Unleashing innovation: making the FCC user-friendly

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Abstract

Purpose – *This paper aims to describe a case study of the FCC, dealing with relieving the tension between technical innovation and the regulation of applications of technology.*

Design/methodology/approach – *The author's experience as Chief Scientist of the FCC is used to show how the innovations of the information age were accommodated under the procedures governing the regulation of communications.*

Findings – *The success of the rapid introduction of digital information technology and networking, replacing analog telephony and inflexible technical rules governing the use of the electromagnetic spectrum, resulted from relatively minor modifications in staffing of a technical planning office lacking currency with the innovations in the technology supporting the communication and broadcasting industries. The support of the chairman, the commissioners, and their confidence in the leadership of the office were critical to success.*

Originality/value – *Leading a regulatory agency to helping rather than hindering progress speaks for itself.*

Keywords *Regulation, Government policy, Telecommunications, United States of America*

Paper type *Research paper*

There is a large literature on the issue of regulation and technological innovation from the varied perspectives of history, politics, economics, law, finance, and engineering. To attempt to add something meaningful to this rich body of writings is challenging. My only qualification is that of a participant for a short but critical period.

When I found myself, on May 1, 1979, the Chief Scientist of the Federal Communications Commission, twenty-three years after receiving my doctorate from MIT, my training said to decide what the most important problems were that needed fixing and to proceed by whatever promising means suggested themselves to fix them. My technical background was eclectic, the result of broad interests and perhaps a bit of impatience, but quite devoid of experience with the theory or practice of regulation. To understand what happened next on the technology and communication policy side of the FCC, it may be useful to look further into my improbable presence.

My doctoral thesis was a quantum mechanical calculation of what happens when diatomic molecules collide, and while a graduate student I worked as an acoustical engineer for Bolt, Beranek and Newman (since renamed BBN). I worked for a time at Westinghouse validating criticality codes needed for the design of reactors for submarine propulsion. At Stevens Institute of Technology I taught and undertook research in range of fluid dynamics issues: sweeping pressure mines, energy loss mechanisms in ocean waves, orbit stability in a plasma betatron, and the production of high pressures and high magnetic fields using chemical explosives. But central for this discussion is my time in the Defense Department's Advanced Research Projects Agency (ARPA, now DARPA).

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My first position at ARPA was as Director of Nuclear Test Detection, a program to provide the technical information needed to negotiate treaties intended to limit the development of nuclear weapons worldwide. I became Deputy Director of the Agency and later its director. This expanded my horizons enormously, into ballistic missile defense, counterinsurgency, and most relevantly, into computer science and its applications to computer networking for military command and control. The most well-known activity in this area was the development of the ARPANET, which has evolved into today's internet.

Next came the Xerox Corporation, whose Palo Alto Research Center was the origin of the local area networks (Ethernet), the personal computer (Alto), the graphic user interface (Smalltalk), and the visionary Dynabook (now exemplified by tablet computers and electronic books such as the Kindle). The internet was not yet a public offering but protocols for moving information between separate networks was coalescing in the minds of innovators.

The last stop before the FCC was as Chief Scientist of the RAND Corporation when I had the opportunity to associate with some very talented people, at RAND and in the federal government, on matters of international and domestic policy analysis.

The impending information age

Central to what I brought to the commission was the idea of continual innovation, new ways to meet practical needs. The need relevant to this discussion concerns the FCC and its then Chairman, Charlie Ferris. Charlie went to the FCC in October 1977. On 23 March 1978 an evolving concept of regulation was formalized in Executive Order 12044, ''Improving Government Regulations.'' It said the President wished ''Regulations shall be as simple and clear as possible. They shall achieve legislative goals effectively and efficiently. They shall not impose unnecessary burdens on the economy, on individuals, on public or private organizations, or on State and local governments.'' The Executive Order further instructed regulatory agencies to review existing regulations on the basis of criteria that included ''the continued need for the regulation,'' and ''the length of time since the regulation had been evaluated or the degree to which technology, economic conditions or other factors have changed in the area affected by the regulation''[1]. In a narrow sense, this Order did not apply to the FCC since it is not an Executive Branch agency. But in a broader sense it reflected a change in how the nation saw, and wished to benefit from, the expanding opportunities generated by the flood of technical innovation during and after the second world war: nuclear, space, electronic, transportation, etc. and the continuing pace of technological development fostered by military confrontation with the Soviet Union.

