# HOW 5G WILL REVOLUTIONIZE TRANSPORTATION

As interest in smart city development continues to grow, transportation agencies have never faced more incentive to modernize their digital capabilities and infrastructure. Public transportation and rail transit are poised for rapid transformation, as both public and private organizations strategize on how to take advantage of 5G networks and the potential they offer.

In this white paper, we'll discuss how 5G and the technologies it enables are already evolving the current state of public transit — and explore key considerations for adopting secure, manageable solutions for connected transportation.

## The State of Transit Today

Transit systems in densely populated areas have increasingly felt the strain of poor visibility into capacity, rapid population growth and outdated transportation management systems. With pre- and post-pandemic traffic and transit ridership levels for comparison, the problems affecting these systems have become more apparent in recent years.

The Metropolitan Transportation Authority (MTA) of New York City serves as a perfect example of the issues affecting modern transit systems. With data collected over the last few years,[1] the MTA's tracking shows that vehicle traffic and subway ridership dipped dramatically in the early days of the pandemic. The goal now is to ensure public safety, build public trust and return ridership to normal levels.

Across the two tunnels, seven bridges, and numerous subway lines that the MTA operates, peak rush hours no longer see the same levels of congestion. This shift coincides with recent increases in work-from-home options, which underscores the importance of planning public transit capacity around service industry hours outside the traditional eight-to-five, weekday schedule.

With the low latency and high bandwidth of growing 5G networks, this kind of data has the potential to provide valuable, actionable insights that improve capacity management and vehicle tracking for urban transit in real time. Alongside the improved data streaming that these networks promise, other industry shifts are encouraging faster adoption of 5G-enabled transit solutions.

[1] MTA Day-by-day ridership numbers

## 3 Trends Accelerating the Evolution of Transportation

Using connected devices to improve user experiences and optimize transit management is not completely new to public and rail transportation. Already, existing networks — particularly 4G LTE networks — are used to provide wireless connectivity for buses, trams, subway cars, trains and more.

Migrating IoT device connections to 5G networks inarguably offers improvements to existing connected use cases in transportation. But often, the technical merits of modernization are not enough to shift an entire industry, especially one with significant legacy infrastructure and logistical challenges creating enormous hurdles to transformation.

In this case, the growth of 5G networks has paralleled three key trends that have changed priorities and goals for public and private transit organizations:

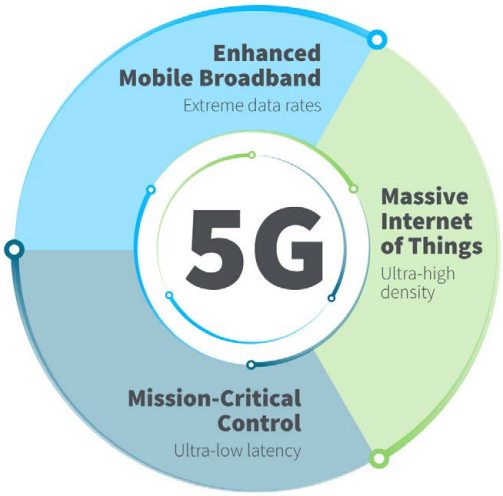
- **Growth of ridesharing:**
  Today, multiple companies have onboarded thousands of contracted service workers to provide passengers with a real-time view into transportation availability via digital platforms. Additionally, peer-to-peer car-sharing platforms have normalized the access-versus-own model of transit. This trend has increased demand for 5G networks and promoted its adoption for other use cases.
- **Autonomous vehicle technology:**
  Implementing autonomous vehicles at scale is still a ways out, and significant challenges remain before the usability and safety of this technology are ready for public transit. However, driverless cars and shuttles are in pilot in dozens of cities, proving the need for 5G to drive innovation in this area.
- **Green tech and renewable energy:**
  Every day, more cities, municipalities, and transportation agencies are investing in sustainability initiatives and solutions to combat climate change. This shift has led to ever-increasing investments in renewable energy and less reliance on coal and gas power for all types of transport. And with 5G connectivity, growing fleets of electric buses and cars can be more easily managed remotely.

Many see 5G as the conduit to create smart cities in which connected applications drive sustainability, public safety and more. Today, most transit systems already utilize LTE networks for wireless management and visibility into ridership, congestion and other metrics. Implemented effectively, 5G-enabled transit solutions will extend beyond the utility of existing data collection, allowing real-time communications with transit vehicles. This will enable "V2X" capabilities such as automated braking to prevent accidents.

