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SOLVING THE IoT PUZZLE

Build or Buy?

WHITE PAPER

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1. INTRODUCTION

In the last few years, the Internet of Things (IoT) has transformed from a buzzword to a business need. Creating new revenue streams is a goal and challenge for most businesses, and IoT is empowering them to stand up to that challenge in a big way. Collecting data and connecting a product or manufacturing line allows people to make informed data-driven decisions, add value, and reduce complexity, which can make a big impact on an organization's bottom line.

As discussed in Exosite's **Data Analytics for IoT white paper**, companies are using IoT to create new value where none previously existed.[1] More than ever before, through their analysis of the data they collect, organizations are becoming more efficient, accurate, and knowledgeable about their products, customers, and markets. Through IoT solutions, machines are getting smarter, gaining context about where they are and what is around them so that they can react. Essentially, we are making machines more human - connecting them to their human counterparts so that together, they can do more than ever before. And, when those intelligent machines are integrated into the enterprise, IoT allows you to remove tasks, decrease complexity and confusion for the end user, and drive accurate, data-driven decision making.

As suggested by a recent **Economist poll**, IoT is becoming less of an if, and more of a what, how, when question.[2] Their poll suggested 95% of people expect their company to invest in IoT, 63% think that without IoT their business will fail, 40% are researching it, and a mere 17% actually have IoT product launches planned. But creating a connected solution involves a complex ecosystem - beginning with a device and data collection, all the way through data processing, business integration, and interactive experience on the web or app. Successful connected solutions must integrate that entire ecosystem in a way that results in a simple, seamless, and cohesive experience for users in order to fully capitalize on the opportunity IoT presents. This task is easier said than done and can be approached in a number of ways.

This white paper will first provide an overview of the IoT ecosystem necessary to develop a connected solution, including what it takes to build an IoT platform, what expertise is necessary, and what to think about when determining how to integrate it with your business. Next, this document will explore the different approaches to developing an IoT solution, namely building your own IoT platform internally or "buying" pieces of it. As a result, you will gain a greater understanding of the benefits and cost associated with each approach so that you can make a smart, informed plan about how to move forward into the IoT generation of your business.

2. THE IOT PUZZLE: ALL THE PIECES

An IoT solution is a lot like a puzzle, although not the simple, 100-piece, distinct-picture type of puzzle. A successful IoT solution is more like a complex, 3-D, 1,000-piece, blurry-picture kind of a puzzle. Understanding all of the pieces in the IoT puzzle is a critical first step when considering developing an IoT solution. Having this information from the outset will help you make informed decisions about what pieces of the puzzle you can or want to own, and how you want all of the pieces to fit together to facilitate the seamless collection and use of your device data to meet your unique business needs.

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[1] http://info.exosite.com/data-analytics-for-iot
[2] https://www.arm.com/files/pdf/EIU_Internet_Business_Index_WEB.PDF

There are big risks associated with developing an IoT solution, and it's important to take this challenge head on and with your eyes wide open. The sections below leverage the experience Exosite has gained from years of building on our own platform to provide you with an in-depth understanding of what it takes to develop an IoT solution and integrate it with your business.

2.1 ARCHITECTURE CONSIDERATIONS

While designing and developing your system, there are a few architecture considerations that you will need to keep in mind that are integral to ensure your IoT ecosystem is a success.

- **Security:** All IoT platforms need to understand potential security threats and address them to ensure that you aren't compromising your data or that of your customers.

- **Reliability:** An IoT platform must be stable and dependable. You and your customers depend on the data being collected to make data-driven decisions. It is difficult to trust the data if your connections are spotty, the platform is unreliable, or data processing is time consuming.

- **Customization:** The ability to customize your IoT platform in the future is important if you will launch products that have different use cases and stories to define them. After all, the wheels you buy for your road bike won't really offer the performance you need on your car.

- **Scalability:** As your product numbers grow, your platform and supporting services need to be able to scale with it, without compromising the integrity, security, reliability, and functional-

ity of your system along the way.

- **Extensibility:** An IoT platform must support ways to integrate with other business systems to extend its functionality and enable better business decisions at the enterprise level based on machine data and user behaviors.