In this deregulatory environment, where did the FCC stand? The FCC, established by the Communications Act of 1934, had a proud tradition, and its Chief Engineer held a plum technical policy job in the New Deal period[2]. During the second world war it did pioneering work on content analysis of Axis propaganda broadcasts, and its Field Operations Bureau was an early arm of the national signals intelligence program[3]. But this level of performance during its first ten years was not maintained over the next thirty. The commission experienced what all organizations encounter. The world changes around it but its internal processes do not. Even if its processes are still sound, they are implemented by people who may not have changed. The Administrative Procedures Act of 1948 codified the processes under which regulators performed their mission, and this may have limited the ease with which innovative approaches to problem-solving could be exercised by regulators.

When I joined the FCC, it did not appear to be an agency capable of doing anything innovative or trend-setting. Communication regulation centered around the granting of licenses; issuing technical standards for the use of the electromagnetic spectrum in identified services; assuring equitable access to what was seen as a scarce resource; and responding to the needs of the big players in the communications industry.

The operating Bureaux of the FCC were supplemented by an overlay of three discipline-oriented Offices: the Office of the General Counsel, the Office of Plans and Policy staffed heavily by economists, and the Office of the Chief Engineer. While intended to provide an approach to regulatory policy that merged the insights of different disciplines and could address common issues across the various services, they were not performing the way Ferris felt was needed. New people were brought in to head those offices. I was simply told to ''cooperate with OPP and the General Counsel'' and ''bring new technologies into use.'' At the time there were a number of innovations waiting in the wings, so the latter task involved selection and ranking rather than discovery.

A regulatory agency must, whether in the spirit of the Carter Executive Order or not, be in some sort of intellectual equilibrium with the industry over which it has responsibility. With respect to the renamed Office of Science and Technology (now the Office of Engineering and Technology) ''some sort of intellectual equilibrium'' implied not only awareness of and competence in the technical areas currently of importance to the industry and potentially to public users, but, like the industry, directing its attention to the uncertain future rather than the established past. When the technology environment is changing relatively slowly, that technical awareness and competence comes from the normal flow of employees through the agency. But the communication scene was alive with ideas in the 1980s, and the normal, relatively slow turnover of staff was not keeping pace with what was needed.

On looking back, the communication environment in 1979 was, by today's standards, quite limited. The development of the mainframe computer industry after the second world war brought with it electronic switching, and the country was adjusting to all number calling. Direct distance dialing had denied the country its favorite PEnnsylvania 6 and BUtterfield 8 exchange names. Mobile telephony was restricted to a small number of dispatch services, and everyone else who needed mobile connectivity relied on pagers and pay phones. TV consisted of 12 VHF channels with 525 line resolution and some less than satisfactory UHF channels. There were no personal computers, and in the absence of text messaging, teenagers were forced to use their voices to communicate.

But much technology was on the way, and Ferris and his fellow commissioners were well aware, through the efforts of the communications industry, of the type and amount of their impending needs. In addition there were new technologies derived from the needs of the national security establishment. While a civil communication satellite industry was flourishing, the use of space by the Defense Department was far more advanced, driven by the needs of strategic optical and electronic surveillance, electronic warfare, missile guidance, tactical situation awareness, radiation hardening, ballistic missile defense, space warfare, encryption, and miniaturized sensor devices. These rapid advances were made possible by technically competent military and civilian organizations working closely with centers of innovation in universities and industry. It was also, not to put too suggestive a spin on things, highly regulated. But it was not regulated by the FCC.

For reasons such as Mike Marcus has noted, commercial communications were not able to benefit from this outpouring of innovation (Marcus, 2009). While by no means frozen in place, putting these technologies to work for the nation overall was moving at what seemed a glacial pace. My charge from Ferris was to make the FCC better able to respond to the new technical opportunities that were becoming available, and which, with the rapid growth in integrated circuits and digital signal processing techniques, promised much more and at an increasing rate. The commission, to use a buzzword, needed to be become more ''user-friendly.''

While the three cross-cutting offices positioned to assist in implementing such changes brought different disciplines and different perspectives, they were not meshing well. The legal perspective had the enormous advantage of such foundations as the Constitution and its derivative laws and case history. The engineers stood pat on the laws of physics that in turn were validated by being forced to conform to the natural world. The economists were in a difficult position, with ''laws'' that lacked the impregnability of those of the other two offices.

