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Smart Connected Products: The New Normal of Product Interaction

Discover new opportunities for your business with latest insights from our international Smart Connected Products experience.

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Smart Connected Products

The advancement of digital technologies like cloud, internet of things and artificial intelligence has in the past years led to the integration of connectivity, software functions, and data collected in a wide range of electro-mechanical products, from small consumer devices to large manufacturing machines - turning them into so-called Smart Connected Products.

The white paper takes a closer look at the emergence of Smart Connected Products, which has led to a reference architecture in their supporting ecosystems.

The first part of this white paper concludes by introducing a maturity model to help companies benchmark their capabilities. The second part focuses on the business implications of Smart Connected Products, and it introduces key components of business models, which are illustrated by successful examples in the market.

Finally, the white paper summarises the business perspective by discussing 10 strategic decisions originally identified by [Porter et al.]. and outlines NTT DATA human-centric viewpoint design sprint approach specifically focused on Smart Connected Products.

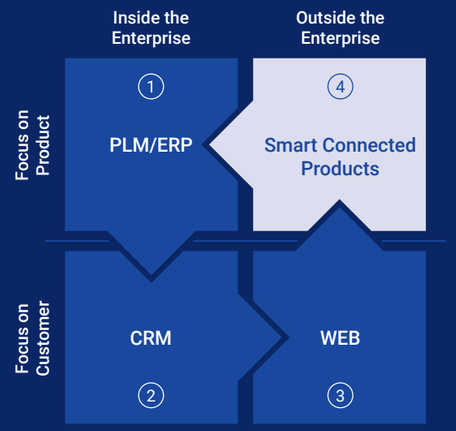
Introduction

The role of Smart Connected Products in the IT landscape

Smart Connected Products are the missing link from the customer back into the enterprise. Over the years, organizations 'internal IT systems were increasingly aligned towards the customer with CRM systems being implemented and web-sites and portals being established. However, the feedback loop back from the customer using the product was often not available or could only be guessed from service requests and verbal feedback via sales and field service teams.

With Smart Connected Products the customer using the product can be closely observed and the value of the product for the customer can be increased over time by relevant product enhancements. In doing so, vendors can evolve their transactional relationships with clients towards a continuous stream of delivered value.

Smart Connected Products as Missing Link - From a transactional to a continuous relationship with customers



Definition of Smart Connected Products

Smart Connected Products (Smart Products) are products, equipment and other things that are typically electro-mechanical systems often provided with processors, sensors, software and connectivity that enable data exchange between the product and its environment, the manufacturer, the operator/ user and other products and systems.

Connectivity also enables some of the product's capabilities to be present outside the physical device, in what is often known as the product cloud. The data collected by these products can then be analyzed to support decision making, enable operational efficiencies and continuously improve the performance of the product.

The impact of Smart Products

When taking a closer look at the impact that Smart Products have on business, we first see the benefits in operational efficiency:

- **Enhanced functionality**, e.g. by delivering new product features through software updates.
- **Improved maintenance**, e.g. by failure prediction and remote maintenance.
- **Optimised lifecycle**, e.g. by using product data from the field to optimise the design of newer generations of the product.
- **Direct feedback from the customer**, e.g. learn about who the customer uses the product and manage the customer lifecycle accordingly.

However, the impact of Smart Products reaches beyond improved operational efficiency and can help a company redefine its strategic positioning in the market by leveraging cross- and up-sell potentials:

- **New value propositions**, e.g. by providing customers with data and intelligence about the product usage so that customers can optimise their usage of the product.
- **New products and services**, e.g. by creating digital companion products which can be offered on a subscription basis.
- **New business models**, e.g. by not selling the product but shifting to a pay-per-use subscription and
- **New partnerships**, e.g. by tying a physical product to a digital eco-system.

