Uptime Institute
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RISK &
RESILIENCY

UI Intelligence report 46

Annual outage analysis 2021

The causes and impacts of data center outages

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Avoiding downtime remains a top priority for all managers of critical infrastructure. But as technology changes, and as the demands placed on IT change, so do the types, frequency and impacts of outages, as well as the best practices in outage avoidance.

30-45 minutes to read

UII-46 v1.1PM published March 29, 2021 last updated April 16, 2021

This Uptime Institute Intelligence report includes:

ABOUT UPTIME INSTITUTE INTELLIGENCE

Uptime Institute Intelligence is an independent unit of Uptime Institute dedicated to identifying, analyzing and explaining the trends, technologies, operational practices and changing business models of the mission-critical infrastructure industry. For more about Uptime Institute Intelligence, visit uptimeinstitute.com/ui-intelligence or contact research@uptimeinstitute.com.

EXECUTIVE SUMMARY

The avoidance of outages has always been a major priority for operators of mission-critical systems. Uptime Institute's annual analysis of data center outages finds that progress toward reducing downtime — and the impact of outages — is mixed. While systems and processes have generally improved uptime and reliability, the impact of some big failures, and a concentration of workloads in a small number of large data centers owned by powerful players, has led some customers and regulators to seek better oversight and evidence of good practices. Innovations and investment in cloud-based and distributed resiliency may have helped reduce the impact of site-level failures, but it has also introduced some error-prone complexity.

KEY FINDINGS

- **In spite of improving technology and better management of availability, outages remain a major concern for the industry — and increasingly, for customers and regulators. The impact and cost of outages is growing.**
- **The causes of outages are changing. Software and IT configuration and network issues are becoming more common, while power issues are less likely to cause a major IT service outage.**
- **Human error continues to cause problems. Many outages could be prevented by improving management processes and training staff to follow them correctly.**
- **There were fewer serious and severe outages reported in 2020 than in the previous year. While progress in improving reliability and availability is always a factor, this decrease may, in part, be due to changes in IT use and management as a result of COVID-19.**

Introduction

Critical IT systems, networks and data centers are far more reliable than they once were. This is the result of many decades of innovation, investment and management. Major failures seem more common only because there is so much critical IT in use, because society's dependency on it is so great, and because of greatly increased visibility through news and social media.

In 2020 — a year in which COVID-19 made a big impact on how and where IT was used — there were, as always, some big outages that affected financial trading, government services and telecom services. However, the outages that made headlines most often were less seismic, affecting consumers and workers at home, such as interruptions or slowdowns of collaboration tools (e.g., Microsoft Teams, Zoom), online betting sites and fitness trackers.

The financial consequences of outages can be high, and the numbers are increasing. The Uptime Institute Global Survey of IT and Data Center Managers 2020 found that four in 10 outages cost between $100,000 and $1 million – and about one in six costs over $1 million.

For this reason, resiliency remains at or near the top of management priorities when delivering services. Identifying and analyzing the root causes of failures is a key step in avoiding further expensive problems in the future.

The growing move to cloud services and the extensive use of colocation can increase resiliency and reduce management worries. But outsourcing brings its own challenges: Uptime Institute research shows that more than half of data center operators and IT managers surveyed have experienced an outage caused by a problem at a third-party data center service provider in the past three years.

The use of public cloud and service providers can hinder visibility and accountability. While providers can sometimes be disarmingly open in discussing their failures, more commonly they provide little or no commentary. Sometimes they do not admit to full outages at all.

This 2021 outages report is one of a series Uptime Institute produces analyzing IT service resiliency. The report uses a variety of sources, including publicly available data (e.g., information reported in news and trade media), multiple Uptime Institute surveys (e.g., Uptime Institute Global Survey of IT and Data Center Managers, Uptime Institute Data Center Resiliency Survey), and other data aggregated and anonymized from Uptime Institute members and partners. For more detail, see **Appendix: Sources and methodology**.

How Uptime Institute tracks outages

Tracking outages is neither simple nor reliable. Not all outages are seen or experienced in the same way by different people, nor are all major slowdowns or disruptions classified as outages. Uptime Institute uses multiple ways to track the overall trends and incidents, but none provide a clear picture on their own. The table below shows the methods used.

Source	Accuracy	Methodology	Limitations
Public reports	Poor	• News/social media • Outage trackers • Company statements	• Mainly big outages and interruptions to consumer-facing services • May lack details • Sources may be untrusted or poorly informed
Uptime Institute surveys	Fair/good	Online surveys conducted by Uptime Institute	• Answers may vary according to role and sample • All responses anonymous
Uptime Abnormal Incident Report (AIRs) database	Good/Very good	Detailed, accurate site/facility-level data shared under a nondisclosure agreement	• Information primarily facility/site-based • All data anonymous

Growing executive concern

In recent years, concern over the impact of outages has been growing — among executives, among regulators, and among the public, who are often directly and sometimes painfully affected. As Uptime Institute has often stated, systems that were not necessarily designed to be mission critical have become so as dependency on them has increased over time.

The rising level of concern is reflected in Figure 1, which is based on the results of the Uptime Institute Data Center Resiliency Survey (January 2021). Almost half (44%) of data center operators surveyed, and even more suppliers/vendors (59%), think that concern about resiliency of data center/mission-critical IT has increased in the past 12 months. Only 5% think it has decreased.