Conceptually the problem of merging three quite different perspectives into a single vision and process was difficult. Regulation means making decisions, choices that can easily be seen, especially in a litigious society, as zero-sum matters. Technology was creating opportunities, but product manufacturers, service providers, and consumers needed a structure within which to choose among technical and market alternatives. The time-honored approach of adopting technical standards worked less well in this period of rapid change as the alternatives and their interactions increased rapidly in time and complexity. Standards and rules that encouraged what seem important today may or may not have their intended consequences tomorrow, and the future brought unintended consequences as well. Things prohibited today in turn prohibited other opportunities tomorrow, unseen at the time of the original decision.

One way out of this conundrum started with the Office of Science and Technology and the Office of Plans and Policy jointly organizing a series of off-site ''planning'' seminars, typically two a year, with analytical papers prepared by staff from the offices and bureaus. Some papers were tutorial, others were discussions of alternative regulatory approaches. All had the effect of identifying issues well in advance of agenda items at commission meetings, improving their supporting analyses, and breaking down the walls around organizations that typically saw each other as policy competitors rather than as team members. The subjects of these sessions included future communication technology, direct broadcast satellites, privacy, and spectrum auctions among others.

Within OST the approach to addressing new technological opportunities centered around people. I established a Technical Planning Staff headed by Mike Marcus. Mike came from the Institute for Defense Analyses (IDA), a think tank that undertakes analyses of future weapon systems for the Office of the Secretary of Defense and the Joint Chiefs of Staff. When ARPA was established in 1958 it was initially staffed by temporarily borrowing from IDA. A frequent suggestion, as early as 1968, has been to extend the technology application management approaches of ARPA to the non-military world. While that civilian ''ARPA'' never materialized, there is an HSARPA in the Department of Homeland Security, the intelligence community has just established an IARPA, and the Department of Energy now has a similar organization. Thus one approach of OST, paralleling my experience on ARPA, was to assist moving advanced technologies developed to meet national security needs to the larger community of public users.

One of the several technologies we thought would be suitable for civilian application was spread spectrum. This seemed to be a no-brainer since DoD used it for covert communication. A technique successfully demonstrated to allow communications to escape the attention to adversaries who are straining to overhear would seem to pose no threat of interference to others users of the same part of the civilian spectrum. But as often noted, the devil is in the details and the concerns of broadcasters, public safety users, and government users stretched out the implementation from the 1981 Notice of Inquiry to the 1985 Report and Order.

When I joined the FCC, I was quoted in an interview as saying I thought it was possible to do things rapidly in government, a remark greeted with some degree of skepticism. Admittedly it was based on my ARPA experience, and the agency's streamlined procurement processes were tailored to its mission of preventing technological surprise. Mike's recounting of his trials and tribulations notwithstanding, I think four years is not too long for something new and for which a substantial amount of concurrence and adjustment of technical standards are required for a large number of different communication services to be approved. ARPA programs typically took three or more years, and that was only the beginning of the transfer of results to the military services where more time would be required before they appeared in fielded equipment supporting doctrinal changes in operations. University research is typically paced by the length of time to a doctorate, now about six years. Industrial research similarly takes time to be adopted as part of the corporation's strategic and operating plans. The invention of the personal computer at Xerox PARC was rejected by Xerox management for a decade until Steve Jobs picked up the ideas of bitmap displays, graphic user interfaces, and object-oriented programming for his independently-conceived Apple computer.

Curiously this had the effect of extending ARPA's impact on military computing and communication to the civilian world. Xerox hired ARPA principal investigators in the early 1970s in establishing PARC and Apple hired from PARC when Xerox failed to utilize the results of their work. I had gone from ARPA to Xerox the lead the effort to pull results out of

PARC to implement Peter McCullough's vision of the paperless office but my efforts were rejected by the xerographic mafia. I left and went to RAND, where Ferris found me two years later[4].

While the OST staff were quite competent at what they were doing when I arrived, I felt the addition of a few people from outside would help focus them on the new issues on the table. What was going on in the USA in the early 1980s was to put in place the foundation of what has been called the information age, the information superhighway, or the information economy. Another common term is the ''convergence'' of computing and communication technologies. The FCC played an important role in its realization.

