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Data infrastructure: an infrastructure or private equity play?

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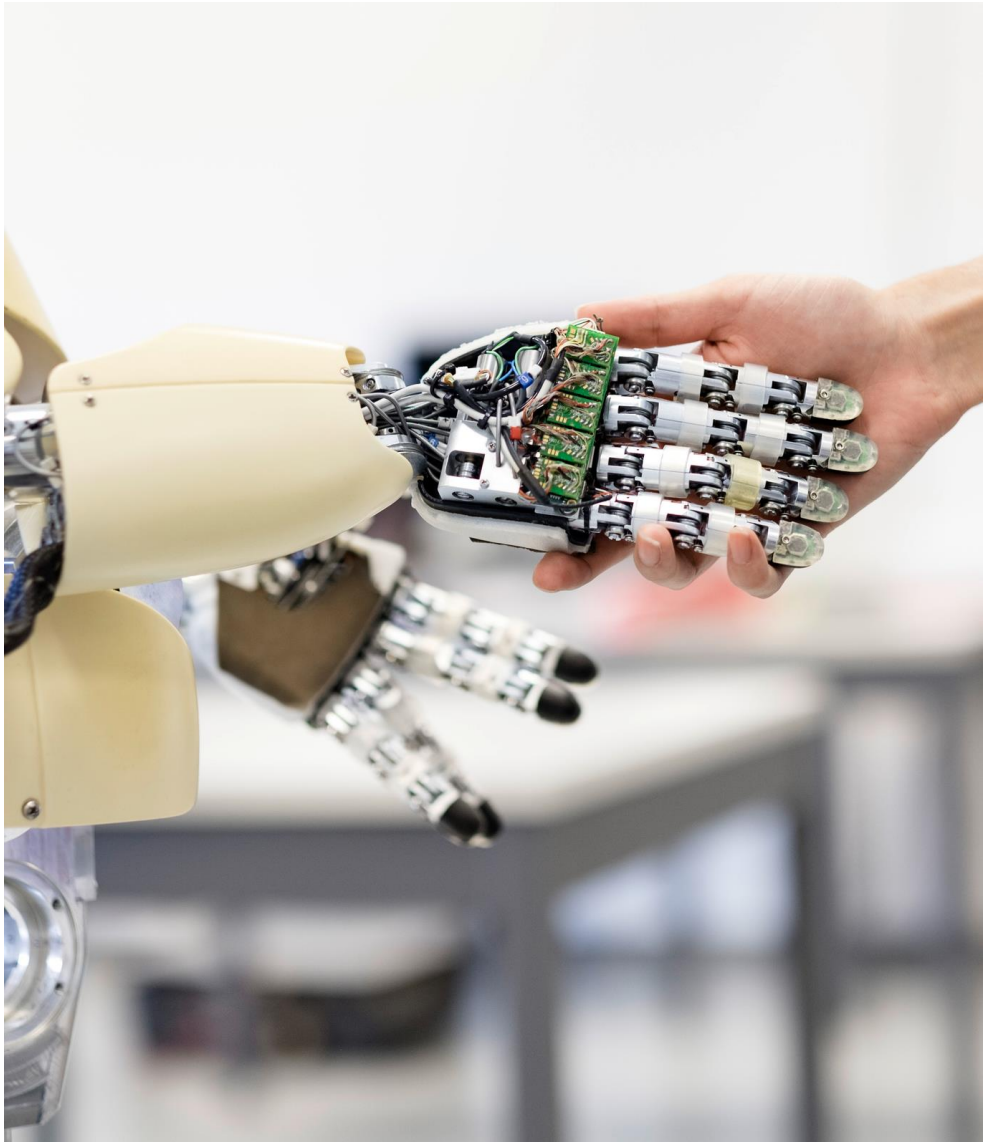


As the lines between infrastructure and private equity become increasingly blurred, the question of categorization - while topical - becomes more trivial. A more relevant consideration is to understand the risks around the cashflows of data infrastructure assets to ensure that the returns are commensurate.