2.2 EDGE-DEVICE ECOSYSTEM

The collection and analysis of data is imperative to uncovering value with IoT - this may be the focus of your product or simply an add-on that enhances the core functionality that your users expect. Either way, you will need to thoroughly think through each component that gives your device the "Internet of Things" label.

- **Data Collection:** Selected hardware will need to support data collection, likely through sensors. It will either need to store data, waiting for the right time to upload it, or continuously upload data at an interval that is optimal in terms of both cost and need.

- **Hardware Connectivity:** Your hardware will need to include a radio, either directly connecting each device to the cloud via cellular or Ethernet or through an external gateway. Gateways often provide greater opportunity to store data locally, increase intervals between data uploads, or process pieces of data before passing it to the cloud. They can also offer the ability to store data in the case of a missing or intermittent connection to the cloud.

- **Communication Protocol:** Device firmware will need to support the collection and communication of data to the cloud through a commu-

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nication protocol. Choosing your communication protocol will largely depend on your use case, including how much data you send, how often it needs to be sent, and what protocols the platform accepts. For more information about communication protocols, see our *Embedded IoT Protocols* **white paper.**[3]

- **Device-level Security Measures:** Security must be considered in terms of the hardware, firmware, and physical location of your device. An easily hackable device can wreak havoc on your data, your customer's experience, and your reputation. For more information about IoT security, see our *Security in IoT Systems* **white paper.**[4]

2.3 HOSTING AND SYSTEMS ADMINISTRATION

Before getting into the meat of server-side development, it's important to ensure you have servers that are ready to host.

- **Server Basics:** Servers are powerful computers that run your applications and handle all the behind-the-scenes operations, maintenance, and monitoring that many of us take for granted each day. They are the environment where your applications and data reside. Unless you have a dependable hosting solution, you put the reliability, security, and scalability of your entire IoT solution at risk.

- **Server Monitoring:** Servers contain operating systems and applications that need to be installed, and then maintained with patches and on-going monitoring to ensure performance is optimal and security is not compromised. This monitoring requires tools that need to be in place

to ensure that any application you are adding to your system is running as expected. And when things don't run as expected, you will need backups, restoration plans and procedures, and people to execute them at the appropriate times.

- **Server Optimization:** To maintain optimal performance, your servers will require regular tuning and optimizations. This is especially important when dealing with the capacity of your system. Capacity includes not only how much data you are collecting, but also how much computation is involved in the analysis you are performing on the data. You will need to monitor your capacity, and plan to scale when demand makes it necessary. The speed at which the data can be collected, analyzed, and then passed on to end-user applications is important to not only the user experience, but also the trust your customers have in your solution.

2.4 BACK-END DEVELOPMENT

Once your product reliably collects data, it sends it to your cloud where it arrives at services running on servers that allow you to store, view, and/or perform computation on your data. This is the back end, or server side, of your IoT solution that is needed to support the communications, analytics, and processing to make your data valuable.

- **Data Storage:** Selecting the appropriate database technology to manage your valuable machine data is critically important to the success of most projects. To do this well, you must understand the differences between relational databases and distributed NoSQL databases, how those databases should be configured, and how they should be optimized and managed over time.

[3] http://info.exosite.com/embedded-iot-protocols
[4] http://info.exosite.com/security-in-iot-systems

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- **Analytics:** The database and backend services you create are not merely collecting and storing data. For your business to truly integrate with IoT in a valuable way, you have to process and evaluate that data. See our *Data Analytics for IoT white paper* for additional information about the best strategies for analyzing your device data.

- **Services:** Adding the appropriate services to take your stored data and execute on metrics and analytics that matter to your product, employees, and/or end users is where you really see the value emerge from IoT. You will need subject matter experts (SMEs) and data analysts to determine what those metrics are and how they can be leveraged to add value. Services that are often designed and developed on your server include:

  - Provisioning your devices, so that they are identified in your cloud and the data they collect is stored appropriately

  - Push notifications that users see on their smartphones each day.

  - A user management system to offer varying levels of access and permissions to different users.

  - API services to interact with your databases that will provide quick and easy access to the data you need when you need it.