The realisation of these benefits requires the development of a successful Smart Product and that in turn means companies have to acquire a new set of skills:

- **Human Centred Design**: Technology does not add value per se. Rather product developers need to understand the situation of their customers. With methodologies from human centered design, like empathy maps, this understanding can be developed and new product designs can specifically address the pains and gains of the customers.
- **Business Model Design**: Understanding humans is however not enough, also the business model needs to be scrutinized. Are customers still willing to invest in the product or is the product just a means to an end, which can be more attractively priced as a service? A competitive advantage often results from the combination of new technology with a new business model.
- **System Architecture**: To combine traditional design and development of electro-mechanical products with software requires new approaches to system architecture, where the traditional product development process needs to be combined with the agile software development process and aligned with Systems Engineering practices.
- **Agility**: The design and development of Smart Products requires agility beyond agile software development. Especially when new business models are tested or new customer segments addressed, a fast feedback loop needs to be established so that issues with the product-market are identified and corrected as soon as possible. At the same time, the often diverging lifecycles of software and hardware need to be synchronised.
- **Security**: The more connectivity a product provides, the more attack vectors for hackers exist. Hence, Smart Products need to be designed with defense-in-depth in mind. Anomalies in the operation of the product need to be identified and over-the-air software updates need to be used to patch vulnerabilities as soon as they have been identified.
- **Artificial Intelligence (AI)**: With more data becoming available from sensors and user interactions, the functionality of Smart Products can be increasingly implemented using artificial intelligence. For this, data engineering and data science capabilities need to be developed in the respective product domains and a proper lifecycle management for training, testing, deploying, and operating the AI models need to be established.

NTT DATA has developed a self-evaluation where companies can assess their skills and gain insights on how to become more mature in the development of Smart Products.

Example: FANUC and NTT increase productivity of manufacturers

In a unique co-creation approach NTT and FANUC developed the FIELD platform to connect various production devices and sensor data from manufacturing sites with business applications. The platform enables customers and application developers to utilize sophisticated machine learning to bring about further productivity improvement and efficiency in the manufacturing industry.

Today, NTT DATA acts as an integrator and application developer for the FIELD system so that customers can link the system with their existing devices and business applications.

For further details check **FANUC 2016**.

Smart Product Maturity Model

To guide the evolution and extension of Smart Products, NTT DATA has developed a maturity model: the NTT DATA Smart Product Maturity Index (SPMI).

The model is also used to benchmark Smart Product offerings in the market.

The maturity dimensions and levels for Smart Products are defined as follows:

	CONNECTABLE	OBSERVABLE	CONTROLLABLE	ADAPTABLE	INTELLIGENT
Functionality	Update	Monitor	Control	Optimize	Autonomous
	Functionality can be updated, e.g. through software update	Functionality can be monitored in real-time (one way data flow)	Functionality can be monitored and controlled in real-time (two way data flow)	Functionality is controlled by a closed feedback loop (two way data flow with feedback)	Recognises scenarios or situations and adjusts functionality accordingly
Adaptability	Configuration-based	Rule-based	Data-based	Model-based	Self-learning
	Product can be adjusted using a fixed set of configuration parameters.	Product can be adjusted using a flexible set of stateless rules	Product can be adjusted using dynamic rules based on data	Product can be adjusted using a trained model	Product can self-adjust based on the past usage
Connectivity	Off-line connection	Online connection	Internet connection	Self connection	Self discovery
	Data exchange requires physical access	Data exchange through a dedicated line	Data exchange through a general purpose internet connection	Data exchange is possible without further configuration (zero touch provisioning)	Data can be exchanged with a dynamic set of communication partners without further configuration

	CONNECTABLE	OBSERVABLE	CONTROLLABLE	ADAPTABLE	INTELLIGENT
Human Machine Interface	Switches and lights	Display and keyboard	Software controlled	Mobile controlled	Augmented reality
	Humans interact with electro-mechanic controls	Humans interact with electronic controls	Humans interact by means of a desktop software	Humans interact by means of a mobile app	Humans interact with controls presented through augmented reality devices
Topology	Point-to-point	Hub-and spoke	Distributed	Mesh	Decentralised
	Connection with only one dedicated counterpart	Connection with multiple counterparts through a central hub	Connection with multiple counterparts through orchestration services	Connection with multiple counterparts through dynamically established mesh structures	Connection with multiple counterparts spread across organisational boundaries
Security	Obfuscated	Protected	Updated	Observed	Self-defence
	Intransparent communication protocols to hide information	Secure communication protocols to protect information	Software updates to address security vulnerabilities in the field	Anomaly detection to observe malicious activities in the field	Active response for protection and counterattack when malicious activities are observed in the field

Smart Product Business Model

While technology is a key enabler for Smart Products it is the new business model opportunities that really matter. To understand what it takes to develop a successful Smart Product, NTT DATA has developed the business model canvas template below.