## How 5G Promises to Transform Public Transit

To use data-driven insights to transform public and rail transportation, operations teams need to be able to establish and manage systems with fast, reliable access to real-time data from the field. At any given moment, a transit system could supply thousands of relevant points needed to help assess how ridership levels are changing throughout the day, whether equipment is safe for operation or whether routing needs to be adjusted based on route closures or other issues that arise.

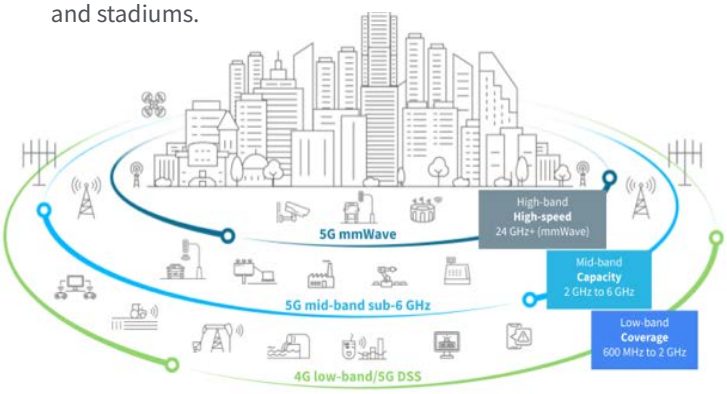
In comparison to LTE networks, 5G delivers enhanced speed for mobile broadband connections, the ability to support massive fleets of IoT devices and ultra-low latency for reliable control of mission-critical systems.




## 5G Game Changers: Spectrum Evolution, Sidelink and Positioning

By providing one network for all use cases, enabling 5G connections for IoT devices in the field would allow transit authorities to connect data across previously disparate systems. Although the availability of each band and its corresponding spectrum range will vary based on location, a 5G network can serve a wide range of spectrum needs:

- **Low-band — the coverage layer:**
  This spectrum provides wide-scale 5G coverage spectrum and is in use today by 2G, 3G, and 4G networks, delivering low capacity, limited bandwidth connections that support relatively low-speed communication.
- **Mid-band — the capacity layer:**
  This layer provides additional capacity in urban and rural areas, delivering new spectrum levels that support larger IoT fleets.
- **High-band — the speed layer:**
  This spectrum delivers outdoor high-speed data connections via millimeter wave in very high-density urban areas, and it may also be deployed in other high-traffic areas like malls, factories and stadiums.




Each band plays a role in delivering the promise of 5G for transforming transit systems. With this three-tiered network architecture, operations teams can prioritize connections based on needs relevant to each use case. Transit systems could reserve high-speed, low-latency communication for mission-critical applications that require real-time functionality while relying on mid-band and low-band tiers for managing the rest of the system's IoT fleet.

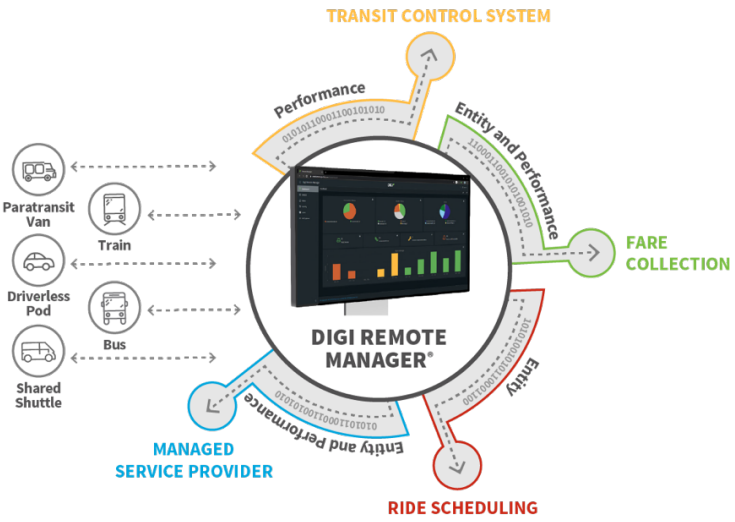
Additionally, carrier aggregation (CA) and dynamic spectrum sharing (DSS) ensure a seamless user experience for connected devices and platforms while 4G LTE and 5G devices share available spectrum dynamically. Not only will these capabilities improve coverage for 5G devices, existing 4G LTE devices will have increased longevity, giving organizations time to modernize their IoT fleets and platforms for 5G-enabled transit solutions.

