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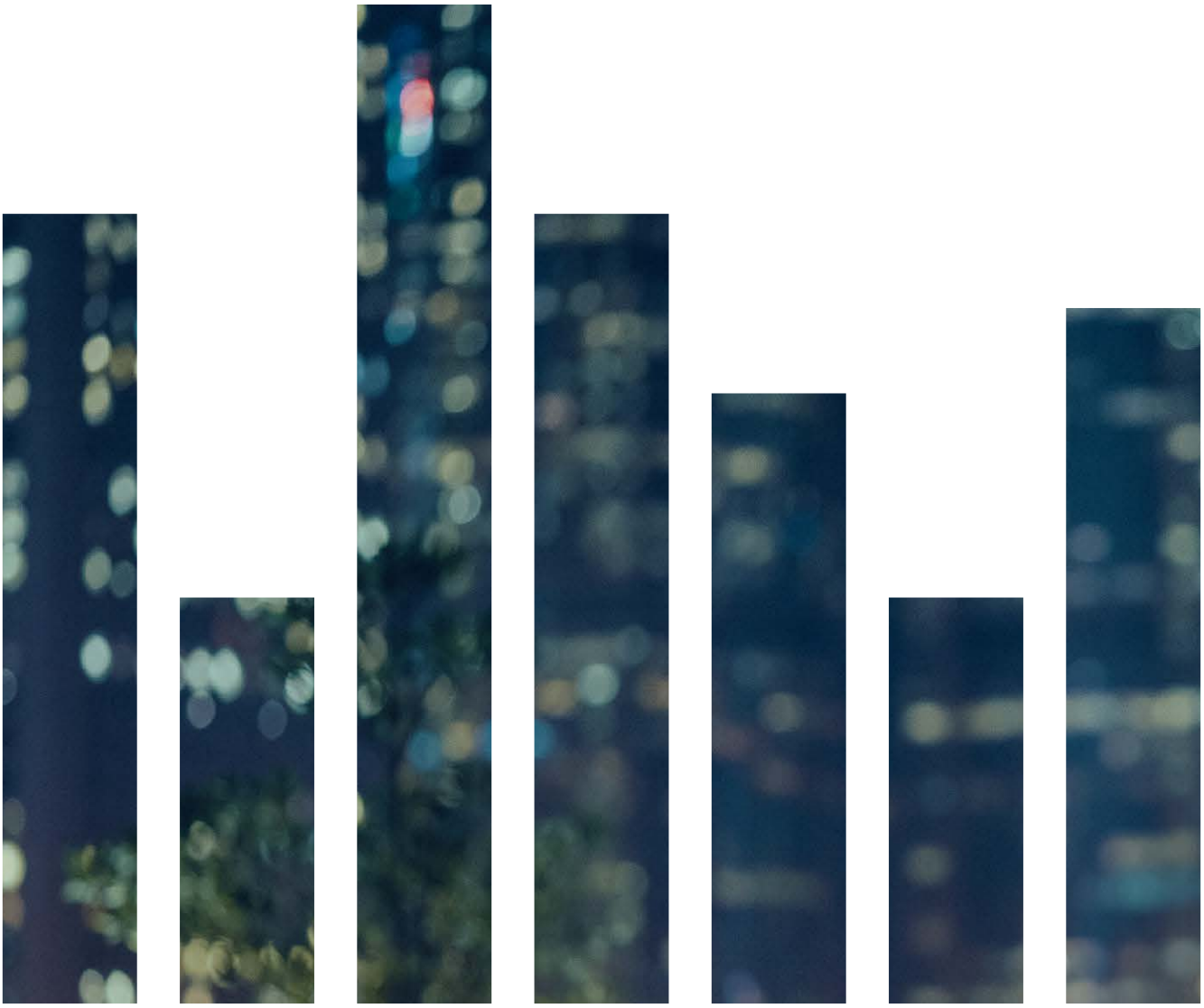


RANKING
THE WORLD'S

MOST CRITICAL INDUSTRIES

INTRODUCTION

It's a morning like any other. You get up, get the kids off to school, grab some breakfast, and make your way to the subway to catch a train into the city. But halfway to your stop, the train screeches to a halt in a tunnel and the emergency lighting flashes on. You check your phone for news but have no service. You sense a panic building among the other passengers and try to remain calm. What is happening, you wonder? How long will we be trapped here? Your heart is racing, and beads of cold sweat form on your forehead.

Or, you're working at the office on a tight deadline. The clock is ticking on the most important proposal you've ever managed. If your company can win this contract, it could make the year—and put you on the fast track to an executive position. You go to the cloud server to access the input from other members of the team, but it's taking forever. You stare at the spinning icon on your desktop, frustration growing. Why is this taking so long? Then, you get the message: *you are unable to connect to the server*. You call IT, and they tell you the cloud provider is experiencing problems. They're working on it, but there's no telling how long it will take. You feel a pain in your gut as sweat runs down your back.