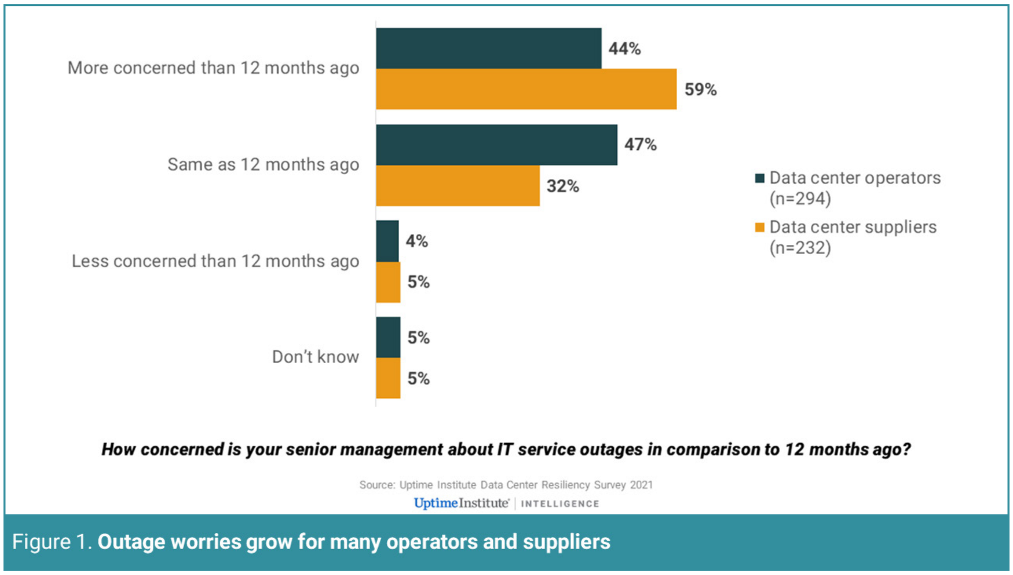
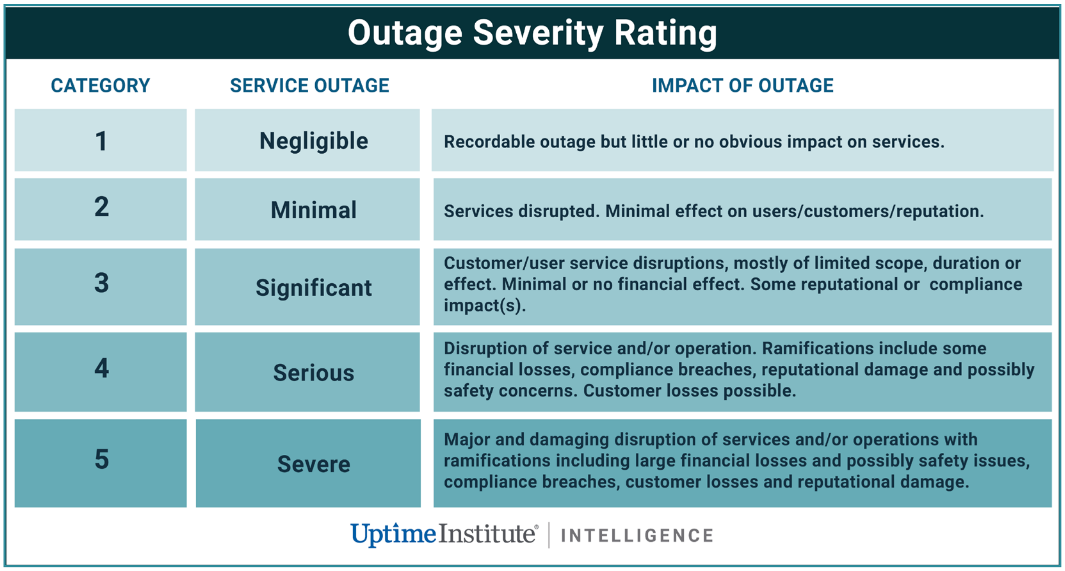


Figure 1. **Outage worries grow for many operators and suppliers**

The pandemic may have stirred up these worries, given the heavy reliance on remote working/commerce, but the concerns were growing anyway. The financial impact of outages (see **Duration and cost of outages**) is substantial and growing, but that is only part of the story. The damage caused by an outage ranges from inconvenience and frustration to compliance breaches, reputational damage, and even loss of life. Uptime Institute's **Outage Severity Rating** categorizes outage severity on a scale of 1-5.



Outage Severity Rating

CATEGORY	SERVICE OUTAGE	IMPACT OF OUTAGE
1	Negligible	Recordable outage but little or no obvious impact on services.
2	Minimal	Services disrupted. Minimal effect on users/customers/reputation.
3	Significant	Customer/user service disruptions, mostly of limited scope, duration or effect. Minimal or no financial effect. Some reputational or compliance impact(s).
4	Serious	Disruption of service and/or operation. Ramifications include some financial losses, compliance breaches, reputational damage and possibly safety concerns. Customer losses possible.
5	Severe	Major and damaging disruption of services and/or operations with ramifications including large financial losses and possibly safety issues, compliance breaches, customer losses and reputational damage.

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Significant, serious and severe outages — categories 3, 4 and 5, respectively — have major ramifications and require a full root-cause analysis aimed at preventing a repeat. For most operators, small IT-level service outages are irritants, but they are also a clear sign that attention and investment is needed. In the discipline of site reliability engineering (SRE), part of modern DevOps (where development and operational IT are merged), even small issues are counted and form part of an "error budget."

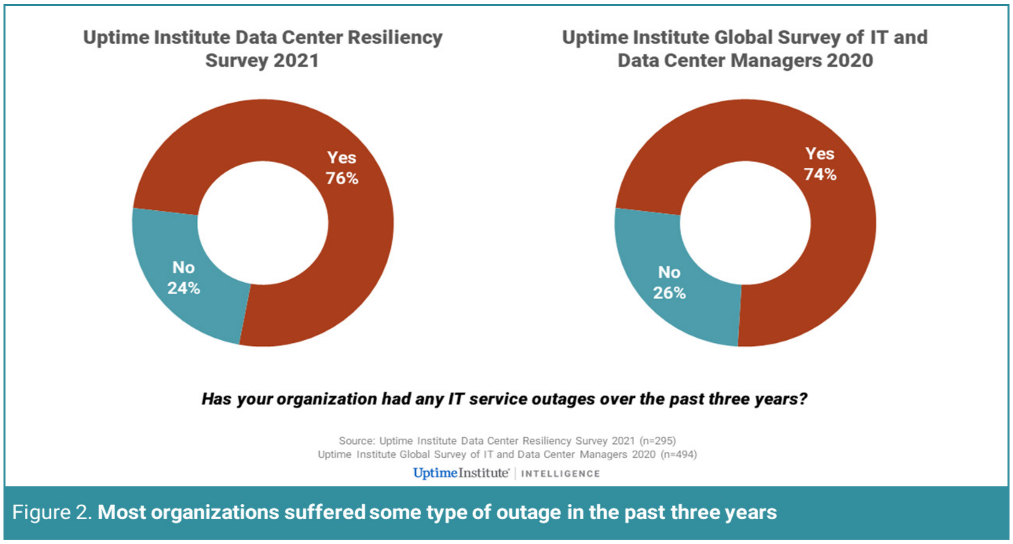
Outage frequency

How common are outages? Is the number of outages increasing? Determining the answers to these questions requires care to avoid drawing misleading conclusions. As noted in **How Uptime Institute tracks outages**, the answers may depend on who is asked and how outages are defined.

