ALTAIR

# GUIDE TO SMART PRODUCT DEVELOPMENT

# INTRODUCTION

Organizations globally are looking at smart, connected solutions to deliver more value to their customers through product innovation, and in turn increase the lifetime value of their products. Smart products provide organizations with a disruptive solution that can provide clear market differentiation, creating new business models via recurring revenue and opportunities for market expansion in an overtly service economy.

It's not always easy, however, to embark on such an initiative. It takes more than adding an electronics circuit to a "dumb" product or connecting to an Internet of Things (IoT) platform to make a device connected or intelligent. Manufacturers need to reexamine their product development approaches and lean on specialized tools to develop truly groundbreaking smart products.

As performance demands continually increase, packaging sizes become smaller, and device connectivity becomes more critical, schematic engineers and product designers need ways to make efficient design decisions and collaborate with one another to optimize complex interconnected mechanical and electromagnetic systems.

## Smart Product Development Guide

The Internet of Things (IoT) has transformed the way companies do business. New product lines, recurring revenue streams, more efficient operations, higher quality, customer centric optimizations, and faster time-to-market are all within reach with the introduction of smart interconnections between systems and assets. This guide is designed to help product developers realize their smart product development vision from ideation, to optimization, to launch and operation. It also provides insights on handling the complexities of connecting smart devices to IoT infrastructure.

## What to Expect



# WHAT MAKES A PRODUCT SMART?

A product can be termed smart when it can independently sense its operating environment and react appropriately, leveraging its built-in intelligence to meet its operational goals - monitor and provide alerts, control and personalize functions, optimize its performance, and in some cases allow an autonomy of operation.

To achieve smart operation, the product uses sensors and actuators, on-board electronics and systems, embedded code, internet and cloud connectivity, and artificial intelligence as integral parts of its design and operation.

# WHY DEVELOP A SMART PRODUCT?

Smart products bring a host of advantages, both to end users and product manufacturers.

## Empower Users

Smarter products can dramatically improve end user experience providing a better control, scope for automation, and operational flexibility. The ensuing analytical insights can further help improve performance and bring down the operating cost of products.

### Environmental Control

Give your users the power to control their environment, exactly how they want to (manually or through automation.)

### Data Analysis + Insights

Help your end users the real state of the world through sensors and intuitive real-time visualizations.

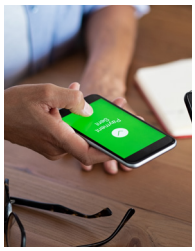
### Improved Support

When things don't go exactly as planned, connect directly with your user and their circumstance.

### Extend User Experience

Where physical products are finite, software is easily extensible. Constantly deliver additional value to your customers with apps.

### Easy Payments



Add more value to your ecosystem and enable your customers to pay direct (and recurring.)

## Improve Operational Efficiency

For product manufacturers, smart products are a competitive differentiator with resultant efficiency in post-sales support and improved product quality through better design based on operational data from the field. Smart products are also more future-proof, and they add the potential for recurring revenue streams.

### Optimize Maintenance

Identify the right time to service your products and save truck rolls. Communicate with your asset directly through an app, while on site.

### Get User + Environment Insight

Learn more about your customers and the way they use your products so that you can make more informed decisions about requirements.

### Extend Product Lifetime + Usefulness

Continuously deliver code to the edge and monitor health to extend a product's market lifetime.

### Detect + Prevent Fraud

Identify when products are not being used appropriately, or worse, fraudulently. Take action to save loss.

### Manage Inventory Past Delivery

Track your products from manufacturing all the way to the field to identify design defects or production run issues.

Taking advantage of smart product innovations requires a different approach to design. Every decision, from the concept design to the IoT system connecting thousands of devices, will influence the overall product design and development process. Each decision should account for connectivity, security, and scalability. These are a few of the key considerations designers need to address:

- What data needs to be collected?
- What is the optimum placement of sensors to collect that data?
- How will the device connect (via the internet, 4G, 5G, private network, or other method) and how will security be ensured?
- What actions will be driven by this data?
- What is the process for remote firmware update?
- How does the product operate in a larger network of assets?

While the business considerations clearly justify an investment towards developing smart products, it is equally important to address the following as you take your first steps:

- Which is the priority use case we should focus on that best addresses our biggest business challenges?
- What technology, tool sets, and expertise will help us best achieve our goals?
- How do we protect and leverage our investments in the legacy technology and applications towards the new direction?
- How can we make this smart product within budgetary constraints?
- What methods and processes can we adopt to ensure a smooth transition to developing smart products?
- Where do we begin?

A set of tools that span concept design, engineering, IoT, and data analytics will help companies answer these critical questions. **Altair offers a collaborative, open architecture environment and domain expertise to guide you through the smart product development process.**

Learn More at altair.com/spd

**How do you convert a traditionally offline product/service to a connected one?**
A beer equipment manufacturer wanted a solution to detect and prevent keg fraud and pilferage throughout their supply chain. They partnered with Altair to develop a beer keg tracking solution that allowed tracking from the point of production all the way to when the empty kegs reach the back of the brewery.

A range of technologies from Altair spanning concept design, engineering, IoT connectivity, and data analytics was used in conjunction with industrial and product design expertise. All of this was achieved without changing the design of the keg, thereby protecting the company's investment in millions of existing kegs, while helping to optimize their supply chain and save cost on truck rolls.

View the Customer Story


## Outcomes

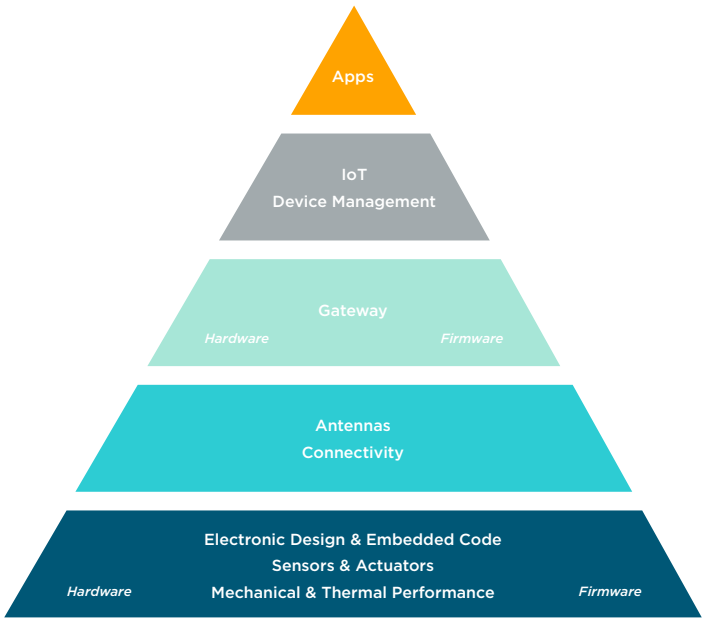
Millions in reduced losses from fraud and pilderage for big distributors.

