

THE PAST, PRESENT AND FUTURE OF THE CUBAN INTERNET

Larry Press¹²

The first two sections of this paper summarize the history of the Cuban Internet and its current state. The third section does not attempt to predict the future, but describes forthcoming technology and suggests policy changes Cuba could make to adopt it — leapfrogging to a modern Internet.

Before the advent of the Internet, Cuba was arguably the leading international computer-networking nation in the Caribbean. Members of Cuba’s research and education community used pre-Internet networks for email, document retrieval and threaded discussions of a variety of technical and social topics; however, when Cuba finally connected to the Internet in 1996, 17 other nations in Latin America and the Caribbean were already online. The US embargo, the economic downturn after the dissolution of the Soviet Union and political fear of free information had delayed Cuba’s connection.

Cuba adopted a limited-access Internet policy in 1996 and today the Cuban Internet is arguably the worst in Latin America and the Caribbean — minimal and unfree — in spite of Cuba being among the leaders in the region in terms of human development. The economy has stabilized relative to 1996, restrictions on the importation of networking equipment have been lifted and the Internet has been shown to be a tool for political control as well as free expression; however, bureaucracy and vested interests have developed within ETECSA (Empresa de Tele-

comunicaciones de Cuba S.A.), Cuba’s government-monopoly Internet service provider.

Cuban technology languished along with its policy. They relied on slow, expensive geostationary orbit satellites for international connectivity until 2013, when they installed an undersea cable to Venezuela and began opening public-access *telepuntos* or “navigation rooms.” Since that time, they have added public WiFi hotspots, digital home connectivity and, most recently, 3G mobile access and 4G trials. These Internet offerings are available in limited locations and use obsolete technology to deliver inferior performance at prices that are high relative to other nations and to Cuban incomes. The government also allows offline circulation of Internet material on portable storage devices and, until recently, allowed community-built and owned networks that were not connected to the Internet.

If Cuba aspires to a truly modern Internet, they should consider what they are doing today as providing an interim stopgap and plan to leapfrog to next-generation technology and policy in, say, five years. I will speculate on that future policy and technology in the final section of the chapter, but first, let us review the past and the present.

THE PAST

Before the Internet, companies like IBM and DEC used proprietary protocols to network their computers and the government built defense networks of

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identical computers (Press 1996b). Later, X.25 and UUCP, open standards that allowed dissimilar computers to communicate were developed.

Cubans began using X.25 and UUCP networks for limited international communication in the 1980s. They used Russian X.25 networks for access to scientific articles and email, but UUCP was more important. UUCP networking was central to communication within the nascent international networking community and Cubans used it for email, file transfer and Usenet News, a large, eclectic collection of global threaded discussions on technology, science, politics, culture, and many other topics (Meshner et al; Press and Snyder 1992; Press and Armas 1992).

Four Cuban organizations had international UUCP links and were serving client organizations (Press 1996; Press 1996a; Press 1996c):

- CIGB, the Center for Genetic Engineering and Biotechnology, served sub-nets in eight organizations and had 950 active accounts. (Several users might share an account).
- CENIAI, the Center for Automated Interchange of Information of the Cuban Academy of Sciences, served 10 subnets and had 732 active accounts.
- TinoRed served the 150 (at the time) Youth Computer Clubs around the nation and 32 non-governmental organizations (NGOs) and had 413 active accounts.
- Infomed served the medical community and had 500 active accounts.

Note that in those days, computer networking was just beginning and Cuba, with its large, well-educated population and fewer than 3,000 accounts, was among the leading Caribbean nations. However, UUCP was an asynchronous protocol—data was transferred several times a day in batches, making in-

teractive applications impossible—and X.25 was inefficient relative to TCP/IP, the protocol used on the Internet, and Cuba did not have a link to the Internet.³

The US embargo and Cuba's economic depression after the dissolution of the Soviet Union delayed their connection to the Internet and, in September 1996, when CENIAI established Cuba's first Internet connection (Press 2011), 17 Caribbean nations were already online (Crepin-Leblond 1996). In spite of the embargo, Cuba's first Internet link was to the US National Science Foundation network under their International Networking Program for connecting research and education networks in developing nations and provided by Sprint (Press 1996b).

Note that the speed of that first international Internet link was only 64kbps and it was soon saturated. Still, limited applications like text chat, email and threaded discussions were possible. Users could also retrieve text documents by sending formatted email messages to a server or accessing a Gopher server (Press and Armas 1996).⁴

While Cuba was late to the Internet, they had experience with small TCP/IP networks within the nation and CENIAI Director Jesús Martínez, Carlos Armas of CIGB and others had been active in regional and international Internet organizations. Cuban networkers shared the values and enthusiasm of the international networking community, believing, correctly, that the Internet would profoundly affect individuals, organizations and society (Press 2011; Press 2015d).⁵ Today, Cuba's nascent Internet developer and entrepreneur community is reminiscent of that optimistic time (Press 2015e).

