On DeWi Unit Economics

Decentralized Wireless. You might see those words as an inherent contradiction. When three US companies combine for 400K+ employees, $400B+ of debt, and $300B+ in annual revenues… When a quarter of the global telecom industry is government-owned… When wireless spectrum auctions are attended by a few dozen bidders, at best… Decentralized? Not so much.

But outside the legacy telecom industry, a few bold entrepreneurs are using crypto-incentives to create a new paradigm for wireless networking: DeWi. Now, if you've spent time with venture capitalists, the words *new paradigm* might invoke feelings similar to those of Herb Allen in 1999, when someone asked for his opinion on the "new paradigm" for valuing technology stocks.

> *"New paradigm…? It's like new sex. There just isn't any such thing."*
> *— Herb Allen, Founder of Allen & Co*

Herb may have been right about *new* sex, but there is a such thing as *better* sex. And as clearly you or I can tell the difference between good sex and better sex, we're convinced that today's telecom industry - a good business - is an unsatisfying substitute for decentralized wireless - a much better business.

Telecom Is a Good Business

All figures refer to combined full-year 2021 results for the top 3 US telcos (ATT + VZ + TMUS).

In the US, the telco industry owns $265B of productive physical assets, such as radios, base stations, and some towers. You might ask - *how productive are these assets?* With $265B worth, telcos generate $315B of annual service revenues. In other words, productive asset turnover is 1.2x. Not bad!

How efficiently are the assets managed? Telcos spend 30-35 cents in input costs - rent on tower space and employee wages - to generate every $1 of revenue. In other words, It's a 65-70% gross margin business.

They also need to operate the mothership. Operating $265B of physical assets is a lot of work—enough work to keep 400K employees busy. Managing the recruiting, payroll, benefits, offices, and coordination of such a large employee base is not cheap. As a result, even with massive scale, the telco industry spends 25-30 cents of every revenue dollar on the mothership (SG&A). After deducting 30-35 cents of input costs and 25-30 cents of operating expenses, US telecom networks are a 40% EBITDA margin business… not bad!

Lastly, how are the assets financed? The telecom industry is a darling of fixed income markets. For one, it's remarkably stable: telcos have a 30+ year operating history of resiliency, with revenues falling sub-3% peak-to-trough during the financial crisis and sub-13% through COVID. Second, the lending opportunity is too big to ignore: telcos represent 5%+ of the entire US corporate debt market (enough to make many, many bankers rich). Given the size and stability of the telco industry, lenders are willing to finance $265B of productive physical assets with more than $400B of debt, at a blended average cost of debt below 3.5%.

Now, you might be thinking — a good business? Telco sounds like an INCREDIBLE business. For every dollar of productive assets, you generate $1.20 in annual revenue and almost $0.50 in EBITDA. You could equity-finance the entire business and still get paid back in 2 years! On top of that, lenders are willing to finance most or all of the business with cheap debt.

Unfortunately for investors, that's not the full story. Telecom networks have no issue *generating* cash flows - they are cash-printing machines with $100B+ of annual operating cash flows - but it's the *distribution* of cash flows that drives

investor returns. And before investors see a dollar of cash flow, telecom networks have a few important mouths to feed.

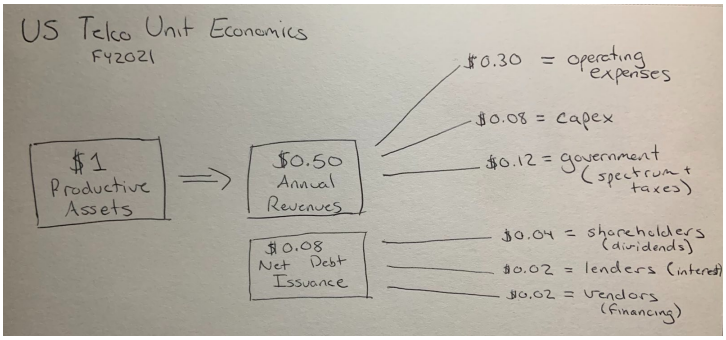
The Governments

The first and hungriest mouth to feed: governments. The US Radio Act of 1927 created the FCC after a surge in number of AM/FM radio stations, endowing the FCC with the power to allocate wireless spectrum licenses “based on the public interest”. Since then, global governments have assumed near-total control of spectrum via an auction licensing system where they control floor prices, auction rules, and bidders. By doing so, governments effectively grant themselves a preferred equity claim on telecom cash flows. These preferred claims are, of course, senior to the claims of common shareholders. The US federal government collected $80B+ of spectrum proceeds from the top three telcos in 2021, which is more than triple what the industry returned to shareholders during the same period (via dividends, which were then taxed even further). Telcos generate 2.4%+ of the entire federal government’s revenues, so this “preferred security” has real value for Uncle Sam — we don’t expect them to give it up anytime soon.