No need to invest in engineering or software development resources.

New revenue opportunity through new product line.

High pre-launch confidence that the product will work in production.

# CONNECTED PRODUCTS HIERARCHY OF NEEDS




When it comes to smart product development, there are many considerations starting from, and extending beyond, mechanical and structural design engineering. Electronic System Development process, including design of electronic hardware and firmware, as well as the sensors, actuators, and the antennas on the device demand a special focus.

Electronic System Development is a specialized subject in itself and is presented in detail in a special eGuide:
Read the Guide to Electronic System Development: Rapid Product Development for Smart Connected Devices

Connectivity is another critical consideration in the design of smart products accounting for antenna simulation and placement, radio coverage, network planning, spectrum management, electromagnetic compatibility (EMC/EMI), bio-electromagnetics, and RF devices.

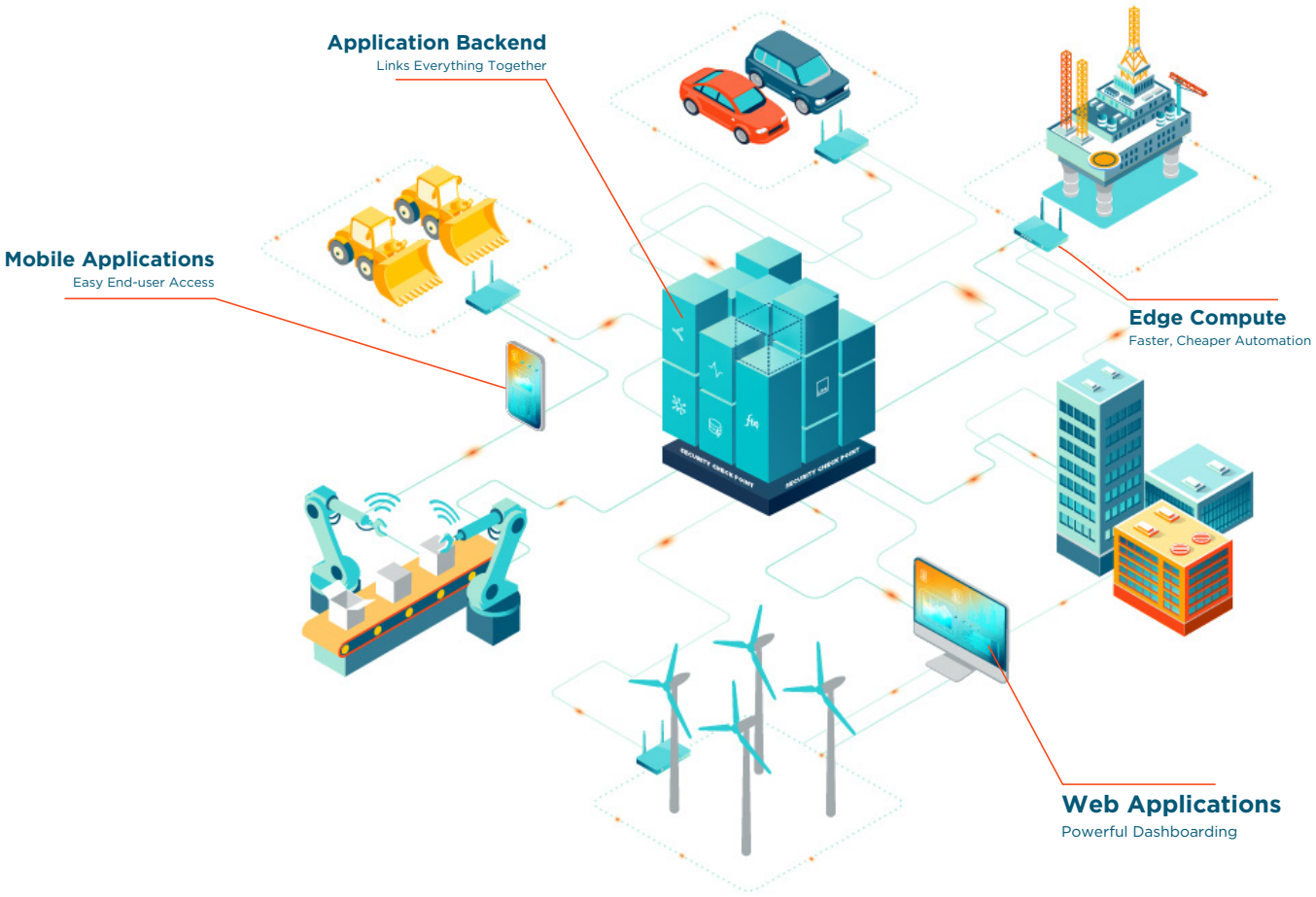
This is followed by another vital piece of technology comprising edge and device management, and for ensuring two-way communication between the device and the IoT infrastructure, enabling efficient collection, management, storage, and use of data for varied applications, including building digital twins for specific use cases. This eGuide focuses on connectivity and integrating devices into the Internet of Things.

"Smart, connected products require a fundamental rethinking of design. At the most basic level, product development shifts from largely mechanical engineering to true interdisciplinary systems engineering."

Porter, Michael, Heppelmann, James (2015), "How Smart, Connected Products Are Transforming Companies", Harvard Business Review October 2015, Harvard Business Publishing, Accessed 17 November 2020

# INTEGRATING DEVICES INTO THE INTERNET OF THINGS

While many companies have a connected product vision, few have everything it takes to quickly and securely develop scalable software to move their product from disconnected to connected. For those companies looking to move fast, scale up and stay secure, Altair provides a powerful IoT software development platform - Altair® IoT Studio™. This includes reliable and secure device communication technology, edge compute and orchestration platforms, data storage, drag and drop stream processing development, real-time data visualization, and machine learning model training and execution tools.



**Toggled iQ Customer Story**

Toggled iQ combines web application, mobile application, hardware, analytics, and edge computing to create a one-of-a-kind smart building data and device management system. This smart-lighting manufacturer wanted to develop a new, connected lighting and building management solution to help their customers save money, improve comfort, and comply with new regulations.

They used Altair IoT Studio to build a complete front end, back end, and edge compute architecture. With this, Toggled's customers can now manage users, onboard devices, manage compute workloads in their gateway product, develop building automation, and optimize energy usage.

