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What Is The Impact Of Packet Loss?

The Answer Depends On Where You Are With IT/OT Convergence

WHITE PAPER

Nobody likes a bad packet.

The corrupted packet has no friends. IT network managers dislike packet loss because it steals valuable bandwidth, reducing the link's available throughput. Managers of OT networks dislike packet loss for a different reason: it negatively impacts latency which could impact real-time applications. Why do IT network managers and OT network managers look at corrupted packets differently?

Before we answer that question, we need to look at how packets turn bad and the impact they have on networks.

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Craig Resnick
Vice President, ARC Advisory Group

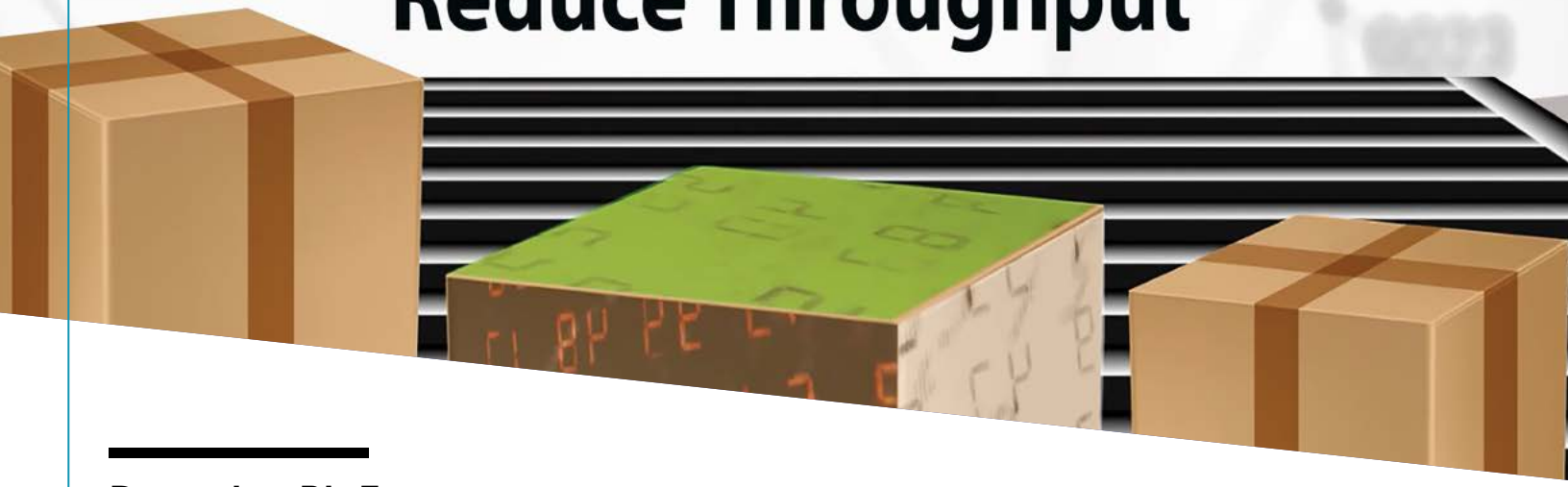
Corrupted Packets

Corrupted packets can occur when they encounter a bit error as the packet moves from one end of the network to the other. Bit errors almost always occur in the lowest layer of a protocol stack, the physical layer. The job of the physical layer is to move information from one end of the network to the other. Typically, this information is represented by a stream of 0s and 1s. The physical layer does not assign any meaning to the stream of 0s and 1s because the upper layers handle that task.

Outside interference such as lightning or other electrical noise can cause the bit error if the physical layer uses copper cabling or wireless connection. In optical networks, a bit error could occur if the optical module fails, causing it to have difficulty determining the stream of 1s and 0s. Other causes could be improperly terminated cabling, dirty fiber optic connectors, or water penetrating the cable.

"To properly address the issue of minimizing the corruption of packets requires the convergence of IT and OT, both from a networking infrastructure perspective and a human resources perspective," according to Craig Resnick, Vice President, ARC Advisory Group. "Converged network architectures bring together IT and OT systems that have long remained separate. As a result, IT and OT professionals who previously only oversaw their own individual systems now must also understand the counterpart technologies to help eliminate, for example, corrupted packets. IT professionals must be able to transfer their experience of enterprise network convergence and ubiquitous use of Internet Protocol into manufacturing applications. OT professionals must be able to migrate from yesterday's islands of automation to today's plant-wide, information-centric architectures to enable the secure flow of information throughout the manufacturing enterprise and beyond."

