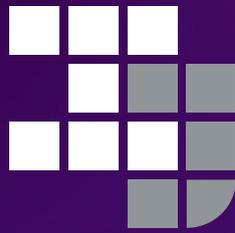


Special Report 2021

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Project Finance & Infrastructure Journal



The Global Digital Infrastructure Survey 2021

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Leaders in digital infrastructure

<div style="background-color: #4a4a8a; color: white; padding: 10px; margin-bottom: 10px;"> 11 Digital Infrastructure Executive Summary </div> <div style="background-color: #4a4a8a; color: white; padding: 10px; margin-bottom: 10px;"> 13 Digital Infrastructure Technology </div> <div style="background-color: #4a4a8a; color: white; padding: 10px;"> 20 Digital Infrastructure Outlook </div>	<p>Defining the digital revolution 4</p> <p>DigitalBridge – the digital infra pioneer 6</p> <p>Digital Infrastructure Executive Summary 11</p> <p>Digital Infrastructure Technology 13</p> <p>Digital Infrastructure Benefits 16</p> <p>Digital Infrastructure Outlook 20</p> <p>Digital Infrastructure Survey Participants 25</p> <p>Infrafinetech – problems, solutions & securitisation 26</p> <p>Cordiant offers new model for digital infrastructure investing . . . 30</p> <p>The DI acquisition bonanza 31</p>
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About M&E Global

MM&E Global is a leading consultancy focused on digital infrastructure. In partnership with Euromoney Institutional Investor and *IJGlobal*, M&E Global has been a leading voice in the technological development of digital infrastructure for the past decade. Mathew Garver and Dr William Cox are co-authors of this special report and managed the global investor survey.



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Defining the **digital revolution**

Sara Pickersgill – co-head of Allen & Overy's global infrastructure group – and her colleagues speak to *IJGlobal* about digital infra and the rapidly-evolving landscape

International law firm Allen & Overy is playing a dominant role in the evolving landscape of digital infrastructure, leading (at time of writing) the *IJGlobal* 2021 DI league tables having acted on some of the most significant deals this year.

For example, this year, A&O advised American Tower Corporation on its acquisition of Telxius Towers from Telefonica, comprising 31,000 communications sites across Europe and Latin America. A&O subsequently advised American Tower on the investment by CDPQ and Allianz in American Tower's European platform to form a new long term strategic partnership.

A&O also advised the sponsor – Digital Colony – on the \$750 million **cell towers sale and leaseback** of more than 4,200 assets, in a transaction with Indonesia-based telecoms provider Indosat Ooredoo.

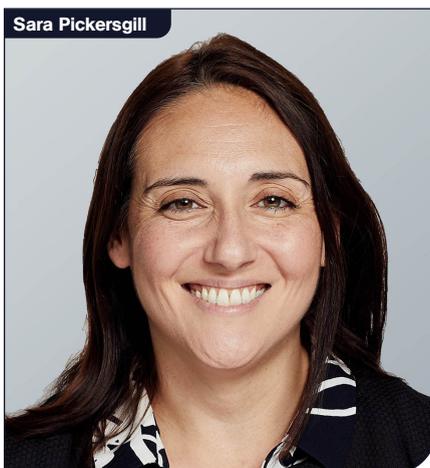
More recently, A&O again acted for the sponsor – this time Clifford Capital – on the highly-regarded **Bayfront Infrastructure Capital Securitisation 2021**, as well as advising Telenor on the merger of Digi.com and Celcom, one of Malaysia's largest M&A transactions. These significant deals closed on 11 June and 29 June respectively and will doubtless feature in next year's *IJGlobal* Awards as a ground-breaking transactions.

Across the broader "infrastructure finance" category in the *IJGlobal* DI league tables for the last calendar year (2020), A&O comes second by deal value but leads (by a comfortable margin) for number of deals closed, having worked on significantly more transactions than any other legal adviser in this sector. Last year, it held a global market share of 11.4% having closed \$12.4 billion of transactions.

Among these deals were the likes of the refinancing of the GSM-R Rail Communications PPP in France which won a trophy in the recently-announced *IJGlobal* Awards 2020 (**details in *IJGlobal* Magazine**).

To give a further flavour of A&O's 2020 international activity, the law firm acted on KKR's acquisition of a majority interest in Telefonica's fibre to the home network in Chile, advised AdaniConneX JV, the joint venture between Adani and EdgeConneX to build out data centres in India and Manassa Hornbaker; and brought to financial close the A\$6.1 billion (\$3.9bn) revolving credit facility for **NBN Co in Australia**.

With digital infrastructure still retaining its fledgling status – one that is surely about to be shed – pedigree and track record for advisers is paramount.



Sara Pickersgill

Given that A&O has positioned itself at the forefront of this burgeoning global sector, that bodes well for the law firm in the years to come.

The digital infra view

IJGlobal has spent the last month compiling the findings of its second annual global digital infrastructure survey – run in partnership with Allen & Overy and M&E Global – and in the coming pages reveals the findings of this far-reaching research.

Last year, the survey revealed a growing degree of comfort in the asset class as market participants increasingly shifted their focus to target developments in this space... a trend that is continued again in this latest survey.

Sara Pickersgill, co-head of Allen & Overy's global infrastructure group, has witnessed the sea change in perception for this asset class – which has been given a significant boost by the coronavirus pandemic.

"The pandemic has increased demand for digital infrastructure with working from home and flexible working among innumerable reasons that have helped push this sector to the forefront of the minds of infrastructure funds that had not been playing in this space before Covid-19," says Sara.

"The pandemic itself has demonstrated the resilience of this infrastructure sector and thrown the spotlight, in many cases, on portfolio selection and diversification. It has highlighted something that took a lot of people by surprise – that not all infrastructure (or even "core infrastructure") is immune to macro-economic events. To

take an obvious point... airports, toll roads and mid-stream energy have all suffered as a result of the pandemic. And it is this that brings into question portfolio selection and diversification."

This, Sara adds, is compounded by shifts in working patterns as offices increasingly open for staff to return... but with many companies incorporating policies that allow an increased capacity to work remotely.

"We all know that we are going to need more fibre infrastructure to meet demand," she says.

One of the key results of the increase in appetite to invest in the sector is that competition for assets has stepped up a gear – which is having the inevitable consequence of driving up prices.

"Competition has become really fierce for quality assets in this sector," says Sara, "but it's not just a cost-of-capital shoot out – the acquirer's profile and expertise is often a crucial factor, something that is marking out the successful funds playing in this space. The winners, more often than not, are those with a well-defined sector specialism."

Jocelyn Land, partner in A&O's global infrastructure group alongside Sara, comments that a similar set of pressures apply to funders. "While we continue to see infrastructure funders maintaining support to their clients in areas such as aviation, they are also keen to diversify their lending portfolios into sectors where current demand is growing and there is a need for capital. While the nature of digital infrastructure assets can vary significantly, these can often be existing businesses with a significant need to raise further funds to expand. This is a sweet spot for many funders who like the ability to assess an existing business while also seeing an opportunity to deploy further capital. The sector is developing quickly and there is significantly more flexibility available now for the right sponsor and asset than there was a few years ago."

Telcos and mobile network operators

The changing role of telecoms companies (telcos) and mobile network operators (MNO) had long been in play prior to Covid-19, but the pandemic has accelerated developments.

"Telcos and MNOs are seeing an opportunity to monetise their infrastructure assets at higher value than they thought possible," says Sara. "This is partly driven by their need for capital to upgrade

infrastructure and densification – to increase capacity – building more towers, adding small cells, installing more fibre-to-the-home, and to roll out 5G.

"They obviously need more capital to achieve these goals and they are often balance-sheet constrained, which means they have greater appetite to partner with private capital."

But it's not all about making a profitable exit, there are also efficiencies to be achieved by telcos and MNOs through partnering with infra funds and building a relationship with an independent towerco or infrastructure operator.

Sara adds: "We have seen lots of active and passive sharing between telcos and MNOs – but those relationships between competitors have not always been happy. Having an independent towerco or netco operator to stand in the middle and lease out the space to a number of them is a happy medium."

This relationship allows the telco/MNO to focus on dealing with customers, and on network and service technology, while a third party – the infrastructure fund – operates the essential infrastructure.

"The efficiencies that can be achieved are many," says Sara. "The independent infrastructure operator can lease out more space and enter into co-location agreements with all your competitors which reduces costs."

"But for the telcos and the MNOs, they are not just looking to monetise. They are looking for an experienced partner to manage assets that are critical to them."

"While there is a lot of capital looking to come into this space, the successful ones are often those that have track record and can demonstrate that they have done all of this before. This again plays well to those with a sector specialisation."

The ESG angle

And then you have the environmental, social and governance aspects of digital infrastructure. Across the entire infra sector, this has evolved into such a key focus area that *IJGlobal* this year launched its inaugural *ESG Awards* to celebrate achievements in this space. In the DI space, ESG is building momentum.

"Infrastructure funds are trying to make compatible their commitments to decarbonisation, to attain stringent ESG targets and reduce their carbon footprint against building out data centres, for instance, that consume huge amounts of energy," says Sara.

"They are having to think strategically about how they offset that impact, finding interesting solutions that range from solar panels on the roofs of these facilities and investing in renewable energy to offset their impact on the grid."

"There are however positives for ESG rankings – even if there are some negatives

"We have seen lots of active and passive sharing between telcos and MNOs – but those relationships between competitors have not always been happy."

Sara Pickersgill

Co-head of global infrastructure group, Allen & Overy

on the E side – as enhanced connectivity could bring some beneficial impacts on carbon footprints with, for instance, people travelling less.

"On the S element of ESG, demonstrable positives include the supporting of local communities and rural connectivity, bridging the social divide in these areas. Further, improved connectivity and access to reliable internet arguably leads to improved access to education and employment opportunities in disadvantaged areas."

Matt Townsend, partner and co-head of A&O's environmental and climate team also observes the growing connection between the sustainability agenda and digital infrastructure. "Whilst the whole life cycle of an asset increasingly needs to be taken into account, countries are not going to hit their climate targets without significant investment in digital assets. These have a major role to play." Matt notes that "many of the core strands of the recently announced 'Fit for 55' package from the European Commission will need digital support and innovation even though they are targeted at many of the more traditional infrastructure asset classes."

Jocelyn Land adds, "We are also really seeing the infrastructure funders increasing their focus on ESG, both in terms of increasing their monitoring of what their borrowers are doing and offering more attractive financing terms to companies that can demonstrate excellence in key performance indicators. As Sara says, the E and the S can conflict with each other in the digital infrastructure space, but the approach of funders is just another incentive to find innovative solutions."

In terms of innovative solutions, Jamie Palmer, a partner in A&O's Sydney office who has worked on several data centre deals in APAC including Equinix' acquisition of Metronode for AUD1.035 billion, notes the breadth of thinking. "We are advising a bitcoin miner who builds data centres that use only renewable energy power sources. This creates a pathway for environmentally conscious investors to obtain exposure to digital infrastructure and bitcoin (as the business model sees the bitcoin generated from the mining activities immediately converted to cash)."

The role of governments

Nobody doubts the scope of the digital infrastructure opportunity. There is a huge international pipeline of greenfield developments on the cards as the DI revolution gains momentum, coupled with government support.

"There is political support for digital infrastructure investment with governments setting ambitious targets," says Sara. "In the US alone, President Biden's announcement of the \$2 trillion infrastructure build which committed \$100 billion to digital infrastructure, particularly to reach currently unserved and underserved communities, is a significant development."

Similarly, the EU has ambitious targets by 2030 for all households to have gigabit connectivity and for all populated areas to be covered by 5G. But political support is coming at a time of increasing scrutiny over foreign investment on the basis of national security considerations. Over the last three years globally we have seen a rapid influx of new foreign direct investment – or FDI – regimes come into force and countries with existing regimes introduce more stringent rules.

"Traditionally the focus was predominantly on defence and security-related sectors, but the vast majority of FDI regimes have extended scope to critical infrastructure – a definition within which digital infrastructure is now firmly seated," says Sara. "Much of this new regulation was hastily put together as a response to the pandemic, with low acquisition thresholds triggering review, lengthy assessment periods, and often with a lack of clarity as to the specific assets falling within scope."

While historically the majority of investments into Europe that are subject to these regimes receive clearance, there are often draconian consequences for falling foul of the rules – in some cases criminal sanctions, or even for individuals, imprisonment.

As a case in point, Sara cites the UK's National Security and Investment regime, set to commence fully on 4 January 2022, bringing with it wide ranging government powers to investigate and intervene in transactions on national security grounds. Data infrastructure and communications networks are among the 17 defined sensitive sectors requiring mandatory pre-notification and clearance.

"The combination of some lack of clarity of exactly what falls within scope of the mandatory regime, civil and criminal sanctions for getting it wrong, and the government's power to call in a transaction for review up to five years after close are bound to create some uncertainty for investors looking to transact in the sector," says Sara, "and while none of that seems to have dampened appetite to invest, transactions in the sector are getting more complicated to bring to the finish line." ■

DigitalBridge – the digital infrastructure pioneer

DigitalBridge Chief Executive Officer, **Marc Ganzi** speaks to IJGlobal about the potential for global digital infrastructure investment and the pioneering role his firm plays in this space

Digital infrastructure (DI) as an asset class has benefited in recent times from strong secular tailwinds around connectivity and the growing importance of access to data, which in turn is driving an upsurge in activity in this space.

Over the next five years, the market anticipates five-fold growth in global network traffic from 50 exabytes per month to more than 250 exabytes – leading to an environment of “invest or die” on big-ticket transactions.

As it stands, there is a requirement for \$1.1 trillion of worldwide investment in mobile capex with about 80% of that sum being deployed on 5G buildouts. This headline figure, however, is likely to be overshadowed by the global data centre capacity buildout.

These investments are key as Internet of Things (IoT) devices impact the market on a daily basis and telecom networks are re-framed and proliferated, making it all the more important for the DI community to fully understand challenges faced on a global scale.

The movement to 5G – a predictable transition that occurs every 7-8 years as mobile technology evolves to the next level

– will bring about a step-change in mobility as the market goes through one of the biggest radio technology changes ever seen (*Figure 1: 4G-5G Comparison*).

Meanwhile on the Cloud side of the DI spectrum, migration is moving at pace. Ten years ago, less than 1% of data were hosted on the public cloud. This rose to 18% last year (2020) with full-year stats for 2021 expected to mark a significant increase, aided in no little part by the Covid-19 pandemic.

As workloads continue to transition to sit on the Public Cloud, the requirement to invest in the infrastructure to support that migration is key to maintain momentum and keep pace with technological developments.

For organisations like DigitalBridge that are entirely focused on this ecosystem, track record is all important, and with 27 years’ investing experience in the DI space, no asset manager is better placed to give its views on the market.

Here Marc Ganzi – CEO of DigitalBridge – explores the global opportunity afforded by the upsurge in investments across the international DI arena, identifying key trends over the next 5-10 years while also sharing a cautionary tale.



DigitalBridge

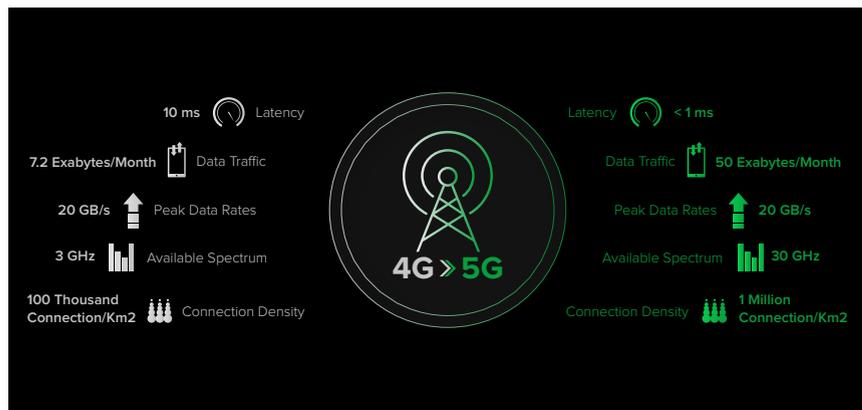
Timing of the publication of the Global Digital Infrastructure Survey 2021 and this report (its second iteration) is ideal given that the DI sector has witnessed a surge in activity over the course of the last two quarters with asset allocators rushing into the space where DigitalBridge is a leading REIT.

DigitalBridge is the only dedicated, global-scale DI firm investing across the ecosystem in towers, data centres, small cells, fibre, and the emerging Edge infrastructure vertical – ideally placing it as a thought leader in this burgeoning market.

DigitalBridge manages more than \$35 billion in assets focused exclusively on the DI opportunity. And this impressive set of assets under management (AUM) has increased by more than 70% since Marc became chief executive last year (2020).

The last few months have been especially active for DigitalBridge, having announced in July the formation of EdgePoint Infrastructure, a leading wireless tower platform in Asia. This investment was preceded in June with completion of the acquisition of Boingo Wireless – a US distributed antenna system and Wi-Fi provider that serves carriers, consumers, property owners and advertisers globally.

Figure 1: 4G-5G Comparison



Source: Qorvo.

In May, DigitalBridge also celebrated the launch of AtlasEdge, a joint venture with Liberty Global to develop Edge data centres across Europe.

One of the key differentiators between DigitalBridge and other asset managers is that it has unique capability to invest, operate and build digital infrastructure. It has the investment experience of an asset manager, deploying capital on behalf of (and in partnership with) large institutional investors that are attracted to the growing, but resilient profile of DI assets.

Market Demand

In recent research, IJGlobal identified cash raised in H1 2021 by unlisted infrastructure funds to target activity in the telecom sector accounted to 12% of all funds to reach final close in that period. As to M&A activity, it is outpacing funds raised in a sector that is not solely reliant on infra funds.

However, the market-wide upsurge in fundraising and M&A activity will play a key role in achieving digital transformation – the integration of digital technology into all areas affecting industries, businesses and consumers, fundamentally changing how the market operates and delivers value to customers.

Organisations' desire to position themselves for sustained growth in the DI space is matched by the need to invest. IBM notes that 90% of the world's data was created in the last two years alone, while the IDG Cloud Computing Survey identifies that 81% of organisations are already using cloud computing or have applications in the cloud – up from 73% in 2018 (Figure 2: Cumulative Data Center Capex).

This transition is set to increase as IDC in a recent white paper predicts that by 2025 nearly 30% of data generated will be real-time, driven by both consumer preference and enterprise needs for real-time data.

The need to invest will continue to drive greenfield developments and – every bit as important – M&A activity as players seek to consolidate their positions.

"The rush by asset allocators is entirely predictable," says Marc. "This sector has attracted so much attention because GPs can write huge cheques in this space."

