

State of Wireless Industry - Wall Street's View

MOKAN Lunch & Learn

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May 2019

All estimates / forecasts are as of 5/3/2019 unless otherwise specified.

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SECTION I:

An In Depth Look At Wireless Strategies Of Big 4 Carriers

Wireless Industry At A Quick Glance

Wireless operators pursuing very divergent strategies

- **AT&T:** Integrating TWX assets and focused on growing WarnerMedia and its Advertising business; T's wireless strategy centered on a bundling approach to combine linear/over-the-top video, content and wireless services
- **Sprint:** Advertising focused on narrowing gap between its network and other carriers (namely VZ) which charge higher prices; Many of promotions involve BOGO (buy-one-get-one free) equipment offers and bundled video product (Hulu)
- **T-Mobile:** Continues to differentiate with consumer-friendly Un-carrier initiatives while expanding its geographic coverage; The focus of its promotions (55+ year-old consumers, military, family plans) centers on higher credit-quality consumers, primarily customers of T and VZ
- **Verizon:** Continues to price at premium based on its network quality vs. peers; Unlike closest competitor (T), VZ sees no near-term need to own linear content and prefers to be over-the-top video/content distributor; Only one of 4 national operators to NOT offer video bundle in its service plans
- **TMUS/S? (New T-Mobile):** If the deal is approved, the "New T-Mobile" will have the most impressive spectrum assets of any of the three remaining players and a strong platform to compete with VZ/T in a 5G world; However, regulatory approval is no "lay-up," particularly with the Department of Justice (DoJ) that tends to look at market concentration metrics like the HHI (Herfindahl-Hirschman Index)

Sample Single-Line Pricing Plan Lead By Carrier				
	T-Mobile	Sprint	AT&T	Verizon
Plan	T-Mobile One	Unlimited Plan	AT&T Unlimited Choice	Verizon Go Unlimited
Terms	Month to month	18-Month Device Lease	30-Month EIP Plan	Month to month
Upgrade Options	Any time, remaining balance due	Upgrade after 12 payments	Must pay 80% of device price	Must pay 50% of device price
Monthly Service Fee	\$70	\$65	\$70	\$80
Monthly Device Fee	\$30	\$30	\$30	\$30
Monthly Data Cap	Unlimited	Unlimited	Unlimited	Unlimited
Total Monthly Cost	\$100	\$95	\$100	\$110
Total 24 Month Cost	\$2,400	\$2,280	\$2,400	\$2,640

Source: Company websites and Wells Fargo Securities, LLC

Big 4 Wireless Carriers' Strategies

Verizon:

- Focused on densification of 5G footprint.
- Being very aggressive in mmWave spectrum deployment (StraightPath was very good acquisition for them if this spectrum works!)
- Working to lay the groundwork for 5G network infrastructure.

AT&T:

- Focused more on spectrum than capital intensive model. Was largest spender (\$18B) in AWS-3 auction
- Currently deploying 60MHz of previously unused spectrum, including FirstNet 700MHz.
- Opted for a mix shift to wireline assets, building fiber to more locations that allow integrated carrier cross-selling (i.e.: wireless, satellite, wired video delivery platforms).

Sprint:

- Most spectrum of all Big 4 carriers, with 208MHz in total. 158MHz of 2.5GHz spectrum, which we view as its “secret sauce”.
- 40% of all data traffic carried on 2.5GHz spectrum, yet only 25% of its 2.5GHz spectrum holdings.
- Network strategy includes “tens of thousands of sites” (i.e.: macros, small cells, femto cells, etc.)

T-Mobile:

- Building out 600MHz network coverage.
- Won \$8.0B of 600MHz spectrum in broadcast incentive auction. Expect to quickly deploy that spectrum, ahead of expectations.
- Own 100MM POPs of 28GHz spectrum, expect to layer that on for 5G capacity over time.

