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WHITE PAPER

CAN INDUSTRIAL EDGE COMPUTING SYSTEMS FIT INTO THE PURDUE MODEL?

A LONG TIME HAS PASSED SINCE THE INTRODUCTION OF THE PURDUE MODEL BACK IN 1992. IT HAS REMAINED VIRTUALLY UNCHANGED SINCE ITS INCEPTION OVER 27 YEARS AGO. IN LIGHT OF THE BLAZING SPEED OF TECHNOLOGICAL CHANGE CHARACTERISTIC OF TODAY'S MODERN BUSINESS LANDSCAPE, IS IT TIME TO RE-EVALUATE THE MODEL'S RELEVANCY? ESPECIALLY WITH THE ADVENT OF THE INDUSTRIAL INTERNET OF THINGS?

When the Purdue Model for Control Hierarchy was published by Theodore J. Williams and the Industry-Purdue University Consortium for Computer Integrated Manufacturing, it quickly became the de-facto standard that guided how manufacturing teams thought about, architected, and implement industrial control systems. The Purdue Model became the barometer of what good manufacturing looks like, the reference point for conversations about systems and data flows, and the defining picture of where operational and plant floor applications sat relative to the rest of the business. In short, it defined the landscape.

With the advent of the IIoT, the Purdue Model may be starting to show its age. Today's technology stack is vastly different than what it was back in the 90s, and a host of new and exciting methods are being deployed to unlock business capabilities in ways that were previously impractical. Most notably, the rapid acceleration of the number of disparate connected devices combined with a mass democratization of computing power introduces new requirements that are not addressed within the linear hierarchy of the model in its current form. Let's take a closer look at what this really means.

The Purdue Model was created with the intention of ensuring security. This is accomplished through the means of a separation of concerns which takes a layered view of how machines and processes function and interact with each other, and how data is produced, transferred, and consumed at the various levels.

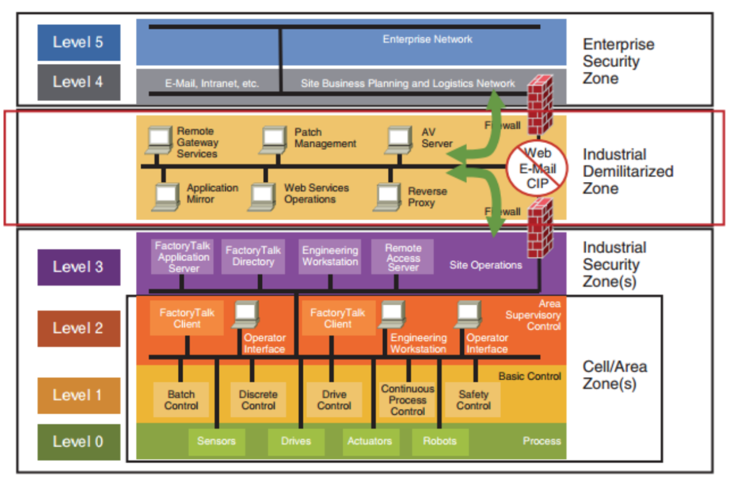

Figure 1: The Purdue Model of Computer Integrated Manufacturing

What Exactly is the Purdue Model?

As shown in Figure 1, the Purdue model provides a guideline for industrial automation and control systems including network and security requirements. It is the most widely used framework across industrial environments globally. Many industrial controls and data collection / SCADA systems are designed around the model, ensuring that new and existing architectures continue to adhere to it. The Purdue model also inspired ISA-95, an international standard from the International Society of Automation that aims to define the interface between enterprise and control systems.

The model is built in a pyramid formation to represent how information is intended to flow from the shop floor upwards into high-level enterprise systems. The model separates the enterprise and operational domains into different zones and keeps them isolated with an industrialized Demilitarized Zone, or DMZ, in between. Built-in security is designed to prevent any security breaches between Level 0 and Level 5.

The model keeps computing and networks deterministic, in other words ensuring that networks on the shop floor remain dedicated to the control systems and do not become "flooded" with non-production related data which could result in network capacity issues that could ultimately stop the manufacturing processes.

The Purdue model intended to regulate and protect required responsiveness for each layer through segmentation. Segmentation then became the primary methodology to mitigate concerns over unwarranted/unwanted traffic making its way down from the IT world and potentially disrupting fragile and untested legacy controls equipment. The Purdue model also paved the way as a blueprint for IT systems to acquire shop floor data without compromising production or causing adverse effects on mechanical equipment that could endanger shop floor workers via the use of a DMZ. Cyber security concerns were also addressed through the use of firewalls placed between the industrial zones and the enterprise zones, effectively isolating data within the zones unless specific business requirements dictated rules be allowed for data sharing.

What are the limitations of the Purdue Model in today's world?

The Purdue Model serviced the world of 1992 very nicely. At that time, cloud computing was just a dream. The bulk of the compute capability required to run the facility and the manufacturing processes was found in on-premise data centers and expensive mainframe technology. Data sharing between manufacturing facilities and central offices was limited mostly to order placement and fulfillment.

These layers and zones contributed to a tightly controlled flow of data, mostly originating from the bottom of the Purdue pyramid upwards, however enterprise planning data is often pushed back down into the model for consumption at Levels 3, 2 and 1.