Marc adds: "Some infrastructure asset classes are out of favour these days – like mid-stream energy due to ESG policies – and investors are looking to find the next big thing... and digital infrastructure is at the top of every infrastructure GP's agenda today.

"That alone adds a whole new layer of complexity because you have a ton of capital flooding into this space with people who do not have an industry operating background, while bankers peddle deals indiscriminately.

"We are at a great take-a-step-back moment to stop and define what is 'digital infrastructure.' It is essential that we be intellectually honest about it and define what makes it infrastructure and what makes it not infrastructure."

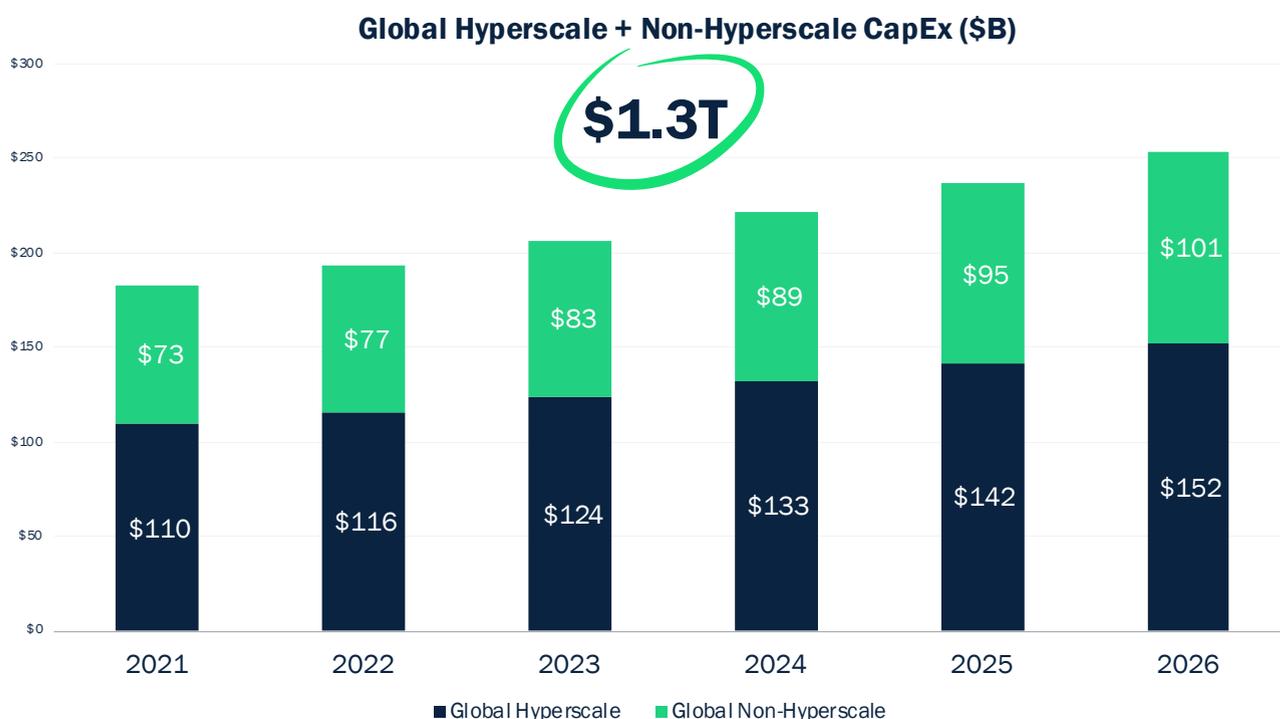
Given DigitalBridge's experience in the DI market and its international scope, it opens up a great deal of opportunity for this market leader to cherry pick its targets.

"We are spending our activities in multiple geographies and sectors," says Marc. "We take a very customer-centric approach to how we put capital to work – and that is obviously going to differentiate us from our peers."

DigitalBridge takes a thoughtful approach to targeting markets and sectors for investment, building on the team's experience and understanding of how digital infrastructure is evolving.

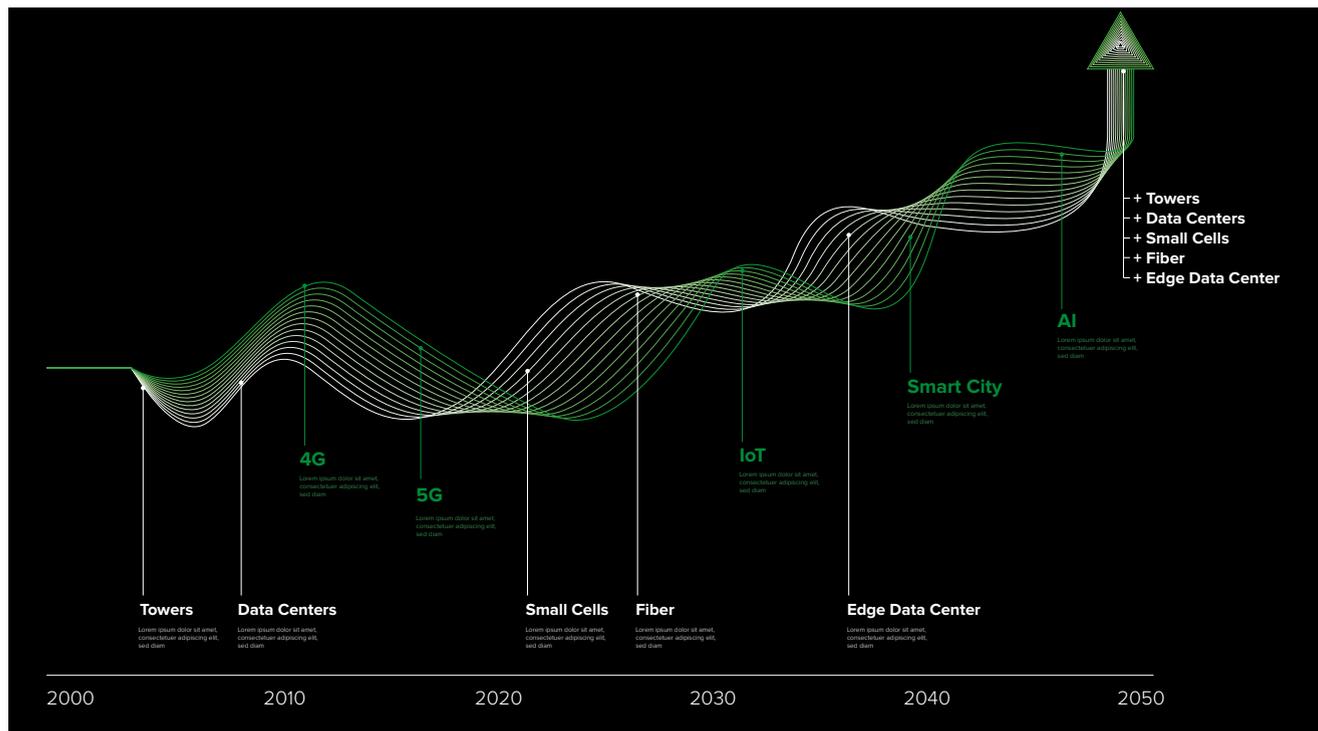
"There are four big thematic micro-trends below the secular trend of digital infrastructure," says Marc. "Take a look

Figure 2: Cumulative Data Center Capex



DigitalBridge Inaugural Investor Day June 2021 - Sources: Credit Suisse, Dell'Oro

Figure 3: DI Progression



Source: DigitalBridge

at big asset allocators. Many of them are super focused on digital because they are telegraphing to The Street that they are secular investors, investing in a secular trend that they think is big... and digital is top of the list.

“But you have to ask what is their investment thesis? Where are you going and what is driving their approach?”

Marc continues: “What we say to investors is that over the next decade there will be four things that will change our lives and that will profoundly change in themselves... and these are: Cloud adoption; the usage and proliferation of IoT devices; the movement from 4G to 5G; and then the movement towards the Edge.”

With a \$1.1 trillion capex spend estimated for the upgrade from 4G technology to 5G alone, the requirement for a diverse set of players to achieve this goal is essential. But 5G is far from the only DI sector writing big cheques. Cloud players are understood to be spending on average \$89 billion per quarter to achieve their goals (*figure 3: DI Progression*).

“With the Edge, you have to consider where servers are going, where the capacity is required and where is the computer workload heading,” says Marc. “One of the

great secular trends coming out of Covid is this migration to digital – all things digital – and this is what has allocators rushing into the game.

“We are building large cloud campuses across Europe, Latin America, North America and Asia – and we think the ability to service cloud customers around the globe is an important macro trend.”

Global asset allocator in

DigitalBridge’s union with Liberty Global (one of the world’s leading converged video, broadband and communications companies) is an ideal case study for its strategy to create a joint venture – AtlasEdge Data Centres – to serve growing European demand for scalable data centre capacity that brings applications and content closer to the Edge.

The JV is subject to receipt of customary regulatory and merger control approvals, and it is anticipated that the transaction will close in Q3 2021.

When it comes to partnering on such landmark deals, it is essential that both parties are skilled in the digital infrastructure space.

“We have a team that’s been doing this for more than 25 years, with deep industry

relationships that drive access to proprietary investments and position us to continue to be a leader in digital infrastructure,” says Marc.

“We are very focused on Edge computing in Europe and we think the proliferation of Edge servers in pushing workloads out to the perimeter of the network in Europe is a big trend.”

DigitalBridge has a strong focus on towers and has built impressive footprint in this space.

Marc says: “We made a significant investment in Vodafone’s tower business, Vantage Towers. Why? Because we believe it is a fantastic business and Vodafone is a great and long-standing customer of ours. Vodafone requires a significant amount of capex to deploy for its 5G infrastructure. That is a great example of investing in the future and investing in 5G.”

On the Cloud side of the business and the migration to Cloud, DigitalBridge has clearly identified Asia as a key market for investment.

“Asia is a unique market and we formed a business there called AgileDC which is building large web-scale campuses throughout the region,” says Marc. “The starting point there has been in Japan, but

we continue to target South Korea, Australia and Singapore as key markets for greenfield development. We also recently announced the acquisition of PCCW's assets in Hong Kong and Malaysia which will accelerate our scale in the region."

"All of the major cloud players need to build more infrastructure in Asia and we believe this is going to be one of the great opportunities in the digital infrastructure space."

The Internet of Things (IoT) ranks as a primary opportunity for DigitalBridge.

"Thinking through the future of wireless networks and all things related to IoT, we made a significant investment in Boingo which is one of the largest owners and operator of indoor wireless networks and Wi-Fi networks," says Marc.

"Those Wi-Fi networks support Enterprise 5G but also support the proliferation of IoT devices inside key venues like airports and stadiums, office buildings and hotels where you can deploy next generation technologies based on Wi-Fi 6 which will ultimately help to manage facilities. It's more than just mobility, it really goes to the operation of the enterprise."

DigitalBridge is taking a sector-wide approach to the market... on a global basis.

"We are working in 5G, Edge, towers and Cloud and we have four case studies from the last six months into why we are investing and how we are investing," says Marc.

"What is interesting is that we're doing this in the US, Latin America, Asia and Europe... these trends are global in nature. One of the great things about digital is that it transcends boundaries and we have done a great job of demonstrating that.

"We are super busy. We have a lot happening. But we're going to stay true to these thematics and continue to invest on a global scale."

A cautionary tale

Any market observer worth their salt will have taken note of a frothy digital infrastructure market which should set alarm bells ringing as prices sky-rocket and competition leads those with less experience to make bad decisions... particularly in an environment where competition can scale up swiftly (*Figure 4: Buy vs. Build*).

"My belief is that today assets are priced to perfection," says Marc. "There is a lot of liquidity flooding into the system, chasing a really hot asset class. However, history has shown us that this is where you can get into a lot of trouble.

"A cautionary tale... there's always an

Figure 4: Buy vs. Build



Source: DigitalBridge.

in-favour asset class, so you have to be aware of the risks. Take a look at mid-stream energy which was the darling of infrastructure 6-7 years ago – and look what happened.

"You saw a lot of marginal management teams moving into the space, raising a lot of capital and feeling the pressure to deploy. This is a conundrum for GPs today – they are on this constant journey to raise more and more money, launch fund after fund, and get fees... but you have to operate the assets.

"Operating the assets is hard. This is not a utility, an airport or a toll road. These businesses are complex and require a deep understanding of technology, your customers, their needs, and the migration path of that network.

"And that's not easy."

DigitalBridge has the benefit of experience having been working in this space for more than 27 years and – up until a couple of years ago – forging its path pretty much alone. That environment has changed dramatically in recent years.

"Now everyone else wants to do it," says Marc. "But my counsel to investors is – do your homework and make sure there's a strong operating team running these assets as it's a hard and complicated business."

With the prices that assets are currently fetching in a frothy market achieving eye-watering multiples, caution should be every investor's watchword.

"We see an alarming trend between the dislocation between M&A prices and ultimately the replacement cost of new facilities. One of the things you can do in this business is over-build," says Marc.

"While it's very difficult to build a new water system or an electricity transmission grid for an entire city, those deals have huge barriers to entry and they trade for the appropriate multiples.

"With businesses in the digital infrastructure space, you can build other fibre networks, data centres, you can overbuild or put another cell tower next to an existing cell tower."

Marc adds: "The ability to build on a greenfield basis is hard and that requires a set of skills that infrastructure GPs generally just don't have.

"So this is going to be a really interesting 5-10 years in investing because the teams that really understand the operational complexity of these assets are going to do well. Meanwhile the teams that do not have that understanding of the operational complexities are not going to do quite so well.

"We are moving into a very bubbly top of the market type of environment and this is where we need to be careful. We need to be prudent, disciplined and this is a moment for pause and reflection. Yes, these are amazing secular trends, but there are also some things happening that are a bit unnatural... purely from a returns perspective.

"Our firm is being very disciplined right now. Discipline is our battle cry at DigitalBridge.

"We have made it here for 27 years and my hope is that we are here for another 27... and the only way we're going to manage that is if we are disciplined allocators of other people's capital.

"That is our job – to be a great fiduciary." ■

The DigitalBridge Difference

INVESTOR • OPERATOR • BUILDER

With a heritage of investing capital efficiently, operating digital infrastructure assets, and building businesses, we have a unique, innovative approach to growth and value creation on behalf of our customers and investors.



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Global Digital Infrastructure Survey 2021

Executive Summary

The *Global Digital Infrastructure Survey 2021* was conducted by *IJGlobal*, sponsored by international law firm *Allen & Overy* and run in partnership with *IJGlobal's* digital infra (DI) partner *M&E Global*. This is the second version of this report (first published 2020) and drew in international responses from almost 200 infrastructure and energy industry professionals who are currently involved in delivering, financing/lending or advising on transactions in the DI space.

The highlights of this international survey (by percent of respondents) are:

- 70% – 5G and advanced data centres are developing most
- 70% – cyber security is the main building block needed in DI
- 65.3% – reducing costs is the main benefit of DI
- 61.1% – resilience is the second main benefit of DI
- 66% – the energy sector will save the most costs from DI
- 63% – smart cities will also save costs
- 71.3% – key benefit of DI for the power sector is to reduce outages and improve resilience
- 79.2% – main benefit of DI for the transport sector is usage optimisation
- 64.3% – cyber breaches constitute the overall biggest risk of DI
- 62% – greatest risk to the public sector for not investing in DI
- 75.3% – governments and regulations are greatest obstacle to DI
- 56% – roads and railways are going to be most outpaced by DI
- 65.3% – lowering emissions is the greatest ESG benefit of DI

These findings – as the coming pages will reveal – identify a significant evolution from the inaugural *Global Digital Infrastructure Survey* that was run in 2020, showing a rapid development in the sector as the market evolves swiftly and participants become increasingly comfortable with it as an asset class. *IJGlobal* anticipates this trend will continue in coming years with a corresponding uptick in market activity.

As to the findings of the latest DI survey, many of the responses are in line with research carried out in recent years.

Connectivity and data centres – IBM identified in 2017 that 90% of the data in the world had been created over the previous two years (2015-2016). This trend has continued and in 2020 global data amounted to 40 Zettabytes (40,000 Exabytes), which is 300 times the data volume of 2005. This explosion in data transfer levels can only be handled by a major expansion to digital infrastructure.

Cyber security – cyber crime cost the world \$1 trillion last year (McAfee, 2020). Now companies worldwide are spending \$1 trillion to combat it, with banking institutions like JP Morgan Chase and Bank of America each allocating \$500 million annually to protect their digital processes (Forbes, 2018).

Cost savings – while traditional cost saving tools such as layoffs can reduce 2% in costs for enterprises, increased efficiency through digital transformation reduces costs by 5-25% (Innovationcloud.com, 2021) (retaintech.com, 2021).

Resilience – countries with good connectivity are able to mitigate half of the negative economic impact of the Covid-19 pandemic (ITU, 2020).

Energy – the energy sector will change more in the next 10 years than it has in the past 100 years, mainly due to digital infrastructure technologies (GE, 2021). Today the world needs 20% less energy to generate \$1 of economic output than 19 years ago (IEA, 2020).

Smart cities – one report estimates that the global smart city technology market could reach \$1.7 trillion in cumulative revenues 2019-2028. This 2019 study also claimed that cities could save \$5 trillion annually by 2022 through improved levels of digital transformation (Navigant Research, 2019).

Power – global demand for power is expected to increase by 50% by 2040, which can only be achieved with digital efficiency gains. Technological advances mean that \$1 spent today on wind and solar photovoltaic (PV) facilities will generate 400% of the amount of electricity that was achieved from \$1 spent on the same technologies 10 years ago (IEA, 2021).

Transmission – power outages are reported to cost American households \$150 billion annually. Microgrids are seen as an effective strategy against power outages, but depend on sophisticated software and data flows.

Transportation – digital infrastructure has given rise to an entirely new sector, the

Intelligent Transportation Market, which already boasted a global market value of \$26.58 billion and a projected CAGR of 5.8% for 2020-2027 (grandviewresearch, 2020).

Public sector – except for the US, only smaller countries make it into the top 10 of the most digitally-advanced countries. In the US, the digital economy was already ranked fourth with a contribution of 9.6% of GDP (BEA, 2021).

Governments – perhaps motivated by the Covid-19 crisis, the European Commission updated its digital strategy in 2020, increasing investments in AI to €20 billion annually through 2030, after spending only €3.2 billion in 2016 on AI (McKinsey, 2020).

Traditional vs. digital infra – for roughly every \$1 million invested in digital infrastructure, 30 qualified jobs are created (AIB, 2020). The European Commission announced its Digital Europe investment programme which will allocate €9.2 billion to digital transformation in the region over the period of 2021-2027. However, most recent estimates are that traditional global infrastructure will need \$94 trillion invested between 2017 and 2040 (GIH, 2021).