Politicians also noticed the Internet and they established an inter-ministerial commission to decide Cuban Internet policy. The Cuban Communist Party

3. For a summary of non-technical reasons for the ascendance of TCP/IP, see (Haverty 2019).

4. BIT-L, a formatted-email document retrieval system from the 1990s, is still in operation (Press 2014e). Gopher, a protocol for text document retrieval with links to related documents, pre-dated the World Wide Web, which was in wide use by 1996. CENIAI maintained a Gopher server in Uruguay, which had a faster international connection than Cuba.

5. Based on our experience as early Internet users, we expected it lead to advances in science, technology, commerce, entertainment, education, medicine, democracy, global unity, etc. We were naïve in not anticipating negative applications and its impact on personal psychology.

Plenum of March 1996 may have been decisive. The meeting was held less than two weeks after President Clinton had signed the Helms-Burton Act codifying the Cuban embargo and providing assistance, through appropriate NGOs, for the support of individuals and organizations to promote nonviolent democratic change in Cuba (US Congress 1996). At the meeting, Carlos Lage, Executive Secretary of the Council of Ministers, spoke of the economic advantages of the Internet, but Raúl Castro, who was familiar with a well-known study of Cuban NGOs by Gillian Gunn, feared them (Gunn 1995). His view was that “Glasnost, which undermined the USSR and other socialist countries, consisted in handing over the mass media, one by one, to the enemies of socialism” (Press 2011a). The Center for the Study of the Americas, perhaps Cuba’s most important, influential, and innovative think tank of this period was also shuttered in 1996 due to government fears of the growth of independent NGOs and civil society organizations (Pérez-Stable 1998; Giuliano 1998).

The hardliners prevailed, and, while internal TCP/IP networks were allowed, Internet access was strictly limited (Rother 1996; Valdés and Rivera 1999). It is noteworthy that Fidel Castro allowed the hardline decision, but understood the importance of the Internet and supported Tino Red and the Youth Computer clubs (Press 2014). However, two years later, TinoRed no longer served NGOs and Cuba had made little progress while other developing nations — notably China (Press et al 1993) — forged ahead. Cuba’s Internet connectivity stagnated, as shown in Table 1 (Press 1998⁶).

My colleagues and I had developed a framework for assessing the state of the Internet in a developing nation along six dimensions: *pervasiveness*, *geographic dispersion*, *sectoral absorption*, *connectivity infrastructure*, *organizational infrastructure*, and *sophistication of use* (Press et al 1998; Wolcott et al 2001). Using

Table 1. Internet hosts for Caribbean nations with population over one million

	Population millions)	Hosts	Hosts/ hundred pop.
Trinidad and Tobago	1.3	552	4.34
Dominican Republic	7.8	3,155	3.97
Jamaica	2.5	367	1.43
Puerto Rico	3.6	160	.42
Cuba	11.0	129	.12
Haiti	7.2	0	0

our framework, we conducted a study of the Cuban Internet and in October 1997 and ranked Cuba at our lowest level on five of the six dimensions. Since two organizations were offering Internet connectivity (to authorized entities, not individuals) and they had formed the Inter-ministerial Commission mentioned above, we ranked Cuba *organizational infrastructure* at the next level up (Press 1997; Press et al 1998). Table 2 summarizes our assessment of the factors affecting Internet growth at that time.

These early networks ran on infrastructure provided by Cuba’s telecommunication monopoly ETECSA. In the early 1990s, Cuba had fewer telephone lines as a proportion of the population and GDP than any Caribbean nation but Haiti, and was closer to the low-income nations than the lower-middle group into which it fell (Press 1996). The dissolution of the Soviet Union and US embargo exacerbated the deficiency leading them to create ETECSA, a joint venture between the Ministry of Communications (MINCOM) (51%) and Grupo Domos of Mexico (49%).

In April, 1995, Domos sold 25% of their interest to STET International Netherlands, a wholly-owned subsidiary of the Italian State Telecommunication Company. Domos defaulted on their capital commitment and lost their equity, leaving STET with 29.29% of ETECSA, the Cuban government 49%, and a coalition of banks the remainder.

