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# Polycentric systems for spectrum management: the case of Indigenous and tribal spectrum sovereignty

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## Abstract

We extend the law and economics analysis of spectrum management by considering the economic case for Indigenous and tribal spectrum sovereignty. We use case studies from the United States, Guatemala, Canada, and New Zealand to show that these movements seek a polycentric system of spectrum management that contrasts with the prevailing monocentric systems of spectrum management in which national governments have the primary authority over spectrum governance. Theories of polycentricity and federalism offer insight into the efficiency of Indigenous and tribal spectrum sovereignty as well as polycentric spectrum sovereignty more generally.

**Keywords** Electromagnetic spectrum · Spectrum management · Indigenous spectrum sovereignty · Tribal spectrum sovereignty · Polycentric spectrum management

**JEL Classification** H1 · K1 · K4 · P14 · Z18

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## 1 Introduction

Ronald Coase's ideas about spectrum eventually shaped spectrum management in most of the world. Spectrum is routinely parceled out and sold in competitive markets just as Coase argued it should be. The liberal licensing regime is a testament to the significant impact of law and economics on spectrum management.

In this paper, we argue that a neglected consideration in the law and economics of spectrum is the foundational question of who has the right to control spectrum. The liberal licensing regime is based on a status quo in which national governments assert control of spectrum. Licensing occurs within this context. This neglected aspect has been brought to light by Indigenous and tribal spectrum sovereignty movements. These movements seek a polycentric system of spectrum management with multiple, nested levels of spectrum governance beyond national governments and the International Telecommunication Union (ITU). Our goals in this paper are to demonstrate the key features of these movements, to articulate the potential efficiency of polycentric systems for spectrum management in the case of Indigenous and tribal spectrum sovereignty movements, and to consider the economic case for polycentric spectrum management more generally.

The centralized features of the liberal licensing regime are sometimes missed in studies which rightly point out the efficiency gains in moving from systems in which spectrum was allocated through bureaucratic hearings to the current system in which licenses are routinely bought and sold in markets. We consider whether a polycentric system, in which local units (such as the governments of Indigenous and Native Nations) have more autonomy to experiment with spectrum, can be a significant source of efficiency gains much like the gains made from the liberal spectrum regime that emerged in the 1990s.

Our emphasis is on providing a balanced assessment of spectrum sovereignty on tribal lands. On the benefits side, besides encouraging experimentation with new ways to manage spectrum on tribal lands, polycentric spectrum governance in the context of Indigenous and tribal lands respects the sovereignty of Indigenous and tribal communities. There are also challenges that may arise in moving toward a more decentralized system of spectrum management, such as a loss of harmonization that may arise through national-level spectrum management, as well as coordination challenges that arise because there are a greater number of autonomous units of governance that participate in spectrum governance. One of our objectives is to provide a framework to consider the pros and cons of polycentric systems for spectrum management on tribal lands as well as to extend such analysis to polycentric spectrum management more generally.

Polycentric spectrum sovereignty is a general framework which recognizes that national governments need not have a de jure monopoly on control and management of spectrum. Currently, spectrum management has some features of polycentric governance, in particular national governments operate within a system in which the ITU has a significant coordinative role in spectrum management. However, a significant barrier to polycentric spectrum management is that national governments are the "local" level of spectrum management. Indigenous and tribal spectrum

sovereignty would constitute a move in the direction of a truly polycentric global system of spectrum management in which national governments and the ITU coordinate with Indigenous and tribal governments as well as with private and nonprofit organizations to manage access to and use of spectrum.

We highlight polycentric spectrum sovereignty on Indigenous and tribal spectrum sovereignty because Indigenous peoples have largely been excluded from the process of managing spectrum. From the perspective of Indigenous people, spectrum management is both centralized and extractive. For example, Native Nations in the US have very little formal autonomy to manage spectrum on tribal lands as the Federal Communications Commission (FCC) has nearly complete authority over commercial spectrum over the electrospace above US territory.[1] Further, tribes do not directly benefit from spectrum licenses sold by the FCC for use of spectrum on tribal lands.

Indigenous and tribal spectrum sovereignty can be framed in terms of efficiency, though we emphasize that the goal of these movements is greater autonomy to manage a valuable natural resource in ways that reflect the values of members of Indigenous and tribal communities. For thousands of years, Indigenous people have related to spectrum by recognizing deities who govern and communicate through lightning, rainbows, and sunlight, each of which are observations of the same electromagnetic spectrum we use today. An indigenous understanding of spectrum has recognized these frequencies through song, prayer, and ceremony since time immemorial in what is presently known as the US. The global movements calling for recognition of Indigenous and tribal spectrum sovereignty seek to reclaim this valuable resource for Indigenous, Tribal, and Native Nations. These movements recognize that spectrum management on tribal lands is an issue of jurisdiction, sovereignty, human rights, and to an extent, property ownership. They also make clear that in nearly all contexts, national governments assert control over spectrum at the expense of Indigenous and tribal communities.

Our empirical analysis consists of comparative case studies of Indigenous and tribal spectrum sovereignty movements in the United States, Guatemala, Canada, and New Zealand, with emphasis on the US. Our case selection is an example of purposive sampling, where characteristics of cases are used for selection non-randomly (Yin, 2018). The chief characteristic is that the movements each represent a sustained effort to redefine spectrum management in ways that prioritize autonomy for Indigenous and Native Nations in decision-making. It also has aspects of a crucial case method given our focus on the movement for tribal spectrum sovereignty in the US. Crucial cases identify instances within a particular phenomenon to gain deeper insight into overall dynamics and underlying factors at play (Gerring, 2006). Such methods are useful to understand the rationales for and challenges confronting these movements. Crucial cases also have some well-known drawbacks, in particular subjectivity in selection and inability to generalize from the case (Gerring, 2007).

[1] In the United States, use of spectrum by the government is managed by the National Telecommunications and Information Agency (NTIA), which coordinates numerous government agencies and the Department of Defense.

One solution is to collect additional cases, as the crucial case may not be unique, which we do by considering several additional cases. Purposive sampling has limitations as well, as selection is not random and, hence, introduces subjectivity (Seawright & Gerring, 2008). To address this, we encourage additional case studies of Indigenous and tribal spectrum sovereignty beyond the ones considered here.

Why revisit the meta-political question of control over spectrum? Besides a sense of justice in addressing the extraction of authority over spectrum on tribal lands, law and economics scholars have pointed out the potential costs of monocentric spectrum regimes. In the US case, the FCC has been criticized because it suffers from the typical incentive problems arising within a large, complex bureaucracy. As Hazlett (2008) points out, while the use of auctions by the FCC is considered a substantial source of improvement in consumer welfare compared to allocation based on bureaucratic priorities, the FCC still relies on centralized mechanisms to allocate spectrum which encourage socially costly lobbying activities. For this reason, Hazlett suggests, at least as a thought experiment, the potential gains abolishing the current allocation of spectrum that has been established by the FCC and starting from scratch. Such perspectives, like Indigenous and Tribal spectrum sovereignty, constitute new and innovative ideas for spectrum management, though in any such example, it is necessary to overcome entrenched interests to set reform in motion. How that occurs is not always clear in law and economics studies that offer constructive insights into how spectrum management could be designed better.

Our paper is organized as follows. In the next section, we provide an overview of spectrum management with a focus on the United States. We consider US spectrum management because of the way the US established government control over spectrum in monocentric fashion is the general way that spectrum is managed globally. Next, we present three additional cases of Indigenous and tribal spectrum sovereignty movements. We then provide, in the two sections that follow, a framework that describes the general features of polycentric systems to manage spectrum and a framework to assess the efficiency of such systems. In the conclusion, we discuss the future of the research agenda on polycentric systems of spectrum management.