Declan O' Brien
Alex Leung

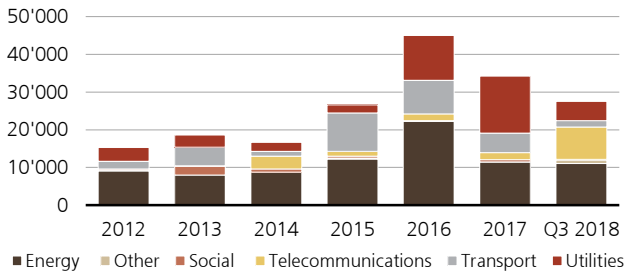
Research & Strategy,
Infrastructure,
Real Estate & Private Markets

Data infrastructure investments: an essential infrastructure asset class or a private equity play?

Introduction

Infrastructure investors have a proven track record as owners of telecommunication assets. However, 2018 is the year when telecommunications infrastructure entered into the mainstream, accounting for more than 30% of invested capital in infrastructure to 3Q 2018. A majority of these investments were in the newer sub-sectors within data infrastructure, i.e. fiber, data centers and, to a lesser extent, "smart" infrastructure. In this paper, we explore whether this trend is simply style drift at a time when the infrastructure sector is experiencing record inflows, or a serendipitous moment presenting a steady stream of opportunities that are well suited to infrastructure investors.

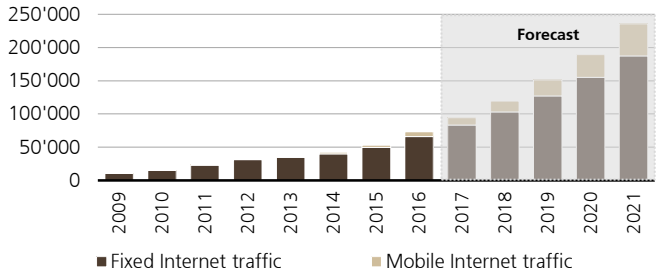
Figure 1: Growing allocation to telecommunications
(USD mlns)



Source: Preqin, December 2018

Somewhat predictably, the answer lies somewhere in-between. As discussed in our paper, The infrastructure equity cycle, fundraising levels have been increasing year-on-year, with fund style clearly moving to non-core investments. However, it is also true that this is an attractive moment for data infrastructure: the proliferation of high definition on-demand video, gaming, cloud services, mobile data usage and IT outsourcing has created a surge in both fixed and mobile internet traffic and this growth is forecast to increase exponentially (see Figure 2). Additionally, the telecommunications incumbents have limited capacity to invest across the spectrum and are prioritizing opportunities in 5G, the next mobile generation – and in many cases, are selling non-core assets to help fund this. This trend also creates further opportunities for infrastructure investors. Growth in data usage underpins the need for further investment into data infrastructure. Many infrastructure investors see their investment in the sector as an opportunity to own tomorrow's essential infrastructure.

Figure 2: Exponential growth in internet traffic
(Petabytes/month)



Source: Cisco Global Cloud Index, 2016-21

However, investment in any sector that forecasts exponential growth poses risks and investors would be wise to look to history to help to navigate investment opportunities in this fast-changing environment. The early 2000s saw a global telecommunication crash (largely resulting from the dot com bubble) which was the result of aggressive bidding for 3G mobile spectrum and rolling-out of competing terrestrial and submarine fiber routes in the US and Europe, based on ambitious growth rates that failed to materialize within the expected investment horizons. This resulted in numerous high profile defaults, bankruptcy filings and an estimated 100,000 job cuts in Europe alone[1]. Two main factors changed this dynamic a few years later. Firstly, the growth of video traffic, beginning with YouTube in 2005 and leading to numerous other Over the Top services such as Netflix, and secondly, the launch of the iPhone in 2007 and the iPad in 2010 that fueled the growth of mobile data applications.

Similarities can be drawn from today's push for 1gigabit/second fiber networks and the hype around 5G. No current consumer demand forecast envisages needing this type of data throughput in the short-to-medium term; however, like with the iPhone, endogenous technologies and applications will most likely emerge that will fundamentally alter how data is created and consumed.