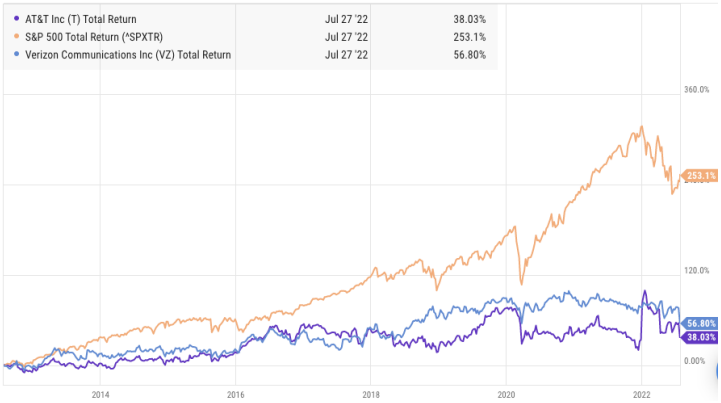
What does this mean for investors? Recall the $265B of productive *physical* assets. The industry’s balance sheet also holds $350B of spectrum licenses. This makes the business a hell of a lot more capital intensive: instead of generating $1.20 in annual revenues for every dollar of productive assets, the telecom business now generates a mere $0.50. And after a 40% EBITDA margin, it generates only $0.20 of operating earnings (vs $0.48 before). Then, hardware deteriorates every year, which causes the industry to re-invest to the tune of $0.08 to maintain the network’s value. So now, we have an industry that generates $0.12 of *sustainable* cash flows annually for every $1 of productive assets on the balance sheet.

Guess how much the industry paid the US government for spectrum licenses in 2021?
You got it: $0.12.

US telcos face a tough conundrum: how do you keep shareholders happy - shareholders whose income depends on the stability of the dividend - when the government takes all of your excess cash flow? The solution: borrow money and pay it out as dividends.



This is - as they say - not a drill. It’s the reality of the industry in 2021. Telecom networks generated $125B of EBITDA, of which $95B was paid out to the US government in the form of spectrum and taxes. Another $50B was re-invested to maintain the value of the physical networking equipment (primarily deploying 5G). The $20B deficit, as well as $26B of dividends, were entirely funded by net debt issuances. US telecom networks are indeed an incredible businesses… just not for investors.



Indexed 10-Yr Total Shareholder Return. Source: YCharts

Note: the counter-argument to this view is "sure, the government sits above you in the cap table and so the upside is capped… but we're downside-protected because they'll never let it go bankrupt!" This is sort of true - we doubt the government would let a top-3 carrier fail. But we think it's misguided as investment advice: there are better ways to play the Greenspan Put. We recommend buying Bitcoin.

The Landlords

It's not just governments who get fed before telco shareholders. Landlords do too.

Remember the $265B of radios and base stations? All that hardware needs to go *somewhere* — and not just anywhere, but in specific locations that are conducive to providing useful coverage. There are two major levers for *useful* coverage: 1) placing hardware close to major population centers, and 2) placing hardware on high surfaces, to facilitate a direct line of sight wherever possible. The best way to achieve these goals: cell phone towers.

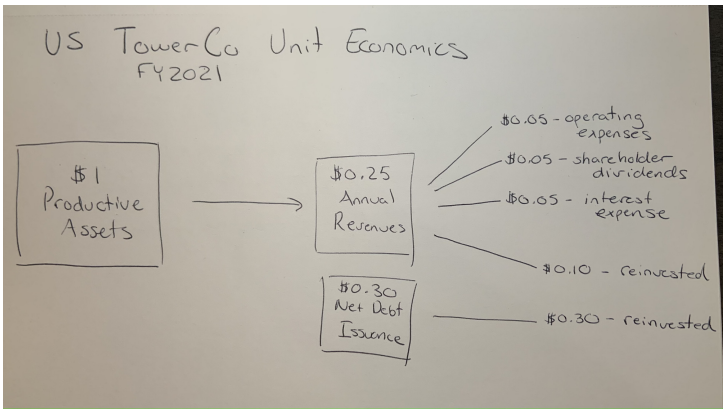
There are 415K+ cell phone towers across the US, which nets out to roughly one tower every 9 square miles. To quickly summarize the unit economics: it costs $250K to build, it earns around $60K in annual rent, and lasts about 20 years. Since telcos provide all the labor and equipment, tower businesses operate at 80% EBITDA margins. Assuming a 20% tax rate, a tower investor might earn a 14% unlevered IRR with low-to-moderate risk.

Why are risk-adjusted returns so attractive? Because towers have a defensible moat: location. Most towers were originally built in the 80's and 90's, before regional zoning laws. These towers would *never* be approved under today's zoning laws, which effectively prevents new entrants. More importantly, it gives tower companies significant pricing power over telcos. Telcos can and sometimes do build their own towers, but the unit economics of single-tenant vs multi-tenant are not compelling (for example, see Crown Castle Q2'22 yields in markets with co-located towers on page 6).