View the Toggled iQ Customer Testimonial

**Outcomes**

New "as a service" revenue opportunity.

Smaller software development investment.

Faster time to market.

Immediate scalability.

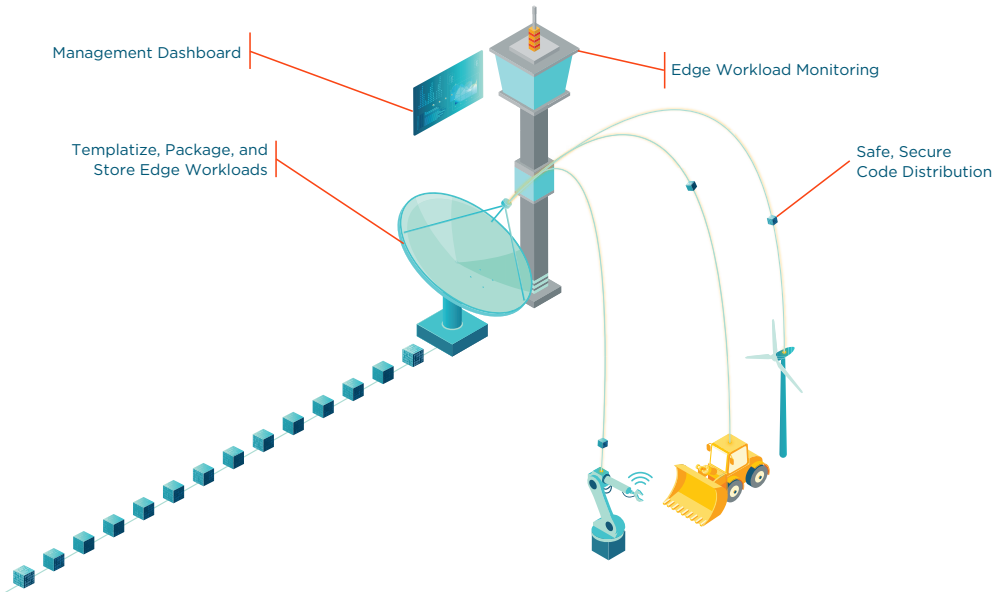
For a free trial of Altair IoT Studio, please visit swx.altairone.com.

### Gateway / Edge Development, Management, and Orchestration

Automation and intelligence often work best when run very close to sources of data collection. Most traditional automation and intelligence software expect a reliable, high-bandwidth internet connection and huge, scalable hardware servers to run it all; but for the edge, access to these resources are not always feasible.

Edge application orchestration can be a complex, nuanced problem – edge compute loads encounter complications ranging from uncommunicative devices, to specialized target hardware requiring specific builds, to mission critical applications running out of hardware resources. Edge orchestration provides a powerful platform for managing these nuances so that you can build automation and execute logic close to devices. For you, that means reduced latency, saving on data transfer costs, and new, powerful intelligence where you need it most.

A toolset built specifically for edge management and orchestration is the best way to optimize performance at this critical stage in the device integration process. Altair's EdgeOps comes with an edge-optimized platform to accelerate development at the edge, and includes tools that help build, manage, and scale automation and intelligence. The management console also helps to assemble, deploy, monitor, and continuously improve applications at the edge.



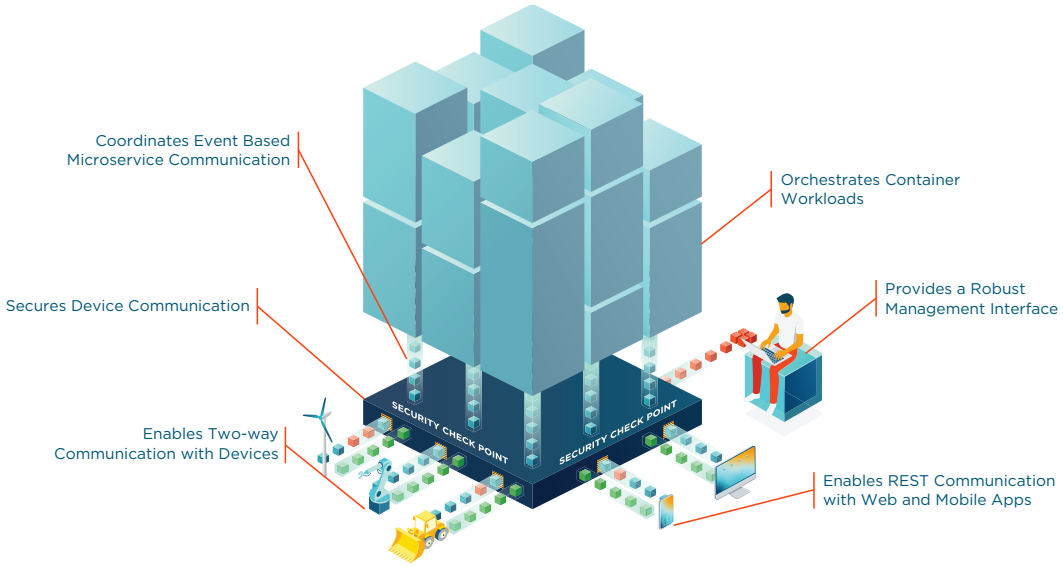

Also related to the edge, embedded development for IoT has many unique considerations – peripheral programming, distinctive communication protocols, battery life awareness, over- the-air (OTA) updates, and tough security. Altair's model-based development (MBD) tools address these using built-in support for easy cloud or device communication, battery state-of-charge (SOC) and state-of-health (SOH) tracking, battery charge optimization, secure OTA firmware updates, and encrypted data transmission. It helps developers iterate their code fast, improve system efficiency, and reduce the embedded system attack surface. Altair Embed® allows you to develop edge applications, deploy autocodegen to an edge-based microcontroller and stream real-time data between the IoT platform and edge device using MQTT (Digital Twin applications). You can also send commands from the IoT platform back to the edge device.

**Turn Your Vision Into Reality With Altair IoT Studio**

## Device Management

Device management necessitates optimized workflows for connecting to thousands of devices, creating virtual representations of those devices, and then organizing them into logical groups. Also critical for the purpose is a secure device communication while enabling a two-way communication with devices.

Connected devices must have robust security to protect the manufacturer's valuable data, but above all, the private data of its users. Companies need to establish system-level oversight, using automatic container scans and other monitoring tools to detect security issues and ensure multitenancy security. Additionally, fine grained access control is needed to identify and correct issues at the individual device level. Internal communication between platform components should also be encrypted to provide an additional layer of security.