6. Not Cleared for Open Publication.

Table 2. Factors affecting internet growth

Determining factor	Dimensions most directly affected
Poor telephone infrastructure	<i>Pervasiveness, geographic dispersion, connectivity infrastructure, and sophistication</i> of use are all inhibited due to the difficulty in connecting end users and networks.
Difficulty attracting capital	<i>Connectivity infrastructure</i> cannot be improved without capital.
Cultural values stressing health, education and equality	Health and educational <i>sectoral absorption</i> is emphasized as is <i>geographic dispersion</i> outside the capital.
Centralized planning	<i>Organizational infrastructure</i> (the <i>Inter-ministerial Commission</i>) is formulated and <i>pervasiveness</i> is reduced due to planning delays.
Concern for national security given US hostility	<i>Pervasiveness</i> is reduced by access restriction.
Protection of embargoed business activity	<i>Pervasiveness</i> is reduced by content restriction.
Propaganda to and from US	<i>Pervasiveness</i> is reduced by content and access restriction.
Threat of use by subversive organizations	<i>Pervasiveness</i> is reduced by access restriction.
Non-commercial economy	Commercial <i>sectoral absorption</i> is inhibited as resources are shifted elsewhere.
Populist history	In seeking to serve rural areas and small towns, <i>geographic dispersion</i> is increased and <i>connectivity infrastructure</i> extended outside the capital.
Emphasis on human capital	Education <i>sector absorption</i> is increased.

In 2011, Telecom Italia sold its share of ETECSA to a company called Rafin, SA, which the Central Bank of Cuba describes as a non-banking financial institution.⁷ The International Telecommunication Union (ITU) describes ETECSA as “one of the last state telecommunication-sector monopolies” but that seems inconsistent with the attribution of ownership to Rafin and banks, raising questions about finance and decision-making authority (Press 2014).

The Internet impacts commerce, education, entertainment, government, etc. in a nation, but the Internet is shaped in turn by the values, laws, politics, and economy, of that nation. Society shapes infrastructure and infrastructure shapes society. While Internet access was limited, Cuban networking was (Press 1998):

- Relatively non-commercial — the first four internationally connected networks dealt with science, education, biotechnology and medicine.
- Geographically dispersed relative to other developing nations — Internet connectivity was only available in the capital city in 29 of the 44 Afri-

can nations with Internet connectivity, whereas Infomed had a presence in every Cuban province and TinoRed was present in nearly every municipality.

- Focused intranationally, not internationally.

Cuba was among the leading Caribbean nations in the pre-Internet networking era, but due to political fear, the poor economy during the “special period” after the dissolution of the Soviet Union and the US embargo, network access was limited. As a result, Cuba is far behind today.

THE PRESENT

Today, the Cuban Internet is arguably the worst in Latin America and the Caribbean — minimal and unfree.

The ITU publishes an annual quantitative analysis of the state of the information society (ITU 2018), which features an ICT Development Index (IDI) for each nation. The IDI is a composite of three sub-indices: *access*, *use* and *skill*.⁸ Table 3 shows Cuban

7. There is an unsubstantiated rumor that Rafin was owned by the Castro brothers (Inversiones de Raúl y Fidel).

8. For details on their methodology, see (ITU 2018a).

Table 3. Cuban IDI and sub-index ranks

	2017	2016
IDI	137	135
Access sub-index	166	169
Use sub-index	151	143
Skill sub-index	62	57

ranks among 176 nations on the IDI and its sub-indices for the years 2016 and 2017⁹ (ITU 2017)

Cuba's IDI rank dropped during the year and is the lowest in Latin America and the Caribbean. Cuba's *access* and *use* sub-indices are only slightly better than those of Haiti, which is last in the region. Those stand in contrast to the skill sub-index in which Cuba ranks 62nd, sixth after Chile, Argentina, Venezuela, St. Kitts and Nevis and Bahamas in the region.

The Cuban Internet is considered *unfree* by Freedom House, which annually assesses nation's Internet freedom through a 3-dimension index: *obstacles to access*, *limits on content* and *violation of user rights*. Freedom House studied 65 nations and Cuba ranked 61st, 59th, and 58th respectively on these dimensions and 61st overall (Freedom House 2018).¹⁰ For a detailed discussion of the Cuban findings, see (Freedom House 2018b).

This dismal record stands in contrast to Cuba's rating in another annual report, the Human Development Report of the United Nations Development Programme (UNDP 2018). The report centers on a Human Development Index (HDI). The HDI considers 145 indicators in computing a summary measure of achievements on their three key dimensions of human development: *a long and healthy life*, *access to knowledge* and *a decent standard of living*.

