Eight Circuit's decision is what is now before the Supreme Court in *Verizon* v. *FCC*. In the meantime the Commission's TELRIC rules remain in force.

II. THE MECHANICS AND ECONOMIC CONSEQUENCES OF TELRIC

How does TELRIC work? The FCC's explanation of TELRIC does not provide details of the method's implementation. Both of the constraints on UNE pricing set forth in the FCC's local competition order–that "embedded costs" of plant actually in place at the time the 1996 Act was passed cannot be recovered through TELRIC prices, and that those prices must reflect the costs of the best technology currently available–give some direction to how firms should calculate UNE prices. Both of those limiting rules also raise interesting questions for competition policy in telecommunications because they are directly relevant to the effect of TELRIC pricing on cost compensation and investment incentives. This section will examine the efficiency and compensation properties of TELRIC both for network equipment already in place at the time of the 1996 Act ("legacy equipment") and for new equipment purchased after Congress passed the Act.

A. TELRIC, Legacy Networks, and Embedded Costs

Before the 1996 Act, local exchange companies invested in their networks for purposes of providing retail services to subscribers, and they did so against the backdrop of regulation that constrained the returns they could earn either through capping those returns directly (rate-of-return regulation) or, later, through capping the prices the carriers could charge their subscribers (price-cap regulation). The 1996 Act changed the incumbents' investment calculus in two major ways. First, it required ILECs to consider not only subscribers' demand for retail services, but also competitors' demand for network elements, in deciding how to expand and upgrade their networks. Second, the Act gave rise to a different pricing standard (TELRIC) for network elements than what had been in place for retail service offerings. But the 1996 Act did not apply only to new network investments made after passage of the Act–indeed such a restriction would have made no sense given the Act's objectives. The Act, and the FCC's implementing regulations like TELRIC, accordingly applied to network equipment that was already in place before 1996. As a result, ILECs that had made investment decisions taking into account one set of regulatory constraints found their ability to recover those investments being governed by an additional set of constraints. The incumbents have been most concerned about TELRIC's prohibition on recovery of "embedded" costs, which the ILECs have contended amounts to confiscation of their past investments. This section examines, first, whether the embedded-cost prohibition TELRIC will necessarily under-compensate ILECs for past network

investments and, second, the efficiency consequences of that prohibition.

1. Compensation for embedded costs

How does TELRIC affect an ILEC's ability to recover the costs of network facilities that were installed prior to the 1996 Act? At first glance, the FCC's pricing rules appear to constrain ILECs to recovering only the forward-looking variable costs of that equipment. The Commission's local competition order states unequivocally that "embedded" costs of legacy equipment cannot be recovered through UNE pricing. Embedded costs consist of all undepreciated, fixed equipment costs that the ILECs otherwise would have expected to recover through their regulated retail rates. Under the 1996 Act, however, some of that network equipment will not be used by the ILEC to provide retail service but instead by a new entrant who will lease the equipment from the ILEC to provide competing retail phone service. Where the facilities involved were installed before the 1996 Act, the FCC's TELRIC rules prevent the ILECs from including a portion of their unrecovered fixed costs in the rates the new entrants pay for use of those facilities. On its face, then, the local competition order appears necessarily to under-compensate the ILECs for competitors' use of such legacy facilities. Closer parsing of the workings of TELRIC, however, shows that such under-compensation is not certain to result. To see why, consider the following example.

Suppose an ILEC installed a new, state-of-the-art switch in 1995 and expected to use the switch for 10 years. Suppose further that the switch cost $1 million and depreciates at the constant rate of $100,000 per year. If a competitor sought to use that switch on an unbundled basis in 2000, what price could the ILEC charge the competitor? The FCC's local competition order makes clear that the actual $500,000 (the remaining undepreciated fixed costs) still embedded in the switch could not be included in the calculation of the price for the competitor's use of the switch. It would therefore appear that the ILEC could only charge the entrant the marginal, or short-run average variable, costs of using the switch. This is the interpretation implicit in the argument made by many ILECs and other commentators that the FCC's TELRIC rules necessarily under-compensate ILECs for their pre-existing networks.