The central message of all this is whatever was improved on the technical side of the FCC when I was there largely centered around people and their interactions, not on process changes. The directions this innovation push took are outlined here. From the successes and failures some lessons about the relationship between regulation, innovation, and public policy are noted at the end.

The opening years of the information age

In 1980 the ''information age'' was on the way and virtually unstoppable, driven by new technologies such as communication satellites and fiber optics, growing applications of low cost digital technology, by the desire for more video services, by global telephony at increasingly lower rates, by new consumer electronic devices, and by the profits to be made by meeting these current opportunities and as well as those implicit in latent demand. The FCC could either help, hinder, or get out of the way. Charlie Ferris and the other six FCC Commissioners were firmly on the side of helping. But how was that to be accomplished?

OPP addressed possible regulatory approaches to encouraging the adoption of new technology, with particular interest in using market mechanisms to replace technical fiat, and the General Counsel saw that commission actions were as bullet-proof as possible in the face of the inevitable judicial challenges brought by the losing sides of commission decisions. The question of what technology was ready for commission action, a weighing of the interference of each new technology with existing communication providers and users, and presenting a balanced view between the hyperbole of proposers and the dire predictions of the opponents fell heavily on OST.

Commission actions relevant to the now heavily-hyped information age can be discussed in terms of the shift from analog to digital technology, improving access to, and quality of, communication services, and the management of spectrum scarcity.

The flexibility of digital representations

In the macroscopic physical world in which we live, all quantities are represented by analog metrics: voltages, distances, weights, sound levels, etc. But the efficient transmission, storage, retrieval, and presentation of information in analog form is inconvenient, inflexible, and expensive. A far easier way to deal with information is to convert it from analog to digital form, work with it in digital form, and reconvert it to analog when analog-based people need to absorb it. Until the development of digital computers at the time of the second world war, there were effectively no devices to deal with digital information.

Mathematics, the basis of science and technology, deals naturally with logic and digits and computer scientists vastly prefer them. The practical construction of devices for converting analog quantities to binary digits was the first step into the information age. Since then matters have gotten better or worse, depending on one's values. The overlap of computers and communication occurred in several ways. It was noticed that the high frequency circuits in computers radiated energy that interfered with existing communication services. In other cases users of stand-alone computers recognized these powerful devices could be more effective if they did not have to travel to the machine and ''talk'' to it by giving it cards with holes punched in them, but could define the task remotely using the existing telephone network to transmit the necessary ''holes.'' This led to a number of consumer devices, some digital, like modems, and some analog, such as the Carterphone, being attached to the telephone network. The FCC Carterphone decision in 1968 allowed the connection of ''foreign'' devices, under the condition that they not harm the network, and thus opened markets for innovation in customer-owned equipment.

The FCC responded to user needs in a variety of computer-dependent proceedings focused on Part 15 of the rules (Table I).

The increasing rate of proceedings is clear, as well as actions to move technology to market. In August 1981 the FCC moved to expedite the Part 15 testing and approval process with the intent of getting new technology into the market faster by allowing manufacturer certification, subject to off-line review, and relying less on FCC laboratory testing.

The Commission's efforts to define what in the connection of computers to each other or to users through the public switched telephone network should be regulated posed far more difficult conceptual problems in view of the rapidity with which computer networking and digital technology were developing. The DoD packet-switched ARPANET, established in 1969, was unregulated. It had grown quite large but was based on leased lines and was not available to the public. The National Science Foundation had assumed a leadership role in networking in the 1980s and extended the DoD computer network to all universities and research organizations. When internet protocols were developed and implemented during this period it became possible to connect any computer or network to any other. For this to be extended to the public, the FCC had to allow resale of common carriage, that is, to allow non-regulated carriers to lease bandwidth from regulated carriers and resell it ''by the packet'' to public users. This ushered in the internet service provider industry. By its definition of ''enhanced services'' based on ''protocol conversion'' to fence itself off from the major action, the FCC adopted a position that it would simply get out of the way of innovation. Although this hands-off posture greatly aided the unregulated development of packet switched, value-added networks for a wide range of economically important and socially useful services, it has left a regulatory vacuum in terms of the malicious use of the