## How 5G Capabilities Will Evolve Public Transit

Lower latency and increased bandwidth are not the only new capabilities that 5G delivers — the 5G New Radio (NR) standard will also support sidelink communications, which allow 5G-enabled devices to communicate directly with one another without any base station involved.[2]

Sidelink also furthers ongoing efforts to improve the accuracy of real-time positioning capabilities of IoT devices. Some smartphones support positioning within 10 meters on a cellular network outdoors and within three meters indoors. While this functionality was originally developed for emergency communications, the rise of autonomous, connected vehicles has made sidelink an exciting opportunity for developing responsive transit solutions that transform the way public and rail transportation systems monitor and manage transit vehicles in ever-changing environments.

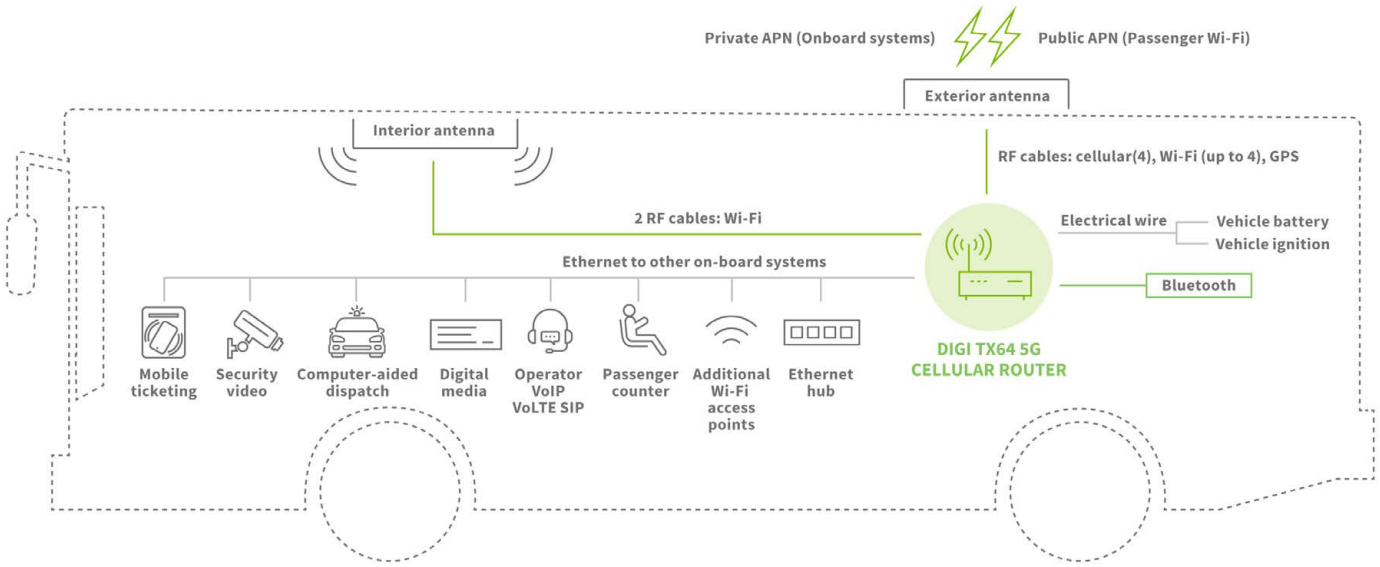
By implementing consistent IoT platforms to manage real-time data collection using transit control systems, public transit authorities can improve passenger service and operations, such as integrated ticketing, responsive ride scheduling and capacity management. With platforms that can centralize visibility, mass transportation can more easily adopt non-traditional mobility services, supplementing options like buses or metro systems with shared shuttles, driverless pods or paratransit vans.




In a world where all mission-critical transit operations are made easily observable, manageable and adaptable based on real-time data, strategies to improve transit costs and safety become much more achievable. Already, 40 cities in the United States have committed to Vision Zero, a strategy to eliminate traffic fatalities and severe injuries, while increasing safe, healthy, equitable mobility for all.[3]

Strategies like Vision Zero are challenging transit authorities and the communities they serve to consider how traffic systems can use 5G-enabled capabilities like positioning to better monitor transportation and make daily transit safer for everyone.