Wireless Strategy, our take:

- All about the bundle! Video and wireless. Expect to roll out 4 different tiers of video service. Watch how your children are consuming content these days.
- TWX acquisition expected to help leverage unique content in compelling service bundles
- Seemed to slow wireless build and focus more on pushing fiber into the ground . Believe T is focused on spending on wireline infrastructure in an effort to support the anticipated wireless data “tsunami” that is on the come with video entering the fold.
- We expect T to shift spending back to towers in 2019 and beyond. Currently deploying 60MHz of spectrum (i.e.: AWS-3, WCS, FirstNet 700MHz).
- Banking more on spectrum than capex. AT&T spent \$18B (the highest bidder) in the AWS-3 auction. Never met a spectrum deal it did not seem to like (i.e. Aloha Wireless, Atlantic Cellular, LEAP).
- Mexico (through the recent acquisitions of Nextel International’s Mexican assets and Iusacell) is part of the view to make a 400MM POP North American wireless footprint.
- T views the critical bundle as “Wireless, Broadband and Video.” With DTV and TWX now closed, it should begin to connect these dots. T’s video strategy with several different offers (i.e.: linear, OTT, thin client, and wireless) is front and center, in our view.

Wireless Strategy, our take:

- Strong overall wireless network quality, in our view; focused on densification of LTE in metro footprint.
- Spent less on spectrum than closest peer (AT&T) in recent spectrum auction. Shifting to capex driven model (with large emphasis on small cells).
- Has first mover advantage on its mmWave spectrum (+24GHz) portfolio, in our view. More supply coming down the pike but not enough in the short term for the other Big 4 to catch up to VZ.
- Like T, we believe it's at the cusp of important changes on wireless side with fixed wireless service being the heart of the 5G offering.
- Playing content side in different way than T. Feel no need to own linear content....but rather partner. Has already signed some important OTT deals with content players (including ESPN and YouTube TV). We believe this will be three pillar strategy: 1) premium content, 2) pay per view and 3) advertising.
- In 2017, went to Unlimited very reluctantly and made T make a similar move.
- When you are on top it is hard to stay there!

Sprint Corp.

Wireless Strategy, our take:

- After the April 29, 2018 S/TMUS merger announcement, the biggest question is whether the two companies will aggressively pursue their standalone network strategies or hold off, pending deal approval/conditions.
- Spectrum value is very deep, with its significant holdings of 2.5GHz spectrum – has more spectrum than any of the big 4 carriers. Big empty airplane!
- Big checkbook behind Sprint is Softbank. Softbank CEO (Masa Son) has dug into the weeds and seems intently focused on turning it around.
- Network has always been an issue for Sprint....but has started to improve. Root Metrics recognition has improved y/y since 2017. Small cells are a major part of the forward looking strategy, though actual network strategy remains a mystery. Most are wondering, is the US like Japan?
- Prioritizing expense improvements in areas like roaming expense, procurement, distribution, backhaul and handset costs.
- Damaged brand, in our view – takes a long time to repair.
- Distribution key focus for Sprint. Optimizing RadioShack stores with Sprint branding.
- Multiple carrier aggregation chipsets slowly working themselves into the base, which would allow Sprint to access multiple 20 MHz channels

T-Mobile US, Inc.

Wireless Strategy, our take:

- Similar to S, the result of its pursued merger has implications that might ripple through its network team's strategy.
- TMUS has had a renaissance since getting the iPhone in April 2013 and successfully embraced social media platform to build the brand. The TMUS user is frugal – but cool at the same time!
- Pulling many “uncarriers” out of the hat.
- Hit and identified all the many “pain points” of the US wireless consumer. The Southwest Airlines of the wireless industry, in our view!
- Clear leader in postpay subs.
- Un-carrier program has driven subs growth, and ARPU stabilization has followed.
- Significant strides with network since completion of MetroPCS acquisition (completed May 2013) , including nationwide launch of VoLTE, ongoing progress toward MetroPCS spectrum re-farming, and vast improvements in network performance
- Largest amount of prepay subs of the Big 4 (16MM+)
- Like Sprint, lack coverage in rural America – however they have been adding this with their A block spectrum and 600MHz. This is good for regional players (like US Cellular) and TMUS was one of the big winners in the broadcast auction, spending \$8.0B in total.
- If industry is turning to video and content – TMUS is opting to partner with content owners vs. owning the content outright.