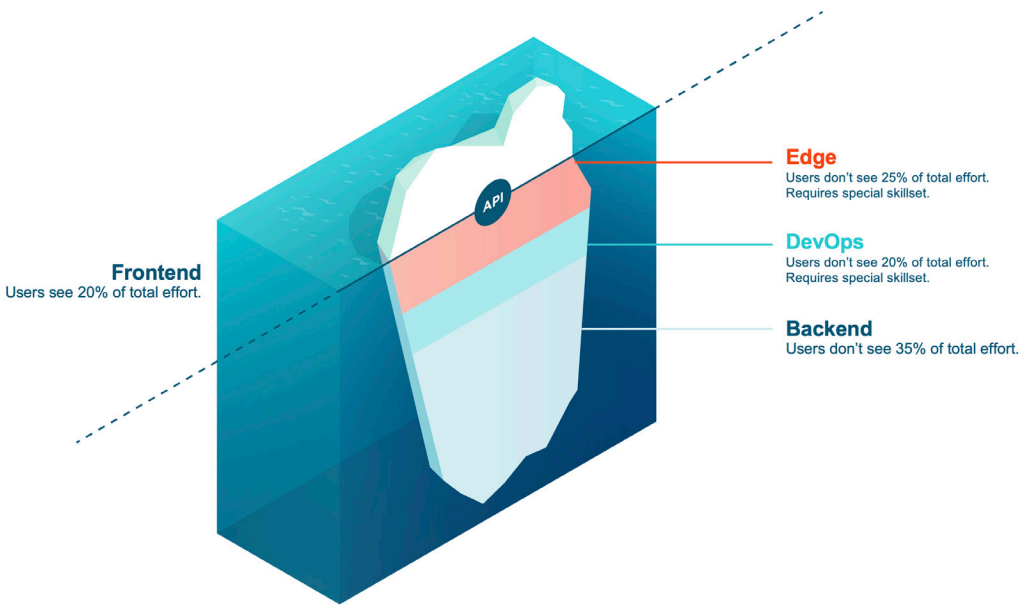

Altair IoT Studio provides a robust management interface to ensure all this while also orchestrating container workloads, coordinate event based microservice communication, and enabling secure REST communication with web and mobile apps. With EdgeOps, containers are easily packaged, lightweight, and designed to run anywhere, from small footprint devices to industrial applications. Multiple containers can be deployed in a single cluster, allowing for scalability and optimal hardware selection.

Spend less time on busy work – instead, accelerate your provisioning process so you can focus on providing the best possible experience to your customers.

**Turn Your Vision Into Reality With Altair IoT Studio**

## Building Applications

Software development for creating smart products is a complicated affair with almost 80% of the effort hidden in the back-end while only 20% gets noticed by the users in the front-end.




In smart product solutions, data events from devices, user actions in applications, database updates, and other events trigger automation. Traditionally, these automation actions typically necessitate provisioning servers, writing and deploying code to those servers, building an API to access the code, and maintaining the whole infrastructure to make sure it runs efficiently. All the effort that goes into development on these back-end tasks risk taking away time and energy for building end-customer features.

Instead what smart product developers need is that your users and employees find new value through mobile and web applications; thereby requiring full control and flexibility on the front-end to build best in class applications. The end goal of smart product manufacturers is to develop solutions that provide seamless experiences between connected products and the application, and allow users to easily understand the products ecosystem.

All this while the back-end should be securely taken care of ensuring the smart product manufacturers require fewer skills there, warrant smaller teams, and with scalability and security taken care of; while providing the power of faster iterations and flexibility and ease of configuration to deploy applications.

To begin with on the **application back-end**, smart product developers require a digital model of the world that their applications can interact with, and which comprises of physical entities – including devices, assets, users, and spaces. It also includes logical entities such as work orders, tasks, processes, and any other entity that should be analyzed, automated, or considered part of the smart product development solution.

**Turn Your Vision Into Reality With Altair IoT Studio**

A specially designed, flexible, secure **ModelDB** to capture, and access metadata for devices, processes, users, tasks, spaces, or any other entity which forms part of the application takes care of this connection. It forms the backbone of the application, providing context to analytics and a digital twin to applications. A built-in fine-grained access control over entities would make data access easy, and data flow decisions simple.

To develop the application logic, **Functions** serve an important purpose in enabling developers write and deploy code without provisioning servers or building an API while ensuring the code runs efficiently. Also important is the flexibility that developers require to write code in any language and deploy to infrastructure automatically - triggering code based on HTTP requests, device, database, and platform events and schedules, and automatically scale and optimize the infrastructure. These tools should also extend to implementation of artificial intelligence models, as well system models and physics models to build digital twins.

Next on focus should be the raw data emanating from devices which can be sometimes inscrutable, rarely where they need to be, and data from one network are almost never formatted the same as another. It is incumbent to solve these problems using a drag-and-drop interface and as little code as you want. Altair IoT Studio helps transform and join data streams, add calculated columns, execute artificial intelligence models, send alerts, convert values, and connect to dozens of different sources or destinations all on live, streaming data – all using point and click, **real-time stream processing**.

With data streaming in terabytes thanks to thousands of devices used in telemetry and reporting in every minute, optimized **RealtimeDB** helps to efficiently, appropriately, and securely manage the data to ensure that right insights are available at the right time.

With data now available in real-time and historical data sources, developers **require data prep and artificial intelligence** tools to extract actionable information in a code-free, secure environment that supports automated data discovery, data transformation, AI, and visualization leading to make accurate predictions about component life, replacement requirements, energy use, maintenance, utilization, and other factors that directly impact quality, sales, customer acceptance, and efficiency. With advancements in data analytics and optimization technologies, it is now easier to streamline operations and / or improve product performance.


On the **application front-end** Real-time data is a huge differentiator but building truly real-time visualization can be difficult. Required are **real-time dashboards** that offer down to-the-second, automatically updating charts complete with anomaly detection and user feedback functions. Many dashboard tools claim real-time capabilities, but smart product manufacturers need to take care in selecting a tool that delivers on its promises. It should be built to be truly real-time and embeddable; and where you can see the data how you want, where you want, and fast enough to act quickly.