Table I FCC Proceedings in the period 1976-1981 on Part 15 computer-related changes

FCC Proceeding	*Date*	*Thrust*
NPRM Amendment to Part 15, docket 20780	14 April 1976	Revise Part 15.7 regarding restricted radiation and low power communication devices
Public Notice requesting six PCs for testing by the FCC	8 March 1979	
FCC Laboratory report on PC testing	August 1979	
First R&O Amendment to Part 15, docket 10780	18 September 1979	Adopted Subpart J for electronic computing devices
Reconsideration of First R&O Amendment to Part 15, docket 20780	27 March 1980	Certification for electronic games, personal computers, and a marketing rule
NPRM docket 80-439	23 August 1980	Hand-held games
NPRM docket 80-284	11 June 1980	Proposed test and verification procedures
Stay Order	4 December 1980	Staying 1 Jan date for coin-operated games
Waiving Order	4 December 1980	Waive Section 15.805 for medical devices
Waiving Order	4 December 1980	Waiver for Tandy Corp.
Waiving Order	4 December 1980	Waiver to manufacturers of personal computers
Order, docket 20780	11 March 1981	Clarifying Section 15.834 re peripherals
R&O, docket 80-439	11 March 1981	Hand-held games
R&O, docket 80-284	25 March 1981	Test and verification procedures
NPRM RM-3815 Use of computing equipment prior to certification or verification	16 July 1981	Proposal to permit use of customized computer equipment at user premises prior to compliance procedure 2.806
NPRM RM-3738 Revision of Subpart J of Part 15	16 July 1981	Proposal to exempt medical diagnostic equipment from rules
NPRM RM-3738, 3739 Revision of Subpart J of part 15	16 July 1981	Proposal to reclassify electronic coin-operated games
NPRM, docket 81-216	26 March 1981	Proposal to amend Part 68 requirements re telephone equipment, including EMI requests in Part 15

Source: © FCC

communication system for individual harm and abuse of the commons. Nevertheless, at the time, the value the FCC could have added through regulation would have been strongly negative.

Another initiative supported by the FCC was what the telephone industry saw as the next step, Integrated Services Digital Networks (ISDN). The adjective integrated referred both to a single subscriber connection providing voice and data services, and to the ability of ISDN networks to be directly interconnected. The first FCC action regarding its jurisdiction and authority over ISDN networks was a Notice of Inquiry in August 1983, and a First Report was issued in March 1984 (Rutkowski, 1985). While ISDN services provided faster packet connections, DSL, cellular, WiFi, Bluetooth, VoIP, and SMS eventually provided a host of services based on the rapid convergence of voice and data that left the ISDN initiative overtaken by events.

Another technology area of major importance to OST was that of satellite and fiber optic transmission of data. The information age would be based on large amounts of inexpensive bandwidth, and that was not likely to be met through more copper in the ground or more microwave towers. Interference had the greatest impact on satellite technology. On the uplink it limited the number of orbital positions available for the frequency bands allocated for space transmission and for which equipment were available. On the downlink, service area beams were limited both by potential signal interference as well as by regulations governing international broadcasting. The satellite manufacturing and launch industries were well-established, space electronics were benefiting in terms of size, weight, and capacity from advances in solid state devices, and the market for traffic unaffected by transmission delays was large and rapidly growing. Fiber optic technology, which started somewhat later, was catching up, and offered terrestrial connectivity at competitive rates and without the transmission delays inherent in the uplink/downlink process. In the event, both found their place, domestically and internationally, with fiber promising both integrated services direct to users and as well as large bandwidth.

Higher quality services

Two developments for the information age where the FCC played a positive role relate to broadcasting. The quality of TV and radio in the early 1980s was limited by atmospheric propagation. The number of stations was limited by interference. These had the additional effects of limiting access for listeners in rural areas, diversity in urban areas, and business opportunities for broadcasters. Direct Broadcast Satellites were the next step and OST played a major role in coordinating the several offices and bureaus to be prepared to address the technical and regulatory issues. DBS was the subject of an early OPP-OST planning session, and the commission approved the service in 1982. The early enthusiasm of industry, represented by seven proposals, all of which were accepted, did not, in the event, pan out. Nevertheless DBS service, both video and radio became a reality and greatly enhanced access to global media as well as providing hundreds of channels able to support diverse sets of interests and needs. Satellites able to support data also became available and this furthered connectivity in low population density areas poorly served by landline and cable services.