The FCC's rules do not, however, constrain access prices for legacy equipment to the marginal costs of that equipment. Instead, they prescribe the same pricing rule for legacy equipment that they

prescribe for new equipment installed after passage of the 1996 Act: the long-run incremental costs of the best available technology for the network element at issue, *i.e.* TELRIC. And TELRIC does include a measure of fixed cost recovery, just of a hypothetical facility rather than the actual network element at issue. For legacy equipment, the question relevant to determining whether TELRIC under-compensates is whether the depreciation allowance in the TELRIC price is less than the depreciation that would be necessary to recover the embedded costs of the actual legacy facility. If the legacy facility was installed only a short time before the 1996 Act took effect, then it is likely that there are substantial embedded costs that will not be fully recovered through TELRIC. If, on the other hand, the piece of equipment to be leased by the new entrant is old and near the end of its accounting life, then it is possible that TELRIC not only compensates, but perhaps even overcompensates, for embedded costs.

A simple algebraic representation more clearly illustrates the point. The equations that follow use the following notation: R = revenue, C = total costs, E = embedded costs, k = costs of capital, d = depreciation, j = joint and common costs, and s = short-run variable costs. The subscript L denotes previously installed "legacy" equipment, the subscript N denotes "new" equipment installed after the 1996 Act, and the subscript B denotes "best-available" equipment at any point in time.

Consider a vector of costs = $C(d, k, j, s)$, which represents the total forward-looking costs of a network element.

C_N = actual forward-looking costs of a *new* piece of equipment = $C(d_N, k_N, j_N, s_N)$

C_L = actual forward-looking costs of *legacy* plant = $C(d_L, k_L, j_L, s_L)$

C_B = TELRIC, the forward-looking costs of the *best available* plant = $C(d_B, k_B, j_B, s_B)$

Let E = embedded costs of legacy plant, where $E = (k_L + d_L)$

Because FCC rules state that the price for a previously installed network element, P_L, must be based on costs of legacy plant net of embedded costs, the rules appear to imply that:

$P_L = C_L - (k_L + d_L) = (j_L + s_L)$.

That would mean that P_L would be equal only to the short-run incremental costs of the legacy plant. But that is not, in fact, the case under the Commission's TELRIC rules. What the rules do is to make TELRIC the price for *all* unbundled network equipment, both new and already installed. So P_L = TELRIC = $C(d_B, k_B, j_B, s_B)$.

To compensate the ILEC for its total forward-looking costs of legacy plant, the price for

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unbundled access to a piece of legacy equipment must satisfy the condition that P_L \$ C_L, which from the above translates into the condition that TELRIC \$ C_L. Breaking this down, whether or not TELRIC will be compensatory for legacy plant depends on whether the following condition is satisfied:

$$[(d_B + k_B) - E] + [(s_B + j_B) - (s_L + j_L)] \; \$ \; 0.$$

Under the realistic assumption that the best-available technology today is more efficient to operate than previously installed legacy technology, short-run incremental costs of the best technology will be lower than the short-run incremental costs of legacy plant. Therefore, it is most likely that $(s_B + j_B) - (s_L + j_L) < 0$. Accordingly, whether the compensation condition holds depends on the relationship between E and $(d_B + k_B)$. And this relationship is much harder to predict or to make assumptions about than the relationship between actual and hypothetical short-run costs. The reason, as discussed earlier, is that the older the legacy plant is, the lower the accounting value of E is because the more it has been depreciated on the company books. Age of plant could thus make the remaining depreciation, d_L, and the remaining capital costs, k_L, quite low. Accordingly, because plant is installed incrementally over time, it is likely that for some legacy plant, $E < (d_B + k_B)$ while for other plant $E > (d_B + k_B)$. Whether TELRIC compensates for embedded costs of legacy plant is thus uncertain. It definitely makes some contribution towards embedded costs, but depending on the age of the plant it may either under-compensate, over-compensate, or get compensation just about right for those costs. The question of compensation for historical costs of legacy equipment is therefore an empirical one that hinges on the distribution of equipment ages throughout an ILEC's network.

In those cases where TELRIC does compensate adequately for embedded costs, *i.e.* where $(d_B + k_B)$ \$ E, the question of whether TELRIC is compensatory overall depends on whether the excess compensation for depreciation and capital costs exceeds the under-compensation for short run operating costs; *i.e.* on whether: $(d_B + k_B) - E$ \$ $(s_B + j_B) - (s_L + j_L)$.

In sum, the above analysis illustrates that TELRIC pricing for network equipment already in place at the time congress passed the Act could, in principle, just as well overcompensate as undercompensate ILECs. This result may appear counterintuitive given the FCC's prohibition on recovery of actual embedded costs through TELRIC prices, but it in fact flows logically from the way the FCC's rules decouple TELRIC prices from the costs of actual network facilities. The key point is that the FCC's prohibition on recovery of actual embedded costs does not mean that only the short-run variable costs of existing networks can be recovered.