Corrupted Packets Reduce Throughput



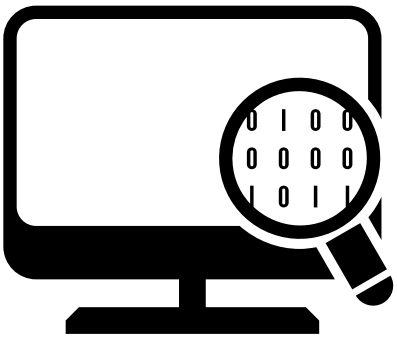
Detecting Bit Errors

The physical layer has no idea if a bit error has occurred. At the physical layer, the bits have no meaning. There is just a stream of 0s and 1s. The physical layer presents the stream of 0s and 1s, including any bit errors, to the data link layer. The data link layer assigns meaning to the stream of bits, e.g., source and destination addresses, framing, and typically, some form of cyclic redundancy check (CRC).

The data link layer, via Ethernet, adds CRCs to frames so the receiver of the data stream can determine if there are any corrupt bits within the packet. The sender takes the packet it will send and runs it through an algorithm. The result of the algorithm is a number, a CRC, that the algorithm attaches to the packet. The packet then continues on its way.

The receiving physical layer at the other end of the link runs the packet through the same algorithm which results in a locally generated CRC. The receiver compares the local CRC with the CRC transmitted as part of the packet. If they are the same, no errors occurred during the transmission. If they are not the same, then a bit error occurred somewhere within that packet.

What does the data link layer do when it detects that a bit error occurred, corrupting a packet? With most protocols, the switch discards the corrupted packet and the receiver asks the sender to re-send the offending packet. That is how a single bit error can cause thousands of wasted bits. The discarded packet and the retransmission can rob a network of valuable throughput and add to a network's latency.



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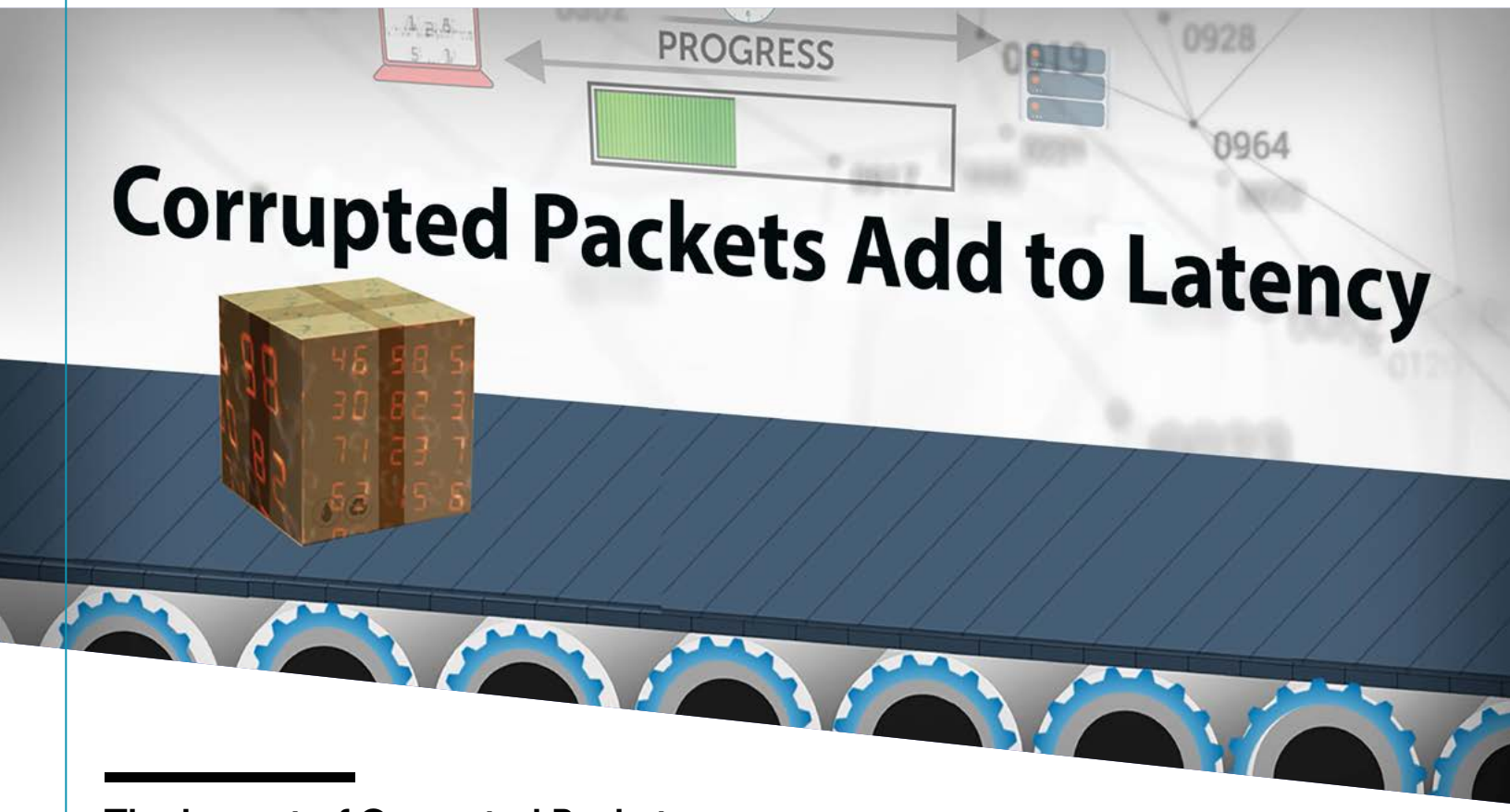
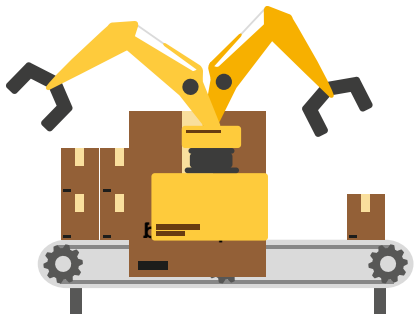