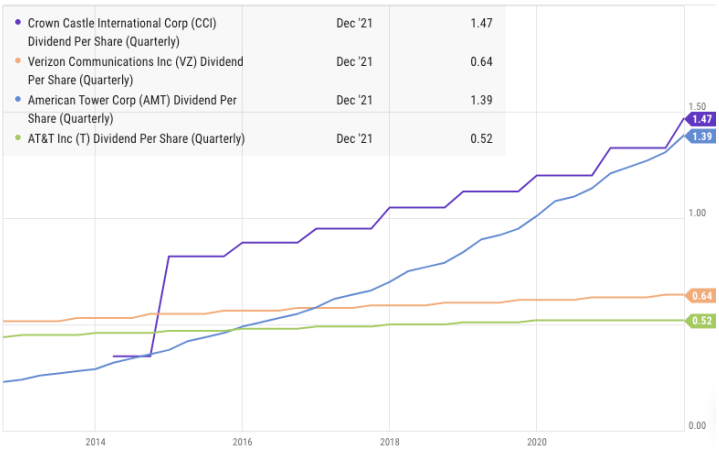
Historically, every 8-10 years telcos deploy a new generation of networking hardware to support increased demand for data transfer. They spent $125B to deploy 2G, $200B on 3G, $325B on 4G, and have spent $225B to date deploying 5G networks. In every wave, tower companies renegotiate rent with telcos, with a lot of leverage on their side. You can see this pricing power at work at Crown Castle, where the book value yield on their tower portfolio has increased from 3% to 11.5% over time (note: three quarters of Crown Castle's revenue comes from the top 3 telcos).

Markets have wisened up to the latent pricing power in towers over the past few years, with valuations increasing from 5-10x book value multiples to 10-15x. In other words, the market assigns $2.5M+ of equity value to a tower that costs $250K to build. This drives a 14% (unlevered) asset yield down to the 2-3% (levered) earnings yield currently paid by tower REITs.

How should long-term investors think about the tower business vis-a-vis the telco business? Remember the telco business: for every $1 of productive assets, it generates $0.50 of revenue and $0.20 of operating earnings. It re-invests $0.08 back into the network, and hands the government the final $0.12. If it needs to pays dividends, it issues new debt. But what about the tower business?



Every $1 of productive assets generates $0.25 of revenue and $0.20 of operating earnings. It returns a bit more than a nickel to shareholders and pays a bit less than a nickel of interest expense. The remaining $0.10 gets re-invested into the business, earning high rates of return. On top of that, it borrows an additional $0.30, at a cost of debt below 3%, to re-invest into the business even further. That is why tower companies' per-share dividend grows at a 7-8% CAGR, while network operators' only grows 2%.



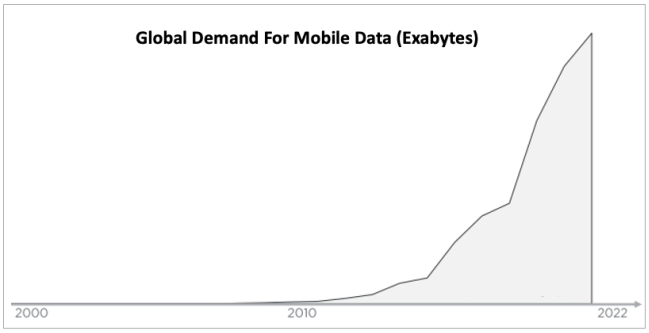
Quarterly per-share dividends paid by US tower REITs (blue/purple) vs network operators (orange/green) from 2012 to 2021. Source: YCharts.

Investment Perspectives

Early-stage thesis-driven investing is risky. In order to reduce risk, the best investors focus on *inevitable* trends. I first heard this from Josh Wolfe, who talks about investing behind directional arrows of progress at Lux. For example, his *Half Life of Technology Intimacy* thesis points out that, in every iteration of mass computing products (mainframe → desktops → laptops → mobile → smartwatches → implants), humans interact with the technology in more physically intimate ways. Similarly, at Ribbit, not a week went by without Micky reminding us of the inevitable trend of software-powered fintech (<$1T market cap) eating the global financial services industry (>$15T market cap).

Whether they label it or not, I think most capital allocators believe in mega-trends that are ultimately reflected in their portfolios. One trend is demographics: developed countries' birth rates are quickly converging to mortality rates, while African and Asian countries expect explosive population growth over the coming decades. Another mega-trend is de-globalization: as citizens of developed countries begin feeling the impacts of climate change on their everyday lives, interactions between nation states become increasingly adversarial as each side seeks to protect the interests of their (wealthy and/or influential) citizens.

But there's one trend we think trumps them all: The Internet. We grew up with internet friends, an internet education, and, eventually, internet money. Since the time Mahesh and I had our first cell phones - mine was a red Motorola Razr circa 2005 - per capita demand for mobile data increased by a factor of more than 300x. And the growth curve is barely flattening.



Source: Crown Castle Q2'22 Earnings

We don't have an edge in predicting whether metaverse, or autonomous vehicles, or smart cities, or blockchain games, or internet-of-things, or something else will be the next digital app that scales to billions of users. But we *are* smart enough to see that whatever killer use case emerges will require *unprecedented* amounts of data. So the question becomes: what asset is the most asymmetrically-levered to global internet usage?