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2. Efficiency and embedded costs

The above analysis demonstrates in simple form that under TELRIC pricing, the undepreciated costs of legacy networks might be fully or partially recovered. In other words, the book value of the legacy networks might not be entirely stranded. But it is not necessarily inefficient on a forward-looking basis to leave stranded costs in the network. First, the ILECs' inability to recover past, embedded costs of legacy equipment should not affect their forward-looking investment decisions. Of course, when that non-recovery was due to regulatory change, the carrier might perceive risk of further changes in the regulatory environment, and will factor such risk into its future investment decisions. But assuming the regulator can credibly commit to a regime going forward, the ILECs' past losses should not affect future operations.

Second, and more generally, there may be a difference between compensation for network costs, on one hand, and efficiency on the other. Sometimes it would be inefficient for firms to recover even those costs that reasonably appeared efficient at the time they were incurred. To see why, consider a network operator that has a switch in place that is only half depreciated and has a book value of $10,000. Assume the switch costs $1000 per-year to operate and maintain. Now assume that a new switch has been developed that costs $10,000 to purchase and costs only $100 per-year to operate and maintain. Over a five year planning horizon, the carrier expects to pay $5000 to operate and maintain the existing switch. If, instead, it purchased the new switch, it would have costs over the next five years of $10,000 + 5($100) = $10,500. In this scenario, the carrier does not switch to the new technology because its existing plant still has an *economic* value (as opposed to book value) of $10,500 - $5000 = $5,500; *i.e.* the difference between the costs of deploying the new switch and the costs of continuing to deploy the pre-existing switch. This illustrates how the economic value of capital (here $5,500 after the technology change) may be much less than book value (here $10,000). Where such is the case, compensation for book value pays the firm more than the market value of the asset and is accordingly a waste of resources.

Now, suppose that the new switch that has just been put on the market marks an even more radical improvement over the previously installed switch, and that it costs only $3000 to purchase and $80 per-year to operate and maintain. Then, over the same 5 year planning horizon, the firm calculates that the existing switch will, again, cost $5000 to operate and maintain while the new switch would

cost $3000 + 5(\$80) = \$3,400$. At this point the existing switch has no economic value and the firm immediately switches to the new technology, notwithstanding that the existing switch is not fully depreciated and that the unrecovered fixed costs of that switch will be stranded.

The point of the above discussion is to show that even in those cases where TELRIC does not compensate the incumbent carrier for its actual embedded costs, it may not be inefficient. If there is a better technology such that the firm should rationally replace its existing, undepreciated plant, then there is no economic reason that prices for access to the new plant must compensate for the stranded costs of the old, and there is no economic reason that a competitor should have to pay the costs of any old plant that the incumbent has inefficiently failed to replace.

Where the problem with TELRIC arises is in cases where the new plant is more efficient than the existing plant, but not enough so to eliminate the economic value of the existing plant. In those cases, TELRIC-based prices for network elements might inefficiently under-compensate the incumbent carrier by treating it as if it had too quickly switched to the new technology and thereby had not only stranded book value, but wasted economic value as well. This point is further developed below.

B. TELRIC Pricing and Forward-Looking Investment

Suppose that a telecommunications firm has efficiently decided to replace old network equipment with new facilities. How does TELRIC compensate for use of new local exchange facilities? The costs of network equipment installed after the Act can, in principle, be fully recovered under TELRIC. Indeed, as the previous section makes clear, TELRIC in theory allows depreciation, capital costs, and short-run operation and maintenance costs all to be recovered. The problem for ILECs, and the controversy for TELRIC, involves how technological change affects cost recovery over time.

Consider an ILEC that purchases a new switch at time t_0. Assume that when the switch is purchased, it is the most technologically advanced on the market. At that moment, TELRIC will reflect the actual costs of the switch. In a static world where technology does not change, or changes so slowly that the switch will be at the end of its useful life by time a better one comes along, there will be no divergence between TELRIC and actual costs of the new switch. But the technological environment of telecommunications is not, of course, so static. The risk for the ILEC purchasing a new

switch at t_0 is that a better one comes along at t_1, at which point the FCC rules require TELRIC to adjust downward to reflect the greater efficiency of the new, best-available technology. This is where the FCC's hypothetical network rule has effect and raises the risks of either under-compensation for forward looking network investment or inefficiently fast replacement of network plant.

