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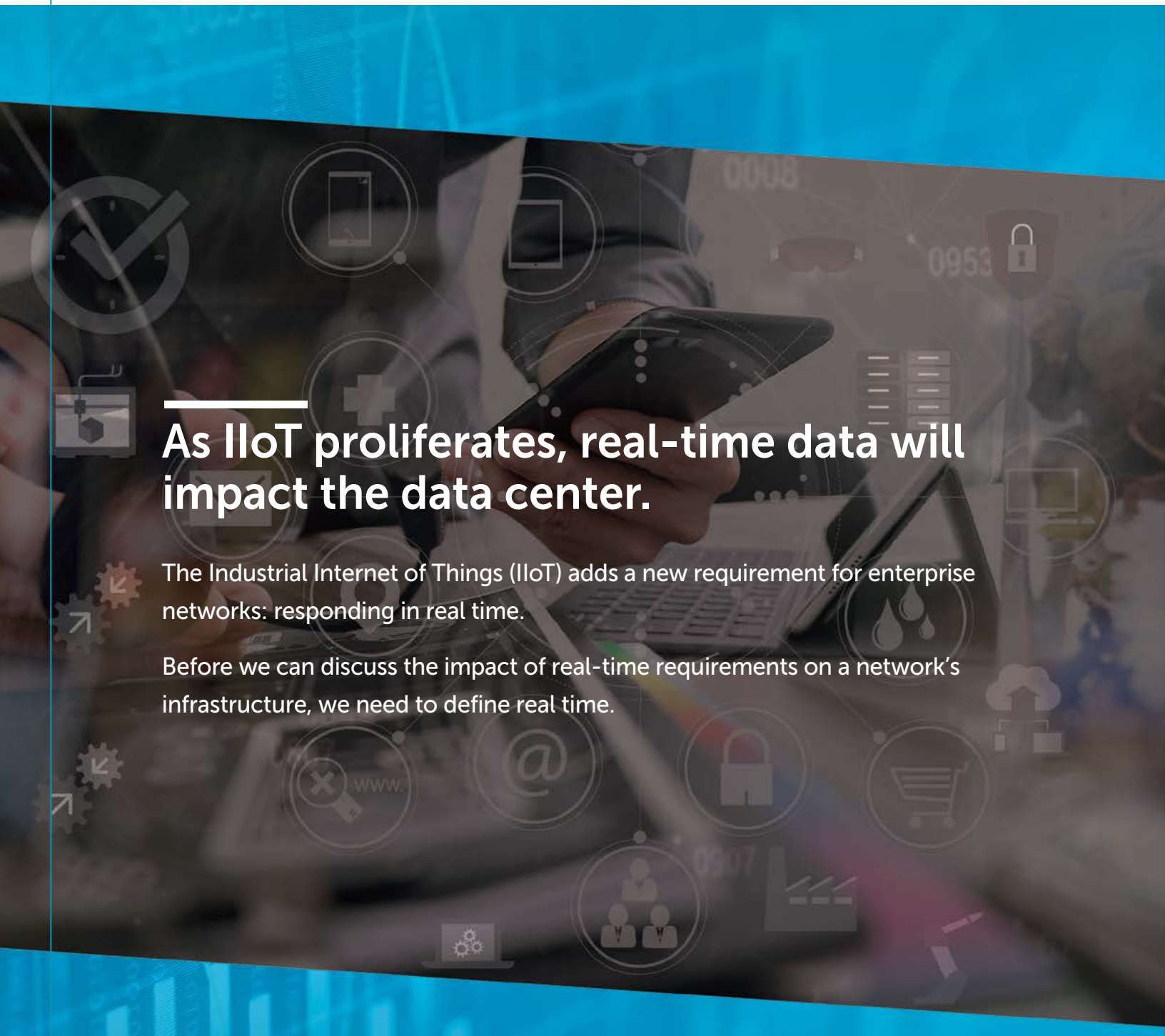
What Is The Impact Of Real-Time Data?

The IIoT Creates New Challenges For Enterprise Networks

WHITE PAPER



As IIoT proliferates, real-time data will impact the data center.

The Industrial Internet of Things (IIoT) adds a new requirement for enterprise networks: responding in real time.

Before we can discuss the impact of real-time requirements on a network's infrastructure, we need to define real time.

What is Real Time?