The evidence in 2020/2021 shows the following:

- Outages remain common and justify high levels of concern and investment. About three in four data center operators/enterprise IT managers responding to Uptime surveys have experienced some kind of IT service outage in the past three years. When this is narrowed down to outages that had a "significant impact," the proportion is about three in 10.
- There is no evidence that the number of outages relative to the overall rise in IT is increasing. Most Uptime Institute data suggests the opposite.
- Severe outages, while rare, occur in small numbers every year, and the results are catastrophic for stakeholders.

Data center and IT staff see disruptions and outages that may not be picked up by all customers, the media or even by their own executives. In 2020 and early 2021, Uptime surveys showed about three in four respondents had an IT service outage of some type in the past three years (see Figure 2).



Source: Uptime Institute Data Center Resiliency Survey 2021 (n=295)
Uptime Institute Global Survey of IT and Data Center Managers 2020 (n=494)

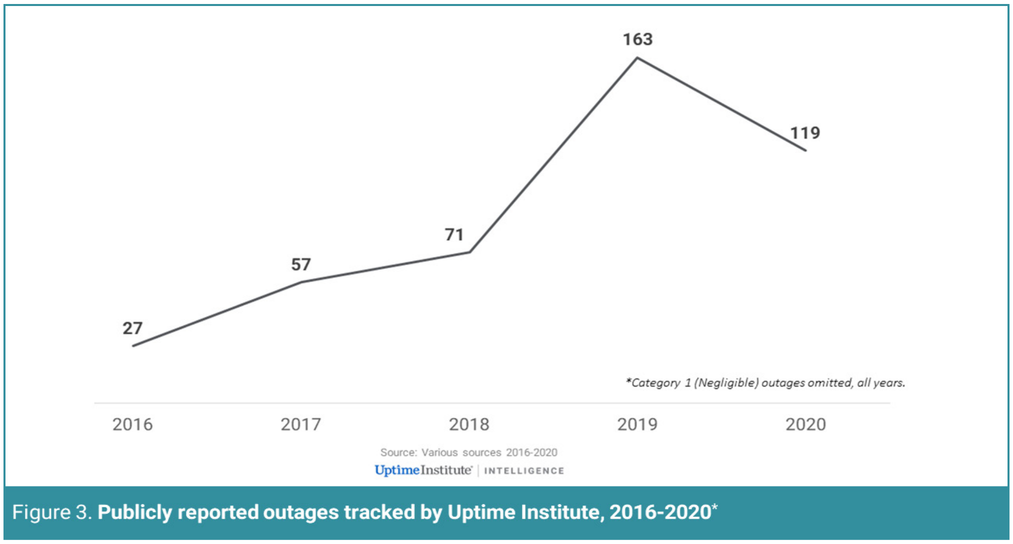
Figure 2. **Most organizations suffered some type of outage in the past three years**

Unfortunately, it is not easy to directly map actual or promised availability (in the form of 99.9x% — the percentage of time an IT system is fully operational) onto generally published data (although, of course, this is possible for a single site or service).

However, as we have often noted, the frequency and duration of outages strongly suggests that actual performance falls short of the published service level agreements (SLAs) of most data center and IT service providers, whether they are enterprises with internal customers, colocation companies or cloud providers. Business owners and customers should never consider SLAs (or 99.9x% availability figures) as reliable predictors of future availability.

Publicly reported outage frequency

As Figure 3 shows, the number of outages that received major media attention was significantly lower in 2020 than in 2019 (which was also the year in which we stopped tracking smaller outages). But as we have stated in previous years, publicly reported outage figures should be treated with great caution, as they do not necessarily represent the underlying number of outages.



*Category 1 (Negligible) outages omitted, all years.

Source: Various sources 2016-2020

Figure 3. **Publicly reported outages tracked by Uptime Institute, 2016-2020***

In our 2019 outage analysis, we noted that the strong increase in publicly reported outages could be partly attributed to greater visibility of outages, more reporting by the media and website trackers, and even better data collection by the Uptime Institute Intelligence team. In our 2020 analysis, we noted that immediate reporting of even the most minor outages (again, often picked up by outage trackers and then repeated in the media) has blurred the overall picture, and we now eliminate many from our sample.

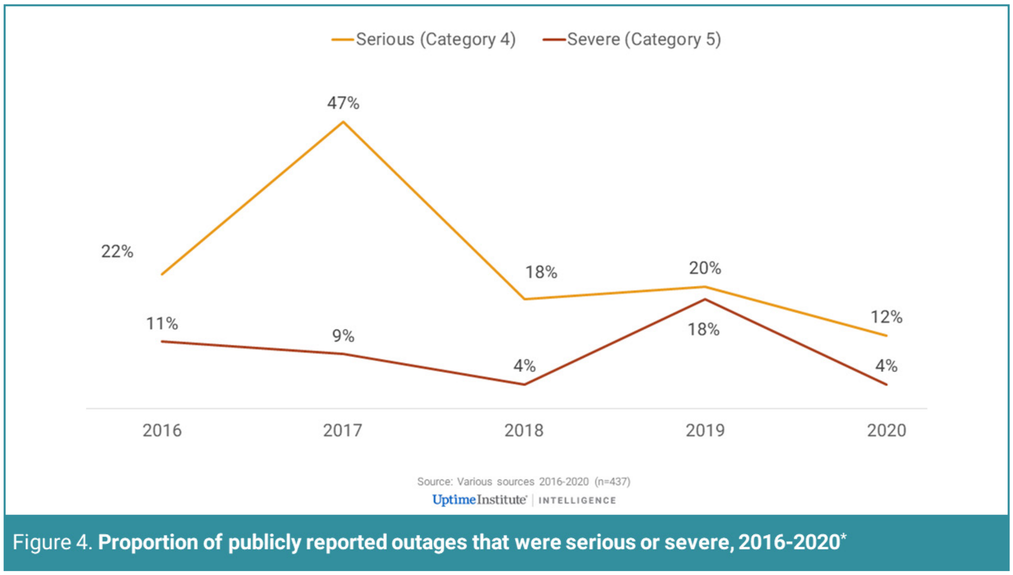
Even if the number of outages dropped, that does not necessarily mean that the resulting level of disruption also dropped. Because more IT is delivered from large cloud and colocation operators, the number of reported outages may be fewer, but the number of enterprises (and customers) affected could be much greater.

