Discovering, Defining and Framing New Smart Systems and Services Growth Opportunities

Harbor's perspective on how strategic business designers and developers should think about identifying and developing new smart systems and services growth opportunities

smart systems design | Harbor Research

Embedded intelligence puts the “smart” in smart services and it will bend the traditional linear value chain into a “feedback loop” through which the heartbeats of connected products will continually flow back through the complex alliances between companies, customers and people that use and support them. Only those that set aside traditional planning and development protocols, embrace user experience to discover new solution concepts and push to define and develop new collaborative business models can win key positions. Embracing radically new approaches to integrating smart things, people, systems and the physical world will drive unimagined customer values and provide opportunities to leapfrog competitors.

SMART SYSTEMS DESIGN

Business strategy and design today need to extend to the experience that users, customers abd partners will have with connected products, services and spaces and, therefore must integrate the processes and systems that are behind these experiences with decisions related to both design and strategy. The convergence of design with strategy will inevitably lead to a new integrated set of processes, methods and disciplines -- the advent of what we call Smart Systems Design.

TABLE OF CONTENTS

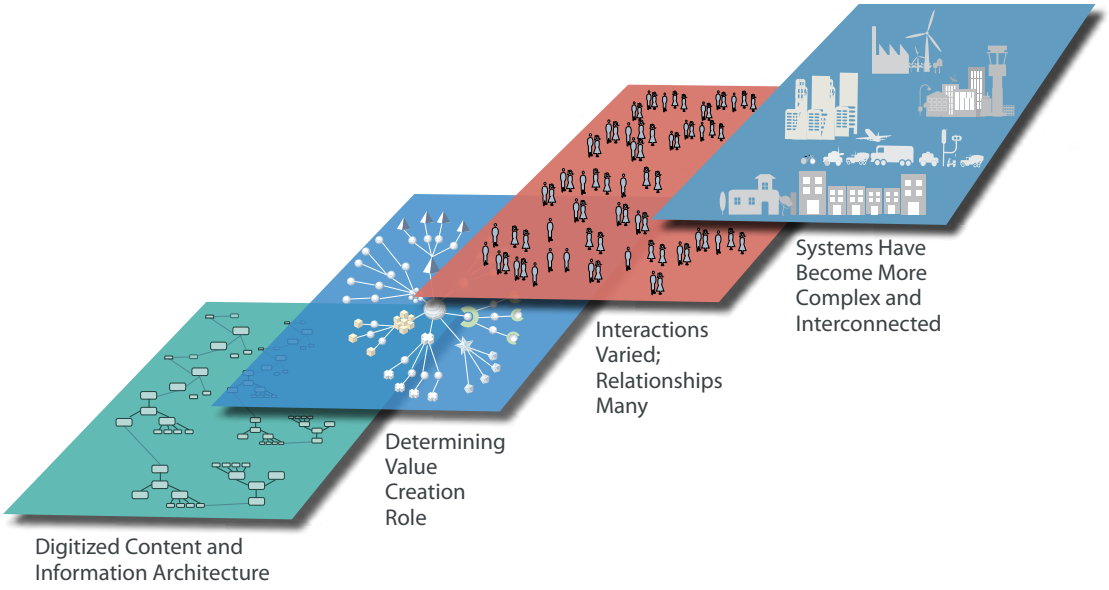
EXHIBITS

01: INTRODUCTION and OVERVIEW

Peer-to-peer information, social networking and pervasive computing are combining to create new modes of collaboration and decision making. People, information, and technology are becoming more connected, distributed and pervasive enabling the convergence of physical and virtual worlds. Social networking technologies are moving to the enterprise and will be embraced and experienced differently than in the consumer space. Network awareness will include knowledge, people and things.

These forces are informing a new trend we call "Smart Business." In its simplest form, Smart Business is a concept in which input—from machines, people, video streams, maps, newsfeeds, sensors, and more—is digitized and placed onto networks. These inputs are integrated into systems that connect people, processes, and knowledge to enable collective awareness, creativity and better decision making. The foundation of Smart Business is made up of "Smart Systems" based on leveraging embedded computing and networking technology to deliver smart, remotely monitorable goods that will support entirely new modes of customer-device interaction and service delivery -- thus, Smart Business.

Exhibit 1: Digital and Smart Systems Technologies Will Inform All Systems



As networks have invaded the "physical" world, traditionally unique components and interfaces between and among electronic as well as mechanical elements are becoming more and more standardized. The implications of these trends are enormous. No product development organization or its suppliers of componentry and sub-systems will be able to ignore these forces -- product and service design will increasingly be influenced by common components and sub-systems. Vertically defined, stand-alone products and application markets will increasingly become a part of a larger "horizontal" set of standards for hardware, software and communications.

