Working Papers Series
Cahiers de recherche

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WORKING PAPER NO. 22

TECHNOLOGY AND TELECOMMUNICATION: A POLICY PERSPECTIVE FOR THE 80's

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ISSN-0225-8013

March 1981

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Résumé

La technologie de l'information est omniprésente dans l'industrie canadienne des télécommunications, s'attaquant aussi bien aux concepts de base qu'aux poltiques régissant l'industrie. Au seuil des années 80, les tendance énumérées dans les lignes qui suivent semblent irréversibles.

Premièrement, le génie de la technologie est sorti de la bouteille pour ne plus jamais y retourner.

Deuxièmement, il est aveugle et ne respecte ni traditions, ni coutumes, ni démarcations entre industries, ni frontières géographiques.

Troisièmement, bien que l'orientation exacte du changement technologique demeure discutable, le taux d'accélération de la nouvelle technologie se maintiendra au cours des années 80.

Quatrièmement, même si les applications technologiques comportent des risques et un certain degré d'incertitude, elles offrent aussi des possibilités sans précédent en ce qui concerne de nouveaux marchés, de nouveaux services, de nouveaux investissements et de nouveaux emplois.

Quelles seront les répercussions de ces forces sur le processus décisionnel au cours de la prochaine décennie ?

Premièrement, la concurrence en matière de recherche et de développement s'accroîtra tant au pays qu'à l'échelle internationale.

Deuxièmement, la durée utile de l'information considérée comme produit deviendra de plus en plus courte.

Troisièmement, l'obsolescence de l'information constituera un processus, plutôt qu'un fait.

Quatrièmement, au cours des années 80, la miniaturisation des produits se continuera au même rythme.

Cinquièmement, les coûts et les prix de l'information continueront à diminuer, et pénétreront des marchés encore indistinctement pressentis.

Sixièmement, les démarcations qui exitent entre les sociétés, les industries, les produits et les services se dissoudront, se chevaucheront et, dans de nombreux cas, disparaîtront.

Septièmement, le nombre de terminaux intelligents sera tel qu'ils envahiront les foyers, les bureaux, les banques et les magasins.

Huitièmement, le contenu, la portée et la diversité des réseaux d'information iront en se multipliant.

Bref, la décennie 1980 encouragera l'initiative, l'innovation et l'esprit d'entreprise des cadres.

Enfin, dans quelle voie la politique publique pourrait-elle s'orienter afin de profiter des possibilités offertes par l'ère de l'information ? Trois choix lui sont offerts.

Le premier consiste à affirmer que le Canada peut s'isoler du progrès technologique, et que notre héritage culturel unique supprime toute obligation de faire un choix, toute nécessité d'établir une stratégie d'orientation. Cette position opte en faveur du statu quo.

Dans le deuxième, on suppose que toutes les futures industries et entreprises d'information existent déjà. Le seul fardeau qui s'impose à la politique est de conformer le comportement des sociétés à "l'intérêt public". Cette option

tente de lier la technologie à l'institution de la réglementation.

Une troisième politique vise à créer des stimulants économiques propres à encourager l'esprit d'entreprise, la créativité et la performance. Exprimée différemment, cette politique tend à libérer l'énergie, la stimulation et la discipline commandées par la compétitivité du marché. Cette dernière stratégie -- que nous recommandons -- a pour corollaire l'abolition des désincitations économiques qui entravent la compétitivité du Canada sur les marchés intérieurs et internationaux. Dans la mesure où la compétitivité d'un pays sur les marchés étrangers reflète les stimulants intérieurs, nous recommandons l'abolition immédiate de la réglementation sur les services d'utilité publique, comme instrument de contrôle social.

SUMMARY

Information technology is assaulting virtually every premise and policy of Canada's Telecommunication Industry. As Canada confronts the 1980's, the following trends appear irreversible.

First, the technology genie is out of the bottle, never to return.

Second, the genie is blind, respecting neither tradition, custom, industry or geographic demarcations and boundaries.

Third, although the precise direction of technology change remains debatable, the rate and acceleration of technology will continue into the 80's.

Fourth, while the technology genie carries with it risk and uncertainty it also embodies unprecedented opportunity for new markets, new services, new investment, new jobs.

How will these forces impact management decision-making in the decade to come?

First, R&D competition will broaden both domestically and internationally.

Second, information product life cycles will contract and shorten.

Third, information product obsolescence will become a process rather than an event.

Fourth, product miniaturization will continue unabated into the 1980's.

Fifth, information product cost and prices will continue to decline, penetrating markets yet dimly perceived.

Sixth, corporate, industry, product and service boundary lines will dissolve, overlap and in many cases disappear.

Seventh, intelligent terminals will proliferate to the point of explosion in the home, office, bank and store.

Eighth, information networks will multiply in content, breadth, and diversity.

In a word, the era of the 1980's will place a premium upon management decision-making, management innovation, management entrepreneurship.

Finally, how can public policy posture and position itself for the opportunities of an information era? Here policy is confronted with three choices.

A first is to assert that Canada can insulate itself from technological change, that the nation's unique heritage and cultural content removes any burden of choice, any necessity for strategic thinking. This position opts for the status quo.

A second option assumes that all future information industries and firms now exist and are in place. The only policy burden is to wed corporate behavior to the "public interest." This option attempts to marry technology to the institution of regulation.

A third policy is to create economic incentives receptive to entrepreneurial risk, creativity and performance. Stated differently, this policy attempts to unleash the energy, incentive and discipline of the competitive marketplace. This latter strategy -- which we

recommend -- carries with it a corollary; the abolition of economic disincentives that handicap Canada's ability to compete both domestically and internationally. To the extent a nation's competitive stance abroad reflects the incentives at home, we recommend the abolition of the public utility regulation as an instrument of social control forthwith.

I. Introduction

This paper examines the impact of technology upon the telecommunications industry. We examine the past, present and future of technology in terms of research, manufacturing facilities, services and regulation. We observe that the telecommunications is moving to a technologically dynamic industry - a transition that has precipitated a series of policy controversies in Canada and the U.S. We explore the anatomy of that conflict with an eye to comparing the Canadian and U.S. experience.

Next we attempt to sort out the direction of public policy by proposing a regulatory framework of three models, a static, dynamic and a hybrid or dual model. We explore the characteristics of each in terms of content and regulatory burden.

We then apply these models to the policy experience in the U.S. and Canada. With respect to that experience we make the following observations.

- First, the technological genie is out of the bottle, never to return.
- Second, that the genie is blind, respecting neither tradition, custom, nor industry boundary lines.
- Third, that although the direction of the genie resists easy prediction, little diminution of technological change appears in sight.
- Fourth, that the genie embodies risk and uncertainty but invites enormous opportunities in new markets and information services.

We also argue that technology is altering significantly the dimension and reach of telecommunications. Indeed, we assert that a relatively new economic phenomenon is at work, a multiple industry entry process whereby a dozen industries are on a collision course. This multi-industry phenomenon applies to tiers of information processing, namely

- multi-industry entry into research and development
- multi-industry entry in equipment manufacturing
- multi-industry entry into information facilities
- multi-industry entry into information services.

We conclude by observing that technology has eroded the premise of public utility regulation in telecommunications/information services. Technology is spurring R&D, manufacturing, innovation, productivity, capital growth, with its concomitant promise of a new dimension in consumer choice. As both cause and effect, technology driven by the incentives of the competitive marketplace has consigned regulation to a state of institutional obsolescence.

That state of obsolescence does not mean, however, that public policy will not attempt to take the model of the past and apply it to the challenges of the future. On the contrary, a disquieting development is taking place in North America whereby the disincentives of the public utility principle are now imposed upon not merely a single firm, not merely a single industry, but inserted upon major sectors of the Canadian and U.S. economy. We argue that the opportunity cost of that extension will be formidable. Finally, we call for the resurrection of market incentives that yield productivity, innovation and economic efficiency. We call, in short, for the abolition of public utility regulation of telecommunications.

As historical leaders in telecommunications, both the U.S. and Canada have tended to be insulated from forces that measure comparative advantage. Today, that advantage can no longer be taken for granted. As we will argue, the international move toward information equipment and services is gaining momentum. France, Germany, Japan and Britain are simultaneously striving to assert leadership in computer communication technologies. At stake in this new dimension of international rivalry is production, unemployment, balance of payments and inflation. To that extent, technology today knows no political boundaries.

II. The Electromechanical Era - A Legacy of the Past

To assess the traditions of telecommunications, we explore five areas: technology and R&D; manufacturing activities; ownership of telecommunication facilities and assets; the provision of telecommunication services; and the evolution of public utility regulation incident to the presumption of scale economies and natural monopoly.

As a prelude to this exploration, however, it is useful to survey the current structure of both U.S. and Canadian telecommunications.

In the U.S. the telephone holding company, typified by American Telephone and Telegraph (AT&T), and General Telephone and Electronics (GT&E), dominate the telecommunications scene. Both AT&T and General Telephone hold ownership affiliates at four levels of the production stage, research, manufacturing, facilities and service. Western Electric, Bell Telephone Laboratory and the 23 operating companies linked by the Long Lines Division of AT&T provide the bulk of telephone service in the U.S., and typify the holding company model. That model is replicated by General Telephone and Electronics organizational structure with a laboratory, Automatic Electric, Lenkurt Electric and some 18 General Telephone operating companies throughout the U.S. To that extent, vertical integration of research, manufacturing and telecommunication services accounts for some 90% of all activities in the U.S.

The independents, as they are known in the U.S., consist of some 1600 non-Bell telephone companies scattered throughout the country, many in less populated areas. These companies, in turn, are supplied by a diverse range of independent manufacturers of equipment and hardware.

The Canadian Telephone industry is both similar and distinct from its U.S. counterpart. Although not holding companies per se, both Bell Canada and B.C. Telephone hold interest in manufacturing affiliates and their respective research facilities. There is, however, a diversity of telecommunications organization and ownership in Canada; namely, Bell Canada, B.C. Telephone (a GTE affiliate), three prairie provinces telephone companies, four Maritime telephone companies and Teleset together form the TransCanada Telephone System (TCTS). TCTS provides nationwide telephone and other telecommunications services in Canada. CNCP Telecommunications also provides national private line voice and data services, and public switched data services.

Given this cursory overview of telecommunication organization and services, what assumptions and premises have supported the activities of R&D, manufacturing facilities and services in North America? Although institutional differences are bound to distinguish and separate Canada and the United States, the parallel between the two countries is striking.

1. Technological Research and Development

In the U.S. research and development has been essentially controlled by incumbent telephone companies in North America, specifically AT&T. That control evolved historically from three sources. An imposing portfolio of telephone patents, a laboratory whose technical expertise was world-wide, an R&D financing system derived from revenues from telephone users combined with revenues from captive suppliers. One need not digress on the evolution of this research and development capability at this point. Suffice it to say that Bell Telephone Laboratory (BTL) acted as literally a patent engine for the Bell System and thus

sustained commanding discretion over nearly every aspect of telephone research and development in the U.S.[1]

BTL thus stood alone in telephone expertise, competence and know-how. Challenge to this institutionalization of research was sporadic at best. Before World War II and even after the war, the only sector of the economy that could possible match the research resources of BTL was the United States government. It was not until during World War II and the subsequent Cold War that the Department of Defense emerged as a patron saint of research and development in areas of telecommunication traditionally reserved to the industry.[2]

R&D activity in telephone facilities appeared similarly narrow and circumscribed. Wire, cable, and microwave radio were regarded as a complementary transmission medium rather than competitive alternatives. The range of options in central office equipment was similarly constrained by the prevailing technology of manual, step, panel, crossbar and stored program machines. Local distribution facilities centered essentially on copper wire pairs (twisted pair) that linked residential or business phones to the telephone exchange. The range of substitutes in telephone stations was similarly subject to industry discretion and choice.

In North America Telephone R&D tended to be insular rather than international in its reach. Bell Telephone Laboratory, in effect, established the standards, protocols, and system requirements that dominated both the U.S. and Canadian market.[3]

In a technical sense, Europe might as well have been separated by two oceans. The Europeans, the PTT's and their suppliers developed one set of standards; North America, its manufacturing affiliates and operating companies proceeded to develop different codes and protocols. These

standards reflected merely one facet of a world that appeared to cartelize its telecommunication R&D, particularly after Western Electric withdrew from Europe in the 1920's.[4]

The rate of technological change in telecommunication was, if not predictable, relatively orderly. Certainly, telephone companies exercised control over the process of technical obsolescence. The carriers elected when to introduce and phase out products and equipment. The life cycle of telephone switching plant was typical: manual, 1880's; step by step, 1894; panel, 1921; crossbar, 1938,1950; stored program control, 1965.[5] Development cycles were of sufficient length as to accord management almost total discretion as to equipment introduction and retirement.

In one sense the size and quantity of research and development expenditures served as a significant barrier to market entry. Bell's electronic switching systems in 1965, stored program control, required in development expenditures some half a billion dollars and 4,000 man years, an outlay that tended to ration the number of firms participating in switching development.[6] Even Bell Canada's successful SP-1 nowhere approached AT&T's expenditures of the ESS switch.[7]

In a word, the telephone industry owned its technology, controlled its R&D base, exercised decisions of technical change with relative impunity. Patents, vertical integration, an exclusive franchise, a commitment to research, combined to accord the industry technological preeminence. This is not to suggest that on occasion industry was not caught off guard by competitive developments in switching or transmission technology.[8] But on the whole, such developments proved the exception rather than the rule. In a real sense, industry expertise stood alone.