Fiber – the "gigabit generation"

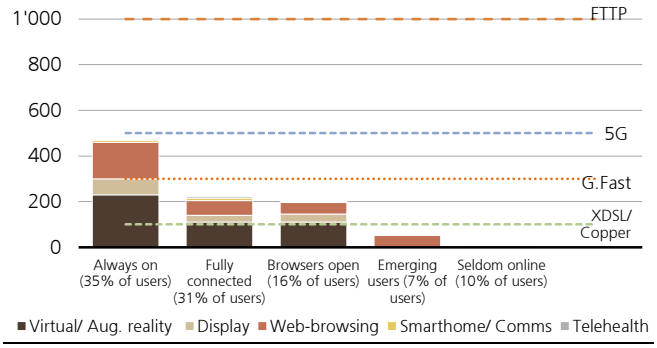
Legacy copper last-mile infrastructure is unable to facilitate the widespread transmission of technologies such as HD on-demand video (including 4K and 3D movies), big data, IoT[2], augmented reality, telehealth and online gaming. Countries such as Japan and South Korea are close to 100% coverage of fiber to the premises (FTTP) or "full fiber"; significant investment is required by many other developed countries to catch up.

Additionally, to allow for the expected growth in home working (so called, "SOHOs"[3]), networks need to provide fast upload speeds as well as download speeds. This is typically poorly supported by xDSL[4] or copper-based services. In the UK, the National Infrastructure Commission undertook a study

[1] David Rudd PhD F.I.E.E C.eng, Spectrum Pricing's uncertain future Electronics World, Vol. 108, September pp. 24 2002
[2] Internet of things – see page 6
[3] Small Office Home Office
[4] Technologies that are used to transmit digital data over telephone lines

to look at the various fixed-line options to 2040 and found that the only one that would satisfy all demand scenarios was FTTP (see Figure 3) however, technologies like G.Fast[5] would provide acceptable coverage at a lower cost under their "moderate evolution of usage" scenario.

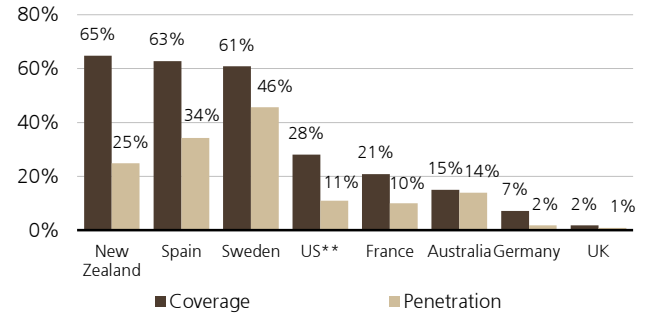
Figure 3: 2040 UK household download peak demand (mb/s) **– moderate evolution of usage scenario**



Source: Frontier, Connected Nations 2017, report by OFCOM

Notwithstanding these cost considerations, the UK government recently announced its ambition to provide "full fiber" by 2033; a big commitment given current coverage of 2-3% (see Figure 4). It seems that most developed countries are reaching similar conclusions that FTTP is the end-game, necessary to attract investment and to provide comfort to governments that their digital infrastructure is future proof.

Figure 4: Take-up varies by country
(Coverage and penetration rates*, %)



Source: NERA, Telecommunications Infrastructure International Comparison, March 2018; *Penetration rate is fiber subscriptions/ total homes in country; **US reported data from Fiber Broadband Association but using different methodology.

As shown in Figure 4, the penetration of fiber-based coverage varies widely between countries. The speed of rollout has been determined by a myriad of factors such as regulation, competition, design of networks, ability to use existing infrastructure and the required level of permission and permits. For example, Spain's high deployment ratio is boosted by the ability to use existing infrastructure (passive), the large proportion of the population living in multi-dwelling units (MDUs), the streamlined planning process and favorable regulation in respect of in-building cabling.
The difference in penetration rates is also heavily impacted by price competition and the speed of the existing connection. For example, the price of FTTP in some European countries such as Switzerland and Italy is now lower than the existing XDSL/copper option which should accelerate the switch to fiber in these countries. Copper networks are expensive to maintain and will largely be switched off once a comprehensive fiber network is in place.