Well, to state the obvious, we could buy telecom businesses. The good news is, they're relatively cheap, pay a 6-8% dividend, and the underlying businesses are cash-generating behemoths. The bad news, of course, is that shareholders are last in line to get paid. Even if mobile data traffic compounds at 25%+ for the next decade, Uncle Sam and the landlords hold all the pricing power, and they have no issue leaving telco shareholders and creditors to fight for scraps (a battle which tends to favor creditors, over a long enough time horizon). We're not big fans of telco stocks.

Instead, we could buy tower businesses. They have proven pricing power and high returns on invested capital. The bad news is that these assets are, generally speaking, priced to perfection. At 2-3% earnings yields and with huge growth expectations already priced in, it's hard to see asymmetric upside in the tower business (although it wouldn't surprise us if a few shrewd investors generate strong risk-adjusted returns in the private markets). But we don't care about near-term dividends, so we're probably better off owning Google or Meta at a 5-8% earnings yield vs a tower business at 2-3%. Unfortunately, at the current combined market cap of $2T, it's tough to see a path to clearing 10x+ returns hurdles owning the equity of tech giants.

What if we could design our dream asset? What would it look like? Remember, what we want is an *index on global data transfer* (i.e., internet usage). Our dream asset would put investors pari-passu with landlords, rather than at the bottom of the proverbial preference stack. It would use spectrum more efficiently, reducing capital intensity while keeping Uncle Sam happy. It would align the incentives of all stakeholders behind a single asset, doing away with rent-seeking dynamics and making the network more efficient as a whole. For every byte of data transferred over the network, everyone becomes a tiny bit richer, in the same proportion. In other words, we want to own ***tokenized bandwidth***.

DeWi Is A Better Business

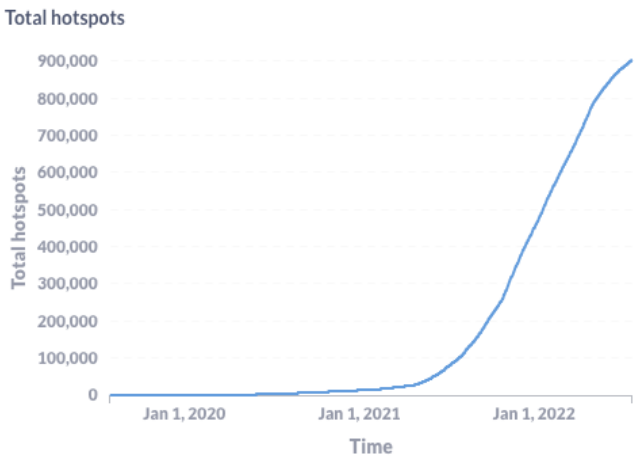
Indulge us for a minute, and imagine a telecommunications industry built with extreme *incentive-alignment* and *interoperability*. What qualities would the industry have?

No Landlords

Location is the moat that allows tower operators to extract excess rents from the telco networks while doing none of the work of acquiring, installing, and maintaining the equipment.

DeWi networks are nothing more than open-source software protocols. They have no ability to install or maintain physical equipment. Instead, the responsibility falls to independent third-parties called *miners.* Miners have an economic relationships with landlords that is much different than traditional telcos.

Before we get there, it's helpful to distinguish between different types of deployments. In general, DeWi networks face a tradeoff between ease of deployment and data transfer capacity. At one end of the spectrum, retail deployments (e.g., a LoRa hotspot in someone's apartment window) can be made simple enough to pass the proverbial "grandma test". They tend to be relatively inexpensive, on the order a few hundred dollars. When combined with token incentives, the low-cost and low-mental overhead can drive extreme viral growth. For example, the number of deployments on Helium's LoRa network grew by a factor of more than 30x in 2021. The downside is a relative lack of data transfer capacity: LoRa hotspots have a maximum data transfer rate of 30-50 kbps.

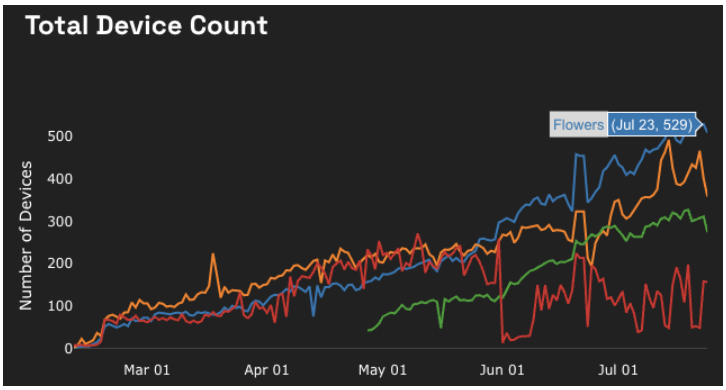


Total LoRa hotspots on Helium. Source: ETL

At the other end of the spectrum are institutional deployments. These deployments require human and financial capital beyond the reach of a casual retail project. Let's use cellular small cells as an example, which are well-suited for placement on rooftops, billboards, water tank, street lights, and other physical infrastructure. High-quality deployments can incur $10K in up-front costs plus an additional $5K in annual rent and operating expenses. There are regulatory burdens to comply with the more than 30 state-by-state small cell regulations. Lastly, there's significant complexity in the planning, installation, maintenance, and optimization of large fleets. It's not for the faint of heart. But we believe that - with the right team and strategy - a few companies will build multi-billion dollar institutional mining businesses with significant moats.

