WHITE PAPER

Technology Foresight: Harnessing technological trends within infrastructure

IFM Investors

July 2022

INFRASTRUCTURE

This paper outlines:

- IFM's view on the landscape of technology trends affecting infrastructure, including the risks and opportunities they present.
- The approach we have undertaken to assess changing technology trends and engage our portfolio companies.
- Summary findings from our risks and opportunities assessment of technology trends, including common themes and trends across sectors as well as sector-specific trends identified through our detailed assessment of emerging technologies in individual infrastructure sectors.
- Examples of IFM portfolio companies that have pursued innovative technology-related initiatives.

New technologies and changing trends have begun to reshape infrastructure sectors, sometimes in profound ways and often across multiple sectors.

Introduction

Infrastructure companies have traditionally experienced a relatively stable technology environment with a fairly predictable future. This reality has changed dramatically in recent years, as a number of long-term global forces have shifted the technology landscape. One of the more important forces driving this change is the exponential rate of technology development and adoption. Disruptive technological changes are already shifting the ways in which consumers, businesses, and governments behave, and this phenomenon is evolving at an unprecedented rate. Innovations in a diverse range of industries have not only unleashed new technology applications, but have also uncovered new intersections across different fields and sectors.

We believe these changing trends are challenging long-standing assumptions about how infrastructure assets are operated and designed. This, in turn, is changing the way consumers utilise infrastructure and interact with infrastructure companies. These changes are likely to continue and are likely to accelerate in the coming years.

In recent years, advances in computing power, data analytics, e-commerce, renewable energy, ride sharing, and drones – just to name a few technology areas – have begun to reshape infrastructure sectors, sometimes in profound ways and often across multiple sectors. It is also increasingly apparent that the value potential of data and digital technology is immense in terms of improving operations and creating additional revenue opportunities.

The disruptive business implications of the coronavirus pandemic have further underscored the importance of technology in operations, employee and customer health and safety, and other areas.

These fundamental shifts and innovative technology trends are expected to have critical implications for infrastructure companies in different sectors, presenting both opportunities and risks. Furthermore, the impact of those opportunities and risks can vary significantly depending on sector and asset-specific characteristics. Companies can be exposed to technological disruption, but they can also mitigate the risks and reap the myriad benefits of adopting cutting-edge technologies.

In this context, we believe it is now more important than ever for infrastructure investors and operators to understand the changing technology landscape and evaluate critical trends as they appear on the horizon. We believe that successfully navigating the complex technological changes occurring within infrastructure requires a nuanced approach that does not simply react to industry trends, but anticipates future risks and opportunities.

Assessing technological change – Our Approach

We have worked closely with our Technology Senior Advisor Sanjay Sarma and our Senior Advisors across different infrastructure sectors to undertake a proactive and systematic approach to identifying and analysing technology trends, from foundational global trends affecting the broader technology ecosystem to specific technology developments affecting individual infrastructure sectors.

In consultation with our sector experts, we have worked closely with Dr. Sarma to conduct in-depth analyses to develop detailed technology trends assessments ("heat maps") of risks and opportunities for each key infrastructure sector relevant to IFM Investors. We continue to monitor these trends and developments, including the impact from the COVID-19 pandemic. Lastly, we share our detailed sector findings with our individual portfolio companies and where appropriate, pursue further deep dives and follow-on actions around particularly salient technology trends that have emerged from our assessment.

This approach helps ensure we are informed on the latest trends affecting infrastructure and are incorporating them into business planning and asset management processes.

We believe that successfully navigating the complex technological changes occurring within infrastructure requires a nuanced approach that does not simply react to industry trends, but anticipates future risks and opportunities.

Key Findings of Our Risks and Opportunities Assessment of Technology Trends

General Trends and Themes

A number of prominent technology trends span multiple sectors, from sensing and asset monitoring technologies to electrification and automation. Infrastructure operators in different sectors are utilising sensing and other technologies to improve operations, detect leaks in real time, and enable predictive maintenance of critical assets. Electrification and automation can enable greater efficiency while providing safety and environmental benefits.

Changing consumer expectations and behaviours are having wide-reaching impacts in every infrastructure sector, and digital and data-enabled capabilities have a central role to play. Proactive companies can leverage customer-side technologies and the abundance of data to maintain and even enhance their valuable customer relationships. End-users are actively seeking more information and transparency, and increasingly expect the more personalised and digital experience that many sectors outside of infrastructure now offer. This change in consumer attitudes sometimes requires infrastructure assets to reinvent aspects of their business model to offer new or enhanced services and customer experiences that can also become new revenue streams.

The unifying thread among many of the trends we identified in our assessment is digital technology. The importance of digital and leveraging data to better manage assets, optimise efficiency, and improve customer service is a preeminent focus for IFM.