The model dictated that the data should be organized to be hierarchical and purpose driven. Data required to run the factory processes came into the system top down and was processed and consumed where it was needed at each level. Data generated from the shop floor was sent back up, sometimes being used at the Level 3 Industrial Security Zone, but more often being passed up through the DMZ into the Enterprise Security Zone where it was used for basic historical reporting purposes.

Today's data flow is no longer hierarchical. Today, manufacturers are adding intelligence at the sensors themselves (Level 1), at the controllers (Level 2), and at the “edge” which can be anywhere along Level 1 to 3 based on where the edge device is placed. All of this to say that points of exposure are occurring much further down the pyramid than the Purdue model ever considered. Due to the expanded power of edge computing devices, vast amounts of data can be collected at Level 1, processed and be sent directly to the cloud. There is no inherent need to funnel data up through different layers. Data can be derived from many sources and service many clients, opening up ever widening pathways for consumption. The IIoT, in all its interconnected glory, has demanded that we change the paradigm from that of a pyramid to…a pomegranate.

So, should we scrap the Purdue Model? How can you bridge the gap on the factory floor?

So does the Purdue model still have its place in today's manufacturing world, or will it have a problem supporting the industrial internet of things? Critics say Industry 4.0 has made the Purdue model at best outdated and at worst obsolete. These outdated applications of the model are seen in use cases where sensor data is being collected at Level 0 and is required to be sent to the cloud to enable predictive maintenance capabilities. Sending Level 0 data to Level 5 directly violates the segmentation aspects of the Purdue model.

Scrapping the Purdue model, however, doesn't work either. The Purdue model still serves the segmentation requirements for both wireless and wired networks and protects the Operational Technology (OT) network from unwarranted traffic and exploits – these are key areas that need to be preserved to ensure the continuous flow of production and the safety of the workers operating the shop floor equipment.

What is needed is a hybrid solution that integrates into the Purdue model to maintain segmentation for traditional instances of IT and OT data flow, but also provides the flexibility that will be needed as Industrial IoT use cases become more prevalent and data becomes less hierarchical and more horizontal.

This level of IIoT flexibility can be attained by adding an Industrial Edge Computing Platform software layer. With this layer, you can make your Industrial IoT project adhere to each level in the Purdue model. This platform layer can sit either at Level 2 or Level 3 and provide data collection capability from OT devices at Level 0, 1, 2 and 3, while also facilitating data collection from IT layers at Levels 4 and 5. The benefit is that the traditional hierarchies inherent in the Purdue model can be bypassed where needed (i.e. sensors sending data from Level 0 to Level 5) by piping the data through the platform to ensure control and security.

Consider Figure 2, which demonstrates how an Industrial Edge Computing platform can be inserted into the Purdue Model:

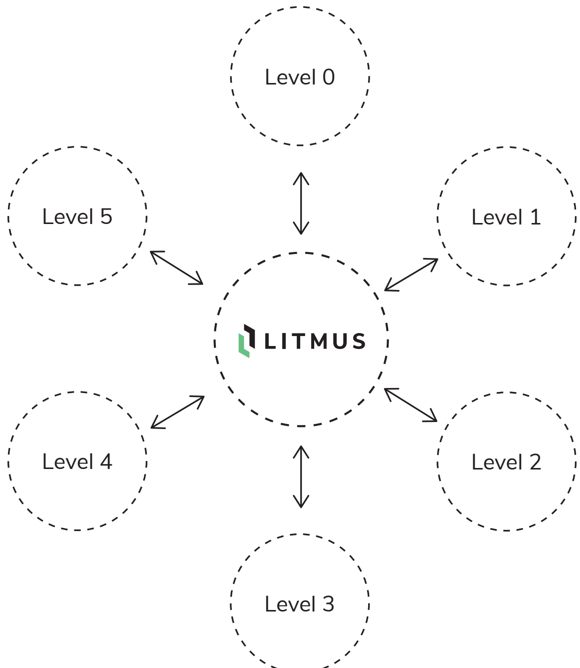

Figure 2: The Purdue Model with an Industrial Edge Computing Platform

The Industrial Edge Computing Platform sits inside the Purdue model, facilitating communications between any level as required. It is the data quarterback in today's new world of the data-enabled enterprise. It is the orchestration platform that makes it easy for systems to communicate amongst themselves using secure and modern protocols. It creates agility and insight by making the right data available in the right format to the right systems at the right time.

Around the outside of the diagram, the traditional and established data flows will continue to persist as per the Purdue Model, maintaining adherence to proven guidance of the model (i.e. ensuring throughput on the shop floor network is not comprised and ensuring safe operation of shop floor equipment).

In conclusion, the Purdue model has inherent benefits which are still valuable in today's manufacturing environment, however the model can be inflexible in how data is acquired and applied in the system. Implementing an Industrial Edge Computing Platform into the model preserves the integrity of the system while allowing the flexibility of disparate data collection and analysis to unlock greater process and production improvements. This flexibility drives the foundation of a flat data collection and analytic environment that accelerates continuous improvement through the exposure of previously siloed data.

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