## 2 A brief history of spectrum

The electromagnetic spectrum ("spectrum," for short) refers to the electrospace through which signals used for the internet, TV, radio, and cellphones travel. Modern spectrum management concerns the rules and regulations governing access to and use of the electromagnetic spectrum (Murtazashvili et al., 2023). Spectrum management is necessary because it is a shared resource. Since signals compete with one another, there is a potential problem of interference. Too many users can render spectrum useless or less useful. Electrospace is also a multi-dimensional good that consists of at least three dimensions—time, space, and frequency (DeVany, 1998)—but as many as seven dimensions (Matheson & Morris, 2012). Licenses are assigned with respect to three of these dimensions: time, frequency, and geography. Thus, one can think of spectrum management as considering the range of rules governing

spectrum use and how changes in those rules can result in better outcomes for consumers.

The need for spectrum management emerged soon after the first radio signals were transmitted by Guglielmo Marconi in Pontecchio, Italy, in 1895. After Marconi's discovery, the demand for radio frequencies would soon be apparent as the public learned that radio waves provide an unprecedented way to communicate. The potential problems caused by interference also quickly became clear. In the early twentieth century, the US Navy became concerned with interference with their radios. Congress responded with the Radio Act of 1912. The Radio Act established licenses that were issued by the US Secretary of Commerce. These licenses were not enforceable in the sense that the license holders did not have rights to any frequency and did not have exclusive use of a particular frequency (Douglas, 1987). These broadcasters recognized that interference with transmissions was becoming an issue, in large part because only a single frequency was allowed for broadcasting, as commercial broadcasting increased in the early 1920s. Before then, anyone transmitting was doing so in a highly unregulated environment. Broadcasting quickly emerged as a big business, and that put in motion efforts to establish a more significant legal framework (Streeter, 1996).

US courts attempted to address growing issues with interference with common law rules to govern the use of spectrum (Huber, 1997; Mahoney, 2001). The Supreme Court attempted to deal with interference problems in several decisions, though their ability to do so was limited because there was not much legal precedent nor regulatory apparatus. In United States v. Zenith (1926), the Court decided that the Secretary of Commerce could not legally enforce exclusive rights to radio frequency. Thus, the licenses could not do much to prevent interference. Other cases attempted to work out rules, such as Tribune Co. v. Oak Leaves Broadcasting (1926), which applied the homesteading principle as a common-law remedy to priority-use rights in spectrum (Hazlett, 2017).

In 1927, the Radio Act, which superseded the Radio Act of 1912, created the Federal Radio Commission (FRC) with broad powers to deal with interference and to manage spectrum. The Radio Act asserted that Congress would control access to spectrum "in the public interest," but that the FRC could issue licenses for particular use. Licenses would be granted based on public interest, convenience, and necessity. The FRC was subsumed by the FCC when Congress created the new agency in 1934 to implement a broader policy for communications, including the system of managing and allocating spectrum. In this same piece of legislation, Congress declared that the federal government had the authority to allocate spectrum (Douglas, 1987). The FCC and Congress would then decide on rules to assign spectrum, which, as noted, were initially through bureaucratic hearings that weighed the political value of an applicant's proposed use of spectrum. The key feature of the so-called "beauty contests" was that who won was decided by a government committee based on a loose understanding of public value (Hazlett et al., 2011).

The federal courts highlighted the flaws of the original licensing system, though the Courts did not have the power to determine the specific business model to allocate spectrum because that was of Congress. What the courts were able to do was highlight the need for Congress to do something. In NBC v. United States (1943)

and Red Lion Broadcasting v. FCC (1969), the Supreme Court demanded that the spectrum management regime address the "chaos" in spectrum and stated that the problem of a "cacophony of competing voices" threatened the ability of society to get the most out of spectrum. But Coase and others recognized that efficiency required thinking seriously about the social costs of beauty contests. They argued that spectrum should be assigned through markets instead of through government committees. Coase recognized that spectrum management involves regulations on power, frequency, and time, all of which must be considered for optimal efficiency. Nevertheless, Congress chose to continue its process of bureaucratic hearings to assign spectrum for decades to follow, which Coase argued was inefficient. The economic problems with bureaucratic assignment were pointed out by Herzel in 1951 and Coase in 1959, though the FCC did not change its spectrum allocation methods until the 1990s (Hazlett, 2011).

Eventually, the idea of markets gained popularity and the FCC began implementing auctions in ways that reflected Coase's "disruptive clarity" about the benefits to consumers and to the government from selling rights to broadcast (Hazlett, 1998). The gap between Coase's good idea and changes in FCC policy were mostly a consequence of political conflicts, especially the influence of the National Association of Broadcasters (NAB), which emerged before the FCC was created in 1934 and had a substantial advantage influencing bureaucratic assignment (Hazlett, 2017). Despite the gap, it seems that there is a consensus that Coase's ideas were central to the modern liberal licensing regime governing spectrum because subsequent changes in spectrum management reflect the value of spectrum. Markets also offer insight into just how much spectrum is worth. From 1994 to 2022, the FCC held over 100 auctions that have generated more than $258 billion in net proceeds for the U.S. Treasury.[2] This enticing value has led to substantial efforts to provide more opportunities for telecommunications companies to acquire spectrum through markets, though political challenges often contributed to delays. The example of TV "white spaces" (which can intuitively be thought of as a frequency transmission buffer zone surrounding each broadcast channel) is a useful illustration.

When TV broadcast first emerged, the state of technology was such that a few stations secured rather large assignments of spectrum to broadcast. The rationale was that broadcasts had to be surrounded by a buffer in space and frequency to avoid interference. As technology improved, the technical need for these large buffers decreased. But, for decades, the FCC did not allow the television companies to sell their white space. Rather, the FCC treated these buffer zones as junk bands even as their value became more obvious. Once cable became more prominent, the efficiency gains from allowing the television companies to sell white space became even more obvious. Eventually, the FCC allowed auctions to these junk bands, leading to more efficient contracting among cable and satellite operators with TV companies. In Coasean fashion, the government's role was to create the market for spectrum, and then the market participants, through competitive bidding, would ultimately determine whether property was assigned to its highest-value use.

[2] https://www.fcc.gov/auctions-summary

In the liberal licensing regime, markets play an especially significant role in determining who gets to use spectrum. It is not a perfect system, as there are different "tragedies" of spectrum management. Hazlett (2005) offers a useful framework in dividing the tragedy of anticommons with liberal licenses (the social costs arising from restrictions on transfer of spectrum rights) and the tragedy of the commons with unlicensed spectrum (the social costs arising from inability to alienate spectrum property). This perspective is especially useful in considering spectrum management, though we emphasize here that it does not speak to the ultimate decision-making authority over spectrum.

The story above demonstrates a significant win for the law and economics approach, with the rise of Coase's ideas. It is also incomplete. The law and economics of spectrum has largely taken the original claim to authority to allocate spectrum and has focused on questions of business models and markets for spectrum. Indigenous and tribal spectrum sovereignty movements clarify that the current systems of spectrum management in the four countries considered are monocentric and that there are concrete ways that such systems could move in the direction of a truly polycentric spectrum management regime that would offer unprecedented opportunities for Indigenous people to participate in the process of spectrum governance.

## 3 Indigenous and tribal spectrum sovereignty in the United States

### 3.1 Federal efforts to address inequities in spectrum management

Spectrum is increasingly recognized as one of our most valuable natural resources. Its value is reflected in how much businesses pay for licenses, how much revenue the governments receive through auctions for those licenses, and uses that are more challenging to measure, including scientific uses such as radio astronomy and "non-profit" uses such as amateur radio, community radio, and use for emergency services. Much of the economic analysis of spectrum seeks to measure the value generated in competitive markets from sale of those licenses to businesses.