The Impact of Corrupted Packets

A corrupted packet impacts a network in two ways: it reduces throughput and adds to latency. Depending on which side of the fence you are on with IT/OT convergence, you will either cringe at the thought of reduced throughput or the thought of added latency. A corrupted packet reduces throughput when the switch discards the packet, and then when it is re-sent. Essentially, the packet must be sent twice. Because the higher layers of the protocol stack can take no action until a correct packet arrives, corrupted packets also add to a network's latency.

IT managers are more concerned about throughput than latency. The latency of the enterprise network is responsive enough for their applications. However, there is an insatiable appetite for more throughput in enterprise networks, for our homes, and mobile devices. Packet loss reduces a network's available throughput.

OT network managers look at packet loss differently. On the factory floor, a network's latency is more important than bandwidth or throughput. For example, when a sensor on the factory floor sends a packet to request an action, it needs the response in milliseconds. The corrupted packet cannot deliver the request, and the retransmission delays the decision on the appropriate action to take. This event can be costly.



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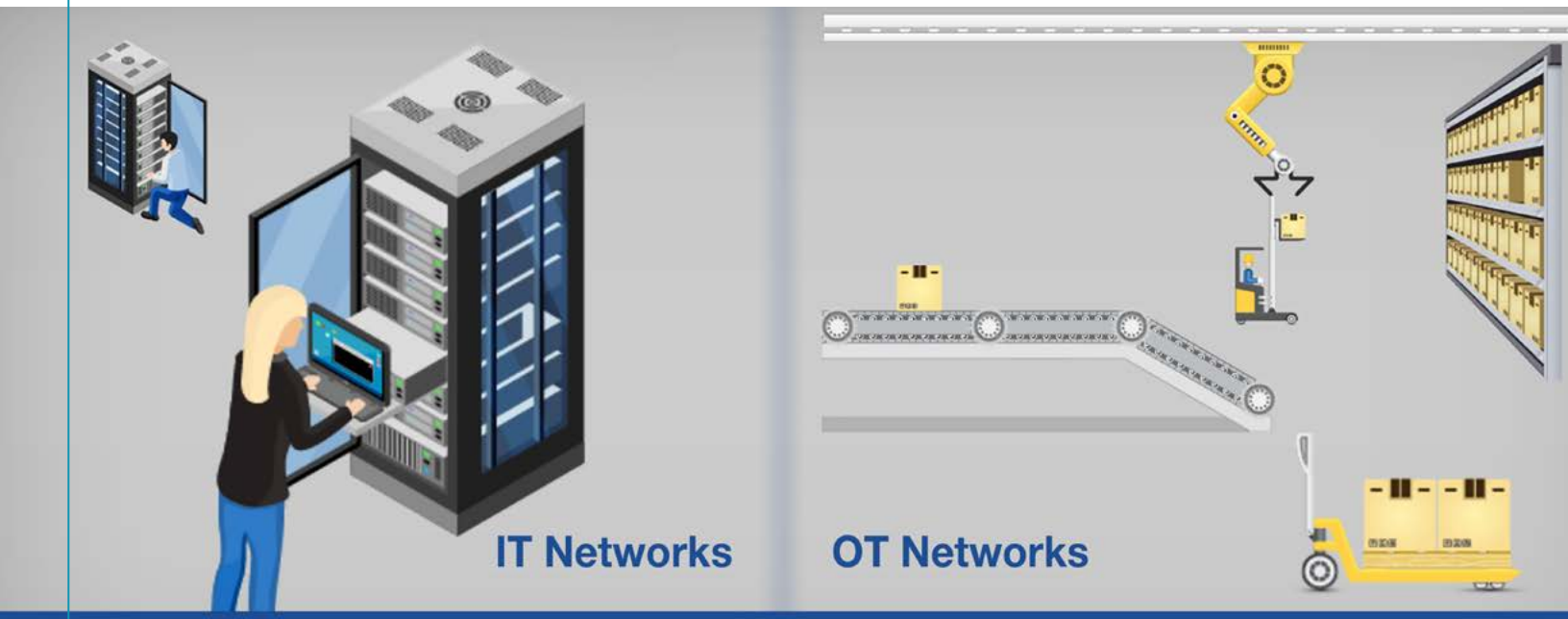


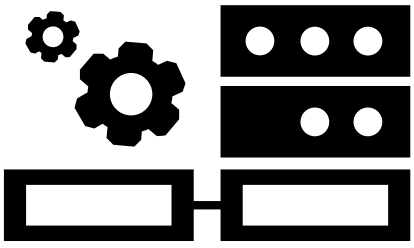
Minimize Packet Corruption

Infrastructure Matters

The IT and OT networking infrastructures play an important role in minimizing packet loss. This is especially the case when network speeds move beyond 10Gb/s. Here are two considerations regarding networking infrastructure and how it may corrupt your packets.

- The first area to consider is proper installation and maintenance of the network. When installing RJ45 jacks, you may untwist the copper pairs more than needed. This could unbalance the pair allowing electromagnetic interference (EMI) to impact link performance. Cleaning the end-face of fiber optic connectors is always important, but even more so at higher network speeds. Proper grounding and bonding eliminate differing ground potentials between different pieces of networking equipment. These are examples that impact the receiver's ability to distinguish the transmitted bit sequence that leads to corrupted packets.

