TEXAS INSTRUMENTS

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Turning the Cloud into a Rainmaker

Texas Instruments TM4C129x Connected LaunchPad + EXOSITE

Introduction

Our lives are changing in exciting ways. Devices in our homes, automobiles, cities and factories are becoming connected to the Internet. This phenomenon has profound implications for businesses. Connected product offerings can lead to increased revenue, reduced expenses and a more engaged customer base. In fact, the Internet of connected products movement is not behind us – it's just beginning, and the possibilities are virtually endless.

However, creating connected products can be difficult. Embedded processor selection, networking, maintaining scalable server infrastructure, billing systems integration, software application development and data and privacy issues can be time-consuming and expensive. Hasn't this been done before? There has to be a better way.

Texas Instruments (TI) and Exosite have partnered to deliver the foundational elements for building connected products. Instead of re-inventing the wheel, use TI and Exosite building blocks to create your connected product vision quickly.

The TI C2000™ TM4C129x line of microcontrollers (MCUs) and the TM4C129x Connected LaunchPad evaluation kit contains the world's first ARM® Cortex™-M4 MCU with an integrated Ethernet MAC+PHY, making it easier than ever before to gather data from your equipment or environment.

The Exosite platform gives you a cloud development environment to monitor data from your device, create visualizations of that data, and set up events and alerts to make your information actionable. Building a connected product doesn't have to be difficult. The new TM4C129x Connected LaunchPad from TI and scalable cloud technologies from Exosite make opening a gateway to the cloud – and designing for the Internet of Things (IoT) – easier than ever before. The remainder of this paper addresses three questions:

- *What is the cloud?*
- *Why does it matter?*
- *What building blocks are available to help you fulfill your vision?*
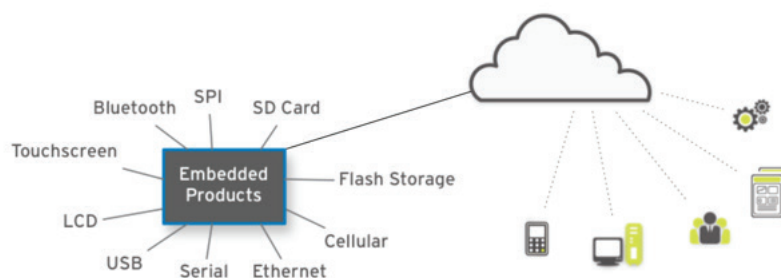
What is the Cloud?

The cloud is a phrase that refers to a set of scalable server infrastructure that facilitates the processing and storage of data from devices or other sources, and enables the creation of web and mobile applications, as well as integration with other software systems (**Figure 1**).
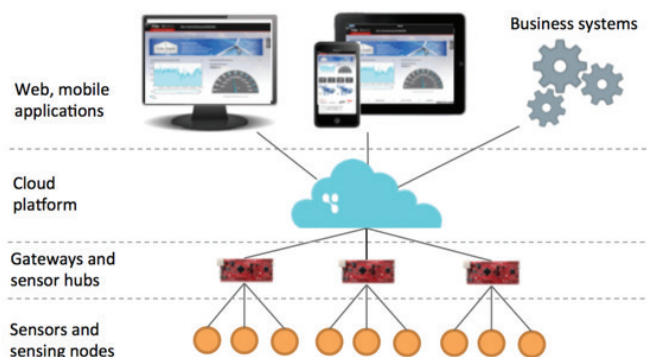
Figure 1: Simplified cloud architecture

For the last 10+ years, there has been a constant evolution of new peripherals and interface standards for embedded devices that have emerged. In 2003, the industry was talking about LCD controllers, USB, Ethernet and CF. In 2007, it was touchscreens, video, hardware accelerators, wireless technologies and SD. In 2011, cellular, Wi-Fi and security were the next hot items.

The cloud is the next "big thing." Just like reading and writing to a serial port, it's now possible to read and write to the cloud. This opens up a new set of possibilities for how stakeholders can interact with that data, turning it into actionable information (**Figure 2**).