The second area where FCC actions and leadership were important was in revising TV technical standards to allow higher definition broadcast video. The first move in this area was when OST supported industry demonstrations of the current analog technology in 1981. Broadcasters and the computer industry joined together to consider the technology options available and ultimately decided on a set of digital standards for HDTV that became the basis for moving forward. Aside from the improvement in image quality made possible was the integration of video and data in the home, where computers and digital data can be integrated to support home information access and entertainment. Moving TV from its VHF/UHF bands will have the additional benefit of recycling these bands for newly recognized needs such as mobile connectivity and public safety.

Managing the presumed scarcity of spectrum

When I joined the FCC I discovered I had instantaneously become a Master Spectrum Manager. I was told that there was a great scarcity of spectrum. Industry, government, and public safety users, spectrum managers, and economists all bemoaned a ''desperate shortage.'' Everyone needed more than what they had; spectrum managers felt they were fighting a losing battle with increasing demand; economists said spectrum should go to the highest value use.

It is true that at any instant of time it seems as if there is a limited supply. On closer inspection one finds that these apparent shortages arise because spectrum is used quite inefficiently. While in some places transmission channels are filled to capacity, in others they are there simply in case they are needed, as with public safety users. In others users share the same capacity, as with party-lines, but the sharing processes are often difficult to negotiate.

Regulation helps this, but it is seen as slow and subject to the unintended consequences that are the result of the finite capacity of human minds to foresee the future, as augmented by political power and greed (or is this simply ''highest value?'') The role of technology can be significant in that it provides alternatives to current practices. Not only must technology be supported at the R&D level, but its results should be utilized in a timely manner through open processes conducted by informed people.

Shortly after joining the FCC I gave a talk to telecommunications scholars at George Washington University. In it I outlined my approach to addressing this apparent scarcity of spectrum. The following are the ''bullets'' I fired:

1. *Reduce user requirements*:
   - signal compression of voice and video to minimize required bandwidth;
   - digital signal processing to improve signal-to-noise ratio and reject interference;
   - more efficient coding and modulation techniques;
   - distribute data and computing resources to minimize transmission requirements;
   - share channels through packetizing information;
   - get signals off the air and onto ''wires'';
   - hybrid systems such as cellular that allow the reuse of spectrum;
   - higher capacity digital networks and more efficient communication protocols; and
   - reuse spectrum through lower power transmissions.
2. *Increase spectrum efficiency*:
   - optimize the entire transmitter/propagation path/receiver instead of piecewise;
   - directional antennas;
   - satellite spot beams;
   - polarization diversity;
   - architectures such as trunking, cellular, packet, and satellite suitably combined;
   - single sideband; and
   - narrower channel widths.
3. *''Create'' more spectrum*:
   - higher frequencies, such as 20/30, 40/50, 90/100 Ghz;
   - operate near absorption band edges;
   - recycle old spectrum;
   - spread spectrum overlays; and
   - FM subcarriers.

4. *New spectrum management tools*:
   - computer based spectrum management facilities for registration;
   - real-time monitoring of spectrum use for channel assignment;
   - enforcement of rules through monitoring of channel use;
   - enhanced communication between spectrum management groups;
   - training of spectrum managers worldwide; and
   - sharing between compatible services.

The subtext was, ''Stop complaining and fighting zero-sum battles. Just work the problem. It's not rocket science.''

What next?

Much of the above has happened in the 25 years since I left the FCC, in some the FCC played a major role and in others where the FCC wisely took itself out of the way. It is unclear to what extent the commissioners and staff had a complete understanding of what was coming. Visionaries in and out of government saw much of what we call, in hindsight, the information age. But it is probably good that there were not so many that the information age was architected and planned through top-down processes. If it had it probably would never have happened because we would not all have agreed to the plan, or even the process for arriving at the plan, and we would still be arguing, watching 12 TV channels, and sending angry snail mail to each other.