**Socomec Customer Story**

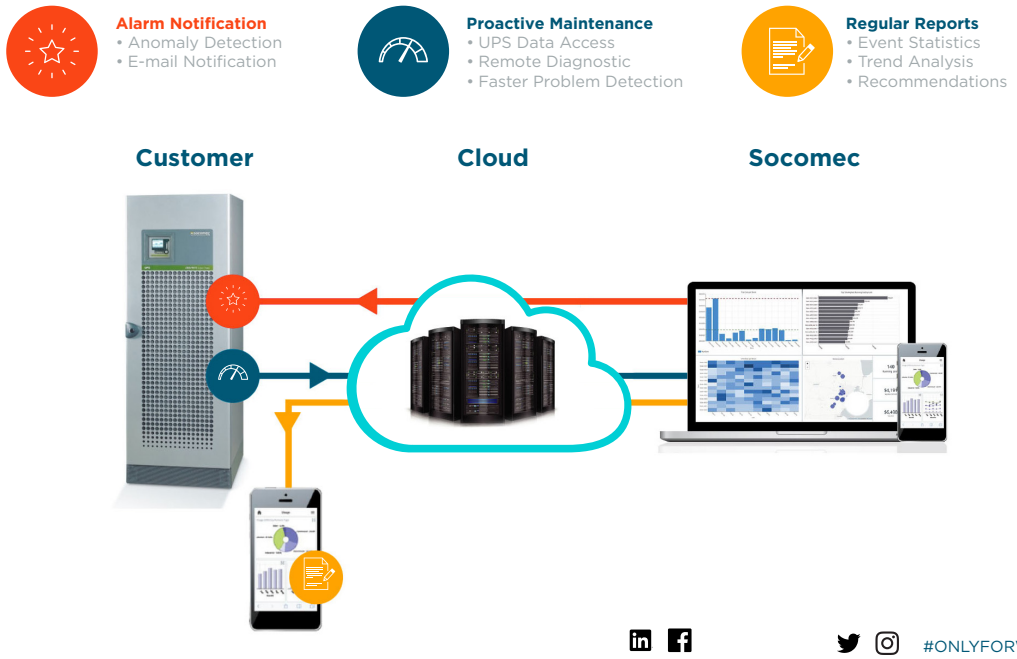
Energy hardware company, Socomec, wanted to connect their uninterruptible power supply to report status and operation data, both remotely and wirelessly on site, for streamlined monitoring and maintenance.

Altair IoT Studio was leveraged as the IoT backend for Socomec's new mobile and web user interface. This allows them to connect all their production devices, manage users, query data, and manage the status of their devices through alerts and monitoring.

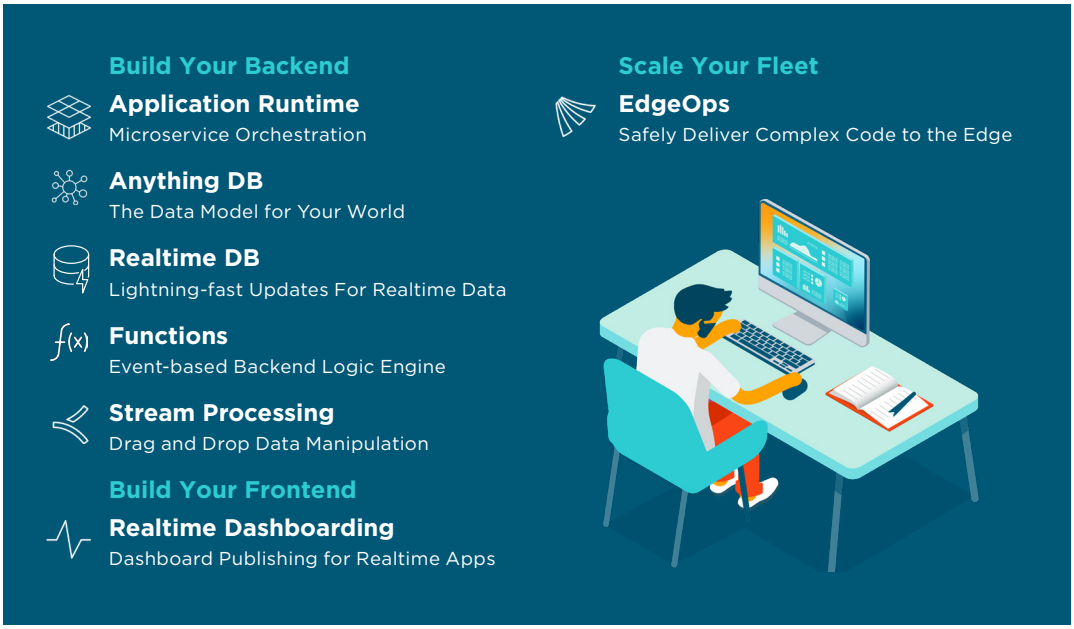
Read the Socomec Customer Story

**Outcomes**

- Faster time to market.
- Smaller software development investment.
- New revenue opportunity through new product line.
- Immediate scalability.



## Altair IoT Studio




Low-code IoT application development platform

An Edge Ops and a low-code application development platform in one - built for developers' existing workflow; making it one of the most flexible tool sets for IoT based smart product development applications.

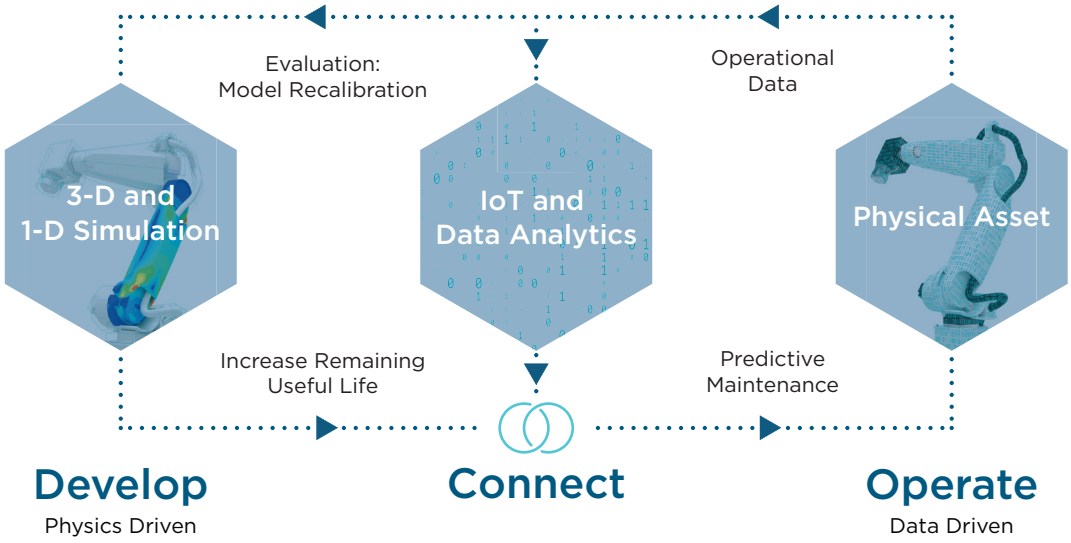
For a free trial of Altair IoT Studio, please visit swx.altairone.com.