In 2017, Cuba ranked 73rd among 187 nations and 12th in Latin America and the Caribbean (UNDP 2018a). In 2014, the Cuban HDI ranked 44th in the world and was second only to Chile in Latin America and the Caribbean (Press 2014a)—Cuba remained constant as the rest of the world progressed.

Still, the state of the Cuban Internet is far worse than one would expect in a nation with a relatively high UNDP Human development index. How might we explain the discrepancy? The historical impediments to the Internet in 1996 have eased. The Cuban economy has improved since the 1990s and the availability of Chinese equipment, primarily from Huawei, has eroded the impact of the embargo (Press 2015a). The Chinese have also demonstrated that a robust Internet is as useful as a tool of a repressive government as for dissidents. Public opinion in the U. S. has softened toward Cuba (and vice versa) when President Obama made a significant effort toward rapprochement (Press 2017g), which included sending high-level delegations to Cuba (Press 2015; Press 2016d), visiting Cuba (Press 2016c) and organizing a meeting with tech entrepreneurs during his visit, but little came of that (Press 2016b).¹¹

While the historical impediments have diminished in importance, other factors have affected the discrepancy between the HDI and IDI. Cuba's health and education systems have increased HDI (and the *skill* component of the IDI) while other factors have impeded the development of the Cuban Internet:

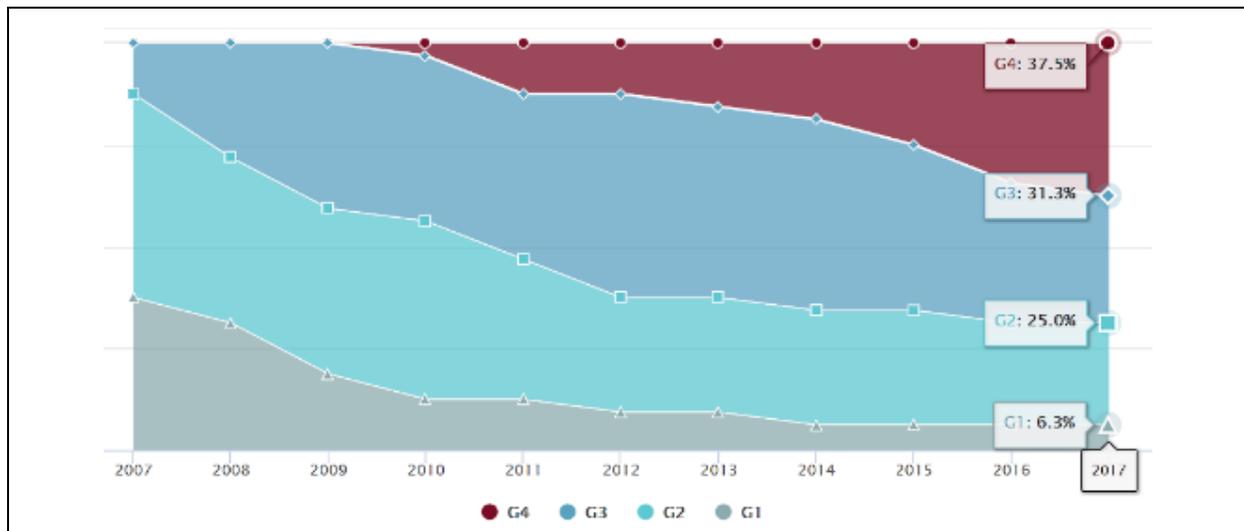
- The lack of freedom discussed above.
- Bureaucracy and vested financial interests (Press 2014; Press 2016).
- Restrictions on self-employment of computer programmers (Camacho 2017, Press 2017).
- Emphasis on the national intranet rather than the Global Internet (Press 2018).

9. 2017 is the latest year for which the IDI was computed because the IDI methodology is being revised.

10. Only China, Iran, Ethiopia and Syria ranked below Cuba.

11. While Trump has made a show of reversing Obama's opening, nothing in his policy directly affects the Cuban Internet (Press 2017l), but it has hardened Cuban rhetoric and no doubt solidified China's role as Cuba's primary IT infrastructure source.

Figure 1. Global telecommunication regulation trends



- Cuban reluctance to engage with US IT companies before and after President Obama's visit (Laughlin 2017; Press 2016b).¹²¹³¹⁴

Underlying all of this is Cuba's obsolete regulatory and infrastructure-ownership policy. The ITU defines four ICT policy generations and Cuba is one of the 28 remaining first-generation nations in the world (ITU 2017a):

- G1: Regulated public monopolies — command and control approach.
- G2: Basic reform — partial liberalization and privatization across the layers.
- G3: Enabling investment, innovation and access — dual focus on stimulating competition in service and content delivery, and consumer protection.
- G4: Integrated regulation — led by economic and social policy goals.