The US government has not yet recognized Native Nations' direct rights over these revenues or their authority over the management of spectrum licenses on tribal lands. This is significant because one reason for Indigenous and tribal spectrum sovereignty is increasing the autonomy of Native Nations to address the digital divide on tribal lands. According to the Organization for Economic Cooperation and Development (OECD), the digital divide refers to "the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access information and communication technologies (ICTs) and to their use of the internet for a wide variety of activities" (OECD, 2001). This is especially a challenge in rural areas, in part because of what Ali (2021) calls the "tyranny of distance," which is the idea that major broadband providers, because of perceptions that rural markets are too small or too costly to serve, provide less infrastructure in rural areas. One reason why broadband access

is important is because it is associated with increased incomes and more economic activities (Whitacre and Gallardo 2022).

The broadband gap on Native Nations can be understood in the broader context of the rural–urban gap in broadband access. In 2015, the FCC established a broadband minimum benchmark speed of 25 megabits per second (Mbps) and upload speeds of 3 Mbps (25/3 Mbps). According to the FCC's Broadband Deployment Report in 2018, 34 million Americans lacked access to service at 25/3 Mbps. Most of the gap was in rural areas, as 39 percent of rural Americans and just 4 percent of urban Americans did not have access to 25/3 Mbps.[3] The National Rural Electric Cooperative Association (NRECA), which represents electric utilities across over half of the landmass in the United States, claimed in a 2018 study that rural households would receive an annual average of nearly $2,000 each in economic benefits, totaling more than $68 billion total over 20 years if they had access to high-speed (data rates and downlink capacity faster than 25/3 Mbps) broadband.[4] According to the FCC's report on broadband in 2021, the number of Americans in rural areas lacking access to 25/3 Mbps fell more than 46%, reducing the gap in half—from 30 percent to just 16 percent at the end of 2019.[5] Expectations for service are also changing. The Infrastructure Investment and Jobs Act (IIJA), passed into law in November 2022, directs the National Telecommunications Information Administration (NTIA) to establish broadband programs, the largest being the Broadband Equity, Access, and Deployment (BEAD) Program, which provides $42.5 billion for broadband infrastructure deployment and adoption, with the priority being "unserved areas" (those below 25/3 Mbps), followed by underserved areas (those below 100/20 Mbps).[6]

Native Nations confront the largest digital divide in high-speed broadband access in the US (Bauer et al., 2022). According to a US Government Accountability Office (GAO) report released in 2022, 18% of people living on tribal lands could not access broadband service, compared to 4% in non-tribal areas.[7] Inequities in broadband access do not fully capture the extent of the digital divide on tribal lands: even if fixed (in a home) or mobile (on a cell phone) high-speed internet was ubiquitous on tribal lands, accessing the connection requires hardware such as computers and routers, the financial stability to purchase an internet plan and said hardware, and the technical training and capabilities required to set up and maintain connection (the latter can be thought of as a gap in digital literacy, or digital equity). Mobile connections may offer a sufficient connection, but the lack of hardware limits a user's ability to use the internet. Mobile data plans and hot spots may be more available

[3] Federal Communications Commission, 2018 Broadband Deployment Report. Available at: https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2018-broadband-deployment-report

[4] National Rural Electric Cooperative Association, "Unlocking the Value of Broadband for Elective Cooperative Consumer-Members," Business & Technology Report, September 2018. Available at: https://www.electric.coop/wp-content/uploads/2018/09/Unlocking-the-Value-of-Broadband-for-Co-op-Consumer-Members_Sept_2018.pdf

[5] FCC, 2021 Broadband Deployment Report. Available at: https://docs.fcc.gov/public/attachments/FCC-21-18A1.pdf

[6] https://broadbandusa.ntia.doc.gov/funding-programs/broadband-equity-access-and-deployment-bead-program

[7] https://www.gao.gov/products/gao-22-104421

in rural and tribal areas lately, but they are also less affordable than fixed wireless, which usually offers less expensive plans and more data than a phone plan.

Especially in rural areas where laying fiberoptic cable is expensive and unaffordable for many Indigenous communities, spectrum rights are necessary to facilitate both fixed and mobile broadband access. Prior to the coronavirus pandemic, as of September 2018, only 18 Tribal entities had *ever* held active broadband-capable spectrum licenses. Of these 18 Tribal entities, four obtained licenses through secondary market transactions by buying or leasing the license from another provider and two obtained a license through an FCC spectrum auction (where the average license costs around $2 million dollars[8]). This means that in the first 24 years of the FCC holding spectrum auctions, only two out of over 560 federally recognized Tribes were able to purchase the right to use spectrum on their lands at auction. The barriers Tribal officials identified to obtaining licensed spectrum include high costs at auctions and, in the case of secondary market transactions, a lack of information on who holds licenses on the spectrum over tribal lands.[9]

Because of this data pointing to spectrum access as a large factor in the digital divide on tribal lands, the FCC began to address these challenges by implementing policies that increased Tribal access to spectrum. These policies provided one-time support to underserved tribal areas by increasing access to spectrum for broadband deployment.[10] In 2020, the FCC opened a Rural Tribal Priority Window (RTPW). The RTPW allowed federally recognized tribes in rural areas to apply for mid-band spectrum (2.5 GHz) licenses without having to participate in FCC auctions. These license re-assignments involved reallocating spectrum from their former uses, such as the Broadband Radio Service. Congress also provided for direct support to individuals living on tribal lands to offset costs of internet access with the Emergency Broadband Connectivity Fund, which included funds to subsidize devices.[11] In October 2020, the FCC granted 154 tribal 2.5 GHz licenses under the RTPW. These licenses are assigned for geographic overlay licenses for unassigned spectrum for up to 117.5 MHz of the 2.5 GHz band for deployments that include broadband and other wireless services.[12]

This has led to calls for greater collaboration with Native Nations as well as to recognize a role for sovereign tribal governments in developing policies to address these gaps (Mack et al., 2022). The FCC's efforts to narrow the digital divide include the Native Nations Communications Task force, originally established as the Native Nations Broadband Task Force in 2011 and renamed in 2018 to reflect its reach beyond broadband deployment.[13] The Task Force is made up of up to 26 tribal and eight FCC senior staff members who each serve for a three-year term. The Task Force, which meets twice a year, offers institutional participation for Native Nations via Indigenous participants in its mission "to provide guidance, expertise,

[8] https://www.gao.gov/products/gao-19-75GAO-19-75

[9] https://www.gao.gov/products/gao-19-668t

[10] https://www.fcc.gov/auction/902

[11] https://www.fcc.gov/document/emergency-broadband-benefit-starts-today

[12] https://www.telecompetitor.com/fcc-puts-focus-on-tribal-broadband-awards-154-tribal-2-5-ghz-spectrum-licenses/

[13] https://www.fcc.gov/native-nations-communications-task-force.

and recommendations to specific requests from the Commission on a range of telecommunications issues that directly or indirectly effect tribal governments and their people."[14] While this increases representation, it does not specifically provide for autonomy for Native Nations to decide spectrum management on tribal lands.

Another FCC initiative seeks to address discrimination by service providers. In February 2022, FCC chairwoman Jessica Rosenworcel announced the formation of a Cross-Agency Task Force to Prevent Digital Discrimination. In November 2023, the FCC implemented final rules under the Bipartisan Infrastructure Law of 2021 to prevent digital discrimination in access to broadband service in the hopes of ensuring "equal access to reliable, high-speed broadband services by addressing discriminatory business practices and policies, enabling the FCC to intervene, investigate, mediate, and penalize companies if necessary."[15] "Digital discrimination of access" refers to policies or practices lacking a technical or economic justification that adversely impact consumers' access to broadband. The FCC also vowed to support agencies seeking to address discrimination in access pursued by tribal governments.