Big 4 Wireless Carriers' 5G Strategies

Hype around 5G slowly turning into reality, in our view

- There is currently a carrier “arms race” to become the first to launch 5G services, which will bring lower latency, higher throughput and longer battery life to the mobile ecosystem
- **VZ:** Initial commercial launch of “fixed wireless” 5G in the second half of 2018 targeted 4 cities (with Sacramento & LA being 2 of the 4); VZ is leveraging its +1,200 avg. MHz of mmWave spectrum for both fixed wireless and mobile 5G applications
- **AT&T:** Currently has 5G across 19 cities and plans to have it nationwide in 2020; while AT&T has been trialing 5G technologies with its “5G Evolution” launches across 23 major metro areas; AT&T has also conducted fixed wireless 5G trials across 4 markets
- **TMUS:** The first to commit to a nationwide 5G roll-out, with initial launches during 2019 and a broader nationwide launch by 2020; TMUS is dedicating a portion of its acquired 600MHz spectrum as its base spectrum for mobile 5G
- **Sprint:** Plans to begin commercial roll-outs of mobile 5G in the first half of 2019, leveraging its ~158 avg. MHz of 2.5 GHz spectrum; Sprint will “tri-band” its entire network over the next 2 years to enable a true mobile 5G experience
- In our view, the near-term winners in the 5G race are the infrastructure “arms dealers,” particularly the fiber providers, small cell and macro tower operators, and spectrum owners
- Near-term winners from the 5G theme under our coverage include CCI, AMT, ZAYO, SBAC and DY; Longer-term, we believe EQIX could have an increasing role in the deployment of compute nodes at the mobile edge

2015	2016	2017	2018	2019	2020	2021
Release 13	Release 14	Release 15	Release 16			
Release 13 Develops standards for LTE-Advanced (including beamforming, MIMO), HSPA+ (high-speed packet access) and LAA (Licensed Assisted Access)	Release 14 Begins development of 5G requirements; Addresses 4-band carrier aggregation, massive MIMO expansion (16+ antennas, beamforming)	Release 15 Phase 1 of 5G: First version of 5G New Radio specified, with ability to operate in any frequency band, support for LTE and 5G, multiple carrier aggregation and 5 Gbps peak downlink	Release 16 Phase 2 of 5G: Adds support and standards for 5G radio, shared spectrum, 5 GHz unlicensed spectrum, integrated access and backhaul, ultra-reliable & low-latency communications	5G Deployments Initial mobile deployments in late 2019/early 2020 in Phase 1 from Release 15; Phase 2 deployments in 2021 based on Release 16, with modifications to access/backhaul functions, unlicensed spectrum and shared spectrum; 3GPP will begin work on Release 17 (not yet specified)		

Source: 5G Americas and Wells Fargo Securities, LLC

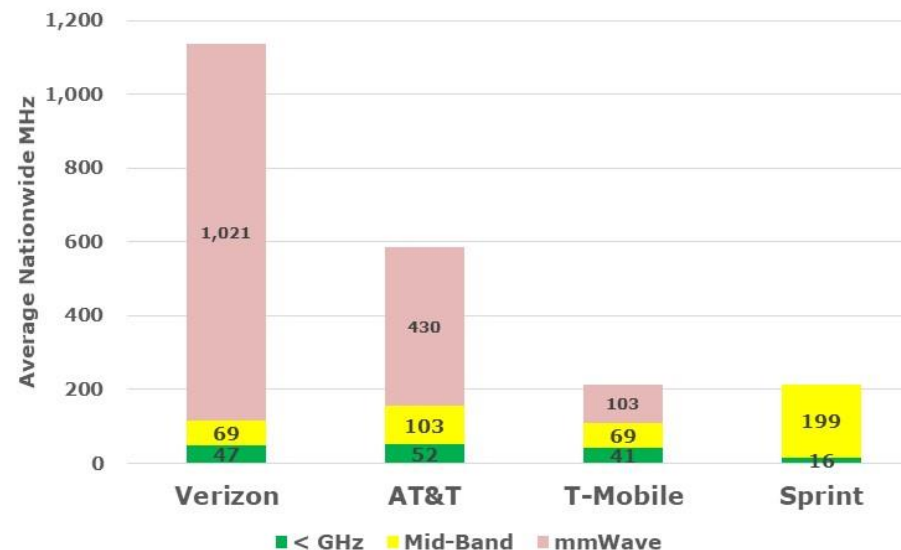
SECTION II:

Spectrum Remains The Lifeblood Of Wireless

Spectrum Remains The Lifeblood Of Wireless

Spectrum remains life-blood of wireless networks, in our view, as evidenced by increasing demand for ultra-high band

- Each wireless carrier is taking a slightly different approach in terms of spectrum deployment for mobile 5G, although we believe low, mid, high and (increasingly) ultra-high band spectrum will all be critical to next generation mobile networks
- **VZ:** Substantial holdings of low 700MHz (C Block), 850MHz, and AWS (purchase from cable consortium + \$10.4B from AWS-3 auction); Largest holder of mmWave spectrum, which it will leverage for mobile and fixed wireless 5G deployments
- **T:** Primarily 700MHz and 850MHz holdings and have been adding AWS and 2.1 GHz for capacity. Spent \$18.2B in AWS-3 auction (mostly in J block) and won the FirstNet award for 20MHz of 700MHz spectrum.
- **S:** Substantial metro capacity with 2.5GHz spectrum (multiple 20x20 channels), along with 1900 and 800 MHz spectrum. Did not participate in AWS-3 or broadcast auctions.
- **TMUS:** Contiguous spectrum bands across the AWS, PCS and 700MHz frequencies. Spent \$1.8B in AWS-3 auction and \$8.0B in broadcast incentive auction. Will use 600MHz as base spectrum for 5G.
- **TMUS / S together in 2019?** The planned merger between S / TMUS (announced April 2018) centers around the 5G argument. With the deepest spectrum position of any of the Big 4 (IF approved!) – we believe this could be the 5G dark horse to watch.



Source: FCC, Moise Advisory, and Wells Fargo Securities, LLC

More Spectrum To Come In 2019

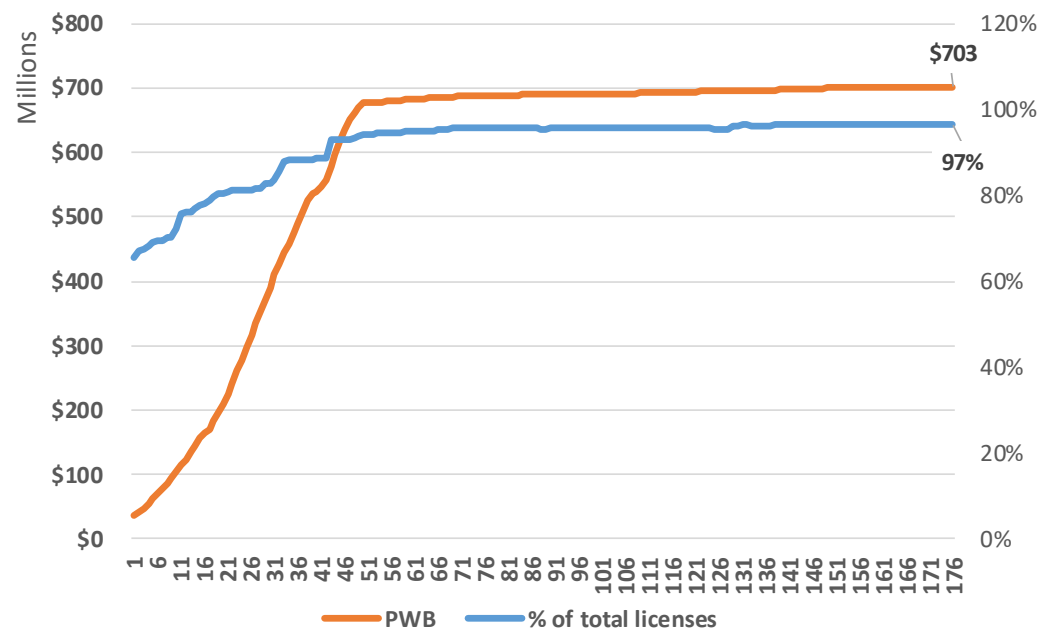
Band Name	Frequencies	MHz	Auction Blocks	Auction Timing	Notes
24 GHz	24.25-24.45 GHz 24.75-25.25 GHz	700	7 blocks of 100 MHz per PEA (2,912 total licenses)	Auction 102 (to follow Auction 101)	There are only four digital electronic messaging service (DEMS) licenses in the 24 GHz band, all of which will be protected as incumbents.
28 GHz	27.5-28.35 GHz	850	2 blocks of 425 MHz per county (3,074 total licenses)	Auction 101 (likely early 2019)	The 28 GHz band was previously known as the LMDS (Local Multipoint Distribution Service); several companies bought LMDS licenses to offer fixed wireless broadband, including Teligent, Winstar and NextLink. However, many of these ventures ultimately failed. The FSS industry does use this spectrum for Earth to space communications, but this is secondary to LMDS. FSS use of this spectrum (Earth to space, but only limited gateway-type services) is secondary to LMDS.
37 GHz	37.6-38.6 GHz	1,000	100 MHz channels	Auction to take place in H2 2019 (37, 39 and 47 to be auctioned together)	This band consists of 1.6 GHz of spectrum (between 37 and 38.6 GHz) and is largely a greenfield spectrum, aside from some limited Federal military uses. Because this spectrum is adjacent to the 39 GHz band, there is support to combine the band with the 39 GHz band to create large contiguous spectrum swaths.
39 GHz	38.6-40 GHz	1,400	100 MHz channels	Auction to take place in H2 2019 (37, 39 and 47 to be auctioned together)	This band consists of 1.4 GHz of spectrum (from 38.6 to 40 GHz), currently allocated to FSS (space-to-Earth, but currently unused) and mobile on a primary basis for non-Federal use. Currently, about a third of the 39 GHz is unused, but the remaining two-thirds have incumbents and has been described as "messy" due to inconsistent geographic areas and in frequencies. The FCC will hold an incentive auction to clear up this spectrum.
47 GHz	47.2-48.2 GHz	1,000	100 MHz channels	Auction to take place in H2 2019 (37, 39 and 47 to be auctioned together)	This band consists of 1 GHz of spectrum (from 47.2 to 48.2 GHz) and is largely a greenfield spectrum.