As it becomes easier and easier to design and develop smart systems, competitive differentiation will shift away from unique, vertically focused product features towards how the product is actually used and how the product fosters interactions between and among users in a networked context. The opportunities this opens up to forward thinking product and service organizations are nearly infinite. Businesses can begin to explore many new possibilities for system solutions unthinkable just a few years ago.

We believe smart systems will drive a multi-year wave of growth based on the convergence of innovations in software architectures; back-room data center operations; wireless and broadband communications; and smaller, powerful, and numerous client devices connected to personal, local and wide-area networks. These technologies will work together in unprecedented ways to solve smarter and more complex business problems than previous generations of computing.

Since the beginning of computing there have essentially been three waves of technology and architecture: mainframe computing, personal computing, and network computing. This next generation of "Smart Systems" technology will add significant new capabilities to computing and network systems. These new capabilities will revolve around real-time situational awareness and automated analysis. As a result, technology moves beyond just proposing task solutions — such as executing a work order or a sales order — to sensing what is happening in the world around it, analyzing that new information for risks and possibilities, presenting alternatives, and taking actions. Smart Systems are:

> *a new generation of systems architecture (hardware, software, network technologies and managed services) that provide real-time awareness based on inputs from machines, people, video streams, maps, newsfeeds, sensors, and more that integrate people, processes, and knowledge to enable collective awareness and better decision making*

The three previous waves of technology each have had significant impacts on productivity and efficiencies;; mainframes standardized transactions; personal computing placed processing power into the hands of professionals; and, networked systems enabled business process automation. What is important about this next wave of Smart Systems is the combined impact of the cycles of innovation. While there is standalone value in each of the innovations in software systems, server infrastructure, network infrastructure, and client devices, it is the combination of all these innovations that will allow computing technologies to inform smarter systems.

SMART SYSTEMS ARE BASED ON HORIZONTAL ARCHITECTURES

As networks have invaded the "physical" world, traditionally unique components and interfaces between and among electronic as well as mechanical elements are becoming more and more standardized. Connectivity and integration will become universal as components, platforms and systems become ever more standardized, open and readily integrated.

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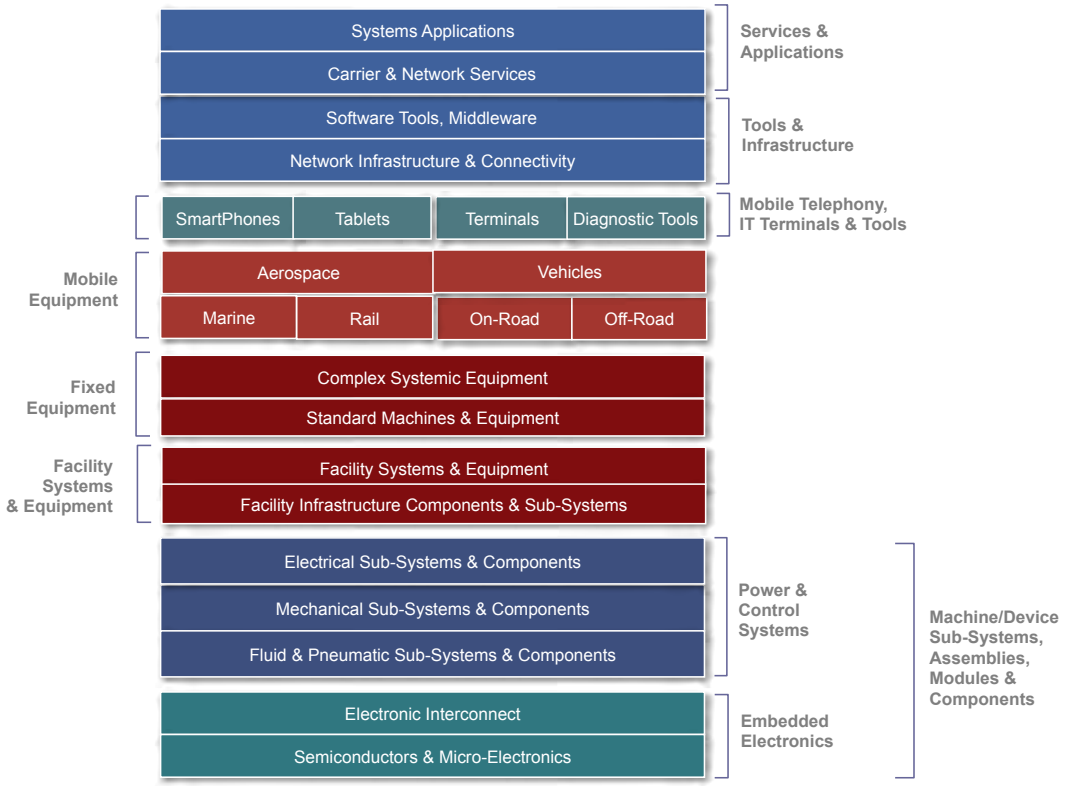
Exhibit 2: Common Architecture Across Physical and Digital Systems