Figure 2: The cloud is the next peripheral

To gain a better understanding of the cloud, let's look at two case studies: Wind farm management and fertilizer storage.

Wind Farm Management

In a wind farm, turbines convert wind energy to electrical energy and either use that energy locally, or sell the energy to a utility company. By cloud-connecting wind turbines such that they autonomously report key data to the cloud, a host of possibilities emerge:

- Data is collected in a central place making it easy to see how the entire farm is performing in aggregate.
- Data from individual turbines is available real-time, showing key mechanical performance metrics: Blade strain, blade pitch, front-bearing temperature, brake temperature, generator RPMs and power output.
- By monitoring individual wind turbine performance in real-time, advanced warnings of mechanical failure are possible. Events and alerts can be set up to proactively alert wind farm management staff of issues that may turn into problems soon.
- By minimizing turbine downtime, and combining power output with local utility rates, it's possible to see real-time analysis of how much revenue the farm is producing at any point in time (**Figure 3**).

Figure 3: Wind farm management dashboard

Fertilizer Storage

Fertilizer storage facilities must control temperature, humidity and ammonia levels in order to maintain a safe environment. By cloud-connecting environmental sensing units at fertilizer storage facilities, temperature, humidity and ammonia may be tracked and monitored at specific points within the facility, and also aggregated to determine the overall air quality at the facility.

By cloud connecting sensors at fertilizer storage facilities, a number of benefits emerge:

- Events and alerts can be set to trigger escalating alarms based on specific thresholds.
- Data can easily be tracked and maintained for safety and compliance reporting needs.
- Analytics in the cloud can be applied such that raw sensor data (temperature, humidity and ammonia levels) can be combined together to derive additional data streams such as an air quality index. Fine-tuning algorithms over time in the cloud is much easier than doing so on the physical sensing devices.
- Overall facility health can be monitored remotely from a web browser or on a mobile phone (**Figure 4**).

Figure 4: Fertilizer storage facility monitor

There are a multitude of other examples of how cloud-connecting a device, product, product fleet, facility, or set of facilities can mean big change to business performance and financial results, but doing so can seem complicated and difficult to know where to begin.

To illustrate this complexity, consider the long tail (**Figure 5**). For the IoT, the massive growth of the industry over the next decade will not be due to large volumes of a small variety of devices (tablets, cellphones); rather it will be due to small volumes of a large variety of devices.
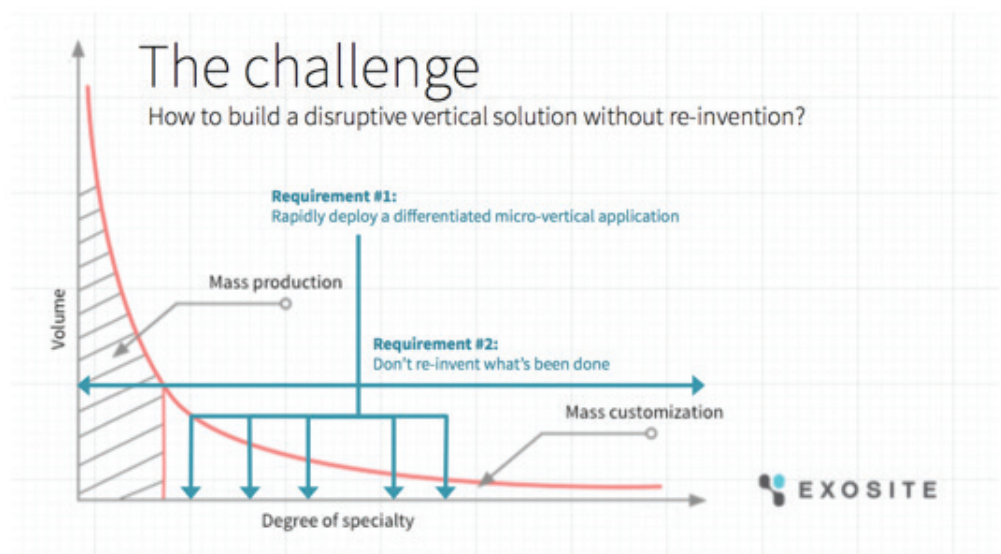
Figure 5: The long tail of IoT micro-verticals

For a specific application, the challenge becomes: (1) how to rapidly deploy a cloud-connected offering (hardware + cloud software), and (2) how to do so without reinventing what's already been done. When making make-versus-buy decisions, the key is to make what is special to your application, and buy/leverage what is not. For example, the device design and behavior, and the user experience are key touch points for differentiation. A cloud-connected processor and a software cloud service platform are building blocks that can be easily leveraged.