There is, of course, a further factor at play: 2020 was the year in which the COVID-19 outbreak caused a lot of businesses to reduce/suspend commercial operations (although, of course, a lot moved online). This depressed some business activity, meaning fewer outages and reduced disruption in some areas (the transportation sector, for example, usually accounts for a small but significant number of serious failures each year). Also, many outages occur during maintenance, upgrades and transition — but in 2020, some data centers postponed critical work as a result of pandemic-related concerns or issues.

Severe outages less common?

How serious are most outages? As stated, the data varies according to who is asked or how it is collected. According to our public outage tracking, 2019 was a particularly bad year for severe outages, while 2020 was the best year yet recorded. Not only were there fewer outages reported by publicly available sources, but a lower proportion were serious or severe. This is probably because the level of business-critical activity was significantly disrupted and/or depressed due to COVID-19.

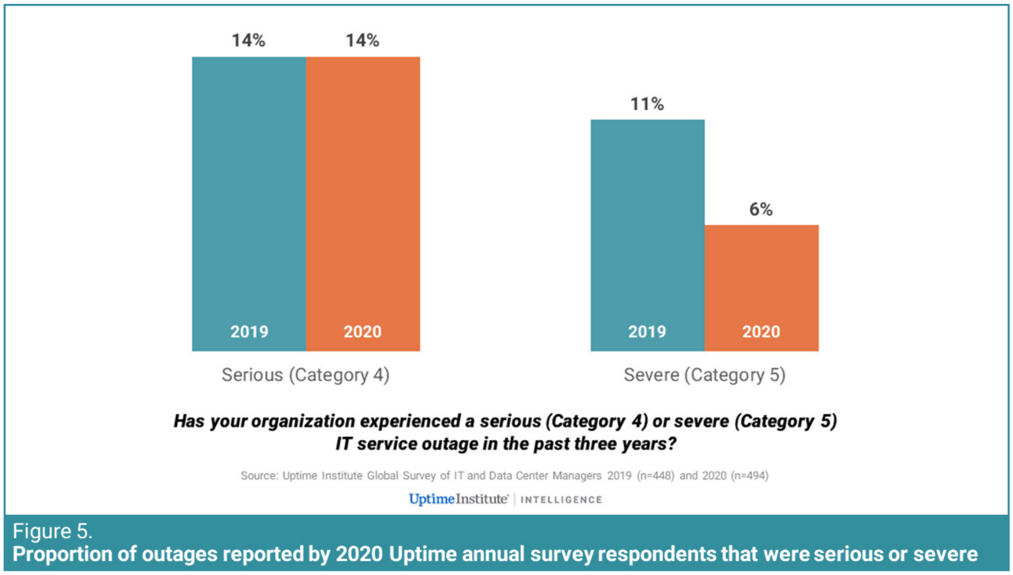
As Figure 4 shows, the trendline in publicly reported outages is difficult to trace, reflecting both the variability in actual disruption year-to-year and the changes in reporting/data collection.



Source: Various sources 2016-2020 (n=437)

Figure 4. **Proportion of publicly reported outages that were serious or severe, 2016-2020***

Uptime's annual global survey data shows a different but clearer picture: For both 2019 and 2020, about one in seven (14%) respondents reported a serious outage in the past three years (see Figure 5). In 2020, the proportion of those that experienced a severe outage in the past three years dropped to just above one in 20 (6%).



Has your organization experienced a serious (Category 4) or severe (Category 5) IT service outage in the past three years?

Source: Uptime Institute Global Survey of IT and Data Center Managers 2019 (n=448) and 2020 (n=494)

Figure 5.
Proportion of outages reported by 2020 Uptime annual survey respondents that were serious or severe

What can be read from the data on outage frequency — from either public or other sources? Two high-level conclusions are:

- Much of the public data is media based and somewhat unstable. But it does suggest that each year, there will likely be between 20 and 50 serious, high-profile IT outages somewhere in the world — outages that cause major financial loss, business and customer disruption, reputational loss and, in extreme cases, loss of life.

- From a data center/IT management and operations point of view, about one in six organizations have had a severe or serious (i.e., damaging and expensive) IT/data center outage in the past three years. This is a trend that will probably continue. Vigilance and investment are necessary.

Outages – the causes

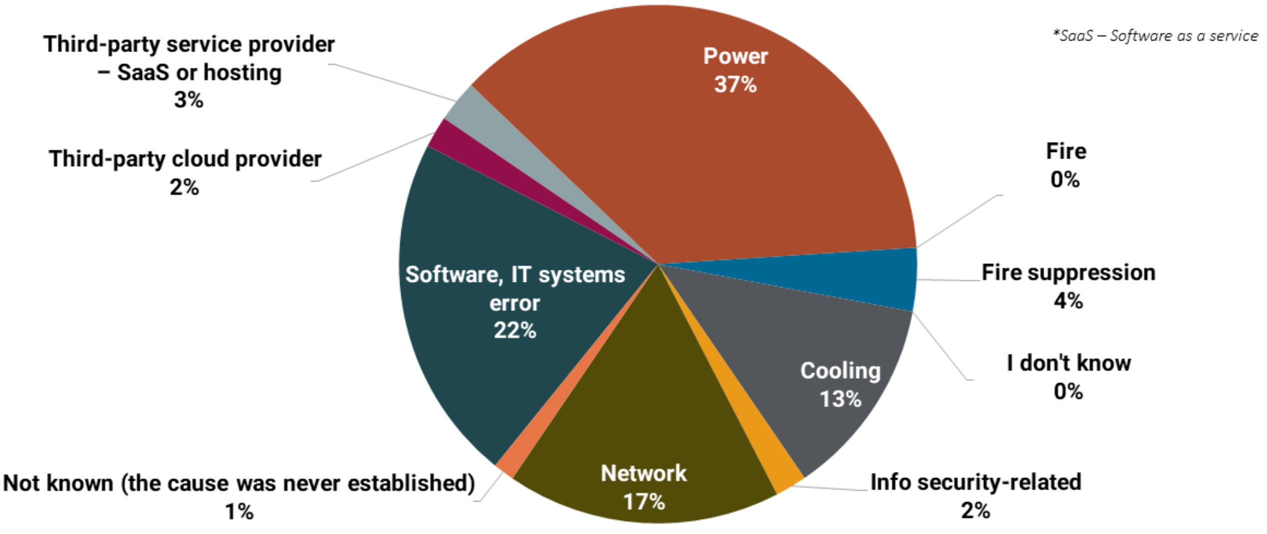
Every outage has a primary cause, and most have several contributory and background causes. But as we have noted, knowledge and understanding of outages depends on who is asked, and even how outages are defined.