2. Telecommunication Manufacturing

Telephone products serve as a mirror image of research and development. A narrow R&D participation translated into a restricted base of manufacturing capability. Western Electric, AT&T's affilate, ascended as the major supplier of telephone equipment in the U.S; Northern Telecom ascended as the major equipment supplier in Canada. Western's position was augmented by exclusive access to two markets; the research and development activities from Bell Telephone Laboratory, and telephone equipment purchases from Bell operating telephone companies. Vertical integration of research, manufacturing, and service served to reinforce the domestic predominant position of the integrated supplier in both the U.S. and Canada.

Moreover, the technology of an electro-mechanical era necessitated sizeable investments in plant, equipment, tools and hardware. Western Electric's Hawthorne works in Chicago, some 600 acres, including a separate railroad company and at one time employing 40,000 suggested that economies of scale were essential prerequisites to plant efficiency and output economies. Presumably, the presumption of scale economies applies to Canada's vertical suppliers as well.[9]

Since the turn of the century, telecommunication manufacturing centers on metal fabrication, techniques requiring tools, drills, machining, wire assembly, components, springs, relays and cams. To the extent product manufacturing required a range of skilled and highly trained employees, manufacturing tended to be labor-intensive. A crossbar switch (first introduced in the U.S. in 1938) required 3300 employees to manufacture a

half million lines per year, employees devoted to materials, parts, printed circuit boards, metal work as well as assembly, wiring and testing. (Table II).[10]

By today's standards, equipment tended to be massive and bulky. In some cases, telephone PBX manufacturers had to be notified when buildings were to be constructed so as to permit installation coordination at the time of construction.

Telephone equipment was designed to achieve a physical life of up to 40 years in some cases of switching equipment.[11] This expectation obviously influenced product design cycles and conditioned the birth of new generations of telephone equipment. Investment facilities were obviously influenced by the economics of investment rate depreciation inherent in public utility rate-making procedures.

Equipment suppliers in the U.S., notably Western Electric, adopted a costing and pricing strategy not unlike their public utility counterpart. Western, for example, included material, labor, overhead or loading as part of its costs and inserted a profit across specific product lines;[12] to the extent that Bell Canada's Northern Electric was a creature of Western Electric, the equipment costing process could presume to be similar. In economic parlance, suppliers engaged in cost plus pricing targeted at a set return on investment. Although earnings proved more volatile than a telephone carrier's rate of return, profits derived from integrated suppliers sales tended toward stability and predictability.

Table I

Cross Bar Switching
(½ million lines/year)

Function	Labor
. materials (parts, PCB, metal work)	1000
. assembly and wiring	2000
. testing	250
Total	3250

3. Telecommunication Facilities

From its very beginning telecommunication carriers in North America owned and controlled the range of physical assets incident to the rendering of telephone or telegraph service. Such capital investment included the basic telephone instrument, the inside wiring of an office or home, the local loop facilities from resident to local exchange switching center, the trunking investment between toll and exchange telephone switching hardware. The range and degree of substitutes for such a capital investment was obviously limited. Indeed, telephone companies in both the U.S. and Canada ban customer ownership of equipment and demand toll access to firms deemed to be competitive. The concept of an end to end service subsumed within it the idea of total ownership of physical plant investment.

4. Telecommunication Services

Operating telephone companies purchased hardware and equipment as an investment base for services rendered their subscribers. Nowhere did natural monopoly appear more imperative or compelling than

in the dimension and quantity of capital expenditures associated with telephone service. A dollar in telephone operating revenues required a capital expenditure two and a half times - an outlay that tended to limit the feasibility of market entry.

Once investment was committed, equipment was then presumed to enjoy a relatively long physical life. Indeed, regulatory authority equated economic depreciation to physical life. Stretched depreciation life automatically presumed that low annual depreciation expense redounded to the subscriber's benefit. Accordingly, hardware, used and useful, was spread over many subscribers, reducing per unit costs. To the extent that competition was, by definition, closed, investment life and retirement devolved to operating company management, sanctioned by the regulatory process.

The sizable commitment of capital investment associated with telecommunication appeared to give credence to the notion of economies of scale. By definition, market entry subtracted from the utilities revenues, raising cost and ultimately raising tariffs or rates to the consumer. By the 1920's, entry in telecommunication services was regarded as wasteful, counterproductive in both Canada and the U.S.[13]

Telephone companies positioned their rates so as that overall revenues covered overall costs. Individual tariffs were tailored and oriented toward value of service pricing. To the extent prices failed to track costs precisely, series of service rates or cross subsidies evolved in which special revenues failed to match specific costs for specific services. Presumably, toll revenues exceeded total costs, the difference reallocated to a reduction of prices billed to exchange customers. Heavy routes generated returns that supported losses on those routes, a process of cross subsidy based on traffic volume. Conventional wisdom

held that metropolitan revenues subsidized rural service revenues thus marking another tier in a matrix of cross subsidy.

Layers of subsidies embodied as tariffs grew and evolved over time in the telephone industry. Cross service transfer of funds further bound the non-Bell and Bell companies together in the form of toll separations and settlements. In some cases, 50% of non-Bell revenues derived from telephone toll settlements.[14] Yet the precise direction of these subsidies depended upon the separation and allocation of joint costs. To the extent such cost separation remained imprecise, question of rate structure approximated art more than science.

In controlling capital investment, telephone companies promulgated policies that tended to increase rather than diminish the ratio of capital to labor. As noted earlier telephone subscribers, for example, were banned from owning telephone instruments, thus shifting a major capital burden from the subscriber to the carrier.[15] In house buying of equipment from captive suppliers, vertical integration, tended to centralize the burden of production to manufacturers of holding companies. Finally, telephone carriers controlled the disposition of used telephone sets, dismantling, melting and removing them from the retail market, limiting the potential of price or non-price market rivalry.

Industry Structure and Regulation

In the U.S. and to a lesser extent in Canada, research manufacturing and service tend to be concentrated within a single corporate entity. Vertical integration evolved as an important generic model for telecommunications. Laboratories designed equipment; manufacturers fabricated hardware, telephone companies bought products as capital incorporated into their investment rate base, subsequent

to services rendered to the consuming public. In the U.S. the telephone holding company coordinated all stages of production, an organization augmented by a series of agreements between various constituent parts of the holding company. The institution of regulation thus inherited the structure and conduct of the telephone companies and sanctioned practices embodied as filed tariffs.

In the U. S., regulation sanctioned the financing of telephone research through a licensed contract agreement between AT&T and the Bell operating companies. The contract placed the holding company between the telephone subscriber on one side and the research laboratory on the other, collecting from one and giving to the other. By the 1920's, regulation criticized the license contract as an intra-corporate transactions between holding company and operating subsidiary. In the U.S. the license contract was reduced significantly under regulatory pressure.[16] The licensed contract continues today as an allowable expense to the operating telephone company.

How did public policy treat the common ownership of utility and manufacturer? Here policy was somewhat ambivalent. One school held that a captive supplier constituted a public utility and should be regulated according to public utility standards. Another school argued that regulation ought to impose competitive bidding standards on telephone company purchases. Certainly, vertical integration tended to rule out competition as an open and objective market test. The result found the carriers create a surrogate to equipment competition - price studies comparing their equipment with that of rivals. Since the early 20's both AT&T and Bell Canada have submitted price comparison studies documenting that purchases from captive suppliers were mandated

by low prices.[17] With few exceptions, regulatory agencies accepted these studies as one standard of vertical integration efficiency.

In accepting natural monopoly of telecommunication services, regulation also imposed a set of economic incentives upon telephone operating companies. Telephone companies were permitted to generate revenues that covered allowable expenses and permit a return on their net invested capital. Traditionally, public utility commissions have been concerned with overall revenue requirements on the income side. Exercises in the disaggregation of particular rates or rate structure and its attendant cost allocation techniques have tended to exceed the resources or the budgets of the interstate or FCC officials, however. Rate structure thus tends to devolve to the judgement of telephone company management.

Over the years, courts assigned standards to classify the legitimacy of telephone company expenses, either allowable or disallowable, whether ranging from wages, salaries, marketing, depreciation, maintenance, contributions to charities or the like. Regulation thus established a set of incentives that permitted telephone companies to recover expenses on a dollar for dollar basis. Long depreciation life reduced depreciation expense.

Rate base economics obviously impacted a utility's investment decisions. Cost plus incentives were clearly institutionalized. The more a utility spent on capital, the more absolute income the carrier derived from that capital. Although commissions reached general concensus as to the evaluation of investment rate base, the type of telephone equipment resided as a prerogative of company management. Investment decisions were management decisions.

Finally, regulation divided and categorized telecommunications services into broad homogeneous markets; message toll telephone, exchange telephone service, private line service, private line video, private line data. In a real sense, regulation established boundary or demarcations between carriers and between services. In fact, regulation policed the boundaries. In the 1950's, for example, the FCC ordered AT&T to sell its telegraph operating companies to Western Union, and ordered the telegraph company to sell its telephone companies back to AT&T.[18] In the 1960's, the FCC ordered AT&T to sell its TWX services to the telegraph company so Western Union could combine the two into a public message service. Thus AT&T was allocated message toll telephone service; Western Union, public message service.[19] Both market boundary decisions were premised on the reality of scale economies.

The public utility principle tended to crystallize and harden telephone company practices. Before the imposition of the public utility concept, operating companies refused customer ownership of terminals, refused to permit competitive toll facilities access to local telephone facilities, refused to permit independent telephone companies access to long distance toll facilities, refused to permit users to share or resell communication lines, refused to purchase equipment on a competitive basis. Once instituted, the public utility principle grandfathered these practices through tariffs under the force of law. Subscribers, for example, who flaunted the ban on equipment ownership now faced service loss enforced by the authority of the state, with oblique references to the "public interest."[20]

To sum up, regulation inherited and accepted the premise of research exclusivity, integration economies, telephone natural monopoly. As we have

noted, regulation did more than merely adopt the structure of the industry; regulation legitimized the premise of the telephone research, manufacturing, facilities and service. Regulation sanctioned the industry's conduct and institutionalized the economics of rate base valuation. Cost plus rate of return emerged as a device to balance the interest of its subscribing public against the interest of the investor public. However, the invocation of the "public interest" standard - never precisely defined - rested upon a world of static technology. That assumption is now under assault.

III. The Electronic Era - The Present

As technology evolved from an electromechanical world to an electronic world, the premise of research, manufacturing, facilities and services experienced profound change and alteration. Consider R&D.

Research and Development

Several developments are occurring in telecommunications R&D. First - the number of participants are expanding; second - government is assuming a critical and important role in the R&D process; third - research and development is becoming internationalized; and fourth - technological substitutes are proliferating.

Participants

If one surveys the research and development horizon, it is clear that research in station equipment, local loops, transmission, switching and related components is undergoing a transition to a broader number of participants. Stated differently, telecommunications is no longer restricted to electromechanical but, in making the transition to electronic, incorporates the expertise of microelectronics, aerospace, chemical, computers, microcomputers, minicomputers, software, business equipment, broadcasting and the like. The candidates for R&D participation are obviously expanding.

The characteristics of new industries in telecommunication R&D are worth noting. First, R&D as a percentage of sales is relatively high - 10% in the case of some of the semiconductor firms.[21] Hence, new firms bring a quantity and resource commitment to the R&D effort that stands in stark contrast to an era of electromechanical technology. Moreover, R&D is

pursued not as a non-profit contribution to the body politic, but as a calculated return on capital. R&D is an investment driven by profits.[22]

Second, government now occupies and plays a critical role in funding R&D effort both in the United States and increasingly in Canada. That role commenced with the research effort of World War II and has ebbed and flowed in the postwar era. In a variety of activities national security has often paced developments in communications, satellites, computers, software, circuitry, rockets, fiberoptics, integrated circuits, robotics, computer aided design, voice synthesis, and voice recognition systems.[23]

Certainly, much of the Department of Defense's funding is generated by technological rivalry with the USSR. Often, R&D for national security products and services finds its way into the commercial sector of the economy, further broadening the base and resources of R&D participation. Stated differently, the expertise of telecommunication is no longer owned, controlled and subject to the discretionary exercise of one industry alone. The telephone industry R&D is now joined by not merely other firms and other industries, but now includes government funding in both Europe and the Far East.[24]

Third, telecommunication research and expertise is hardly confined to North America exclusively. An examination of Europe and Japan finds multi-national industries pursuing a wide variety of research in terminals, transmission, switching and solid state devices and software activities.[25] This corporate effort is augmented by government commitment to occupy a national presence in microelectronic technology. In short, research and development rivalry and competition today is international. It is doubtful that any one nation enjoys technological exclusivity in all facets of microelectronic research.

Substitutes

Fourth, technological substitutes are increasing rather than decreasing in number, quantity, and dimension. The tradeoffs between wire, cable, fiberoptics, satellites, switching, radio, broadcasting, crossbar, stored program control, packet switching increase rather than contract. This proliferation of technological substitutes stands in sharp contrast to the limited range of alternatives available to the industry a generation ago.

These developments suggest that the quantity of resources devoted to pushing back the state of the microelectronic art - computers, switching, software, transmission, terminals - is broadening and deepening. Total world R&D estimates are at best speculation but a research endeavor of some fifteen billion dollars annually would not be surprising.[26] That quantity, and momentum is bound to impact the manufacturing side of telecommunication production.