The items on the canvas can be used to judge the readiness of the organisation for the successful development and launch of a Smart Product. It is worth noting that some of the items can have far-reaching consequences. For example, a "direct 'link' to the customer" can mean that for products which are distributed through wholesale or retail a direct contractual relationship between the vendor and the customer needs to be set-up and in case of further monetization of services around the Smart Product additional systems for billing, payment, and customer service need to be set-up.

Furthermore, existing sales channels may require significant investments as Smart Products may require new skills for sales and service. Often such skills reach beyond the capabilities of field service personnel so far mainly concerned with electro-mechanical products.

Smart Product Business Canvas Template - Building blocks for smart business models

KEY PARTNERS	KEY ACTIVITIES	KEY RESOURCES	CUSTOMER RELATIONSHIPS	KEY SEGMENTS
• Clound vendors • Software vendors • Industry consortiums • Eco system/ API owners	• Software design & dev. • Software operations • Security operations • Data analytics • Product development • Lean start-up	• Software engineers • System engineers • Security engineers • Field service engineers • Software and subscription product manager • Machine learning models • Product data • External data • Industry Standards	• Direct "link" to the customer • Recurring transactions/ relationship • Insights in product usage	• Direct customers • Wholesale customers • Security engineers • New customer segments (e.g. interested only in data, integrators)
	VALUE PROPOSITIONS • Data driven insights (and other operational efficency) • Pay-per-use • Insurance		**CHANNELS** • Indirect (traditional wholesale) • Direct (traditional salesforce) • Direct (APIs, data, services)	

COST STRUCTURE	REVENUE STREAMS
• Clound operations • Security operations • Consulting • Professional Services	• Upgrades (innovations) • Subscriptions (insights) • New services (insurance)

Smart Product Reference Architecture

It is unlikely that Smart Products will immediately reach the highest levels of maturity right from the start. As a result, it is of utmost importance that the early versions of the products are supported by an architecture that allows for a constant evolution and expansion of the capabilities.

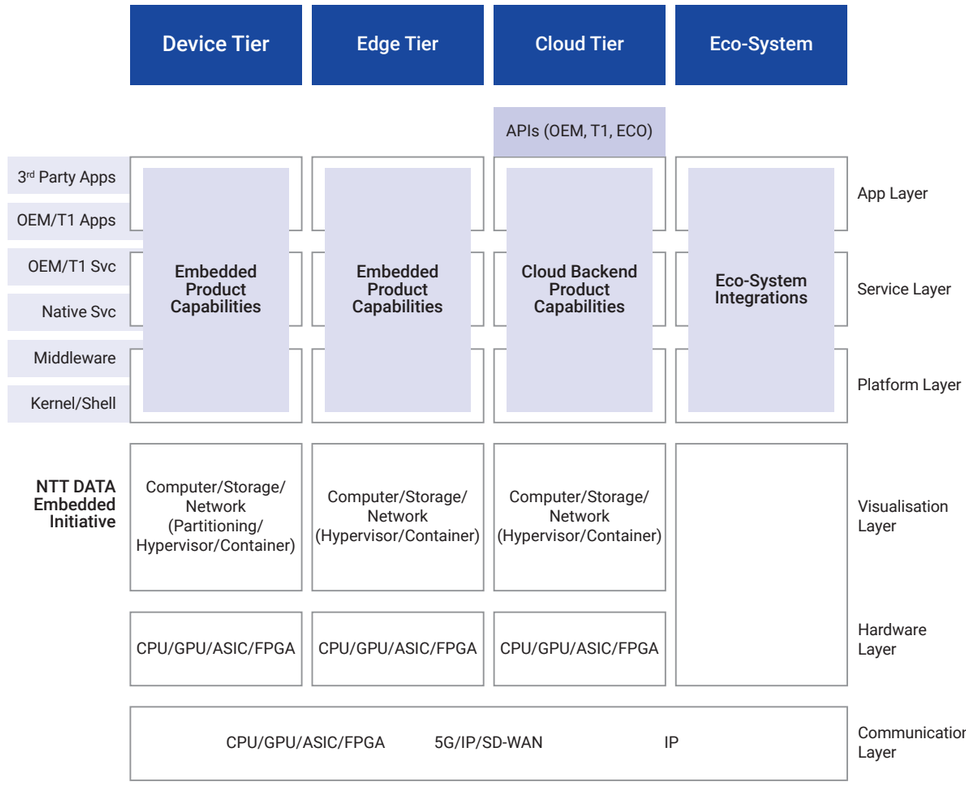
For this purpose, NTT DATA has developed a reference architecture for Smart Products comprising four architectural tiers:

- **Device Tier:** computing resources, which are directly embedded in the product and allow for real-time processing and have to consider limited scalability of embedded resources (processing power, memory size).
- **Edge Tier:** computing resources, which are deployed in the field in close proximity to the device and allow for near-real-time processing. Edge resources follow the same architecture as cloud nodes with some limitations around storage and allow to run small private cloud instances which can be used to aggregate data, implement store and forward mechanisms, or perform other resource intensive tasks.
- **Cloud Tier:** virtually unlimited scalability of compute resources and storage for long-term storage of data, training of machine learning models, management of fleets of devices, or facilitation of remote access. The main limitation of the cloud tier is the bandwidth, latency, and availability of the network connection to the devices.
- **Partner and Ecosystem Tier:** in addition to the cloud tier operated and maintained by the device vendor, the ecosystem tier allows the connection to partner services like marketplaces, payment services, or smart environments (factories, cities, transportation).

To be successful in the market and effectively support a wide range of business strategies and model (see next chapters), the Smart Product needs to support two integration approaches with partners and eco-systems:

- **Outside-in strategy:** the customer brings her own services and data to the Smart Product to increase the value when using the product. For example, instead of developing a custom payment service for subscriptions around the Smart Product, an existing payment service (e.g. PayPal) can be used.
- **Inside-out strategy:** the product vendor brings services and data of the Smart Product in wider eco-systems to increase value and revenue. For example, instead of trying to develop their own smart home services, a consumer device can provide interfaces to existing smart home ecosystems (e.g. Alexa).

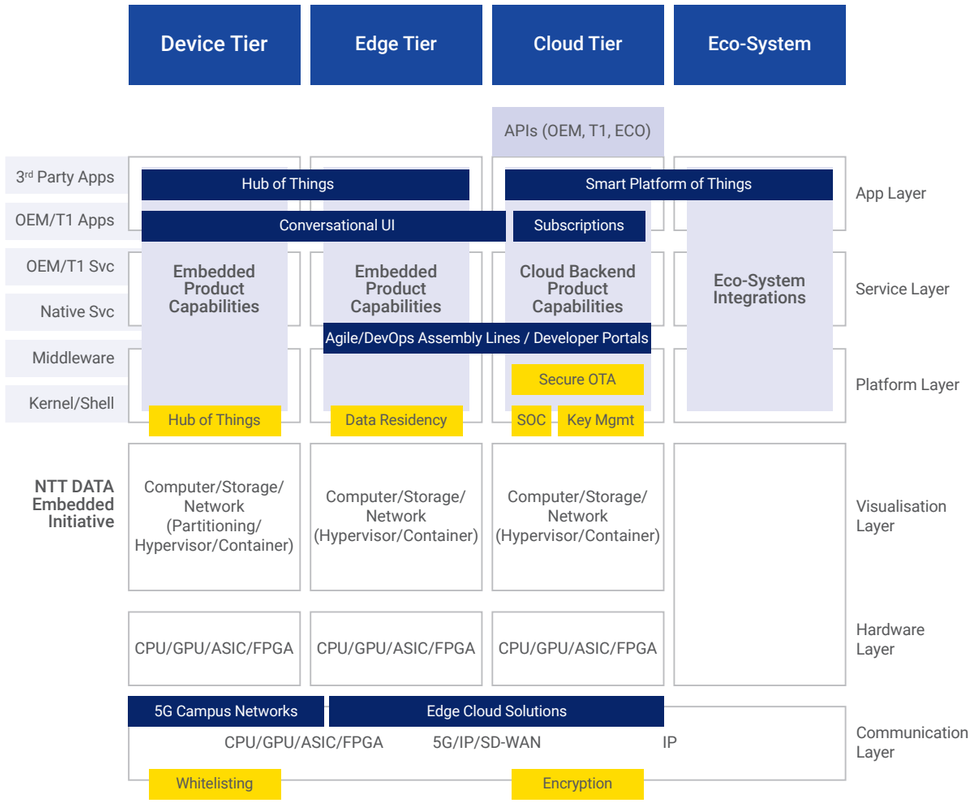
Reference Architecture - Standardisation and flexibility through APIs and virtualisation