The definition varies, but generally, a real-time system is one that provides a smooth, seamless user experience. This is certainly the case when watching HDTV or listening to streaming music. The video frames and audio samples arrive quickly enough and at the right time. This allows the viewer or listener to integrate them into a smooth experience rather than discrete samples. This definition also applies to digital control systems implemented on the factory floor or a flight control system. In those applications, if the digital control system does not respond fast enough, bad things can happen. But that doesn't answer the question.

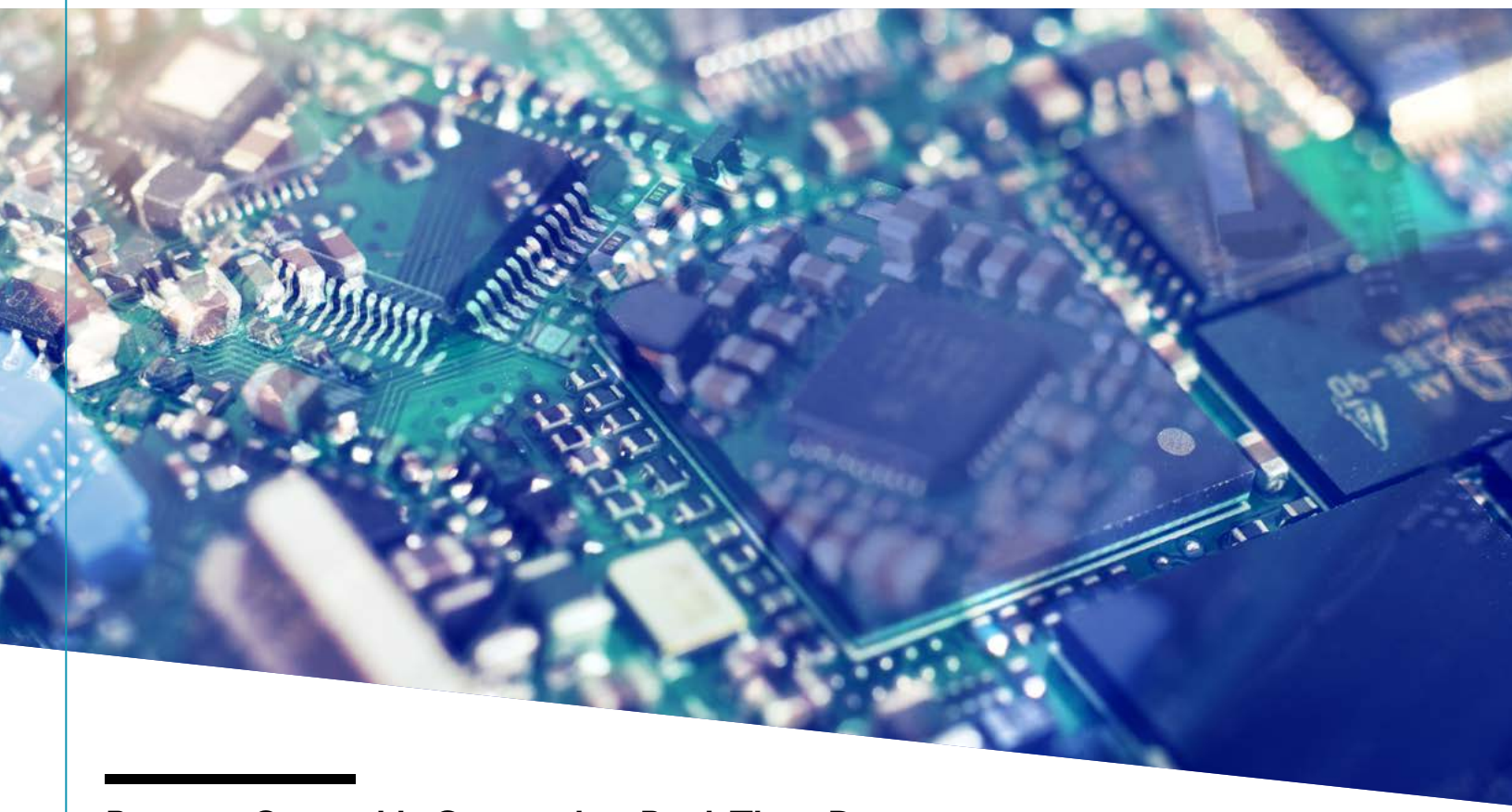
How fast must a digital system respond to inputs, or provide outputs, to qualify as real time? That depends.