Manufacturing

In examining the telecommunication manufacturing, we will look at the following areas: the participants, design/life obsolesence, product content, miniaturization/integration, manufacturing employment and product cost pricing.

Participants

As the mirror image of research and development, manufacturing is similarly experiencing the phenomenon of multi-industry entry. The candidates are obvious. Computer firms, aerospace, software, business equipment, petroleum, chemicals, semiconductors, all have joined the

traditional telephone companies as manufacturers of equipment and hardware.[27] Certainly, manufacturing is no longer confined to domestic industries or firms. Markets today are taking on an international dimension as well.

Design Cycle

As multi industries contribute to the resources of research and development, the telephone industry is experiencing a contracting and shortening of design time cycle. The predictable decade or more of economic life embodied in products is no longer as certain as it was three decades ago. Today design cycles border on the furious. For example:

- Semiconductors - 2 years[28]
- Mainframe computers - 4 years[29]
- Automatic test equipment - 12 months[30]
- Printers - 18 months[31]
- CRT's - less than 2 years[32]

The other side of product life cycles is the contraction of economic life attending economic innovation and obsolescence. In contrast to the premise that telecommunication could be viewed as used and useful over decades, the rate of product obsolesence today is quickening and accelerating. For example:

- Semiconductor memories - 4 generations in 5 years[33]
- Microprocessors - 3 generations in 5 years.[34]
- Packet switching - 3 generations in 8 years.[35]
- Satellites - 5 generations in 20 years[36]

. CRT's - 4 generations in 5 years[37]

. Telephone PBX's - life has shrunk from 10 to 5 years.[38]

Contracted economic life suggests that writedowns may no longer be an isolated event in telecommunications products. Siemen's Corporation in Western Germany recently wrote down 230 million dollars of development cost for an analogue switch.[39] The company observed that the central office machine would have been obsolete by the time production was scheduled. French telephone manufacturers expected a six year transition from electromechanical to digital switching. However, the transition is closer to two years.[40] In a real sense, product life in the telecommunication industry is assuming attributes of the computer industry. AT&T's celebrated retirement of a Manhattan central office switch is obviously reminiscent of an era past.[41]

Product Content

As chip complexity increases, as per unit costs of logic and memory decline, as reliability is enhanced, the content of silicon penetrates all aspects of telecommunication plant. Table III projects the silicon production of a typical product line in telecommunications leading to intelligent machines and intelligent products; and some anticipate that 20% of all semiconductor output will be consumed by the telecommunications industry within three years.[42]

Moreover, chip size and complexity blurs and erodes traditional market boundary lines between components, products and systems.[43] Indeed, some project that a silicon chip will embody a system, implying, of course, that the semiconductor industry will inevitably

Table II

ESTIMATED TOTAL AVAILABLE WORLD TELECOMMUNICATIONS MARKET FOR SEMICONDUCTORS BY EQUIPMENT TYPES

(MILLIONS OF DOLLARS)

	1978	% TOTAL	1979	% TOTAL	1980	% TOTAL	1981	% TOTAL
Switching	239	22	288	23	362	25	429	25
Station	186	18	226	18	277	19	343	20
Transmission	85	8	100	8	102	7	120	7
Carrier System	38	4	37	3	44	3	52	3
Data Com	153	14	188	15	229	15	274	16
Radio Tel	112	11	124	10	133	9	137	8
Microwave	89	8	100	8	110	8	120	7
Facsimile	45	4	50	4	50	4	67	4
Other	122	11	138	11	158	10	172	10
Total	1,069	100	1,251	100	1,465	100	1,714	100

Source: Merrill Lynch Pierce Fenner & Smith, Inc. Semiconductor Industry Outlook Report.

be manufacturing final products in selling hardware to telephone operating companies.

Chip complexity and miniaturization precipitates products integration. In the electromechanical era, separate products incorporated distinct capabilities, e.g., PBX's, typewriters, copiers, computers, facsimile machines. Today single products incorporate and integrate these diverse functions. Computers, for example, process data and manipulate words. PBX's embody accounting capability, switching capability and route electronic messages.[44] Indeed, a San Antonio company has announced a product that will drive word processing, data processing, electronic message services, data and voice communication management - all in one unified intelligent terminal.[45]

Some have predicted that telephone PBX's will incorporate software memory housing the equivalent of an electronic directory.[46] The French have embarked on employing a videotex unit in every home that is to replace directory services manufactured out of paper.[47]

Clearly intelligent products no longer respect traditional boundary lines. The distinction between telephone, data, mail, telegraph, typing, copying is less clear-cut than in the past. In one sense, miniaturization and integration obliterates product, market, indeed industry distinctions.

Labor Content

Nor can the manufacturing process be separated from the technological impact of microelectronics upon employment. As miniaturization

continues apace, equipment, material, assembly and testing lends itself to automation. Recall a crossbar of a half million lines per year required 3300 employees. Today, a digital switch with the same capability requires employment of 120 personnel.[48] (See Table IV). The Hawthorne works of Western Electric now employs 7,000. workers as against a peak of over 40,000.[49]

Miniaturization erodes one's perception of optimum plant size. A coaxial cable plant at two million square feet stands in contrast to 50,000 square feet for a fiberoptic plant.[50] A plant constructed for crossbar equipment, 3300 employees, obviously enjoys a different cost dimension and optimization compared to a plant of 120 employees. One felicitous observation has it that an electronics firm grew so fast that it was forced to move to smaller headquarters.[51] Telephone suppliers are either moving out of old plants or engaging in disinvestment of plants erected during the electromechanical era. And now robotics are appearing on the horizon, all of this suggesting that the traditional premise of economies of scale and optimum plant size will be subject to reappraisal.

Reductions in plant size obviously impact capital requirements and production costs of product fabrication. As integrated circuits decline on the average of 25 to 30% annually, product price declines suggest that entry into manufacturing is no longer as forbidding as in the era of electromechanics.[52] The computer industry typifies the capital dimunition over the last 15 years. Twelve years ago General Electric, RCA and Xerox dropped out of the computer mainframe industry on grounds they could no longer bear the capital burden of new product introduction. Today new corporations, new firms "clone" both IBM peri-

Table III

Digital Switching

(1/2 million lines/year)

Function	Labor
Materials	20
Assembly & Wiring	50
Testing	50
Total	120

pherals and IBM mainframes and do so without resorting to accessing the public equity market.[53] That process applies with equal force in telecommunications hardware. Witness Mitel and Plessey in Canada and Rolm and Digital Telephone Company in the U.S.

Finally, as telecommunication trends from electromechanical to electronic, costing and pricing practices have altered and shifted. In the electromechanical era, manufacturers multiplied standard costs by a price factor which included a rate of return on investment and posted the price to the utility customer on the premise that demand was price inelastic.

Today, however, it is by no means certain that these premises operate with the same validity. Certainly, new manufacturing firms fabricating products with high IC content and capability engage

in different pricing philosophies. In contrast to standard cost pricing, these firms have begun to engage in learning curve pricing and a new perception of price elasticity not unlike the phenomenon of digital watches, hand calculators and video games.[54] Injecting that price philosophy into telephone equipment products and components is bound to be disruptive to incumbent and traditional communication suppliers - integrated or not.

As chips incorporate more and more capability, product size contracts and shrinks. Table V traces the size reduction of computers since 1960.[55] Technological experts insist that any arresting of the microminiaturization trend cannot now be detected. And industry observers argue "We ain't seen nothin' yet!"[56]

Finally, microminiaturization cost/price reduction alters marketing and distribution of producer's goods. Marketing bypasses sales agencies and migrates directly into a retail effort. The 7,700 Radio Shack stores now market home computers in competition with IBM.[57] The trend toward retailization has spread to Xerox, Digital Equipment, IBM, Hewlett-Packard, Data General and Texas Instruments.[58] The retail trend has even surfaced in telephone equipment as well.

Are these trends likely to persist next year? Most industry observers suggest they will. In fact, the forces driving productivity, microminiaturization and innovation have only begun, they insist.

To sum up, the premise supporting manufacturing is under technological assault. Entry into microelectronic equipment across all telecommunication product lines is accelerating. Start-up costs and capital requirements are no longer as formidable as in an electromechanical era. Declining product life precipitates product obsolescence and places a premium on pricing flexibility, product innovation, and product marketing.

Silicon content yields product productivity, miniaturization and integration. The manufacturing base now includes new domestic industries as well as overseas suppliers. Pricing is no longer a mechanical exercise in cost plus. Non-pricing factors now erupt as an important ingredient in product marketing. These changes stand in sharp contrast to the analog electromechanical world of a generation ago.

Services

Technological change has spilled over into telecommunication facilities. Technology has eroded the basic premises supporting such services, including the alternatives of capital equipment, the cost of investment hardware, the economic life of some costs and the homogeneity of telecommunication demand. Each will be examined.

The diversity in microelectronic equipment broadens the alternatives of capital inputs to operating companies buying telephone hardware. The array of substitutes in station apparatus during the past fifteen years reflects this growth of product technology.

Terminals today now include and embrace computer CRT's, PBX's, TV sets, key telephone systems, cash registers, money machines, minicomputers, pagers, word processors, home computers, CB radios, facsimile units, desk copiers - indeed, some go so far as to include backyard earth terminals.[59] The proliferation of competitive substitutes in long haul or transmission facilities may appear less dramatic than in the terminal area. Nevertheless, that process continues as satellites, coaxial cable, digital radio and fiberoptics pose as cost tradeoffs in that sector of communication plant.

Switching obviously lends itself to a growing list of product alternatives as machines trend from an analogue to a digital mode. Mainframe computers, minicomputers, microprocessors, packet switching, circuit switching, radio packet switching, all pose as tradeoffs for data and voice.[60] Indeed, some argue that satellites themselves will soon embody on-board switching units.[61]

Conventional wisdom holds that technology, however vibrant in terminals and switching, is quiescent in the local distribution area; the area that links the telephone subscribers' equipment to the central office. Here it is contended that local distribution constitutes the last bastion of natural monopoly. But consider the options- microwave radio, FM radio, direct broadcast satellites, coaxial cable, broad band coaxial cable, mobile radio, fiberoptics, infrared light data, the electronic

power line, to say nothing of CB radio. And consider also the following developments on the supply side:[62]

- Computer firms link intelligent terminals via coaxial cables within buildings, increasing speed beyond the 9.6 kilohurtz permitted by pared wire.[63]
- Computer firms link intelligent terminals via CATV coaxial cable.[64]
- Banks link computers by infrared light, bypassing coaxial cable of telephone companies.[65]
- Computer firms link terminals via FM radio, rooftop antennas, space satellites, bypassing sunk investment in local distribution faciliities.[66]
- Newspapers link terminals to distribution points of 160 miles utilizing digital broadcast techniques.[67]
- Two-way computers communicate by electric power lines within buildings and offices.[68]
- A New York bank employs a hand-held terminal plugged into an electric wall socket for electronic banking.[69]
- Two way computers push information retrieval systems from the home TV.[70]
- American Satellite bypasses local distribution facilities with rooftop dish antennas.[71]

All suggest that the local loop and inside wiring will experience technological agitation. Today investment diversity, an extension of technological diversity, occurs in terminals, switching, transmission

or local distribution facilities. These alternatives obviously confer more options to users than in an electromechanical era.

Capital Costs

Microelectronics is generating cost reductions in products that pose as inputs to telephone carriers. As products embody more silicon content, as prices fall and decline, telecommunication capital expenditures no longer pose as formidable barriers to market entry. New firms, new industries, are entering and supplying equipment and plant facilities. Indeed, the user himself is becoming part of the entry process. In the business users' make-buy decision, forms are integrating into telecommunication services and measuring tradeoffs between leasing services vs. providing them in house. As the entry process continues apace, new firms can bypass much of the sunk investment of incumbent telephone companies, thus challenging long-standing concepts of economic life, depreciation and product writedowns.

Economic Life

The operating rule that telephone assets can assume a 40-year life, immune from technological obsolescence, is no longer secure. As substitutes proliferate, as costs drop, as innovation quickens, new equipment competes with old, new assets compete with existing capital. At the same time, old equipment may trend into a non-competitive stance, vis-a-vis its cost alternatives, such that users, as we noted, shift away from equipment leasing to purchasing hardware incident to make-buy decisions. Cost reductions are on such a scale that the carriers imbedded with old hardware risk losing business to subscribers buying state of the art equipment.

Services, Cost and Tariffs.

Technological change has proved disruptive to telephone rate-making. Certainly the process of market entry challenges long-standing traditions of rate averaging and rate cross subsidy. Whether the market consists of telephone terminal, business station equipment, toll private lease services, long distance message toll or data communications, entry as viewed by the telephone industry is regarded as threatening and cream-skimming.

In a private market setting entry is nothing but resource allocation driven by consumer choice. The fact that technology has created opportunities for the entry process does not make that process any less controversial, however. As we will note in our discussion of policy issues, incumbent telephone companies are apprehensive to challenges of long-standing practices that range from accounting to pricing, from write-offs to cost allocation. Certainly the telephone industry is undergoing an agonizing re-appraisal of all of its policies as the pace of technology continues unabated.

Nowhere is that reappraisal more striking than in the relationship of telephone companies to each other in the United States. Toll separations between AT&T and the independent telephone industry is obviously a crucial financial adhesive. But such revenue transactions may no longer be controlling in geographically separating the industry.