Assets and Services for Smart Products

NTT DATA is ranked as a leader by analysts in the "Internet of Things" segment and provides assets and services to effectively and efficiently implement Smart Products in alignment with the reference architecture.

Assets for Smart Products - A comprehensive toolbox for solving real world problems



These assets have been developed over many years in IoT projects across our business and provide building blocks for the development, connection, and monetization of Smart Products. By using the assets, in combination with bespoke functional components, customers can develop Smart Products in an agile way (e.g. proving early prototypes on standard hardware like Raspberry Pis or Nvidia Jetson boards) and iterate fast to find the best product market fit:

- IoT Backbone (HOTSPOT): An end-to-end solution for Smart Products, which combines a multi-protocol gateway with a vendor agnostic smart cloud platform handling core functionalities like device registration, software updates, or data analytics.
  Example Use Case: HOTSPOT is already being used in many projects on a wide variety of topics. One specific use case uses narrow-band IoT on water meters in order to monitor and forecast water usage through IoT and AI solutions, control drinking water quality, and model water demand and consumption. In this project HOT interacts as multiprotocol device sources and exposes them to SPOT. SPOT as a platform has been used to solve specific IoT problems for example RT bus, storage, ingestion, digital twin, configuration, and device management.

- Conversational UI (IVE= Intelligent Virtual Entity): A framework for developing innovative conversational human machine interaction on top of multi-vendor cloud services (e.g. Google Dialog Flow, Amazon Lex or Microsoft Luis).
  Example Use Case: Our customers are using IVE as a single point of contact for a 24 hours a day automatic support. IVE enables their customers to benefit from issue resolutions or information requests through different digital channels such as chat, email, WhatsApp, voice, smart speaker for tracing all user requests.

- Subscriptions (DEMETRA): A set of cloud-native micro-services for subscription, provisioning and payment services, which also provides a highly automated development processes on top of cloud platforms (e.g. Google Cloud Platform, Amazon Web Services or Microsoft Azure) so that the solution can be extended with further cloud services for specific functionality of the Smart Product.

Example Use Case: Our customers intend to ride the possibilities offered by DEMETRA qualifying as a third party provider and act as payment initiation and account information service provider. This enables our customer from the field of mobility, to offer payment services for rental car, toll and insurance combined with Account Information Service from a single source. These great benefits such as customer experience improvement and generating more cross/up-selling opportunities.

- 5G Campus Networks: Reliable wireless communication is key for many Smart Product applications. The 5G standard allows for local installations of 5G networks, e.g. in production facilities, and NTT DATA can provide OpenRAN infrastructures which provide improved reliability, security and cost effectiveness compared to legacy RAN solutions. In comparison with today's WLAN infrastructures, a 5G campus network provides higher scalability and most importantly seamless radio cells as require by mobile devices like transportation robots.
  Example Use Case: In Ensō - The Space for Creators NTT DATA provides a 5G Campus Network which can be used as a lab infrastructure by our clients for testing 5G applications of Smart Products.

All assets follow the same design principles and are cloud vendor agnostic so that solutions can be designed with controlled vendor lock-in for cloud providers.

In addition to the assets, NTT DATA also provides services addressing the key challenges for Smart Products identified in the previous section:

- Business Design: NTT DATA's global design units under the brand of Tangity bring a human centred approach into the design of products, services, and user interfaces, so that the capabilities of Smart Products are aligned with the needs of the users and that technology and complexity do not stand in the way of a successful product launch (as it has happened many times in the past).