The Opportunity

You have probably heard about significant projections for the growth of IoT. Cisco®, Ericsson® and others, have projected that there will be 50 billion connected devices by 2020. Intel™, GE™, McKinsey™ and a host of others have provided their own similar predictions. Regardless of the exact number, we know two things:

1. The growth of IoT is coming.
2. Consumer expectations are changing and connected devices and polished user experiences are the new normal.

Consumers are getting accustomed to having nice user interfaces on their smartphones and tablets. Those expectations are carrying across work/personal life boundaries and users of industrial equipment, household appliances and medical devices expect a great experience. There is significant first-mover advantage here to companies in industries with products that carry traditionally poor user experiences.

What Does it Matter

Now that we've talked about what the cloud is, let's move on to talk about why it matters. There are a number of reasons why cloud-connecting your products can be advantageous from a business perspective:

- Cloud-connecting your device can mean increased revenue (i.e. charging for premium cloud-connected features) or for reducing expenses (i.e. roll fewer trucks).
- By reducing unscheduled maintenance visits, more margin can be added to existing support contracts or the support contracts can be delivered more effectively.
- Safety compliance reporting may be more easily tracked and reported on, saving precious time and money, not to mention reduced data entry errors.
- Customer experience may be improved with a connected product line. One example of this is that call centers can have up-to-date information about the customer's equipment before they call in, leading to a higher quality support call experience, increased brand equity and deepened customer loyalty.
- Next-generation designs can be improved by gathering usage data on legacy equipment in the field.
- New types of service contracts can be created by predicting and pre-shipping consumables that need replenishment before the customer knows they need them.
- Federation with business systems is possible, such that reduced usage could trigger a sales team member to follow up. For instance, if an MRI machine is underused or overused, it may mean that the hospital may need another machine or perhaps more training. A cloud-connected system that can federate with a customer relationship management (CRM) tool could generate a sales lead when the events of interest occur with devices in the field.

There are many more, but these are a taste of what is possible when a product fleet becomes cloud-connected.

New Business Models

With new usage models come new business models. A number of new business models and value propositions emerge for connected product fleets:

- **BOM-model pricing.** Roll the cost of the cloud into the purchase price for the device, and guarantee cloud service for X years under defined conditions.
- **Recurring pricing models.** Subsidize the price of the device, reducing capital costs for customers, and build a recurring revenue source.
- **Cloud add-ons.** Introduce the idea of an "add-on" service for your device if you don't have it already. This allows you to keep device costs low, but charge premiums for customers that need additional cloud-connected options.
- **Retrofits.** Cloud-connectivity is/will become the new normal. Sell more of what you have today by adding new cloud-connected features to existing product lines. Read: retrofits.
- **Improve existing margins.** By proactively monitoring equipment, existing business models can become more valuable. By only sending service personnel when there is a problem, few trucks can be rolled and margins on service contracts can increase.

There are many more business model innovations that will emerge in the coming years.

Introduction to Exosite

Now that we've discussed what the cloud is, and why it should matter to you, let us introduce Exosite and how you can use Exosite to build your connected product business quickly and easily. Exosite makes it fast and easy to build connected product businesses. Exosite has the common building blocks for creating a world-class IoT business which lets you focus on your core business: Creating great products and great user experiences.

One of the ways Exosite does this is to allow users to connect devices and start prototyping devices and dashboards on day one. Then you're ready, you can take it to production, integrate with manufacturing and more – without duplicating any work from the prototype.