Both are potentially nightmare scenarios in their own way, that considering the complexity of today's critical systems are surprisingly rare, but is one more "critical" than the other? If the train starts moving a minute later, that situation becomes nothing more than an interesting story to tell your co-workers later in the day. But, if the cloud server stays down for the rest of the day and you can't get the information you need to complete the proposal, your company has missed a major opportunity to expand its business and jobs may be in jeopardy.

This report ranks the top seven critical industries based on the impact of a disruption in that industry. It also lists the top critical industries in terms of financial impact and identifies three emerging industries that are rising in criticality as they grow and evolve.

To some degree, criticality is subjective and dependent on the situation. The fact that one industry may rank slightly higher than another on a list of most critical industries doesn't mean much if it's your money or your reputation at stake. Almost every industry today relies on critical systems that can create significant value when they function as expected and significant disruption when they don't.

Defining Criticality

In analyzing what makes an industry critical, we identified 15 criteria, encompassing the range of potential impacts from the loss of availability of critical systems, and weighted them based on the severity of the impact. These criteria were then used to create a criticality rubric that our panel of global critical infrastructure experts used to score the industries.
They included:

- Unplanned downtime's impact on human health
- Financial impact of unplanned downtime in terms of lost sales and opportunity
- Societal order depends on availability
- Potential environmental impact of unplanned downtime
- Significant portion of the affected company's/affected affiliate's resources depend on availability
- Cost of recovery, including repairs, affected asset replacement, and alternate measures required during downtime
- Immediacy of impact
- Ripple effect from unplanned downtime
- Likely scope (local, regional, national, global) of effects of unplanned downtime
- Subjective industry criticality ranking
- Impact of reputational damage caused by unplanned downtime in the competitive marketplace
- Lack of availability causes frustration and angst
- Unplanned downtime brings the risk of high media/public outrage
- Probable duration of impact (operational, not reputational)
- Industry's prioritization of availability

THE WORLD'S MOST CRITICAL INDUSTRIES

Of the 22 industries analyzed, here are the industries (in reverse order) that scored the highest on our criticality rubric:

7. Smart Cities (605)
6. Defense (613)
5. Cloud and Colocation Services (614)
4. Oil and Gas Production (626)
3. Telecommunications (634)
2. Mass Transit (643)
1. Utilities (712)

7 SMART CITIES (605)

While Smart Cities is a broad term subject to multiple interpretations, our panelists used the following definition from *Wikipedia* in analyzing the criticality of this growing industry:

> *"A smart city is an urban development vision to integrate multiple information and communication technology (ICT) and Internet of things (IoT) solutions in a secure fashion to manage a city's assets, including local departments' information systems, schools, libraries, transportation systems, hospitals, power plants, water supply networks, waste management, law enforcement, and other community services."*

Clearly, the broad scope of what a Smart City can encompass would result in significant disruption from any downtime; yet, the Smart City vision has not been fully implemented, reducing the impact of disruptions. Still, the idea is advancing rapidly in many areas of the world.

As panelist Jun Michael Tian, senior director of strategic planning in China for Vertiv, noted, *"As Smart Cities continue to advance, disruptions in the supporting technology will impact transportation, law enforcement, public safety and other factors that haven't been identified yet. While the consequences of downtime in Smart Cities' technology aren't as widespread as other industries today, the potential is huge."*

Smart Cities was rated highly critical based on the financial impact, immediacy of impact, ripple effect, media/public outrage and societal impact of a disruption. Its inclusion in this list despite its immaturity speaks to both the huge potential of Smart Cities initiatives and the need to employ appropriate critical infrastructure systems as new sensors and systems are deployed.

6 DEFENSE (613)

"The defense industry has extremely high standards for its critical systems as they may be required to support live command and control for battlefield operations. Life and death decisions are made based on the information provided by critical systems."

– TONY GAUNT, senior director of colocation, cloud, and banking, financial services and insurance in Asia for Vertiv

Considering the critical role the defense industry plays in national security, it's not surprising to find it ranked as one of the most critical industries.

In addition to its role protecting lives, defense scored highly based on the immediacy of impact, potential broad scope of downtime, and potential for societal disruption. Because of the stakes involved, the defense industry typically invests heavily in reliability, redundancy and security to protect critical systems. It is also an industry that tends toward secrecy, establishing its own specifications for critical systems and requiring strict conformance to specifications and high levels of availability from its vendors. *"If there's downtime in the defense industry, you're probably not going to hear about it,"* Gaunt explained.