Today in the US the independents are diversifying out of their respective geographic market areas and invading each others territory with abandon.[73] Through the formation of holding companies, non-Bell operating companies are penetrating the interconnect equipment market (United Tel, Continental Tel, GTE); penetrating via satellite relay the long distance toll market (GTE, Continental Tel); penetrating the packet switched data market (GTE); and penetrating telecommunications software and consulting market (Rochester Tel.).[74] Even traditional boundary lines separating telephone and telegraph are no longer sacred. Western Union, after vacating the long distance voice market in 1879 announced last year its intention to reenter that field.[75]

Summary

How can the drift of technology and the erosion of assumptions supporting research, manufacturing and telecommunication services be summarized? Table 5 represents such an overview. Consider research and development. One can describe an era of electromechanical technology as being R&D strained, the rate of technological change orderly, product substitutes relatively narrow, product and service boundary lines identifiable and research expertise essentially a parochial domestic endeavor. By contrast today, R&D moving into electronics the research base is broadening rather than narrowing, the technological rate of change is accelerating, research and development is now international rather than domestic in scope and market boundary lines are softening if not eroding.

Table IV

Technological Contrast

		Electromechanical	Electronic
Research and	.	Electromechanical	Electronic
Development	.	Limited R&D Base	Broad Base
	.	Discretionary change	Accelerated change
	.	Limited substitutes	Expanding substitutes
	.	Domestic expertise	International Expertise
	.	Crisp market boundaries	Softened Market Boundaries
Manufacturing	.	Narrow base of participation	Expanding base
	.	Product size - large	Product size - miniaturization
	.	Product content - labor	Product content - capital
	.	Design cycle time - long	Design cycle time - short
	.	Product Life - long	Product life - contracting
	.	Cost plus pricing	Learning curve pricing
Services / Facilities	.	Capital intensive - limited entry	Capital diversity - less entry restriction
	.	Cost of Capital - prohibitive	Cost of capital - declining
	.	Depreciation life - long	Depreciation life - contracting
	.	Investment substitutes - limited	Investment substitutes - expanding
	.	Rate base accounting - unquestioned	Rate base accounting - inadequate
	.	No entry	Market entry
	.	Geographic separation	Geographic fusion
	.	Service boundaries clear	Service boundaries coalesced

The contrast in manufacturing technique is similarly compelling. In the electromechanical era the number of suppliers appeared limited and confined to essentially telephone manufacturers. The production labor content of products was relatively high. Product economic life was predictable, cost plus pricing a standard practice in telecommunication fabrication, product market boundary lines stable and discernible.

In contrast, today's environment reveals a multiplicity and growing number of suppliers in telecommunication hardware, a multi-dimension in product supply, an increase in semiconductor content, a contraction of product economic life attendant innovation, miniaturization of product size, reduction in product life cycles, a prevalence of learning curve pricing, the blurring of product boundary lines and a continual proliferation of product substitutes.

Telecommunication services in the electromechanical era was capital-intensive as well. Capital investments endowed equipment with long depreciation lives and capital products were relatively limited. Telephone carriers engaged in rate base accounting, value-service pricing, rate cost averaging under a universal service commitment. Market demand was essentially homogeneous.

Today, capital costs are declining and diminishing. Investment alternatives are spreading and proliferating. Depreciation life is contracting, rate base accounting suspect under technological change. Cost allocation is reassessed under increased market diversity and submarkets and market segmentation accepted as a new matter of management commitment. These developments have obviously spilled into the policy sectors of both Canada and the U.S.

Stated differently, technological changes are assaulting long-standing assumptions of economies of scale in R&D, in manufacturing, in telecommunication services. The acid test for economies of scale is market entry, a process endemic to virtually all levels of communication activity. The reality of market entry poses an obvious series of policy questions. Will this process continue into the 80's? What changes are likely to occur in R&D, manufacturing, facilities and service? Here we must enter the realm of conjecture.

IV. The Microelectronic Era - The Future

In speculating about the future, one must rely essentially upon industry participants and observers as to the drift of trends and developments. Consider research, manufacturing, facilities and service.

1. Research

Consider the number of industry participants in R&D today and project that base into the future. Industries - not merely firms - include:

- telephone
- computer
- minicomputer
- microprocessors/peripherals
- semiconductors
- software
- aerospace
- business equipment
- oil/chemical
- consumer electronic
- cable/broadcasting

This base is not merely multi-industry, it is multi-national and multi-government. There is no suggestion that the quantity of resources devoted to information processing will diminish in the forseeable future. Indeed, information R&D is truly multi-disciplinary - making distinctions between voice, data, video and text meaningless.

2. Manufacturing

How will manufacturing evolve in the decade of the 80's? Industry participants make the point.

"The electronic factory is coming. The only question is when."

- "Really it (the factory) is an anachronism. We don't have buildings with machines going clank, clank, clank!" [77]
- "The economics of semiconductor production will make it more profitable for semiconductor firms themselves to build computers." [78]
- "If, in the future, the entire function of units are combined in a small number of integrated components, components which are not developed by the telephone industry but other parties, the result will be a shift in know-how." [79]
- "Computer aided design, computer aided manufacturing, automation will automate the generation of artwork, automate the printed circuit and board manufacturing, automate tape preparation, automate the preparation of programs and automate test equipment." [80]
- "The semiconductor devices we are making are no longer components, but systems on a single chip." [81]
- "The dividing line between a component and a system is disappearing." [82]
- "The integration of semiconductor components with even greater functional units is leading to shift of know-how from the manufacture of equipment to the manufacture of components." [83]
- "Manufacturing of chips is nearly akin to building a finished product in which it will be used. You are already 80% of the way there." [84]
- " A computer business is becoming a chemical business in many respects. I think polimer physics and chemistry are more critical skills in the electronic industry than semiconductor physics." [85]

What industries will participate in product manufacturing?

The following industry candidates exist today:

- telephone
- telegraph
- terminals
- computers
- minicomputers
- software
- microprocessors
- semiconductors
- business equipment
- consumer electronics
- aerospace
- chemical/petroleum
- broadcast/cable
- automotive

What is the likely trend of product productivity and cost?

- Semiconductors will double in complexity every two years.[86]
- Fifteen years of research and testing on a space laser communication system will culminate in December 1981 with the launch of the first laser communications equipped satellite.[87]
- The number of components per chip can be expected to grow dramatically for at least another 10-15 years.[88]
- A $10,000 minicomputer will cost $1.10 in 1990.[89]
- A half million dollar mainframe computer will cost $100 in 1990.[90]
- On microelectronics - "all projections show continuous, massive development for the next 15 to 20 years." [91]
- A prototype kyrogenic computer, a three-pound computer, is capable of doing 70 mips. By 1984 IBM can expect to produce 250 mips. At the present time the large computer can produce 3 mips.[92]

What is the product life scenario in the next decade?

- We will see more changes in the next ten years than in the past ten. [93]
- Technology shows no signs of slowing down. [94]
- Its (rate of change) is going to come faster and faster in the next five years. [95]
- Every two months after the device (microprocessor) is purchased, something better comes out. [96]
- Some OEM (computer terminal manufacturers) are redesigning products every six months. [97]
- The frightening thing in this business is, that if you are not first, second or third, you are in trouble. [98]
- "It follows that we can experience no reduction of technological advance...." [99]
- "Product designs are likely to change much more frequently in the future, either by redesign of hardware or the reprogramming of existing hardware." [100]
- When writing the first draft of this book, I predicted a number of events to occur within the next ten years; further research revealed that most of these events had already occurred." [101]

3. What options are possibilities for communications facilities?

- point of sale devices
- word processing terminals
- minicomputers
- CRT terminals
- portable earth stations
- portable telephone
- desk size computer
- FAX equipment
- intelligent copiers
- mobile telephone
- CB radios
- intelligent PBX's
- intelligent key systems
- intelligent TV
- video tape recording
- paging devices
- electronic mail terminals

- Switching equipment
  - analog
  - digital
  - minicomputer
  - microcomputer
  - packet switching
  - satellite switching
  - terminal switching
  - radio packet switching
  - TV activated switching
- Transmission - Long Haul
  - satellite
  - fiber optic
  - analog radio
  - digital radio
  - coaxial cable
  - microwave
- Local Distribution Facilities
  - copper wire pairs
  - coaxial cable
  - fiber optics
  - direct broadcast satellite
  - FM broadcasting
  - digital microwave
  - broadband coaxial cable
  - electrical wire
  - infrared data link
  - packet radio

- Software
  - computer
  - publishing
  - libraries
  - newspapers
  - financial information
  - medical
  - directory assistance
  - remote data base
  - network software
  - etc.

4. What information services and networks will likely proliferate?

- electronic funds transfer networks
- home computer networks
- electronic mail networks
- point of sale networks
- facsimile networks
- data base network
- video conferencing
- telephony networks
- telegraph networks
- cable TV networks
- satellite networks

How can one summarize the developments and trends in the future? First, a word of caution. Many of the firms developing equipment, facilities and service will experience casualties and fail. The future is by no means assured or without risk. But having said that, one can hazard the following predictions:

- the research and development base can be expected to expand
- government will continue to fund and underwite key areas of R&D
- R&D will be internationalized
- product life cycles will continue to shorten
- product obsolescence will not diminish
- product costs and prices will continue to decline
- product integration will proceed unabated.
- facility substitutes will continue to erupt on a broad front
- information networks will proliferate and grow
- intelligent terminals will embody speech recognition and voice synthesis

In a word, the microelectronic era will herald an information economy[102] whose calculations will account for 50% of GNP by the middle 1980's. One can no longer speak of industry or industries, but rather aggregative sectors of an information economy.

As we move toward an information age, the adjustments to a new environment have not been without stress or controversy. That controversy has spilled into the public policy arena as a series of issues or debates in both Canada and the U.S. It is to these issues we now turn.

V. Policy Conflict in Regulation

That technological change has spilled into the policy arena is all but obvious. Three broad issues point to a growing debate as to the direction and content of policy; the structure of R&D, manufacturing, facilities and services; the boundary line question of communication and information; the jurisdictional conflict of diverse government entities.

1. The structural conduct debate includes the following questions:

- Is the ownership of utility and supplier necessary for economic efficiency?
- Is vertical integration essential for service or product innovation?
- Does vertical integration foreclose market access?
- Do captive suppliers earn excess profits?
- Should subscribers attach equipment to switched telephone lines?
- Should policy encourage specialized carrier entry?
- Should specialized carriers gain access to local distribution facilities?
- Is marginal cost pricing appropriate for competitive markets?

Telephone carriers with ties to equipment suppliers insist that the dual ownership of utility and manufacturer result in efficient production costs, lower product prices and hence reduced telephone rates to the subscribing public. The proof of the value of vertical integration often centers on price comparison studies supplied by telephone companies to various regulatory agencies.

Generally such studies match integrated suppliers against comparable equipment manufactured by competitive or general trade suppliers. Whether the equipment compared is station transmission, switching or other apparatus -

invariably such studies argue that the integrated supplier enjoys a price advantage.[103] It follows that integrated telephone companies buy equipment at reduced cost and serve the best interest of the telephone subscriber. Prices are gleaned from catalogues, selected through telephone surveys or modelled in the case of more complex telephone apparatus and hardware.

Price comparison studies have served as one proxy for measuring efficiency at the supply level. Reaching as far back as the 1920's such studies,whether supplied by AT&T, Bell Canada or General Telephone argue that vertical integration yields prices lower than equipment competition.[104] AT&T's study is illustrative of the mechanics of such an efficiency standard. The company balances Western Electric equipment with comparable competitive hardware.

However, in 1977 the FCC reversed its policy of tacitly accepting the validity of AT&T's price comparison studies.[105] An administrative law judge and subsequently the full commission concluded that the telephone companies price comparison methodology was flawed, that suppliers were foreclosed from the market, that in some instances general trade prices were overstated.[106] Subsequently, the Commission ordered AT&T to modify procurement so as to permit general trade suppliers' products access on a fair, equitable basis.[107]

On the other hand, few state regulatory agencies have challenged these price comparison studies supplied by the Bell System or the General Telephone system. In the U.S. at least, a regulatory chasm exists into which one regulatory jurisdiction is accep t ing the price comparison studies, the other rejecting their validity.

The exploration of vertical integration has gone beyond the price comparison test, however. When Western Electric's efficiency is challenged the company introduces testimony that directs itself to economic productivity as proof of Western's operations.[108] Canada, too, has experienced a history of equipment price comparisons that parallels the U.S. Canada's regulatory agencies over time have occasionally examined price comparison studies submitted by B.C. Telephone as well as Bell Canada; and, as in the U.S., equipment price billed to a carrier's rate base has rarely been disallowed.[109]

The CRTC has recently sought to audit Bell Canada's price comparision studies submitted on behalf of Northern Telecom. This endeavor prompted the carrier to remind the commission that the premise of such studies - namely product and firm comparability, rested upon equipment comparability; comparability of product life cycles, software content, specialization and economic environment.[110]

In sum, vertical integration, price comparison and equipment competition continue as part of a regulatory dialogue in both the U.S. and Canada. Vertical integration, given its narrow market base, finds regulatory agencies searching for a test of the buying, cost, pricing and non-price decisions of an integrated utility. Price comparison studies in both the U.S. and Canada have served as one such surrogate. But now that institution is inviting increasing criticism; and in the case of the FCC, price comparison studies have been rejected outright. Nevertheless, price comparison studies persist as part of the regulatory scene in both Canada and in the U.S.