- Agility: In comparison with traditional electro-mechanical products, the technological possibilities for Smart Products are endless. However, this makes the upfront design very difficult, as many of the technologies need to be explored and understood during the product development and prototyping process. NTT DATA is an early adopter of agile methodologies in software projects and today implements agile methodologies as well outside the domain of software development, e.g. for critical parts of the product development process.

- Security: Smart Products are increasingly controlled through software so that cyber security is directly linked with product safety today. NTT DATA's Cyber Security division maintains partnerships with key vendors for security components and provides blueprints for solutions like secure software development, identity and secret management, anomaly and intrusion detection, and operates in cooperation with NTT Ltd., a global network of security operating centres (SOCs).

- Data Science: Artificial intelligence is a key enabler for Smart Products to respond to data and interact with the environment in a meaningful way. NTT DATA's data science team has developed the MEDUSA methodology to identify proper AI use cases and to develop, deploy, and operate the AI components over the lifecycle of the product or service.

First we shape our Smart Products, then our Smart Products shape us.

Conclusion: Strategic Choices for Smart Products

When looking at the business model canvas for Smart Products we can draw two conclusions. For one, a number of new skills and resources are required on the supplier side.

However, Smart Products open up a number of new strategic choices for companies, like new value propositions, new services, and even entirely new markets. In [Porter et al.], the strategic choices have been summarized in the following ten questions:

1 Which set of Smart Product capabilities and features should the company pursue?

2 How much functionality should be embedded in the product and how much in the cloud?

3 Should the company pursue an open or closed system?

4 Should the company develop the full set of Smart Product capabilities and infrastructure internally or outsource to vendors and partners?

5 What data must the company capture, secure, and analyse to maximise the value of its offering?

6 How does the company manage ownership and access rights to its product data?

7 Should the company fully or partially dis-intermediate distribution channels or service networks?

8 Should the company change its business model?

9 Should the company enter new businesses by monetising its product data through selling it to outside parties?

10 Should the company expand its scope?

While this set of pointed questions on the strategic options is already of great help for vendors of Smart Products, answering the questions is not always easy. Firstly, they address a very broad scope and secondly, many of the questions have interdependencies. So where to start? NTT DATA believes that the only starting point can be the user or customer of the Smart Products and we have developed a design sprint format to work from human to the business model.

Smart Product Design Sprint - A two day workshop for finding the MVP scope of Smart Products

	PROBLEM | SPACE	SOLUTION | SPACE
	Day 1 Need-Finding & Define	Day 2 Solutionise & Prototype
Morning	**Understand** Design Keynote Goals **Need-Finding** Interviews & Instant Expertise	**Sketching** Solution Napkins Heatmaps & Speed Critique / Feasibility & Viability **Prototyping Part I** Rough & Rapid
	Lunch	
Afternoon	**Synthesis** Personas How Might We Challenge **Story Mapping** User Journey / Customer Value Map Storyboards	**Prototyping Part II** Finalise Prototype / Combine Key Features **Pitching** Dry Run / Pitch Doctoring **Conclusions** Next Steps & Feedback

The design sprint starts off in the problem space, where the challenges that the Smart Product should address are explored from the perspective of the user or customer. The activities follow a "diamond shaped pattern" and firstly open up the problem space using proven creativity methods before secondly reaching a conclusion by focusing on a single key problem. From the problem space, the sprint moves on to the solution space, again following a "diamond shaped pattern", where creativity is piqued again to explore a wide range of solutions before one or two are selected and tested in a concrete prototype. The whole process is completed in a very condensed two to three day format.

ENGINEERING SMART PRODUCTS

Download NTT DATA's keynote from the Digitized Engineering Conference SYSLM 2019 which illustrates the evolution from digital product engineering to engineering of digital or Smart Products.

DIGITAL TWIN COMPUTING

So what is next after Smart Products? NTT Group invests a multi billion budget on ICT-related research and development. The latest vision of a connected world has been laid down in a white paper on Digital Twin Computing. Starting from digital twins of Smart Products as we know them today, NTT envisages a world where all the digital twins are interconnected and resemble wider ecosystems like entire facilities, supply chains or customer populations. Based on this interconnection of digital twins, new business opportunities can be identified and then proven in complex simulations, taking into account not only the individual customer or product but the whole ecosystem in which they operate.

Further Reading

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