Hexagon Wireless, a team who we are proud to call our partners, recently deployed a small cell node on the 6th-highest building in Salt Lake City, creating over 7 miles of cellular coverage. These nodes are capable of handling a 200-250 mbps, so while costs are 1-2 orders of magnitude higher than retail deployments, it is more-than-offset by a 3-4 orders of magnitude increase in data transfer capacity.

For networks, however, the real tradeoff is slower growth: the added complexity and costs of institutional deployments produces a network growth curve that is more linear than quadratic.



Total Pollen outdoor small-cell nodes. Source: Pollen Mobile Explorer

To summarize: there are retail deployments with a few hundred dollars or less in up-front costs, low or zero operating costs, and weak data transfer capabilities, but with the potential for quadratic growth. Then, there are institutional deployments with significant up-front and ongoing operating costs, strong data transfer capabilities, but with linear growth trajectories. Now that the tradeoffs between the two are clear, we can better explain the economic dynamics of landlords in DeWi.

For retail deployments the relationship is obvious: the property owner and the miner are the same economic actor. In these cases, we can think of mining revenues as flowing straight to the bottom line of the network, since there is zero incremental rent or operating expenses incurred.

For institutional deployments, the relationship is less obvious. Most still incur rent expenses to a third-party landlord. However, we believe that property owners in DeWi will be more open to revenue-sharing agreements, i.e. they will accept reduced fiat-denominated fixed rents in exchange for a percentage of token-denominated variable mining rewards, than in the legacy telco industry. They'll do this because, unlike in TradWi, *landlords can see exactly how much value the hardware on their property is generating.*

This is the how the industry works today: tower companies negotiate with telcos on a master-services basis, meaning telcos pay the same rent for a tower in Central Park as they do in central Missouri. When tower companies demand rent increases, they apply it across the entire portfolio. Obviously, some towers provide more valuable coverage than others, and tower companies are theoretically incentivized to price-discriminate to earn more of the economics. But negotiating rent on a location-by-location basis is too cumbersome given the 415K+ towers across the US. On top of that, there's an information asymmetry: tower companies have a rough estimate based on population size and urbanization rate, but telcos know the exact data transfer through the equipment at a specific location. If a tower company were to approach a network operator and say, "hey, you can reduce your cash rent, but pay me a fraction of a penny for every byte that moves through one of my towers", they would be at a structural negotiating disadvantage.

In DeWi networks, usage and rewards data is readily available on-chain on a device-by-device basis. Every piece of hardware is represented on-chain by an NFT, linked to a private key stored in the hardware's secure element. Once a device is connected on-chain, smart contracts can programmatically split revenue-share payments out of a tenant's mining rewards, without funds ever hitting the tenant's wallet and risking non-payment. More importantly, there's no information asymmetry, so landlords are no longer at a negotiating disadvantage. Everyone knows which properties are more valuable, in data transfer terms, than others. If I own a tower in a high-quality location with rapid growth in data transfer volumes, of course I'd want to earn a portion of my cash flows indexed to that growth. I still don't want to do any of the operational work which could - god forbid - threaten my 80% EBITDA margin and 25x EBITDA multiple.

But when a DeWi miner comes knocking at my door, asking to pay half of their rent in cash and the rest via revenue-sharing from the mining rewards earned on *my specific towers*, it's a no-brainer. In fact, companies like Hexagon Wireless are already operating DeWi deployments on towers, with profitable unit economics to boot.

So, at one end of the spectrum (pun intended) exist retail DeWi deployments, where rent is being explicitly taken out of the network and "replaced" with an incentive-aligned tokenholder. At the other end of the spectrum exist institutional DeWi deployments, where there is partial replacement of rent with incentive-aligned revenue-share agreements.

The true unlock in both cases is providing better price discovery for landlords. By connecting hardware to a decentralized blockchain, landlords are able to trustlessly verify the volume of data transfer flowing through their specific property, and therefore to understand the value of their property. It transforms those who would have otherwise been landlords (demanding fixed $ rents) into partially- or fully-aligned stakeholders (demanding token/equity dilution).

Hence, the first maxim of DeWi: No Landlords.

No Wasted Spectrum.

This section is bound to ruffle some feathers, so let's start with a few facts:

- Governments effectively own a class of preferred shares in telecom networks which allows them to divert cash flows into their coffers via spectrum auctions. This is true in the US, where the industry is owned entirely by public shareholders, as well as in markets like China/Russia/UAE, where telecom networks are majority-owned by the government. Spectrum auctions have added $250B+ to the US treasury.
- In 2015, under Commissioner Ajit Pai, the FCC allocated a band of spectrum for public use between 3550-3700 MHz called *Citizens Broadband Radio Service* or *CBRS*. Despite its namesake, CBRS is only partially democratic: there is tiered access, with strict control over usage. If you're interested to learn more about CBRS, read the callout below. TL;DR is:
    - 1) Due to its usage in US Naval radar systems, CBRS is heavily policed under close supervision by the FCC.
    - 2) DeWi networks currently operate in the lowest tier of CBRS access, which means they are susceptible to interference from other tiers.
    - 3) There is a huge amount of regulatory overhead in CBRS. The FCC works closely with only 4-6 parties who are responsible for policing the band.