Source: FCC and Wells Fargo Securities, LLC

Auction 101 Summary: 28GHz For \$0.0112/MHz-POP

- Auction 101 concluded on 1/24/2019 after 176 rounds of bidding.
- Provisional winning bids (PWBs) totaled \$702.6MM, or \$0.0112/MHz-POP.
- This represents a discount to the \$0.017/MHz-POP that VZ paid for StraightPath.
- While winning bidders remain unknown at this time, we suspect VZ was most active in this auction.
- Auction 102 expected to begin no sooner than 4 weeks after the release of the public notice announcing the closing of Auction 101. In Auction 102, the FCC will be auctioning off 2,912 unpaired licenses in the 24.75 GHz to 25.25 GHz band. Unlike Auction 101, the FCC is essentially offering nationwide spectrum (~313 million POPs), so we expect this auction should bring in more interest from the carriers than Auction 101 as it offers more of a clean slate to pick up spectrum in wider swaths. In our view, AT&T will top that list.

Auction 101: \$703MM in PWBs, or ~\$0.0112/MHz-POP



Source: FCC and Wells Fargo Securities, LLC

What is Next on Spectrum Front?

- Watch what is happening on 3.5GHz CBRS scene (TMUS and VZ pressing there)
- Don't forget about unlicensed spectrum (5GHz)
- And....with the S / TMUS announcement – there could be a divestiture of 2.5GHz
- C-Band also getting a lot of attention (satellite spectrum)
- More mmWave auctions coming (LMDS – is the 3rd time the charm?)
- What is Charlie Ergen's next move??
- Is Verizon really comfortable with their existing spectrum portfolio? (Especially post the February 2017 Unlimited Plan)....if they don't need more spectrum – they will need more cell sites!