  - Third-party integrations to manage connection to tools that empower and enable others at your business to benefit from the fruits of your IoT labor.

2.5 USER EXPERIENCE DESIGN

Once you have defined your personas and their use cases, you'll know what data is valuable, how to collect it, and analyze it in order to really capitalize on this new value stream from your IoT product. It's then time to focus on how your end users will see and interact with the data.

- **Adoption:** Your knowledge of and execution on user experience or interactive design can make or break the adoptability of your product. Users often choose solutions that are easy to understand and provide high perceived value in the context in which they use it. In order to succeed in this area, you must give it the respect it deserves.

- **Research & Validation:** Knowing your users is no small task. Assumptions you make about what they want to see, when they want to see it, and how it's displayed need to be verified. This means reaching out to users, listening, and integrating feedback into an interactive design that serves your users.

- **Usability:** A solid IoT solution removes confusion, reduces tasks, and minimizes mistakes for your end user. If your product is too complex or has a steep learning curve, the target of your IoT application will be largely missed, and users will quickly abandon it for their old, manual, and reliable alternatives. Understand where your users have problems or experience points of confusion, and find ways to provide clarity and simplicity.

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2.6 FRONT-END DEVELOPMENT

Client or application-side development requires that you choose your front-end framework and develop standards around what your teams will create.

- **Application Programmable Interfaces (APIs):** It is important to identify, design, implement, and test all of the APIs that are needed by entities external to your solution. Examples of this include device-facing APIs, management APIs, provisioning APIs, and APIs to integrate external services and data. Similarly, you will need to design how your front end will interact with the back-end APIs for your solution, and ensure that performance is acceptable as your solution grows.

- **Applications:** Web and mobile applications play a critical role in helping end users visualize data and gain insight. With each browser or mobile OS deployment, you will test and update over and over again. Every few years, you will completely revamp your look and feel to incorporate new methodologies and technologies, and ultimately optimize the user experience to continue to impress and dazzle your end customers.

- **Support:** Once you have released your product, you have to be especially keen to the on-going support that your front end is going to need. The way your user interacts with their data is paramount to your solution and, with the changing landscape on mobile operating systems and web browsers, you will need to make regular updates to keep things running and to incorporate new features that add even more value to your solution. This is true of not only consumer products, but also industrial solutions.

2.7 BILLING AND PAYMENT MANAGEMENT

Your IoT business integration won't be free to you, so it can't be free to your customers, right? Determining how to not only make money on your connection solution, but also to bill and collect payment is a critical step in IoT success.

- **Monetization:** Understanding the value your solution provides to your end users can provide key insight into what they may be willing to pay for. Exosite's *Monetization Strategies for Connected Products* white paper provides insight about the monetization strategies common to IoT solutions in order to help you hone in on what business model will work for your product.[5]

- **Billing & Payment Collection:** Once you have determined how you will monetize your solution, you must determine a way to collect payment from your customers or build the value into the payment for your goods. Your business could already have a partnership with a service that provides billing, invoicing, and payment acceptance, or you may have a proprietary billing and payment system with which your IoT solution can integrate. If not, you will need the expertise to research features to build your own or find partners that can provide off-the-shelf solutions that meet all of your needs. Either way, you must take into account federal and state laws, as well as contract terms.

2.8 INTEGRATED FEATURES

Amongst the ecosystem components above, there will be features that need to span across several of them to create valuable services and tools for your team and customers that promote

reuse, interoperability, and extensibility as your business grows. These types of services and tools help you transition from one product to many, from one team to many, and from one market to many.

- **Device Provisioning:** Your device will need to be provisioned, so that it will have knowledge of the platform to which it will connect; the back end will also need to enable the platform to handle the data the device sends to it. This means some sort of custom code on the device or embedded in the chip itself is needed, as well as a platform with support to accept the device communication. As you extend from one product to many, the device provisioning system will need to handle an array of device models and configurations.

- **Device Management:** Once your device is in the field rendering itself useful, you will need a way to ensure that you are able to manage device status, deploy firmware updates, and control versioning, so you won't have to create custom tools for each product. It is most useful when updates can be rolled out simultaneously to all devices or dynamically to different groups based on information like region or device firmware version. As you launch additional follow-on devices and projects, your device management solution will need to be flexible enough to cope with a variety of hardware types, firmware versions, and device groups.