1. Inefficiency of a full-replacement assumption

The most aggressive interpretation the "best available technology" requirement of TELRIC is that the ILEC must model its forward-looking costs as if it will truly replace all of its existing network every time better technology becomes available. Of course, no rational firm would in fact tear out its facilities and replace them in so wholesale a manner with each technological advance. To do so would be to waste substantial economic value each time the network was replaced. New equipment may be better, but it might not be efficient to deploy it the moment it becomes available. Suppose you drive an old car that gets 20 miles-per-gallon, needs an annual tune-up, and costs $500 per year to operate. If a new model appears that gets 50 miles-per-gallon, needs to be tuned only every five years, and costs only $200 per year to operate, you won't necessarily junk your car and buy the new model. For, when you factor in the remaining life in your old car and the purchase price of the new car, it might be cheaper over the foreseeable future to keep the older car. The same considerations apply to a firm's replacement of network equipment.

If replacement does occur every time technology improves, the firm's forward-looking costs will likely be quite high and, correspondingly, so would prices for network elements. A firm that anticipates having to discard an asset as soon as a more advanced version hits the market will not invest unless it can depreciate the asset fully by time technology next changes. Depreciation allowances in a full-replacement model would therefore be very high compared to depreciation in a model that allows the firm to replace network equipment not based on comparative technology, but based on comparative economic value of old versus new equipment. By repeatedly causing assets to be replaced, a full replacement model will often waste economic value, inefficiently increase the amount of resources devoted to network functions, and drive up UNE costs.

Why then would the FCC and some CLECs advocate a full-replacement model? The answer may be that they did not intend to treat the ILECs as if they had actually replaced their networks, but

only as if they were under competitive pressure to price UNEs as if the network had been replaced with the best available technology. The idea then appears to be that the ILECs price as if their operating and maintenance costs are those of the best, rather than existing, equipment. So perhaps what the Commission and the new entrants had in mind was that existing equipment stays in place where it is efficient to keep it, but that UNE prices decline based on the assumptions that the short run costs of that equipment have declined to match the short-run costs of the latest technology. In other words, that UNE prices should reflect the benefits of the best-available technology without reflecting all the capital and depreciation costs that would truly be involved in deploying that technology throughout a given network. Yet the economic logic of this idea and its consistency with TELRIC pricing are hazy.

If what the FCC means is that incumbents must match the total, long-run incremental costs incurred by new entrants who have installed the latest technology, then those costs should include the capital and depreciation costs of the new technology, which the new entrant would have had to incur. The new UNE price should not, then, be a hybrid that combines the lower depreciation and capital costs of the existing technology with the lower short- run costs of the new technology. The correct efficiency calculation does not mix and match: it compares the short-run costs of the existing technology with all the forward-looking costs of the new technology, and only switches over if the latter are lower than the former. The key point here is that, if the incumbent has made an efficient decision not to replace a network element, it has done so because the long-run costs of the existing technology are *lower* on a forward looking basis than the costs of the new technology. It makes no sense, then, to further lower the incumbent's UNE prices to reflect the short-run cost efficiencies of the new technology. An efficient carrier does not switch just because the short-run costs of new technology are lower than those of existing technology. The capital and depreciation costs of the new technology must be factored in.

A pricing scheme that mixes and matches the capital costs of efficiently retained, existing plant with the short-run costs of new plant does not actually measure the TELRIC of any real piece of network equipment. It does not capture the long-run costs of the new technology because it includes the lower capital and depreciation costs of the existing plant; it does not capture the long run costs of the existing plant because it includes the short-run costs of the new technology. The result would be that both new entrants deciding whether to build their own networks and incumbents deciding whether

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to replace their existing facilities have distorted incentives. A new carrier thinking of building the best available network would have to anticipate charging UNE prices that do not fully recover its capital and depreciation costs. Meanwhile, an incumbent carrier deciding whether to replace existing plant would have to anticipate that new technology would not only reduce the capital value of its network, but reduce its ability to recover short-run costs as well. New firms will accordingly under-invest in new facilities, and incumbent firms will either under-invest or too quickly depreciate their networks to avoid under-recovery of costs when technology changes.