Environmental sustainability is another ever-present theme. Specifically, climate change is an area of concern across all sectors that requires technology-related solutions. As the impact of extreme weather intensifies (as the devastating wildfires in Australia and the US in recent years have demonstrated acutely), we expect infrastructure operators across every sector to assess technology-related solutions to help build resilience to catastrophic climate events and reduce emissions and other environmental impacts.

Sector-Specific Trends

The impacts of new technologies and technology-related trends on individual infrastructure sectors vary in their magnitude, direction and estimated timeframe of impact[1]. Summaries of our key findings for each sector are highlighted below, including our hypothesis on the impact COVID-19 has had, and may continue to have, on technology trends as we begin the transition to a "new normal" following the pandemic.

Toll roads

- The evolution of tolling technologies, transportation technology, and data-enabled technologies relating to intelligent infrastructure, analytics and the Internet of Things (IoT[2]) are all substantially altering the toll roads sector.
- For example, **distance-based global tolling,** while likely to be at least 15 years in the future, presents a potentially radical change to the revenue model of the sector. We believe the adoption of **new toll collection and payment methods**, particularly **contactless technologies**, will also accelerate due to COVID-19.
- We expect the evolution of transportation technology – including a critical mass of **autonomous vehicles** and **electric vehicles** (both of which are projected to be reached 10-15 years from now) and other mobility-as-a-service technologies – to have varying impacts depending on the specific characteristics of each toll road. Autonomous vehicle technology can already contribute to improvements in safety and increase the capacity of toll roads.
- Drivers also appear to be increasingly demanding **electric charging** and **high wireless bandwidth** along the road, changing the design of road infrastructure and the ways in which users interact with roads.
- Another example of a technology trend affecting toll roads is rapidly improving **real-time route optimisation services** such as Waze and Google Maps, which can reduce traffic and allow increasingly digital customers to know when to travel and potentially avoid paying tolls or use alternative routes.

[1] It is also important to note that technology trends with potential risks can also represent opportunities depending on sector- and asset-specific factors. In the toll road sector, for example, autonomous vehicles are often perceived as posing a threat to traffic on toll roads; however, autonomous vehicles can travel closely together, and increased adoption of autonomous vehicles and truck platooning technology (the linking of multiple trucks in a convoy) can increase capacity by allowing for greater vehicle throughput on toll roads.

[2] The Internet of Things describes the network of physical objects and devices that are embedded with software, sensors and other technologies that can connect and exchange data with other devices over the internet.

- The importance of **data and analytics** is a key theme and opportunity for toll roads, whether in enabling **active communication with vehicles**, **collaborative route planning**, or other applications of analytics leveraging passenger data to improve service and increase revenue opportunities.
- The need for **technology integration** has also increased due to potential inter-state restrictions as a result of the COVID-19 pandemic, such as the potential need for "health passports" between states and nations.

Airports

- We expect technological change to have a significant impact on the revenue makeup of airports. In particular, **leveraging data and digital technologies** can significantly improve asset value through improved operations and commercial opportunities from new products and services.
- Data and analytics are important across the airport ecosystem, including parking, check-in, security and retail. From **biometrics, facial recognition, electronic baggage tagging** to **digital customer interfaces, mapping and wayfinding**, a long list of digital trends presents key opportunities at every step of the airport customer journey.
- As digital and e-commerce disrupt the retail industry, innovative retail approaches, such as **targeted advertising leveraging passenger data**, are likely to improve the profitability of airports, while reshaping the customer experience for the better.
- Other critical trends impacting the airports sector include **5G connectivity** and airport-adjacent services that present revenue risks and opportunities, including **ride sharing**, **autonomous vehicles**, and **electrical vehicle charging**. For example, ride sharing is already impacting terminal design, while autonomous vehicles may impact airport parking revenue.
- The impact of COVID-19 on the air travel industry has been enormous. The ensuing recovery and post-pandemic new normal will have technology-related implications for airports, including hygiene and the use of **disinfection technologies, ventilation and filtration technologies, flow management technologies** to pre-map and optimise a faster and less crowded passenger journey through the airport, and **terminal redesign**.

Ports

- Technologies ranging from **IoT-based sensing and monitoring** to **increased roboticisation and autonomy** – including automated/semi-automated container terminals and autonomous ships – have significant implications for ports.
- Ports may be able to leverage **live tracking data** from containers, inventories and trucks in order to improve operations, by optimising efficiency during loading and unloading and reducing wait times, thereby increasing revenue.
- More centralised and interconnected **data management** can help ports drive greater efficiencies and provide new revenue-generating services.
- **Autonomous ships** (estimated to materialise as a significant trend in approximately 15 years) may lead to smaller ships and increase the competitiveness of smaller ports. In the near term, **automated underwater vehicles** have the ability to scan ships underwater for both security and maintenance purposes.