▼ *Sidebar: details on CBRS access tiers. Skip this section if you're already familiar.*

💡 First in line is the US government. More specifically, the US Navy, whose standard-issue air traffic control radar system, the AN/SPN-43, relies on the 3550-3650 MHz band of spectrum. In order to protect the Navy's access to this critical band, anyone using CBRS spectrum must register with a SAS, or System Access Administrator.

Becoming a SAS is not trivial. First, you need to build a network of coastal sensors that detect when Navy ships are nearby. It doesn't take many sensors - only a handful per coastal state - but they need to be very reliable. Unfortunately, deploying the sensor network is the easy part; then comes the slew of government approvals. First, you need approval from the Wireless Telecommunications Bureau, which is itself made up of five different divisions. Then, the Office of Engineering and Technology. Finally, you need the blessing of both the National Telecommunications and Information Administration, a division of the Department of Commerce, as well as the Department of Defense. Only four companies have successfully jumped through all four hoops: two public companies (Google & Commscope), one telecom startup with $150M+ of capital raised (Federated Wireless), and a three-person government consultancy based in McLean (Key Bridge).

In short, in order to become a SAS you need deep pockets, deep relationships, and lots of patience… if you don't have at least 2 of the 3, you don't stand a chance.

💡 Second in line are holders of Priority Access Licenses (PALs). In July 2020, the FCC made $4.5B by auctioning off 20K+ such licenses to 250+ bidders (top bidders: Verizon & Dish). However, very few are actually in use. Each license represents a 10-year renewable claim to a 10-MHz channel within a certain county, and can range from $0.10-0.20 up to $0.50-0.70 per MHz-PoP, depending on density and demographics of an area. Licenses can be sold in the secondary markets via brokers or even leased off to third parties, but all trades and leases must be reported by the SAS to the FCC on a daily basis.

💡 **Finally - assuming there are no Navy radars or active PAL-holders around - the CBRS band is available for public use. This is where DeWi networks operate today.** There are, however, significant limitations to operating on CBRS spectrum. In addition to the interference from higher tiers, there is a maximum EIRP power limit of 47 dBm/10 MHz. The telco industry is pushing for higher limits (72 dBm/10 MHz), but such an effort can take years even with significant lobbying and incumbent support.

To a crypto-skeptic, these facts support an obvious conclusion: the US government will never allow a DeWi network to reach scale. There's no chance the US government watches helplessly while a crypto-network eliminates 1/40th of its revenue base. And given the heavy-handed regulation of CBRS, there are many ways for the government to stop DeWi from succeeding (or, at least, to prolong its success indefinitely).

To a crypto-maxi, the same facts support the opposite conclusion: DeWi networks will beat legacy networks over time, because they don't need to abide by the regulatory red tape and high spectrum costs that holds back the legacy system.

We think the truth is nuanced, and requires some pragmatism on the side of DeWi networks. It's unlikely, in our view, that the US government allows DeWi networks to outcompete an industry that provides 2.4% of its revenues, at least not without taking a similar cut. Therefore, we urge the founders of DeWi networks: from the start, allocate a portion of fully-diluted token supply for future government demands. Call it whatever you like - "spectrum", "bribes", "taxes", "lobbying" - but know that eventually, governments will want their piece of the pie. It's better to plan for this up-front, rather than be forced to change monetary policy down the line and destroy trust in the network's currency. In fact, we think the best DeWi networks will use token allocations for spectrum as a competitive advantage: for example, by using treasury funds to acquire Priority Access Licenses in key geographies before competitors.

If DeWi networks have to pay the government for spectrum, how is it any different from a legacy telcos?

The difference is extreme interoperability, which drives more efficient markets for licenses. The FCC sold 20K+ CBRS licenses in 2020, but usage of the licenses and secondary trading volumes since then have been negligible. It's not that this spectrum is not valuable: a former FCC commissioner estimated $8-16B of market value, with a consumer surplus of as much as $260B. But transacting in these licenses is a complete, utter pain in the ass.

Why is it so bad? Because the FCC requires strict documentation and pre-approval for any trade or lease on a daily basis. Doing this at scale requires building a direct integration into the FCC, which is no easy feat. Federated Wireless announced plans to build a user-friendly "airbnb for spectrum", but after roughly a year and a half, they launched the offering with a "light touch integration" (no documentation or pre-approval), meaning that spending sixteen months convincing the FCC to soften their requirements was an easier path than building a direct API integration. This light-touch integration is used by Helium and Pollen to onboard CBRS hotspots.

But what if you could easily trade licenses? or lease them out for a few hours at a time? or split licenses into geographic parcels and sell them in parts? A school might lease a license from 8am to 4pm on schooldays for their own private LTE network, while a nightclub down the street leases the same exact spectrum on weekend nights. Or, a stadium might lease spectrum on gameday and only pay for the few square blocks of tailgates, rather than buying a license for the entire county.