### 3.2 Limitations with the RTPW

The RTPW acknowledges systematic exclusion of Native Nations from spectrum access, as evidenced by disproportionately large gaps in broadband access on tribal lands. The National Congress of American Indians issued a statement that the RTPW is "one small way Congress and the FCC can fulfill their commitment to Tribes."[16] Their statement viewed these changes as the "first step to addressing the inequities of this underserved population—it will give Tribes an actual chance to secure broadband access for their communities." It is historic in that it put more spectrum licenses in the hands of tribal governments than ever before, but the policy had many notable shortcomings. For example, the exclusion of Native Nations in urban areas was unusual, and arguably unprecedented, in the broader scheme of Federal Indian Law. Usually, a policy that affects one federally recognized tribe affects the other 573. In this case, however, the FCC earns hefty revenue from the sale of urban spectrum licenses. Limiting the sale to only rural Native Nations ensured the FCC's revenue on the sale of urban spectrum licenses would not be impacted. Native Hawaiian Nations were also ineligible to gain spectrum through the RTPW. Furthermore, tribes were given only three months to apply online for the licenses even though many nations needed time to pass resolutions through their legislature. Additionally, tribal governments were not meeting during this time due to quarantines because of the COVID-19 pandemic and some Native Nations have yet to gain broadband internet even at their Tribal headquarters.[17] If tribes did not acquire rights during the window, they did not receive licenses. Without licenses, it is more challenging and

[14] https://www.fcc.gov/native-nations-communications-task-force.

[15] https://www.fcc.gov/task-force-prevent-digital-discrimination

[16] https://energycommerce.house.gov/committee-activity/hearings/full-committee-hearing-on-addressing-the-urgent-needs-of-our-tribal

[17] Letter from Senator Heinrich, Congresswoman Haaland, and 33 Members of Congress to Chairman Pai RE: 30-day Extension Period—2.5 GHz Rural Tribal Priority Window Order (August 18, 2020) [requesting COVID-19 2.5 GHz Rural Tribal Priority Window extension of no less than 180 days].

more expensive for Native Nations to build their own internet networks, negotiate and sublease rights, and develop revenue streams. Because of the challenges brought on by the COVID-19 pandemic, tribal government shutdowns, and tribal administrators struggling to access the online window to access the auction application before the deadline, some Nations may have missed this opportunity.

### 3.3 The DIGITAL reservations act and polycentric spectrum

Though there have been recent steps forward, what remains clear from current FCC efforts is that there is very little autonomy for Native Nations to manage spectrum. The policies reviewed do not specifically provide for autonomy to tribes to manage spectrum, nor is it clear whether the RTPW empowers Tribal citizens to claim discrimination for actions on Tribal lands under this policy. Tribal actions always require approval from the FCC, which is inconsistent with tribal sovereignty. Additionally, there are few opportunities for tribes to develop their own solutions to issues of spectrum management.

At a more fundamental level, the FCC's assertion of control and its seemingly limitless powers over spectrum on and off tribal lands are a consequence of self-ordained federal dominance over Native Nations rooted in the Doctrine of Discovery. The fifteenth century papal edict declared any land inhabited by non-Christians along with resources that came with it was *terra nullius*: unclaimed property that could be claimed by explorers on behalf of colonial governments. Though the Doctrine of Discovery predated the US Constitution by hundreds of years, American jurisprudence from the time of the framing of the US Constitution in 1787 until today has recognized Congress as the supreme authority over Indian Nations, a legal relationship deeply rooted in the concepts behind Doctrine of Discovery. In 2023 the Catholic Church rescinded the Doctrine of Discovery, but it remains the legal framework of laws relating to (or failing to include) Indigenous peoples in the United States and Canada, among other colonized countries. Federal policies such as the Dawes Act of 1887 attempted to create a framework for economic development on Indian reservations by imposing the European concept of individual property rights, a foreign and nonsensical concept to many Indigenous Peoples (Graeber & Wengrow, 2021). The Dawes Act went further in that it required 25 years to establish "competence" to own property, thus imposing requirements on Indians that white people did not have to satisfy to own property. Rather than recognize autonomy of Native Nations, the defining feature of the Dawes Act was establishing tremendous authority of federal bureaucrats to determine what Indians could and could not do on reservations (Dippel et al., 2022).[18] The perceived failure of the Dawes Act to enable economic development on reservations led to its abandonment with the Indian Reorganization Act (IRA), which in 1934 established a system of trusteeship over land that locked in place reservation property. It was only in the 1970s that the federal government finally recognized Tribal autonomy in any meaningful way.

[18] "Indian" is a legal term of art defined in 25 USC §5304 to mean a member of a federally recognized tribe.

Even in the era of self-determination, the federal government maintains broad authority over reservations if it wants to assert that power. A lesser-appreciated feature of the current regime is that Native Nations do not have any specific autonomy to manage spectrum on tribal lands. Under the current FCC regime, the federal government maintains all formal authority to determine spectrum management. Thus, the FCC attempts to provide for greater equity in access to spectrum mentioned above takes for granted that the FCC "owns" spectrum and decides on its management.

A significant proposal to address these issues is the Deploying the Internet by Guaranteeing Indian Tribes Autonomy Over Licensing (DIGITAL) Reservations Act. This bill, sponsored by then-Congresswoman Deb Haaland (as of 2023, Haaland was Secretary of the Interior) and Senator Elizabeth Warren, was referred to the Committee on Commerce, Science, and Transportation, where its congressional journey ended. Nevertheless, the DIGITAL Reservations Act offers a vision for Tribal spectrum management that better aligns with Tribal sovereignty by requiring a Tribe's consent before spectrum can be sold on their lands. Its key provisions are that Tribal governments would have the authority to manage their spectrum. Tribes would be able to opt into the FCC system for spectrum, but it would be an autonomous choice. The Act also includes a "build or divest" process to ensure existing internet service providers with licenses develop networks, establishes a Tribal Broadband Fund paid for by spectrum auctions to generate more funds for reservations, and directs the FCC to expand efforts to improve measurement of broadband gaps and impacts of connectivity efforts.

The Act envisions a polycentric system of spectrum governance, one in which Native Nations have the autonomy to decide how to manage spectrum, including deference to the FCC (Blackwater et al., 2023). There remains a role for the FCC under the plan, but Tribes are empowered to manage spectrum in a way that aligns with their priorities and values. Under the Act, Tribes have the right to decide what to do with spectrum, including any allocation and assignment rules on tribal lands. This would provide tribes with the most opportunity to allocate spectrum for tribal lands, rather than waiting on the FCC to allocate it to the Tribes.

## 4 The global movement for indigenous and tribal spectrum sovereignty

### 4.1 Telecommunications liberalization and its discontents: the movement for Indigenous and tribal spectrum sovereignty in Guatemala

Globally, Indigenous peoples engage in their way of life and language through community radio to preserve and grow language. Community radio is a forum for Indigenous Peoples to rage against injustice and heal together from the ongoing violent assimilation practices of colonial governments. When considering the value of community radio to Indigenous communities and the fact that colonial governments have given themselves total authority to disenfranchise Indigenous communities from

their languages, communities, and natural resources including spectrum rights, one can see why Indigenous people would turn to pirate radio as a solution.

Guatemala has rightly earned a reputation for liberalization of radio spectrum. Indeed, studies of liberalization in Guatemala find large social benefits when more spectrum is made available (Hazlett & Muñoz, 2009a, 2009b). Along with El Salvador, Guatemala has led Latin America in spectrum liberalization, as measured by greater competition in telecommunications markets and, ultimately, more coverage provided by telecommunications providers.

These liberalizing reforms, which have rightly been praised for improving consumer welfare, nonetheless leave out certain aspects of telecommunications reform. For Guatemala, these reforms started with the 1996 Ley de Telecommunicaciones. This law allows anyone to request any license not currently allocated to other users and encourages, in the case of interference with adjacent bands, that the parties mediate the conflicts themselves through private negotiation. If private negotiations fail, affected parties can sue in courts for damages caused by signals (Minervini, 2014). As Ibarguen (2003) points out, "the Guatemalan liberalization indicates that the transformation of the radio spectrum into private property rights can remove barriers to entry and yet not result in chaos." These licenses, known as Títulos de Usufructo de Frecuencias (or TUFs), have created a more flexible telecommunications market in the country where bandwidth parcels or frequency bands are purchased by those who value them most highly. In addition, TUFs' owners are allowed to sell, rent, subdivide, or consolidate their spectrum rights as well as use different technologies at will.