ESG – digital technology could reduce carbon emissions by 15% (or one-third of the total reduction required) by 2030. The World Economic Forum states that the global economic and social impact of digital transformation will be worth roughly \$100 trillion by 2025. ■



Digital Infrastructure Technology

Digital infrastructure consists of components that build on each other. Fifth generation (5G) mobile connectivity and advanced data centres go hand-in-hand, processing and transporting up to a projected 181 zettabytes by 2025 (Statista, 2021).

5G can transmit up to 1,000x the data amount of 4G. Smart applications involving cities, water, transportation, industrial production, in turn, build on advanced data centres, connectivity and the Internet of Things (Figure 1).

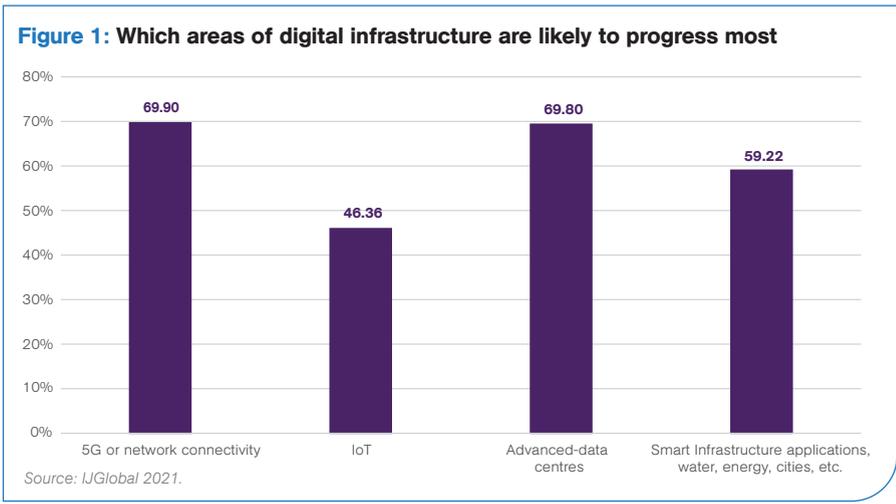
Nearly 70% respondents see 5G connectivity and advanced data centres as the areas with the most immediate growth. The advantages of 5G over 4G and older generation technologies are:

- faster data transmission
- increased responsiveness – lower latency
- connecting more devices – for IoT and other smart applications

Connectivity

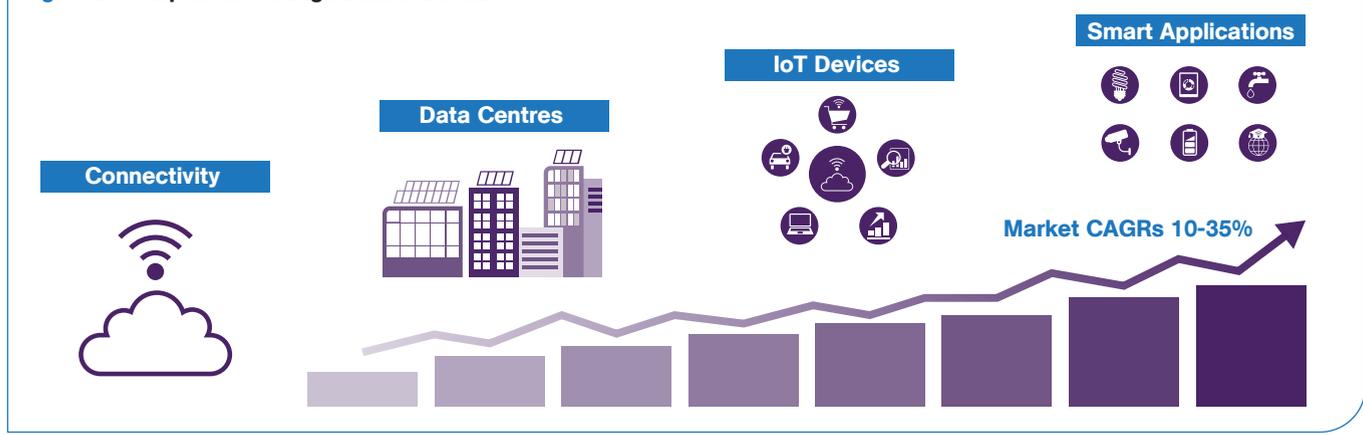
There are two dimensions to 5G/ connectivity – B2C and B2B. In the first instance, B2C is popularly known largely as mobile networks involving smartphones, laptops and computers (Image 2). In February 2021, more than 30% of the world's countries had access to 5G (lifewire.com, 2021).

However, advancing to 5G is not a simple feat. It involves five major technologies to raise bandwidth and data transmission:



- millimeter waves – opens up more frequencies and thus data capacity and speed
 - small cell base stations – improves coverage of millimeter waves because these waves are more easily obstructed by walls and even rain
 - Massive MIMO (multiple input, multiple output) – 100 ports, instead of 10-12 per radio tower
 - beamforming – helps focus the increased signal density and number put out by Massive MIMO, thus decreasing interference and raising signal distance
 - full duplex – enables simultaneously sending and receiving data. Current base stations can only send or receive. Currently, the scales are tipping towards B2C applications, such as connected cars, smart industry, smart transport, among others.
- For the first time in 2020, there were more B2C IoT connections than B2B non IoT connections. Of the 21.7 billion active connected devices worldwide, 11.7 billion (or 54%) were IoT device connections at the end of 2020 (IOT Analytics, 2021).

Figure 2: Components of Digital Infrastructure



This development is driven by the need for efficiency in industrial and large public infrastructures and the compound annual growth rate (CAGR) dramatically increases as you advance up the digital infrastructure staircase towards IoT and applications.

The challenge for emerging markets is to get past the expensive phases of setting up 5G connectivity and advanced data centres, although new business models have raised the margins of installing and operating networks and data centres.

Revenue from wired connectivity (all interface functions and controllers) will grow by a 3.9% CAGR to reach \$26.3 billion in 2024 (Gartner, 2021). By comparison, estimates are that the B2B IoT segment will soon top \$300 billion in revenues (Intel, 2021).

Data Centres

Nearly 70% of respondents to the *Global Digital Infrastructure Survey* see advanced data centres as progressing strongly in the coming years. Clearly data must be processed and stored in order to be transmitted via 5G. To meet rapidly-growing needs to handle data, advanced data centres are replacing older, less efficient facilities that are being upgraded or phased out.

Data volumes in data centres increased by more than 4x between 2010 and 2018 (Data Center Knowledge, 2020). The global data centre market is anticipated to reach \$174 billion in revenues by 2023 with a CAGR of 4% between 2018 and 2023 (Arizton Research, 2020).

In 2010, smaller data centres run by large organisations and telecommunications companies handled 79% of the world's computing. By 2018, some 89% of computing was hosted by cloud data centres, including hyperscale and smaller cloud computing facilities (Sverdluk, 2020).

And there is a cost benefit from scaling up facilities. Increasing a data centre capacity from 1,000 to 100,000 servers reduces the relative total cost of ownership (TCO) by 80% (Microsoft, 2020).

Transformation in the data centre sector is characterised by five major developments:

- standardisation/consolidation – older, smaller and less efficient data centres are replaced by larger, more efficient and more standardised facilities
- virtualisation – virtualised desktops can be hosted in data centres, lowering costs and energy costs for companies
- automation – automating tasks such as provisioning, configuration, patching, release management, and compliance are needed, not just when challenged by too few skilled IT workers

- security – the annual economic damage of cyber breaches is estimated at a cost of roughly \$1 trillion (McAfee, 2021). Respondents of this survey cite cyber security as one of the major risks of digital infrastructure
- energy efficiency – energy is a major cost position in data centre operations. Cutting energy costs while increasing scale has kept data centre energy consumption at roughly 1% of global energy consumption for more than 10 years (Kooimey, 2020)

Most data centres of all types are located in the US with a global share of 38%, although Asia is the fastest growing region and should lead by capacity within the course of 2021. Currently there are 597 advanced hyperscale data centers worldwide (Statista, 2021):

The average annual cost of operating a large data centre amounts to between \$10 million to \$25 million. Just under 50% goes for hardware, software, disaster recovery, continuous power supplies and networking. A second large chunk is allocated for maintenance of applications and infrastructure. The remainder of the cost is for heating, air conditioning, property and sales tax, and labour costs (Stream Data Centers, 2021).

The drive for more efficiency and regulators' push for carbon neutrality has led to data centre operators focusing on methods to save energy. Typically, servers and data equipment consume roughly 55% of the energy, 30% goes for cooling, 12% for power distribution losses and 3% for lighting (Data Center Knowledge, 2021).

To save the energy costs of keeping a data centre at 70F/21C or cooler, data operators have built new centres in cold countries such as Canada, Scandinavian nations and Switzerland, thus benefiting from colder ambient temperatures. There have even been experiments to host them under water.

The standard for measuring operating efficiency in data centres is the Power Usage Effectiveness (PUE) ratio, which is total centre power input / power used by IT equipment. PUEs of 2.0 or lower are considered good. The PUE of data centres has been declining consistently over time from 2.5 in 2007 to 1.59 in 2020 (Space Watch Africa, 2021).

However, running data through centralised data centres is partially giving way to cloud and edge computing facilitated by 5G. This means that data movements and storage are closer to the machines and people where the data is needed and processed.

IoT & Applications

Nearly 60% of survey respondents see smart applications and 46.36% IoT as developing strongly in the near future – yet, both are inextricably related. Smart applications cannot function without IoT. For many, IoT is a less tangible concept than the smart applications which IoT functions enable. Yet the IoT is large, reaching \$11 trillion by 2025, according to one study (WEF, 2019). The CAGR is projected at 26.9% for 2020-2025 (marketdataforecast.com, 2021).

"In the simplest terms, the Internet of Things refers to the enormous network of connected machines that is the result of adding connectivity to devices beyond traditional computing devices. IoT encompasses billions of network-connected sensors, cameras, wearable devices, vehicles, assembly lines, and even robots. Combined with the computing power of the cloud, IoT data will feed an AI engine, delivering insight and new levels of machine-to-machine coordination that will improve lives and accelerate economic growth" (Intel, 2021).

An IoT device supplier described IoT simply as: "The essence of IoT is taking an inanimate object (a refrigerator), applying sensors to detect something (the refrigerator door has been left open), and it communicating its findings to you (you receive an alert about the open door), giving you control over your business and systems in a more streamlined way" (Monnit, 2021).

The IoT market is typically segmented into three components:

- software – data management, remote monitoring, network management, security solutions
- hardware – sensors, cameras
- services – managed services, professional services

Key players in the IoT space include Alcatel-Lucent, Amazon, Atmel, Cisco Systems, Google, Hewlett-Packard, Huawei Technologies, IBM and Oracle.

Industries most widely using IoT include IT and telecommunications, retail, healthcare, automotive, public, manufacturing, logistics, among others. While many think of smart cities when they think of IoT, Industrial IoT (IIoT) is the major revenue driver as enterprises of all sizes seek to reduce the total cost of ownership of their facilities through IoT.

Retail

E-commerce sales worldwide will grow from \$25 trillion to \$29.8 trillion by 2022 (eMarketeer.com). Stores could develop to

look more like showrooms where customers can shop with a virtual cart without cashiers. In addition, 5G will improve inventory and stock management real time.

Healthcare

Doctors and patients will be more connected. Wearable devices could alert healthcare providers when a patient is experiencing symptoms – like an internal defibrillator that automatically alerts a team of ER cardiologists to be ready for an incoming patient, with a complete record of data collected by the device.

Agriculture

Using data from sensors located in fields, farmers can determine crop areas needing irrigation, suffering from disease or pests, and conduct health monitoring of livestock, plus benefits in supply chain efficiency.

Manufacturing

Production facilities will be seriously upgraded with 5G, AI and IoT. These technologies will facilitate predictive maintenance, helping control costs and minimise downtime. Production processes will be analysed and immediate adjustments made. Output will increase at lower costs.

Logistics

Inventory can be more effectively tracked and communication among vehicles improved. Thus, monitoring a fleet and supporting driver navigation can be upgraded.

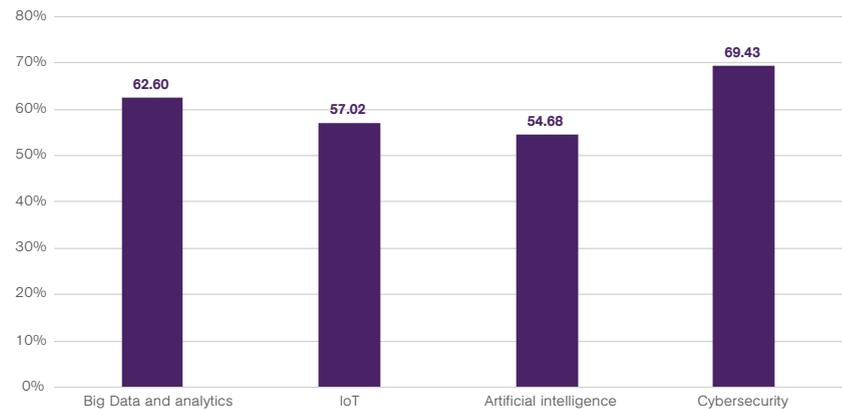
Cloud and IoT make cyber security the most important issue

Respondents to the *Global Digital Infrastructure Survey* cite cyber security, big data and analytics, IoT and AI all as important building blocks in the digital transformation of infrastructure processes. The range between cyber security at nearly 70% and AI at roughly 55% is narrow because all building blocks are strongly interrelated. However, respondents are right to cite cyber security as a primary concern.

IoT is about connecting devices with devices and people. This necessarily exposes data to higher cyber risks than if it travelled through hard wires to and from data centres, which is estimated to offer an 85% protection level (Zewdie & Girma, 2021). With data movements becoming more decentralised (via edge computing), these data become more difficult to protect.

With cloud computing growing at 17% annually to currently \$227.8 billion (and 50% growth in 2020), cyber vulnerabilities have been on the rise. In 2020 alone,

Figure 3: Which technology building blocks are most important for infrastructure digitisation



Source: IJGlobal 2021.

cyber attacks via the cloud have increased by 250% across all industries. This works out to 7.5 million attacks in 2020 (Securitymagazine, 2021).

Decentralised computing – be it through employees working from home or sensors and machines exchanging big data in a factory – has facilitated a 4x increase in cyber breaches during the pandemic (FBI, 2021).

Estimates are that the economic damage of cyber breaches now totals more than \$1 trillion annually – a 50% increase over 2018 (McAfee, 2021). Some 56% of companies recently surveyed admitted not having a proper plan in place against cyber attacks. And the likelihood of catching a cyber criminal is 0.05% (WEF, 2020).

Yet the trend is that data will neither take a detour via data centres nor through the cloud, but will move between IoT devices at a micro level (edge computing) – all this facilitated by 5G. One estimate is that more than 50% of enterprise data will be processed outside of data centres and the cloud in a few years (Gartner, 2020).

One upside to this is that when networks are down, people and machines can keep working because data is still flowing and being processed. While this is economical and efficient, decentralising data processing to this extent poses an added cyber security risk.

Big data and AI

Without AI, digital infrastructure would only be a huge and growing soup of disorganised and non-actionable data. AI recognises patterns in data, improves features and makes predictions in this flood of data. Global GDP could be 14% higher by 2030 as a result of AI (PwC, 2017).

Massive, evolving and complex datasets constitute the raw material which AI needs in order to be effective. With 127 new devices being connected to the internet every second, data volume is huge and potentially useless without AI (Zewdie & Girma, 2021).

Artificial Intelligence

AI can be defined as a machine's capacity to decode and understand the input in an intelligent system. It commonly encompasses five technologies (Schiliró, 2020):

- computer vision
- natural language
- virtual assistant
- robotic process automation
- advanced machine learning

In any case, AI is big business, attaining a business value of \$4 trillion by 2022 (Gartner, 2018). Nearly 55% of the respondents in this survey consider it a key building block of digital infrastructure.

Besides AI being the key to making data useful and actionable, it plays an important role in improving cyber security. With cyber threats constantly changing strategies, AI is a way to adapt an organisation's cyber defense. This translates into several functions which raise cyber security – reporting existing vulnerabilities on real-time, big IoT data analytics, cyber attack detection, and containment delivering threat alert.

The downside of AI/machine learning is that hackers use it too in developing more sophisticated cyber attacks – giving all the more reason for digital infrastructure to use it as a defense mechanism. ■

Digital Infrastructure Benefits

Cost reduction, resilience and ESG are considered the greatest overall benefits of digital infrastructure, with regulatory compliance getting less than a sixth of the votes given to the top two.

Digital infrastructure itself does not reduce costs, but the technologies it enables do. While traditional cost saving tools such as layoffs can reduce 2% in costs for enterprises, increased efficiency through digital transformation reduces costs by 5-25% (Innovationcloud.com, 2021) (retaintech.com, 2021). In addition, layoffs have a backlash effect on costs both for enterprises and society.

Despite this upside, a study found that more than half of enterprise IT executives found it difficult to secure approval for digital transformation projects (Interoute, 2018).

Respondents to the *Global Digital Infrastructure Survey* were right to put cost savings on top of the list of reasons to digitally transform.

Cost efficiencies in shipping and freight

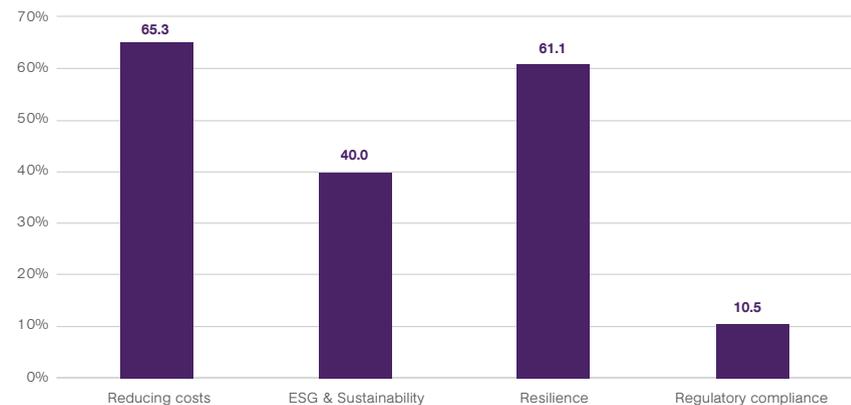
World trade is among the largest of all sectors, reaching a volume of more than \$19.051 trillion in 2019, increasing by 26% since 2008. This includes in excess of 24 million containers on 6,136 ships moving around the world (shippingandfreightsources.com, 2020).

