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**A**s a follow-up to “How to Develop an Industrial Internet of Things Solution” in the Feb/March 2016 issue of *Uptime* magazine, this article introduces a series that provides further details about the approach to develop Industrial Internet of Things (IIoT) solutions. The series of articles is based on first-hand experiences of designing, developing and delivering (IIoT) services.

Each of the three articles will be dedicated to the three phases of the IIoT product lifecycle.

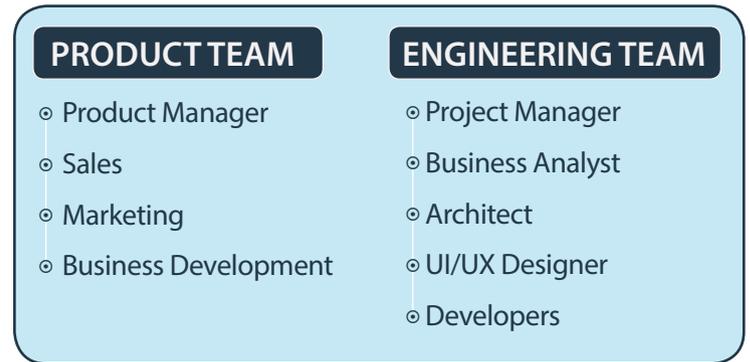
- 1 **Providing a Solution** – Starts with a new product idea and is focused on evaluating market potential for a new product concept, as well as understanding technical and managerial aspects behind developing it.
- 2 **Research and Development** – Focuses on the development of the product, its components and subsequent product releases. This phase is also used for further mastering of the business model and evaluating intermediate product versions with clients.
- 3 **Service Delivery** – Starts at the moment the first product version is made available to clients. The goal of this phase is uninterrupted delivery of the service and providing value to clients and users.

### Providing a Solution

This first article focuses on the providing a solution phase. So what is this phase all about? Well, many will say providing a solution is the most important of the product lifecycle phases. This is the phase where you must verify if your product idea matches what the market expects. You have to create a shared product vision and its prototype and, finally, you need both technical and managerial plans for the development and delivery.

Unlike the old approaches to product development, you don't need to spend too much time in this phase, around three months should do. That's because the new process assumes several iterations along the whole IIoT product lifecycle, so just spend enough time here to make an informed go/kill decision. To learn more, a good reference is *The Four Steps to the Epiphany* by Steve Blank.<sup>1</sup>

The iconography in Figure 1 presents the major steps specific to the providing a solution phase. Starting with the people and their roles, roles are usually divided into two team profiles: product and engineering.



Both teams need to work very closely together; it is crucial for working out a solution that is justified from both the business and engineering perspective.