- Another consideration is the media type, for example, copper or fiber. You should consider CAT6A unshielded twisted pair copper cabling for new installations, as it provides the best performance for most applications without the added expense of shielded cable. For harsh environments where EMI is present, you may need to install shielded copper cable or fiber cabling which is immune to EMI.



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Infrastructure Matters

Using the Right Infrastructure

IT and OT network managers might disagree about how packet loss impacts their networks, but they can agree that a robust infrastructure can help prevent packet corruption.

Panduit's Category 6A UTP copper cabling systems use an advanced **MaTriX Technology** that guards against EMI and alien crosstalk from adjacent cables. It provides isolation characteristics near that of shielded twisted pair cabling without the extra effort and cost associated with shielded cable. That isolation could be important on the factory floor or in dense cable deployments in the enterprise to remove the impact of alien crosstalk.

Panduit's **Signature Core™ Fiber Optic Cabling System** provides the longest reach available for a multimode optical fiber. It also allows more complex network architectures that may need more connectivity than simpler implementations. Fiber optic links are increasingly deployed on the factory floor due to their inherent noise immunity, not because of the need for speed.

The **Panduit High Speed Transport** web page provides help with selecting the right media type. The website also has an array of industry best practices and advice on the proper installation of both copper and fiber media, link testing, and how to maintain the network infrastructure.

Don't let a packet go bad.

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

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