2. Is the utility-supplier entity essential to innovation?

Carriers owning manufacturing affiliates insist that vertical integration contributes to the innovation process.[111] According to telephone companies, innovation is a system concept, an interdependency made up of billions of parts. All components must interface, the new with the old; New generations of hardware must match existing hardware. The combination of research and development, manufacturing and service has, as its grounding, the innovation of products and services at all stages of production that emphasize a total response to the needs of the telephone subscribing public.

Critics argue that vertical integration acts to inhibit the innovative process and stifles the introduction of new hardware, new products, new services and new plant.[112] Indeed, critics of vertical integration insist that the supplier-utility relationship limits, narrows, and constricts the choices available to the telephone operating companies and ultimately the subscribing public. They argue that innovation is enhanced, aided and abeted through market rivalry, diversity and competition in the supplying of telephone equipment. To that extent, competitive advocates insist that operating companies purchase telephone equipment on a competitive access basis as a means to institutionalize and promote the process of innovation.

These arguments have found expression in both the U.S. and Canada. On the U.S. side the test of innovative performance has been examined in several phases of telephone and plant and equipment including station tranmission, switching and local loop distribution facilities. The investigations have surfaced in private antitrust suits, including Litton vs. AT&T, ITT vs. ATT, ITT vs. GTE, MCI vs. AT&T, Datran vs. AT&T.[113] Common throughout these private suits is the question of the economic

stimulus to the innovation process. Finally, the FCC's investigation of Western Electric documents the critical role of supplier competition in the innovative process.

Similarly, in Canada, both BC Telephone Company and Bell Canada's innovation records have been examined before Canada's CRTC and Restricted Trade Practices Commission.[114] Vertical integration as a market structure is subject to continual assessment in terms of product and service innovation.

3. Does vertical integration act to foreclose independent suppliers?

During the past ten years, the issue of market foreclosure has become a critical policy issue in the United States. For example, private suits have been filed by independent suppliers alleging that captive manufacturers gain preferential access to research and development, standards, specifications, budgets, corporate planning and equipment needs of the telephone operating companies. Defendants, on the other hand insist that the trend of research and development, manufacturing and services is orchestrated teamwork whose sole end is to secure better communications services at lower prices.

Recent antitrust settlements in the United States by private litigants have turned on the vertical foreclosure issue. GTE, in its ITT/GTE suit, agreed to provide equitable access to ITT, an independent supplier to General Telephone's operating company needs.[115] And in a recent settlement involving AT&T and ITT, the Bell System has agreed to purchase some two billion dollars of equipment from ITT over the next ten years assuming comparable standards of quality and prices.[116]

The U.S. Department of Justice's AT&T complaint goes to the heart of the foreclosure issue.[117] Indeed, the Department of Justice seeks divestiture as a means to restore market access, market competition and market rivalry in telecommunications manufacturing. On the other hand, the FCC's inquiry into Western Electric's relationship requested that Bell institutionalize a process that encouraged general trade supplier access to Bell's 23 operating companies.

The issue attending foreclosure of Bell Canada and Northern Telecom represents still another aspect of conduct associated with vertical structures. Nevertheless, basic to the Consumer and Corporate Affairs argument before the Restricted Trade Practices Commission, is the issue of market access and foreclosure.[118] This investigation is sill in progress.

4. Do captive manufacturers enjoy excess profits on sales to telephone companies?

A vertically integrated market structure inevitably raises questions of returns on investment. Integrated manufacturers derive and may enjoy excess profits in selling to a captive market - returns that ultimately burden the telephone rate payer. In the U.S. AT&T has submitted profit comparability studies to both federal and state regulatory agencies. Generally, these studies demonstrate that while Western Electric's profits exceed that of a regulated telephone company, Western's return on investment is less than that enjoyed by comparable manufacturers in the electronic industry. No assessment of risk is included in the nature of comparison although references to the accelerator principle are applied to Western Electric to document Western's sales volatility.

While the FCC has never formally disallowed profits on Western Electric's prices billed to AT&T, occasionally state commissions refused to accept Western's status as a manufacturer. Rather, these commissions have treated Western as a quasi public utility and disallowed prices in excess of the return enjoyed by regulated telephone company.[119] This policy of rate disallowance, however, is the exception rather than the rule.

On occasion, Canadian regulatory authorities have found it necessary to examine Northern Telecom profits. In the late 1960's, for example, the CTC ordered Northern Telecom to disaggregate its rate of return as assigned to Bell and non-Bell business. Such a study, presumed an acceptable cost allocation method, and disparity in profits derived from overseas customers and domestic customers. In 1974 the CTC observed that Northern Electric's disaggregated profit study was of "doubtful usefulness"[120] and the investigation discontinued.

Profits drived from a captive market continue to beset regulatory agencies in North America. However, in much the tradition of the price comparison studies, some agencies have ignored the rate of return issues, while others have attempted to impose profit ceilings. Few agencies have insisted that return on captive sales be abolished or eliminated.

5. Should subscribers be permitted to attach equipment to switched telephone lines?

This issue straddles both the U.S. and Canada and focuses on telephone company practices that embody an end to end concept of leasing service rather than selling equipment. Given that concept, telephone companies traditionally deny customers the right to own and attach equipment to the dial network. The carriers insist that the end-to-end concept

protects the network from technical harm, insures adequate repair, maintenance and reliability and mandates quality through carrier control of terminal devices. Centralization of responsibility, insists the carrier, is essential to a mandate to deliver quality service to the public at large.

Critics of carrier attachment policy insist that leasing equipment and banning user ownership of hardware removes the incentives for price competition, dampens product innovation, and insulates the carrier from responding to individualized needs of its subscribers. And outside manufacturers argue that foreign attachment tariffs effectively preclude access to the business and residential equipment market, thus inhibiting suppliers' ability to compete against captive manufacturers.

Both the United States and Canada are in the process of reevaluating long-standing prohibitions on customer ownership embodied as filed tariffs before regulatory bodies. In the past decade, the U.S. has moved from upholding an absolute ban on user ownership of equipment to a certification program enabling users to purchase type accepted equipment sanctioned by the FCC.[121]

Similarly, the CRTC, undergoing a reevaluation of foreign attachment tariffs, is moving to an interim certification program that broadens subscriber choice in equipment and apparatus ownership.[122] Whether such an attachment policy extends to carriers outside of the CRTC jurisdiction is obviously controversial and uncertain.

In the spring of 1980, the FCC Computer II Ruling did an about face. The Commission proposed to deregulate all telephone terminal equipment and to permit dominant carriers - GTE and AT&T - to offer such equipment via a separate corporate affiliate.[123] At the same time, several legislative proposals contemplate the separate subsidiary concept as a vehicle to achieve partial deregulation. Subsequently, AT&T has reorganized itself into separate affiliates in accordance with the philosophical drift of the FCC and proposed legislation.

6. Should public policy encourage market entry in selected markets?

This critical issue, obviously laden with controversy, embraces not merely questions of user ownership of station apparatus and microwave equipment, but rather the question of market entry into specialized carrier markets, value added services, and communication satellite services. The U.S. has, over the past two decades, tilted toward a competitive, intermodal policy that sanctions user ownership of private microwave, point to point radio microwave by carriers, specialized microwave systems, value added communications systems and competitive domestic satellite systems.[124]

The incumbent carriers, telephone and telegraph companies, have in the past insisted that technological competition is unworkable, that carriers do not treat such options as mere tradeoffs, but as complementary plant investments inherent in a total service commitment. Finally, the carriers insist that new entry dilutes investment, raises costs, lifts prices and generally fragments investment and plant endowed with traits of natural monopoly.[125]

Adherents to technological competition assert that rivalry stimulates innovation and investment efficiency, marketing and demand growth; that

carriers vesting an interest in sunk capital costs may be tempted to delay the introduction of competitive alternatives until old plant is written off.[126] Critics, in short, submit that asserting new technology exclusively to incumbent carriers vesting an interest in existing plant forestalls and delays the availability of products, hardware, and services to the user public. Not surprisingly, new entrants argue that a policy of open access best insures that investment, service, products and facilities are made available to the user in a timely manner.

The U.S. in particular, continues to experience a running debate on the question of service entry and service rivalry. Whether the issue turns on private microwave, satellites, specialized carriers, domestic satellites, the reselling of circuits or value added carriers, the exploration of public policy has been before the congressional level, FCC dockets, state regulatory commissions, appeals to the judicial process and proposals to rewrite the Communication Act of 1934. In each issue, the merits or demerits of competitive access continues as a common theme; the incumbent carriers resisting market entry, new firms affirming the virtues of open access.

Canada appears to experience less policy turmoil than the U.S. in many of these matters. Although CNCP competes with TCTS in private line voice and in packet switching services, Canada has not paralleled the U.S. by sanctioning specialized carriers or in approving private ownership of microwave communication systems, (certain hydros excepted). Moreover, the merger of Telesat Canada and the Trans Canada Telephone System combines and limits alternative technological rivalry within the confines of a telecommunication consortium.[127] Yet, TCTS vested little interest in satellite relay until a new generation of satellites threatened to

bypass the carrier's control of local distribution facilities and hence introduced direct market rivalry. In any case, Canada has tended to opt away from a policy of direct technological competition.

7. Should specialized carriers access local distribution facilities?

This policy issue represents an extension of a policy sanctioning market competition and entry. Local telephone companies enjoy monopoly in local distribution facilities between customer premises and switching facilities, and deny access to longhaul carriers that compete with their own toll facilities. In the United States, the policy question turns on whether all long distance companies or only AT&T Long Lines can gain access to the local distribution facilities of the telephone industry.

Specialized carriers, on the other hand, insist that they be accorded the same interconnection privilege that local Bell operating companies give to either AT&T or Western Union Telegraph Company. Failure to receive interconnection, they argue, is tantamount to an exercise in price discrimination. The issue of local access has surfaced continually at the FCC in various dockets and inquiries.[128]

With relatively few exceptions, most state commissions prefer a policy that interstate toll telephone revenues contribute to the costs of local exchange service, presumably reducing the price of local main station services. Assuming one can disentangle joint and common costs, one estimate has it that the average revenue of a main station is $9.00, the average monthly cost is $16.00, the difference of some $7.00 made up by a toll contribution.[129] Traditionally, billions of dollars are allocated in toll separations and settlements.

If toll competition eliminates profits on the long distance area, the snortfall on the exchange must be made up by higher rates or some estimated of 80% of the former rates or a shortfall between 6-8 billion dollars annually.[130] Moreover, deregulation of terminal equipment now proposed by the FCC may further reduce the rate base at the local exchange level.

The result has seen a coalescence of FCC and state commission concern over the toll contribution issue. The FCC, and indeed Congressional legislation, contemplate institutionalizing a subsidy whereby all toll carriers contribute to the subsidy of local exchange rates. Indeed, such a tariff is now in position, Exchange Network Facilities (ENFIA).[131] The question is, who should administer the ENFIA pool and what interstate carriers should be susceptible to its application.

Few state commissions have posed questions as to the content and rationale for exchange rate toll telephone services. For example:

. Why should a competitive market - toll, subsidize the monopoly market - local? Of all the theories of public utility concept, this surely stands monopoly pricing upside down. Most theoreticians worry that monopoly markets subsidize competitive entry (the A-J effect has been with us almost 20 years).[132] In the next decade will regulation policy reverse this alleged cross subsidy flow?

. Why are exchange rates rising and toll rates falling? Few commissions have examined the impact of flat rate at exchange service level. Few agencies have asked the question, do flat rates so reduce marginal cost that the subscriber thus possesses little incentive for off-peak calling, thus driving up peak plant capacity, inflating the rate base inherent in a cost plus incentive system.[133] Stated

differently, few commissions have closed the conceptual loop between pricing and plant investment.

Until recently few commissions have questioned why little technological ferment occurs in local distribution plant. Commissions automatically sanction AT&T's license contract as a legitimate operating expense. Few commissions ask what type of research and development is funded by that license contract - why are toll facilities emphasized in R&D and local exchange neglected - even acknowledged by Bell Telephone Laboratory.[134]

Finally, few agencies question the technical state of switching equipment in the local exchange area, particularly in smaller communities. Had commissions inquired, they would find a rate base loaded with vintage equipment dating back to the 1920's.[135] Moreover, the procurement practices of integrated carriers purchasing step by step equipment when crossbar and digital switching was available raises serious questions as to product and technical innovation. Today we have the spectacle of state commissions insisting that competitive markets should subsidize monopoly markets, that old technology should subsidize new technology.

8. Is marginal cost pricing a proper carrier strategy in responding to competitive markets?

The status of common carrier response to competitive entry in selective markets is longstanding and exceedingly controversial. The telephone carriers insist that any policy that sanctions competition must be equitable, open and fair. The carriers definition of equity generally rests upon marginal cost pricing as a proper vehicle to respond to specialized carrier or satellite carrier competition.[136] The telephone carriers insist that marginal cost pricing can make some

contribution to overhead costs, will reduce rates to all consumers, and will give the company flexibility to disaggregate and assign costs on the basis of forward-looking plant allocations.

Critics insist that the ability of a regulated telephone company to straddle both a competitive and a monopoly market endows that firm with sufficient discretion to engage in cross subsidization that in effect, renders market rivalry null and void. Hence, skeptics, especially the specialized carriers, argue that not two but one single costing standard applied by the telephone carriers; namely, a fully distributed cost in both message toll telephone service as well as competitive private line service. The test, insists the specialized carriers, should be a fully allocated costs.