As shown in Figure 3, the capacity provided by fiber means that obsolescence risk, and therefore replacement risk, is low. However, there are circumstances where fixed wireless access (FWA)[6] can be a cost-effective solution, such as for wireless backhaul, point-to-point enterprise connectivity and in difficult to access rural areas or as an interim solution. 5G FWA testing has delivered speeds that are equivalent to FTTP (actual levels expected to be lower). Verizon is investing heavily in this solution in the US. Over the shorter-term, FWA using 4.5G, the next spectrum being auctioned for mobile, could provide a connection speed that is better than existing connections in some areas, albeit still well short of FTTP and providing lower reliability[7]. This could be attractive if it can provide a cheaper access point for light internet users and may impact the ultimate penetration rate achieved for some FTTP projects.

Note on 5G:
There is a lot of confusion around 5G as it is used casually when referring to mobile and FWA. Our colleagues at UBS Evidence Lab are cautious around the rollout of true mobile 5G, i.e. technology that will enable mobile download speeds of c.10x faster than current 4G technology due to a number of technical and regulatory barriers. They modelled that approx. 636,000 small cell towers would be required to provide reliable coverage to NYC, making the economics very challenging. The "5G" mobile spectrum being rolled out at present is actually more like 4.5G[8] as it is still in mid band spectrum so it won't be the game changer that some promise.

However, there is increasing interest in 5G for FWA. Some of technical limitations of 5G for mobile coverage can be eliminated by more powerful and more targeted transmission as regulation places a lower threshold for safety on fixed connection versus mobile. The costs of equipment required for the point-to-point connection may make it better suited to enterprises/MDUs than individual homes. The earliest adoption of 5G in Europe is likely to be in the enterprise/industrial sector, e.g. corporates building a localized 5G network to connect machinery and robotics with very high security levels.

[5] G.Fast optimizes the existing last-mile copper network and targets performance of 150Mbps to 1Gbps.

[6] Fixed Wireless Access is an alternative means of providing internet connectivity that uses wireless network technology rather than fixed lines

[7] There are a number of technical innovations, such as multiple input, multiple output (MIMO) antenna technology that could improve the proposition.

[8] Currently 4G spectrum is 0.7GHz and 2.6GHz. New spectrum being auctioned for "5G" is mid band @ 3.5GHz to 5GHz. True 5G requires access to high mm. wave (>24Mhz)

Fiber opportunities for infrastructure investors
Many infrastructure managers see the buildout and acquisition of fiber networks as a unique opportunity to own essential assets with attractive growth potential. Their activity has been boosted by the limited competition from telecommunication providers (telcos) who are increasingly focused on buying 5G spectrum and securing funding for 5G deployment. This trend should continue as telcos' 5G capital expenditure (CapEx) is forecast to grow by 23% p.a. from 2018-2025[9]. Infrastructure investors have been very active in the fiber space, completing investments in both fiber backbone (trunk network) and rolling-out FTTP (last mile connections).

- *Investing in the backbone:* the growth in data and the need for robust networks for 5G will make these assets very attractive, especially for neutral players or those with unique or exclusive fiber routes. These businesses typically generate most of their earnings from providing wholesale services to internet service providers, Over the Top services (e.g. Netflix) and content providers or dedicated connections for enterprises and governments. Unless there is a unique or exclusive route, customer contracts tend to be short-term (typically three to five years), which exposes the businesses to price compression upon contract renewal.

The entry point for infrastructure investors is typically to acquire brownfield businesses as most developed countries already have well-established fiber backbones. Certain networks in dense areas can be attractive, but are often subject to competitive pricing pressure. Rural areas and certain subsea cables typically benefit from more limited competition.

Noteworthy transactions in this space were Antin's purchase of Ufinet in May 2018, Stonepeak's acquisition of euNetworks in November 2017 and the investment into Altice Fiber by an infrastructure consortium in December 2018.