Figure 1: Main activities in the providing solution IIoT product phase

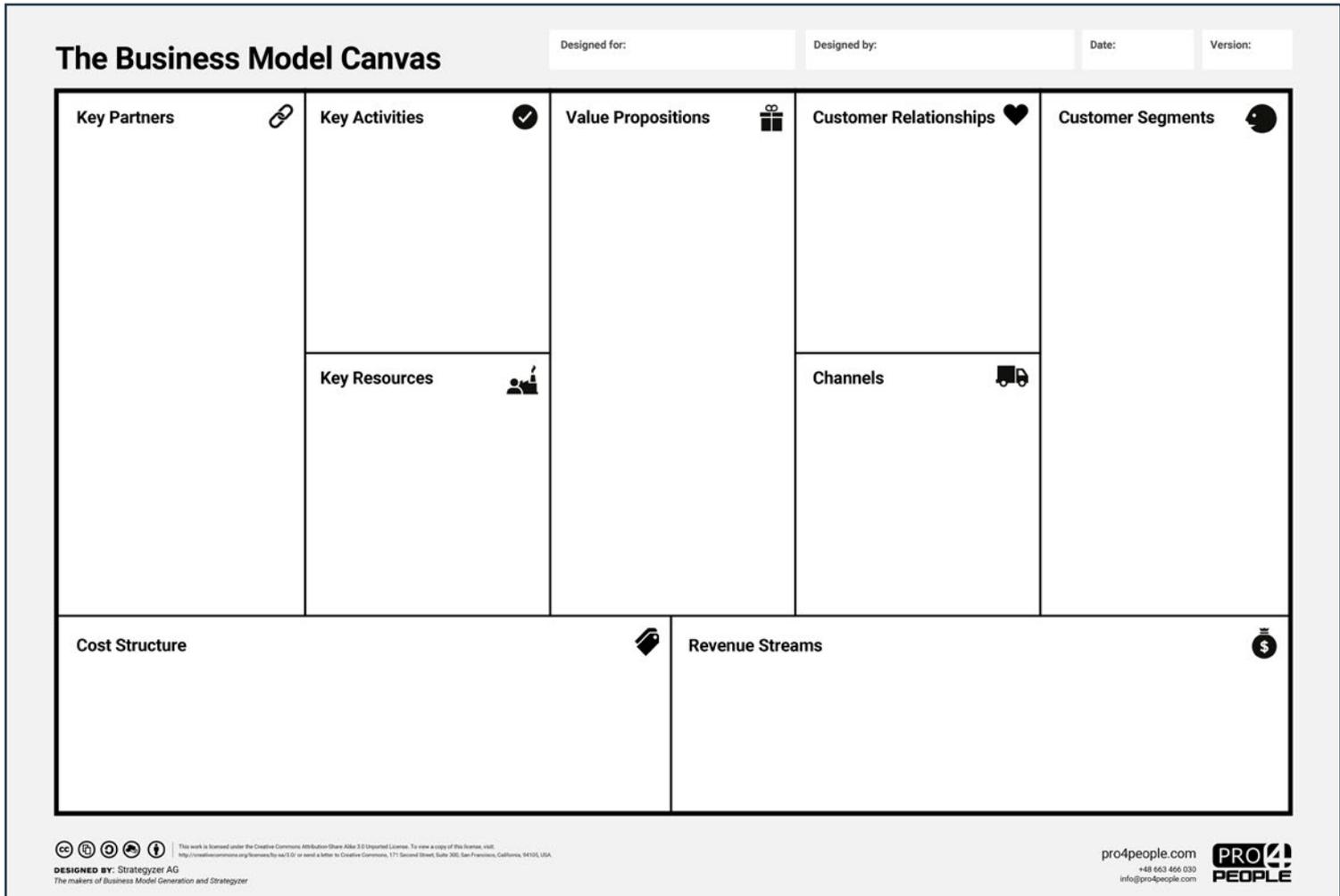


Figure 2: The business model canvas template<sup>2</sup>

### Business Model and Value Proposition

The business model and the value proposition are the most important components in the providing a solution phase. Two good tools to use are the business model canvas and the value proposition canvas proposed by Alexander Osterwalder. They usually take the form of a multi-day workshop focusing on the business model and value proposition. It is a great exercise in forging a common product vision, challenging it and sharing with the whole team.

In addition to these canvases, a documented hypothesis on your product, customers, channel/pricing, demand creation, market types and competition should be the outcome of such a workshop. For that purpose, you can use the customer discovery templates from *The Four Steps to the Epiphany*. The participation of the whole product team and representatives of the engineering team is required in order to share the product's vision.

You might think you're done when you have everything documented, but not really. The business model, value propositions and your hypotheses will be the most often challenged, updated and modified parts of your product lifecycle documents. Think of these documents as a good, solid starting point to hold direct meetings with your customers and initiate the customer development process. This ongoing activity, which should be executed along all IIoT product lifecycle phases, is represented by the spiral in the Figure 1 iconography.

### Solution Architecture

When you have your product vision documented in its first version, it's time to start working on the IIoT architectural solution. The goal of preparing a solution architecture is to propose how the product vision will be implemented in a technological dimension. Within the solution architecture, you will have to find answers to these questions:

**Edge Devices:** What type of devices will be used? Does the solution use sensors, meters, or actuators? Are you going to use one of the existing edge devices or build your own? What is the cost of such a device? Will it be running off batteries or the mains? How long is the device going to be running off batteries? What protocol will be used for communication with the backend system? How will the user perform its installation and configuration? Is the hardware device firmware going to be updated along its lifecycle? What security measures does it require?

**Connectivity:** What type of connectivity will be used to enable the edge device to communicate with the backend application? What is the security of the selected channels? What is cost of the selected channels (e.g., SIM card, Wi-Fi router)? Does the connectivity require any intermediate device, such as a gateway or mobile phone? What is the reliability of the selected channel? How much energy of the edge device's batteries is consumed by the communication system?

**Backend (Internet Services):** Where is the data from the edge devices sent (e.g., cloud service or client deployed service)? Is there a separate backend application for each client (a single tenant) or is the data separated within one system (multi-tenant)? After what time will clients expect the processed data to be available? How long should this data and information be stored and available? What is the backend application infrastructure cost? What effort does it take to make the backend application operational (service delivery)?

**Frontend (Web Browser Application):** What authentication/authorization is required? How do clients access data from the backend? How can they access the data and information? How will the data and information be presented? What web browsers are going to be supported? What other devices (e.g., mobile devices) will be used to access the data? What different levels of privileges should the users have?

**Mobile:** Which mobile clients will be used to access the data (e.g., iOS, Android, phones, tablets)? Are mobile clients used to execute preliminary configuration of the edge devices at the installation site (e.g., Wi-Fi configuration or parameter setups)? How is the mobile application presenting the dilemmas of asynchronous communication between edge devices and a mobile application?