The liberalization has many parallels in the US, including increasing reliance on markets.[19] Also like the US, Guatemala's Indigenous peoples have been largely excluded from conversations on liberalization of spectrum management. The legal conflict involving the Maya Kaqchikel de Sumpango illustrates the challenges confronting Indigenous peoples in Guatemala. Community radio stations operated by Mayan broadcasters and raided by Guatemalan police were at issue. State authorities confiscated the radio and transmission equipment of Indigenous groups for broadcasting without a license. This was a clear violation of Guatemala's liberal licensing regime which, like most liberal licensing regimes, involves clear rules regulating broadcasting without a license.

The issue of Indigenous communities being left out in the liberal licensing regime was raised in 2020 by the Inter-American Commission on Human Rights (IACHR). IACHR filed an application with the Inter-American Court of Human Rights over the case of the obstacles faced by four community radio stations operated by Indigenous Peoples in Guatemala as an exercise of their rights to freedom of expression and cultural rights.[20] According to a merit report issued by IACHR, without access to spectrum, Indigenous Guatemalans could not establish community media outlets or enjoy and exercise the right to freedom of expression through these outlets. These infringed

[19] Liberalization along lines like the US and Guatemala has been a consistent emphasis of telecommunications policy globally (Gómez-Barroso et al., 2017).

[20] Press Release, Organization of American States, IACHR Brings Guatemala Case before the IA Court, (Sept. 25, 2020), https://www.oas.org/en/iachr/media_center/PReleases/2020/232.asp.

upon rights were protected by Article 13 of the American Convention of Human Rights of 1969. IACHR asserted that Guatemala's General Telecommunications Law (Ley General de Telecomunicaciones of 1996), enacted in 1996, established the highest financial offer as the only criterion for allocating radio frequencies and that Indigenous people who lack the economic resources to compete in liberalized markets were disadvantaged. Hence, equal opportunity did not account for inequities Indigenous people faced to be able to meaningfully participate in the liberalized markets.

The IACHR report underscores that the regulations amounted to discrimination and violated the sovereign rights of Indigenous communities. IACHR deemed that the state had not adopted any positive differentiation measures (legislation, practices, or policies) to remove the barriers that Indigenous Peoples faced to accessing radio licenses on equal terms. IACHR provided a set of recommendations to the state of Guatemala: legal recognition of community media in domestic legislation and adopting a specific plan to promote diversity in the media; adopting measures to regularize the status of community radio stations that are currently operating outside the legal framework; adopting measures to guarantee Indigenous people have effective access to radio frequency on equal terms, in accordance with Guatemala's constitution rights to free expression; to refrain from enforcement against Indigenous Peoples; and to provide for economic compensation in these specific cases for the expropriation of community radio equipment.

It is also much like enforcement in liberal licensing regime in the US, where the FCC has a long history of similar raids against unauthorized broadcasters. Under US federal rules, anyone who broadcasts without a license is considered a "pirate" radio station (Dunbar-Hester, 2014). There is even a perception that more enforcement is required. The recent PIRATE Act of 2020 increases the penalties for unauthorized broadcast and expands authority of government agents to seize equipment used by alleged radio pirates. The FCC's argument was that such increasing enforcement was necessary to deter pirate radio operators, although like before, whether the interference caused a specific problem was not required, only that the broadcasts were detected, and that the broadcaster did not have a license (Ashworth, 2019, 2020). The "solution" has been to promote community radio, whereby community radio operators can acquire a license. Still, such community radio recognition says little about enforcement for violations and does not address the reality that the community radio band opportunities do not address inequities in ability to compete in markets for licenses. Community radio might be a solution in Guatemala, but it does not fully respect Indigenous sovereignty. Without proper consultation and support, communities may not know how to acquire a costly license or that licenses are available even if such rules are in place.

### 4.2 Indigenous and tribal spectrum sovereignty movements in Canada

There are several similarities of spectrum management in Canada as in the US. Spectrum in Canada is managed by the Canada Radio-Television and Telecommunications Commission (CRTC). Like the US, First Nations, Métis, and Inuit people of Canada were not consulted in creation of this organization, spectrum is managed

mainly by the CRTC, and the licensing process was designed for stations with substantial funding. Also as in the US, Canadian Indigenous communities confront some of the most extreme gaps in broadband access (Hudson & McMahon, 2022).

Indigenous people have confronted similar challenges with using spectrum including accusations of radio piracy. Neskie Manuel, of the Secwépemc people of Canada, wrote about the experience with a community pirate radio station in *Islands of Resistance*, an anthology of pirate radio stations in Canada (Manuel, 2010). Secwépemc Radio broadcast from the Neskonlith Reservation from 2005 to 2007 without a license from CRTC (Cocullo, 2022). In Manuel's words:

Operating this radio station is an expression of who we are as a people; it is the modern version of the campfire where people would share stories. Many Secwépemc stories center around the adventures of Coyote, the best traveler of the land. He is the best traveler of the land for many reasons, but the main reason is a gift that was given to him by the Creator, the gift of innovation. Coyote was warned by the Creator that this was a powerful gift and he must use it for good and to help the people. We are using this radio to decolonize our airspace, our minds and our hearts. We are not pirates, we are Secwépemc (as quoted in Cocullo, 2022).

Like federal actions by the US and Guatemalan governments, CRTC cracked down on broadcasters they believed were "pirates," based in part on their view that spectrum is scarce and the rights to its use must be enforced, including enforcement actions against Indigenous people broadcasting on First Nations' land. Such enforcement presumes the legitimacy of Canada's system of governance of spectrum. The movements for spectrum sovereignty in Canada question this presumption. Because Canadian treaties and the Constitution Act of 1982 bolster Indigenous rights to land and other resources, the question of whether Canada should recognize First Nations' rights to spectrum has risen to the surface of Indigenous politics in the past few years.[21] At an Assembly of First Nations meeting in December 2020, First Nations chiefs passed a resolution requesting access to high-speed internet for remote Indigenous communities. In February 2022, the Union of British Columbia Indian Chiefs also passed a resolution supporting a spectrum policy in Canada. In April of 2023, the Assembly of First Nations passes the resolution titled Government Support for First Nations Digital Connectivity and Spectrum Sovereignty which calls upon "the Government of Canada to immediately stop all sales and renewals of any spectrum licenses and permits on Indigenous traditional territories until consultations on the issue of spectrum have been completed with First Nations governments and mandated organizations in both official languages."[22]

The current policies proposed to remedy this situation include a CRTC consultation to co-develop indigenous broadcasting with First Nations, Métis, and Inuit broadcasters, content creators, and audiences with goals of setting aside frequencies and ensuring opportunities for regional and community stations. Additional goals include funding, mainstream media quotas for Indigenous content, artists, and journalists, and set-aside spectrum. More generally, these movements see value in Indigenous

[21] https://policyoptions.irpp.org/magazines/april-2022/wireless-spectrum-indigenous-communities/

[22] https://afn.bynder.com/m/535dc33a00caf660/original/Final-Resolutions-2023-Special-Chiefs-Assembly-April-Ottawa-ON.pdf

and First Nations people having their own independent bodies, with autonomy to make decisions about use of spectrum on tribal lands, as an alternative to colonial-era regulations and regulatory processes to manage spectrum(Cocullo, 2022).