Let's take it a step further. What if you could apply leverage and other financial primitives to spectrum licenses? What if you could securitize them into financial derivatives? In other words - what if we tokenized spectrum?

Spectrum licenses can be trivially represented as non-fungible tokens on a public blockchain. Once the assets are on-chain, users are able to leverage the entire DeFi ecosystem of apps and liquidity built by crypto developers over the past five years. Protocols like Centrifuge already enable the tokenization of real-world assets. Once an asset is tokenized, there are NFT exchanges, NFT lending markets, and even NFT-based derivatives. These protocols are mostly used for profile pictures collections today, but there's no reason they can't be used for tokenized spectrum NFTs — the underlying ERC-721 architecture has been battle-tested for more than four years. Immediately after tokenization, a fully-developed capital markets ecosystem for spectrum licenses would instantly become available to market participants, driving lower transaction costs, better price discovery, and higher volumes in spectrum license markets.

> 💡 If you're active in crypto circles, you may have heard a similar thesis on voluntary carbon credits becoming interoperable with DeFi, with companies including Flow Carbon, Moss, Nori, and Regen raising $100M+ to tokenize carbon credits. In the carbon credit market, the central ledger is controlled by a non-profit (Verra) rather than a government agency (the FCC). But the real difference is this: there's $1B worth of voluntary carbon credits globally, yet more than $350B+ of wireless spectrum in the US alone. It's a different ballgame.

Great, NFTs & DeFi… But why is DeWi actually better than TradWi?
This is how the industry works today: networks bid against each other in massive government auctions, and then keep licenses idly on their balance sheet for years while they deploy compatible equipment and market their network offerings. In the meantime, the licenses are unproductive assets on the balance sheet with no way of earning a return. The only semi-productive thing to do is take out leverage against them (recall that US telcos own $265B of equipment plus $350B of licenses, against which they have $400B of outstanding debt).

Now, imagine a world with robust tokenized spectrum markets: a DeWi network, and even traditional telcos, no longer need to hold massive amounts of assets idly on their balance sheet. They can lease the spectrum to partners, pledge the licenses as collateral for loans, provide liquidity to hedgers and speculators, securitize the licenses into structured products, or any number of other things to earn an incremental return on those assets. The result is that DeWi networks are more capital-efficient, using assets more productively than their legacy counterparts.

Hence, the second maxim of DeWi: No Wasted Spectrum.

Investor Perspectives

We've imagined a new type of type of telecom network, a *decentralized* telecom network, that satisfies two qualities: ***No Landlords*** and ***No Wasted Spectrum.***

- ***No Landlords*** reduces pricing power dynamics of DeWi vs TradWi. Rather than trying to extract maximum fiat rents from the network, landlords (especially with the most valuable locations) are incentivized with outsized token-ownership in the network. The result is that the network as a whole is more efficient. Today, telcos generate 40% EBITDA margins and generate 80% EBITDA margins. The best DeWi networks will be somewhere in between.
- ***No Wasted Spectrum*** reduces asset inefficiencies of DeWi vs TradWi. Once spectrum licenses are tokenized, the velocity of licenses increases orders of magnitude. DeWi networks will be able to share, trade, lease, leverage, or even securitize spectrum by tapping into DeFi markets. At the same time, spectrum costs can never be completely eliminated, as governments will find ways to extract economics from DeWi networks. As we walked through above, the telco business generates a productive asset turnover of 0.5x *after spectrum*, or 1.2x *before spectrum*. The best DeWi networks will end up somewhere in between.

What does all this mean for investors?

First-Order Thinking

US telcos generate $315B in annual revenues at a 40% EBITDA margin and valued at a 7x multiple ($875B of enterprise value). Tower companies generate $13B of revenues at an 80% EBITDA margin and a 25x multiple ($250B of enterprise value). By satisfying the maxims above, DeWi networks will operate at both higher margins and higher asset efficiency than TradWi.

Let's say, for example, DeWi networks earn 55% margins (vs 40%) and 0.8x productive asset turnover (vs 0.5x). For every dollar of productive assets on the balance sheet, this DeWi network earns $0.45 vs $0.20 for TradWi networks. **In other words, DeWi networks can offer data transfer at less than half the cost of traditional networks and still earn competitive economics.** This is true even if you assume zero price elasticity for data transfer (i.e., no incremental demand), but could be even lower.

At a 50% price discount to TradWi, the addressable market for DeWi networks in the US alone is $150B+ revenues. If DeWi captures only 10% of the market, the networks could generate $15B revenues ⇒ $7.5B EBITDA ⇒ $75B+ network value. **The entire market cap of DeWi is <$1.5B today, implying 50x+ upside from today.** Even if it takes

15 years to get there, this type of exit would compound investor capital at a 30%+ IRR. We, of course, think the true upside can be multiples bigger than this, and come sooner.

As a base case, DeWi networks are a structurally-advantaged business vs centralized telecom networks, with valuations that can compound investor capital at high rates for a decade or more.