Covid jolted this sector – as it did so many – to advance digitally. Estimates are that 125 tech companies are disrupting the sector digitally. Shockingly, this complex sector still relies on a lot of manual paperwork. However, a recent survey revealed that 67.7% of executives interviewed said they would invest in technology following the lessons learned through Covid (Ocean Insights, 2020). This would mean that a five-to-seven day process could be reduced to seconds/minutes.

Typical examples of how digitalisation using digital infrastructure can reduce costs in most industries include:

- energy costs – these are a big cost for most companies. Even old equipment can be optimally maintained and energy consumption optimised, impacting costs
- software – centralising data from all

Figure 1: Most Important Overall Benefits of Digital Infrastructure



Source: IJGlobal 2021.

- areas of the company made available to the rest of the company in real time, informing decision making
- using the cloud – data is hosted on a cloud-based system, allowing savings of up to 50% compared to traditional physical infrastructure
- Internet of Things – IoT makes each machine smarter and able to measure performance, and process/analyse data. This raises productivity, improves product quality and reduces downtime
- automate tasks and processes – allowing management to translate decisions into results quickly
- reduce human error
- better inventory management
- consolidating databases to facilitate negotiating better prices from suppliers
- reduce unnecessary travel
- payment and collection management
- paper and administration – reducing paper use is ecological, storage, ink, printer and administrative costs. Each printed page can cost between 2 and 15 cents. The average office employee uses 10,000 sheets of paper annually, of which 50-70% is waste (mps.com, 2019)

Resilience

More than 60% of survey respondents to the *Global Digital Infrastructure Survey* thought that resilience was a fundamental

benefit of digital infrastructure. The UK National Infrastructure Commission defines that “digital system resilience refers to the ability of increasingly pervasive digital infrastructure systems to operate as intended and recover from incidents responsively” (National Infrastructure Commission, 2017).

While digital infrastructure is typically thought to support infrastructure resilience, it can also create fragilities which are summarised in the chart on the next page.

The Covid-19 pandemic has been a good proving ground for the resilience of digital infrastructure. Countries with good connectivity are able to mitigate half of the negative economic impacts of the Covid-19 pandemic. Wi-Fi capacity has seen an 80% increase from PC uploads to cloud computing platforms with additional peaks from video conference calls. In emerging markets, capex in added capacity has gone up, while investments in other (more sophisticated digital areas) has declined (ITU, 2020).

The pandemic has sharpened the awareness of the digital divide. Governments are attempting to mitigate these inequalities by issuing 250 regulatory responses worldwide. Internet use in Latin America and the Caribbean is at 70%, while it is 38% in Sub-Saharan Africa, 91% in North America, and 86% in Western

Europe. The use of the internet for business purposes in Sub-Saharan Africa is only 7% (ITU, 2020).

Given that telecommunication, cable and fibre-only companies maintain a capacity reserve of 50%, this part of the digital infrastructure was able to digest demand spikes caused by Covid.

Given that cost reductions constitute the biggest driver for digital transformation, the *Global Digital Infrastructure Survey* asked which sectors are likely to reduce costs aided by DI.

Energy savings

Valued at more than \$7 trillion, the energy sector is one of the world's largest, constituting 10% of global GDP (Economywatch, 2015).

A total of 66% of respondents to the survey think cost savings in the energy sector will be greatest. GE claims that the energy sector will change more in the next 10 years than it has in the past 100 years, mainly due to digital infrastructure technologies (GE, 2021).

The energy sector has already become a lot more efficient and its economic impact has grown. Today the world needs 20% less energy to generate \$1 of economic output than 19 years ago (IEA, 2020).

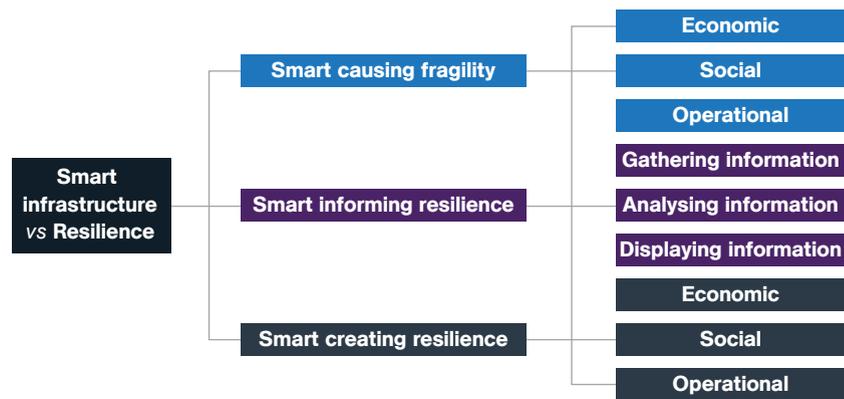
"Energy" encompasses various subsectors involved in extracting, generating, storing and delivering energy: fuel production, power generation, energy infrastructure, industry generating energy, energy transport and buildings.

There are two types of energy sources (Investopedia, 2021):

Non-renewable:

- petroleum products and oil
- natural gas

Figure 2: Smart Infrastructure Resilience Overview



- gasoline
- diesel fuel
- heating oil
- nuclear

Renewable:

- hydropower
- biofuels such as ethanol
- wind power
- solar power

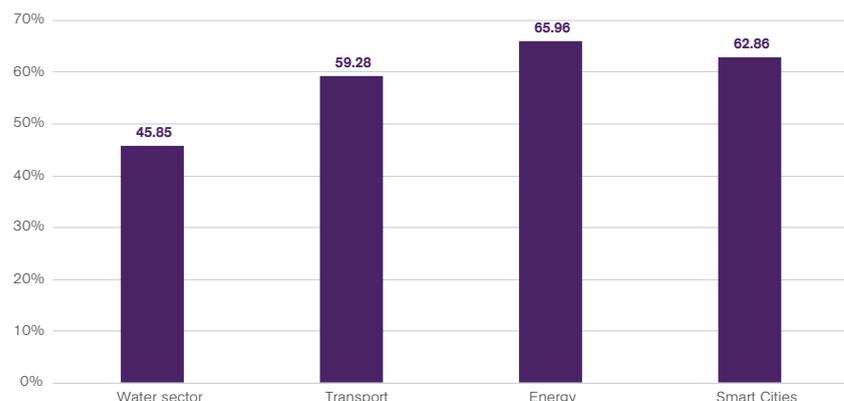
Although fossil fuels supply more than 80% of the energy consumed, renewable energy sources make up 70% of the \$1.9 trillion of total investments in the energy sector. Global energy consumption is set to grow by 4.6% in 2021 (IEA, 2021).

According to the International Energy Agency, digital transformation powered by improvements in DI will cut costs in the energy subsectors as follows:

- oil and gas – digital technologies could decrease production costs between

- 10% and 20%, facilitated by advanced processing of seismic data, the use of sensors, and enhanced reservoir modelling. Recoverable O&G resources could be increased by 5% globally, with the greatest gains possible in shale gas coal industry – efficiencies here will be lower than in the other areas, but will be felt in geological modelling, process optimisation, automation, predictive maintenance, and improved employee health and safety. Driverless trucks and tele-remote equipment operated from the control room are examples
- power sector – digital transformation could save roughly \$80 billion annually, which amounts to 5% of total annual power generation costs. Savings would occur in operations and maintenance, improving power plant and network efficiency, reducing unplanned outages and downtime, and raising the useful life of assets. Drones could cheaply monitor thousands of kilometres of transmission lines over all types of landscape (IEA, 2017)

Figure 3: In which sectors cost savings from digital infrastructure will be greatest



Source: IJGlobal 2021.

Digital processes can cut energy sector costs in several ways:

- gathering data via smart meters, which gather high-resolution energy consumption data from homes and businesses, as well as technologies that collect a range of data related to energy use, such as sensors that record light levels, temperature, or location (e.g. GPS tracking)
- analyzing data with powerful computers and software algorithms which process and analyse data and generate solutions to use energy more efficiently, such as building information models in commercial buildings, "digital twins" in industrial production facilities, and on-board computers in automobiles

- changing the physical environment based on data analysis. Many connected devices use digital signals to optimise energy use instantly. In buildings, connected devices such as lighting systems, heating and air-conditioning equipment, and water heaters can be programmed to save energy, depending on the time of day and occupancy levels. In industrial facilities, smart actuators and drives can be controlled via advanced industrial energy management systems to make subtle changes to optimise energy use while increasing safety and reducing production costs

The transportation sector is a space that is treated in greater detail below. Here the digital transformation will drive significant cost reductions. In the large subsector of trucking and logistics, digital solutions for trucks and logistics could reduce energy use for road freight by 20-25% (IEA 2018).

A study on China points out that digital transformation can drive revenues in the automotive, healthcare, freight/logistics and consumer/retail by 10-45% by 2030. Meanwhile productivity could jump 3-10% (McKinsey, 2016).

Smart cities

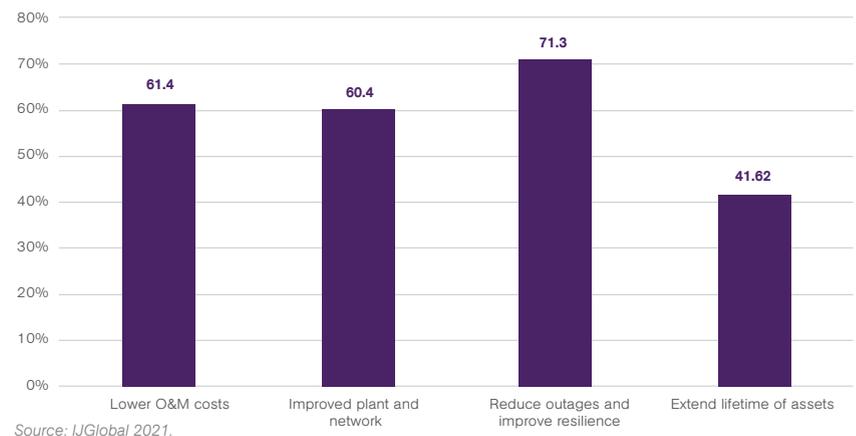
Respondents to the Global Digital Infrastructure Survey 2021 thought that smart cities were another high-ranking candidate for cost savings via digital infrastructure.

By 2050, some 68% of the world's population will live in cities (OECD, ASCE, 2020), with an estimated 180,000 people moving to cities every day. This puts added strain on infrastructure and costs people time in getting around. Intel estimated that a smart city could return 125 hours per city dweller annually, amounting to an economic equivalent of \$5 trillion every year (see smart city, 2018). One report estimates that the global smart city technology market could reach \$1.7 trillion in cumulative revenues 2019-2028 (Navigant Research, 2019).

A further study in this space reveals that cities could save \$5 trillion annually by 2022 by improving their levels of digital transformation. In a typical mega city of 10 million inhabitants or more, savings could include:

- public institutions – savings per city annually could amount to \$4.95 billion. Key areas are street lighting upgrades and smart buildings. Street lighting maintenance costs alone could be cut by 30%
- enterprises – by using more energy

Figure 4: How will digital infrastructure benefit the power sector?



efficient transport options, such as drones, robots or driverless vans and trucks, as well as and smarter production facilities, companies in cities could save \$14 billion per mega city

- savings – city dwellers could save \$26.69 billion per city per annum in utilities, smart meters, micro grids and through a hybrid education system (ABI Research, 2017)

IoT applications, which was a €1 trillion market in Europe in 2020, open up countless opportunities for improved efficiencies in cities. "Barcelona's smart street lights, which analyse required brightness via the IoT and have contributed to a 30% energy reduction; a networked and intelligent transport system on the M42 motorway in the UK, which has decreased travel time by 25% and accident frequency by 50%; and IoT-based health monitoring of patients with multiple chronic diseases in the Netherlands, which has led to a 20% increase in efficiency" (ADL, 2019).

Benefits for the Power Sector

Respondents to the Global Digital Infrastructure Survey 2021 see reduced outages, followed by lower operations and maintenance (O&M) costs and improved plant and networks as the top impacts of DI on the power sector. All these benefits are inter-related and depend on improved digital transformation.

The power sector in particular faces the challenge of producing more electricity while generating fewer emissions and maintaining affordable prices for consumers.

Since 2008, data collection, storage, and transmission costs in the power sector increased by more than 90%. Digitalisation could save \$80 billion per year, which

constitutes 5% of total annual power generation costs (IEA, 2018).

Global demand for power is expected to increase by 50% by 2040, which can only be achieved with digital efficiency gains. Technological advances mean that \$1 spent today on wind and solar photovoltaic (PV) facilities will generate 400% the amount of electricity of \$1 spent on the same technologies 10 years ago (IEA, 2021).

Accordingly, investment by the power sector globally is anticipated to rise by 5% in 2021 to more than \$820 billion, with renewable energy making up the lion's share of that amount at \$530 billion. Investments in grids and storage make up the remainder (IEA, 2021).

Power outages

Power outages are claimed to cost US households \$150 billion annually. An estimated 70% are caused by bad weather and this number has doubled since 2003 (Kohler, 2021). Some 11% of outages in the US are caused by squirrels and the rest by machine failure (Edison Electric Institute, 2020).

In addition to costing power companies revenues and profits, outages are estimated to cost US companies \$27 billion annually resulting from interruptions in operations (E source, 2018).

Microgrids are seen as an effective strategy against power outages but depend on sophisticated software and data flows, which in turn require a reliable digital infrastructure network to be in place. A microgrid is a smaller local grid powered by an additional power source, such as wind turbines. It can be connected or disconnected from the main power grid as needed and thereby can keep electrical supply at a constant rate in the case of

power outages or demand peaks. It often uses renewable energy sources, thus is easily complying with stricter regulations for carbon neutrality placed on utility companies. Unfortunately, given their detachment from the main grid, their data streams are separate, which also raises the level of cyber security in the electrical network.

Smart monitoring technology

Wireless smart meters and smart sensors are placed along the power grid and monitor power equipment and power lines, significantly reducing O&M costs and improving reliability. The sensors are run by analytics software which detects power overloads, circuit imbalances and measures voltage levels. When there is a problem, they enable technicians to locate the problem and fix it quickly, preventing a power outage or reducing its duration.

Gas plant efficiency

Gas-fired power generating facilities are already known for low O&M costs. According to the IEA, more sophisticated gas plants can boost efficiency from 39-60%, entailing an average O&M cost of \$25 per kW. Combined heat and power plants can even achieve 80% efficiency while hardly costing more in O&M.

Our Survey reveals that 60% of respondents believe the transport sector is among those to benefit most from digital infrastructure (see p.12, Figure 3). Indeed, transport is one of the most variegated sectors, including logistics, airlines, marine, railroads, trucking, airports, highways, rail systems, ports and services. These subsectors overlap considerably.

While the global transportation sector was estimated at generating \$5.1 trillion

in revenues in 2018 and making up 6% of global GDP (Plunkett Research, 2018), the logistics industry alone was estimated at \$9.6 trillion in revenues in the same year. Logistics could be producing \$12 trillion in revenues by 2023 (Armstrong & Associates, 2018). The US logistics sector is seen as producing \$2 trillion in revenues and making up 10% of GDP (Freightwaves, 2018). Global CAGR in logistics revenues is seen at more than 5% through 2023.

Nearly 80% of respondents to the survey think that usage optimisation is the main benefit. There are several ways in which digital transformation can benefit this huge sector.

Digital twins, AI, real time decisions and new road design

One strategy is creating a digital twin of a real asset such as a road, mirroring the asset 1:1. Digital twins are an increasingly common way of monitoring and improving the performance of assets in most sectors. In the transportation sector, digital twins make particular sense and are a way of raising the capacities of existing infrastructure.

The digital twin is connected with the asset, such as a road system, via the digital thread. Sensors on the road and CCTV provide constant, real time coverage of the roads in the system, such as traffic flow per lane, amounts of surface water, drainage performance and the need for preventive maintenance.

With digital twins providing data, the next digital component needed is AI to make these data actionable. With the help of the digital twin together with AI algorithms, decisions on traffic management impacting capacity utilisation can be made based on data and more accurate projections. AI could pinpoint needed adjustments in the timing of traffic signals by spotting

patterns, such as congestion on an exit ramp. Analysing large data amounts real time allows for ongoing adjustments to road network operations (wsp.com, 2018).

Digital twins of existing connected road networks and AI can also shorten and optimise the process of an outline design for the new road. This type of advanced outline design is multi media. It allows for a 3D drive through and simulations on the projected road, avoiding expensive mistakes due to mis-designing the road.

Intelligent transportation

Digital infrastructure has given rise to an entirely new sector, the Intelligent Transportation Market, which already boasted a global market value of \$26.58 billion and a CAGR of 5.8% for 2020-2027 (grandviewresearch, 2020).

The market consists of the entire array of products and services associated with digital traffic control and management, such as sensors, software and analysis systems. The increasing number of vehicles on roads, aging infrastructure, and lack of traffic data management are growth drivers for this burgeoning sector. Here, public institutions – as owners of the physical infrastructure – are drivers behind implementing intelligent transport systems. The intelligent transport systems market had a value of \$22.88 billion in 2020, and could reach \$30.65 billion by 2026, applying a CAGR of 5.11% over 2021-2026 (Mordor Intelligence, 2012).

Railways

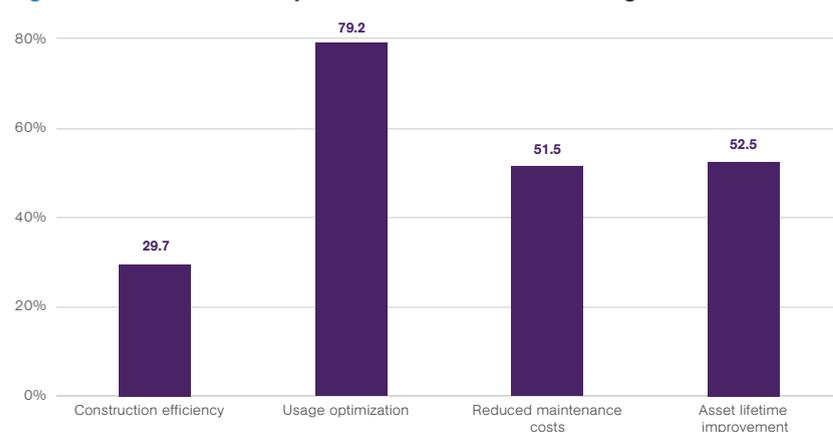
Governments – particularly in Europe – have long been working on digitally transforming railways. Driven in part by environmental goals to reduce emissions, the European Commission created Shift2Rail in 2014 to develop advanced solutions for Europe's railroads.