[2] Bell Labs Sidelink: Unlocking the full potential of device communication with 5G
[3] Vision Zero Network Vision Zero Communities




## 5G-Enabled Use Cases for Public Transportation

In many cities today, transit authorities have already implemented communications hubs to improve the rider experience. As more and more people engage in a distributed work model, riders expect to be able to use Wi-Fi connections as they ride the bus or train.

Even as the demand for these features continues to grow, cellular routers must support a growing list of use cases (and Digi TX routers support all of these today):

- **Critical and non-critical traffic segmentation at the radio level**
- **Redundant radios for seamless failover or bandwidth aggregation across carriers**
- **Dead reckoning for Global Navigation Satellite System (GNSS) navigation that supports location positioning**
- **High-speed passenger Wi-Fi**
- **On-board security video**
- **Infotainment and digital signage**
- **Fare collection**
- **Automated passenger counter**

## Transit Capacity Management Pilot

Today's transit agencies are challenged in finding ways to provide healthy, safe transportation while preventing overcrowding, increasing operational efficiency with variable ridership and making transit capacity data accessible to the public.

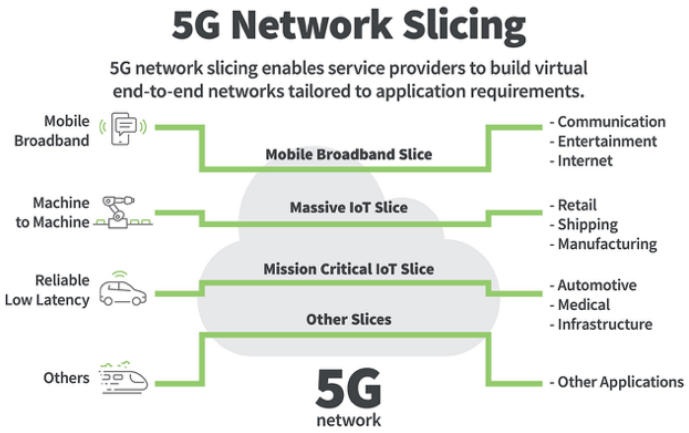
The Chicago Transit Authoritys (CTA) is running a pilot project on the 79th Street bus line to assess ridership levels and implement capacity management with Digi Remote Manager® and Digi TX54 cellular routers, providing:

- **Ridership counting using 3D imaging sensors for real-time capacity monitoring.**
- **Projected capacity monitoring based on real-time and historical data.**
- **Hybrid cloud and edge computing analytics using machine learning to send out additional vehicles when occupancy is predicted to increase.**

Equipping commuter vehicles with these 5G-enabled capabilities can help transit systems improve the passenger experience through real-time transit planning. Achieving these goals — while also pursuing new capabilities like improved yard management and location road-mapping — requires transit solutions that enable responsive data management at scale, which is often difficult to achieve sustainably.

## Network Slicing for More Efficient Computing

To support all of these capabilities at the same time, transit authorities will need to implement network slicing, which allows organizations to manage and optimize multiple logical "slices" of functionality for specific use-cases, even as they all operate on the same 5G stand-alone (SA) network infrastructure.




A 5G network operator may offer one slice that is optimized for high bandwidth applications, another that has been adapted for low latency, and a third that is designed to support a massive fleet of IoT devices. Depending on this optimization, some of the 5G core functions may not be available at all network slices. For example, a slice that is servicing IoT devices would not need the voice function that is necessary for mobile phones. As a result, available computing power is used more efficiently.

## Cybersecurity in a 5G World

Efficient operations are a critical component of developing truly transformative and sustainable innovation in transportation. However, transit authorities also need to consider the unique cybersecurity challenges that face 5G-enabled use cases.

In the past, the operational networks that IoT devices connected to remained relatively isolated, leaving air gaps that incidentally protected these networks from many security risks that exist today. Now, as 5G spectrums become more common — connecting existing networks — individual IoT devices and network management platforms have become much more vulnerable to attack.