The ITU computes a regulatory index using 50 indicators and in 2017 Cuba ranked 172nd among 190 nations (ITU 2017b). Only Bolivia ranked below Cuba among the 31 Latin America and Caribbean nations. Cuba was ranked 157th in 2007 — they remained static while others evolved, as shown in Figure 1.

While the current state of the Internet is grim, it has improved since the activation of the ALBA-1 undersea cable connecting Cuba to the global Internet (Madory 2013).¹⁵ The cable enabled Cuba to begin expanding Internet access and in 2014, they announced that the computerization (*informatización*) of society was a priority for Cuba (Granma 2014).

Since that time, ETCSA has introduced several public-access offerings:

- They began with navigation rooms where Internet access was available for a fee. Today there are

12. Trump's disavowal of President Obama's policy did not directly affect the Cuban Internet (Press 2017a; Press 2017h) and his establishing a Cuba Internet Task Force (Cuba Internet Task Force 2019) has generated political rhetoric, but little more (Press 2018f; Press 2018g).

13. Google has been particularly active in Cuba with top executive visits and roughly monthly visits from staff. They have reportedly made significant infrastructure proposals, but Cuba has only allowed them to provide user equipment for a WiFi hotspot and install servers on the island to speed access to Google content (Press 2016e; Press 2016f).

14. While Cuban President Díaz-Canel has met with US executives (Press 2018i), Cuban policy toward the US does not seem to have changed (Press 2017k).

15. Prior to 2013, international traffic was routed over slow, low-capacity geostationary satellite links.

918 computers in 259 navigation rooms, 95 of which are in Youth Clubs. (ETECSA 2019)¹⁶

- Next came WiFi-access points, where people could access the Internet using a laptop, tablet or smartphone. Today there are 956 of these hotspots. (ETECSA 2019a)
- The availability of fixed digital access from homes followed. The service is only available in certain neighborhoods since it requires an equipment upgrade in the local telephone central office and depends upon the condition of the wiring to a home. There are currently 70,418 connected homes, 95% of which connect at 1 mbps, the lowest download speed available. (Guevara 2019).
- The latest offering, third generation (3G) mobile access, became available in December 2018 and during the first month of operation around 859,000 accounts were opened (Guevara 2019; Press 2018e). (They are also conducting 4G trials (Press 2019h).
- ETECSA also offers Internet access to enterprises at speeds ranging from 19.2 Kbps to 1 Gbps, point-to-point links, domain registration, data center and email service to enterprises. Prices for global Internet access are significantly higher than for the national intranet. (ETECSA 2019b).

3G mobile access is the most important of the public online offerings. During the limited 3G-rollout period of December 4–6 2018, Internet activity roughly doubled over previous levels and when the rollout was complete, they roughly doubled again to about 4 times that of the pre-rollout level. During the first month after completion of the rollout, there were nearly 2 million transactions and the revenue was over 13 million CUC (Press 2019c).

The Internet service initiatives described above have things in common:

- They are very expensive relative to world prices and Cuban incomes.
- Access is limited to certain locations.
- Connectivity is slow, cutting user productivity and making some modern applications impossible.
- They use obsolete technology (with the exception of WiFi hotspots).

In addition to online access, Internet content is available off-line through *el paquete semanal*, a weekly digital distribution of entertainment, software, games, news, etc. on portable hard disks and flash drives (Dye, et al 2018; Kessler 2015; Fenton 2016; Parish 2018; Press 2015c).¹⁷ *El paquete* is updated weekly, distributed throughout the island by a decentralized, ad hoc two-tier “organization” of largely autonomous people, and may be Cuba’s largest private employer. Four “maestro” organizations, called *casas matrices* or “compilation houses,” three in Havana and one in Santiago de Cuba) compile weekly terabyte collections that are distributed throughout Cuba by many independent *paqueteros* or “distributors.” While it is technically illegal, the Cuban government tolerates *el paquete* because its content is non-political and satisfies public demand for Internet content. The unwritten rule of thumb adhered to by all compilers in order to garner continued government tolerance and avoid police crackdown seems to be “no politics and no porn” (Henken 2017; Henken 2020).

El Paquete content was available on SNET, a community-built and operated network in Havana (Pujols, et al 2017; Martínez 2017) until new regulations were passed making it and smaller community networks in other cities illegal (Press 2019i; Press 2019j). Many Internet-like services—social networks, discussion forums, software libraries, etc. were available on SNET, but it was local to Havana and not connected to the Internet. In 2017, 56,000 users were registered in discussion forums alone (Pujol, et al 2017). Like *El Paquete*, SNET and small commu-

16. Note that navigation room connectivity has been unchanged for the last six months, suggesting that this is no longer a priority.