The fundamental difficulty with TELRIC regulation as it has so far been applied is that network investment is treated as being driven by technology rather than by economics. This is implicit in the requirement that TELRIC prices adjust continuously to reflect the cost advantages of the best-available technology, and that they do so as if that technology had been deployed network wide. Whether regulators truly assume periodic full-replacement of network equipment or assume that an ILEC will keep some existing facilities in use but reduce UNE prices to reflect any cost savings that would come from using new technology, under-recovery of costs and inefficient investment decisions are both likely to result. The question then arises whether insufficient returns and inefficiency are inherent in all forward-looking price regulations, or whether there are ways to implement a TELRIC pricing constraint that do not have these drawbacks.

The next two sections will discuss how the under-recovery and inefficiency hazards could be eliminated or greatly reduced through greater incorporation into the TELRIC scheme of the economics of network investment. The next section will discuss an interpretation of TELRIC that would allow incumbent carriers fully to recover their forward-looking costs, even under the constantly adjusting, network-wide "best available" technology standard of TELRIC, by allowing firms to set economic (as opposed to regulated) depreciation rates. The section after that one will show how even better results could be achieved by relaxing the scope of the "best-available technology" standard.

2. TELRIC with Economic Depreciation Allowances

Consider the investment decision of the firm that has purchased the new switch at t_0. When will that firm replace that new switch? It will do so at earliest, as the previous section shows, when the

operating and maintenance costs of that switch exceed the sum of the purchase price of a new switch plus the operating and maintenance costs of that new switch.

A rational carrier will therefore not necessarily replace the switch purchased at t_0 just because a more efficient switch comes along at t_1. To be sure, the new technology at t_1 reduces the economic value of the technology purchased at t_0. But, until new technology is efficient enough that it reduces the economic value of the old technology to zero, the old will not be discarded for the new. How, then, does TELRIC fit in to this efficient replacement calculation? The FCC's pricing rules have been interpreted to require ILECs to model their costs as if new technology is installed network-wide once it becomes available at any single point in the network. This would seem to require ILECs to base UNE prices on costs that are lower than the ILEC's actual costs–*i.e.* on the costs of the t_1 technology even though the t_0 technology is still in place in the network. This, in turn, would appear to under-compensate the ILEC in a dynamic world where technology is continuously changing.

In fact, however, such a pricing rule need not lead to under-recovery of actual costs. So long as the ILEC can set forward-looking depreciation rates on network equipment in anticipation of later technological improvements, it can recover its costs under TELRIC. To set depreciation such that TELRIC prices will, over time, be compensatory, the ILEC needs to factor in a schedule of expected technological changes over the life of the network element at issue. Based on the anticipated decreases in TELRIC-based prices that will result from the predicted technological changes, the carrier can decide when to invest in new technology and how fast to depreciate that technology in the early periods so as not to be left with stranded costs or unrecoverable economic value when technology changes.

Suppose an incumbent carrier purchases a new switch and needs to recover $10,000 over the 10-year life of that switch to compensate for its total long-run costs. If technology will not change over the life of the switch, the ILEC can set UNE prices such that revenue from use of the switch is $1000 per year for 10 years. But now assume that the ILEC knows that new technology will come along every 5 years that will improve the efficiency of switching by 10 percent. If the ILEC does not take this change into account, it will recover $1000 per-year for 5 years but will then, pursuant to the TELRIC regulations, have to reduce its UNE price by 10 percent to a level that will yield revenues of $900 per-year. The total recovery over the 10-year life of the switch will then be only $9500, leaving the ILEC under-compensated. A rational carrier would, however, take the expected technological change

into account in setting its UNE prices from the beginning. Instead of charging

prices that yield $1000 in annual revenue, it will charge prices that produce revenues of $1100 per-year for the first 5 years. It would then, at the end of 10 years, have recovered the full $10,000 notwithstanding the technology change and associated decrease in TELRIC prices.

There is a legal uncertainty about whether the kind of pricing discussed above, which might result in quite high short-term prices for new network elements because of the front-loaded depreciation, still complies with the FCC's pricing rules. This legal question in turn translates into uncertainty for investment plans of the incumbent telephone companies. The uncertainty arises because the neither the FCC nor the various state public utility agencies have plainly granted such flexibility with depreciation schedules. Nor, however, have they clearly stated that only the regulated depreciation schedules (which are used to assess retail rates for telephone service) can be used for UNE pricing under TELRIC. Indeed, the FCC states in paragraph 29 of the First Report and Order that States have discretion to set appropriate depreciation rates. Moreover, there is in principle a good argument that allowing firms to take future technological change into account in setting their current TELRIC rates is both efficient and in accord with the forward-looking nature of the TELRIC regulations. For, allowing such foresight in the depreciation schedules will preserve efficient investment incentives for incumbents, avoid the incentives to distort investment through inefficient delay in implementing new technology, and at the same time never require competitors to pay the ILEC anything more than the ILEC's cost of implementing the new technology.