For movies in a theater, the frame rate is 24 frames per second (fps), or a new frame every 42mS. When viewing the individual frames at 24 fps or faster, the viewer experiences smooth, uninterrupted movement as she would in the real world. To enhance the experience, some filmmakers are shooting movies using 48 fps. For CD quality audio, a new sample of the music arrives every 22.6µS, although an audiophile might argue the sample rate should be faster. A digital flight control system can take an action 20 times per second, or faster.

There is a difference between viewing data in real time and acting on data in real time. While listening to music or watching a movie, you are consuming the content in real time. However, you do not have to take an action in real time. A digital control system is more complex than that. Not only does it need to take a sample from a sensor at the appropriate sample rate, it also must analyze the sampled data and possibly provide a response within that sample rate.

"Real-time IIoT at the edge enables, for example, anomalies to be detected and alarms raised so operators or controllers can take appropriate actions. Leveraging IIoT technology in real time at the edge can also help improve manufacturing process quality and production yields, enabling more production data to be collected and analyzed at the device itself. IIoT at the edge helps bridge IT and OT environments; bringing real-time information from legacy sensors, devices, controllers, and assets into automation or enterprise architectures. These technologies are driving the industry to evolve at a faster rate now than at any time in history, with an explosion in the number and variety of real-time IIoT edge applications having positive effects on industry worldwide," said Craig Resnick, vice president, ARC Advisory Group.

> "The IIoT provides technology that is able to collect, aggregate, filter, analyze, and relay data at the edge of industrial processes or production assets, all in real time."
>
> **- Craig Resnick,**
> Vice President, ARC Advisory Group



Process Control is Generating Real-Time Data

End users and manufacturers of IIoT technology are using several concurrent technological advances to deploy IIoT: sensors, Moore's Law, and the ubiquity of bandwidth. Without them, the IIoT and the linkage of the factory floor to the enterprise data center would not be possible.

- **Sensors** — Sensors like microelectromechanical systems (MEMS) accelerometers, gyroscopes, and inertial measurement units (IMU), have become small enough with a reduced cost, making wide deployment practical.
- **Moore's Law** — Doubling the number of transistors in an integrated circuit every two years has resulted in small, cheap CPUs and memories.
- **The Ubiquity of Bandwidth** — IIoT devices that gather data need to send that data upstream for analysis. The ability to connect to a network is available everywhere. There is a wide range of ways IIoT devices can connect to the network, for example, copper or fiber optic cabling, Wi-Fi, ZigBee, and cellular, to name a few.

Deploying IIoT devices generates large amounts of data, which is not the problem. The problem is that the data must be analyzed and acted upon in real time.

The Raspberry Pi single board computer is an example of how Moore's Law has predicted the rise of small, cheap CPUs and memories.

Data Centers and Real-Time Data

With several exceptions, most enterprise data centers need not process and act on data in real time. Although streaming websites such as Netflix and Spotify are sensitive to the real-time nature of their end-users' experience, they sufficiently compress the streams so the real-time requirement is not a burden for their data centers.

Examples of data centers that need to support real-time applications are those that support audio or video chat services. A telephone conversation is extremely sensitive to latency, or the delay through a network. It becomes more difficult to conduct a telephone conversation in real time when the mouth-to-ear delay is greater than about 200mS. The one-way latency using a geosynchronous satellite can be as much as 300mS. This leads to several problems, including double talk, or talking over one another[1].

Another application sensitive to latency is virtual desktop infrastructure (VDI), or thin clients. The typical desktop or laptop contains sufficient processing power, memory (RAM), and disk storage to support the user's applications. Everything is self-contained and can function without communication with a network. With VDI devices, most of the processing power, memory, and disk storage reside elsewhere, either in the enterprise's data center or in the cloud. An example of a VDI device is Google's first generation of Chromebooks. Thin clients require low-latency networks because the time delay between the thin client and its resources could impact the real-time responsiveness. Users expect that a thin client will have the same responsiveness as a typical desktop or laptop.

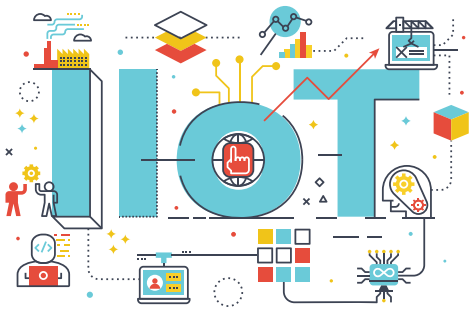
Not all applications require data processing in real time.