SECTION III:

Towers Are Core Asset In Communications Infrastructure

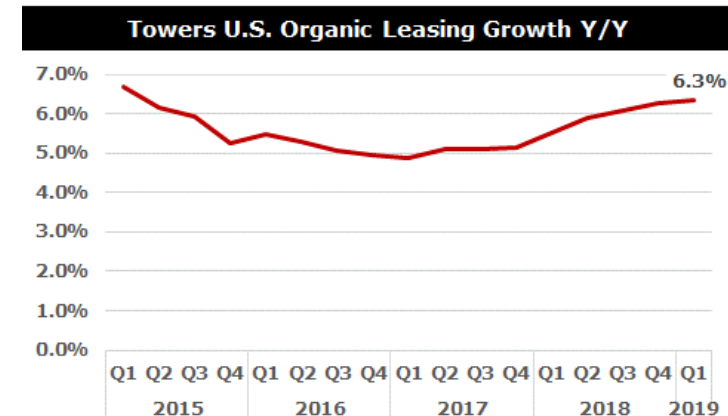
Towers Remain The Core Wireless Asset

Fundamental drivers intact for towercos, in our view.

- A number of fundamentals remain intact, in our view, for the tower sector in 2019 which should drive U.S. carrier leasing activity up yr/yr
- Small cell and network densification are accelerating ahead of 5G services, with small cell RFPs up significantly yr/yr along with RFPs for dark fiber to cell sites
- With all 50 states opted into FirstNet, T has started its first wave of amendments, with the towercos providing conservative guidance on FirstNet's 2018 impact; T will deploy the 700MHz FirstNet spectrum along with its AWS-3 and WCS
- While Sprint and T-Mobile proposed merger is driven by network synergies, we believe the near-term will be positive for the tower cos. Irrespective of the merger, both carriers still have spectrum to light up – namely S's 2.5GHz spectrum and TMUS's 600MHz. Checks show S messaging to vendors implies steep ramp in spending related to Massive MIMO antennas and new site build. TMUS checks show no slow down in network investment since the merger announcement. It remains focused on clearing and lighting up its 600Mhz spectrum for deployment
- After several years of y/y decline in wireless capex spend, all 3 tower companies poised to benefit from reacceleration of U.S. wireless capex in 2018 and 2019E.

Big 4 Wireless Capex Trends (\$MMs)						
	2015	2016	2017	2018	2019E	2020E
AT&T	\$9,666	\$11,204	\$10,324	\$11,340	\$10,870	\$10,913
y/y %	-15.1%	15.9%	-7.9%	9.8%	-4.1%	0.4%
Verizon	\$11,725	\$11,240	\$10,310	\$8,486	\$8,788	\$9,008
y/y %	11.5%	-4.1%	-8.3%	-17.7%	3.6%	2.5%
T-Mobile	\$4,724	\$4,702	\$5,237	\$5,541	\$6,081	\$6,000
y/y %	9.4%	-0.5%	11.4%	5.8%	9.7%	-1.3%
Sprint	\$4,855	\$1,700	\$2,510	\$4,043	\$5,550	\$5,500
y/y %	-6.2%	-65.0%	47.6%	61.1%	37.3%	-0.9%
Total	\$30,970	\$28,846	\$28,381	\$29,410	\$31,289	\$31,421
y/y %	-1.3%	-6.9%	-1.6%	3.6%	6.4%	0.4%

Source: Company reports and Wells Fargo Securities, LLC estimates



Source: Company reports and Wells Fargo Securities, LLC

SECTION IV:

*Fritzsche's View...Fundamentals Intact
But Struggle With Risk/Reward At
Current Valuations*

Fritzsche's View

➤ **Expect Continued Growth In 2019, Driven Mainly By VZ & TMUS**

- After a historic slow 2016 leasing year, 2017 returned to growth, and was continued through 2018. VZ remained consistent in its network spend and TMUS began deploying its 600MHz spectrum expeditiously.
- Big 4 carriers (T in particular) maintained their defiant stance in dealing with the towercos, but that pushback waned some in 2018, where momentum started to build (as did towercos' backlogs).
- Our checks confirm that T has resurged in towerco spending, and is poised to contribute to increased organic growth rates with the towercos in 2019.