# BUILDING DIGITAL TWINS

The logical extension of smart product development is, of course, the digital twin. A digital twin is essentially a digital model or a virtual replica that connects to a real life asset, mimicking its every action. This pairing of the real and virtual worlds allows for remote monitoring of the asset, an understand of its behavior in its operational environment, and enables analysis of the in-field data by using physics-driven and data-driven models. The smart product development process accounts for the design, connection, and analysis that can eventually be leveraged for digital twins.

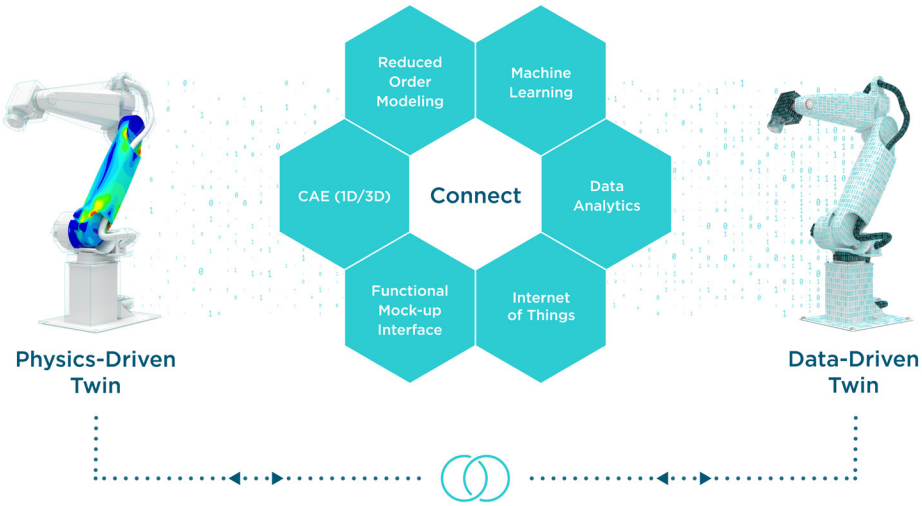
Digital twins help organizations optimize product performance, gain visibility into the in-service life of a product, know when and where to perform predictive maintenance, and how to extend a product's remaining useful life (RUL). The Altair digital twin integration platform blends physics- and data-driven twins to support optimization throughout the product's lifecycle, taking a complete, open, and flexible approach that enables digital transformation vision on your terms.

On the production front, digital twins improve your asset's performance, efficiency and remaining useful life. They are a digital window into your asset's operation, applying physics and machine learning in real time so you can gain otherwise inscrutable information into behavior then translate it directly to action. This reduces the cost of operation, avoids production stoppages from catastrophic failures, and extends the working life of individual assets.



While digital twin's usefulness is unquestioned, their effective implementation can be difficult – every problem to be addressed with a digital twin needs a different approach to find the optimal solution. Altair addresses this complexity through a unique blend of physical simulation methods, data analytics, and machine learning techniques to provide a complete picture of the status of a product in the real world. Our approach can help you add virtual sensors where physical sensors are impossible, intuit maintenance needs ahead of catastrophic breakdowns, and optimize test rig performance - all using the same toolset.

Learn More About Altair's Digital Twin Offering




Altair IoT Studio is integrated with Altair's market-leading simulation and data analytics platforms, so you can realize true digital-twin strategies that leverage real-time operational device data. This level of integration ensures you reduce your product development time and lower costs throughout the entire product lifecycle from concept design to in-service operation.

Learn More About Altair's Simulation Offering
Learn More About Altair's Data Analytics

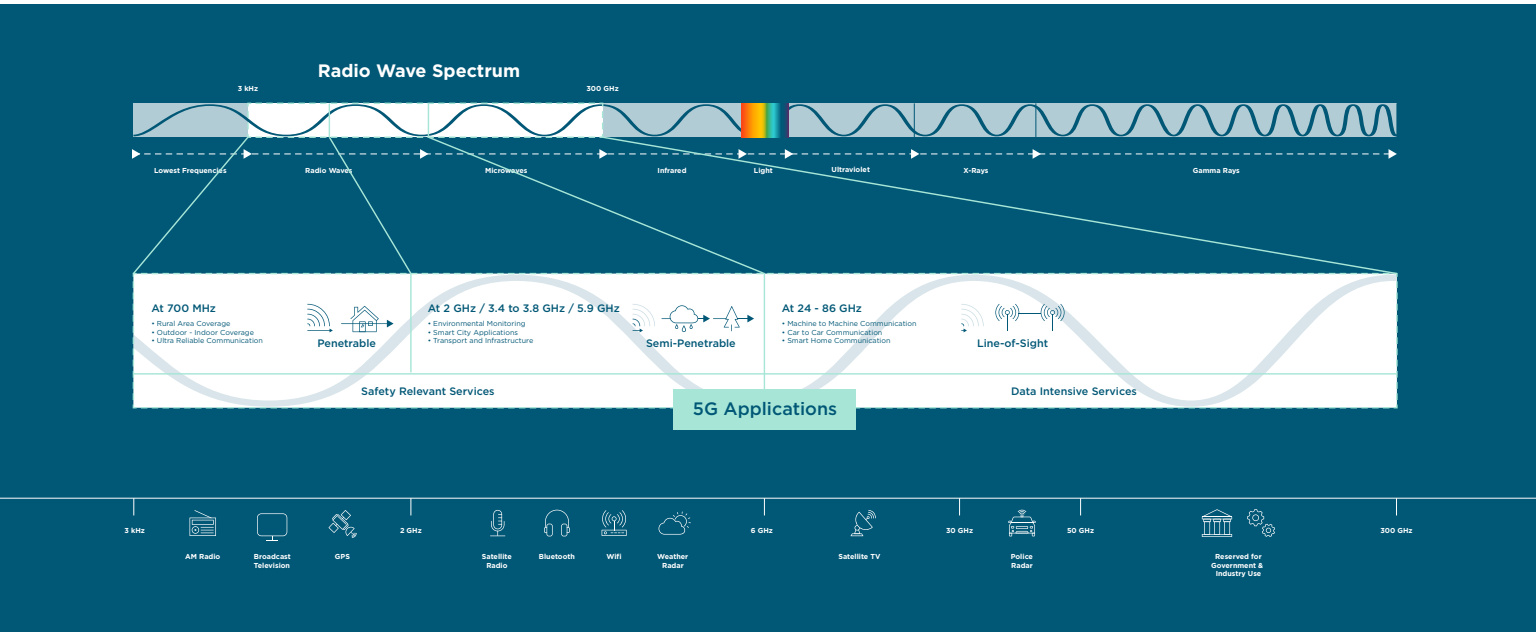
# WIRELESS CONNECTIVITY

Simulation can help product designers to optimize the deployment of wireless networks based on radio coverage and capacity and ensure wireless connectivity and compatibility by leveraging spectrum management wireless coverage tools.