Midstream

- **IoT** and **supervisory control and data acquisition (SCADA), robotics, augmented reality** and other innovations can dramatically improve the operations of midstream assets.
- **Drones, robotic crawlers, sensors** and **digital technologies** are critical in pipeline operations in order to detect leaks or perform corrosion inspection and analytics.
- Oil and refined product demand, as well as the volumes transported, will also likely change due to factors such as the increased adoption of **electric vehicles** and **new transportation fuels**, with company-specific ramifications for the midstream sector.
- Some midstream assets will be better positioned than others, depending on strategic location, cost relative to other modes of transportation, and other competitive and macroeconomic factors. There are also opportunities to diversify the product mix (e.g. biofuels).

Water Utilities

- The infrastructure for water distribution is ageing and many traditional sources of water are under threat from climate change and demand strains. It also appears customers are seeking greater visibility into their water usage and quality, changing the way in which water systems are instrumented and managed.
- **Sensing technologies** and **end-use demand management** are already being used by water utilities.
- Technology has a key role in efficient distribution and application of water for agriculture and for monitoring environmental impacts. The industry has also seen substantial advances in **water conservation and treatment technologies**, as well as in the **smart water grid**.
- The increased availability and utilisation of data enables **sensing technologies** and **predictive maintenance analytics** that improve operations and detect leaks, while avoiding capital expenditures. Data also enables **smart resource monitoring** so utilities can prepare and manage their water supply to help ensure that demand can be continuously met.

Electric Utilities

- **Renewable energy, electric vehicles, distributed energy resources** (especially **battery energy storage**), **smart meters**, and a host of other **customer-side technologies** that make up the data-rich smart grid are already transforming the electric grid.
- The electric **utility of the future** will have to become increasingly two-way, resilient and smart, rather than the centralised generation and one-way transmission and delivery model of the last century.
- **Sensors, measurement**, and **data** are becoming key components of a smarter and more resilient grid, from **grid sensors** to **data visualisation and modelling** technologies that help utilities forecast power supply and demand, manage loads, and identify problems promptly.
- Recent investments in the grid's physical infrastructure have yielded massive amounts of **customer data**: in fact, data from **smart meters** and the **intelligent grid** may be the most important and valuable resource to the utility of the future.
- In the long term, utilities may eventually become data companies that work with smaller service providers that generate, store and transmit electricity. As consumers become increasingly digital, utilities can leverage the abundance of data now available to offer innovative customer-side applications that generate new revenue opportunities and improve customer service. This suggests the utility business model may have to be fundamentally reimagined.

Sensing and Asset Monitoring

Across infrastructure sectors, technology is driving better operation, maintenance, and monitoring of critical assets. This trend is applicable to many infrastructure sectors but particularly prominent in sectors such as water utilities. A few examples of IFM portfolio companies deploying sensing and asset monitoring technology include:

01
Anglian Water's leakage detection technologies

02
Aqualia's smart water services

Electrification and Automation

Electrification and automation, trends that cut across sectors, can enable greater efficiency while reducing emissions and enhancing safety. This is particularly salient in the toll road sector. A few examples of IFM portfolio companies deploying electrification and automation technology include:

03
Indiana Toll Road's electric vehicle charging infrastructure

04
Aleatica's pilot projects testing autonomous truck-platooning and wireless electric vehicle charging technologies

Customer Empowerment

Technology is enabling service providers to help meet the expectations of increasingly mobile and digital customers. A few examples of IFM portfolio companies deploying technologies that improve customer service include:

05
Ausgrid's battery Virtual Power Plant (VPP) trial

06
Indiana Toll Road's deployment of fibre optic technology

07
Vienna Airport's artificial intelligence (AI) chatbot service

08
Manchester Airports Group's MAG-O, a digital and e-commerce start-up business

Examples of Technology Adoption by IFM Portfolio Companies

Our discussions with IFM infrastructure portfolio companies suggest many are actively leveraging cutting-edge technologies to address emerging trends and a number have already started to pursue technology-related initiatives that have the potential to generate tangible value from important technology trends. The examples below[1] detail some of the more prominent themes and megatrends – sensing and asset monitoring, electrification and automation, and customer empowerment technologies – and how IFM portfolio companies are addressing them.