Uptime Institute's most detailed and reliable source on outage causes is its AIRs (Abnormal Incident Report) database. In the over 25 years (1994 to present) of data collection, electrical failures accounted for 80% of all IT load losses in data centers. But this sample is focused on the well-maintained, critical facilities of operators who are active members of Uptime Institute. Outages in this group are now very rare.

About three in four Uptime survey respondents experienced some kind of IT service outage in the past three years.

Looking at global, enterprise-class IT more generally (spanning private data centers, colocation and public cloud), Uptime Institute's annual survey data provides a consistent picture over several years, with power problems invariably the biggest single cause of outages.

Uptime's 2020 global survey shows that on-site power failure is still the biggest cause of significant outages, accounting for 37%, followed by software/IT systems issues and networking issues (see Figure 6). But many of this group would not necessarily have full visibility into third-party cloud/software as a service (SaaS) outages, for which they will likely have no responsibility. Over time, Uptime Institute expects that more outages will be caused by networking and software/IT, and fewer by power issues (see further analysis below).



What was the primary cause of your organization's most recent significant incident or outage? Choose one.

Source: Uptime Institute Global Survey of IT and Data Center Managers 2020 (n=152)

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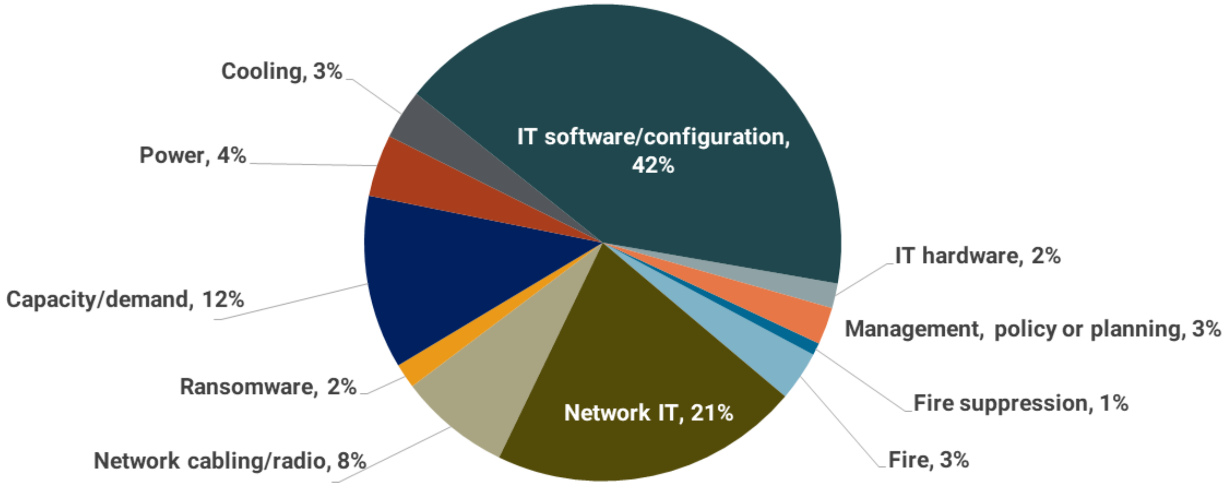
Figure 6. **On-site power issues caused over a third of most recent significant outages**

Tracked public outages for 2020 tell a different story, with power problems accounting for very few outages, and software/IT and network accounting for almost three in four (see Figure 7). But this data should be understood in context: it is based on outage trackers, public statements and media accounts, and often true causes are either never revealed or are reported as "IT/technical issues."



Source: Various sources 2020 (n=119)

*Category 1 (Negligible) outages omitted, all years

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Figure 7. **Causes of publicly reported outages, 2020***

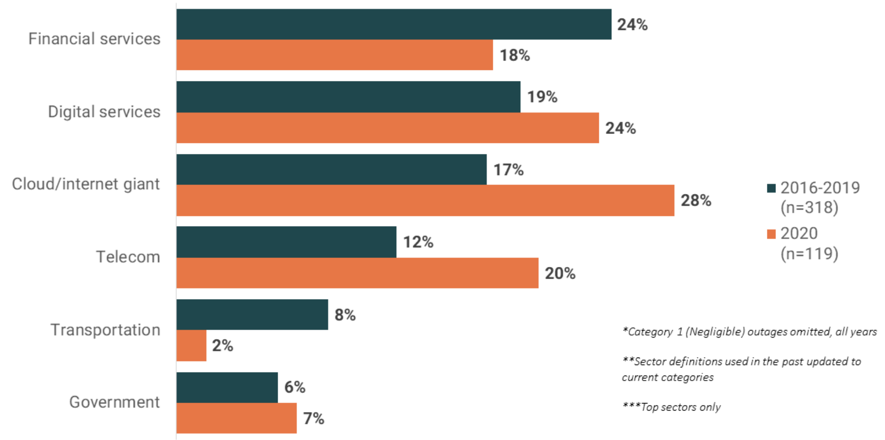
The data is consistent with a long-term trend of more network and IT/software outages, resulting from greater use of public internet-based services and of complex, multisite availability zones. This trend will likely have been exaggerated and/or accelerated during COVID-19 lockdowns.

This rise in outages caused by IT systems and network issues is due to the broad shift in recent years from siloed IT services running on dedicated, specialized equipment to an architecture in which more IT functions run on standard IT systems, often distributed or replicated across many sites. As more organizations move to cloud-based, distributed IT (driven by a desire for greater agility and automation), the underlying data center infrastructure is becoming less of a focus or a single point of failure. This does not mean, however, that there is any case, at least at present, for de-emphasizing site-level resiliency or investing less. Site-level failures invariably cause major problems, regardless of whether distributed resiliency architectures are deployed.

Service provider and cloud outages

Cloud, hosted and many other internet-based services and workloads are designed to operate with low failure rates. Large (at-scale) cloud and IT service providers, in particular, can incorporate layers of software and middleware, orchestrated by artificial intelligence and other big-data approaches, and reroute workloads and traffic away from failure. On the whole, they provide high levels of service availability, at huge scale and growing complexity. Even so, no architecture is fail-safe, and professional, specialist management, however sophisticated, is no guarantor of fault-free operations.

As Figure 8 shows, commercial provider/operators (cloud/internet giant; digital services — here, including colocation; and telecom) together accounted for almost three-quarters (72%) of all outages in 2020 (note: we no longer report very minor service interruptions). This is a significant increase on the five-year average figure (53%) for digital services, cloud/internet and telecom combined. But this increase probably says little about reliability and is more likely to be the result of their growing market share and the impact of COVID-19 on traffic/IT use.