Five digital initiatives of Shift2Rail improve everything from the subsystems of trains (traction, brakes, doors), maintenance of the European rail traffic management system, improved customer services (ticketing, trip tracking) and freight punctuality.

The net result is to improve rail competitiveness and cutting the life-cycle cost of railways by 50%, doubling its capacity and increasing its punctuality by 50% (European Parliamentary Research Service, 2019).

A feasibility study by Germany's rail operator Deutsche Bahn revealed how increased digital transformation involving an investment of €1.7 billion could improve passenger and freight capacity utilisation to the order of 20% by 2025 (Deutsche Bahn, 2018). ■

Figure 5: How will the transportation sector benefit from digital infrastructure?



Source: IJGlobal 2021.

Digital Infrastructure Outlook

Nearly two-thirds of respondents to the Global Digital Infrastructure Survey see cyber security as the greatest risk of digital infrastructure, which generates annual economic damage of \$1 trillion (McAfee, 2021).

With data travelling easily through the cloud and edge, it has become much easier to hack. Yet governments are slow to react. The US Department of Interior spent a mere \$209,000 on cyber security in 2016, while Homeland Security put out \$1.7 million during the same year. While estimates see this figure increasing to \$22 billion by 2022 for the entire US Government, private enterprises worldwide are estimated to spend \$1 trillion in 2021 to combat cyber risk. Large banks such as JP Morgan Chase and Bank of America each deploy \$500 million annually to protect their digital processes (Forbes, 2018).

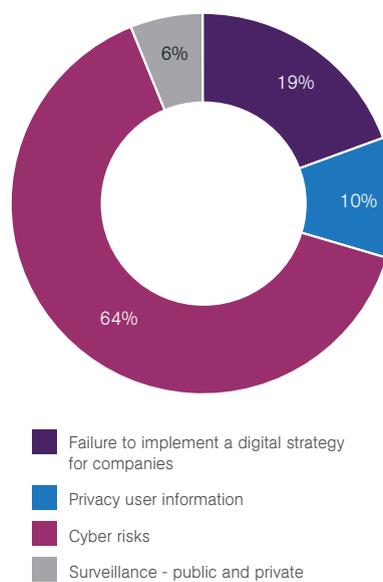
With the Covid pandemic, pressure on the world's digital infrastructure jumped, exposing its cyber security weaknesses. With many executives working from home and data travelling a lot more between locations, hackers find it easier to access data networks. An October 2020 survey of businesses put information security in first place as a priority for organisations as a result of the pandemic (WEF, 2021).

Several massive cyber attacks further shocked the world. A prominent example was the December 2020 attack by the Russian SVR (foreign intelligence agency) on Solarwinds network management system which is used by 300,000 customers worldwide, including the US Departments of Defense and Treasury, and 425 of the US Fortune 500 companies (Sans, 2021).

In the World Economic Forum's 2021 Risk Report, cyber threats rank fourth among the short-term risks. It ranks data security second among the greatest risks for the next three-to-five years. Yet, in the same study, cyber threats only rank ninth in terms of likelihood and tenth in terms of impact. Clearly, the severity of cyber risk has not yet fully reached broad stakeholder groups.

Cities are particularly vulnerable to cyber attacks. The WEF puts it forcefully: "Make no mistake: the world is in the early stages of a techno-war against city governments

Figure 1: Risks of Deploying Digital Infrastructure



Source: IJGlobal 2021.

and urban infrastructure. And while some cities have bolstered their capabilities to patch their vulnerabilities, they are entirely unprepared for the scale of cyber threats that are coming" (WEF, 2019).

Some 70% of all ransomware attacks in the US are on state and local governments. Iran virtually paralysed Atlanta's public services in 2018 in the largest attack on a city in US history (WEF, 2018).

Cities are easy targets because they are digitally "dumb". City technologies are often outdated and the brightest tech minds rarely work for the public sector. Funding and digital understanding are, broadly speaking, low in city governments. Current improvements in digital infrastructure, such as connected homes and smart cities, are likely to make things worse, offering cyber criminals more and easier entry points.

A problem source is that municipal networks are typically not unified but are

characterised by an unintegrated collection of wireless networking protocols such as Wi-Fi, RF-Mesh, ZigBee, Z-Wave, Wi-SUN and LoRa. These operate without heeding each other, creating application silos that make it difficult to serve city-wide applications.

As 5G networks bind together existing wireless networks, providing real-time, end-to-end visibility in transportation systems. Unifying network protocols allows a connected vehicle to travel seamlessly between different access points.

Failing to digitally transform

Only 19% of survey respondents believe that companies will be left behind if they do not take advantage of the opportunities digital infrastructure affords them. Yet, the WEF headlines that "companies that do not digitally transform will fail" (WEF, 2020).

Digitalisation can make a company 500% faster, leaving competitors behind. Customers are less brand loyal than they used to be and faster companies can quickly snap up market share, benefiting from digital communication channels. Netflix had an asking price of \$50 million in 2000 (Digital Marketing institute, 2018). Today Netflix has a market cap of \$255 billion, nearly \$100 billion more than in 2019 prior to the Covid pandemic.

A survey of EU companies by the European Central Bank revealed that the top digital priorities were big data (~86%), cloud computing (~84%) and e-commerce (~79%). Companies saw the top obstacles to digital transformation as adjustment of companies' organisation (~70%), recruitment and retention of highly skilled ICT staff (~59%) and development of ICT skills among staff (~40%) (ECB, 2018).

Finally, many tend to confuse the related – yet different – terms of digitisation, digitalisation and digital transformation. Digitisation refers to the conversion from analog to digital data processing. Digitalisation presupposes digitisation but means using digital technologies to improve business processes. Digital transformation is where companies should be now, entailing a broad use of data, software, AI and thus creating a digital culture from within.

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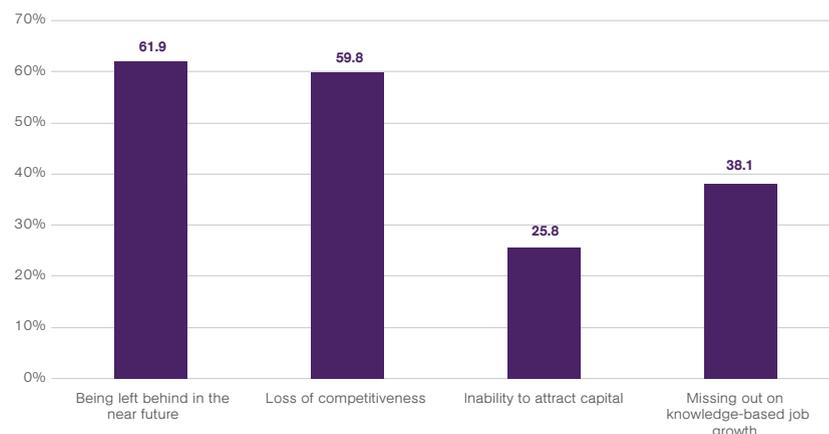
DIGITALBRIDGE

Like enterprises, countries not sufficiently investing in digital infrastructure will be left behind and lose their competitiveness, say respondents to the Global Digital Infrastructure Survey. The 2020 World Competitiveness Report by the World Economic Forum puts upgrading digital infrastructure and capacities in second place in a list of the 11 priorities for economic transformation (WEF, 2020). The graphic below illustrates the relationship between GDP development and digital transformation of three country groups.

A US government study indicated that the digital economy already constituted 6.9% of US GDP in 2017 (NCBI, 2020). In 2019 that figure had already jumped to 9.6% (BEA.gov, 2021). With estimates about the contribution of the “digital economy” to global GDP currently ranging from 3% to 15% by 2021-2025, one estimate claims that in 2020 the digital economy already constituted 22.5% of global GDP. This study takes a very broad definition of digital economy, including digital skills and capital (Oxford Economics, 2020).

In essence, countries not investing in digital transformation will not only forego an increasing part of their GDP and employment growth as increasingly processes go digital. Their rate of decline is likely to accelerate as all facets of the economy and society lose out to more efficient digitally based economies that will rob market share off laggards at an accelerating rate.

Figure 2: Risks to Public Sector for Not Deploying Digital Infrastructure



Source: IJGlobal 2021.

A study by the European Commission assessed how many GDP percentage points were attributable to digital technologies in 2015-2020. EU countries trail the US significantly and in 2020 the EU was at the level of the US many years ago (EU, 2020).

If some sectors such as manufacturing, mining, healthcare, and education, were to double their use of digital assets and increase the digitisation of labour, the 27 EU countries could add €2.5 trillion to their total GDP by 2025, increasing GDP growth by 1% annually (McKinsey, 2020). Indeed, simply unifying networks and connectivity across the European Union could generate

€415 billion annually in added economic value, according to the EU’s Digital Single Market (DSM) initiative, which is one of the EU’s 10 core development programmes (Arthur D. Little, 2019).

In the US, the digital economy was already ranked fourth according its contribution to GDP in 2019 (BEA, 2021), behind real estate, rental and leasing at 13.4%, government with 12.3% and total manufacturing achieving 10.9%.

Another analysis demonstrates how the growth of the digital economy has far outpaced total GDP growth in the US since 2006 (BEA, 2021), in some years up to 5:1.

The US takes the top spot in the 2020 Digital Competitiveness Ranking (as it did in the 2018 and 2019 rankings) and is also ranked first in the digital knowledge sub category. However, it is the only large country in the top 10.

Indeed, another study shows only small countries among the top 10 in terms of digital skills. None of the largest economies such as the US, China, Japan or Germany are among the top 10 countries for digital skills. All the leaders are relatively small, and six are European (WEF, 2020). Four of these smaller countries are in the top 10 for both rankings, connecting digital skills and digital competitiveness, including Finland, Sweden, the Netherlands and Denmark.

Challenges for Digital Infrastructure

The overwhelming majority of respondents to the survey think governments and regulators stand in the way of developing digital infrastructure and thus the digital transformation of their countries.

This starts with people and their digital skills and understanding. Nearly 40%

Figure 3: Digital competitiveness ranking 2020 Top 10

Overall Rank		Knowledge	Technology	Future Readiness
1	USA	1	7	2
2	Singapore	2	1	12
3	Denmark	6	9	1
4	Sweden	4	6	7
5	Hong Kong SAR	7	2	10
6	Switzerland	3	11	5
7	Netherlands	14	8	4
8	Korea Rep.	10	12	3
9	Norway	16	3	6
10	Finland	15	10	9

Source: IMD, 2020.

of respondents of the Global Digital Infrastructure Survey see insufficient technical expertise as an obstacle to digital transformation.

A recent study claims that European governments together lack 8.6 million digitally qualified employees to implement Europe's 2020 Digital Strategy. The result is that the WEF labeled governments "the dinosaurs of the digital age: slow, lumbering and outdated". Germany alone is said to need 700,000 digitally skilled personnel by 2023 (McKinsey, 2018).

Germany – Europe's largest economy – is an example of a country combining government inertia with a tight digital skills market. It has suffered a significant loss in competitiveness over the last three years, according to the WEF, in a December 2020 report. Meanwhile, the OECD has encouraged the country to invest more in digital infrastructure and transformation (OECD, 2020).

In 2016 the German ministry responsible for infrastructure and digital infrastructure announced a 14-year, €265 billion infrastructure investment programme in traditional infrastructure including roads, railways and waterways. However, it included no mention of digital infrastructure (Global Government Forum, 2021).

The reasons for digitally lagging go beyond the lack of digital competency. In the case of Germany, lack of capacity to build digital infrastructure and a complicated approval process for connectivity projects further slow things down.

A comparison of countries with respect to the conditions they offer for data centres is a case in point. Germany offers a more reliable power supply and better data protection. By comparison the US offers lower power prices, quicker approval processes and better access to specialised personnel.

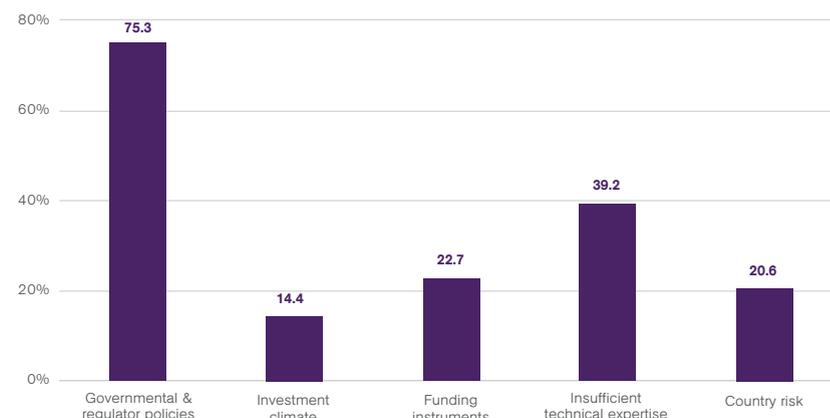
Yet despite this performance, the US Federal Communications Commission estimates that more than 21 million citizens do not yet have a broadband connection (Global Infrastructure Investors Association, 2020).

Catching up

Perhaps awaked by the Covid crisis, the European Commission updated its digital strategy in 2020, increasing investments in AI to €20 billion annually through 2030, after spending on AI only €3.2 billion in 2016 (McKinsey, 2020).

Worldwide, governments appear to be scrambling to pave the way for a digital transformation. The OECD recently summarised worldwide digital efforts:

Figure 4: What will pose challenges to digital infrastructure?



Source: IJGlobal 2021.

- national digital strategies are increasingly coordinated at the highest levels of government. In 2019, four more countries reported coordination at the prime minister/chancellery level and several more indicated a ministry dedicated to digital affairs than in 2016
- in the last three years, many countries – including Australia, Austria, Colombia, France, Germany, Korea, Spain, the UK and US – issued national 5G strategies
- all OECD countries and several partner economies enhanced access to and sharing of public sector data. Only a few (Australia, Germany, Japan, Singapore, US) also have initiatives to facilitate data sharing within the private sector
- digital security innovation is an emerging trend in the OECD. Several OECD countries – including Australia, France, Germany, Israel and the UK – established open innovation centres to promote DI development
- by mid-2020, more than 60 countries had a national AI strategy. Priority areas include AI-related R&D (Canada, US, European Commission), AI adoption (Finland, Germany, Korea), and AI skills (Australia, Finland, UK, US)
- blockchain and quantum computing are attracting increasing policy attention worldwide. Several countries have issued a blockchain strategy (Australia, People's Republic of China, Germany, India, Switzerland). Others (France, Italy) are developing one. The US, China and the European Union are leading on quantum computing R&D expenditure
- dealing with the socio-economic effects of the Covid-19 pandemic has become a policy priority in the digital area.

Governments, academia and businesses in OECD countries (UK, US) have rapidly developed AI systems to predict and monitor the spread of the disease and advance medical research

- OECD national privacy enforcement authorities, as well as the European Data Protection Board and the Council of Europe, have issued guidance on the collection, processing and sharing of personal data in relation to Covid-19
- digital security agencies in countries such as Canada, the Czech Republic and the US have responded to the Covid-19 crisis by raising awareness, monitoring threats and providing assistance
- all OECD countries have policies to support digital uptake by firms, particularly start-ups, and the creation of new businesses

Traditional Infrastructure vs. Digital Infrastructure

Traditional infrastructure sectors will be outpaced by digital infrastructure, according to respondents to Global Digital Infrastructure Survey. In particular, roads and bridges are predicted to suffer, with renewables taking the smallest hit.

Yet the amount of investment needed to keep traditional infrastructure going and keeping pace with economic growth is stunning. Estimates are that global infrastructure will need \$94 trillion invested between 2017 and 2040. Annual investment in infrastructure will have to be 3.5% of global GDP to realise this goal (Global Infra Hub, 2020).

By 2050, the world population is estimated to reach 10 billion. This will require highly ambitious infrastructure

investments, such as:

- 13,000 buildings every day
- 700,000 miles of roads every year (enough road to wrap around the globe 28x)
- 2 million miles of power grids annually
- 4 million miles of water and sewage pipes
- by 2050, more than 87,000 bridges will have to be built annually (Redshift, 2019)

US President Joe Biden's infrastructure spending plan calls for \$621 billion of public funds to be allocated to traditional transportation infrastructure, with a small part devoted to expanding broadband. However, 28% of this would go for electric vehicle infrastructure which is based on digital infrastructure (USA Today, 2021).

Private investment in infrastructure was only \$106 billion in 2019, which is roughly 0.13% of global GDP, down from \$156 billion in 2010. Some 77% of this was in high income countries with low-risk profiles and predictable annual returns (IJGlobal, 2019).

Digital vs. traditional infra

By contrast, digital infrastructure investment needs look modest. In Asia, one of the most ambitious and competitive digital markets, the digital infrastructure financing gap is estimated to reach \$512 billion by 2040. And this is more than 50% of the global infrastructure investment gap (AIB, 2020).

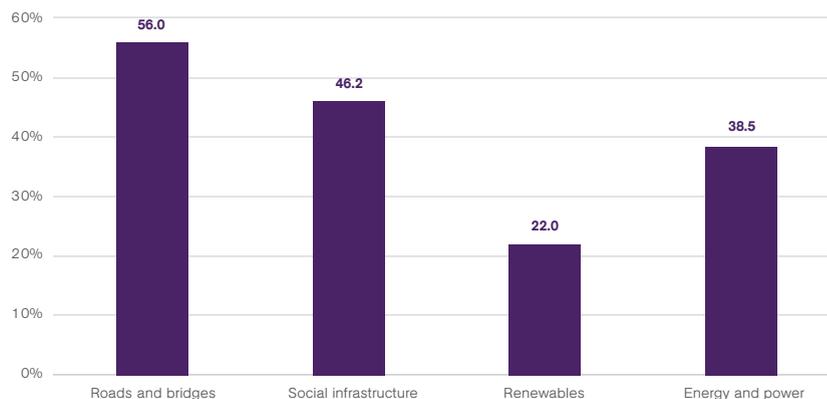
The European Commission announced its Digital Europe investment programme which will allocate €9.2 billion to digital transformation in the region over the period of 2021-2017 – a small amount compared to traditional infrastructure. Yet, this investment could raise the European GDP by €415 billion annually and help create four million new jobs (European Parliament News, 2019).

Importantly, investment opportunities in digital infrastructure are highly heterogeneous, ranging from software to sensors. Even smaller investments can have major economic and social impacts.

The economic impact of investing in digital infrastructure and digital projects are more compelling. One estimate claims that digital transformation, automation and AI will contribute an added \$13 trillion to global GDP by 2030 (GIIA, 2020).