- **Application Hosting:** Common, reusable tools and processes for static application file hosting enable a full application to be hosted within your IoT platform. This also enables follow-on application derivatives and variants to serve new or adjacent markets.

- **Customizable APIs:** Simplify your IoT solution design and create a tailored approach to device data interaction so that you can decide exactly what context, application logic, and device/user access make sense for your solution.

- **Integrated Roles & Permissions Management:** Integrated user services will provide a permissions scheme that handles authentication, management, and role definition that can be built into application permissions to reduce complexity and ensure security.

- **Standardization Tools:** Reuse of common components like hardware, integrations, and application frameworks will enable an IoT product deployment strategy that your entire organization can leverage to create consistency and minimize duplication, while maintaining the flexibility to customize.

3. PUTTING THE PIECES TOGETHER

Now that we have covered all the components that need consideration when integrating your business into the IoT world, it's time to figure out how you will actually do it. As the expert in your industry, you know the ins and outs of your product and how to get it made. This is a great place from which to start evaluating your approach to developing an IoT solution that is a good fit for your organization, industry, and end users.

The two most common approaches to the IoT puzzle include building the puzzle from scratch and buying the puzzle pieces, which involves partnering to varying degrees with experts in the field who have built IoT products and services. The sections below will discuss the benefits and challenges of each.

3.1 BUILDING THE PUZZLE FROM SCRATCH

Building your own IoT platform is a great way to have complete control over your IoT solution, from the collection of data to the end-user experience. All of the pieces of this puzzle are yours to integrate, maintain, and enjoy. This decision is often favorable for organizations that already have the necessary expertise in-house, or have the means to hire the expertise necessary. It can also make sense for organizations that do not see the IoT products and services on the market they need to meet their business needs. If you build, you can customize a solution to perfectly fit your application without having to compromise any feasible functionality or leave pieces of the puzzle out.

Along with the benefits associated with building your own IoT platform, it is important to also take into consideration the risks and costs. If you aren't already an expert in all facets of the complex IoT ecosystem, there is a steep learning curve that will likely result in failures that can delay your time-to-market or impact the trust of your target market. Beyond the complexity of the technology, the team needed to successfully implement a solution of this type is probably more complex, cross-functional, and costly than the solution itself. This team must research, architect, design, develop, and maintain the platform. Finally, the coordination that is needed to align the diverse number of individuals, technology disciplines, and functional groups within your organization in order to make your IoT solution truly successful can be daunting.

3.2 BUYING THE PUZZLE PIECES

There are a host of options when it comes to buying products and services to enable your IoT solution. Infrastructure providers, boxed solution providers, IoT platform providers, edge-device ecosystem providers, and connectivity providers are all options that are available to help ensure success for your IoT product. For the purposes of this paper, this section will focus on the benefits and challenges associated with the first three.

The advantages to these buy options are clear - they are a good fit for organizations that may lack in-house expertise that spans the entire IoT ecosystem or that need help reducing time to market, increasing value, and decreasing risk. You can focus on the areas of IoT solution development with which you are already familiar, while leveraging the expertise and knowledge of IoT product-enablement companies for the areas in which your experience is less mature. The key in making the right selection is having a realistic understanding of the strengths and weaknesses within your organization.

3.2.1 INFRASTRUCTURE PROVIDERS

Infrastructure providers consist of big players like Amazon AWS, IBM SoftLayer, Microsoft Azure, and Google. You can think of infrastructure-as-a-service (IaaS) and platform-as-a-service (PaaS) providers as companies that provide individual puzzle pieces, each in their own box, that you must sort through and combine to ultimately create your solution. These IaaS/PaaS providers provide the bare minimum components you need to create a connected solution

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- networking, storage, computing power - so you won't need to work around unnecessary features or attempt to fit your square peg into a round hole. And it's all available at a seemingly economical price. While this is tempting, it's also where critical hang-ups and delays can occur.