*Category 1 (Negligible) outages omitted, all years

**Sector definitions used in the past updated to current categories

***Top sectors only

Source: Various sources 2016-2020

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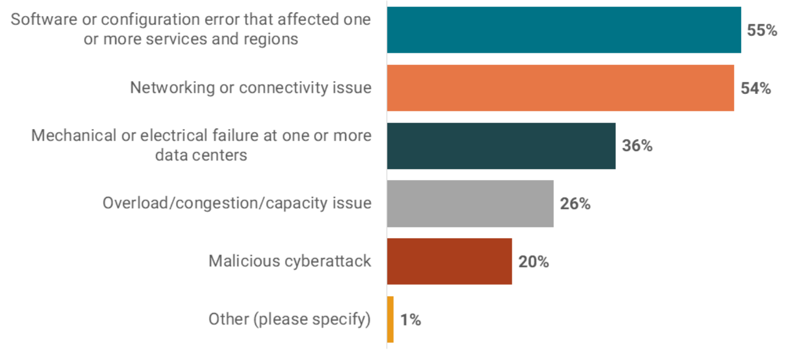
Figure 8. **Publicly reported outages by sector, 2016-2020*,**,*****

When third-party data center service providers do have an outage, customers are immediately affected — and they may seek compensation and a full explanation. Many regulators and enterprises now want increased visibility, accountability, and improved SLAs — especially for cloud services. Currently, even big enterprise customers do not always know why an outage occurred until long after the issue has been resolved, nor can they necessarily ensure in advance that their supplier's data centers (or the IT) are well designed and operated.

According to Uptime Institute survey data, more than half (56%) of all organizations using a third-party data center service have experienced a moderate or serious IT service outage in the last three years that was itself caused by a problem at a third-party provider.

As Figure 9 shows, the most commonly cited reasons for service interruptions involved software or networking. This is now often the case — complex backup regimes and availability zones, intended to improve resiliency and responsiveness, come with their own problems. Mechanical/electrical issues were also cited as common causes.



What were the most common root causes for the third-party IT service provider-related outages experienced at your organization's data centers over the past three years? (Choose no more than three)

Source: Uptime Institute Data Center Resiliency Survey 2021 (n=92)

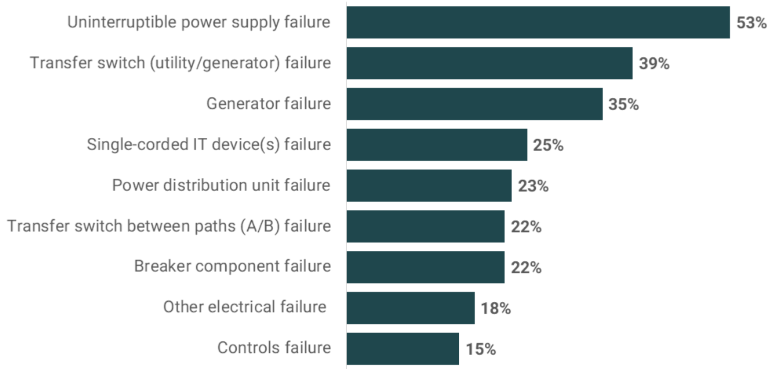
Figure 9. **Most common causes of third-party service provider-related outages**

Power outages

Power-related outages have long been the scourge of data center management. A power event is usually sudden, binary (on/off), sitewide, and has an immediate impact on many services. Although diagnosis and even restoration of power can be quick, IT systems can take many hours to be restarted safely.

The rate of power-related outages is steadily falling, both as a cited cause in major public outages and as the cause of outages reported by Uptime Institute members. But power outages still occur, although many are prevented by good design, effective processes and staff action (see **The human factor**).

The most common causes of power-related outages are shown in Figure 10.



What were the most common root causes for the power-related IT outages at your organization's data centers over the past three years? (Choose no more than three)

Source: Uptime Institute Data Center Resiliency Survey 2021 (n=97)

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Figure 10. **Most common causes of power-related outages**

Data center managers will not be surprised that failure of uninterruptible power supplies (UPSs), transfer switches and generators (usually failing to start) cause most power-related outages. These devices are a last line of defense, often for very large numbers of servers and IT equipment.

Uptime Institute engineers report that static UPSs fail due to a number of reasons:

- Fans fail frequently because they are usually inexpensive and operate all the time. A single fan failure does not take a unit down, but the failure of multiple fans may.
- Snubber capacitors can fail from wear and tear. Regular preventative maintenance will reduce the number of failures.
- Batteries fail due to age and require good management, close monitoring and adherence to replacement schedules. Many failures are because batteries are not monitored closely enough by experienced technicians.
- Inverter stack failures are least common. They are more likely to occur when the unit is overloaded, although wear and tear can also cause failures.

UPS problems are more likely with age, and operators of data centers without trusted concurrent maintainability designs (the ability to bypass any item of equipment for maintenance without interrupting overall service) can be more likely to postpone maintenance or replacement.

Generators are reliable, but require regularly scheduled maintenance, fuel checks and testing. ATS (automatic transfer switch) units are generally robust, but failures may occur with active controls or with a loss of direct current (DC) power to those controls. Other less common failures are due to mechanical issues, such as bearings wearing out or a jammed switch.

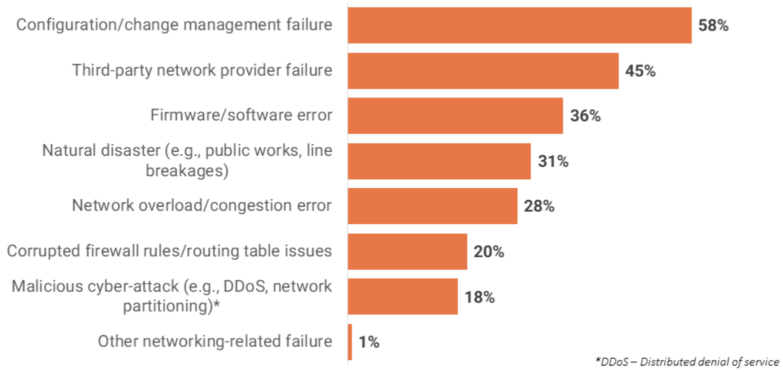
Uptime Institute engineers also report that sometimes switch gear will be set up with controls to mimic an ATS — and many will call this an ATS

— even when it is not an actual ATS. These units may fail from controls failures, loss of battery power, or circuit breakers that fail to open or close when signaled.