- *Fiber to the premises:* rolling-out fiber to residential properties and businesses. Mostly targeting less dense areas that incumbent operators have underserved. Investors typically take rollout risk and make an assumption on the speed of take-up and the ultimate penetration rate. The economics of rolling-out fiber in rural areas are challenging, so in certain cases projects may receive government subsidies e.g. the Public Initiative Networks (PINs) in France.

Notable transactions in this part of the market were KKR's purchase of Deutsche Glasfaser and Infracapital's acquisition of Gigaclear in 2015. In the US, states such as Kentucky and Pennsylvania have used public-private partnerships to rollout out fiber networks.

The interest from infrastructure investors in fiber has contributed to high valuations in the sector, with average enterprise value (EV)/EBITDA of around 12.5x[10] over the past five years; the range varies widely with some businesses trading for around 18x. Looking at some of the macro tends, it is not difficult to justify these valuations, but it is worth noting that many of these businesses take on significant risks around price, penetration rates and competition.

Data centers
This paper provides a high level assessment of the data center sector. Please refer to our fourth innovation paper "Data centers, real estate, and the evolution of technology" for a history of the sector, key drivers and risks. There are a number of entry points for investors into data centers ranging from more real estate-type long-lease investments to more private equity ones that take more operating and technology risks. Data centers will typically provide a secure facility including power, cooling, raised floors and several fiber-based connectivity service providers. We categorize investment types into three broad sub-categories below, ranked by operational/technological risk:

- *Wholesale:* Customers lease an entire room or locked cage within the data center and will install and maintain their own equipment. They will typically purchase connectivity directly from the internet service providers at the site and cross-connect[11] with cloud providers from the data center.

- *Co-location:* customers lease a couple of racks or a locked cage within the data center along with cross-connects to service providers within the center. They may purchase connectivity directly from the service providers at the site or as a bundled service from the data center. They may also purchase basic managed services such as remote hands.

- *Managed services / cloud:* offer more full-service solutions: cloud servers, managed security, backup/disaster recovery, virtualization and IT application hosting.

The preferred option for corporates has traditionally been private cloud connection whereby they access a wholesale or co-location site via a dedicated connection; however, as security has improved, more enterprises are moving onto the hybrid cloud. In a hybrid cloud environment some of the daily computing requirements, e.g. business-critical databases will continue to be handled in the private cloud while additional traffic demand, e.g. a web-centric applications with demand fluctuations can be met by public cloud. Data center activity is forecast to roughly double between 2017 and 2021, with the public cloud expected to account for 73% of total activity, up from 56% in 2017. Therefore, it is important that data centers are capable of facilitating public cloud services to make them future proof.

Wholesale businesses have traditionally attracted real estate investors where they provide a shell and core whereas Infrastructure investors' preferred model has been co-location where they can offer power, connectivity and additional

[9] Analysys Mason, European Telecoms Summit 2018
[10] MergerMarket, company filings, press releases, UBS estimates, broker research
[11] A cross-connect is any connection between facilities provided as separate units by the datacenter.

services, and create a platform to build the business. The services provided are colloquially referred to as "ping, power and pipe", i.e. rack or floor space (customers "ping" computers remotely), electrical ("power"), and access to alternative network ("Altnet") fiber-based connections and a high-quality internet connection ("pipe"). The clients range from SMEs, large corporates/government and, increasingly, large public cloud providers (hyperscalers) such as Amazon Web Service (AWS) and Microsoft Azure – although they may seek more limited services at more competitive rates. As well as building their own data centers, hyperscalers frequently rent space in co-location data centers. In addition to capacity, it allows them to "on-ramp" customers who require additional capacity and services. Please refer to our paper on data centers for further details on this topic.

Data centers providing managed services and cloud can tap into the positive macro trends of growth in public cloud and higher-margin managed services. There is a slight dichotomy with regards to managed services-focused data centers. On one hand, datacenter services can be very sticky with low churn rates as it is difficult for an organization to switch providers once all of their data is integrated into the software/platform (as iPhone users considering the switch to android might relate to). However, on the other hand, with more focus on asset-light services and fewer barriers to entry, the traditional infrastructure features are less present.