In essence, the intepretation of TELRIC suggested above, which would allow firms to set depreciation rates and UNE prices today taking into account technological change tomorrow, acts more as a limitation on UNE revenues over the life of a network element than as a limitation on UNE prices at a point in time. It requires that an incumbent carrier be allowed to charge higher prices earlier and lower prices later, than those that would arise under regulated, straight-line depreciation. So long as the total revenues over the life of the equipment cannot exceed the costs of the equipment, the rule should also reasonably balance productive and allocative efficiency concerns as well.

The depreciation-adjusted TELRIC calculation can be demonstrated algebraically using the same notation introduced earlier. Here, however, we are concerned with TELRIC of new plant, $TELRIC_N$, rather than the pricing of legacy plant.

Let $TELRIC_N = C(d_N, k_N, j_N, s_N)$. Assume that at t_0, $TELRIC_N = TELRIC_B$, the cost of the best

available technology, because firms purchase the most advanced technology when they replace old equipment. If the firm can fully recover its costs of the new technology before technology changes, the new technology at t_0 remains the best available technology over the life of the element, and the FCC's pricing rules will be fully compensatory. If, however, technology changes during the economic life of the new element, then at $t_{i>0}$, $\text{TELRIC}_B < \text{TELRIC}_N$. In that case, if cost recovery occurs over several periods, then the future technology shock could lead to under-recovery of costs, because the FCC's rules require UNE prices to adjust downward to reflect the new technology's improved efficiency. To avoid this, the ILEC should price over time according to the following rule: set $P_0 > \text{TELRIC}_N$ ' $3t_i$, subject to the constraint that $3P_i = \text{TELRIC}_N$.

Another way to phrase this is that the firm should be allowed to set the price for the new network element, P, at t_0 such that P_0 + the TELRIC price of the best available technology in future periods equals the total long-run costs of the network element that was new at t_0, *i.e.* TELRIC_N. In other words, the incumbent network should be able to price such that $P_0 + 3(P_B)_{i>0} = \text{TELRIC}_N$. This implies that as TELRIC_B μ 0 over the life of the network element at issue, P_0 ' TELRIC_N μ 1; *i.e.* that as future UNE prices go toward zero, current UNE prices rise toward the total costs of the element.

One objection that is sometimes heard to setting UNE prices so that they capture element costs early is that new entrants would be paying inefficiently high prices to the incumbent in the early periods. But this is not likely to be the case. In fact, the entrant would be paying only the amount that the incumbent itself has decided it is rational to pay to use the network element in those early periods. If the incumbent's original investment decision was rational, then there is no reason to believe the entrant's incentives are improperly biased by paying a proportional share of the long-run incremental costs of that investment. It bears no higher cost than the incumbent itself. The only risk for the new entrant is that it pays very high prices in early periods in anticipation of a technological improvement that in fact does not occur. But then, TELRIC should require the constraint, already discussed, that the access revenues over the life of an element not exceed the long run incremental costs of that element. So, if a predicted decrease in prices due to improved technological efficiency does not occur, UNE prices should decline anyway as the depreciation allowance declines.

If the FCC's TELRIC regulations do not permit the kind of flexibility discussed above, then incumbent firms will have a hard time recovering investment costs and will bear much higher risk from uncertainty over future technological innovation. TELRIC could create an enormous disincentive

to invest in new technology because of fears that prices will just drop again later when a yet superior technology emerges. It could also lead to a situation in which ILECs are substantially under-compensated which, in turn, inefficiently biases the build-or-buy incentives of new entrants away from construction of their own competing networks. The entrants in effect would receive subsidized access and a free option on new technology implemented by the incumbent firms. The normative implication is that TELRIC, or any forward-looking pricing rule for network facilities, should allow the possibility of compensation for total costs of future investments.

The pricing rule discussed above, which is basically TELRIC with economic depreciation rates, mitigates the problem of under-compensation for an ILEC's forward-looking costs. But does it lead to efficient investment and entry decisions by incumbents and new competitors respectively? The answer is probably not. The above rule still assumes that the ILEC has deployed the most efficient technology network-wide. Even if replacement does not really occur, the fact that the FCC's TELRIC scheme requires UNE prices to reflect whatever efficiencies new technology would bring if installed throughout the network. The ILEC will therefore likely be constrained to charge UNE prices that prevent it from recovering its actual, forward-looking economic costs. Anticipating the stranding of those costs, the ILEC will set depreciation allowances higher than they should be. If regulators reject those depreciation allowances, the ILEC will under-invest in its network. From the CLEC's perspective, higher depreciation allowances translate into higher UNE prices which either send incorrect cost signals about the relative merits of building a network versus purchasing UNE access or reduces the incentive to enter altogether.