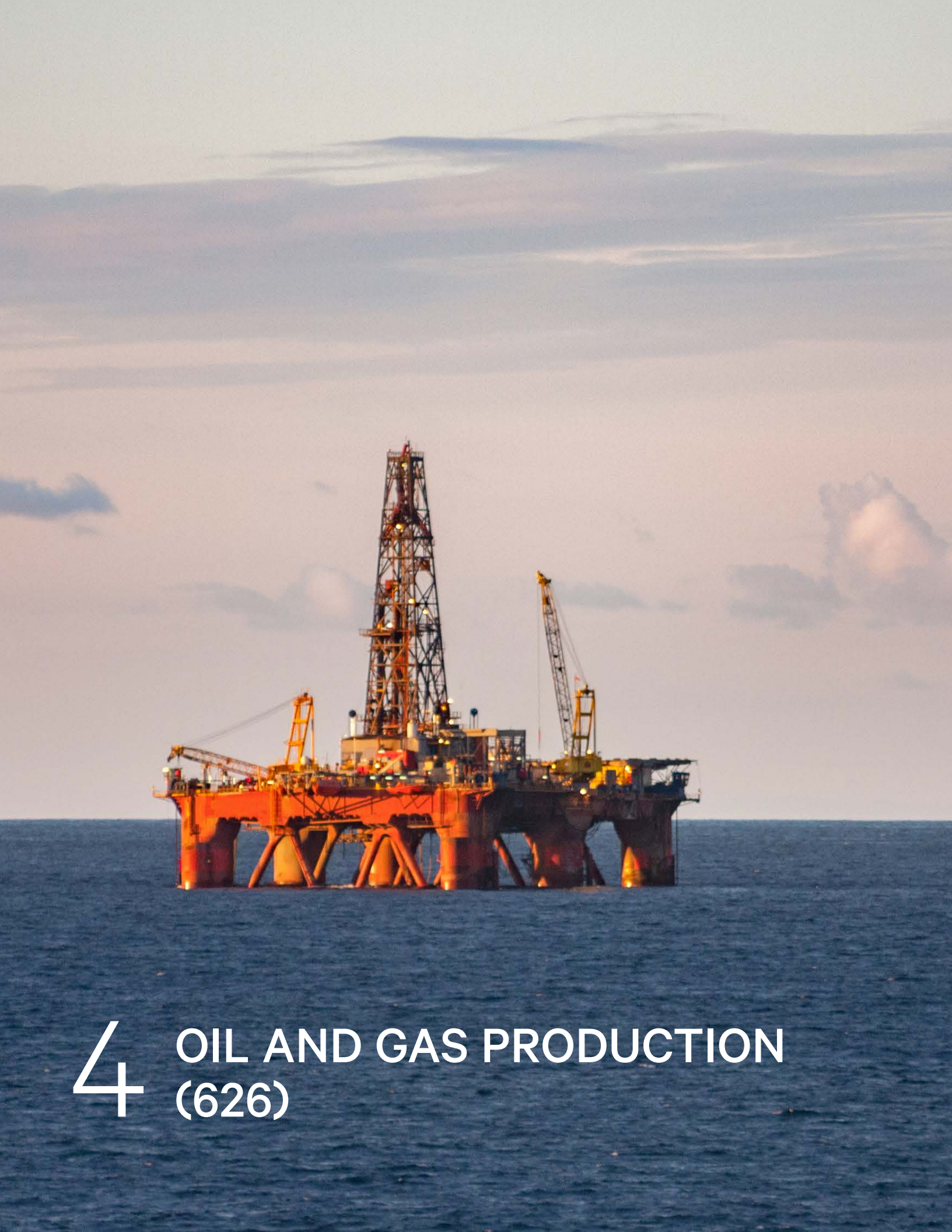
5 CLOUD AND COLOCATION SERVICES (614)

> *"Their business model in this industry is directly dependent on availability, so, they have a strong financial incentive to protect their customers from disruption. Yet, they also face the challenge of having to scale quickly to capitalize on market opportunities while delivering cost-effective services in a highly competitive market. As a result, they have been instrumental in pioneering new approaches to data center design that deliver high availability while enabling the ability to quickly add capacity."*
>
> **– PETER PANFIL,** vice president of global power at Vertiv

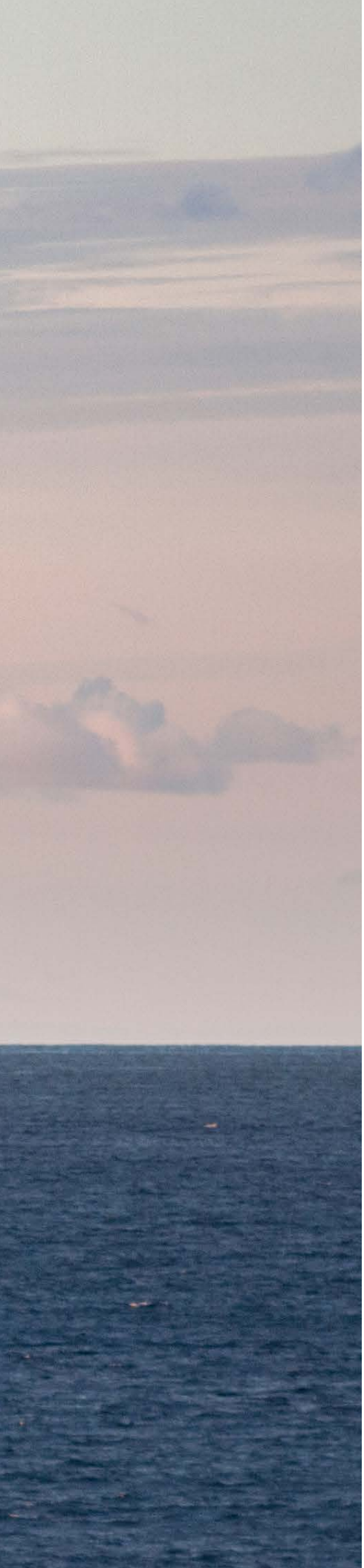
Cloud and Colocation Services have experienced strong growth in the last five years as the industry has expanded to meet the demand for storage, compute and networking capacity by a wide range of other industries that now depend on these platforms to deliver services to customers and employees.