The information age has not been an unmitigated blessing. Nothing is. We now complain about information overload, but whose fault is it if we overeat? At the same time we complain that Finland and Estonia are ahead of us in being ''wired,'' we forget that Estonia was taken down for three days by angry communists because a Soviet war memorial was moved. We complain that other countries have a greater per-capita number of cell phones while each US neighborhood bitterly resists the construction of cellular base stations and microcells. The internet supports a wide variety of criminal activities. Careless handling of personal data and laptops exposes millions to identity theft. Blackberrys, cell phones, and texting reduce the utility of face-to-face interaction and pollute restaurants, trains, lectures, and artistic performances. We substitute connectivity for new infrastructure investment and rely on a manifestly vulnerable internet for the control of critical infrastructure services such as electric power. Foreign governments romp through our government computers taking what they need. Personal privacy is a thing of the past, although the eyes and ears of a small town probably never provided the privacy we so fondly recall.

The development of the information age is far from over. While brakes on the abuse of technology are important, those on technology itself are to be avoided. Since reliable predictions of the future of technology are obviously impossible, concerns over unborn technology being precluded are difficult to evaluate. But the FCC, in discharging its legislated authorities, should recognize that it needs to couch its regulations in a way that makes it easier to back away from unintended consequences than it is to walk into them. As it encourages communication innovation, or at least not slow it down, the FCC should attempt to limit damage to current users of the communication commons. Where changes are mandated, a showing of net gain to the commons should be attempted, recognizing the inevitable lack of precision that entails.

Both regulation and markets have a role to play in addressing these issues. But however user-friendly regulatory agencies of government become, they must not forget the observation of Pogo that, ''We have met the enemy and they are us.''

Notes

1. Jimmy Carter, Executive Order 12044, ''Improving Government Regulations,'' The White House, March 23, 1978. On May 30, 1980, the US Regulatory Council reported to the President that they had examined ''regulatory techniques that depart from the rigid 'command-and-control' style that dominates most federal regulatory programs. We have defined eight types of innovative techniques.

Most of them rely in part on market forces to meet regulatory goals.'' On June 13, 1980 Carter passed on these eight ideas in a memorandum to federal regulatory agency heads. But in his memorandum he pulled back from market-force dogma when he noted that ''these techniques are not always appropriate. In some cases, only the traditional approach of rigid, detailed 'command-and-control' regulation adequately protects public health and safety.'' One can imagine there must have been some heated discussions in the White House between May 30 and June 13.

2. The subtitle to the act defines it as ''Being an act to provide for the regulation of interstate and foreign communication by wire or radio, and for other purposes.''

3. The work of the FCC is examined in a series of RAND reports. Under Project RAND, Alexander L. George, ''The Intelligence Value of Content Analysis'', RM-116, 15 February 1949, notes, ''During World War II the major belligerents obtained important information by monitoring and studying the mass communications of their enemies and allies. Although it is known that the Russians, Germans, and French made use of rudimentary content analysis procedures, only the British and the American governments organized special intelligence operations making use of content analysis techniques. In the United States government, the Analysis Division, Foreign Broadcast Intelligence Service (FBIS) of the Federal Communications Commission was most closely identified with this function.'' In the same report series, George notes in ''Qualitative and Quantitative Procedures in Content Analysis,'' P-617, 15 December 1954, ''From a methodological standpoint, the wartime analyses of the FCC are unusual and interesting because of their concern with the problem of methods of inference.'' In RM-116 is an interesting characterization of the FCC staff. ''FCC and PID [the British counterpart organization] had specialized knowledge about the theory of mass communication, its 'laws' and characteristics. In addition, they acquired over time special knowledge about the behavior of particular enemy communications media units (domestic radio, domestic press, foreign transmissions). The unique contribution of 'communications research specialists,' therefore, stemmed from his greater familiarity with the enemy's characteristic ways of manipulating mass media of communication.'' After WW II, the FBIS unit was moved into the new Central Intelligence Agency where it continued its function, and even retained its organizational name, until well into the 1990s.

4. The ''paperless office'' eventually arrived, but Xerox's only contribution was to circumvent its own vision by specializing in copiers and laser printers whose only purpose is to turn out paper. The Ethernet LAN was invented at PARC but Xerox did not know what to do with it and gave it away.

References

Marcus, M. (2009), ''Wi-Fi and Bluetooth: the path from Carter and Reagan-era faith in deregulation to widespread products impacting our world'', *info*, Vol. 11 No. 5, pp. 19-35.

Rutkowski, A. (1985), *Integrated Services Digital Networks*, Artech House, Dedham, MA.

About the author

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