Previous advances in wireless technology have primarily focused on consumer mobile phone communication, but the 5G revolution will also be a central player in the development of the factory of the future. With low latency, high reliability, and time sensitive networks, 5G opens up exciting possibilities for industrial IoT applications.

Meeting the promises of reliable and efficient communications, however, brings new challenges to the design of 5G products. 5G connectivity requires high throughput, low latency, and exceptional coverage at a reasonable cost, all while reducing energy consumption. As networks and applications grow, the precise simulation of antennas in their environment is the key to developing the next generation of broadband products. Altair 5G simulation solutions support and enable the innovation and deployment of wireless connectivity technology improving communication, assuring compatibility, and reducing energy consumption and emission.

Altair's electromagnetics analysis tools allow teams to optimize wireless connectivity, including 5G, ensure electromagnetic compatibility (EMC), and perform radar cross section (RCS) and scattering analysis. From antenna simulation and placement, radio coverage, network planning, and spectrum management, to electromagnetic compatibility (EMC/EMI), bio-electromagnetics and RF devices, Feko combines with other Altair tools to optimize system performance through machine learning and reduce modeling time for complex systems to ensure every device is communicating efficiently, every time.



### Simulation-driven 5G Solutions

To deliver the increased speed, low latency, and other benefits promised by 5G, telecom system integrators, engineers, and consulting companies must have efficient 5G development tools.

Altair provides integrated simulation of 5G antennas and 5G networks, that help to understand the use case, define the requirements for the 5G infrastructure, and create a usage plan to apply for the frequency spectrum. Taking a holistic simulation approach, network planners avoid interferences upfront and prevent radio wave leakage in surrounding areas.

### Coexistence and Interference Issues

With coverage, propagation, and network analysis software, engineers can examine how the device's antenna signals will interact with other electromagnetic signals in its environment. Just in a household alone, there could be Bluetooth and WiFi signals from phones, TVs, speakers, and computers, LTE signals from phones and tablets, and increasingly, Zigbee signals that are often used in smart devices like lighting, thermostats, and security systems. Careful planning is necessary to avoid interference issues that might severely hamper the performance and perceived quality of your smart device.

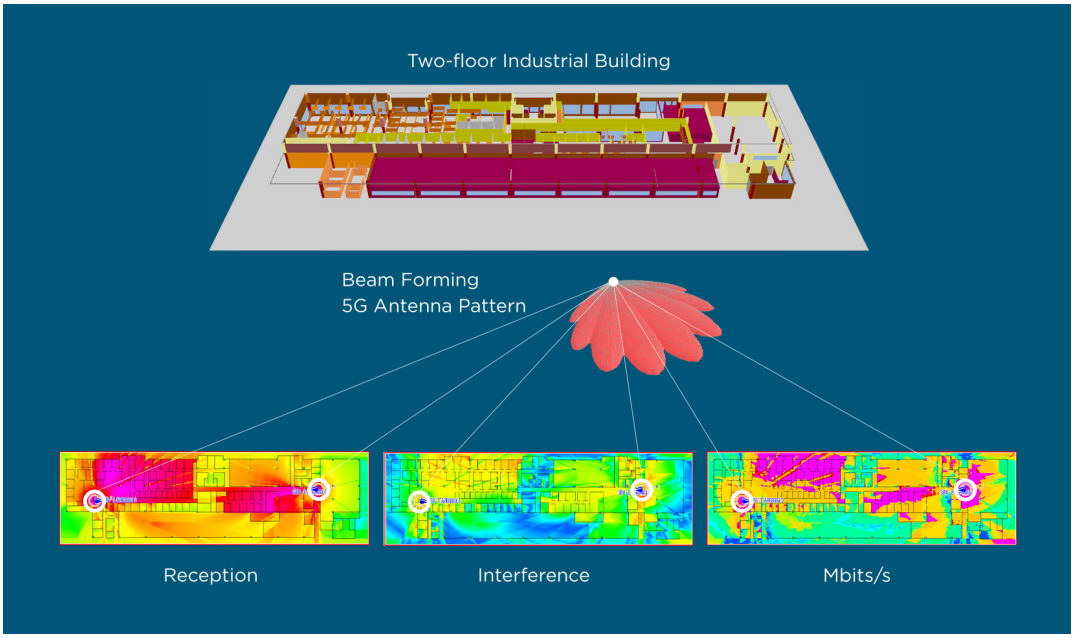
Wireless electronic devices often support both Bluetooth and Wi-Fi connectivity. The 2.4 GHz Wi-Fi frequency band is very close to the Bluetooth operating frequency, so the coexistence of these two technologies within the same device can often lead to interference issues.

Watch Solve Coexistence and Interference Issues in Smart Devices Using Altair EM Solution

### Getting 5G Regulatory Approvals Faster

How can you actively drive the network license application process, to realize 5G applications quicker? Altair enables optimized 5G network planning in complex environments like urban outdoor-indoor scenarios. The possibility of exact representation from single antennas up to complete systems interacting with their infrastructure and environment allow a unique prediction quality and efficient network realization.

The openness of Altair's 5G network simulation tools allows for a smooth integration into existing planning environments. With integrated empirical wave propagation models, we can help accelerate the network license application process.




### Device to Device Communication

Altair accelerates the development and integration of device-to-everything communication, allowing for better management of integration aspects, reduction in complex tests, better planned test runs, and lower development costs.

Altair provides the most comprehensive virtual test drive for 5G connectivity. The possibility of exact representation from single antennas to complete systems, as they interact with the device structure and environment scenarios, allows for a unique prediction quality and efficient design of wireless applications.

### 5G Infrastructure Development

A 5G revolution is only possible with an extended communication infrastructure. The holistic representation of massive MIMO antennas within a network can significantly improve antenna designs, all while reducing development time, ensuring faster application integration, and better device characteristics. Such automated design processes accelerate the path to innovation, reduce testing and measuring campaigns, cut development costs, and speed time to market.