17. Weekly contents of some of Cuba’s *paquete* compilation houses or *casas matrices* are published online at <http://paquetedecuba.com/>

nity networks in other cities were tolerated as long as they enforced rules like not allowing political or pornographic content, connecting to the Internet or promotion of illegal drugs (Press 2014c).¹⁸

History and culture shape the Cuban Internet. For example Roberto, a *paquetero*, knows his customers, gives them technical assistance, tailors their content to suit their tastes and charges differently depending upon their ability to pay and another *paquetero*, Carla, says “I basically sell it to my customers and friends. They already know me, and other *paqueteros* don’t come here, since its already covered by me. There’s a market base for everyone in Havana” (Dye, et al 2018). The creators of Ninjacuba, an online service for matching technical professionals with projects, say they want to build a sustainable company, not become a “unicorn” startup (Press 2017f). Cuba might bring a degree of social entrepreneurship to the Internet.

THE FUTURE

This section focuses on future policy and technology. If Cuba aspires to a truly modern Internet, they should consider today’s offerings and policies as interim stopgaps and plan to leapfrog to next-generation technology and fourth-generation policy that is designed to meet economic and social goals, not to maintain political stability and telecommunication bureaucracy and revenue. I will discuss technologies that are becoming available and suggest policy changes I would consider, beginning with policy.

In the previous section, we saw that Cuba is stuck at first-generation regulation with all infrastructure ownership and decision making centralized in ETECSA and MINCOM. The usual transition from

first generation policy is to invite global companies to bid on the right to install infrastructure in return for a license to provide service for a limited time. For example, Doug Madory has suggested that Cuba follow the example of Myanmar, which in 2013 was, like Cuba today, a near Internet “greenfield” with a government-monopoly service provider. They called for bids from mobile Internet service providers and over a dozen companies responded. The two winners pledged to provide mobile connectivity in 90% of the country and paid \$500 million in return for 15-year licenses (Madory 2014).

Myanmar’s IDI rank rose from 150th among 176 nations in 2013 to 135th in 2017 (ITU 2017), but might they have done better? With a market-driven approach such as this, company profit projections determine investment levels, but Cuba has the opportunity to prioritize economic and social policy goals and those goals might be better served by viewing the Internet as infrastructure, like streets and sidewalks, rather than a market commodity. As African Internet scholar, Steve Song states: “The strategic goal of infrastructure is not to derive economic benefit from the asset itself, but to generate economic benefit by maximizing the use of the asset” (Song 2018). Consultant Bob Frankston agrees, citing the fact that the Internet was designed to be a “dumb” network, simply delivering data packets from one computer to another as efficiently and fairly as possible. Innovation and investment occur at the edge of the network (Frankston 2018).¹⁹

How might this infrastructure approach play out in Cuba?

18. See (Pujol et al 2017) for a statement of SNET rules and penalties for violating them.

19. The dumb-network design goal was to some extent a product of the technology of the day. For example, network traffic could have been encrypted, but that would have resulted in untenable delays at the time. (Note that encryption has negative as well as positive results).

One possibility would be to decentralize infrastructure ownership and operation by creating municipal networks.²⁰ Doing so would be politically difficult, but this might be a good time to do it because Cuba recently adopted a new constitution that de-centralizes executive governance by reducing provincial government and strengthening municipal government. (Frank 2019).

Municipal networks would connect to a national backbone and, through that, to International links operated by ETECSA. ETECSA would also support the municipal networks by consulting and purchasing international bandwidth, telecommunication equipment, infrastructure installation equipment, etc. Locally elected officials would control the municipal networks and representatives of the municipal networks would shape ETECSA policy.²²

Cooperatives, where customers jointly own and manage the network are a variation on the decentralization theme (Song 2019). In Spain, the UK, Argentina, and other nations, the decision was made to cooperate with and support community networks — to treat them as cooperatively owned Internet service providers. Cuba could have chosen to cooperate with and support SNET and smaller community networks (Press 2017e; Press 2017i), but they decided instead to transfer SNET’s services and content to ETECSA and to provide access through the Youth Computer Clubs.²³ The government says SNET “will grow with the increased infrastructure” and claims that the intent of the new regulations is to expand Internet access, but many in the SNET community fear losing

access to and control of the assets they had created (Anonymous 2019; Press 2019k).