The spectrum sovereignty movements for First Nations and Indigenous peoples in Canada can also be compared with the US. The FCC approach has focused on using policies such as the RTPW to increase access to spectrum; First Nations in Canada are seeking similar policies to provide for greater access. Early in 2024, the Ministry of Innovation, Science, and Economic Development Canada (ISED) announced an Indigenous Priority Window (IPW) for the 800 MHz Cellular and 1900 MHz Personal Communications Services (PCS) spectrum licenses. Like the TPW in the US, the goal of the policy is to put more spectrum licenses into the hands of Indigenous communities, but this policy approach falls short of realizing spectrum sovereignty in its entirety. This policy can also be contrasted with the DIGITAL Reservations Act, which proposed a greater autonomy to manage spectrum. Like Native Nations in the US, First Nations in Canada have little autonomy to manage spectrum on their lands, which remains centralized with the federal government, and the policies mentioned above would not alter the fundamental structure of spectrum management. In short, the IPW is a step in the right direction, but at its core, it is a colonial policy calling for Indigenous groups to apply to get back some of what was taken from them, without fundamentally redefining authority to manage spectrum.

### 4.3 Indigenous and tribal spectrum sovereignty in New Zealand

The Māori people of New Zealand have made inspiring progress in their fight for spectrum rights. The government of New Zealand ("the Crown"), like the governments of the US, Guatemala, and Canada, relies on markets to allocate spectrum. In 1996, New Zealand became one of the leaders in the movement for markets; yet the Crown government also has a centralized, or monocentric, system of spectrum license allocation. The Ministry of Business performs functions like the FCC in managing auctions. Like the other cases, the Ministry was established without consultation with Indigenous people.

There are similar limitations with liberal licensing in New Zealand as we have discussed in the other cases. In New Zealand, this included conflict over the rights of Māori radio to broadcast. Māori radio was important to transmit language and cultural values and was a response to the imperial system established by treaties between the Māori and the British Crown in the nineteenth century. Hence, Māori broadcasting was a counter-imperial response, one to strengthen Māori language and culture, and a challenge to the perceived limitations with neoliberal regime starting in the 1990s (Hoar, 2019).

Like in other countries, Indigenous people challenged the system that separated their people from their resources.[23] The Māori asserted their rights to spectrum in the Waitangi Tribunal, resulting in the Waitangi Tribunal Report of 1999 which

[23] Radio Spectrum Management and Development Interim Report. 1999. https://forms.justice.govt.nz/search/Documents/WT/wt_DOC_68205379/Radio%20Spectrum%20Interim%20Report%20W.pdf

affirmed that spectrum is a treasured resource (known to the Māori as "Taonga") and, therefore, included in the treaties between the Māori and the government of New Zealand. As a result of the report, in February of 2022, various Māori parties signed a memorandum of understanding with the government that includes the allocation of 20 percent of commercial spectrum to the Māori.

The memorandum of understanding also established a new Māori Spectrum Entity (MSE) to enable Māori participation and development in the telecommunications sector. The understanding is that the MSE will become a formal entity allocated NZD 32 million to establish the organization over the next five years and another NZD 48 million to fund Māori use of spectrum. The plan is then to release 400 MHz of spectrum within the 3.5 GHz band, a quarter of which will be granted to Māori, as well as all unallocated spectrum in the 2100 MHz and 2300 MHz bands allocated to Māori. In addition, the government promises 20 percent of all future commercial spectrum releases will be reserved for Māori. Spectrum was auctioned by the government to telcos by the Ministry of Business until the COVID-19 pandemic. The change introduced a reduced flat rate of roughly $250,000 per 10 MHz; even at that rate, the Māori spectrum allocation will be valued in the tens of millions of dollars (Trafford, 2022).

One of the contemporary challenges to improving tribal relations in New Zealand is that the Māori people were excluded from constitutional processes (Novak, 2023). The movement described above demonstrates that Māori have also been excluded from the spectrum management bureaucracy. These inequities in the formal rules of the game are currently being renegotiated. The central claim, from Māori Tribal entities, is that the 1840 Treaty of Waitangi requires rights to spectrum as a natural resource. This was supported by the Waitangi Tribunal. The plan, with reservation of substantial spectrum for Indigenous Nations and people, makes progress in recognizing the claims to spectrum by Indigenous people, even though the government explicitly states the agreements are non-binding and it disagrees with the findings of the Waitangi Tribunal.

## 5 Polycentric spectrum sovereignty

Indigenous and tribal spectrum sovereignty is an example of a polycentric system of spectrum governance. In this section, we describe the features of polycentric spectrum governance generally. This provides the foundation for analysis of the pros and cons of polycentric spectrum sovereignty in the specific case of Indigenous and tribal spectrum sovereignty in the next section.

According to Ostrom (1990, 2005), polycentric systems of governance have the following features: (1) autonomy of local units to manage resources; (2) multiple levels of rules; (3) methods of determining membership in the relevant decision-making unit; (4) adaptability of rules to changing circumstances; (5) nested governance whereby several levels of governments with different scope of authority manage resources; (6) enforcement decisions made by local units; and (7) reliance on working rules, or rules-in-use, that include informal rules for addressing challenges. This framework has been used to analyze governance amateur radio communities,

**Table 1** Polycentric versus monocentric spectrum management

| Dimension | Polycentric spectrum management | Monocentric spectrum management |
|---|---|---|
| Autonomy of local units | Local units have autonomy to decide how to manage spectrum, including business models | National government determines business model and uses of spectrum |
| Levels of rules | Rules operate on multiple levels | Harmonization of rules through centralization of authority |
| Membership | Local units decide membership in decision-making bodies at the local level | Participation is determined at the national level |
| Adaptability | Local units can adapt rules as they see fit | Changes in rules occur through centralized process |
| Nestedness | Several levels of government with institutionalized mechanisms for coordination | Single government authority that may interact in limited fashion with international spectrum management organizations |
| Enforcement | Decisions on enforcement made by local units | Enforcement by national government agencies |
| Working rules | Reliance on formal and informal rules to adjudicate disputes and manage conflict | Reliance primarily on formal, bureaucratic rules |

which have features of polycentricity: the FCC serves a coordinating and regulatory role, with substantial local autonomy for amateur radio clubs to define rules for members of their community (Bustamante et al., 2023). Table 1 contrasts polycentric and monocentric systems for spectrum management based on these dimensions.

Examples of polycentricity in spectrum management include amateur radio, for the reasons mentioned. Indigenous and tribal spectrum sovereignty is an example of a polycentric system as well. Under such a system, tribal and Native Nations have autonomy to manage spectrum, a significant resource, if they want it. In such a system, multiple levels of rule operate in spectrum management. Tribal governments would determine eligibility for the purposes of their governance. Rules would be subject to change based on the demands of Indigenous peoples, through the processes and procedures they create to manage spectrum. This aspect enables adaptability in response to changing conditions. Indigenous and tribal spectrum sovereignty is also nested, as Indigenous governments coexist within the overarching national regulatory framework, have opportunities to enforce rules as they wish (including determining enforcement actions against radio pirates and any other unauthorized users), and create a framework in which working rules at the local level can enjoy some autonomy. For example, a Native Nation government could create a framework that enables people to work out disputes among community radio users, amateur operators, and individuals who want to broadcast to small audiences.

A polycentric spectrum framework can also inform analysis of the current system of spectrum management. Spectrum management is monocentric from the perspective of Indigenous and Native Nations vis-à-vis national governments (such as Native Nations interacting with the FCC in the US). Governance of spectrum globally is polycentric in that the recommendations of the ITU are adopted and implemented by national bodies. In turn, national regulatory bodies influence the allocation recommendations made by the ITU. Beyond this, many of the rules are worked out by cell phone providers who come to agreements on use of cells to enable expansion of networks (Sandvig, 2004).

There are also gaps in the extent to which it is polycentric. Most notably, there are few opportunities for self-governance beyond the national level. National governments also appear to have the main role in spectrum management. It is not clear that ITU has independent enforcement authority, and it does not have independent authority to set the agenda. Accordingly, the polycentric features could be strengthened by providing more authority to the ITU, as well as more authority to governments that operate below the national level, as well as institutionalizing a greater role for business and nonprofit organizations in spectrum management.