As a result of these risks, transit systems need to deploy 5G-enabled devices that include key hardware and software security features, designed to thwart attacks at multiple points, which is often referred to as a cybersecurity "kill chain."[4] Digi TrustFence®, which we describe later in this white paper, provides transit agencies with multi-layer protection against cyberthreats:

- **Secure boot with authentication and validation of embedded software.**
- **Protected hardware ports that use login prompts, hardware random number generators (RNGs) and cryptographically secure pseudorandom number generators (CSPRNGs).**
- **Continuous monitoring, vulnerability and penetration testing, static analysis toolsets and fuzzing tools to provide support throughout the security lifecycle.**

[4] Lockheed Martin Intelligence-Driven Computer Network Defense Informed by Analysis of Adversary Campaigns and Intrusion Kill Chains

## Digi 5G Solutions for Secure, Scalable Smart Transportation

To capitalize on the speed, reliability and security of 5G, transit systems need high-performance routers and management solutions that support fast, reliable communications. Digi offers devices tailored to meet the demands of transportation use cases.

- **Digi TX54** is a rugged, high-availability LTE-Advanced 5G router supporting Gigabit Ethernet speeds for transportation and industrial applications that require redundant communication for reliability and traffic segmentation. This complete, FirstNet Trusted™ solution, with integrated system-wide management and sophisticated security, is ideal for public transit, smart traffic management and first responder applications. (See the New York City DOT traffic management case study to learn about their city-wide implementation.)

Digi TX54

- **Digi TX64 5G** is a 5G and 4G LTE-Advanced Pro cellular router with remote management, security, firewall and integrated VPN that is tailored to mobile transportation systems. With dual redundant communications and untethered dead reckoning (UDR) using GNSS and inertial sensors, TX64 5G supports mission-critical use cases in vehicles, including first responders, bus and light rail, and paratransit vehicles.


Digi TX64 5G

- **Digi TX64 5G Rail** is a 5G rail-certified mobile router designed for both light rail and heavy commercial rail use cases. The 5G module also operate on LTE bands with integrated remote management and security, dual-redundant communications, and UDR. Both TX64 5G and TX64 5G Rail are FirstNet® certified for mission critical communications in public emergencies.


Digi TX64 5G Rail

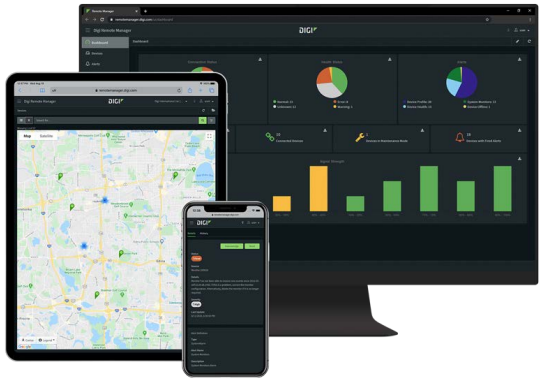
- **Digi EX50 5G** is an enterprise class, high-speed 5G NR and 4G LTE-Advanced Pro Cat 20 dual connectivity cellular router supporting Fixed Wireless Access (FWA). With an extended operating temperature range and standards-based Power-over-Ethernet (PoE), Digi EX50 5G offers deployment flexibility, allowing organizations and municipalities to take advantage of 5G networking slicing for secure, high-performance communications.


Digi EX50 5G

## Unparalleled Security, Management and Support

Digi Remote Manager (Digi RM) delivers best-in-class monitoring and management for your deployment, enabling you to scale to a fleet of any size. With Digi RM, you have a single, secure platform to access data and manage devices from anywhere. Edit configurations, update firmware, monitor, schedule and automate tasks — all from your desktop or tablet. And, with the industry's most extensive life of APIs, transit agencies can integrate third-party applications for deeper insights and control.