The European Commission expects the smart cities market to exceed \$2 trillion by 2025, driven mainly by AI. While 60% of investments in smart cities is likely to be private, public institutions will end up owning 70% of the assets (McKinsey, 2018).

Figure 5: Which traditional infrastructure sectors will be outpaced by digital infrastructure in the next two years?



Source: IJGlobal 2021.

And the social benefits of digital infrastructure investments are substantial: every \$1 million invested in digital infrastructure creates roughly 30 qualified jobs (AIB, 2020).

Digital Infrastructure and ESG

Respondents to the Global Digital Infrastructure Survey share strong consensus that digital infrastructure will lower emissions and reduce the data footprint of the data economy.

Digital technology could reduce carbon emissions by 15% – or one-third of the total reduction required – by 2030, according to the Exponential Climate Action Roadmap, a global initiative supported by the UN and numerous companies. This could happen by making energy generation, agriculture, manufacturing, land use, transportation, buildings and city traffic management

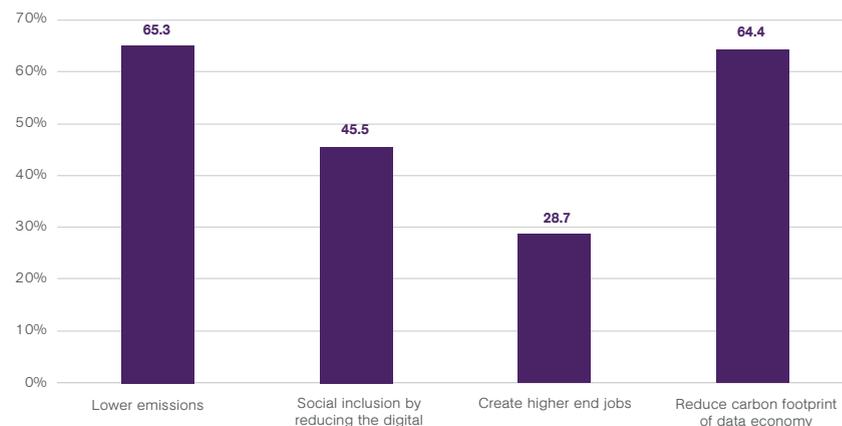
smarter and more efficient. It involves using technology to raise manufacturing and throughput of products, for example, while consuming less energy and producing lower waste levels.

Indeed, the World Economic Forum thinks that the global economic and social impact of digital transformation will be worth roughly \$100 trillion by 2025 (WEF, 2019).

Digital infrastructure is the prerequisite for reducing emissions and achieving carbon neutrality – a goal underwritten by most First World countries. What they are leaving out is that this only has a chance of working if digital infrastructure is massively developed first.

According to this 2021 survey, 75.3% of the respondents believe that governments are, and will be, the biggest impediment to developing digital infrastructure. This number is up from 73% in last year's survey.

Figure 6: How will ESG standards shape digital infrastructure?



Source: IJGlobal 2021.

As such, governments and regulators constitute the main obstacle to a clean environment.

One reason for governments' reticence may be financial. Christine Lagarde, the ECB head, stated at the Brussels Economic Forum on 29 June 2021 that the public and private sectors in Europe will have to invest €125 billion in digitisation annually to meet environmental goals (ECB, 2021).

Upgrading legacy tech

Digital infrastructure is the key to digital transformation and to realising ESG (environmental, social and governance) goals. Fewer emissions, better water and effluent management, energy savings and more knowledge-based jobs add up to reducing negative environmental impacts. But all this depends on installing the latest technologies in legacy systems.

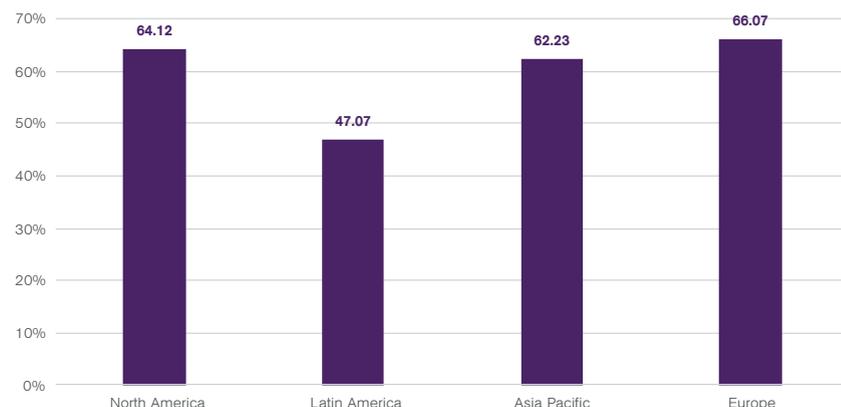
Manufacturing, for example, accounts for more than 17 million tons of emissions annually. Most equipment in the world's factories is 20, 30 or even 50 years old. Sensors installed on old equipment can monitor and help vastly raise their efficiency.

The good news is that upgrading legacy equipment is getting easier and cheaper, thanks to wireless communication between sensors and control centres, as well as between factories. Lagarde declared that European companies have digitised 20-25x faster than previously thought possible. In the past, factories had to be rewired, an expensive undertaking. But the data volume resulting from wireless data flows requires 5G and modern data centres.

Without modern and high-capacity data centres as well as fibre connectivity, there is not going to be sufficient bandwidth to handle data loads.

The transportation sector is responsible for 21% of emissions globally, 73% coming from short journeys. Digitally based technologies are now coming together to dramatically transform this sector and its environmental footprint.

Figure 7: Which regions will benefit most from the deployment of digital infrastructure in the next two years



Some critics claim that digital infrastructure requires much more energy to run and thus is itself a polluter. The EU thinks that data volume will increase by 500% between 2018-2025. Yet energy consumption by data centres and data transmission consumes only 1% of world energy production, and it is hardly increasing due to rising efficiency in hyperscale data centres.

Social impacts are seen as secondary

Respondents to the Global Digital Infrastructure Survey see the connection between DI and social factors, such as inclusion and higher qualified jobs as second to its environmental impacts.

Even so, DI is driving social inclusion by exposing an ever-increasing number of people to a common knowledge base and access to resources. Globally social media accounts totaled 3.484 billion in 2019, up 9% year-on-year (Zenith Research, 2020).

In 2018, 194 billion app downloads from Android and Apple devices were carried out, generating \$101 billion in revenues (App Annie, 2019). Global e-commerce sales are expected to increase from \$25 trillion in 2018 to \$29.8 trillion by 2022 (eMarketeer).

Europe, North America and Asia Pacific are deemed to be the regions most likely to benefit from digital infrastructure in the near future, according to respondents to the survey.

The Covid pandemic exacerbated the digital divide among countries. In most cases it accelerated the pace of digital investment and development. But in the case of many emerging markets, investment was in fact due to negative GDP growth.

A current study recently published in the Harvard Business Review takes a close look at 90 countries in terms of their digital status quo and digital potential in 2020. The study considers four dimensions of a country's digital infrastructure:

- supply – how developed the digital infrastructure is
- demand – willingness of consumers to engage digitally
- institutional environment – legal and regulatory context
- innovation and change – talent and potential to develop digitally

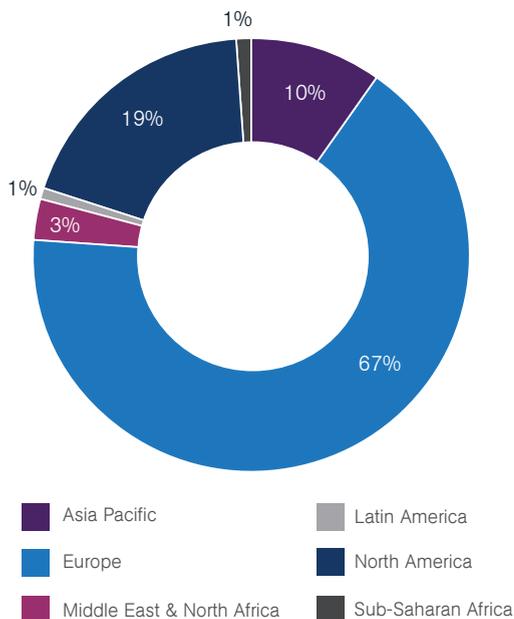
The study categorises countries as Stall Outs, Stand Outs, Break Outs or Watch Outs. Stand Out countries have established digital economies but are still improving. The top 3 Stand Out countries are Singapore, the US and Hong Kong. Break Out economies are transforming quickly, such as China. Stall Out nations are well developed digitally but are not advancing quickly, which includes many European countries. Here Ireland, Iceland and Switzerland are the closest to becoming Stand Out economies. Finally, Watch Out countries include many emerging market regions such as Latin America and Africa, which could be moving towards a Break Out position (HBR, 2020). ■



"Digital infrastructure is the key to digital transformation and to realising ESG goals."

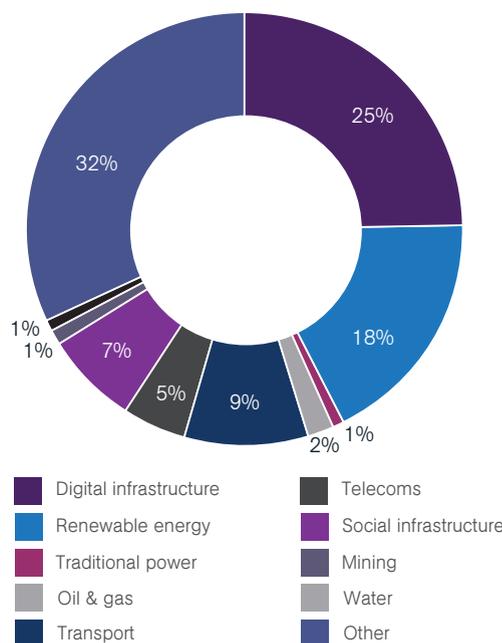
Digital Infrastructure Survey Participants

Figure 1: Where are you located?



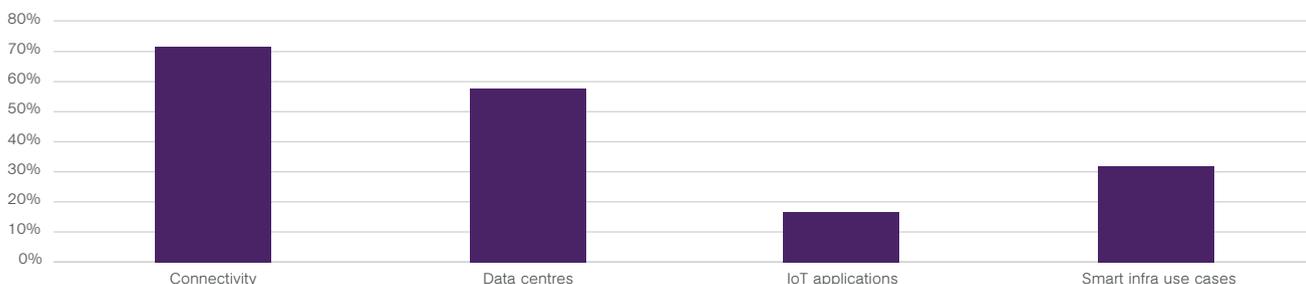
Source: IJGlobal 2021.

Figure 2: What is your sector?



Source: IJGlobal 2021.

Figure 3: In what digital infrastructure segments are you investing?



Approach of the Survey:

196 executive around the World participated in the second consecutive survey of its kind. The questionnaire was jointly developed by M&E Global and IJGlobal based on extensive research of current issues related to digital infrastructure and the digital economy. Most questions allowed respondents to rate the answer options on a scale of 0-100 points, indicating their relevance or importance. These responses were then averaged out and the consolidated ratings published here. No individual responses are being revealed or published.

The Survey was live throughout the summer of 2021. The Survey was launched and propagated via the IJGlobal site, emails to IJGlobal subscribers and M&E Global contacts, as well as via social media such as LinkedIn.

Infracomtech – problems, solutions & securitisation

Fintech has disrupted nearly all aspects of financial services. However, the impact of fintech on infrastructure – or infracomtech – has been one of the weakest links, finds *IJGlobal* APAC editor **David Doré**. It's time for that torpid state to change...

The financial services industry's embrace of financial technology continues apace. Kakao Bank's W2.55 trillion (\$2.2 billion) IPO in July 2021 valued the Korean internet-only bank at more than \$16 billion. Payments startups had several megarounds at increased valuations during Q1 2021, including Klarna's \$1 billion raise.

DeepSee.ai's nearly \$23 million Series A in March showed momentum accelerating for automating capital markets processes while trade finance investors and originators welcomed Tradetec's more than \$9 million Series A.

Incumbent financial institutions and fintech disruptors have been looking at blockchain to improve operational efficiency in financial services. It's effectively used in commodity trade finance and logistics.

Companies now can track moving stocks on pallets. "In the old days, the warehouse

certificate could be fraudulently re-used. Having blockchain in a closed group enhances security for that trade including KYC compliance," says Tokyo-based Scott Neilson, project development and finance partner at Allen & Overy.

Fintech has significantly enabled and disrupted nearly all aspects of financial services. However, the impact of fintech on infrastructure – what *IJGlobal* dubs infracomtech – has been one of the weakest links. It's time for that torpid state to change. Fortunately, green shoots are appearing on the horizon. Some are already under your feet.

Problems? What problems?

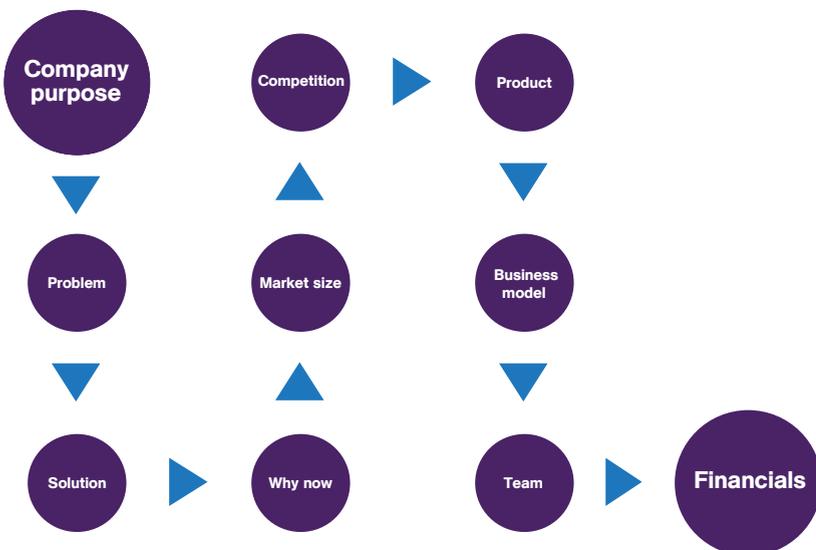
Today's infracomtech entrepreneurs have easy access to legendary startup pitch decks. Venture capital firm Sequoia Capital tells you straight up what they're looking for in their deck template.



"In the old days, the warehouse certificate could be fraudulently re-used. Having blockchain in a closed group enhances security for that trade."

"A core problem with infrastructure is that the failure rate – that is projects under development that don't reach financial close – can be as high as 80, even 85%," says Giridhar Srinivasan, chief executive of Infraclear, a Washington-DC-headquartered startup. "But the problems don't stop there. The asset's life is often riddled with operational and management challenges."

Figure 1: Sequence of Sequoia Capital's pitch deck template



Source: *IJGlobal* 2021.

A 3x3 matrix aids Peter Adriaens, director of the Center for Smart Infrastructure Finance, to frame the challenges and innovate solutions with its industry collaborators, including Ripple, Nuveen, and WSP.

"Fintech's first access point in construction to a large extent has been in opex," says the University of Michigan professor of environmental engineering, finance and entrepreneurship.

Asian Infrastructure Investment Bank (AIIB) principal investment officer Stefan Shin backs up this claim. "We've had a lot more discussions about infratech compared with fintech's applications in infrastructure financing," says the Beijing-based banker.

"The infratech solutions we've seen tend to focus on smart ways to operate and manage assets – like the ability to adjust solar panels to account for the time of day and seasonal changes in the sun's path across the sky."

Perhaps the construction industry has responded constructively to *Imagining Construction's Digital Future* – a June 2016 article by Rajat Agarwal, Shankar Chandrasekaran, and Mukund Sridhar from McKinsey.

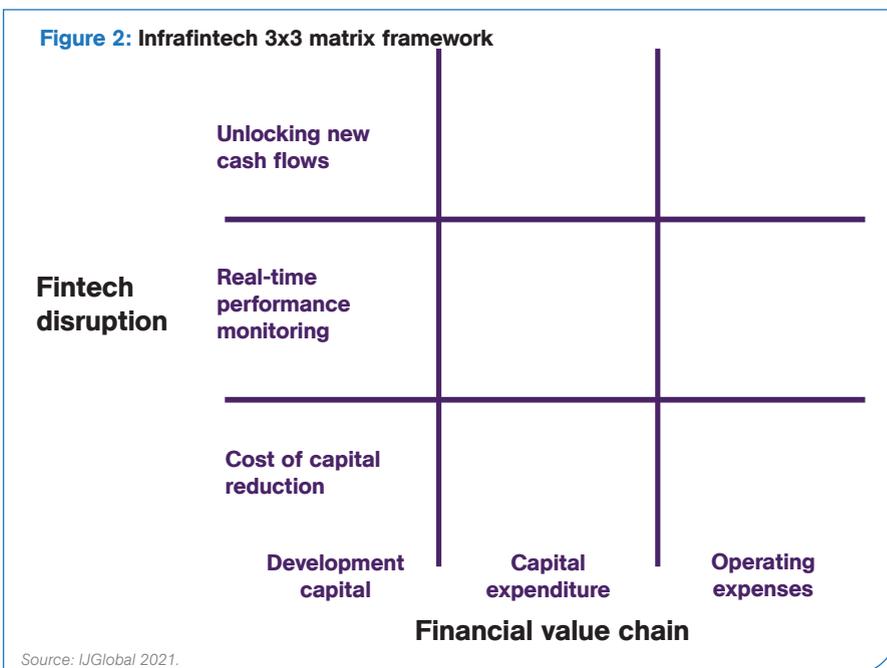
The Asia-based McKinsey partners at the time noted that large projects normally took 20% longer to complete than scheduled and were up to 80% over budget. Financial returns of EPCs were often relatively low and volatile. The trio showed that the construction industry was one of the least digitised. Among 22 sectors, it was second to last, just beating agriculture and hunting.

Interestingly, the finance-and-insurance sector was the fourth most digitised. Yet the sector's indisputable digitisation has had a conspicuous bald patch – the nexus between fintech and infrastructure finance... or infrafintech.