Panelist Peter Panfil, vice president of global power at Vertiv, has worked closely with many cloud and colocation providers on the design and deployment of critical power systems to ensure the availability of their data centers. *"Cloud and colocation providers are becoming the hub of the digital economy, and downtime can have implications that ripple through society,"* said Panfil.

Cloud and Colocation were scored highly based on the financial impact of disruption, company resources dependent on availability of services, immediacy of impact, and the priority the industry places on availability.



4 OIL AND GAS PRODUCTION (626)

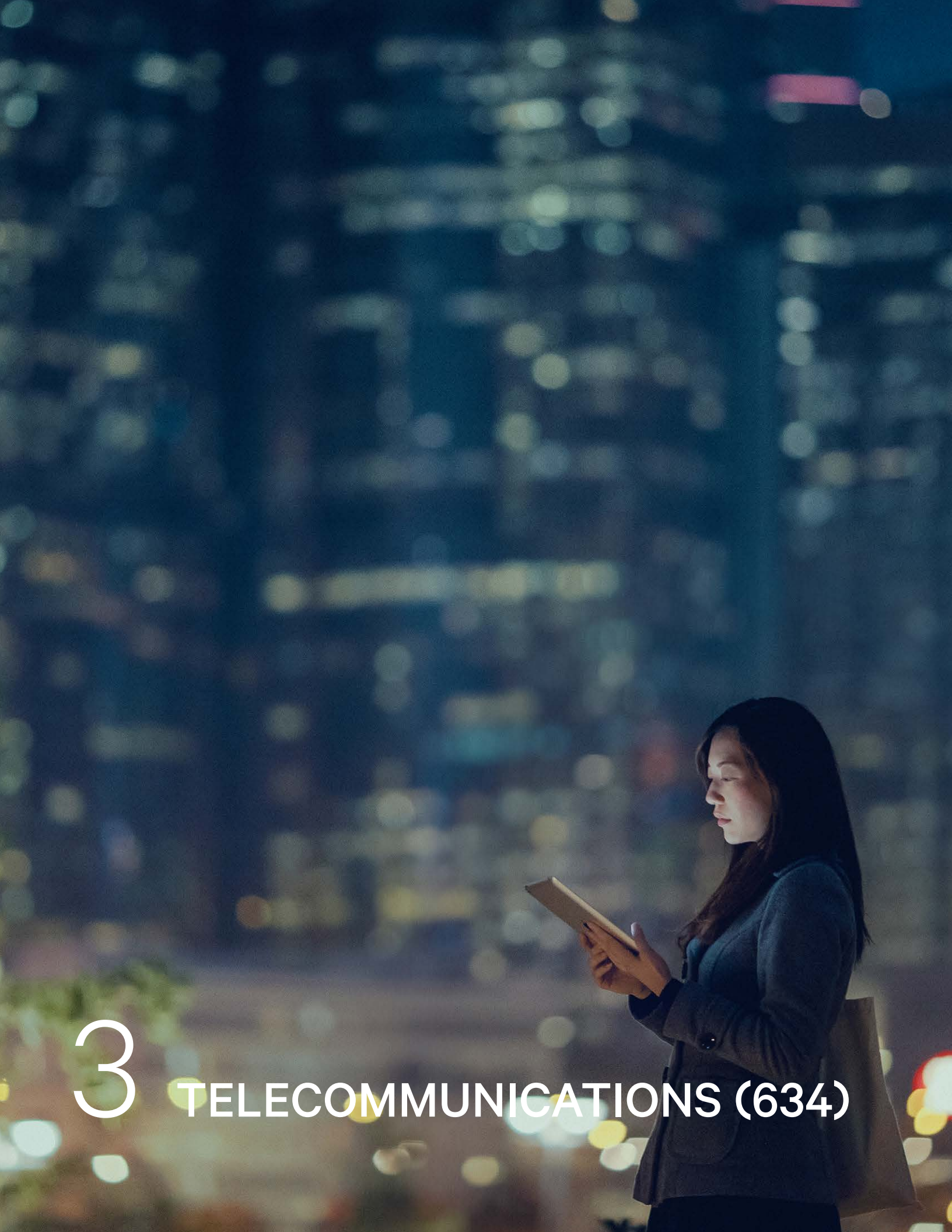


"In Oil and Gas, safety comes first and there is no compromise on it. Modern technology plays an important role in monitoring and securing these installations. Specifically, the industry believes in multiple redundancies and continuous power to assure that every component within systems—every sensor, every valve and every PLC— is online 100 percent of the time, even in an emergency shutdown situation."