01 **Anglian Water's leakage detection technologies:** Anglian is an industry leader in the detection of leaks, using a variety of different advanced techniques to detect leakage in real time. In an industry first, Anglian adapted a form of naval technology known as advanced noise loggers to listen to changes in sound underwater, using immersed acoustic sensors to listen to sound waves inside pipes to pinpoint leaks. The technology works alongside other technologies including thermal imaging drones and satellite imagery to spot and reduce leakages, helping save millions of litres of water. Anglian is continuing to innovate to further reduce their leakage by over 15% by 2025. The latest deployment includes the installation of fibre optic sensor cables to continually monitor the pipes for leaks, enabling high-speed broadband for operational purposes as well as potentially bringing high-speed internet connectivity to customers as an innovative and valuable new service.

02 **Aqualia's smart water services:** Aqualia has deployed an analytics platform to enable smart water cycle management, capturing information from a network of connected smart water devices and using technologies such as big data, cloud computing, machine learning, and artificial intelligence to optimise water treatment and reduce water waste. Sensors and gauges are used to collect and analyse large amounts of information and data that result in business intelligence, allowing for energy efficient processes, demand prediction, continuous monitoring, and the early detection of leaks.

03 **Indiana Toll Road's electric vehicle charging infrastructure:** Indiana Toll Road has deployed Level 3 / DC fast-charging infrastructure that can provide an 80% charge to electric vehicles in just 30 minutes, mitigating "range anxiety" – one of the key barriers to electric vehicle adoption. Drivers will be able to easily find the charging stations by syncing with the EVConnect cloud platform, which allows drivers to search for charging stations from their phone. A smartphone app also enables secure payments, provides active charging data, and delivers real-time notifications when the vehicle is fully charged.

04 **Aleatica's pilot projects testing autonomous truck-platooning and wireless electric vehicle charging technologies:** Truck platooning–the linking of multiple trucks in a convoy to enable close following–uses connectivity technology and automated driving support systems. Increased adoption of truck platooning technology could increase toll road capacity and reduce emissions on the road. Aleatica is conducting a research and development project to evaluate the costs and benefits of autonomous roads and truck platooning with Mercedes-Benz, a leading truck manufacturer. Additionally, Aleatica's road in Italy, the A35 Brebemi-Aleatica motorway, recently launched a cutting-edge pilot project to test contactless dynamic inductive charging of electric vehicles. The first-of-its-kind collaborative project will test this futuristic technology enabling on-the-road wireless charging of electric vehicles on an adjacent section of the road.

05 **Ausgrid's battery Virtual Power Plant (VPP) trial:** This trial allows customers to sell electricity from their batteries back into the grid and receive cash payments from Ausgrid. The dispatchable capacity from the batteries helps the grid network particularly during demand peaks. This innovative demand management pilot engages customers by working with customers' existing renewable energy investments and offering them financial incentives.

06 **Indiana Toll Road's deployment of fibre optic technology:** This deployment is designed to increase connectivity and help meet the expectations of increasingly digital and mobile customers. ITR's Intelligent Transportation System (ITS) provides the backbone for fibre commercialisation along the road, which should provide more connectivity to customers and potentially additional revenue for ITR.

07 **Vienna Airport's artificial intelligence (AI) chatbot service:** This AI solution is designed as a communication tool to provide customers with instant and reliable information. All visitors to the airport can use the chatbot for queries related to COVID-19 and transportation, as well as for facility information and directions. The chatbot also helps gather user insights, enabling the airport to identify trends and opportunities for improvement across the airport.

08 **Manchester Airports Group's MAG-O:** MAG has launched its own start-up technology and e-commerce business called MAG-O, which is designed to take MAG to the next level of its digital journey, especially as customers' expectations of customer service have increased over recent years. MAG-O's mission is to continuously pursue the adoption of technologies that can modernise and personalise the passenger experience, including how passengers find and book flights, receive live flight notifications, purchase car parking and fast track services.

[1] This is a selection of the many examples across IFM portfolio companies and is non-exhaustive.

Conclusion

In the coming years, infrastructure sectors will face an evolving set of risks and opportunities from new technology trends and other global forces. It is imperative we develop a nuanced understanding of the technology landscape to help ensure we are proactively acting on emerging trends to minimise risks and unlock tangible value.

As part of our active and long-term asset management approach, we will continue to incorporate technology considerations and engage with our portfolio companies as appropriate to help ensure we are well-positioned to capitalise on opportunities.

With foresight and a proactive approach, we believe we can navigate potential challenges and opportunities in order to succeed in a future of technological change.

IFM-28SEPTEMBER2021-1843026

HEAD OFFICE

Level 29 | Casselden | 2 Lonsdale Street | Melbourne | VIC 3000

+61 3 8672 5300 | www.ifminvestors.com | investorrelations@ifminvestors.com

MELBOURNE • SYDNEY • LONDON • NEW YORK • BERLIN • TOKYO • HONG KONG • SEOUL • ZURICH • AMSTERDAM

TL_IFM034