With Altair's open environment solutions, integration with proprietary tools allows for seamless and accelerated development processes. Combined with optimization technology, automated design processes accelerate the innovation path and reduce the time to market.

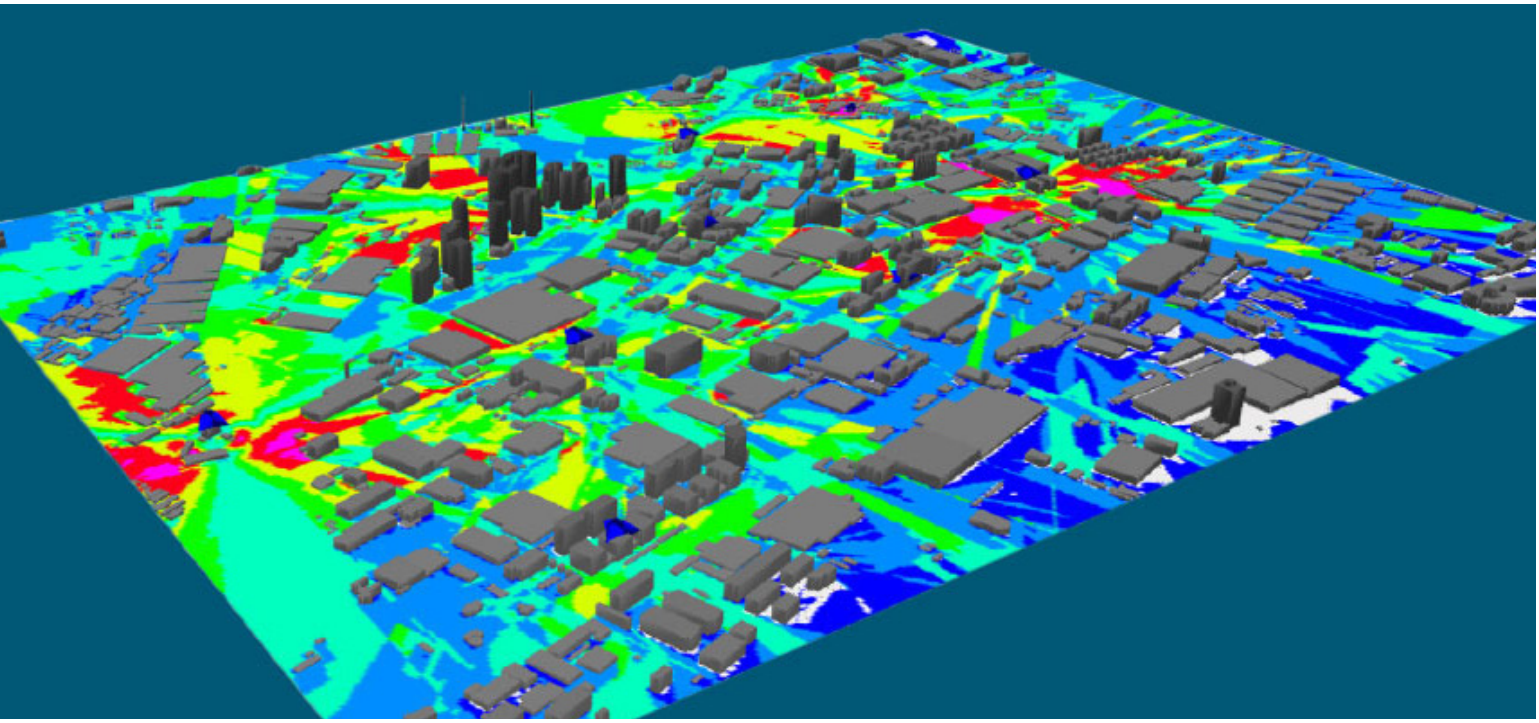
### Ubiquitous Network Coverage

Reduce the number of time-consuming tests and measurement campaigns in the field. Measurement campaigns become more meaningful with the preliminary and follow-up evaluations using Altair simulation. In operation, the required speeds and data rates are ensured for all users.

Accelerate your 5G radio coverage analysis and evaluation with Altair 5G simulation software. Plan and optimize 5G new radio networks considering different existing and new scenarios and business cases.

Altair supports your planning phase, allowing you to quickly and easily simulate countless scenarios. Altair's 5G simulation tools uniquely combine antenna design with radio coverage and planning analysis and provides the broadest set of scenarios for 5G applications.

Interested in antenna design on the device?
Read the Guide to Electronic System Development



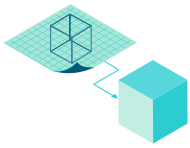
# WORKING WITH ALTAIR

Altair has the knowledge and technology to help you realize your Smart Product Development vision from beginning to end – from ideation, to optimization, to launch and operation.

Altair's simulation-driven design solutions deliver a smarter approach to electronics product development, addressing challenges and infusing optimization into all aspects of the development process from PCB design to packaging and manufacturing feasibility. Combined with Altair's electronic system development software, mechanical and multiphysics optimization tools, and design for manufacturing technology, users have a comprehensive package of solutions to develop innovative, high-quality smart products faster and more cost-efficiently.

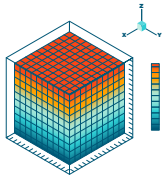
If you're interested in the electronic system development process, including the design of electronic hardware and firmware, as well as the sensors, actuators, and antennas on the device, download the Guide to Electronic System Development: Rapid product development for smart connected devices
Learn More About Altair's Smart Product Development Offering

### 1 Product Design



- CAD Studio
- Generative Design
- Rapid Prototyping

### 2 Product Engineering

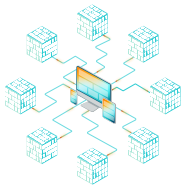


- EM Wave Simulation
- Electric Motor Simulation
- Topology Optimization
- PCB Simulation
- Manufacturing Simulation
- Motion Simulation
- MBSE/Multi-physics

### 3 Embedded Development

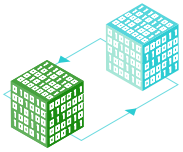
- Embedded IDE
- Code Generation
- HIL Simulation
- RTOS
- Edge Orchestration

### 4 Software Development



- Device Management
- Data Storage
- Stream Processing
- REST API
- User Access Control

### 5 Continuous Improvement



- Real-time Dashboards
- ML Model Training
- ML Pipeline Deployment

Altair is a global technology company that provides software and cloud solutions in the areas of product development, high performance computing (HPC) and data analytics. Altair enables organizations across broad industry segments to compete more effectively in a connected world while creating a more sustainable future.

To learn more, please visit www.altair.com