– JEAN-BAPTISTE TROLLÉ,
vice president of global industrial sales and marketing for Vertiv

Downtime in the Oil and Gas Production industries, including offshore installations, has the potential to be catastrophic.

The release of the movie, "*Deepwater Horizon,*" chronicling the 2010 disaster on an offshore platform, served as a powerful reminder for panelists of the consequences of failure in offshore production. *"'Deepwater Horizon' highlights how complex the challenge of protecting these systems is,"* explained panelist Jack Pouchet, vice president of market development at Vertiv. *"Most critical industries have backup systems in place, but that alone doesn't provide immunity from failure. These technologies need to be supported with a disciplined approach to training and testing."*



3 TELECOMMUNICATIONS (634)

"Telecommunications remains fundamental to our ability to communicate, is critical to commerce, and enables life-safety efforts. The fact that telecommunications services were not disrupted by the series of earthquakes that hit Italy in 2016 allowed first responders to exchange information on where the highest number of causalities were located, expediting response and minimizing the loss of life from this natural disaster."

– EMILIANO CEVENINI, vice president of sales, AC power, and business development in EMEA for Vertiv

The Telecommunications industry set the standard for availability of critical services with the development of the traditional telecommunications network during the twentieth century. The industry has invested heavily to achieve similar levels of availability in mobile communications this century, although the nature of mobile makes it nearly impossible to deliver the same level of availability as the traditional network.

Telecommunications scored highly among panelists in financial impact, societal order, immediacy of impact, and the effect of downtime on the company's reputation. Telecommunications providers not only prioritize and invest in critical systems to ensure availability, they spend millions in marketing dollars to promote the reliability of their networks to enhance customer confidence and create competitive differentiation.

2 MASS TRANSIT (AIR AND RAIL) (643)

"We are seeing significant expansions of the rail system in many areas as populations continue to migrate to cities and these urban centers attempt to reduce congestion and pollution."

– ETIENNE GUEROU,
vice president of industrial in Asia for Vertiv

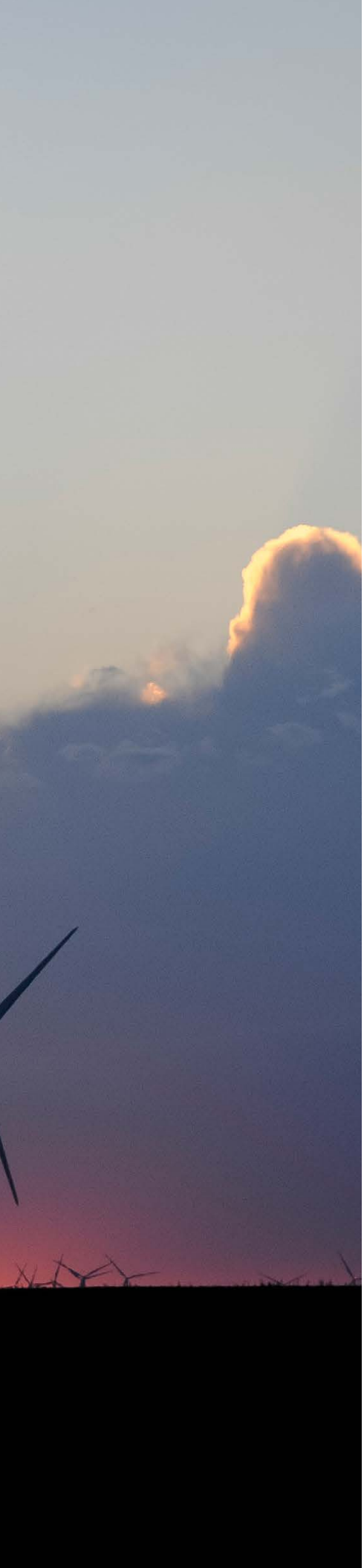
Virtually every stage of air transportation, from reservations to air traffic control to flight control systems, is heavily dependent on technology. Even small delays at one airport can ripple across the entire network, leaving passengers stranded hundreds of miles from home.

The chaos that can ensue from a disruption in air travel was evident when a volcanic eruption in Iceland in 2010 grounded hundreds of flights across Northern Europe, creating a ripple effect across the air transportation system that had passengers stranded for days.

Rail transportation is similar to air in the impact of downtime, although it tends to be more localized and more immediate, with greater angst and societal disorder among commuters dependent on rail for basic transportation.

Mass Transit was ranked highly by panelists based on the risk downtime introduced to human health, societal order, the ripple effect, and public outcry.

1 UTILITIES (712)



"I'm not surprised to see utilities at the top of the list. Power generation and distribution underpin most industries. Everything depends upon the utility, and when the supply of any utility goes down just about every industry is affected."

– **ROBERT LINSDELL,** managing director for Vertiv in Australia and New Zealand

Utilities, defined in our analysis as "nuclear power, gas service, water treatment, and electric generation, distribution and transmission," were ranked the world's most critical industry by our panelists.