Skeptics of marginal cost pricing also observe that incremental pricing is not without its theoretical foundation. The problem, they insist, is translating theory into practice, an exercise in the separation of joint costs.[137] Such tiers of allocation are largely beset with hundreds of engineering, economic and accounting judgement calls, insist the specialized carriers. To that extent, cost allocation is inherently arbitrary, and critics insist that carriers must establish accounting rules for various submarkets as a standard to establish open and equitable rivalry. Still others argue that present day accounting standards of the carriers cannot yield adequate cost allocations with a great deal of precision. A few students of the industry insist that carriers be prohibited from any diversification at all, while other observers argue that separate subsidiaries imposed upon telephone companies will solve the question of cross subsidization and joint cost allocations.

Questions of rate structure abound in the terminal area as well as in telephone company responses to specialized carrier competition.

The legacy of marginal cost pricing in the U.S., however, dates to 1962 when AT&T filed tariffs in response to the FCC's decision to liberalize private microwave.[138] Since that time, the rate structure issue remains essentially unresolved despite numerous cost inquiries and lengthy docket investigations. The FCC has insisted that data supplied by the telephone company has been inadequate or non-existant or is arbitrarily derived. The telephone company, on the other hand, insists that the data is accurate, adequate and that the carrier must possess sufficient flexibility to deal with that environment of market competition. Whatever the answer, rate structure cases tend to elude easy policy resolution.

Although the Canadian rate structure issues are of more recent vintage, the CRTC's cost inquiry of Bell is indicative of a new examination of rate structure interest in Canada. Certainly, Canada can be expected to examine similar inquiries into carrier tariffs on the interconnect market.

2. The Boundary Line Debate.

- Should policy encourage entry into switched as well as private line services?
- Should carriers tariff intelligent terminals?
- Should carriers offer value-added services?
- How should carriers diversify into data processing?

1. Should policy encourage entry into message toll telephone service as well as private line service?

The carriers submit that if dedicated leasing is to be opened up, market entry, competition and rivalry in message toll telephone service should be off limits for such competition.[139] Message toll telephone service,

they argue, embodies the essence of common carrier exclusivity in terms of cost, pricing, scale operations and the like. In any case, the carriers contend market entry would be selective, a form of cream-skimming in which the incumbent telephone company would be left with the dregs.

Advocates of market entry in MTS type services argue that technology is limiting market distinctions and that these include the softening of separations between switched services and dedicated services to the business customer.

The classic example of market boundary in the U.S. is the Execunet Decision. Here a specialized carrier, MCI, offered a switched service that both the FCC and AT&T opposed and denied. But in judicial review, the courts upheld MCI's new service, despite the fact that the commission had argued that MCI had clearly jumped its private line demarcation and had offered an MTS type of service.[140] Subsequently, MCI's switched service has been offered by ITT, Western Union, and Southern Pacific.[141] Although the FCC has announced a docket investigating the nature of MTS type services, the fact of the matter is that switched services are now being offered by several firms and questions of market entry may have been rendered moot by the passage of events. Whether Canada will similarly be faced with these types of services remains an open question.

2. Should carriers tariff intelligent terminals?

This question is erupting with greater frequency as customer station equipment embodies microelectronic logic, circuitry, and memory. Telephone companies can exploit chip technology as well as firms in the computer industry. Thus telephone companies file tariffs on cathode ray tube displays, PBX's with memory, PBX's with accounting capability, PBX's with data processing features, much to the objection of the computer industry.[142] The latter industry insists that such services are data processing in content and thus are unfit

candidates for public utility regulation. The carriers insist that their equipment and hardware merely respond to the needs and requirements of their business customers.

Often the issue of tariff appropriations turns on semantic content. AT&T's Data Speed 40 typifies the struggle over definitional distinctions between communication and data processing. To illustrate, AT&T filed a tariff on the Dataspeed 40 which included a display terminal, some buffering capability and a printer. AT&T termed the unit "communication processing" and the FCC sanctioned Bell's filing as a communication service.[143] The computer industry strenuously objected to the Commission's definition - terming the Dataspeed 40 service as an unregulated, data processing activity. Whether such a confrontation between communication carrier and computer manufacturer surfaces in Canada remains to be seen.

Recently, (April 1980) the FCC's Computer II Inquiry - in deregulating terminal equipment - appears to cut the Gordian knot of telephone/information appliance boundaries. As noted, a separate subsidiary enables carriers to diversify into providing "smart" machines on a non-regulated basis.[144]

3. Should carriers offer information/telecommunication service?

The question of proper boundary lines between regulated and unregulated services has erupted with greater and greater frequency over the past 15 years. Telephone companies insist they have no choice but to follow the imperatives of technology, to offer such equipment in order to serve the customer with required offerings. The computer industry has observed with apprehension, as carriers incorporate new techniques and new hardware, file tariffs on what the computer industry terms data process-

ing services. Non-regulated firms are even more concerned that commissions, both at the state and the FCC level, accept tariffs on the grounds that these services fall within the public utility concept. In case after case, the computer industry has contended that AT&T's services, whether in the form of PBX or packet switching, Advanced Communication Services, is tantamount to migrating into computer services and facilities.[145] Thus the issue of borderline continues to erupt before regulatory agencies.

Commissions have attempted to define, delineate and establish market boundary lines in the hope that such demarcations, once established, would not be transgressed or violated. But successful policy pronouncements have been elusive. As soon as one docket is completed, another docket commences with the aim of searching for greater definitional precision. Since 1966, the FCC has attempted to separate markets on the basis of the following definitions.

- Data Processing
- Communications
- Communication Processing
- Hybrid Data Processing
- Hybrid Communications
- Basic Voice Service
- Non-Voice Service
- Enhanced Non-Voice Service
- Smart Terminals
- Dumb Terminals
- Message Switching
- Circuit Switching
- Line Resale
- Line Sharing [146]

In each of these exercises, the Commision sought to define ground rules that separated competitive and monopoly markets. Each attempt has met with frustration as boundaries refused to remain fixed and static.

As we have noted, an issue that recurs continuously is the status of market boundary lines and the AT&T in 1956 Consent Decree. The decree, derived from the 1949 antitrust suit established regulated communications common carriers as the market standard that would constrain AT&T's activities.[147] In a sense, such a boundary circumscribed Bell, its markets, its activities, to public utility regulation as a form of containment of Bell's diversification activities. But much to the apprehension of the computer industry, AT&T as well as other telephone companies has offered new services to subscribers that incorporate intelligent data processing or software capability.[148] Over the past years, the Department of Justice, the FCC, and Congress have searched for ways to soften the reach of the consent decree on the ground that the decree provided an incentive for the telephone to broaden rather than contract regulatory jurisdiction.

Both the FCC's Computer II Docket and Congressional legislation[149] have coalesced over time. Each contemplates the creation of a separate subsidiary to enable Bell to diversify into competitive information services without carrying the tradition of public utility regulation. As noted, Bell has reorganized along regulated (core) and unregulated (enhanced) services.

Despite these efforts, the erosion of boundaries continues inexorably. The American Association of Newspaper Publishers recently sponsored an

amendment to pending legislation that prohibits telephone companies from offering a nationwide electronic newspaper.[150] Presumably, the Canadian carrier and Bell Canada are not similarly burdened with the problems associated with their U.S. counterpart. Nevertheless, an occasional legislative proposal before Parliament suggests that attempts to broaden Bell Canada's market may also include data processing or information services as a legitimate vehicle for carrier diversification. The boundary line between view data service, electronic bibliographic services and electronic newspaper service is likely to recur as a policy issue.

3. Jurisdictional Issues

Technology has finally precipitated what can be called administrative/jurisdictional questions - namely, what agency decides questions of market entry; on what grounds - and who resolves controversies over market overlapping? In the United States, jurisdictional disputes have erupted between state regulatory agencies and the FCC; in Canada, issues have erupted between the provinces, the federal government and the CRTC.

If one reviews the U.S. experience in station equipment, cathode ray tube displays, specialized carriers, vertical integration, interconnection, and local access charges, invariably one finds the states opposing federal policies in what they regard as their constitutional jurisdiction. Invariably, too, these issues are turned over to the courts for final resolution.

Customer ownership of station equipment provides a classic case of this jurisdictional split. The states generally accepted tariffs that banned and precluded customer ownership of station equipment, PBX or key telephone systems. Indeed up to 1974, one state prohibited plastic covers on telephone directories. In 1968 the Commission upheld the attachment of subscriber-owned equipment to the nation's dial-up telephone lines. With few exceptions, the state com-

missions opposed this change in the interpretation of Bell's filed tariffs. The quarrel between the states and the FCC over jurisdiction of terminal equipment erupted when the North Carolina commission took its brief to the court on grounds the Commission had transgressed its control over state jurisdiction.[151] The courts upheld the FCC.

Tariffs on Bell's terminal equipment provides still another instance of the boundary line question. As noted earlier, the FCC's Common Carrier Bureau ruled that Bell's display terminal constituted sufficient electronic content and logic as to be classified as data processing and recommended the tariff be rejected. Within four weeks Bell filed the same tariff in some thirty states; a tariff which was accepted as a legitimate offering.[152] By the time the full commission addressed the question of the status of Bell's terminal display, the service had been sanctioned as a regulated state activity. Faced with this fait accompli, the Commission reversed the Common Carrier Bureau and classified the Dataspeed 40 as communications regulated service.

The states and the FCC squared off against each other in matters of specialized common carriers and access into various local markets. In 1972 the FCC ruled that specialized carriers could compete with the long lines division of AT&T. The states challenged the propriety of that ruling before the FCC and again in the courts. Indeed, some states asserted regulatory jurisdiction over specialized carriers operating within state boundaries as part of their toll services. Again the courts have tended to place federal jurisdictional authority over that exercised by individual states.[153]

Vertical integration has also precipitated a jurisdictional quarrel between the states, the FCC and antitrust law enforcement. GTE's acquisition of independent telephone companies appeared outside of federal jurisdiction to the extent that GTE was a holding company, not an operating telephone company. State commissions similarly rejected jurisdiction over telephone mergers. Thus when General Telephone acquired Hawaiian Telephone Company, a private antitrust suit filed by ITT prompted GTE to assert that regulatory pervasiveness, at both the state and the FCC level, immunized its merger activity from antitrust scrutiny. [154]

Canada, too, is not without similar jurisdictional tensions. Does the CRTC possess jurisdiction over terminal equipment if Bell Canada has no tariffs on file before the Commission? If the CRTC orders attachment of customer equipment to the dial-up lines, does that policy apply to the Prairie Provinces and the Maritimes? If the CRTC orders the Trans Canada Telephone System to make available its local distribution facilities to the CNCP telecommunications, does that policy also apply to the Prairie Provinces and the Maritimes? Not unlike the U.S., attachments and interconnection are likely to erupt and persist as jurisdictional disputes between provinces and the federal government.

Summary

A review of the policy disputes under structural, boundary and jurisdictional issues leaves the impression of turmoil and policy disarray. Our thesis is that the genie driving much of this disquietude is technological in content. All of this places an enormous burden upon regulatory and policy decision-making. A conceptual framework to sort out these policy issues might prove useful. Once that framework is in place, it can be employed to assess a series of alternatives open for future consideration. We turn now to an examination of regulatory models.

VI. A Regulatory Framework

To postulate a framework of public policy, we begin by assuming a continuum or spectrum of technology. At one polar extreme we assume that technology is relatively stable, if not static. This model also assumes that one industry occupies a market whose boundary lines are clear, fixed and easily discernible. We term this polar extreme the static model.

At the other extreme is a dynamic technology - a technology whose participants consist of many industries, industries coalescing so that boundary lines in research and development, in manufacturing, in facilities and in services are virtually indistinguishable. We term this model the dynamic model.

The middle ground, in straddling the polar extremes, represents a hybrid combination; a model that embodies varying elements of both static and dynamic technology. Here two markets reside side by each, and boundary lines or market delineations separating the two are fairly clear-cut. We designate this model the dual model.

1. The Static Model

Let us examine each of these models as cases of public utility regulation of telecommunications. In the first model, the static, single industry model, market delineation attempts to describe the telephone industry, its history and rationale for public utility regulation.

The public utility principle holds that regulation must replace market forces because of its unworkability or because of the inefficiency of market competition. The workability of competition is grounded on several premises - capital requirements, economics of scale, and demand

elasticity. The burden, size and cost of investment commitments in certain industries by definition rations and restricts market entry into that industry. Scale economies presume that one firm can provide services at unit costs lower than if production was allocated among several competitive firms. Efficiency, in short, resides with size.

Finally, service alternatives or substitutes are relatively distant and far removed. Given an absence of choice, the consumer is relatively insensitive to price changes. The service in question also possesses clear cut boundary lines separating and distinguishing that service from competitive alternatives.

A static model of stable technology, single industry, clear-cut boundary lines, describes the condition of natural monopoly. In so doing, market forces are deemed unworkable in protecting the interest of the consumer. An institution is deemed necessary to replace the market; hence resides one rationale for the public utility principle.

In a static model, regulation stands between the firm as a franchised legal monopoly and the consumer or user public. Regulation attempts to balance the interests of each, protecting the consumer from extortionate or discriminatory rates, insuring the firm a return on capital commensurate with the universal service commitment.