## 6 Economics of Indigenous and tribal spectrum sovereignty

The advantages (or "pros") of polycentric governance include encouraging experimentation, local autonomy, and greater flexibility to address novel challenges. Potential disadvantages (or "cons") include exacerbating coordination issues, declining harmonization, and challenges implementing spectrum policies.

Encouraging experimentation is a potentially significant source of efficiency gains in spectrum management through a more decentralized approach to spectrum management. Experimentation is significant because there are many different technologies available to encourage spectrum sharing as well as many groups that can provide broadband services, including Native- and Indigenous-owned businesses. Tribal autonomy provides such opportunities, as the following example from the US illustrates.

A perceived challenge arising from national control of spectrum in the US is that there may be less opportunity for innovative use of new technologies. Dewayne Hendricks, who initially began working outside of the FCC to encourage innovation in spectrum with activities in the Kingdom of Tonga, located on an archipelago in the South Pacific Ocean, starting in the late 1990s. Later, Hendricks would move back to the US, collaborating with Native Nations to deploy innovative technologies to improve broadband access, and tried to address this issue (Hurtig, 2002). It is an interesting story that illustrates the possibilities when Native Nations have autonomy to manage and collaborate regarding innovation in spectrum management as they see fit.

Hendricks pushed the idea of Wi-Fi for everyone, criticizing experts who say congestion and interference in unlicensed spectrum prevent Wi-Fi networks from scaling up successfully. He pointed to the Wireless Broadband Access Network Coordination organization, which brought together 50 wireless internet service providers to prevent congestion and interference, as an example of the possibility of such scaling up through a bottom-up process. The goals of these initiatives include free Wi-Fi networks at the county level and, eventually, a Wi-Fi cloud over the entire state for use by anyone (Hurtig, 2002). Impressed with his work, the FCC invited him to sit on their Technological Advisory Council. When the Tonga project fell apart, he turned to the FCC initiative to improve telecommunications in Indian country, partnering with the Turtle Mountain Band of Chippewa's reservation to devise new ways to manage spectrum (Miller & Guzelian, 2003).

The story above should be interpreted with care. Hendricks had specific ideas that he thought the Tribes would be interested in and prioritized their buy-in for any specific implementations of technology to improve spectrum management. He suspected a spectrum commons would spur new technology and, perhaps, a more effective use of the airwaves. Over time, he thought that this vision would encompass much of the radio spectrum. The key, he suspected, was to use technologies that exist or can be fast tracked to close the digital divide. The problems he saw was that government may not be as interested in trying new practices. The governing bodies give too much consideration of interference (the white space problem demonstrates a kind of over-emphasis on interference problems that reduces spectrum for others) and reserve too much spectrum for groups for exclusive use (exclusivity is prioritized over creating sharing systems). These problems leave too little spectrum to support wireless broadband. The government restricts technologies like spread spectrum, ultrawideband, and cognitive radios that would enable everyone to share frequencies (Jonietz, 2002).

This example suggests the promise of polycentric spectrum management. The Turtle Mountain Band of Chippewa Reservation, which is in the present-day state

of North Dakota, provided an opportunity for the Tribe to experiment. Hendricks set up a wireless network, meeting FCC requirements governing frequency, power, and transmission, which he created through consultation with what was considered the best approach for the Turtle Mountain Band of Chippewa. Indigenous and tribal spectrum sovereignty seeks to institutionalize and amplify these sorts of opportunities, as they represent—on a limited scale—the value of collaborative experimentation on Tribal lands.

These experiments with spectrum technologies will not always benefit society, as some may not work. But the value of experiments is not that all work, but that experiments that do not work are useful information, or knowledge, that contributes to progress in ideas about spectrum management. What the example just discussed shows is that the FCC is not the only government entity that can encourage (or stifle) innovation in spectrum management.

Consideration of government failures in spectrum management can also be considered as part of the efficiency considerations with Indigenous and tribal spectrum sovereignty. Tribal governments and Indigenous communities may be less subject to rent-seeking than what occurs over national spectrum policy because Native Nations are predominantly rural areas, and the stakes may be lower because researchers are experimenting with licenses that are considered "less valuable" by the FCC but that are highly valued by tribes, especially those willing to innovate.

The potential efficiencies above should be weighed against the costs of implementing Indigenous and tribal spectrum sovereignty. One aspect of implementation involves coordination challenges that may arise with more autonomous units with authority to manage spectrum. To the extent that Indigenous and tribal spectrum sovereignty involves greater autonomy—and hence responsibility—to manage spectrum, Native Nations become, in essence, like the FCC (or a mini-FCC). Native Nations, because they are sovereign, would have the ability to allocate and assign property rights to spectrum, including the autonomy to make decisions about commercial and non-commercial use. Two issues related to implementation that are especially significant: coordination issues arising under greater autonomy for Indigenous and Native Nations and questions about capacity of tribal governments.

Any implementation of Indigenous and tribal spectrum sovereignty would require, to some extent, coordination among Native Nations and national governments. In the US, this could potentially involve coordination among 574 federally recognized tribes and the FCC. Coordination in the allocative functions is largely addressed internationally and is achieved at the ITU, a specialized agency of the United Nations. But coordination can also be accomplished by telecommunications companies directly, as they do, for example, in unlicensed bands. But spectrum sovereignty does not envision atomistic Tribes without overarching authority. Rather, it is a vision of polycentric governance. The DIGITAL Reservations Act does not seek to abolish the FCC. Spectrum sovereignty envisions Tribal governments as a significant source of innovation in spectrum. This reflects the ongoing problem of national governments generally establishing a framework that continues to define the national government as the dominant force over Tribes (Blackhawk, 2018).

This may not pose as much of an issue as it may seem. In the US, there is already substantial coordination between the federal government with Tribal and Indigenous

nations. There are many organizations of Tribes, including regional organizations, that constitute ongoing sources of heterarchical relations that contribute to Tribal collective action. There are dozens of regional Tribal organizations, as well as national organizations, which serve as points of coordination of Tribal governments as well as a forum to coordinate relations among Tribes and the US government.

The experience of SpaceX with Native Nations offers some insight into how such coordination might occur. SpaceX's Starlink beams internet to users through its constellation of low earth orbit satellites (these are known as "megaconstellations"). Starlink hoped for eligibility to tap the FCC Rural Digital Opportunity Fund by providing service to the southwestern Indian lands. The Affiliated Tribes of Northwest Indians (ATNA) wrote to the FCC explaining that they were not consulted in the process and that once Starlink accesses funds, Tribes will be prevented from doing so because they will be considered funded. ATNA raised several issues, including steep up-front costs and high monthly rates and gaps in bandwidth available for customers. Though SpaceX and the FCC collaborated on subsidies, another issue is whether Tribes offer access to spectrum, which SpaceX promised to do. In this regard, SpaceX recognizes several of the key aspects of spectrum sovereignty, including consent and autonomy of tribes to decide how to address issues with spectrum access on tribal lands.[24]

Indigenous and Native Nations and tribal Capacity issues for some tribal governments are also a significant consideration because some Native Nations may be overwhelmed by funding and staff and time commitment spectrum management requires. One possibility is for national governments to manage spectrum, but to distribute the benefits from spectrum to the respective tribal governments in ways that the tribes have guaranteed rights to spectrum. This is, perhaps, exemplified by the approach the New Zealand government is taking with new commercial spectrum. Since Native Nations have their own governments, they could also assume more authority over spectrum if they want it, though such initiatives might require additional support to improve the capacity to manage spectrum.

A comparative economic analysis might be informed by consideration of set-aside spectrum. Spectrum set asides assign spectrum for exclusive use by industry. The goals may include promoting public use of a resource by encouraging competition. There is no single approach to set asides, and different countries have implemented set asides in many ways.