3. TELRIC with efficient network growth and replacement

As the above section makes clear, the overriding difficulty with TELRIC for efficiency purposes is the assumption that the best-available technology has been fully deployed in the network. But a forward-looking cost model, even one that looks to the long run, need not contain such an assumption. Instead, the model could reflect how rational firms in fact expand and replace their assets. And they do so incrementally, not in wholesale leaps. Importantly, this may be true even in a long-run, forward-looking analysis.

A rational firm does not automatically jump immediately from its existing network to what

would, at that moment, be foreseeable as the technologically optimal network, discarding its installed assets and rebuilding its facilities from scratch. The existing network likely has economic value, meaning that continuing to maintain and operate some current facilities will be less costly than writing off those facilities and immediately replacing them with more advanced technology. A "flash cut" to the long run would discard such economic value of current facilities.

Instead, efficient firms add and replace network plant on an incremental rather than total basis. They replace existing plant only when it loses economic value — *i.e.*, when it becomes more expensive for the firm to maintain and operate an existing facility going forward than it would be for the firm to purchase and operate newer technology, taking into account in this calculation anticipated future developments in demand and technology.

Put differently, it is important to recognize that, when the starting point of the investment analysis is an existing network rather than a blank piece of paper, the efficient mix of technology going forward may differ from the most advanced technology available. Consider, for example, a network in which the customer loops consist mostly of copper cable. A new network built today would likely minimize costs by deploying significantly more fiber-optic cable and much less copper than is currently installed. If we assume that to be the case, then the firm starting from scratch might build a network whose loops contain proportions of fiber and copper that like the inverse of what we actually see in place today. But that does not mean that the firm owning the existing, mostly copper, network should tear out copper cable and replace it with glass. It is likely to be more efficient for the operator to move forward *incrementally* with some mix of copper and fiber — a mix that takes into account the existing network as a whole with all its complementary and inter-operating parts, as well as risk factors for changing technology and demand — as it expands and replaces its network.

A rule that constrains UNE prices to the total, long-run, forward-looking costs of a network that evolves incrementally could avoid some of the pathologies of a rule that assumes, in either a strong or mild way, that networks change completely with each change in technology. To see why, consider the loop example above. Suppose the loops currently in place in an incumbent's network are 90 percent copper and 10 percent fiber, but that the best available technology involves loops that are 100 percent fiber. The incumbent will keep many of its copper loops in place because it is expensive to remove them and to replace them with fiber. So where the copper is working well and does not cause high maintenance costs, the firm will keep it for the time being. The firm will, however, use

fiber in those areas of its network where it does need to replace loops or to expand the number of loops in its network. Suppose next that the firm has a planning horizon of three years into the future for loop investment, at the end of which it anticipates having actual loop plant that is 70 percent copper and 30 percent fiber as a result of replacing and expanding the network with new fiber loops. (Assume the firm does not look further ahead because it is unclear that fiber, as opposed to various wireless technologies in development, will still be the best available technology beyond that horizon.) What loop technology should be assumed in setting TELRIC-based prices over the three-year planning period?

The full-replacement model would assume that all loops in the network were fiber, since that is the "best-available" technology, even though only 30 percent will in fact be fiber after three years of efficient expansion and replacement of the existing network. In contrast, an incremental-replacement model would assume at most 30 percent of the loop plant was fiber (it might assume a lower percentage over the three years because the 30 percent level would not he reached until the end of that time.) The 30 percent fiber assumption might well lead to higher UNE prices than the 100 percent fiber assumption that would be made in applying the FCC's TELRIC rule. But that is only because the 30 percent assumption better captures the costs that the incumbent, investing efficiently over time, actually expects to incur in providing unbundled loops. With prices that better enable the ILEC to recover its costs of operating its network, the ILEC will make more efficient investment decisions and the potential competitive carriers will make better entry decisions.