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Once a device becomes networked and is monitored for the primary purposes of device status, usage tracking, and consumables replenishment, it will also serve the larger business purpose of being a key driver for the vertical customization of services in general. For example, "asset management" is an important service that incorporates a number of different variables and systems (diagnostics for equipment health monitoring, location services for maintenance and spare parts planning, etc.). Application service providers need to organize

the devices and system capabilities they offer configured for the environment in which they operate—factory, office, hospital, and elsewhere. A product inventory program will have a much different configuration in a factory than it will in an office building. More than ever before, the drivers, needs, and environmental conditions will determine the way technology is implemented. Ultimately, all devices and services, like asset management, will be highly configurable to match the needs of a particular venue, or even of a particular end-user.

HORIZONTAL SOFTWARE TO ENABLE VERTICAL APPS and SERVICES

Technology developers and related services providers will realize revenue streams within this new market model in multiple ways that align to the so-called "tech stack" in the following categories:

» **Enablement:** the communications capabilities attached to or embedded in each machine to be connected;

» **Network Services:** the wireless or wireline communication medium used to receive/send machine data including configuration and provisioning, network service charges, and support services;

» **System [level] Applications:** the integration software or middleware that most people today refer to as "platform" software for the IoT; and,

» **Value-Added Application Services: which include** the [managed] services delivery for vertically-focused value added applications.

as networks have invaded the "physical" world, traditionally unique components and interfaces between and among electrical, electronic as well as mechanical elements are becoming more and more standardized

Within these four "stack" segments, one of the most critical "foundation" elements are systems applications described above. When we refer to system apps and platform functions we mean a set of state-based application functions that are horizontal in nature and often characterized in a general sense as "middleware" that are not seen by the end user (we do not like the term middleware as it risks generalizing capabilities that are unique to the Pervasive Internet and offer unique opportunities for suppliers).

In its most basic and practical form, our concept of "Systems Applications" is based on "connectivity and device management services integrated with data aggregation and management functions. But that's not as simple as it sounds. Capturing the real value of Internet-connected devices goes much further than providing connectivity, databasing, and some transport scheme. For example, real pervasive managed services will allow networked, intelligent devices to execute remote applications as if those applications were part of the internal operating system. This type of enablement can bring extraordinary value to the growing population of networked devices with increasing amounts of embedded intelligence.

System applications are fairly generalized and are created by applying generic connectivity functions to a particular venue. The breakdown of System Applications is as follows:

» **Status, Monitoring & Diagnostics:** Status applications capture and report on the operation, performance, and usage of a device, or the environment that the device is monitoring. Diagnostics applications allow for remote monitoring, troubleshooting, repair, and maintenance of networked devices.

» **Upgrades & Configuration Management:** Upgrade applications improve or augment the performance or features of a device. They can prevent problems with version control, technology obsolescence, and device failure. This kind of program makes site visits to upgrade products unnecessary and eliminates the need to keep track of what has been upgraded and when, thus saving time and money.

» **Control & Automation:** Control and automation applications coordinate devices into a sequenced pattern of behavior. These applications also allow for special-case discrete actions of a device under certain circumstances.

» **Location & Tracking:** Profiling and behavior-tracking applications are used to monitor variations in geography, culture, performance, usage, and sales of a device. These applications can also be used to create a more customized or predictive response to end-users of a device.

» **Data Management & Analytics:** Business intelligence and specialized analytical software such as data mining and predictive analytics, video image analysis, pattern recognition, and artificial intelligence algorithms.

A key characteristic of Systems Applications will be the importance of how their basic functions can be combined to provide vertically focused solutions -- the bulk of which will increasingly be delivered as a managed or value-added service. In conceptualizing how platforms would support Value-Added Applications Services, system-level applications would be called upon and integrated in differing configurations to provide vertical value-added applications. For example, a combination of monitoring, diagnostic, control and tracking functions could be configured to provide basic functionality required to enable an energy management application.