"In bigger infrastructure projects we are now limited to traditional methods. Volume of transactions, regulation, and political risk are barriers to entry for new ways of doing business," offers Neilson of Allen & Overy.

Infrastructure asset tokenisation gives the right to access the value and performance, through a blockchain solution, of infrastructure sponsor or funds' equity, private equity of the SPV owning the concession, or loans and bonds issued by sponsors. Gaps persist between the innovative asset classes and business models inspired by tokenisation and existing regulatory frameworks.

Another challenge for infrafintech's adoption in Asia's project finance market is that there's more money than there are good projects. "In a highly competitive market like that, how does fintech move into the space?" asks Neilson. "Is infra finance a low hanging fruit or would it be better to concentrate on other areas first like consumer or SME finance?"



Peter Adriaens

"Fintech's first access point in construction to a large extent has been in opex."

Adriaens underscores: "The biggest value proposition will be in fintech's ability to facilitate the delivery of development capital and capex, which is always the hardest to get. Eighty percent of projects die on the vine and never reach financial closure. The opportunity is how to open the funnel to make projects bankable."

Solutions addressing the financial value chain

At a macro level, thought leaders continue to advocate for governments, sponsors, lenders, EPCs and advisers to move away from standalone projects. They argue for enhanced integration of the development, construction, and management of complementary assets. The industry should habituate packaging electricity, water, and whatever the third asset is into a single project, the insiders argue.

"Asset tokenisation is a strong contender to finance infrastructure in the future," says the Center for Smart Infrastructure Finance's Adriaens. "Data are not beholden to siloed assets like we've conceived in the past. Bundling these different data assets so that they are not stove-piped is crucial. Finland has excelled at this integration."

No one questions the importance of integration in transport.

"Beyond O&M improvements, another area is making infrastructure more user friendly. Connectivity plays a large role in our Infrastructure for Tomorrow strategy," adds Shin of AIIB. "A goal is to make the transition from one mode of transport to another as seamless as possible. Smart technologies are increasingly being used in the field to improve the commuter or traveller's experience."

The use of the same project finance law firms, banks, and advisers with roughly the same templates has yet to translate into a significant reduction in failure to reach financial close or (when transactions close) the time to closure has yet to accelerate appreciably.

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Some solution providers are focusing on the project agreements.

"Every time I told technologists that I wanted to gather thousands of publicly-available loan and concession agreements and use natural language processing to extract data on top of it," recalls Infraclear's Srinivasan, "they all asked, startled, 'What ... that's not been done before? That's not too crazy to do'."

He adds: "NLP is well suited to finding hidden value in the supposed cacophony of agreements. Even though the agreements may not be standardised in the truest sense, they are harmonised."

Law firms, as controllers of the agreements, have a unique role to play.

"Legaltech intersects with fintech to a certain degree," says Neilson, who heads A&O's banking and finance team in Asia Pacific. "We are working to smooth our clients' documentation management processes as they negotiate and execute the project finance loans. These efficiency gains can particularly enhance smaller projects, like renewables, where you stick with the solar developer as they build up their portfolio."

The law firm's innovation incubator Fuse has a range of companies that may bolster infrafintech, including building custom, closed marketplaces for banks and fund managers to trade the securities of real assets.

State Street Alpha for Private Markets solution will be an incumbent's counterattack. The launch will follow the anticipated close in September of Charles River Development's acquisition of private markets front-and-middle office platform Mercatus.

Solution providers are also attempting to convert real assets to digital assets. They then



"Beyond O&M improvements, another area is making infrastructure more user friendly. Connectivity plays a large role in our Infrastructure for Tomorrow strategy."

connect the data streams to the actual P&L of the asset.

"Connecting the digital twin to the P&L of the project finance or project companies is on the top of everyone's wish list. It's the Holy Grail to crack that nut," offers Adriaens.

Incumbent and disruptive telcos are also a factor in infrafintech's development. They are becoming involved in smart infrastructure. Some are consuming data from the infrastructure assets and not just gaining insights but taking it down to a popular Ethereum token called ERC-20. The telcos are forward integrating and unlocking value.

Infrafintech's role in securitisation

Infrastructure asset-backed securities (IABS) are a part of the industry's landscape where infrafintech may bear its most valuable fruit.

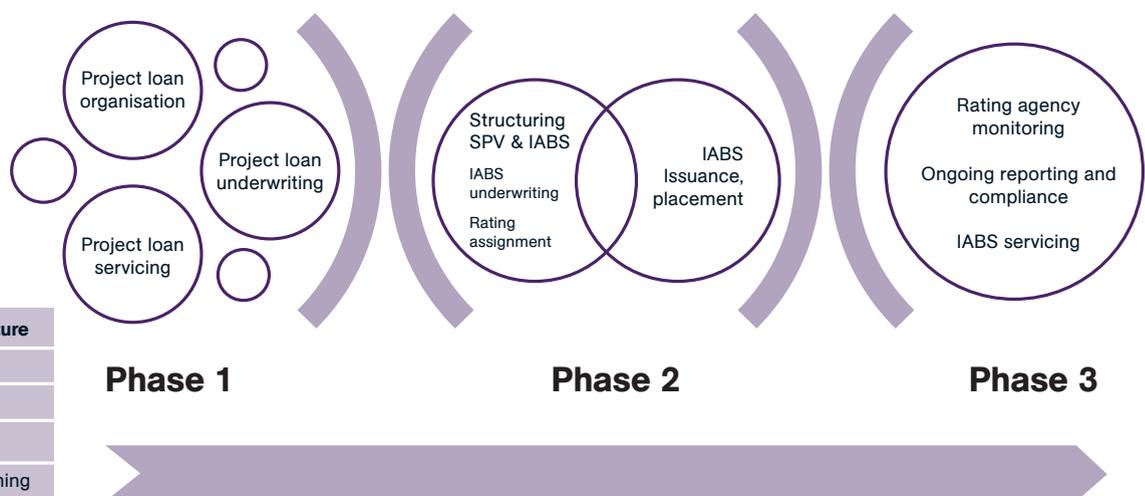
"You are right to point to the securitisation type model," shares Neilson. "We have explored those models with clients. You could securitise anything within reason with coins for instance. Take EPC contractors. You could securitise the revenue streams under those EPC contracts and issue a coin offering."

Before the advent of residential- and commercial-mortgage-backed securities, the real estate industry exhibited many of the same obstacles hobbling infrastructure's ability to recycle capital.

In the US market, the difference between the pre- and post-securitisation era is crystallised by the reduction of the myriad of loan types to the simple bifurcation of conforming and non-conforming loans. These loans align with the financing limits set by Federal Housing Finance Agency and meet underwriting guidelines established by Fannie Mae and Freddie Mac.

"Just before real estate was securitised, there was a hodgepodge of loans. As soon as RMBS and CMBS gained traction, there was a powerful financial incentive to securitise," argues Srinivasan. "We envision fintech allowing IABS also to take off."

Figure 3: Core industry participants' problem with project finance collateralized loan securitisation information technology



Source: IJGlobal 2021.

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Giridhar Srinivasan



"A core problem with infrastructure is that the failure rate – that is projects under development that don't reach financial close – can be as high as 80, even 85%."

A project banker reflects: "Securitisation is not vanilla financing. By itself, securitisation is a technology or technique linking the loan and securities markets, enhanced by diversification. Perhaps AI's use of Big Data might someday match an investor's optimal risk-return profile to a specific tranche in a securitisation issuance."

"In Asia, there's not a lot of trading of infrastructure loans," offers Neilson. "The project finance banks, multilaterals, and ECAs tend to hold the loans and the commercial banks make money from hedging services and the like."

He points out the healthy – but not huge – market in France of ECA backed-project loan securitisation. "Yet in Asia the secondary market is more plain vanilla."

Infrafinetech founders may solve problems in one or more of securitisation's three phases.

An IABS industry of the future may broadly delimit phase 1 with only project finance loans that have reached financial close. Phase 2 would draw from that opportunity set and structure the IABS. Post-issuance, or phase 3,

would involve rating agency monitoring, and administration and trustee services.

"If the opportunity set of assets and project loans could include 500 assets, then AI's value proposition only grows. The trade-off is that while the average loan size in the securitisation would likely fall, the administrative and servicing costs would rise. Here, evaluating and adapting technology in microfinance may be useful," notes a banker.

Fintech platforms focused on digital securitisation have already gained regulatory approval to issue and sell digital assets and securities to investors. Some are positioned to facilitate IABS and insurance-linked securities, general- and limited-partnership structures, and capital raising by startups. These platforms are likely to dislocate administration and trustee services.

A banker considers that AI and infrafinetech would have a "huge impact" on the IABS market after the issuance. A private blockchain would be used in a closed group of investors and post-issuance administrator. The blockchain would enable a more reliable view into the project company's account.

"Blockchain would also allow investors more direct access to a project's operational performance, if say we had the ability to view data about how much electricity a dam is producing on a week-by-week basis," says the market insider. "Reporting for impact would also get a big boost."

Neilson cautions: "When there's talk about bringing a securitisation to market more quickly, you need to compress not only the time for due diligence but also the negotiation phase. The human element will always be there ... no matter how much you can speed up using tech, you still need to negotiate the commercial structure and terms. Multiple parties are always involved, and regulatory issues can be complex. Not everything can be solved by the tech."

Bayfront Infrastructure Management chief executive Premod Thomas told *IJGlobal* the day of Bayfront's \$401.2 million IABS issuance: "The received wisdom is that project financing is clunky, bespoke and highly structured. We are taking a different view. Onboarding assets can be quicker. On the distribution side, we are having interesting conversations with exchanges about tokenisation. Issuing asset-backed securities tokens is on people's minds."

A call to action – Get in touch to learn more
Successful infrafinetech platforms will adapt to the varied – sometimes competing, often complementary – interests of actors in the infrastructure finance market.

"In some systems there could be resistance to the model. Incumbent companies might not

Premod Thomas



"The received wisdom is that project financing is clunky, bespoke and highly structured. We are taking a different view. Onboarding assets can be quicker."

like the dislocation because they are selling a service that the new upstart is trying to disrupt. They don't want to be disintermediated out of that process," Neilson notes.

The compressed margins in project finance are spurring self-interested bankers to take a keen eye to infrafinetech.

"Project finance is a part of the bank that is suffering," offers Srinivasan. "Bankers need a faster, more data-driven way to get deals done. We're a lifeboat for project finance."

Infrafinetech entrepreneurs are attempting to innovate the crossroads between the financial value chain and reducing capital charges, improving real-time performance monitoring, and unlocking new cash flows.

Securitisation is the arena where founders and their teams may discover the most meddlesome customer pain points. Hence the structuring, issuance, and servicing of IABS are microcosms of the larger infrafinetech puzzle.

"We are very interested to hear more about fintech projects in infra finance," says Neilson. "Everyone wants more efficiency, reduce people hours devoted to tasks better automated and decreased risks." ■

Cordiant offers new model for digital infrastructure investing

Private markets investor Cordiant Capital tapped public investor demand earlier this year, with the £370 million (\$512m) IPO of a new digital infrastructure fund. *IJGlobal* recently spoke with the fund's chairman, **Steven Marshall**, about long-term investing, the mid-market opportunity and synergies across the various segments of digital infrastructure.

Cordiant Digital Infrastructure is led by Steven Marshall, who spent 20 years in digital infrastructure "before it became a defined sector". Marshall was previously president of American Tower Corporation's US tower division, developing the network neutral telecommunications model in the US, Germany, France and a dozen other countries.

Marshall retired from American Tower in 2018 and returned to his native Britain, where 18 months ago he found a partner in Benn Mikula of Montreal-based private funds manager Cordiant Capital.

Instead of setting up a GP/LP fund, Cordiant eyed an opportunity on the public markets – raising one of the largest UK investment trusts of the past decade (and, alongside Digital 9, one of two digital infrastructure funds to IPO on the LSE this year).

"Investment trusts have evolved over the years to buy real assets. It's becoming a natural home now for permanent capital," says Marshall. "It gives fund managers and private individuals access to this sector."

Rather than having to sell down and retrieve tied-up capital after 5-10 years as a GP/LP fund winds down, a listed fund can offer a portfolio company the assurance of being in it for the long haul. This is attractive to both a portfolio company's management and its customer base, says Marshall.

Cordiant Digital Infrastructure's investment approach is to focus on the mid-market, pursuing deals in the slightly less competed €100-500 million range, in contrast to the recent \$6-8 billion mega-acquisitions being carried out by the likes of American Tower and Cellnex.

"You see massive trophy deals being done – we are looking for mid-market deals, where there is slightly less demand," says Marshall. Cordiant's new fund targets three key areas of investment: towers, fibre and data centres. But part of the pitch to investors is the synergies that can be achieved across these areas.

"I see more synergies across the three digital infrastructure sectors than we've ever seen before," says Marshall. "Historically you had tower, fibre and data centre operators that didn't move outside their own sectors. But now 5G and environmental issues are starting to drive much more connectivity across those three sectors."

He adds: "Why would you build a house if you were going to rent the drive from somebody else. If you're going to build a data centre, why wouldn't you make sure it's got the fibre connectivity and get the benefit of that as well?"

As an example of these synergies, Marshall points to the Cordiant fund's first investment: the Czech telecoms group Ceske Radiokomunikace (CRA), which was acquired from Macquarie funds in May. The company operates 660 towers, 3,730km of fibre as well as edge data centres, which are being repurposed from existing properties.

Cordiant is also working on the acquisition of a Norwegian fibre and data centre developer. The 2 deals have a combined value of £451 million (\$625m), made up of £318 million of equity and the assumption of £133 million in debt.

Together, the 2 assets produced a combined EBITDA of circa £40.5 million in 2020.

The 2 deals also left Cordiant with just £43.4 million in uncommitted capital after the IPO, paving the way for a second, £185 million equity raise in June.

"We came out for a second raise very early on," says Marshall.

With global demand for digital capacity growing at double digit rates, digital infrastructure can offer investors an attractive yield premium to other assets such as bonds.

"You start to generate this theme of long-term, sustainable, growing cashflows with blue chip customers," says Marshall. ■

Steven Marshall



"Why would you build a house if you were going to rent the drive from somebody else. If you're going to build a data centre, why wouldn't you make sure it's got the fibre connectivity and get the benefit of that as well."

The **DI** acquisition bonanza

Digital infrastructure assets are flying off the shelf. *IJGlobal* editorial director **Angus Leslie Melville** turns the focus on international M&A activity in H1, with a glimpse towards the rest of the year...

Acquisitions across the global digital infra space have been impressive so far this year with *IJGlobal* logging a significant uptick in international activity and funds marshalling forces to catch up with early movers.

The *IJInvestor* Funds & Investors Report H1 2021 revealed the busiest half-year of fundraising since H2 2016 with \$61.3 billion of final closes logged in the first 6 months by 45 funds. While those vehicles have a range of strategies, the ones that target telecoms – primarily digital infra – are on the rise... in both senses.

The largest fund to have logged a final close in the first half with a DI strategy was IPI Partners II at \$3.8 billion, having initially targeted just \$1.5 billion for equity investments. It is an unlisted, closed-ended fund managed by ICONIQ Capital and Iron Fund Partners-backed fund manager IPI Partners.

The IPI vehicle acquires, develops, leases and operates hyperscale and enterprise data centres and related assets on a global basis (non-US investments in countries in the Morgan Stanley Capital International Index are capped at 40%). IPI Partners II has a 12-year term and a 4-year investment period, both commencing from the date of first close (December 2019).

The next largest to have hit final close in the first half of this year (again with a DI strategy) is the \$2.25 billion Grain

Communications Opportunity Fund III, having also had an initial target of \$1.5 billion – but topping out at its hard cap. Like the IPI vehicle, it targets equity but only focuses on North America.

It is an unlisted, closed-ended fund managed by Grain Management, aiming to provide equity financing for the acquisition of both greenfield and brownfield telecom assets, with a focus on wireless and spectrum projects across North America. It has a 10-year term with 2 possible extensions of 1 year and aims to achieve gross IRR of at least 20%.

Stepping down in scale, but still impressive at \$1 billion, is the Digital Alpha Fund II – an unlisted, closed-ended investment fund managed by Digital Alpha Advisors. This fund aims to make around 12 equity investments in 5G infrastructure, Wi-Fi 6 solutions, cloud computing and IoT-enabled smart city solutions.

The fund was launched in April 2020, with an initial target of \$750 million and it reached final close in April 2021 above its hard cap. Investors in the fund include sovereign wealth funds, pension funds, endowments and foundations, consultants, and health systems primarily from North America, Europe and the Middle East.

At the more humble end of the scale having reached \$533 million, the Principal Digital Real Estate Fund is an unlisted,

closed-ended fund managed by Principal Real Estate. It targets equity investments in US data centres.

Primary geographical markets the fund will focus on include Dallas, Chicago, Phoenix, Northern Virginia and northern California, as well as secondary markets such as the Pacific Northwest, Atlanta, Austin/San Antonio, Southern California and north east US.

The fund was launched in 2020, reporting an initial close at \$241 million. Second close was achieved at \$457.5 million in May 2021, and the vehicle reached final close on 9 June 2021, raising \$533 million.

There were also some interesting developments for listed vehicles with a couple of launches for digital infra asset focused funds.

Digital 9 Infrastructure (DG19) – the LSE-listed fund managed by Triple Point Investment Management – was the biggest of these. The fund's IPO was held on 31 March 2021 with a maiden investment secured in the subsea cable market.

DG19 was seeking to raise up to £400 million (\$548m) from its float, but brought in £300 million from the initial LSE IPO. The fund is backed by Triple Point (\$6.5 million commitment at IPO), which provided seed assets for the vehicle. It then came back to the market in late May raising another £175 million taking it well beyond its initial target in a period of 3 months.

Table 1: Telecoms Funds at Final Close - H1 2021

Fund Name	Fund Manager	Fund Currency	Fund Strategy	Target Size (USDm)	Final Size (USDm)	Final Close Date	Time Taken to Final Close (Months)	Asset Stage Target	Region Targets
Digital Alpha Fund II	Digital Alpha Advisors	USD	Equity	\$750	\$1,000	Apr 21	12	Greenfield, Brownfield	Global
Grain Communications Opportunity Fund III	Grain Management	USD	Equity	\$1,500	\$2,250	Apr 21	5	Greenfield, Brownfield	North America
IPI Partners II	IPI Partners	USD	Equity	\$1,500	\$3,800	Apr 21	17	Greenfield, Brownfield	Global
Principal Digital Real Estate Fund	Principal Real Estate	USD	Equity	Undisclosed	\$533	Jun 21	6	Greenfield, Brownfield	North America

Source: *IJGlobal* 2021.