Set-aside spectrum in the EU for 5G networks offer additional insight into how to assess the efficiency on Indigenous and tribal spectrum sovereignty. The European Union (EU) promotes harmonization of radio spectrum for wireless connections across

[24] Starlink's efforts to provide tribal lands broadband received substantial news coverage, including in *PC Magazine* ("Native American Tribe Gets Early Access to SpaceX's Starlink and Says It's Fast," October 8, 2020); *Newsweek* ("SpaceX Starlink Internet 'Catapulted Us Into the 21st Century,' Native American Tribe Says," October 9, 2020); and *Futurism* ("SpaceX Gives Native American Tribe Early Access to Starlink Internet," October 14, 2020). Though there may have been some hype in these headlines, what is clear is that Musk's company engaged with Native Nations in the process and Starlink believed that addressing the tribal broadband gap was a significant benefit from the Starlink megaconstellation of satellites.

borders, particularly for 5G networks. Governance consists of public policies and cross-border coordination through organizations of Member States, as well as participation in the ITU. 5G requires sufficient access to spectrum in certain bands to ensure performance and coverage, especially the 3.4–3.8 GHz band (Robles-Carrillo, 2021). Harmonization provides similar standards and relies on auctions to allocate spectrum. Set-asides, which vary by country in terms of specific designs, provide for localized licensing agreements that allow stakeholders to manage their own 5G networks. The pros of set-asides include localized control, more targeted implementation of 5G with potential to address specific needs of particular sectors, and perhaps greater security and coverage, while the challenges include efficiency concerns in moving away from market-based allocations, reduced competition in the broader market, presence of alternatives (including use of the national licensing regime, unlicensed spectrum, and spectrum leasing), and evidence from other Member States that sharing spectrum, rather than set-asides, are workable solutions for the demands of cell providers (Kuś Massaro, 2022). Set asides may lead to higher prices for consumers, thereby reducing social welfare, and from a dynamic perspective, contribute to less efficient use of spectrum resources.

Indigenous and tribal spectrum sovereignty has features like set-aside spectrum, as both set-asides and spectrum sovereignty for Native Nations depart from a harmonized, market-based system to allocate spectrum as exemplified by the FCC regime in the US. For this reason, many of the pros and cons mentioned above could be used to analyze Indigenous and tribal spectrum sovereignty. Perhaps most significantly, reliance on national licensing, unlicensed spectrum, and spectrum leasing are alternatives. In the US, the FCC has focused on these alternatives. Potential discussions of the cons of Indigenous and tribal spectrum sovereignty include increased costs for consumers on Tribal lands, as well as the general issue that in moving from a harmonized, market-based system, there may be efficiency losses.

Recent research on spectrum use in New Zealand offers further insight into comparative analysis along the lines of studies of set-asides. Howell and Tang's (2023) analysis of the Indigenous spectrum sovereignty movement in New Zealand asks the question of whether setting aside spectrum for Indigenous communities is putting spectrum to its highest-value use. Howell and Tang (2023) argue that the economic value of tribal spectrum control might not be as great as perceived because, while the policy of allocating spectrum to the Māori Spectrum Entity fulfills legal treaty obligations and transfers wealth and control from the Crown to the tribal entity, a tribal entity that receives spectrum at no cost may not have the same economic incentives as industry parties participating in auctions. They suggest that meeting legal obligations may not necessarily align with meeting economic objectives, potentially compromising the efficient deployment of the spectrum. Each Indigenous and tribal spectrum sovereignty movement provides an opportunity for such analysis.

## 7 Conclusion

The core message of our study is that prevailing market-oriented systems of spectrum management are monocentric and that there are both equity and efficiency rationales for moving in the direction of polycentric spectrum management. One

of the shared features of these movements is effort to improve equity of access to spectrum within the monocentric regime. There is not a single path toward doing so. In the US and Canada, national regulatory bodies have established windows that increase access of Indigenous and tribal people to spectrum. New Zealand's spectrum authority has set aside spectrum for Indigenous communities. In Guatemala, efforts have focused on establishing more robust opportunities for community radio managed by indigenous people. These efforts, by institutionalizing sharing of spectrum with Indigenous and tribal communities, each constitute a move toward polycentricity because they provide for greater access to spectrum.

The US movement suggests an even greater opportunity to decentralize spectrum. One of the features that is rather unique to the US movement for spectrum sovereignty is its emphasis on reconsidering the metapolitical authority over spectrum. The specific way to do so would be for Native Nations to have the authority to opt into the FCC system or to manage spectrum themselves.

Decentralizing authority over spectrum would constitute meaningful progress in realizing the vision of a truly polycentric system of spectrum management, one in which Indigenous and Native Nations, as well as other business and nonprofit organizations, have greater autonomy over decisions about spectrum management and use.

Indigenous and tribal spectrum sovereignty, if realized, could advance the goal of a truly polycentric system of spectrum management across the globe. The ITU plus national governments is a start, but much more is necessary for the system to be truly polycentric. One important gap is that national governments are the "most local" units. What Indigenous and tribal spectrum sovereignty movements show is that there are opportunities to include another level of spectrum governance in the spectrum management regime. This vision of polycentric spectrum governance includes the ITU in a coordination role, with national governments and a layer of decision-making bodies below the national governments, as well as the potential for regional spectrum management organizations and management by private and nonprofit entities.

The central efficiency justifications for polycentrism are that experimentation and hence innovation may improve. There are also challenges. Coordination problems would have to be overcome. Nonetheless, there are good reasons to consider ways to encourage experimentation with spectrum. Current approaches to decentralizing spectrum point to opportunities for transmitters to develop their own rules to govern use of spectrum, which has been referred to as spectrum anarchy (Bustamante et al., 2020). Spectrum anarchy seeks improvements in spectrum management in the monocentric system. Indigenous and tribal spectrum sovereignty seeks autonomy to make these decisions locally. In that way, it is an even more radical idea than spectrum anarchy, but also one that recognizes that any use of spectrum may benefit from government regulation. Spectrum sovereignty is a new idea in that the national government is not the only game in town.

There is also powerful normative justification based on tribal sovereignty as a justification for return of rights over spectrum as a natural resource (Blackwater, 2020). For example, Māori spectrum rights are justified in part by previous treaties with the British Crown that recognized Indigenous rights over natural resources on

tribal lands. More generally, one of the equity rationales for Indigenous and tribal spectrum sovereignty is that Tribes will receive a valuable resource through spectrum sovereignty. Our analysis points to ways to improve equity in spectrum management. We also emphasize that greater autonomy for Native Nations to manage spectrum may create opportunities for efficiency through innovation, as well as provide a framework to consider some of the potential challenges to efficiency arising from decentralizing spectrum authority.

Coase, who lived beyond 100 years, made numerous contributions across various fields throughout his long life. Eventually, Coase's ideas about the virtues of competitive markets to allocate spectrum became the standard practice. Much good eventually came from these ideas, but they were a long time coming. We see similar parallels with Indigenous and tribal spectrum sovereignty. It is easy to point to challenges with a major rethinking of how spectrum is managed, such as by potential coordination issues among Indigenous and tribal governments. One could easily assert that hundreds of governments asserting sovereignty would result in chaos—a sort of political anticommons, where rights are fragmented; one could easily imagine that sovereignty would be seen as interfering with the dynamic, market-based allocation of spectrum and, hence, interfering with the internet and affecting all aspects of business. The wins of the liberal licensing regime—we have more spectrum than ever before—should not distract from the fact that none of the countries considered have legislated autonomy to Indigenous Nations to manage their spectrum. Just as Coase's ideas took a long time to become policy, spectrum sovereignty is likely to require time to change the vision. What is clear is that there is a powerful rationale for it, not just an economic one, but one based on equity, social justice, and legal rights.

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