Asset selection is critical, especially as a credible exit strategy for an operator of a small-to-medium size portfolio of data centers could be a sale to a strategic. The key asset-level considerations are the energy supply to the site, the energy efficiency of the datacenter and the availability of competing Altnet fiber-based services. Data centers are increasingly energy intensive assets, so high efficiency is critical both from an operating cost and an environmental perspective. The industry uses the power usage effectiveness (PUE)[12] metric to benchmark centers. A high PUE would make the center less competitive in a rising power price environment. Efficient assets that also use renewable sources of electricity and have low water usage (increasingly important in certain regions) will be most attractive for ESG-focused investors.

Proximity to major urban hubs can also be important as low latency/delay is important for a number of customers. Increasingly, there has been a trend towards "edge cloud", which simply means getting data center processing power closer to the end user to reduce delays. This model follows a "hub and spoke-type" approach, i.e. where small edge data centers are located in data dense areas and supported by larger data centers in less dense (and cheaper) areas. Reliable, low latency connectivity between these locations is critical for applications that are highly interactive, e.g. online gaming, enterprise applications such as customer relationship management tools, or disaster-recovery solutions for financial institutions that require real-time back-up. The hyperscalers are increasingly looking to complement their large out of town locations by occupying space in data centers that can provide them with low latency capabilities.

Data center opportunities for infrastructure investors

Infrastructure investors have typically invested in co-location data centers with a buy and build approach. Although infrastructure investors are attracted to co-location assets that have long-term contracts, the typical contract length for co-location is around three to five years so most co-location centers will take an element of re-leasing risk. Data centers have barriers to entry but these are more nuanced than for traditional infrastructure. Firstly, while contracts may not be long-term, churn rates tend to be low as moving data centers can be a cumbersome process. Additionally, access to the required levels of power, connectivity and the location of the data center creates some barriers to entry, especially for edge data centers where it is difficult to construct new assets, but this is not the case for all portfolios. Some co-location owners are seeking to boost income by offering higher-margin managed services, which arguably moves the asset further away from the infrastructure definition.

Telcos have been actively disposing of data centers as they seek to raise money to fund their 5G plans and optimize balance sheet use. However, competition in this market is intense as listed data center businesses such as Equinix and Digital Realty Trust (combined size: c.USD 60 billion) are very active in the space. Nevertheless, infrastructure players have been making headway, notably Brookfield and Infravia's purchase of AT&T and Altice's data centers, respectively, and MIRA recently completed the acquisition of a standalone data center business, Aligned Energy in the U.S. However, the competition from strategic buyers, real estate investors and infrastructure players has led to high valuations of c.16x[13] over the past eight years. The ability to achieve an exit through multiples sources is a positive, but infrastructure investors should be aware of the asset-level considerations, discussed earlier, to ensure that their portfolio will continue to be attractive into the future.

Smart infrastructure

Two questions immediately come to mind: what exactly is "smart" infrastructure? And what are the investment opportunities for infrastructure investors? In its most simple form, smart infrastructure is the combination of technology and data to improve productivity and efficiency. It has been driven by improved connectivity and the ability to process and analyze large data sets (big data). The technology component is typically transmitters, sensors and software that creates and transmits data to the internet, commonly referred to as the internet of things (IoT).

Examples of smart infrastructure include smart meters used in the water and electricity sectors; sensor-enabled street lighting; cameras used to detect traffic levels and for security; sensors that measure air pollution; waste bins that communicate when they are full; and electric vehicle charging

[12] PUE is determined by dividing the amount of power entering a data center by the power used to run the computer infrastructure within it. PUE is therefore expressed as a ratio, with overall efficiency improving as the quotient decreases toward one

[13] MergerMarket, company filings, press releases, UBS estimates, broker research

points that can provide voltage and frequency balancing services to the grid using vehicle-to-grid dispatch. These initiatives cover transportation, energy, security and environmental services, all essential elements of a sustainable society. This is perhaps why they are often described under the catch-all of "smart cities". However, it would be misleading to say that there is a pipeline of coordinated smart city projects that the private sector can get access to. To date, aside from some pilot projects, there has been a limited appetite from governments to invest in coordinated smart city schemes. The most likely scenario is that smart cities are built in stages with the initial focus likely to be on transportation and energy components.