These value added application services are solutions that integrate people, business processes and assets and are delivered as managed services. Examples of value-added applications services include the following:

» Asset management and optimization
» Supply chain integration & business process management
» Customer support
» Energy management
» Security management

Players will create solutions that combine elements of industry-specialized hardware devices, vertical industry software, and industry-focused wireless/wired networks with data management tools to optimize business processes and performance both operationally as well as financially.

Smart Systems technologies and applications will help organizations address the key challenge of optimizing the value of their balance sheets, allowing them to move beyond financial assets and liabilities to their physical assets and liabilities (like electric grids or hospitals) and then to their intangible assets and liabilities (like a skilled workforce or brand). Assets and liabilities tend to be very industry-specific, even more so than processes that may be common across industries. And the task of optimizing the value of these assets and liabilities is vertically focused because optimization requirements vary dramatically from industry to industry.

02: FRAMING SMART SYSTEM GROWTH OPPORTUNITIES

In a world where everyone claims to be "customer focused," it's surprising how very unfocused most suppliers' view of their customers really is. It is impossible to define either "right system" or "right potential customer" except in terms of customer needs. Customer needs drive demand and drive behavior. Within and across traditional "industry" segments, there are a wide variety of customer types. Understanding customer needs and behaviors are the "keys to the kingdom" of effective marketing.

Segmentation, to say the least, is the very challenging process of constructing proxies for multiple customer attributes that often are just distant approximations for customer needs. We have come to believe that segmentation in the era of smart "connected" systems needs to carefully combine and integrate three critical dimensions:

» Needs, Context and Usage: characterizes user experience which lies at this heart of designing effective solutions and is based on human centered design principles meaning, it is based upon an explicit understanding of users and usage tasks and the environment where it takes place.

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» Buying Behavior: characterizes potential customers by the attributes or behaviors that relate most closely to how they buy, what they buy, and why they buy it.

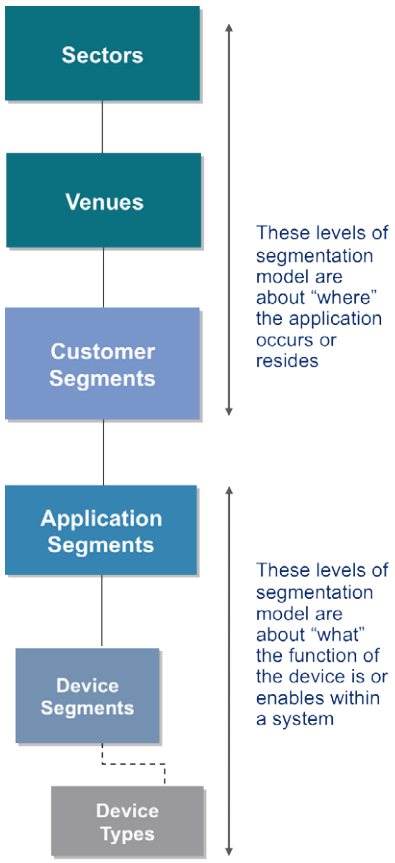
» Demographics: data, statistics and information about size/scale, industry segment, geography and other quantifiable parameters.

Companies trying to address new Smart Systems and Services opportunities need a market model and segmentation schema that can address both qualitative and quantitative dimensions - we all need to understand buyers and users needs and behaviors as well as how many at what scale. With that said, any effective segmentation schema also needs to address

the impact of mobility across differing usage contexts. Just consider the number of devices that exist with the potential to be networked. Walk through a typical day and note the variety of electronic devices with which you interact and, most importantly, the context of usage and how that changes from "venue to venue" (i.e. home context versus vehicle context versus office context, etc.). Each device's uses and functions have the potential to be expanded with networking in addition to the growing diversity of interactions. Just think about your smart phone's ability to integrate with and interact with a very broad range of devices.

This phenomenon is not just about the dichotomy between people communicating with people or machines communicating with machines: it also includes people communicating with machines (e.g. a networked ATM), and machines communicating with people (e.g. automated stock ticker alerts on your PDA). The Internet's most profound potential lies in its ability to connect billions of smart sensors, devices, and ordinary products into systems that will enable many new user experiences.