ETECSA could also collaborate with *El Paquete Semanal* by providing them with Internet connectivity and distributing some of their content.²⁴ Cuban schools and other organizations could also make use of local area network-based courseware that is periodically updated from the Internet, for example, educational material from the Khan Academy and MIT (Press 2016j).

ETECSA is currently deploying 15-year old 3G mobile technology and charging a price most Cubans cannot afford.²⁶ Once they develop enough backhaul capacity to support it, I would advocate a drastic 3G price cut, better yet make it free — in other words, consider it infrastructure rather than a marketable service. Doing so would generate new, innovative applications. It would also expand the population of experienced, demanding users, ready for future technology. The economic and social benefits of free 3G Internet connectivity would outweigh the cost and it would benefit ETECSA in the long run.

I would also advise Cuba to become more open to cooperation with US companies and organizations. For example, Google has worked hard to establish Cuban relationships, but little has come of their effort (Press 2014d; Press 2016b; Press 2016e). Google could provide infrastructure and support for the development of Spanish language entertainment and educational content if Cuba were willing (Press 2015h). For example, one can imagine Google deploying wholesale fiber in Havana as they have in

20. Lest one assume publicly owned infrastructure is necessarily inefficient, state-owned Antel provides telecommunication services throughout Uruguay, including the most remote areas (Baca et al 2018). Antel is the sole provider of wired (ADSL and FTTP) connectivity in the country, yet only Barbados and St. Kitts and Nevis outrank Uruguay on the IDI (ITU 2017) and there are many examples of effective community networks in other nations. There are numerous successful large and small municipal networks in Latin America (Baca et al 2018) and throughout the world.

21. As noted above, the Internet was designed to be decentralized. The Internet protocols were invented in order to interconnect heterogeneous networks and it is a collection of interconnected, autonomous networks.

22. These municipal networks would not be homogeneous. For example, a large city like Havana might follow the example of Stockholm, which operates a municipal backbone and provides wholesale access to retail Internet service providers (Press 2014).

23. There are now 611 Youth Computer Clubs throughout the island (Youth Club 2019).

24. Much of the content is pirated and ETECSA would not be able to host that.

25. With their penchant for innovation and stress on education, Cuba has an excess of available technical talent (Press 2015e).

26. Remittances from Cuban expatriates and family members living abroad account for a significant portion of ETECSA revenue.

three African capitals (Press 2016h) or a YouTube production space as they have in several cities (Press 2018d).

Cuba should also be planning to adopt future technology. For a start, they need another undersea cable. I do not know the capacity of the current ALBA-1 undersea cable, but even if it is far from saturated, Cuba needs a second cable. The ALBA-1 landing point is at the east end of the island and a second landing point near Havana would reduce the load on Cuba's terrestrial backbone, lower latency time, and provide backup in case of a temporary cable breach. Terrestrial capacity conservation would cover the cost of the cable.

Ronald Bechtold, chief information officer at the Pentagon said the US cable at Guantanamo would "be for the entire island in anticipation that one day they'll be able to extend it into mainland Cuba," but that was denied later (Press 2015g). In 1996, Deputy Assistant Secretary of State Daniel Sepulveda led a US delegation to Havana to discuss telecommunication and the Internet. At the time, he said there were at least a half-dozen proposals to construct an undersea cable between the US and Cuba, but nothing has happened (Press 2016d). Regardless of who installs it, a second cable would be valuable.

Satellite technology is changing rapidly. Several years ago, I suggested that ETECSA use geostationary satellites to provide connectivity in rural towns as a stopgap measure (Press 2013a; Press 2017j). While that remains an interim option, low and middle-earth orbit (LEO and MEO) satellite constellations may play an important role in the future of the Cuban Internet (Press 2018a; Press 2019).

Cuba uses SES O3b MEO satellites for international connectivity today (Press 2017b) and SES will deploy significantly improved satellites beginning in 2021 (Press 2018b). OneWeb, SpaceX, Telesat, and China's Hongyun Project will be deploying constellations of LEO satellites between now and 2025 (Press 2017c; Press 2017d; Press 2017m; Press 2019d). These satellites will be capable of connecting Cuba's mobile network, municipal networks, organizations like schools or clinics and rural homes there-

by saving Cuba the expense of investing in their fiber and high-speed wireless backbone.

To satisfy the FCC, SpaceX, OneWeb and Telesat have deadlines for covering the US so Cuba, being near the southeastern US, could receive early coverage. The Hongyun project will focus first on rural China and, since Havana is around the same latitude as southern China and around 180 degrees longitude from central China, Hongyun may also be able to offer service in Cuba. Furthermore, China has a strategic motivation for doing so (Press 2019e).