With reliable power underpinning so many of the other services and systems we depend on daily, Utilities scored highly on almost all of the criteria in the criticality rubric. Downtime has an immediate and broad impact, can create societal disruption, and often ripples across other industries, paralyzing business and commerce.

Panelist Tom Nation, vice president and general manager of power system services in North America for Vertiv, agreed. *"Many industries have protections against loss of utility service, such as UPS and backup generators, and these are very effective against short-term and isolated disruptions. But when large portions of the grid go down, as happened in the blackout that affected the Northeast United States in 2003, the disruptions are so widespread that our entire society is paralyzed."*

THE COST OF DOWNTIME

"Financial impact of unplanned downtime" was one of the most heavily weighted criterion in the criticality rubric and one that tends to drive new technologies and best practices in critical infrastructure. The three industries that ranked highest on this criterion were:

3. Cloud and Colocation
2. E-commerce
1. Financial Services

Of the three, only Cloud and Colocation made the list of Most Critical Industries, and that was based on the number of businesses that now depend on these platforms and the broader impact of disruption to these operations. Financial Services ranked tenth overall.

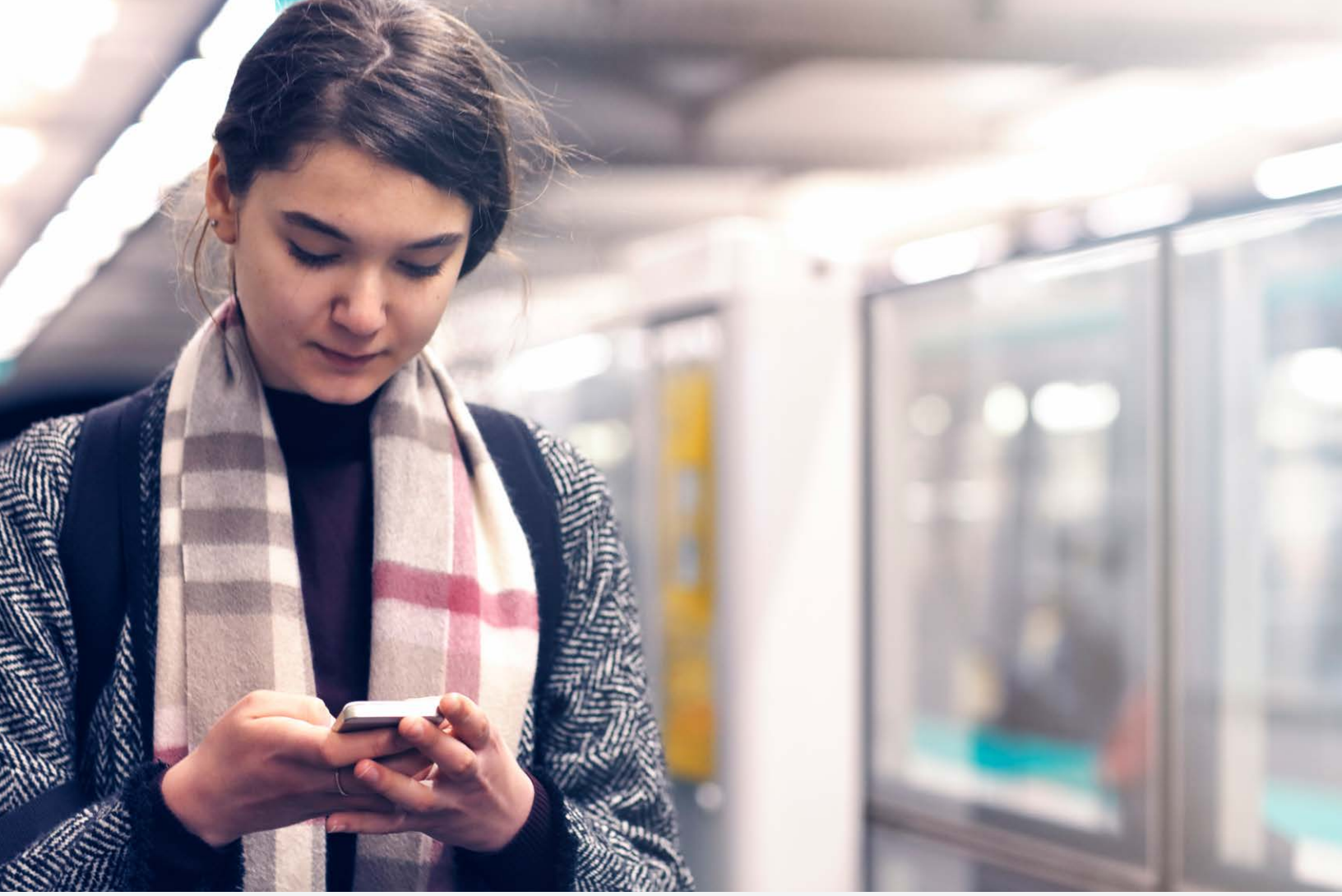
"From a data center infrastructure perspective, we see few industries that invest as heavily as these three," observed Gaunt. *"All three have their revenue and profitability tied directly to the availability of their data centers, and data center downtime can have huge financial and reputational implications."*

EMERGING INDUSTRIES = EMERGING CRITICALITY

As noted in the discussion of Smart Cities, some industries included in our analysis are advancing rapidly and will become more critical as they evolve, most notably Smart Cities, Cloud and Colocation and Alternative Energy.