These are just a few of the questions for which the architecture should provide the answers. It does not have to be 100 percent ready, but it should be detailed enough to enable the project manager to break down each architectural decision into a work package so the engineering team can start working on the first prototype.



## Program/Project Initial Planning

OK, you have a product concept, solution architecture and a technology stack. Now it's time to turn them into a plan of actions that will take you from where you are to the go live or product launch milestone. As you may have already concluded from the previous paragraphs, there's a lot of work to do. You will have to start a program that coordinates these projects:

1. Edge device development;
2. Backend/web applications development;
3. Mobile application development;
4. Building a service delivery team.

For this, you will need a project/program manager on board. A program management plan (PgMP) and project management plans (PMPs) should be prepared. The accuracy of the software development schedules and effort estimations will be quite low at this stage, but you still need these calculations to make an informed go/kill decision. Integration of all the projects is a very important aspect of the program/project planning. You will have three engineering teams working in parallel on the components of a single solution. Their integration should be the priority from the very first days of the project.

Another outcome of this activity is a high-level product road map for the program's duration. It should be more detailed for the next quarter. This will enable your development teams to start working efficiently while you are preparing further details with the product team.

## Technology Selection

Technology selection is another important activity in the technological dimension. Its goal is to provide a short list of technologies – a technology stack – to be used in the project. Since at this moment you already have a product vision documented in the business model and the related document and the solution architecture, you can choose those technologies that will meet such requirements.

With a conscious selection of the right technologies, you can significantly lower infrastructure expenditures, speed up development, as well as bring down its cost. Usually, these technology issues need to be addressed:

- Programming language and the technology stack for the edge device;
- Infrastructure as a cloud service provider;
- Backend programming language and the technology stack;
- Relational databases for storing processes information;
- NoSQL databases for storing a large amount of data;
- Desktop client programming language and technology stack;
- Mobile client programming language and technology stack;
- Development and continuous integration environments;
- Automatic testing technologies.

It should be stressed that nowadays there are a lot of mature and reliable technologies, such as database servers and development environments, that are free of charge. They are mature enough to be used for your product development without spending up-front licensing or infrastructure costs at this point. Another advantage of specifying the technology stack is the possibility to select an external software development company with the competencies aligned with your technology stack selection.

## User Interface/User Experience Concepts

User interface (UI) and user experience (UX) concepts are the first activity on the third main stream of the solution providing phase. The goals of this stream are to build a life prototype that will be used to verify client interest in the solution, check the technical feasibility of the assumed solution architecture and convince the business stakeholders to invest in the IIoT solution.

During this phase, users will be interacting with quite complex technical solutions. At the same time, you want to make the technology totally transparent so they can focus on the purpose of using the IIoT system (e.g., monitoring a pump's performance). Users will be interacting with various elements of the system, including:

- An edge device – installation, configuration, status identification;
- A mobile device – initial configuration, data/information feeds, notification;
- A web application – reports, summaries, complex tasks.

The purpose of the UI/UX work is to design and implement the system in such a way that users are guided all the time through various scenarios of using the system and can understand and use the system for their business purpose. It is not as easy as it sounds. There are some major challenges for the IIoT systems, such as asynchronous communication. What is that? Here's an example: With a traditional lightbulb, when you switch the light on, it lights up immediately. But to do the same with a mobile application and an intelligent lightbulb, it may take some time because of the communication schema/delay. You need to design the application in such a way that this approach is clear to users. It gets even more complicated if your measurement device communicates with the backend system only twice a day, for example.

So this gargantuan work starts right here, just a few moments before your solution prototype development.



### Prototype Solution/ Prototype Evaluation

It is the prototyping that differs the most modern IIoT development from old product management principles. With the current technology status, maturity of the available technology stacks and ready to use hardware and cloud platforms, there should be no problem with launching a first product prototype in around three months. You already have taken part in the projects where the first working systems were presented after three months or even four weeks if a backend solution was already available.

The goal of this activity is to verify your technology providers, but most of all, present the live and working solution prototype to customers and gather their feedback on your product concept. From that moment on, the business model and product concept should be the subject of continuous adaptation and readjustment to market needs. You should work with your clients on the working prototype to verify that the assumptions you made about the product really resonate with client expectations.

### Go/Kill Decision

Finally, you have come to the end of the solution providing phase. You should invite your IIoT program sponsors and both the product and engineering teams as you present the outcomes of the providing solution phase, the business model, value proposition and all hypotheses made about the product, together with the market research. Next, explain what the solution architecture is going to look like, what technologies were selected and how that will impact the final cost of the overall IIoT solution.