Hence, it is our belief that the best fundamental organizing principle for segmentation is "venue" instead of a traditional "vertical" industry or otherwise segmentation schema. Within a venue-driven structure, we also believe it is important to organize and segment opportunities into specific customer segments as well as applications and use cases within apps. This way the hierarchy is based on the upper layers of the model comprised of segments that are organized by "location" or, the environment where the system or solution is operating and, the lower two layers of the model is organized by applications, usage and functions. Finally, the lowest layers of this approach are based on devices and their demographics and, as a result, provide the means to quantify the potential scale of the smart systems opportunity.



To summarize, the overall structure is organized in the following layers:

» **Economic Sector:** Broad grouping of multiple venues within a relatively homogeneous area within the economy such as consumer versus, government, versus industry.

» **Venues:** Vertical usage segments that take into consideration the nature and use of a smart connected device or system such as retail, transportation, healthcare or industrial.

» **Customer Segments:** Within a venue, a customer segment is a homogenous "served" market segment (e.g. Power Generation within the Energy Venue).

Exhibit 3: Smart Systems Venue Map and Market Model

Resources

Agriculture		Water Utility		Oil & Gas		Mining		Electrical Power	
Field	Facility	Transport	Plant	Exploration & Extraction	Oil & Gas Transportation	Under Ground	Surface	Power Generation	Transmission & Distribution
• Cultivation • Irrigation • Harvesting • Livestock	• Irrigation • Cultivation • Livestock	• Water Piping & Storing Station	• Water & Waste Treatment	• Onshore Oil & Gas Rigs • Offshore Oil & Gas Rigs	• Pipeline / Offloading Monitoring	• Digging & Drilling Equip.	• Crushing Machinery • Sedimentary Handling Equipment	• Wind & Solar Generation • Conventional Generation Equipment	• Generation Equip. • Transmission & Distribution Substation

Buildings and Facilities

Homes		Buildings		Public Venues		
Single Tenant	Multi Tenant	Commercial & Institutional	Industrial	Transport Venues	Borders & Ports of Entry	Military Bases
• Appliances • Utility Metering • Lighting Components • Intrusion, Detection & Alarms		• HVAC Systems • Lighting Components • Metering • Electrical Power Distribution • People Moving		• Intrusion, Detection & Alarms • Video / Image Surveillance • Tracking Equipment		• Identification / Access Control Equipment • Video/Image Surveillance

Infrastructure

Environment		Urban Systems	
Environment	Structures	Transportation	Pedestrian
• Air Pollution Monitoring Systems • Flooding Detection Systems	• Building Infrastructure Monitoring • Transportation Infrastructure Monitoring	• Charging & Refueling Equipment • Parking Equip. • Road Traffic Systems	• Waste Mgmt. Systems • Street Lighting Systems • Pedestrian Traffic Systems

Industrial Manufacturing

Process Industries	Hybrid / Converting	Discrete Manufacturing
Plants	Mills	Factories
• Control Equipment • Process Systems • Instruments & Sensors • Oil & Gas Processing Equip.	• Instruments & Sensors • Converting Machines • Batch Processing	• Controls Equip. • Packaging Equip. • Fabrication Equip. • Material Handling Equipment

Transportation

Personal	Commercial	Military	Public	
Aerospace	Marine	Rail	On-road Vehicles	Off-Road Vehicles
• Fixed-wing Aircraft • Rotorcraft	• Cargo Ships • Passenger Vessels • Underwater Vessels	• Trackside Systems • Subway / Light Rail Vehicles • Freight Wagons • Locomotives	• Goods & Materials Transport • Passenger Transport	• Construction Machinery • Combat • Recreational

Consumer IT

Consumer Products		Consumer IT
Mobile	Fixed	Fixed
• Wearables • Infotainment • Developer Kits	• Media Devices • Fixed Media	• Home Office Equipment

Professional IT

Network Communications		
Network Infrastructure	On-Premise	Data Center
• Transmission Equipment • Public Switching Equipment	• Networking Infrastructure • Storage Devices • Cooling Equip. • Computer Servers	• Networking Infrastructure • Storage Devices • Cooling Equip. • Computer Servers

Healthcare

Health Delivery		Mobile/Personal	
Hospitals & Labs	Clinics	Mobile	Fixed
• Lab Test Equip. • Patient Imaging Equipment • Patient Monitoring Devices		• Fitness & Care Equipment • Monitoring Devices • Support Devices	

Retail & Commercial Services

Distribution & Supply Chain		Retail		Entertainment	Hospitality	Professional Services		Institutional Services	
Wholesale	Retail Distribution	Big Box	Specialty	Stadiums & Entertainment	Hotels & Restaurants	Financial	Technical	K – 12 Schools	Universities & Campuses
• Transaction & Tracking Devices • Material Handling Equipment	• Transaction & Tracking Devices • Material Handling Equipment	• Transaction & Tracking Devices • Appliances • Point of Sale Systems		• Point of Sale Systems • Audio & Video Equipment	• Point of Sale Systems • Large Appliances	• Office Equip.	• Office Equip.	• Student Engagement Devices • Vending Equip. • Signage Devices	• Student Engagement Devices • Vending Equip. • Signage Devices

» **Applications:** Applications provide a function or a related set of functions based on a grouping of related devices (e.g. fixed patient monitoring within healthcare, fleet tracking and management within transportation, energy management within buildings, etc.).