Second-Order Thinking

The economics described above describe DeWi networks *as a whole*, since the network *as a whole* operates more efficiently than traditional telcos.

But now that we have *no landlords* (i.e., miners incur all hardware/labor/rent expenses) and *no wasted spectrum* (i.e., tokenized spectrum facilitates sharing of licenses across the network), what does it mean to own the "equity" of a DeWi network?

Let's use $SAL, the native token of an imaginary DeWi network, as an example. Owners of $SAL tokens don't incur any rent/labor/rent expenses (those are paid by third-party miners). They also don't incur spectrum licensing expenses (licenses are tokenized and then rented "as-a-service" by miners or groups of miners). As a $SAL holder, I don't have a claim to excess cash flows, in the traditional sense.

Clearly, I am not an equity-holder of the network. But I am an owner of the network, since **at any given time I can use my $SAL tokens to access a pro-rata portion of the total data transfer capabilities of the network.** For example, if the total network has a capacity of 1,000 GB and I own 1% of the circulating supply of $SAL, I can burn my tokens and transfer 10 GB of data. After my transaction, there are now 1% fewer $SAL tokens outstanding, but since the network's data transfer capabilities remain the same, everyone else's $SAL tokens are able to "buy" a bigger piece of the network's data transfer capabilities. The flip-side of this is dilution in the form of tokens paid out to miners to build the network, which has the opposite effect of reducing every other tokenholder's claim on future data transfer capability.

Therefore, the basic economics of DeWi network tokens: you're owning a pro-rata piece of the (undetermined) future data transfer capabilities of the network. In order to increase data transfer capabilities, tokenholders are diluted by newly-issued $SAL tokens in the form of mining rewards. When users transfer data over the network, they must burn their $SAL tokens, removing them from circulation permanently, and thereby forfeiting their pro-rata share of *future* data transfer and increasing ever other tokenholder's share.

Therefore, the value of a $SAL token, from a utility perspective is:

- (+) Value of Future Network Data Transfer Capabilities
- (-) Dilution from Miners
- (+) Burn From Future Data Transfer
- == Utility Value of $SAL

Of course, the three are reflexive: higher dilution via mining rewards leads to a bigger network, which can lead to higher future data transfer burn. Now we have an asset that: 1) is indexed to global data transfer growth, and 2) is reflexive onto itself. **In other words, we've created tokenized spectrum! An asset that's asymmetrically levered to global data consumption.**

Third-Order Thinking

In general (not just DeWi), crypto-networks have a few drivers of value:

- **Utility Value:** for DeWi, this is the value of being able to transfer data over the network. For compute blockchains like Ethereum, this is the value of being able to use compute power on a trustless global computer. Generally, utility value can be estimated with supply/demand and issuance/buyback mechanics, or - as a shortcut - using a multiple of fees/cash flows.
- **Governance Value:** tokenholders have rights analogous to shareholder rights. In many cases, they are stronger, since tokenholders can directly impact on-chain parameters of the protocol in a cryptographically-secured way, instantly. Shareholders' rights, on the other hand, rely on the protection of the courts, which move much slower. Control premiums in traditional equities are generally 20-30%, and we suspect the value of a "governance premium", if done correctly, is in a similar range.
- **Call Option on Monetary Value:** on the basis of only utility value and governance value, most layer-1 crypto-networks today are wildly overvalued (e.g., Aptos raising at a $2B valuation before launching). This is because investors are really buying a *call option on monetary value*, or the commodity money thesis. I say *call option* because the base case path is for BTC or ETH to become digital money. But the alternative layer-1 thesis goes something like this: Bitcoin is a dying network because transaction fees are too low to support the network, and Ethereum's roadmap is too complicated. Monetary premiums are so valuable that, even if the chances of success are really low, it makes sense to buy an expensive call option on a new layer-1 blockchain - if it ends up being widely used for its utility, it could also capture the monetary premium which is worth 100x+ more.

DeWi networks have a real line of sight to accruing meaningful utility value. There are networks like Helium, with nearly a million nodes deployed (albeit, for a still-unproven LoRa network). There is $1T+ of global telecom operator revenues, providing a service that DeWi networks are able to provide at fractions of the cost due to their advantaged unit economics. This doesn't require new any new use cases or user behavior (like compute blockchains, which require users to pay a premium for censorship-resistance). Due to the physics of DeWi networks, they are both *censorship-resistant* and *lower-cost* than traditional telco networks. The best of both worlds.

Yet investors attach almost no monetary premium for DeWi networks. Everyone is overpaying for the the call option on tokenized compute (i.e., ETH, SOL, NEAR) to become digital money. The combined market value of **compute** layer-1 blockchains is more than $300B. The combined market cap of **bandwidth** layer-1 blockchains is less than $2B. And the latter has, in our opinion, a much clearer path to generating hundreds of billions of dollars of utility value (a prerequisite for achieving a monetary premium).

If you can figure out why, please hit our line. In the meantime, we'll be busy partnering with entrepreneurs to build the future of DeWi. If you're building or investing in the space, please hit us up - we'd love to work together.

- Sal (*sal@ev3.xyz)* & Mahesh (*mahesh@ev3.xyz)*