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It invests in controlling stakes in operational assets with an existing customer base in the fibre, data centres, tower infrastructure and 5G sectors primarily in the US, UK and northern Europe.

Another listed vehicle – Cordiant Digital Infrastructure – raised £185 million through a placing on the London exchange. A total of 185 million shares were sold at an issue price of 100p per share under the company's placing programme.

Cordiant announced on 17 May (2021) that it had hoped to raise £250 million and, given the success enjoyed by DGI9, it will likely go for a second IPO.

The net proceeds of the placing will be used to acquire pipeline investments that include opportunities in the US, Canada, Scandinavia, and other European markets.

Using the broader “telecoms” tagging, *IJGlobal* identifies cash raised by unlisted infrastructure funds in H1 2021 to target activity in this sector accounts for 12% of all funds to reach the final close landmark in this time period (see figure 1).

As to vehicles in fundraise mode, this reveals an interesting geographical strategy (Figure 2) with 53% taking a global approach (by final close target size) and Europe attracting the largest specific regional focus. Of all the unlisted funds with a telecom strategy that are in fundraising mode at the time of writing, a total of 10% have a shared strategy for Europe and Asia Pacific.

When it comes to unlisted funds with a telecom focus in raising mode (by number of funds, not value), half of them have Europe as a geographical focus (Figure 3). More than a quarter – 28% – have a global mandate, while 11% have that twin prong approach of targeting Europe and Asia Pacific. Only 6% have a dedicated focus on North America and 5% target Europe in addition to North America.

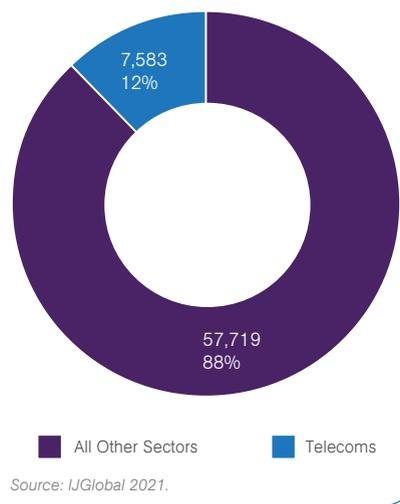
The M&A environment

When it comes to M&A activity, the H1 report reveals that renewable energy was – somewhat predictably – the most popular infrastructure M&A market accounting for 67% of transactions closed in that period. M&A renewables deals led by infra funds amounted to \$21.7 billion in deal volume.

However, digital infrastructure is on the rise and *IJGlobal* has tracked some key developments in the first half of this year.

Perhaps the busiest company to have been on an acquisition spree is Cellnex, but to report on all its recent activity would leave little room to write about anything else. It's relentless activity in recent times gives Cellnex every right to describe itself

Figure 1: Capital Raised at Final Close (USDm) H1 2021



as “Europe's leading operator of wireless telecommunications and broadcasting infrastructures”. It has a portfolio of around 129,000 sites, about 91,000 of which are already operational, with the rest in the process of finalisation or planned rollouts up to 2030.

In mid-June, Cellnex received the green light from Italy's competition authority – Autorità Garante della Concorrenza – to proceed with its €10 billion (\$12.12bn)

acquisition of the Italian portion of the CK Hutchison portfolio. CK Hutchison Networks currently manages and operates about 9,100 telecommunications sites for the mobile operator WindTre.

This Italian deal with CK Hutchison is part of a larger transaction encompassing 24,600 telecoms sites across Sweden, Austria, Denmark, Ireland and the UK. The Swedish, Austrian, Danish and Irish assets were transferred to Cellnex in January.

Separately, in February, Cellnex reached an agreement with Cyfrowy Polsat to acquire 99.99% of its telecoms infrastructure subsidiary Polkomtel Infrastruktura. The target operates the group's passive infrastructure (7,000 towers and sites) and active infrastructure – 37,000 radio carriers covering all the bands used by 2G, 3G, 4G and 5G and 11,300km of fibre backbone and fibre-to-the-tower backhaul, and a national network of microwave radio links.

The agreement involved an investment of €1.6 billion by Cellnex, plus an additional programme to roll out up to 1,500 sites, as well as investments in active equipment, mostly for 5G, for a further €600 million over the next 10 years.

Switching to infrastructure funds, but staying in Europe, 3i Infrastructure earlier in June completed its acquisition of a 60% stake in German fibre business DNS:NET. It paid €182 million to private equity houses Deutsche Beteiligungs and DBAG ECF.

Figure 2: Telecoms Funds in Raising Mode by Target Size (USDm) - Geographic Target

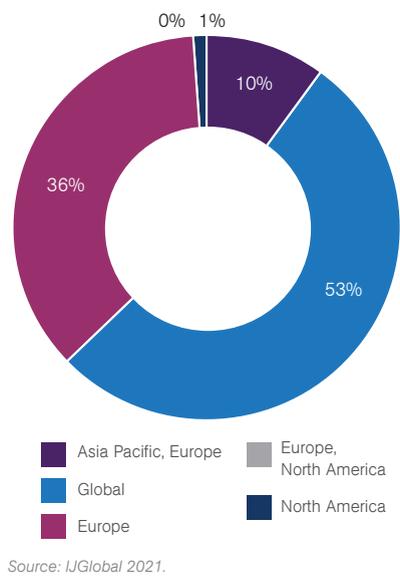


Figure 3: Telecoms Funds in Raising Mode by Number of Funds - Geographic Target

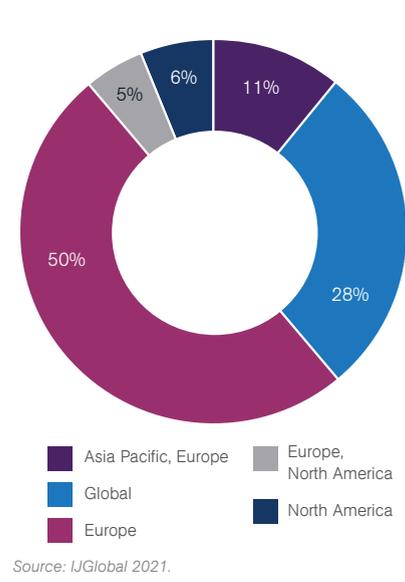


Table 2: Telecoms deals with Infra Fund involvement - H1 2021

Transaction Name	Company Name	Financial Close Date	LT Accredited Value (\$m)
Flanders FttH Network	EQT Infrastructure V	25/03/2021	222
Lefdal Mine Datacenter (10MW) Additional Facility	Archmore Infrastructure Debt Platform II Columbia Threadneedle Sustainable Infrastructure Fund	28/05/2021	116
Acquisition of Axion	Archmore Infrastructure Debt Platform Asterion Industrial Infra Fund I InfraDebt Ethical Fund	08/01/2021	98
TNG Stadtnetz FTTH Network	Archmore International Infrastructure Fund II	03/03/2021	91
Acquisition of A Stake in Telcom Group	Gresham House British Strategic Investment Fund	01/07/2021	87
Acquisition of iBus Network	India Infrastructure Fund	20/04/2021	20
Acquisition of a Stake in Borderlink	Gresham House British Strategic Investment Fund	14/04/2021	14
Acquisition of a Majority Stake in Ngoya Etix Data Center	African Infrastructure Investment Fund 3	04/03/2021	N/A
Acquisition of a Stake in Voneus (2021)	Israel Infrastructure Fund III	25/03/2021	N/A
Acquisition of Supernap Italia	IPI Partners II	26/02/2021	N/A
Placentia Smart City Fiber Network	Smart City Infrastructure Fund	03/06/2021	N/A

Source: IJGlobal 2021.

Meanwhile, Macquarie Capital agreed in June to create an investment partnership with San Francisco-headquartered Prime Data Centers. This investment is being led by Macquarie Capital's infrastructure investment and development team and the JV plans to make capital investments of more than \$5 billion over the next 10 years to develop a portfolio of data centres across Europe and North America.

A more concrete development in the same month saw UK-headquartered Amber Infrastructure enter the Australian digital infrastructure sector with the acquisition of a majority stake in data centre platform i.seek. Together they have an expansion strategy beyond iseek's existing 5 purpose-built data centres in Brisbane, Northern Queensland and Sydney.

The deal was finalised on 18 June, adding to Amber's A\$7 billion (\$5.23bn) Australian portfolio which includes more traditional infra assets in social infrastructure and transport.

Back in Europe and Allianz Capital Partners made its debut investment in the

European tower space with the acquisition of a 10% stake in the European arm of American Tower. This transaction is valued at €530 million, implying an enterprise value of €8.8 billion for American Tower Europe (ATC Europe).

The investment will sit in the Allianz European Infrastructure Fund and it sees Allianz join CDPQ as a shareholder in the company following CDPQ's acquisition of a 30% stake in early May 2021 for €1.6 billion.

The list of accomplishments from the first half of 2021 is not endless, but it is impressive – building a head of steam that shows no sign of letting up.

Market view

And key market players are very much of that view – a head of steam is building and digital infrastructure assets are all the rage.

Steven Sonnenstein, senior managing director at Digital Bridge Investment Management, says: "We will see continued momentum and accelerating investment into the sector as more and more



"Recent pressures in more traditional sectors of infra – transport/energy – through the pandemic has seen portfolio managers looking to bolster returns and offset that underperformance."

Adam Ringer



"Driven by secular data growth, low interest rates, increased strategic and infrastructure market liquidity and familiarity I would expect demand for participation in the space to remain strong for the rest of 2021."

institutional investors turn their attention to digital either as a result of rebalancing their infra portfolios and/or as a result of creating a new allocation for this sector.

"Recent pressures in more traditional sectors of infra – transport/energy – through the pandemic has seen portfolio managers looking to bolster returns and offset that underperformance."

Sonnenstein adds: "In addition to that, the current low interest rate and low inflation environment will act as a further contributing factor to the overall acceleration in infrastructure investments near term. I also believe that the impending threat of tax hikes will see increased seller activity as certain investors may seek to crystallize investments ahead of an impending capital gains tax increase."

"On the flip side, valuations continue to climb as more and more investors pour into the sector. So as investors potentially stretch themselves to achieve these full valuations, they may be faced with unwanted pressure on the capital structure of their businesses once interest rates and inflation turn upwards."

Adam Ringer, a partner for infrastructure equity at AMP Capital, is of much the same mind as Sonnenstein saying: "Driven by

secular data growth, low interest rates, increased strategic and infrastructure market liquidity and familiarity – both debt and equity – I would expect demand for participation in the space to remain strong for the rest of 2021.

"This was the case prior to 2020, but this has accelerated since the onset of the pandemic.

"Given this is a secular trend that was significant prior to Covid, I would expect this to continue and remain strong whatever normal looks like in future. I think if there was any doubt that data infrastructure was an essential service in 2019, then there isn't one now."

Sara Pickersgill, co-head of Allen & Overy's global infrastructure group, has witnessed the sea change in perception for this asset class – which has been given a significant boost by the coronavirus pandemic.

"We saw M&A momentum building in the space prior to 2020, but the pandemic itself has demonstrated the resilience of digital infrastructure. This has increased demand with investors looking to diversify their portfolios given the challenges suffered by some of the more traditional infrastructure and transportation assets over the last 18 months."

AMP's Ringer adds to the discussion on demand saying: "This is well documented as is the consequential increase in valuation in the most well understood parts of the sector such as wholesale to MNO passive towers or transport fibre. However, what I find interesting is the sector has other pockets of opportunity for infrastructure investors.

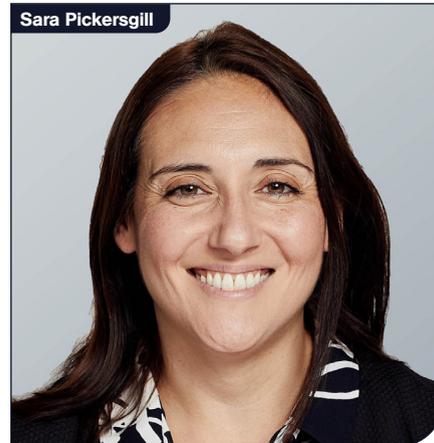
"From FttH to investing in cloud service provided by data centres or even software defined networks, strong recurring revenue can be seen, largely backed by strong network effects leading to barriers to entry."

Oliver Bradley, managing director responsible for digital infrastructure investments and part of Macquarie Capital's infrastructure investment and development group, says: "It has been a busy year so far for M&A in the fibre space, with a number of processes launched across Europe. Valuations continue on an upwards trend and it will be interesting to see if that continues."

"It is possible we may soon start to see increased consolidation in markets with a significant number of 'altnet' fibre operators, although that is more likely as businesses mature in terms of their roll outs."

A&O infrastructure partner Jocelyn Land comments that a similar set of pressures apply to funders. "We are seeing infrastructure debt funders keen to diversify their lending portfolios into the sector. A particular sweet spot is operational assets

Sara Pickersgill



"We saw M&A momentum building in the space prior to 2020, but the pandemic itself has demonstrated the resilience of digital infrastructure."

having a significant need to raise further funds to expand, as we are seeing in many parts of the sector given the need for fibre roll out and 5G."

MacCap's Bradley says: "The other key trend is the creation of 'fibrecos' in partnership with existing integrated telecom companies, such as we are seeing in the Netherlands, Germany, Spain and the UK.

"These can be attractive for telecom companies as they can enable them to access low-cost capital and in off balance sheet structures that enable them to optimise leverage. Sometimes there can be options to re-consolidate in later years once the business has matured and is EBITDA positive."

The A&O partners are very much of this mind and believe this trend is set to continue as telcos and MNOs look to monetise passive infrastructure through partnering with infrastructure funds.

"Competition has become really fierce for quality assets in this part of the sector," says Pickersgill, "but it's not just a cost-of-capital shoot out – the successful funds playing in this space are, more often than not, those with a well-defined sector specialism and established track record."

Digital Bridge's Sonnenstein concludes: "As I've said before, digital infrastructure investments are operationally intensive and require continued oversight and engagement from its shareholders. Distractions from a bad capital structure are never welcome."

Oliver Bradley



"It is possible we may soon start to see increased consolidation in markets with a significant number of 'altnet' fibre operators, although that is more likely as businesses mature in terms of their roll outs."

"Passive investors who don't align themselves with the right operating partners run a higher risk of not being able to react dynamically to an ever-changing environment. These businesses rely on providing a 'five 9s' standard and maintaining strong customer relationships. These relationships and reputations take a lifetime to build and a nanosecond to destroy."

H2 off to a flying start

The appetite for digital infrastructure assets shows no sign of letting up in the second half of 2021 with significant developments already having been logged.

In mid-July, Digital Realty and Brookfield Infrastructure Partners agreed to establish a 50:50 JV – BAM Digital Realty – to develop, own and operate data centres in India. Digital Realty chief executive William Stein said at the time of the announcement: "India is a rapidly emerging data centre market and offers a bright future, with accelerating adoption of digital business models among a population that recognises the role of technology for future economic development."

Brazil saw an interesting development when Grain Management acquired internet service provider Grupo Conexão from Acon Investments. While the value of the deal was not disclosed, Conexão's abortive attempt to launch an IPO last year (2020) valued the company at R\$2-3 billion (\$380-570m).

It operates in 6 Brazilian states and has a fibre-optic network of around 13,500km, serving 450,000 homes and 20,000 businesses, and is Grain Management's first acquisition in Latin America. David Grain, chief executive of Grain Management, said at the time: "The opportunity set for both strategic and organic growth through the acquisition of Conexão is solid. Telecommunications growth in Brazil is robust and aligns with the macro trends around which our firm invests."

Meanwhile, in Australia telecommuting company Swoop agreed to acquire South Australian broadband provider Beam Internet – also known as Wan Solutions – in a deal valued at A\$6.7 million (\$5m). This is Swoop's second acquisition since relisting on the ASX stock exchange earlier this year (May) and while it is a smaller deal, it stacks up the notion that DI assets are hot property and buyers are building portfolios.

Marguerite II Fund announced in early July that it was acquiring a 100% interest in Conapto, a Swedish data centre operator, with the deal slated to close soon after. It is buying the asset from Swedish private equity vehicle Segulah Fund V.

Stockholm-headquartered Conapto operates 2 data centres and a backup site in the capital's region. It has already started to expand its Stockholm North data centre in Sollentuna, and once complete this will add 2MW of capacity. Conapto provides data centre colocation facilities fed 100% by renewable energy and it launched in 2018 following the acquisition of Sungard Availability Services' Swedish operations by Segulah Fund V.

Malaysian telco Axiata in early July was eyeing options to acquire a stake in Indonesia-based internet provider Link Net from Luxembourg-based CVC Capital Partners and Indonesian telco First Media. CVC holds a 35.55% share in Link Next through Asia Link Dewa, while First Media – a subsidiary of Indonesian conglomerate Lippo Group – owns 27.9%.

In the US, Searchlight Capital Partners and Simple Broadband announced early in the second half that they were investing in All Points Broadband, a Virginia-based internet service provider. Founded in 2014, All Points Broadband connects rural communities with full fibre and wireless services. It currently has 25,000 residential and business customers in Virginia and Kentucky, with plans to expand to other states. This deal is expected to close this quarter.

IJGlobal reported on 1 July that Brookfield's core infrastructure fund and Swedish pension fund Alecta were acquiring a 49% stake in Telia's tower business in

Jocelyn Land



"We are seeing infrastructure debt funders keen to diversify their lending portfolios into the sector."

Finland and Norway. The stake is being sold for €722 million (\$855m), implying an enterprise value of €1.524 billion on a debt free basis and an EBITDA multiple of 27x.

Telia has the largest tower infrastructure footprint in the Nordics and the Baltics, with 25,000 towers and rooftop sites. In Finland and Norway, Telia's tower business is made up of 4,700 towers with a 2020 revenue of €88 million and EBITDA of €56 million. Telia announced plans earlier this year to partner with external parties to develop its digital infrastructure assets and it will use the proceeds to deleverage, reducing its net debt-to-EBITDA to around 2.1x. The deal is expected to close in Q4.

At the end of June, The Future Fund consortium agreed to acquire for A\$2.8 billion a 49% interest in InfraCo Towers from Australian telecom giant Telstra. InfraCo Towers is one of 4 offshoots of Telstra formed out of the restructuring which was finalised earlier this year (March) and it holds the country's largest network of mobile tower sites.

The 49% stake is to be acquired by a consortium of Future Fund as the largest investor, SunSuper and Commonwealth Superannuation Corporation. The investment will be managed by New Zealand-headquartered alternative asset manager Morrison & Co.

All of these deals complete the view that fundraising for digital infrastructure assets will continue at pace, but will be outpaced by M&A activity which brings to the table a lot more players than purely infrastructure funds. ■

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