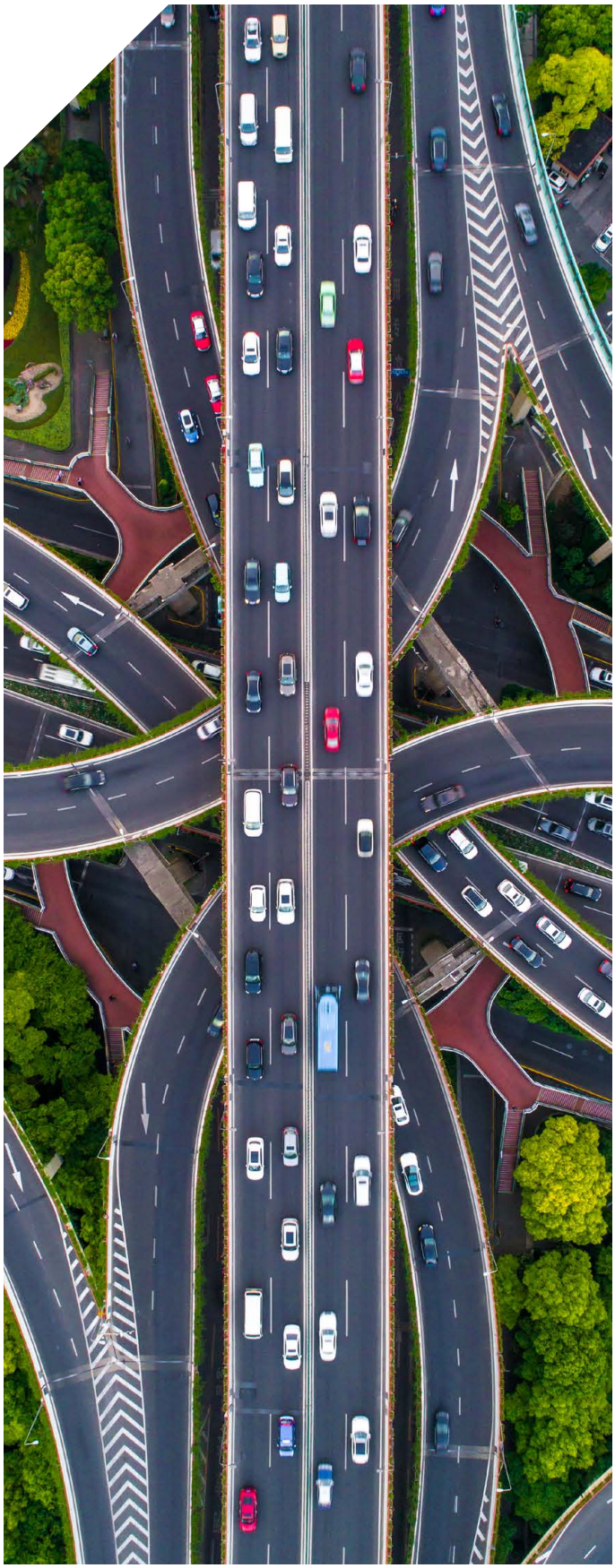
Digi can also support your planning and deployment as well. Digi Professional Services offers site surveys, provisioning, application development and training to help your organization achieve rapid time-to-deployment goals.



Digi solutions provide all-in-one connectivity, security, network management, and sophisticated software. Industry-leading Digi TrustFence® provides a security framework and ongoing vulnerability reporting that are ready for the demands of public transportation, keeping pace with changing requirements based on US, EU, and UK standards, among others. Digi TrustFence seamlessly integrates device security, device identity, and data privacy capabilities across your device deployment — so your implementation can adapt in the face of new and evolving threats.

Ready to learn more about how you can transform your transportation system's communications for performance and reliability?

Contact us to speak to a Digi expert.




## Why Digi?

Digi is a complete IoT solutions provider, supporting every aspect of your project, from mission-critical communications equipment to design and deployment services to get your application designed, installed, tested and functioning securely, reliably and at peak performance.

Digi builds its products for high reliability, high performance, and versatility so customers can expect extended service life, quickly adapt to evolving system requirements and adopt future technologies as they emerge. Digi cellular routers, servers, adapters and gateways support the latest applications in traffic, transit, energy and smart cities.

Our solutions enable connectivity to standards-based and proprietary equipment, devices and sensors, and ensure reliable communications over virtually every form of wireless or wired systems. An integrated remote management platform helps accelerate deployment and provide optimal security using highly efficient network operations for mission critical functions such as mass configuration and firmware updates, including system-wide monitoring with dashboards, alarms and performance metrics.

## Company Background

- Digi is publicly traded on the NASDAQ stock exchange, symbol DGII
- Founded in 1985, Digi has 35+ years of experience connecting the “things” in the “Internet of Things” — devices, vehicles, equipment and assets
- Headquartered in the Twin Cities of Minnesota, Digi employs over 700 people worldwide
- The business has been profitable for 18 consecutive years
- Digi’s annual revenue is around $300 million
- The company has 285 patents issued and pending (150 issued)
- In our three decades in business, we have connected over 100 million devices

As an IoT solutions provider, Digi puts proven technology to work for our customers so they can light up networks and launch new products. Machine connectivity that’s relentlessly reliable, secure, scalable, managed — and always comes through when you need it most. That’s Digi.

## Contact a Digi expert and get started today

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