➤ **Towers Have Had Impressive Run; Struggle With Risk/Reward At Current Valuations**

- Peer group trades at +21x 2020E AFFO, by our estimates. Continue to push and set peak levels.
- 5G hype is there but not there in reality (yet). Believe most carrier activity is currently revolving around 4G initiatives. We anticipate 5G will come but not until standards are set, and are in early innings.
- Sprint and TMUS pursuing standalone network deployment activities. Pace of builds remains an unknown but TMUS clearly isn't slowing down, and S has confirmed it was 2x its network capex spend in 2018 and 2019.
- AT&T's "One Touch" initiative (700MHz FirstNet + AWS-3 + WCS) under way and ramped through YE2018.
- VZ is consistent and we don't expect them to slow down. Fiber is big focus but small cells and macro are natural extension of this fiber push.....you wouldn't do one without the other! VZ's entire message is about the strength of the network, and life has gotten a lot harder for VZ since the Unlimited plans launched in February 2017.
- DISH's buildout deadline is looming and committed to building nationwide narrow-band IoT network with \$500MM - \$1.0B of initial capital.

American Tower REIT, Inc.

Thesis:

- We believe the overall macro environment (i.e. spectrum crunch, LTE deployment) bodes well for towers. However, on the international side, AMT faces some headwinds beyond FX (loss of Indian customer; less LatAm spend by AT&T) and the U.S. carriers seem to be facing near term issues which has caused spending to be less than robust than hoped.

Investment Positives:

- Relatively conservative leverage vs. tower peers
- International exposure represents better growth area over time, in our view
- International focus also gives it large “portfolio diversification”
- Domestic growth driven by Big 4 carrier spending, with T as largest new business customer
- Own VZ towers that have strong lease up opportunity
- Organic growth intact, with 2019E expectations for +7.0% U.S. organic tenant billings offset by -2.0% internationally driven by India wireless carrier consolidation.

Concerns / Risks:

- International segment has lower zoning requirements and FX currency risks
- Potential carrier consolidation could reduce demand for tower space
- Technological advancements that enhance the voice capacity of wireless carrier networks

Crown Castle International

Thesis:

- With over 74% of its towers in the top 100 markets, we believe CCI's tower portfolio is well positioned to benefit from 3G/4G spending currently under way in many major cities. We also believe CCI's small cell / fiber strategy offers it a unique role in the 5G conversation with the largest US carriers.

Investment Positives:

- High urban concentration, with ~75% of towers in top 100 markets.
- Strongly committed to small cell deployment, with +7K nodes deployed in 2018, 10-15K more planned for 2019, and +20K additional in the pipeline for +2020.
- Fiber portfolio, including Lighttower (announced Summer 2017), FiberNet (FPL), and Sunesys assets, consists of +60K fiber miles that can be used as backhaul for small cell segment.
- Well positioned to benefit from small cell densification and 5G roll-out in major markets, in our view.
- CCI checks many of the infrastructure boxes (small cells, macro, fiber) we believe this will serve it well in a 5G environment as carriers tend to be more willing to work with providers with multiple solutions (more tools in the tool kit)

Concerns / Risks:

- Fiber / small cells more of an active infrastructure investment vs. macro. Thus there are more soft costs / SG&A associated with this model.
- Questions persist about “colocatability” of small cells.
- Lower international exposure relative to certain peers limits growth opportunities, in our view.
- Lower barriers to entry in small cell – can ZAYO and CCI overbuild one another?

SBA Communications Corp.

Thesis:

- As the smallest public tower company, SBAC is an attractive asset, in our view. That said it is facing FX headwinds and lower organic growth rates with higher leverage than peers.

Investment Positives:

- High-quality tower portfolio, in our view, with more capacity than peers.
- SBAC executes a balanced growth strategy between organic growth domestically and international expansion via site builds and measured acquisitions.
- Smaller scale gives SBAC better opportunity to grow via private acquisition.

Concerns / Risks:

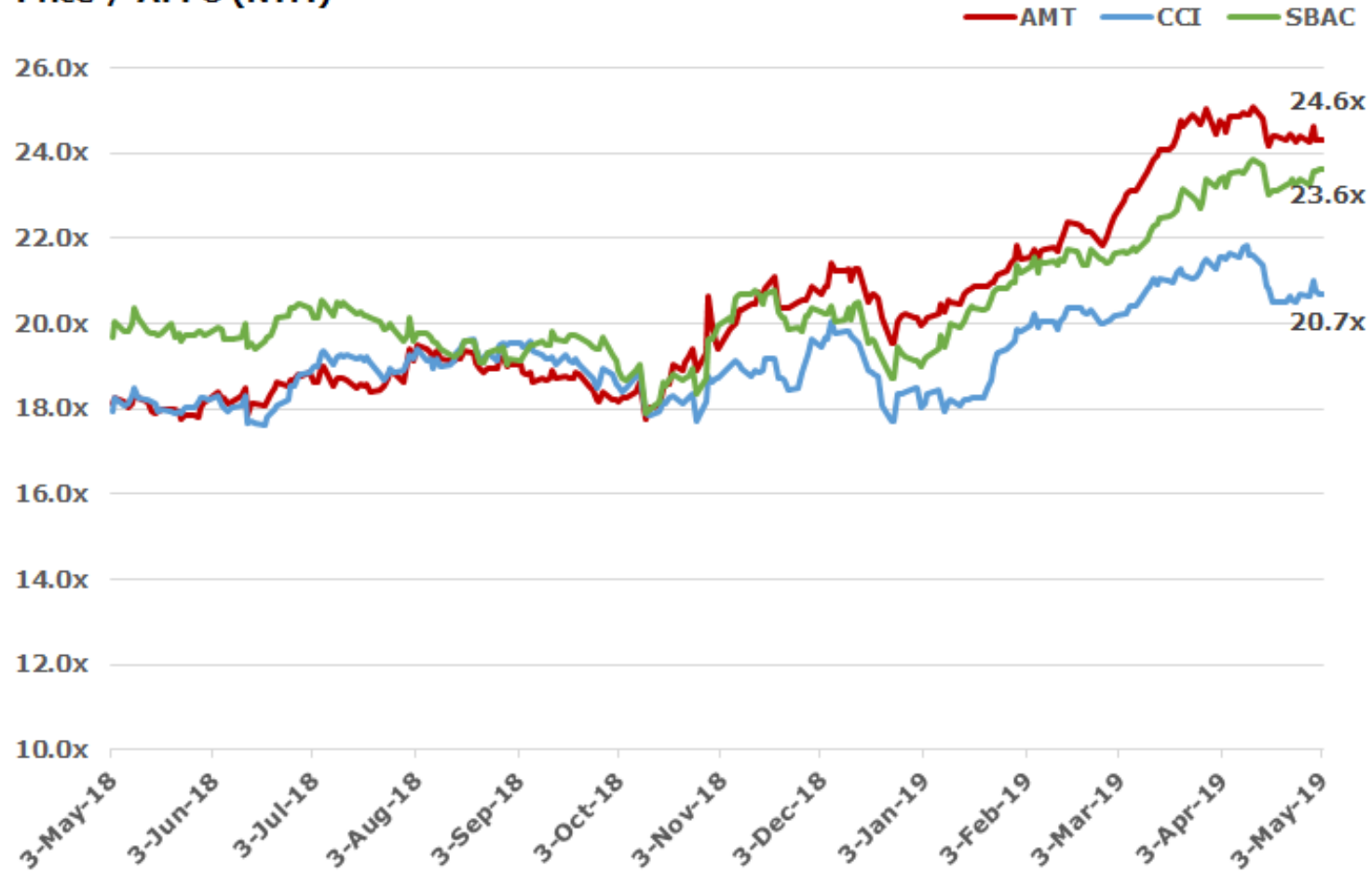
- High leverage relative to peers.
- Less scale given lower number of towers in portfolio.
- Zero small cell exposure.
- FX headwinds from Brazil.
- Has reputation for being highest priced tower cos – especially aggressive in amendment pricing

EV / EBITDA (NTM)



Source: FactSet Information Systems and Wells Fargo Securities, LLC

Price / AFFO (NTM)



Source: FactSet Information Systems and Wells Fargo Securities, LLC

Company	Investment Rating	Stock Price
T	Market Perform	\$30.62
TMUS	Outperform	\$73.61
VZ	Outperform	\$56.99
S	Market Perform	\$5.48
AMT	Market Perform	\$192.80
CCI	Outperform	\$124.03
SBAC	Market Perform	\$204.19

Note: Prices as of 5/2/2019 close

Source: FactSet Information Systems and Wells Fargo Securities, LLC estimates

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