» **Device Segments:** Device segments are groupings of functionally homogeneous devices (e.g. point-of-sale devices, off-road construction equipment, power distribution devices, etc.).

» **Device Categories and Types:** These are individual device types (e.g. portable payment terminal, circuit breaker, locomotive, etc.).

Harbor Research Smart Systems Venue Map is our organizing schema for the Internet of Things opportunity. This approach to segmentation provides coverage and, with few exceptions, represent all potential applications for the Internet of Things. As technology advances and adoption matures, the amount of interactions between and amongst people, machines and systems will dramatically increase.

MOVING FROM SIMPLE TO COMPOUND SOLUTIONS - APPLICATION EVOLUTION IS KEY

Apple and some of its peers in the consumer space present an interesting case for how connected product business models are evolving. Apple's model is based on a Smart System solution and platform that pulls together technologies from multiple domains and packages the solution in a way that wins buyer acceptance. But more importantly, the platform model provides for and enables extensive third party collaboration and contributions.

Looking beyond Apple, players like Google, Amazon, Facebook, Salesforce and others are also driving platform models in the evolving mobile internet arena. Salesforce and Amazon have many thousands of developers building applications and businesses. Google, with its Android platform, has created a phenomenal market position. What these models all have in common is that they are not traditional product-focused approaches; they are based on collaboration, participative product development and smart services innovation, and are organized and leveraged with a common business and technical platform.

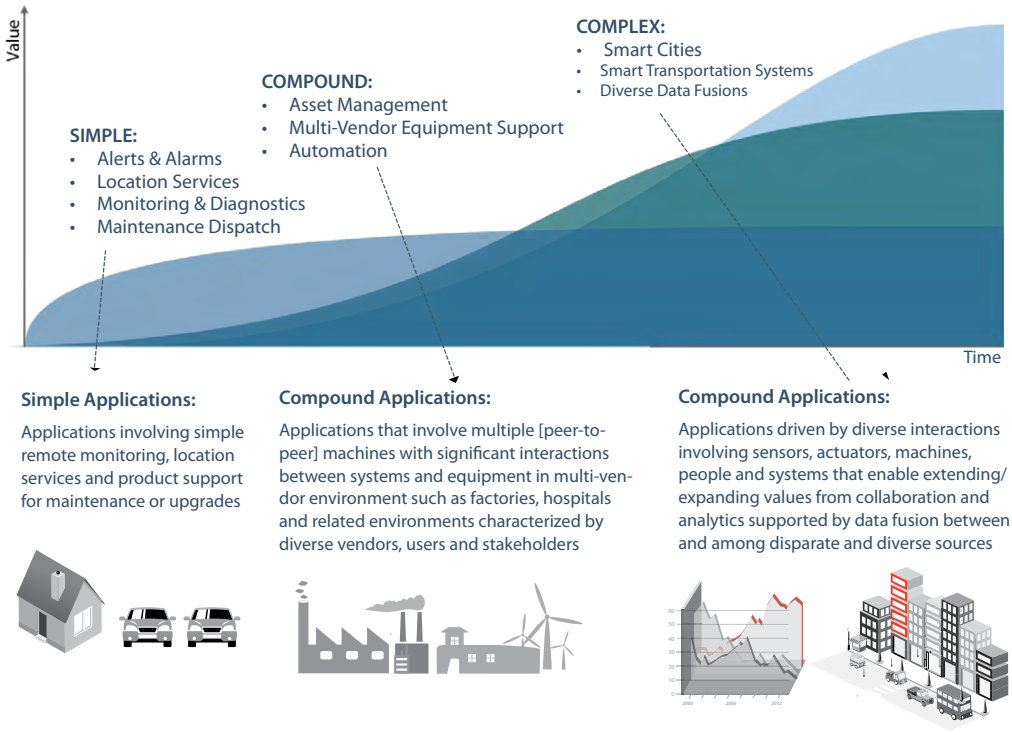
Unlike the B2C world, IoT and M2M applications have evolved in a context where applications such as remote monitoring and support for equipment have been tied closely to equipment services contracts.