One objection that might be raised to the incremental-replacement model is that it is not truly "long run" because it does not let all inputs of production vary over time. The model instead looks only to the end of a more limited planning period. It is true that in principle a long-run analysis is one in which nothing is fixed and in which all inputs and costs are assumed to be variable. Indeed, the purpose of a long-run economic analysis is to determine what a firm's optimal cost structure would be if it could change all aspects of its current production technology. But that does not mean that a firm's long-run cost study must vary all existing inputs to yield efficient results and comply with economic principles.

For, although the goal of a long-run, forward-looking analysis is to minimize the degree to which a firm's investment decisions are constrained by previous choices about the size, design, or technology of its network, it might not be efficient for the firm to assume that all inputs change even

in a long-run study. A firm's long-run model should allow for the *possibility* that all inputs are variable. But it need not, and in the real world probably will not, assume that all inputs are in fact varied. Before an existing input is varied, the firm must be able reasonably to predict *how* that input should be assumed to change in the model; *i.e.*, it must be able rationally to calculate what an input should vary *to*. If technology is changing over time, the firm might be able to make reasoned predictions about what the replacement technology and its associated costs will be for only a limited time into the future. At some point, the cost model becomes too speculative to serve the purpose of guiding efficient investment and pricing decisions. The firm's cost study might in practice therefore be able to have only a limited time horizon, over which it is not efficient to assume that all inputs change. So long as the planning period for an incumbent carrier's long-run decisions about network investments is as long as reasonably possible, there is nothing wrong with basing forward-looking prices for UNEs on a cost model that does not look beyond the end of that planning period and the network that is then expected to be in place.

This section of the paper has shown that a TELRIC regulation for UNE prices can have varying compensation and efficiency properties depending on the specifics of its underlying technological and economic assumptions. The section has essentially considered four different versions of TELRIC: (1) a "strong" version of the full replacement model in which forward-looking costs are modeled as if the network were in fact periodically dug up and replaced; (2) The FCC version, which assumes full deployment of new technology for purposes of deciding how UNE prices should decline over time, but which does not truly assume that the incumbent actually replaced its network and incurred the high capital and depreciation costs of full replacement; (3) a model in which there is some assumption of full replacement (either the "strong" assumption or the FCC's weaker version), but which also allows for economic depreciation rates in anticipation of such full replacement; and (4) a model that assumes efficient, incremental replacement over time and that bases UNE prices on the mix of existing and new technology that is expected to be in place going forward over the firm's long-run planning period.

These models show that it is possible to improve on the efficiency and compensation properties of the FCC's TELRIC regulation. The question remains whether any of these models would, in fact, be fully compensatory or efficient on a forward-looking basis. For, even in the incremental replacement model, UNE prices are based on costs expected to be incurred in the future, not on the costs that an incumbent carrier incurs at the moment it provides a UNE to a competitor. This

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disjunction could, in theory, lead to a shortfall in cost recovery and slightly distorted entry and investment decisions. The next draft of this paper will address this question directly, and will suggest that, despite the existence of a theoretically better pricing rule, a forward-looking rule could work adequately well and even have some advantages over an actual-cost rule in practice.

III. CONCLUSION

When the Supreme Court considers the FCC's TELRIC rules this Fall, it will have to address three important questions: (1) whether the prohibition on recovery of historical "embedded" costs confiscates the ILECs' property in violation of the Takings Clause; (2) whether the "best-available technology" standard will under-compensate the ILECs on a forward-looking basis; and (3) whether that standard is an unreasonable interpretation by the FCC of the 1996 Act's provisions mandating "cost"-based pricing for unbundled network elements. This paper has made a preliminary effort to address these questions. As the analysis above demonstrates, the FCC's TELRIC rules do not necessarily confiscate the ILECs' historical, embedded costs, although they may do so in a particular case. The rules as implemented to date are more problematic on a forward-looking basis, however. The assumption that new technology will be fully deployed once it becomes available will likely lead to UNE prices that under-compensate the incumbents for efficient investment, and thereby send inefficient signals for such investment as well as for entry by new competitors. Incorporating economic depreciation rates into the TELRIC cost model could alleviate the compensation problems, but to correct the rule's inefficiencies the "best-available technology" standard itself will have to be relaxed and replaced with a model that better reflects how efficient firms in fact upgrade and replace their network facilities.

As mentioned, this draft is preliminary and important questions remain. One, which will be addressed in the next draft, is what the optimal UNE pricing rule might be and how it compares with even the most correct economic interpretation of TELRIC. The next draft will also engage in a more complete examination of the relevant body of takings law and how it informs the constitutionality of TELRIC. Comments on these points, as well as those addressed in this draft, are most welcome.