"Cloud and Colocation growth continues to accelerate," noted Gaunt. *"Here in Asia, we are right at the beginning of the up curve for core industries' cloud adoption and it's likely that future critical services—the IoT networks that support Smart Cities and Manufacturing, for example—will develop in the cloud. Cloud and Colocation providers are demonstrating they can deliver a combination of availability and convenience that exceeds what many organizations can achieve on their own and will attract increasingly critical applications in the future."*

Alternative Energies, which include solar, wind, fuel cells and energy storage, are growing at a rate of as much as 42 percent per year and will play an increasingly important role in protecting industries from over-dependence on the electrical grid in the future. *"Currently, most applications of alternative energy technologies are supplementing utility power,"* noted Nation. *"However, we are seeing early adopters use Alternative Energy as their primary source of power. The more these technologies can demonstrate their reliability and cost-effectiveness, the more viable this approach will become."*



What's Worse—Not Being Able to Get to Work or Not Being Able to Post About It?

One of the factors that went into the criticality rubric was the stress created by a disruption. This was described as *"angst or frustration from downtime."* It was not weighted heavily, but for providers of services, creating angst and frustration among users is not taken lightly. It can generate negative publicity and, if experienced frequently, cause users to abandon the service.

The two most highly rated industries based on this criterion were Mass Transit and Social Media, with Social Media edging out Mass Transit for the top spot. Apparently, we get more frustrated about not being able to post about the train running late than we do about the train actually being late.

"Social media has gained a reputation for being somewhat trivial, and there's no doubt some percentage of content is, but it has also become a highly important means of communication and societal connection," said Pouchet. *"It serves as a primary news source for many people, a direct communication channel between government leaders and the general population, and an important resource during disasters."*

"Social media providers have been in a position similar to cloud and colocation providers in recent years," explained Panfil. *"They are having to build out capacity quickly to keep up with growing demand while simultaneously adapting to higher expectations for availability from users who are increasingly dependent on their services. This has driven new innovation in data center design and construction practices."*

CONCLUSION

While the world has grown increasingly digital, we are still heavily dependent on traditional industries, such as utilities, mass transit and telecommunication, which provide the day-to-day services that allow us to function in our personal and business lives.

At the same time, increasing digitization has created interdependencies across critical industries that are unparalleled. In almost every case, downtime in one industry has impacts that extend beyond that industry. Disruptions in the electrical grid ripple across all industries; delays in rail and air transport disrupt commerce; and downtime in a colocation facility extends across multiple businesses and shuts down the streaming video service we turn to for relaxation after a hard day's work.

As this trend continues and new critical industries emerge, the critical infrastructure that supports these industries becomes more important than ever. Industries across the spectrum must continue to invest in the technology, processes and services required to keep critical systems operational. We may never be able to eliminate all natural disasters or human error, but with proper planning and investment, we believe we can achieve a world where critical technologies always work.

METHODOLOGY

This non-scientific ranking was developed by our team of global critical infrastructure experts. First, they identified the 15 criteria that define critical systems, and then weighted each to create a “criticality rubric,” which panelists used, assigning a value of 1-5 for each criterion for each of 22 industries. When the weights were applied to these values, an aggregate score for each industry was computed. Averages for each industry were then calculated to develop the list of the most critical industries.

Vertiv Criticality Rubric

CRITERIA	YOUR SCORE 1 = NOT APPLICABLE 5 = VERY APPLICABLE					WEIGHT
	1	2	3	4	5	
Unplanned downtime's impact on human health						30
Financial impact - unplanned downtime causes lost sales and opportunity						20
Societal order depends on availability (i.e. downtime causes disruption to day-to-day life)						20
Potential environmental impact of unplanned downtime						10
Immediacy of impact - an outage takes a toll right away						10
Cost of recovery - repairs, affected asset replacement, alternate measures required during downtime						9
Significant portion of the affected company's/affected affiliates' resources depend on availability						9
Ripple effect (unplanned downtime takes out other systems, within or outside the initially affected organization)						9
Likely scope (local, regional, national, global) of effects of unplanned downtime						8
Subjective industry criticality ranking (please rank this industry based on your own experiences and knowledge and for those you scored 4 or 5, explain why you think this industry is extremely critical)						8
Impact of reputational damage caused by unplanned downtime in competitive marketplace (in the most extreme cases, this reputational damage could extend beyond the affected organization/company to the whole industry)						7
Lack of availability may not cause societal disruption, but it causes frustration and angst (i.e. when video streaming goes down on a Friday night or your social media game is not available for a morning public transportation commute)						7
Unplanned downtime brings the risk of high media/public outrage						7
Probable duration of impact (operational, not reputational)						5
Industry's prioritization of availability (do businesses in this industry spend significant time and resources to ensure their own availability?)						5

Most Critical Industries Panelists

Emiliano Cevenini

Emiliano Cevenini is vice president, power sales and business development for Vertiv in Europe, Middle East and Africa (EMEA). Emiliano started his career as an R&D engineer and subsequently became an R&D project manager in 1997. His positions of increasing responsibility include technical sales support and marketing manager, product marketing manager and vice president of international sales and marketing. Since 2016, he has led business development activities in key market vertical segments for Vertiv, including transportation, healthcare, smart grids and other applications adjacent to the data center industry.