To date, remote services and M2M systems have largely been focused on simple remote diagnostics and simple tracking/location services – in large part because of technical complexities and business model challenges (see below).

Existing technology has proven cumbersome and costly to apply with many conflicting protocols and incomplete component-based solutions. The challenges of developing applications and integrating diverse devices onto networks in an interoperable manner have been big adoption hurdles. The inability of today's popular enterprise IT systems to interoperate with distributed heterogeneous device environments is an obstacle that we are finally overcoming.

Return from simple applications, while extremely valuable, is limited to the manufacturer's service delivery efficiency. Contrary to what current market offerings depict, however, the value of connectivity does not have to end with just simple applications focused on a single class of device or machine.

Exhibit 4: Smart Systems Application Evolution - From Simple To Compound To Complex Apps



As technologies mature and open standards become the norm, applications based on deeper, peer-to-peer interactions between devices, systems and people will drive more compound and dynamic value streams. This opens up new collaborative business model opportunities that have the potential to drive much greater value for the customer.

These new business model opportunities are much closer in many respects to the consumer-driven models described earlier, and can provide many lessons for the "cloistered" equipment manufacturers in B2B arenas. The business benefits of large scale open collaboration in the B2B arena are just beginning to be recognized.

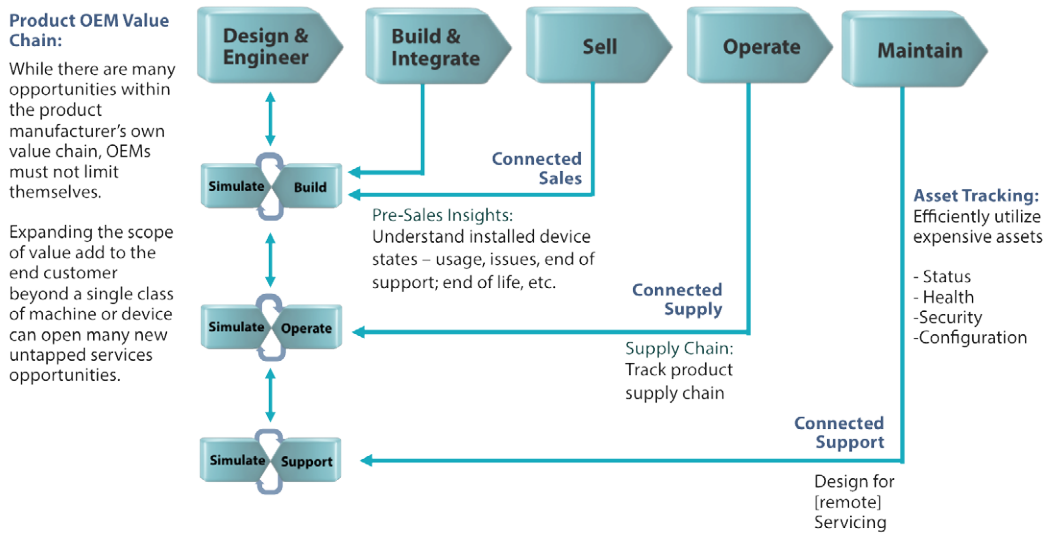
BUILDING COMPOUND VALUE FOR USERS and CUSTOMERS

Moving from "Simple" to "Compound" applications involves multiple collaborating systems with significant interactions between and among devices, systems and people. No longer is the focus solely on the product supplier's ability to deliver support for their product efficiently. Rather, value is brought to the customer through business process automation and optimization.

Consider any of the larger diversified industrial players that sell complex machines like GE or Siemens. In the power turbine business, for instance, major electric utility customers have good reason to hate equipment failures. At the least, any downtime creates huge opportunity costs for these customers; often it means they have to pay hefty regulatory compliance fines.

To reduce that risk, players like GE and Siemens have invested heavily in monitoring and diagnostics so they can deploy a technician or engineer ahead of a failure (preemptively) as opposed to doing so according to a schedule based upon assumptions (proactively) or, even worse, after the power has gone off (reactively). For one thing, this has a dramatic effect on the profitability of these players maintenance services. Most manufacturers cannot charge more than $100 to $130 per hour for their technical support because of price and benefit pressures from local competitors. But because of efficient network-enabled services, leading

Exhibit 5: Look Beyond Captive Equipment and Value Chains



players can charge $500 to $600 per hour for the same technician who has become a subject matter expert.