For transportation, the expectation is for a significant ramp-up in the adoption of electric vehicles (EVs) – UBS Investment Bank forecast that 15% of new global vehicles sales will be electric by 2025. The early take-up has been boosted by changing consumer perception, falling vehicles/battery prices, government subsidies and policies announcing bans on internal combustion engine vehicles over the next 10-15 years in many developed counties. However, in order for this adoption rate to materialize, significant investment will be required into the charging networks as the current network is inadequate and is seen as a major obstacle to the purchase of an EV. UBS forecast that USD 360bn of investment is needed to 2025. The M&A market for charge point operators has been very active over the past 18 months with acquisitions of operators by oil and gas majors (Shell and BP), utilities (Engie and Enel) and other players including infrastructure managers such as Meridiam, supporting the growing EV narrative.

Simultaneously, trials are ongoing for autonomous vehicles (AVs), which if widely adopted, could challenge the fundamental need to own a car. Instead of owing a vehicle you can instead use so called "mobility as a service", where autonomous vehicles are shared between multiple users so that the overall cost is reduced significantly. For example, UBS Investment Bank estimates that a ride-hailing service (like Uber) costs is around USD 2.50/mile but this reduces to USD 0.70/mile once the driver is removed, making the economics of sharing rather than owning, very attractive. As with EVs, significant investment will be required to make cities AV ready. A recent report by Tech Republic found that 50% of U.S. cities are preparing their cities for automated electric vehicles.

The energy industry has traditionally provided flexibility to the grid using supply-side levers, e.g. ensuring that supply always meets demand by directing power stations to adjust their output. With intermittent renewables now accounting for an increasing share of generation, such supply adjustments are becoming more challenging and expensive, so demand-side responses are required. With the rising popularity of distributed renewables and energy storage (including electric vehicles), infrastructure such as smart meters and smart grids are required to allow households and distributed energy suppliers to monitor their own electricity output and consumption, share data with other parts of the grid, and sell excess electricity into the network, ensuring flexibility and reliability of the entire system.

Smart infrastructure opportunities for investors

There are a range of opportunities for infrastructure investors within the broad definition of smart infrastructure. There have been a number of transactions in the UK and German smart metering markets, with investors attracted by the part-regulated revenue profile. There are opportunities to finance "infratech" companies in the demand-side and frequency response part of the market. Some of these ventures have physical assets such as utility-scale batteries whereas others are aggregating and optimizing assets using big data techniques. This part of the market is possibly more suited to those investors with more of a private equity risk tolerance. There is significant interest in using smart infrastructure for traffic management and more than a dozen projects have been financed in the managed lanes sector in the US over the past five years[14].

We've also seen public-private partnerships for smart city projects gaining popularity in cities like Toronto and Atlanta, which are looking to upgrade their energy, utilities, telecom and transportation network. Whitehelm Capital recently launched a EUR 250 million smart city fund. However, we caution against over-optimism in the growth of integrated smart city projects with plenty of pilot projects not resulting in subsequent opportunities for the private sector. Amey recently reported an impairment of its early investment in the UK's smart city initiatives, a timely case study. However, we would expect the components of smart city projects, e.g. street lighting, demand-side response and EV charging to create tangible opportunities for private investors.

Perhaps the real opportunity for infrastructure investors is not in the pipeline of transactions, but in using the principles for asset management, i.e. to improve the performance of existing assets or targets. For example, in the airport sector owners can use technology and data to optimize terminal and retail spaces saving CapEx. In the electricity and water sector companies are using sensors, acoustics and infrared heat systems to detect leaks and structural weaknesses in pipes and cables. Sensors can also be embedded in road assets to monitor its structural integrity and identify localized damage, such as damage caused by rock falls. These types of initiatives could unlock significant value for infrastructure investors.