Tony Gaunt

Tony Gaunt is senior director of colocation, cloud, and banking, financial services and insurance for Vertiv in Asia. Tony is responsible for the development of the Vertiv business in the data center, colocation, cloud and financial services markets in Asia; incorporating the company's full suite of product technologies and service offerings across the region. Since entering the industry in 1996, Tony has held roles of increasing responsibilities within sales and strategic account management including the position of UK sales manager. In 2011, Tony joined the company as a result of an acquisition, where he has held national roles in Australia, before joining the Asian team in 2013 as the director for cloud, colocation and global enterprise accounts.

Etienne Guerou

Etienne Guerou is vice president of industrial for Vertiv in Asia. Based in Singapore, Etienne has deep experience in the industrial sector. Under Etienne's leadership, industrial business in Asia has grown four-fold over the past three years. Vertiv now has a strong business in Korea and has also made inroads in several markets including Malaysia, Indonesia, Vietnam and Philippines. He was also instrumental in setting up the industrial technical and products/ solutions team based out of Kuala Lumpur that has been critical to the success of Vertiv in the region.

Robert Linsdell

Robert Linsdell is managing director for Vertiv in Australia and New Zealand. Robert has more than two decades of experience across technology-driven industries, including telecommunications, electronic materials and powder coating. In addition, Robert has previously held board positions with the European Council of the Paint, Printing Ink and Artists' Colours Industry (CEPE), Intellect UK and the European institute of Printed Circuit (EIPC). Robert and his team are focused on aligning customers ICT and business strategies to reduce energy costs in sustainable and innovative ways. Robert has been a presenter at international conventions at China Printed Circuit Association (CPCA), Shanghai; Semicon, Europe; Internepcon, USA, Europe and Japan; Gartner CIO Conference; and The Innovation Forum Sydney.

Tom Nation

Tom Nation is vice president and general manager of power system services for Vertiv in North America. Tom joined the company in 2011 and has more than 20 years of experience with managing technical service teams that help businesses increase the availability and performance of their critical electrical infrastructure for data centers, communication networks, and commercial and industrial facilities. Tom is a member of several professional organizations including the InterNational Electrical Testing Association (NETA), Institute of Electrical and Electronics Engineering (IEEE), and National Electrical Contractors Association (NECA).

Peter Panfil

Peter Panfil is vice president of global power for Vertiv. Peter has nearly 38 years of experience in embedded controls and power. He works to apply the latest power and control technology to industry-proven and emerging topologies to provide the highest availability and highest efficiency systems for business-critical applications. Additionally, Peter partners with customer groups to incorporate industry trends into new product development. In 1994, he began his career with the company and held several managerial positions including vice president of engineering and vice president and general manager of AC power before becoming vice president of global power.

Jack Pouchet

Jack Pouchet is the vice president of market development at Vertiv. Based in Southern California, Jack works closely with major OEMs, large data center owners and operators, and leading mission-critical engineering firms to help improve day-to-day business and operational efficiencies while ensuring reliability, resiliency, and availability. Jack brings more than 20 years of related OEM power supply, power generation, distribution, and power product sales and marketing experience to Vertiv, giving him a unique end-to-end perspective of the entire AC and DC power path.

Jun Michael Tian

Jun Michael Tian is senior director of marketing for Greater China, focusing on analyzing market trends, understanding customer needs and consulting on products. He has 18 years of experience in the data center field. He joined the company as UPS R&D engineer, advancing to positions of increasing responsibility. Michael holds a bachelor's degree in electric systems and a master's degree in power electronics from Tsinghua University (China Beijing). He also holds an EMBA from China Europe International Business School.

Jean-Baptiste Trollé

Jean-Baptiste Trollé is vice president of global industrial sales and marketing for Vertiv based in France. He started his career in sales and moved to product management. He subsequently joined the company through an acquisition, where he took on positions of increasing global responsibility. In 2013, he assumed leadership of the sales operations function before becoming vice president of global industrial sales and marketing.

ABOUT VERTIV

Vertiv designs, builds and services critical infrastructure that enables vital applications for data centers, communication networks, and commercial and industrial facilities. Formerly Emerson Network Power, Vertiv supports today's growing mobile and cloud computing markets with a portfolio of power, thermal and infrastructure management solutions including the ASCO®, Chloride®, Liebert®, NetSure™ and *Trellis*™ brands. Sales in fiscal 2016 were $4.4 billion.

For more information, visit **VertivCo.com/MostCritical**

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