Cuba should also be planning for future terrestrial wireless technology. Much of the world is currently using fourth generation (4G) mobile communication technology, but we are about to begin a long transition to 5G wireless. Cuba is currently installing 3G and testing 4G mobile technology (Press 2018c) while the US and other nations will begin deploying early, immature versions of 5G technology this year. When mature, 5G will enable new applications and be competitive for fixed as well as mobile connectivity, but 5G standards definition, manufacturing and deployment will all take time.

5G will require many "small cells" because it uses high-frequency radio signals that do not travel as far as 4G signals and are more easily blocked by obstructions like trees and buildings. For example, there are about 154,000 cell towers in the US today and an industry association, estimates that there will be 800,000 small cells by 2026 (CTIA 2019). The U. S. embargo and Cuba's emphasis on education have left them with an innovative do-it-yourself ethic and one can imagine non-professionals or municipal employees rather than ETECSA employees installing "small cells" in their neighborhoods (Press 2018h).

Cuba's strategic and commercial ties with China give them an important advantage regarding 5G wireless. Huawei, which dominates the Cuban Internet infrastructure market, is the world leader in 5G development and, if the Cuban government were willing, Havana could possibly have widespread 5G coverage and applications before Miami (Press 2019f).

Looking toward the future, we must also recognize the potential downside to Cuba achieving a ubiquitous Internet. We have seen that Freedom House

considers the Cuban Internet to be unfree and Cuba has used the Internet as an international political weapon (Press 2013a) and is using it as a domestic political tool, most recently when government trolls waged a pro-ETECSA Twitter campaign to counter public complaints about high prices (Inventario 2019). The example of Myanmar, mentioned above, also offers a cautionary tale. Privatization of the mobile phone network led to a rapid rise in Internet utilization, but it also contributed to the Facebook-facilitated Rohingya genocide (Mozur 2018).

Russia²⁷ has waged cyber war against businesses and societies for a decade and Europeans have experience defending against them.²⁸ Imagine what the Cuban government could do with Russia-style access to Facebook data or the fake news they could create and circulate on YouTube (Press 2019a).

Many of our current problems with the Internet are a by-product of the advertising business model of companies like Google and Facebook (Wu 2016). There are alternative ways to finance the Internet — they license television sets in Great Britain; we pay Netflix and others for content in the US and Cubans pay for El Paquete (though it is heavily subsidized by piracy). Might Cuba show us a future Internet financed without reliance on advertising?

CONCLUSION

We saw that Cuba was among the leading Caribbean nations in pre-Internet international networking. They connected to Soviet networks for access to scientific articles, databases and email and they communicated with the nascent global networking

community — exchanging email, transferring files and participating in threaded discussions on technology, science, politics, culture, and many other topics. However, financial problems, difficulty in obtaining equipment and fear of the role free information had played in the dissolution of the Soviet Union, led to a decision to control access to the Internet.

Cuba connected to the Internet in 1996, but by that time they had fallen behind other nations in the region, access was strictly limited and international traffic was routed over low-capacity geostationary satellites. In 2013, an undersea cable connecting Cuba with Venezuela was installed, increasing international capacity and four means of public access followed: navigation rooms, WiFi hotspots, home ADSL and 3G mobile connectivity are now available in some parts of the country. These are expensive, slow and, with the exception of the WiFi hotspots, use obsolete technology. Cuba is one of the least connected nations in the world and ETECSA is one of the few remaining government-monopoly Internet service providers in the world.

Looking toward the future, I discussed steps Cuba could take if they aspire to a ubiquitous, modern Internet.²⁹ I considered policy trends and options, next-generation technology and Cuba's human resources, values and culture in formulating my suggestions. Cuba has fallen behind the world, but they are taking stopgap measures today and could deploy next-generation technology when it is ready — in, say, five years. Next-generation policy will be a tougher problem.

27. Russia is not alone. China has done extensive industrial espionage and Iran and North Korea have also waged cyber-attacks (Carlin and Graff 2018) as have the US and Israel in the case of Stuxnet.

28. Many governments have acted to safeguard privacy and security and fight attacks on infrastructure and lies, fake news and filter bubbles designed to undermine democracy. Cuba can learn from nations like Estonia (Amaro 2019) with its security and privacy technology and Ukraine for fighting political and social attacks (Cain 2019). They can also evaluate legislation like the European Union General Data Protection Regulation for safeguarding citizens' personal data and giving them control over it.

29. This is just a starting point. Cuba should consult a variety of international experts on forthcoming technology and alternative infrastructure ownership and regulation policies.

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