Networking outages

Networking issues are now emerging as one of the more common — if not the most common — causes of downtime. The reasons are clear enough: modern applications and data are spread across and between data centers, with networking ever more critical. To add to the mix, software-defined networks have added great flexibility and programmability, which can introduce failure-prone complexity.

The Uptime Institute Data Center Resiliency Survey 2021 results shown in Figure 11 support the complexity diagnosis. Configuration errors, firmware errors, and corrupted routing tables all play a big role in networking-related failures, while the more traditional worries of weather and cable breaks are a relatively minor concern. Congestion and capacity issues also cause failures, but these are often the result of programming/configuration issues.



*DDoS – Distributed denial of service

What were the most common root causes for the networking-related IT outages at your organization's data centers over the past three years? (Choose no more than three)

Source: Uptime Institute Data Center Resiliency Survey 2021 (n=130)

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Figure 11. **Most common causes of networking-related IT outages**

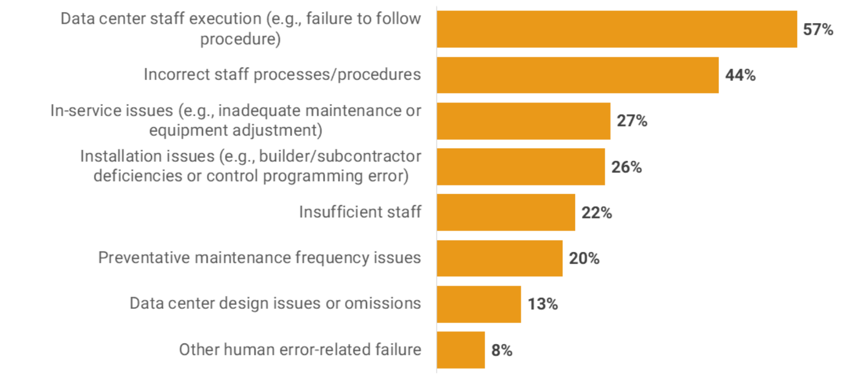
Networks are complex not only from a technical point of view, but also operationally. While enterprise data centers may be served by only one or two telecommunications providers, multicarrier colocation hubs can be served by many. Some of these links may, further down the line, share cables or facilities — adding possible overlapping points of failure or capacity pinch points. Ownership, visibility and accountability can also be complicated. This contributes to 45% of respondents having experienced an outage in the last three years caused by a third-party networking issue — something over which they had little control.

A few of the organizations that avoided network-related incidents put this down to luck — and to be fair, luck can play a role. But the majority of those who avoided downtime attribute it to a more controllable factor: investment in systems and training. As with the prevention of power issues, money spent on expertise, redundancy, monitoring, diagnostics and recovery, along with staff training and processes, will be paid back with more hours of uptime.

The human factor

Uptime Institute is often asked, What percentage of outages are caused by human error? There are many ways to interpret that question, and for this reason, Uptime is wary of citing a single number. Uptime Institute's confidential incident reporting system (the AIRs database), which documents thousands of incidents, suggests an aggregated year-on-year average of 63% of failures due to human error. In Uptime's 2020 annual survey, 75% of respondents said their most recent downtime could have been prevented with better management or processes — another way of looking at the role of human decision-making and actions. And in our most recent (2021) data center resiliency survey, 42% of respondents said they had experienced an outage in the last three years due to human error. Clearly, human errors in the data center and in IT account for a lot of outages (and incidents in which outages are narrowly avoided).

For those seeking to avoid downtime, a key question is, We know human error is a factor in many outages, but what are the causes of human error? As Figure 12 shows, failure to follow procedures or following incorrect procedures are the most commonly cited reasons.



What were the most common root causes for the human error-related IT outages at your organization's data centers over the past three years? (Choose no more than three)

Source: Uptime Institute Data Center Resiliency Survey 2021 (n=106)

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Figure 12. **Underlying causes of human error-related outages**

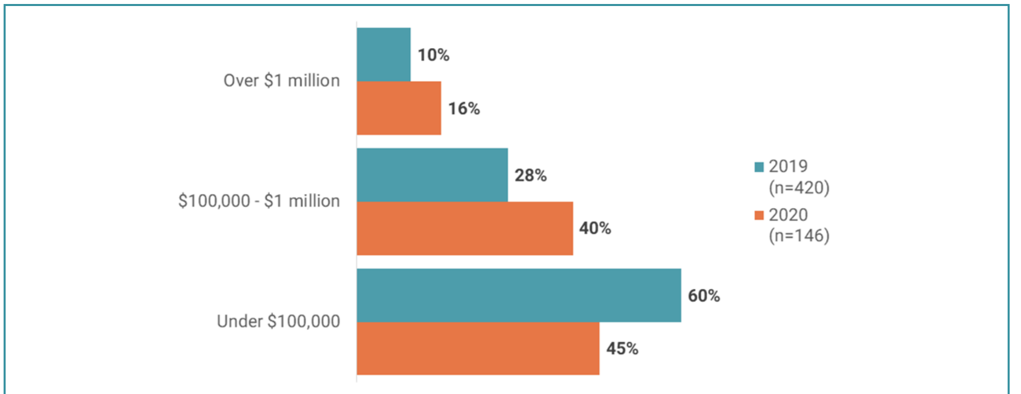
Given the high and growing costs of outages (very often in the hundreds of thousands of dollars), this suggests that investment in staff, in training and in ensuring better management and processes will ultimately provide a payback — even if it is difficult to measure.

Duration and cost of outages

Vendors of resiliency products and services frequently emphasize, and sometimes exaggerate, the financial and business damage caused by outages. However, the data is patchy. It is widely known that major outages at large companies have had a huge impact — in a few cases, above $100 million in losses. Each year, there are certainly many cases that cost several million dollars, or tens of millions.

Most organizations fail to collect good data on outage costs, and even those that do cannot account for all costs, such as reputational damage or the failure to be considered for a large future contract.

In 2020, Uptime research suggests that the cost of outages is going up (see Figure 13), with over half who had experienced an outage saying it cost more than $100,000. (Uptime does not calculate average costs due to the huge range and number of outliers.) The damage from an outage can vary enormously, depending on when it occurs, to whom, and how long it lasts.