The economics of rate base economics need not detain us here. They abound in the literature. Suffice it to say that revenue requirement, cost allocations, rate of return considerations are essentially mechanistic. The rules of the game are long-standing if not unanimous. A firm must generate total revenues to cover total costs

and provide a return on net capital investment. Rate of return is equated with cost of capital, the investment rate base can be measured by several standards. Operating expenses over the years follow a familiar pattern of allowability. Clearly, the incentives that drive a static model are distorted toward a cost-plus bias rather than a cost reduction bias. Indeed, for two decades the literature has abounded with permutations and combinations of what is known as the A-J effect.

Recently the static model has been amended by the theoretical explanation of a multi-product firm in contrast to the traditional assumption of a single product firm. The regulated firm in providing more than one service with a welfare optimizing price vector may experience competitive entry in a particular submarket. Should public policy encourage that form of corporate entry and rivalry?

The sustainability theory of the monopoly firm holds that under certain conditions market entry is undesirable.[155] Assuming that technology is static, a multi-product monopoly is "natural" if that monopoly can produce the entire industry's output at less cost than any combination of two or more firms. The cost advantage of the monopoly firm, however, is grounded not on economies of scale, a single output concept. Rather, the monopolist's cost advantages reside in economies of scope (minimal ray average costs).

Each service offering exhibits different demand slopes so that the incumbent regulated firm optimizes social welfare through Ramsey pricing. This pricing scheme requires some prices to be above AC while others are below AC, according to the inverse elasticity rule. In this manner the price vector chases the least number of consumers out of the market and allows TR=TC enforcing the zero profit constraint.

This Ramsey optimal solution, however, may be short-lived. It is quite possible that where price is above AC market forces will attract entry. Ironically, an entrant with higher costs is theoretically able to profitably undercut the lower cost, zero profit regulated monopolist. By so doing, economies of scope are forfeited raising the total costs to society. Entry under these conditions is deemed inefficient. Monopoly must be sustainable by regulatory policy. Indeed, adherents to the theory argue that market entry "fragments" demand and as innovation is "destructive".[156]

The sustainability theory argues that natural monopoly is a viable economic solution that optimizes consumer welfare. In a theoretical sense, this amendment augments the credibility of the public utility principle and embodies regulatory commissions with wider and deeper rationale to extend jurisdiction beyond the traditional rationale of a single product monopolist.

2. Static/Dynamic Model

The dual static/dynamic model occupies the middle ground between the polar extremes between dynamic and static technology. In this model, one market is held relatively resistant to technological change; another market experiences great degrees of market innovation, obsolescence and volatile demand. This framework assumes two industries are residing side by each, separated by clear, discernible boundary lines.

Given that demarcation, regulation pursues two policies. On the static side, rate base economics proceeds in the tradition of revenue requirement, operating expenses, rate of return on net invested capital. Natural monopoly obviously precludes a market entry policy.

But the other market, the dynamic market changing costs, erupting demand, and rampant innovation invites market entry and rivalry. Here regulation acknowledges that the entry process is

generated by technological change and emerging consumer requirements. Regulation thus pursues a policy of restricted market entry.

In the dual model the burden of regulation is rendered infinitely more complex. The regulatory process becomes a bit schizoid with entry encouraged in some markets, banned and excluded in others. The agency must police the boundary lines with the utmost vigilance to see that no leakage occurrs between the two.

The dual model regulatory approach imposes burdens upon the telephone carrier as well. In the static model the carrier confronts a homogeneous demand, POTS, as a single supplier. In the dual model, the regulated firm participates with others in exploiting the opportunities inherent in market dynamism. The firm too finds itself operating in two distinct environments.

Regulation is burdened by at least two problems - how to prevent the dynamic market from infecting economies of scope, economies of scale, and sustainability; and yet how to prevent monopoly firms from pre-empting or deterring competitive market entry as a working process. This problem is further complicated if the regulatory agency acknowledges that boundary lines separating static and dynamic markets are no longer immutable, but actually present a moving target.

Consider, for example, the complexities preventing the dynamic market from infecting the static. If regulation rules that this market is congenial to competition, where should competition cease - private lease service, MTS, WATS or local exchange service? Invariably, regulation can find itself frustrated that entry under one set of circumstances may be altered by technological shifts in boundary line demarcations.

Consider the other side of the dual model. Here regulation must oversee prices, revenues and cost of firms enjoying captive customers. Inevitably, joint costs and price discrimination emerge as controversial policy issues. Here stands a monopoly firm pricing competitive services under an incremental cost philosophy. How should cost be identified, separated, and allocated? What price is socially optimal? What standards guide rate-making? Which direction does cross subsidy run? Suddenly, regulators delve into the intricacies and minutia of cost allocation and rate structure - or, as one participant remarked - embarking on a trip to the center of the earth.[157]

In short, rate structure issues carry with them elements of cross subsidy, predatory pricing and potential market foreclosure. Regulation finds itself wrestling with the lexicon of economic theory, fully allocated costs, marginal costs, long-run incremental, short-run incremental, Ramsey prices, inverse elasticity, to say nothing of market definition.

Despite these impediments, regulation must somehow inhibit the monopoly firm from engaging in a pricing strategy that renders null and void the dynamic side of the dual model. Indeed, entry can be invalidated if a monopoly firm can manipulate a competitive environment from the sanctuary of an exclusive franchise. Regulation seeks to protect the dynamic side from the static side. This dual concept imposes an unprecedented burden of subtlety and judgement upon the machinery of due process.

C. The Dynamic Model

The dynamic model assumes that rates of technological change, innovation, obsolescence and service explosion will continue unabated - that multiple industries participate in research and development, manufacturing, facilities and services; that boundary line separations are virtually indistinguishable and boundary line sorting patently impossible. The dynamic model assumes that multi-industry entry, demand elasticity, demand growth, non-price innovation, multi-industry participation into manufacturing renders a concept of economies of scope essentially irrelevant. Given the dissolving nature of industry boundaries, the dynamic model questions the validity for public utility regulation, at least in an economic sense. Stated differently, market dynamics have superceded the need for regulatory protection and industry control and rendered the assumption of natural monopoly an anachronism.

VII. Regulation and Public Policy

A. Static

Predictably, a series of policy developments in Canada and the U.S. reveal three patterns within a regulatory framework, the static, dual, and the dynamic model. Consider the static regulatory framework.

In this model the vertical issue of research and development, manufacturing, facilities and services are assumed to be immune from a technological dynamism congenial to market entry and competition. Here policy argues that research and development and manufacturing is imbedded with traits of scale economies, that telecommunications services are endowed with economies of scope. In this model, regulation assesses capital investment of carrier equipment via the price comparison test. No competitive procurement is inserted on top of the utility-supplier relationship.

Similarly, investment facilities are confined within the control of one firm. Regulatory policy does not find it useful to promote customer ownership of microwave relay facilities, satellite terminals, or telephone station apparatus. Nor does regulation find it necessary to foster market entry as a spur to carrier performance. This policy discourages private microwave, specialized carriers, satellite specialized carriers, value added carrier, resale or line-sharing. Incumbent telecommunication firms control their investment, facilities, and services within their own entity and organization. A concept of a single integrated network argues against a policy of market entry or market specialization.

The boundary line question of the static model is a settled issue. Boundaries are clear, concise and crisp - a policy that applies to private line services, message toll telephone services, telex, TWX, video, data and the like. Geographic boundary lines are similarly separated between toll and exchange services. Given these clean demar-

cations, regulation's mandate is to protect the integrity of the public utility concept of service, cost, price and revenue. Jurisdictional questions tend to be easily resolved in a static mode. Conflicts between federal and provinces in Canada and state and the FCC in the U.S. are assumed to be accommodated through the vehicle of joint boards and commissions.

We assert the static model is a statement of the past, not the future. It ignores the pace of technology, the diversity of research and development, the role of innovation, the reality of non-price competition. By equating the absolute size of R&D with the incentives that drive innovation, the static model misses the essence of economic incentives. The static model assumes that telephone plant is essentially immune from exogenous technological obsolescence, that multi-industry entry into research, manufacturing, facilities and services should not exist.

A static model is tempted to opt a chosen instrument approach that narrowly constricts a nation's investment portfolio in future services and markets. This model fails to comprehend and come to grips with the reality of technological ingenuity, creativity and change. Paradoxically, the static model is a high risk strategy that places a nation's bet on a single firm or industry. The static model ignores the opportunity cost of firm failure, misjudgement, or marketing myopia.

Finally, the static model places undue reliance - not to say faith - on the wisdom of a regulatory commission. The model assumes somehow that regulation can substitute its expertise, knowledge and judgement for literally thousands of decision-makers in the marketplace. The model assumes that due process can allocate billions of dollars and do so with the "public interest" as its running guide and standard. The static model, in short, presumes a regulatory agency is endowed with a rare degree of managerial perspicacity.

B. Static/Dynamic

The dual model asserts that regulation can orchestrate two worlds and enjoy the benefits of both. Under this framework, regulation can separate and define research and development, manufacturing facilities and services with relative ease. In the U.S. the separation of two Bell Laboratories, two Western Electrics, and two Bell operating companies - one devoted to monopoly or static services has been proposed with a dual model in mind. The dual model premise is that a clear demarcation runs from research to telecommunication services.

Given the existence of two markets, policy is confronted with several tactical choices. First, encourage entry into selected communication markets. Second, provide a vehicle for carrier diversification into dynamic markets. Consider the first problem. Under the premise of a static/dynamic model, regulation encourages entry into certain submarkets - private microwave, specialized carriers, domestic satellite, value-added or resale selling of services as well as station equipment, PBX's, key systems, automatic call distributors, data modems and the like. Furthermore, policy encourages interconnection and attachment as a complement to competitive entry into selected telecommunciation markets.

In actual policy implementation, the FCC has moved to accommodate diversity in private line services, private microwave, MCI, specialized carriers, domestic satellite, and shared uses of facilities as well as equipment ownership. The FCC has also pursued a policy that requires interconnection between specialized carriers and telephone company local distribution facilities; and certified customer station equipment attached to telephone lines.

A variation of this approach is simply to forebear regulation on what is called non-voice or enhanced non-voice services. This is the thrust and strategy of the FCC in its recent Computer Inquiry II, in classifying basic voice and enhanced non-voice services, a policy now being implemented by AT&T. The Commission proposes to deregulate the latter with carrier participation via a separate subsidiary approach. In Canada, Bell Canada, Alberta Telephone, New Brunswick Telephone have formed separate subsidiaries to diversify into data processing services. Thus the separate subsidiary attempts to cut through the complexities of joint cost allocation problems.

The boundary line question persists, however, in the dual approach. Where is the demarcation between voice and enhanced non-voice, electronic funds transfer, voice storage, communication processing, software, PBX's and the like. In the U.S. tariffs are filed on the premise that these services fall within regulation.

And nowhere is the dual policy model more controversial than in the attempt to preserve alleged subsidies to the local exchange subscriber. Indeed, the U.S. government is proposing to institutionalize that subsidy by exacting an access tariff to all toll carriers, presumably whether local telephone loops are employed or not.

Jurisdictional questions under the dual approach are equally controversial. Jurisdictional quarrels have erupted between the states and the federal government on certification, interconnection and access to local distribution facilities.

Canadian policy is also tilting toward a dual model approach. Bell Canada has sought to determine whether user-ownership of terminals is in the public interest and the CRTC has sanctioned interconnection of CNCP telecommunications providing access to local distribution facilities of the TCTS. The CRTC has also sanctioned interconnection of radio common carriers to the Bell Canada network.[158]

The other side of the dual question is how to permit carrier diversification into a dynamic market. The U.S. is currently involved in this exploration. One approach is to require the carriers to maintain cost accounting standards so as to identify possible cross subsidy between monopoly and competitive services. But as we have noted, a second approach is to create a separate subsidiary and to place that subsidiary at arm's length from a regulated entity; an approach advocated at the FCC - while maintaining jurisdiction over what is termed a "dominant carrier."

In another sense, public policy is experiencing unprecedented forms of jurisdictional and borderline questions - the separation between broadcasting, mail and voice, telephone and newspaper, publishing, banking and telecommunications. The jurisdictional question holds the potential of a regulatory nightmare in terms of which agency exercises jurisdiction, which agency establishes the ground rules, and who is to ajudicate between respective spheres of influence. Obviously, judicial review will be invoked.

A policy that assumes a dual model is accordingly not without its regulatory burdens. How, for example, can regulation separate and cleave research and development, manufacturing, facilities and corporate marketing?

How can regulation police rate structure, separate subsidiaries or semantically define distinctions between voice and data when such distinctions are technologically meaningless? How can regulation patrol the differences between data, voice, software, mail, publishing, broadcasting, satellites, video conferencing and word processing? The answers are not forthcoming.

And how can regulation "regulate" a carrier's separate subsidiary? Specifically, how much capital per year can be transferred from a static market firm to a dynamic market firm? 10 million? 100 million? 300 million? What standards insure that a capital infusion is suboptimal or optimal, predatory or merely a prudent investment decision. Once again, commissions presume the answer is both knowable and doable - heroic assumptions in an era of technological dynamism.

In short, how can regulation implement the static/dynamic regulatory model? The answer, subsumed in the principle of "public interest", is not inspiring. Consider the following:

First, conventionally services included telephone, telex, TWX, toll service, exchange service, private line service and data. But new services, publishing, teletext, videotext, electronic voice, electronic mail, electronic funds transfer, point of sales devices, data banks, newspapers, information on a remote basis, all pose as substitutes for physical travel.