Conclusion

Infrastructure investors have been increasingly active in the data infrastructure sector; so, is this an infrastructure or a private equity play? While the goal posts continue to widen regarding what actually is considered infrastructure, investments, in our view, should produce stable and predictable cashflows either through an embedded market position or a robust contractual framework. Within the three areas covered in this paper, there are opportunities that fit comfortably within this definition, such as: an established FTTP network/concession or a network with a unique route, a data

[14] Moody's, FAQs: Credit Risks of Managed Lanes, September 2016

center with revenues secured by long-term contracts, or a smart city under a PPP (P3) regime.

However, the majority of investment opportunities in this sub-sector will not fall neatly within the above examples as they require investors to take a significant degree of revenue and operational risk. While the long-term fundamentals are very supportive, the objective of achieving predictable cashflows in the future requires many of today's assumptions to materialize. This arguably sits closer to private equity-style risks than infrastructure ones. Nonetheless, these assets are critical to the functioning of a modern society – a textbook definition for what constitutes an infrastructure asset. So, the answer is nuanced. The question is also somewhat trivial as the lines between infrastructure and private equity have become increasingly blurred and many investors now think of infrastructure, real estate and private equity more holistically as real assets. It is perhaps more useful to think about the return profile of your investment. If income makes up the majority of your return you are likely to be more on the core/core-plus spectrum whereas if you're more reliant on capital growth because you're building a business and reliant on future performance, you will align more to a value-add or opportunistic strategy, and the return profile should be commensurate with this risk profile.

We caveat that these assets are heterogeneous and each transaction needs to be considered on its own merits and within the context of regional dynamics. Below we set out our high level views on which type of investments should broadly be valued at a premium/discount.

Taking a position

Investments to start discounting

Fiber:
- FTTP businesses reliant on aggressive rollout, high penetration rates with a low existing asset base
- FTTP networks in markets where there is the likelihood of a competitive fiber overbuild (often by the incumbent Telco)
- Wholesale operators without any unique routes or buildings, where short-term contracts create a larger risk of price compression. Smaller players are particularly exposed as they may have smaller bundles of services and will be less likely to maintain prices on renegotiation

Data centers:
- Older data centers with high latency or high PUE ratios that may require significant capital to remain competitive
- Individual sites or small campuses that are not interconnected with alternative connectivity providers
- Datacenters who rely on revenue growth from managed IT services. While this is a growing element of the market, cashflows are not predictable, more open to competition and dependant on the experience of management to operate in a dynamic and changing environment
- Data centers with a high degree of customer concentration

Smart infrastructure
- Businesses where rollout is subject to public planning delay/bureaucracy
- Innovations that fail to offer tangible economic or social benefits

Investments to start valuing with a premium

Fiber:
- FTTP businesses with a proven track record and growing business in regions where there is a supportive regulatory framework
- FTTP businesses where existing connection is very poor or where copper subscription is expensive and can be matched by fiber
- Wholesale or large-enterprise providers with barriers to entry such as unique routes or long-term contracts with creditworthy counterparties

Data centres:
- Modern data centers with low PUE ratios and scalable access to diverse energy supplies
- Edge data centers near data dense areas as ideal for on-ramping by hyperscalers and more barriers to entry
- Datacenters in unique second or third tier locations where competition is less likely
- Efficient sites that maximize use of clean energy and have low water usage will be more attractive for ESG-focused investors, making their investment more futureproof
- Data centers with long-term contracts with creditworthy counterparties

Smart infrastructure
- Smart cities procured under public-private partnerships
- Assets focused on reducing carbon emissions, e.g. the use of sensor technology in street lighting
- Demand-side response solutions such using electric vehicles charging to balance the grid
- Managed lanes and traffic congestion infrastructure such as using sensors and cameras to increase mobility

Infrastructure Research & Strategy Team

Declan O' Brien
Alex Leung

For more information please contact

UBS Asset Management
Real Estate & Private Markets (REPM)

Declan O'Brien
Tel. +44-20 7567 1961
declan.obrien@ubs.com

Alex Leung
Tel. +1-212 821 6315
alex-za.leung@ubs.com

Follow us on LinkedIn 

www.ubs.com/infrastructure

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