Micro-Vertical Engine Approach

Exosite has a business and product development philosophy called the "Micro-Vertical Engine approach" for rapidly deploying specialized applications based on three pillars:

1. **Zero barriers.** Exosite has partnered with TI to reduce the barrier to entry in the IoT space by cloud-connecting the TM4C129x processor family and Connected LaunchPad development platform such that the devices can talk to Exosite by default, right out of the box.

2. **Infinite access.** Once your device data is in the cloud, you may use it anywhere. This includes generating reports, sending events and alerts and integrating with business system of all sorts.

3. **Immediate value.** Exosite was created to allow customers to build IoT businesses quickly and efficiently. Exosite has an integrated billing system, tools to speed up time to market and customizable branding that allows easy configuration of the look and feel, colors and graphics.

TM4C129x Connected LaunchPad

Exosite has partnered with TI to cloud-enable the Connected LaunchPad evaluation kit, which is based on the TM4C129x MCUs. With an ARM Cortex-M4, integrated Ethernet MAC+PHY, security features and flexible set of I/O, it is a great processor for building connected products such as an IoT sensor hub (**Figure 6**).
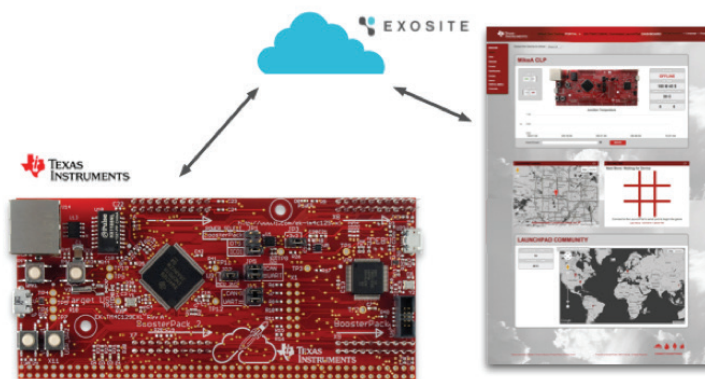
Figure 6: A view to cloud data from device.

For developers using the Connected LaunchPad with Exosite, they can see the data from their device on day one. To add it to Exosite, it's a snap (**Figure 7**).

Options for every application
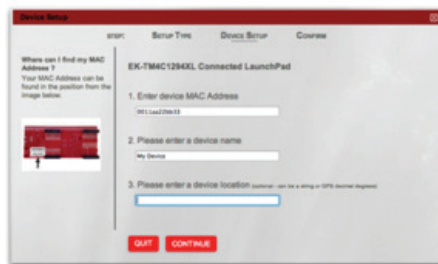
Viewing the status of I/O on the device is easy:
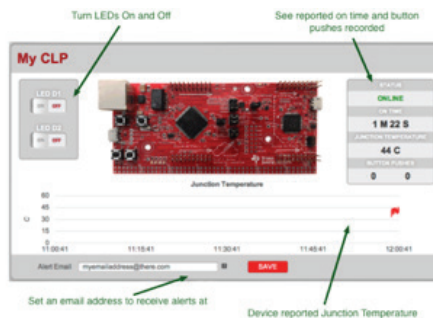
Figure 7: Viewing device status via Exosite

When developers are ready to move to production, upgrade to an Exosite Whitelabel account to give you full control over product fleets, firmware upgrades, manufacturing integration and a branded look and feel that is just your own.
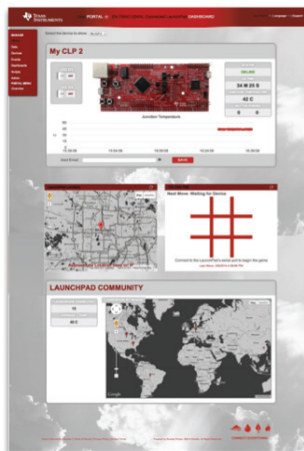
With foundational building blocks from Texas Instruments and Exosite, combined with great ideas from hobbyists and developers, the next great product is just around the corner.
What will you connect?

For more information, please visit **www.exosite.com/ti** or **www.ti.com/launchpad**.

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DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
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