The number of participants including the publishing industry, the software industry, the telephone industry, the computer industry, the

newspaper industry, the aerospace industry, banks and broadcasting, as well as business equipment - all are entering the information delivery market and doing so today.

Second, information facilities link intelligent machines, bypassing the sunk investment of the telephone industry. Cable TV combines with satellites; word processing and data processing combines with satellites; cable combines with home information networks, all moving toward the establishment of separate networks on a local, a regional, and national level.

Indeed, geographic boundaries separating telephone companies are now eroding as telephone companies move into each other's territories, competing in each other's turf, competing for each other's customers. Boundary line distinctions within telecommunications as well as among information services are disappearing. The combination of terminals, satellites, fiberoptics, microprocessors, radios, produces a network of networks, giving a technological trend that will persist for at least a decade.

Finally, cost reductions enable users to buy and piece together their own information facilities and services. In-house firms are engaging in telephone switching, teleconferencing, video conferencing, electronic mail, electronic funds transfer, computer dating management, and ownership of earth terminals as well as the ownership of packet switching networks. In the decade to come user ownership options are likely to expand rather than contract.

The incredible explosion of intelligent terminal creates a demand, a need and a search for alternatives to twisted wire pairs of copper. This is not to suggest that all such options are economically viable. Some will obviously fail. The point is that a process of selection and exploration has commenced and will continue.

Indeed, asthe options proliferate and as prices fall more products will become affordable by the user public. The trend is apparent in telephone, in computers, word processing, telephone switching, electronic message switching and satellite earth stations.

Technology is rendering asunder distinctions between voice, data, publishing, broadcasting, common carrier, data processing, switching, transmission, data terminals and software. Technology is erasing the boundary lines between MTS and private line. Technology is moving toward information sectors of the economy, not merely melting distinctions between firms and industries. In short, a dual model policy is at best one of short term duration only.

The Dynamic Model

. This model makes the following assertions as to the future of telecommunications and information:

. The technologigal genie is out of the bottle

. The technological genie is blind

. That although the direction of the genie resists easy prediction, no diminution of technological change appears in sight.

. That the genie embodies risk and uncertainty, but invites enormous opportunities in new markets and services.

Furthermore, market entry is now a multi-industry phenomenon.

. entry into research and development is multi-industry.

. entry into manufacturing is multi-industry

. entry into facilities is multi-industry

. entry into communication services is multi-industry

. entry into information services is multi-industry.

There is something more. Technology today is the great deregulator. Technology, in spite of the public utility principle, is circumventing the concept of an exclusive franchise. Technology, in spite of regulation, is circumventing the concept of a captive consumer. Technology, in spite of regulation, is circumventing the concept of R&D exclusivity.

VIII. Conclusion

Consider future trends in microelectronic productivity as depicted in Transistors per Silicon Chip.

TRANSITORS PER SILICON CHIP

1960:	ONE	(1)
1970:	ONE THOUSAND	(1,000)
1980:	ONE MILLION	(1,000,000)
1990:	ONE BILLION	(1,000,000,000)?

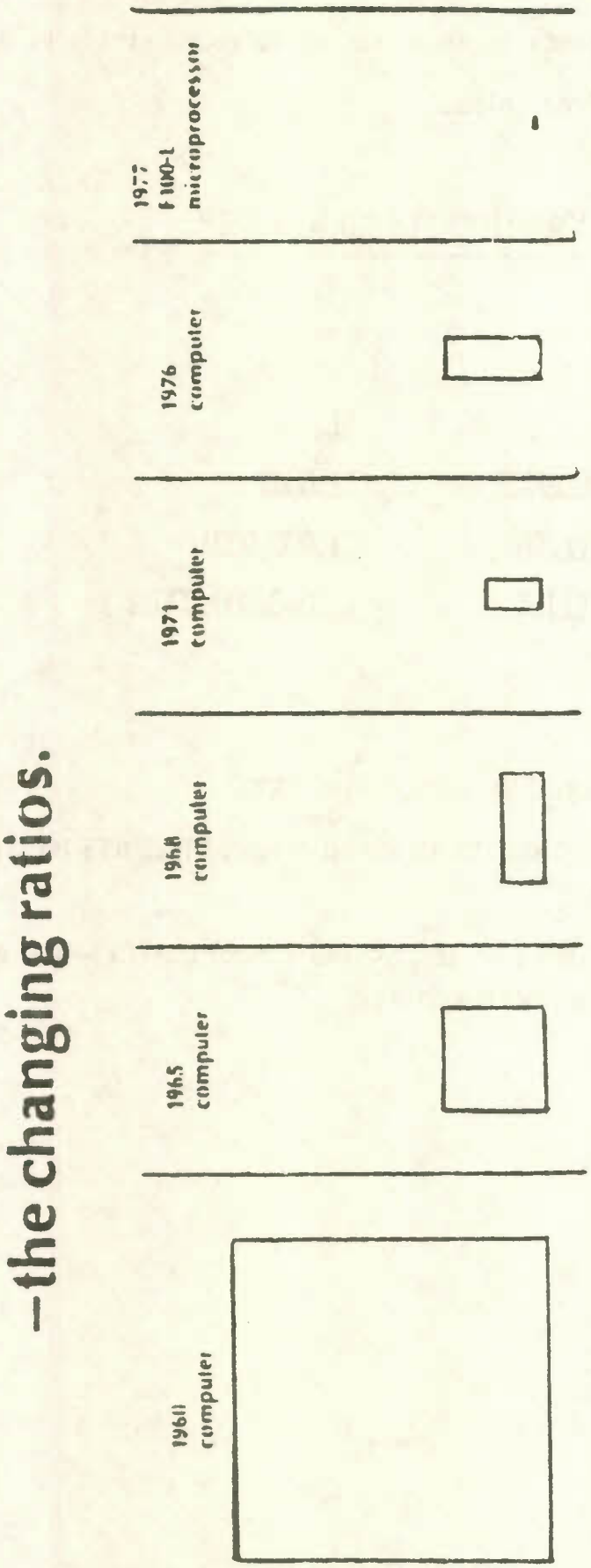
"THE COST OF THE ELECTRONIC IS APPROACHING ZERO"

"THE SPEED OF THE ELECTRONICS IS INCREASING TOWARDS LIMITS WHICH ARE SET BY THE SPEED OF LIGHT"

"THE SIZE OF THE ELECTRONICS IS DECREASING TOWARD LIMITS WHICH ARE SET BY THE GRANULARITY OF MATTER ITSELF" [159]

Consider also the implications of the inevitable shrinkage of intelligent products.[160]

Table V



And finally, recall that logic and memory costs are expected to decline from 20 to 30% annually in the decade of the 80's. What then should be the stance of public policy?

A first irony is that telecommunication carriers themselves are beginning to perceive regulation as a limit to opportunities and as a constraint upon effective performance. The carriers themselves are beginning to face the future rather than defend the past. The problem is that the legacy of the public utility principle inhibits carrier transition and adjustment. Indeed, regulatory authorities conjure the image of natural monopoly where no monopoly exists. Regulatory authorities speculate on the intricacies of Ramsey prices as market demarcations dissolve and disappear. With technology exploding, with competitive alternatives erupting in terminals, inside wiring, local loops, switching, transmission, trunking and alternative data systems, regulation concentrates on such irrelevancies as quantifying "scope" and "scale". Today we witness a scholastic speculation as to whether Teletex systems should offer "equal" time and whether the Post Office is a telephone company.

In the meantime, business firms as consumers of a broad range of information services inhabit an environment beset by intensified domestic and international rivalry. As Canada's competitors enjoy information technology that reduces cost, enhances revenues and expedites corporate decision-making, Canadian firms - not merely carriers - find themselves constrained, handicapped and disadvantaged. Therein lies the real opportunity cost of the public utility concept - a cost in goods not produced, jobs not created, investment not committed, R&D not undertaken, profits not earned, markets not penetrated, exports not achieved.

Stated positively, it is incumbent upon public policy to sponsor, foster and create an environment receptive to rewarding risk, creativity, foresight and performance. Policy must confront the future, not resurrect the past - however illustrious. Policy must recognize that traditional boundaries no longer exist, that technology today dissolves market, geographic and institutional demarcations. Furthermore, that process will continue into the decade of the 80's.

This dissolving does not imply that any policy assessment is not without resistance or frustration. It is tempting to assert that technologicical change "can't happen here," that a nation's heritage or "content" insulates a policy from the inevitability of choice and decision. Such a perception tends to blind rather than enlighten. Indeed, we assert that public policy in confronting the 1980's must come to grips with the inexorable dissolution of the concept of natural monopoly. That choice, that perception, that reality is both a burden and an opportunity.

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110. See CRTC-TElecom; Public Notice 1979-29; Submission to the Canadian CRTC with respect to Northern Telecom prices, Nov. 15, 1979.

111. Billingsley, op. cit. p. 12.

112. See M.R. Irwin, "The Telephone Industry" W. Adams, ed.; The Structure of American Industry (New York: Macmillan) 1977, p. 324.

113. U.S. v. American Telephone and Telegraph Company; Western Electric Company, Inc. and Bell Telephone Laboratories, Inc., Civil Action 0074-1698, U.S. District Court, D.C. Nov. 1974, cited hereafter as Bell government suit.

114. Bell Canada "Submission to the Canadian Radio-Television and Telecommunications Commission with Respect to Northern Telecom Prices, Nov. 11, 1979.

115. The ITT and Datran suits were settled out of court; Bell's MCI decision is on appeal; see Litton Systems, Inc., Litton Business Telephone Systems, Inc.; and Litton Business Systems, Inc. v. American Telephone and Telegraph, et. al., U.S. Southern District of N.Y. 1976.

116. International Tel. and Tel. Corp. v. American Tel. and Tel. 444F. Supp. 118 (S.D.N.Y. 1977) Suit settled in 1980.

117 Bell gov. suit, op. cit.

118. Director of Investigation and Research, Combines Investigation Act, The Effects of Vertical Integration on the Telecommunications Equipment Market in Canada NI (1976) (cited as Greenbook)

119. See California Decision, 1962.

120. See Greenbook, op. cit. Also Exhibit T-1686 Before the Restricted Practices Trade Inquiry, Feb. 21, 1980.

121. F.C.C. In the Matter of T-F Carter and Carter Electronics, Complainants v. American Telephone and Telegraph Co., et. al. Defendants, Docket No. 17073. 1968.

122. CRTC, Telecom Decision CRTC 80-B Bell Canada - Interim Requirements Regarding the Attachment of Subscriber Provided Terminal Equipment August 5, 1980. See also Challenge Communications Limited v. Bell Canada, Telecom Decision, CRTC 77-11, Oct. 7th, 1977.

123. F.C.C. In the Matter of Amendment of Section 64-702 of the Commission Rules and Regulations (Second Computer Inquiry) Docket 20828, April, 1980.

124. F.C.C., In the Matter of Establishment of Policies and Procedures for Consideration of Applications to Provide Specialized Carrier Services in the Domestic Point to Point Microwave Radio Service and Proposed Amendments to Parts 21, etc. of Commission's Rules, July, 17, 1970. See also Domestic Telecommunications Common Carrier Policies, Committee on Commerce, Science and Transportation, U.S. senate 95th Congress, 1st Session, March 1977, p. 167.

125. See Final Report, President's Task Force on Communications Policy, Dec. 7, 1968.

126. Glen R. Pafum "Telecommunications/Common Carrier," Merrill, Lynch, etc., Institutional Report, March 1979, p. 35.

127. Telesat Canada, Proposed Agreement with Trans-Canada Telephone System, Telecom Decision, C.R.T.C. 77-10, August 24, 1977 (1977) 3 C.R.T.C. 265 Reversed by Cabinet, Order in Council PC 1977-3152, November 1, 1977.

128. FCC, In the Matter of AT&T, et al, Offer of Facilities for Use by Other Common Carriers, Docket 20099, Memorandum,Opinion and Order, May 7, 1975.

129. Laurence Garfinkel, "Network Access Pricing" in H.M. Trebing, Issues in Public Utility Regulation,(East Lansing, Michigan: Michigan State University) MSU Public Utilities Papers, 1979, p. 153-70.

130. N. Cornel, D. Kelley, P. Greenhalgh, "Social Objectives and Competition in Common Carrier Communications: Incompatible or Inseparable?" February, 1980, p. 16.

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132. H. Averich & L. Johnson,"Behavior of the Firm Under Regulatory Restraint" American Economic Review 52:1052 (Dec. 1962).

133. See N. Cornell, D. Kelley, P. Greenhalgh, op. cit. p. 16.

134. In California Public Utilities Commission Staff Report on the Affiliated Relationships of the Pacific Telephone and Telegraph Co. with Bell Laboratories, ATT General Departments, 195 Broadway Corporation, 1978; See also Statement and Recommendations of the Common Carrier Bureau's Trial Staff, Feb. 2, 1976 p. 4-5; 34-98; Also FCC Final Decision, 1977.

135. See G. Pafum, op. cit. p. 35.

136. Walter G. Bolter,"The FCC's Selection of a "Proper" Costing Standard after Fifteen Years - What Can We Learn from Docket 18128" p. 333 H. Trebing, ed., Assessing New Pricing Concepts in Public Utilities, (East Lansing: Michigan State University) Proceedings of the Institute of Public Utilities, ninth annual conference, 1978. Also, A.M. Froggatt, "Incremental Pricing in Practice," H. Treving, Essays on Public Utility Pricing and Regulation (East Lansing: Michigan State University) 1971 p. 157.

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April 10/87