Present the live solution prototype proving the technological feasibility of the solution, along with the testimonials from the first meeting with clients when presenting the working prototypes.

Last, but not least, present the program and project plans, including the time, cost and resources required to execute the program.

If you have done your job well, it should be enough to take your product team to the next phase – research and development, starting with the “Go To Development” gate. If you failed, don’t worry. IIoT will surely come with another project to your organization and you have just gained a lot of experience to get ready for it.

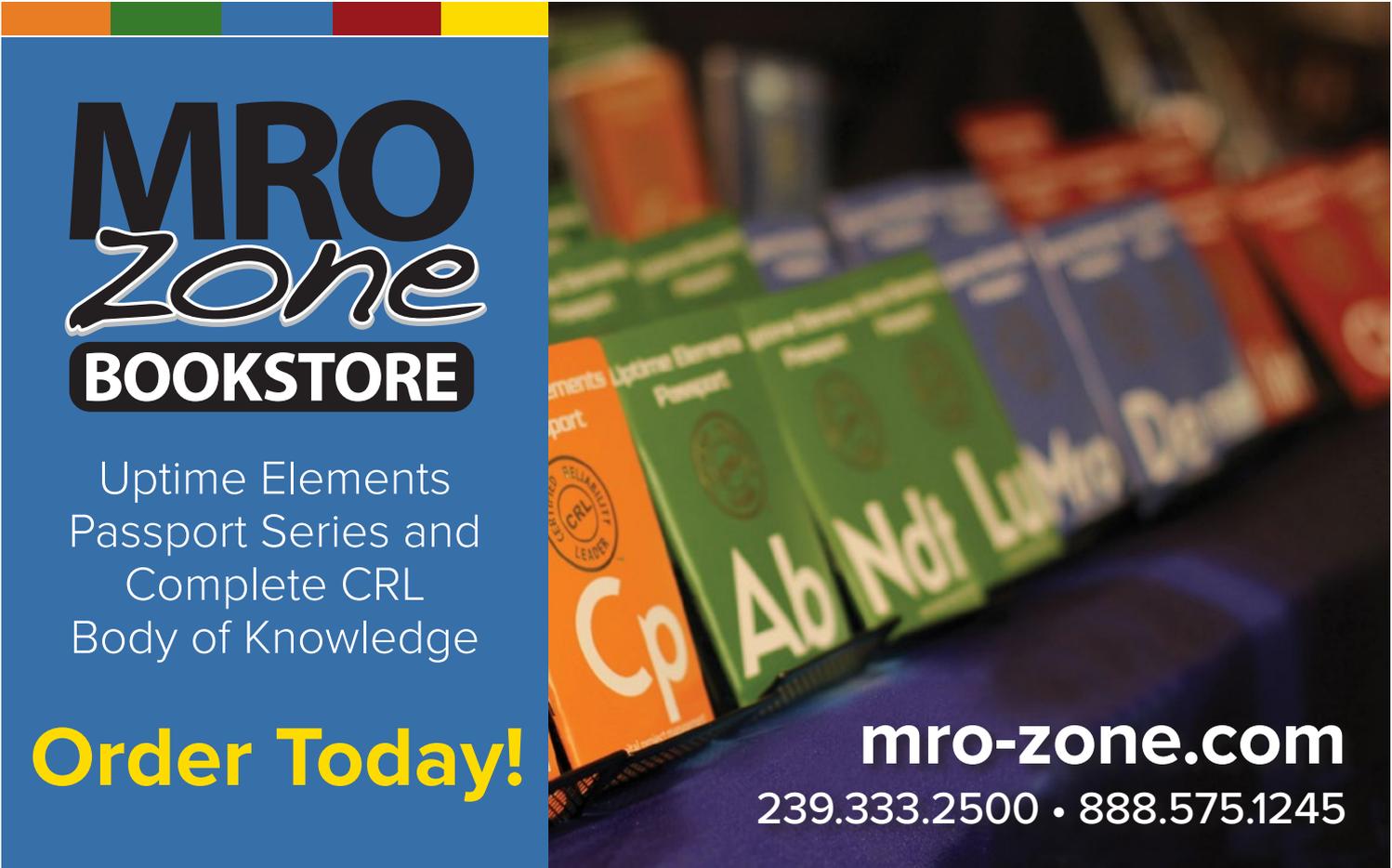
Interested in learning the next steps? Be sure to read the upcoming article, “How to Develop an Industrial Internet of Things Solution Phase 2: Research and Development.”

### References

1. Blank, Steve. *The Four Steps to the Epiphany – Successful Strategies for Products that Win*. California - K&S Ranch, 2nd edition, July 2013.
2. The Business Model Canvas Template: <http://businessmodelgeneration.com/canvas/bmc>



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