The costs and challenges with scaffolding a system based on raw IaaS/PaaS components are hidden within the human resources required to integrate the disparate pieces—not only in salary and benefits, but also in the time it takes to build a team that has the trust and direction needed to contribute in an efficient and timely manner. You'll also likely need to leverage partners for other areas of the ecosystem, which adds another layer of relationship and integration management. Finally, one of the most important challenges is ensuring that the appropriate security measures are in place at each integration and within each service or application to keep your users, data, and brand integrity safe. Ultimately, there are no clear directions for your success when selecting this path.

3.2.2 BOXED SOLUTION PROVIDERS

Boxed solution providers can act as a full-service IoT shop, taking care of every aspect of your IoT solution for you. You connect your device and send the data into their products, where it is analyzed and visualized using their tools and integrations. With this path, time-to-market is often expedited and includes necessary support and training along the way. Because your complete solution is in their hands, it's important to develop a strong relationship with your solution provider.

However, selecting a boxed solution provider means electing to use their entire system, terms, and con-

ditions. The pre-determined features, tools, and integrations that expedite time-to-market minimize the opportunity to customize the system for your specific application and use case. As a result, you must mold your solution to fit their template, use their partnership ecosystem, and adhere to their software updates. When customization is available, it is generally expensive, both technically and financially, and extends timelines. Ultimately, the closer you get to off-the-shelf products, the less control you have over the development cycles—the design and usability of your product will be limited by how their solution was built.

3.2.3 IoT PLATFORM PROVIDERS

IoT platform providers carry reusable puzzle pieces that can be swiftly assembled to create an IoT solution in a reliable and secure way. IoT platform providers offer services and user interfaces that are tailor-made for the types of users and companies that need to create IoT solutions. Common features of an IoT platform include services like device provisioning and connectivity, device management, data ingest, stream processing and analytics, data storage, cloud-to-cloud integration, APIs, user management, and application hosting. Great IoT platform providers also offer a unified user experience for manufacturers to be able to configure and tune these pieces rapidly to create highly differentiated IoT solutions.

One of the major benefits of using an IoT platform provider is that you don't need to re-create services and features that already exist, leaving you valuable time and energy to differentiate in the areas that matter to your business while also getting to market faster. Another critical advantage is that standard

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DevOps, monitoring, maintenance, intrusion detection, vulnerability management, and support are often included in the platform cost, meaning you don't have to maintain a large internal team to manage the servers and infrastructure you might be tempted to build when using an infrastructure provider.

The challenges of an IoT platform provider will come in managing your relationship and technical compatibility with the platform provider. It's important to find a partner that your team trusts, both personally and technically. As in any relationship, when the communication breaks down, so does the relationship. If the technology your partner uses is one that doesn't fit with your ecosystem, or that your internal team doesn't know or have the ability to learn, you may face unexpected roadblocks and slower time-to-market.

4. CONCLUSION

Throughout this white paper, we've talked about the what and how that make IoT solutions complex; it's not as simple as taking a puzzle you already have completed and adding a few additional pieces to expand the puzzle's picture. Some of the pieces in IoT solutions are standard, like the edge pieces that every puzzle has—they are used across many different solutions. Other pieces are unique to an industry or even to an end application. The ability to capitalize on the already-established edge pieces, and then customize and integrate in ways that make sense for your IoT solution, will make the difference between months and years of development and between hiring a few resources and multiple departments of people.

The key in all of this is to maximize differentiation for

your business by focusing on your core competencies and reducing your time-to-market by partnering, purchasing, and leveraging the rest. IoT platforms are a great way to ensure that you've got all the pieces you need to build that IoT solution without getting to the end and realizing that you've got pieces that aren't a good fit or are just not there at all. You will have the added benefit of the expertise of the IoT platform team, and their experience through the tough stuff will save you time and money so that you can focus on the things that will make your IoT solution unique.

IoT represents a multitude of technologies that are rapidly changing and evolving over time. It's in your best interest to choose a flexible approach that will get you quickly to market and does not box you into a corner, allowing you to be open, innovative, and flexible with your IoT solution. This ensures that as the market matures, your product can too. From many perspectives, an IoT platform provider will be the best choice for most businesses looking to launch into the IoT space.