[1]"Impact of Delay in Voice over IP Services." VoIP Performance Management, January 2006.

Improving Response Time to Real-Time Data

There are several options network architects or network managers can consider to prepare their data centers for supporting real-time applications and the IIoT.

- **Check your network —** The network may be intermittently dropping packets. The rate of dropping packets may be low enough to not notice the impact on throughput, but a dropped packet in a network that needs to respond in real time may wreak havoc on latency.
- **Use a low-latency infrastructure —** Different media have different latencies. For example, the latency through an optical fiber link may be several hundred nanoseconds, whereas the latency of a 10GBASE-T link is approximately 2-2.5µS. This may not seem like much of a difference, but depending on the network's architecture and the number of hops, the latency of the media could have an impact. Exploring the media used for the network is one of the easier ways to lower latency.
- **Upgrade the network's speed —** Although increasing the network's speed does not shorten the media's inherent latency, it does increase how fast packets are reassembled.
- **Use lower latency equipment —** Switches, routers, and servers all have a latency associated with them. You can improve a data center's responsiveness by selecting lower latency equipment.



Is your data center prepared to support real-time applications and the IIoT?

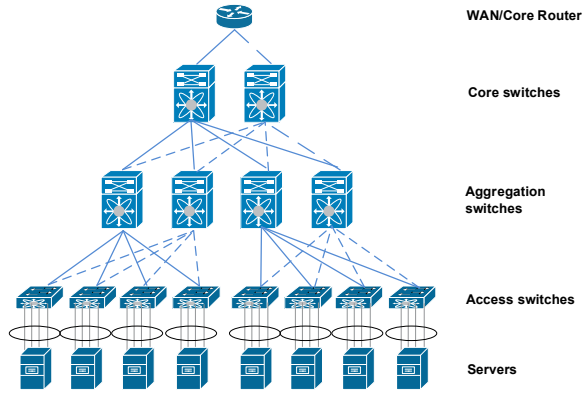
- **Adopt a spine-leaf architecture —** A traditional network architecture has three layers: access switches, aggregation switches, and core switches. You could adopt a spine-leaf architecture where an entire layer of switching does not exist, improving latency and responsiveness.

- **Implement a time-sensitive network —** A time-sensitive network (TSN) has mechanisms to control three aspects of a network: jitter, latency, and guaranteed bandwidth. Historically, TSNs have been proprietary and somewhat costly. However, organizations such as the IEEE have created standards for implementing TSNs with support from various vendors. With a TSN, the data that requires action in real time takes priority over the non-real-time traffic.

- **Edge computing —** To shorten latency, locate the computing resources closer to the IIoT devices that are generating the data. Edge computing is a trend that is a contrast to locating computing resources in a few very large, hyperscale data centers. Panduit's Pre-Configured Micro Data Center is an example of edge computing.

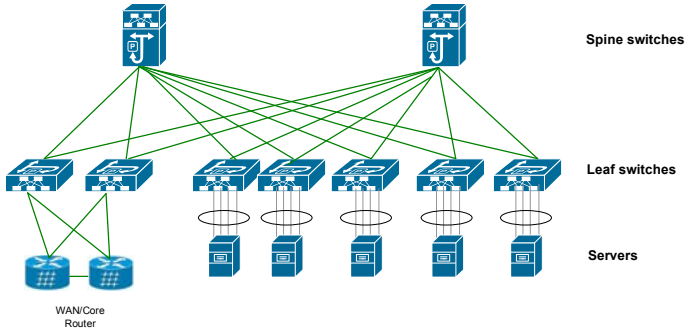
Traditional 3-Tier

Traditional Three-Tier Data Center Network Architecture



Spine-Leaf

Spine/Leaf Data Center Network Architecture



Ready for IIoT

The result of deploying IIoT is not just that it will generate vast amounts of data, it is that some of the data will need to be acted upon in real time. The definition of real time depends on your application. Depending on required response time, the typical enterprise data center may not support real-time IIoT applications. If the latency through the network and data center is too long to support the desired IIoT application, there is a range of options you could entertain from something as straightforward as changing out networking infrastructure, all the way to adopting edge computing.

Understanding real time is key to understanding its impact on your network's infrastructure.

For more information on the IIoT and automating the factory floor, visit **Panduit's factory floor landing page** on our website.

Subscribe to our blog at Panduitblog.com to access remaining papers in this series and learn more about network bandwidth, packet loss on the plant floor, edge computing, and how they relate to the IIoT.

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