Please estimate the total cost of this downtime incident (from outage to full recovery) for your organization, including direct, opportunity and reputation costs using the following options. Choose one.*

** All figures in US dollars*

Source: Uptime Institute Global Survey of IT and Data Center Managers 2019 and 2020

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Figure 13. **Outage costs are rising**

If outage duration is an indicator of costs, then some organizations suffered some expensive failures in 2020, according to the publicly reported data (see Table 1). A greater proportion of problems lasted more than four hours in 2020 than in the past — possibly because of the issue of IT, software and network complexity previously discussed. But COVID-19 may have distorted the picture, with businesses such as travel and bricks-and-mortar retail operating under tight constraints in 2020. The focus switched; among the most costly incidents in 2020 was the loss of bookmaking services during a major racing event.

Table 1. **Outages getting longer?***

Duration (hours)	2017 (n=57)	2018 (n=71)	2019 (n=140)	2020 (n=119)
0 - 4	36	29	69	21
4 - 12	13	25	26	70
12 - 24	4	6	14	15
24 - 48	2	4	14	6
> 48	2	7	17	7

** Outages for which the cause was not known were eliminated from the analysis.*

Note. *Times reported are time to service recovery, not time to full business recovery.*

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Summary

For the past several years, Uptime Institute's research has led to some clear and consistent findings. A few, however, appear to point in somewhat contradictory directions, which can lead to misunderstandings.

One of these misunderstandings concerns the level of availability and outages generally. Overall, the level of reliability of data centers has been improving, not worsening. But this is not always clear from figures that show a high and consistent rate of outages experienced by IT and data center management.

The anomaly may be simply explained. The level of investment in new data centers, in an ever-increasing amount of IT capacity, and in new IT services in recent years has dwarfed that of all previous decades. The frequency of outages has grown too — but much more slowly. Even so, the risk of an outage at any data center, or for an IT service, is still high enough to concern managers and to justify high investment.

The growing use of cloud-based or network-based resiliency has created some confusion, since some IT technicians have extremely high expectations of these technologies. Some operators quote five nines availability or have implied that system-wide failure is nearly impossible. This is clearly not the case.

Such modern IT architectures are designed to overcome component, equipment, and in some cases, site-level failures; equally, they are designed to support more fluid movement of data and processing, allowing rerouting of traffic to replicated data. But significant investment and expertise is required to operate this successfully, and some of this technology is still in its infancy. At scale, distributed resiliency can introduce complexity and other challenges that may lead to failures, some of which are not easily foreseeable. This explains why a growing number of outages result from software and network systems and configuration errors. Distributed resiliency is a methodology still in development: it works well, but not perfectly. In the long term, greater investment and experience, and the use of advanced monitoring and optimization technologies, will help to reduce failures more significantly.

> Uptime Institute's research points to one simple and actionable finding: Human error is often the result of failure to follow processes, or of having inadequate processes. Better focus, management and training will produce better results.

The number of outages is only one metric, and not the one many managers will worry about most. A bigger concern is the likelihood — and possible impact — of outages for their type of operation.

In this regard, IT is paying the price of its success: The costs of outages are rising, along with the disruption caused. This is the result of several factors, including the growing dependency by business/society on IT; the concentration of IT in fewer companies/large data centers; and the difficulty of quickly resolving complex system outages, sometimes spanning multiple sites.

Because of the importance of IT and data centers, and the impact of outages, many regulators of financial services, emergency services, telecoms and central governments are reaching the conclusion that greater visibility, accountability and control is needed.

Prevention of outages is a constant challenge that requires attention, investment, and analysis on several fronts. But Uptime Institute's research does point to one simple and actionable finding: Human error, which lies at the root of many outages, is often the result of failure to follow processes, or of having inadequate processes. Better focus, management and training will produce better results.

Appendix: Sources and methodology

Uptime Institute currently has four data sources for monitoring data center and IT outages or incidents that can potentially lead to outages:

- **Uptime Institute Global Survey of IT and Data Center Managers.** This long-running series of annual surveys, with 846 respondents in 2020, asks detailed questions about outages; some of the findings are discussed here. This represents the most statistically significant dataset relating to outages in the critical infrastructure industry.
- **Uptime Institute Data Center Resiliency Survey.** This global survey specifically focuses on outages and resiliency-related issues. The first survey was conducted in January 2021, with 642

respondents split between data center operators and suppliers/services companies. The results are compared and contrasted with those from the Uptime Institute Global Survey of IT and Data Center Managers, which is conducted midyear.

- **Uptime Institute Intelligence's public outages database.** Since the beginning of 2016, Uptime Institute has collected data about major IT outages from media reports and other public sources (social media, outage detection sites, etc.) on an ongoing basis. This effort enables us to collect information on major outages that become visible to the public and the media, and, over time, to identify patterns.
- **Uptime Institute's Abnormal Incident Report (AIRs) database.** This is a long-standing confidential system for global Uptime Institute members to share details of incidents under a nondisclosure agreement. Most incidents recorded do not actually lead to outages — many are "near misses." We do not include such incidents in the analyses described in this report.
- **Uptime Institute Professional Services.** Uptime Institute conducts Digital Resiliency Assessments and root-cause analyses of failures on behalf of clients, globally. Although these assignments are confidential, the experience garnered from these incidents further informs our analyses.

The methodology used for the bulk of the findings in this report is limited and the data should be understood in this way — it is primarily useful for trending and, while we believe it is directionally accurate, it is not a representative dataset for all outages. There are several limitations:

- If a failure is not reported or picked up by the media or Uptime Institute, it will not be recorded. This immediately means there is a bias toward coverage of large, public-facing IT services, and sometimes more so in geographies with a well-developed and open media.
- We limit failures to those that had a noticeable impact on end users — a major fire during data center commissioning, for example, may never be registered. We have also eliminated all category 1 outages — small, short failures where the business or reputational impact is negligible.
- The amount of information available varies widely from outage to outage, and sometimes there is very little information available at all. It has regrettably been necessary, in some of the analyses, to include outages for which the cause is "not known" — meaning it was never disclosed.
- Finally, while we include IT system failures, we do not generally include cybersecurity breaches, except those that can lead to complete service interruptions.

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ABOUT UPTIME INSTITUTE

Uptime Institute is an advisory organization focused on improving the performance, efficiency and reliability of business critical infrastructure through innovation, collaboration and independent certifications. Uptime Institute serves all stakeholders responsible for IT service availability through industry leading standards, education, peer-to-peer networking, consulting and award programs delivered to enterprise organizations and third-party operators, manufacturers and providers. Uptime Institute is recognized globally for the creation and administration of the Tier Standards and Certifications for Data Center Design, Construction and Operations, along with its Management & Operations (M&O) Stamp of Approval, FORCSS® methodology and Efficient IT Stamp of Approval.

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