But, in the end, these are still examples of simple applications largely focused on the product manufacturer's own value chain. They are simple "hub and spoke" remote support. While there is value in these models, there are significant untapped opportunities for providing new value for the users and customers.

Instead, Smart System's true potential lies in the integration of diverse machines, information systems and people—its ability to connect billions upon billions of smart sensors, devices, and ordinary products into a "digital nervous system" that will smoothly interact with individuals and the physical world. The nature of compound and complex systems applications is just beginning to be understood where the information value generated by

these capabilities positions players to take on significant additional tasks for the customer in the future, such as:

» Managing and automating a customer's spare parts inventory and service delivery chain for maintenance processes providing vastly improved levels of service and responsiveness;

» Providing the customer's first line support staff, the machine builders' service technicians and other third party support personnel with complete access to a unified machine maintenance record that captures all of the machine's performance data, history and knowledge about the status of the equipment, enabling faster and more effective maintenance processes;

» Analyzing the history of the equipment in use against diverse data sources such as weather patterns and peak usage requirements to optimize its performance;

» Providing entirely new services to the customer, such as "security as a service," where security and privacy for all devices, machines, networks and data is provided as a managed service.

Customers are looking to equipment manufacturers not just for high-quality equipment, but also for help in optimizing their ability to supply consistent and high-quality products and services to their customers. This evolution will allow manufacturers to tie their revenue and pricing models directly to the benefits they provide.

Taken one step further, applications that drive interactions between and among devices, sub-systems and people across enterprise and public sector systems will potentially allow extending and expanding values from third party collaboration and large scale data integration and analytics that, while complex, will drive the highest possible value from smart systems.

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If you place this evolution into a much larger context – say how the Internet of Things will impact our planet's resources – the potential impacts become even more profound. Even with the productivity improvements we see today, modern power delivery systems are still extremely inefficient. Over 20% of electricity generated each year is never consumed from the grid. This represents more than enough energy to power an entire region, like the United States or Europe, for an entire year. Utilizing network and data management technologies to make the grid more efficient would allow us to retire well over 1,000 coal-fired power plants. Combining sophisticated sensors, real-time connectivity, and massive computing power, can equip businesses for the next level of optimization across virtually all sectors of the economy.

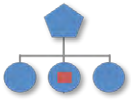
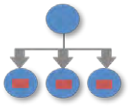
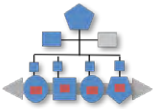
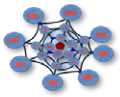
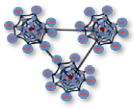
03: SMART CONNECTED BUSINESS MODELS

A new Smart Systems business model will re-think the whole relationship of people and devices to business systems and processes. It must be built upon true, across-the-board digital automation, accomplished by enabling everyday electronic devices to communicate with and control each other, supplemented by a whole new generation of information tools for managing rich, vast streams of meaningful data. The goal is to fully integrate people and assets into smart systems that are self-sensing, self-controlling, and self-optimizing—automatically. Unfortunately, not enough manufacturers are thinking about it this way.

We have observed many new and creative value added services and business model innovation opportunities which, for the most part, often appear too "aggressive" or "risky" for the typical industrial B2B players. Manufacturers often miss new opportunities because traditional company cultures have all too often defined services as subservient to the product, as no more than a "bootstrap" business with little up-front investment or innovation.

Even those companies that have built remote services offerings have tended to only focus on their device, their machine and their value chain – missing the opportunity to more openly collaborate with partners and customers and provide integration for a much broader scope of systems within the customer's operations.

Exhibit 6: Smart System and Services Business Models

Solo Driven		Partner Driven		Open Collaboration Driven	
Embedded Innovator	**System Professional**	**Solutionist**	**Value Chain Aggregator**	**Collaborator**	**Community**
					
Largely focused on remote support automation & data value for specific product	Leverages services automation to feed diverse needs across product provider delivery chain	Builds broad support capabilities across the entire life cycle of target equipment or delivery chain	Collects, organizes data with aim to optimize interactions across single provider dominant delivery chain	Builds / extends value via collaboration with customers, channels and providers across collective delivery chains	Drives value via extensive multi-party collaboration and by leveraging private, public, and partnered info sharing
Largely harvests product usage data to identify needs and functions – real-time "field intelligence" on products and customers	Feeds device intelligence from field to support for efficiencies - pre-emptive maintenance & replenishment via remote monitoring and diagnostics	Offers new process or application / performance optimization values - sells life cycle capabilities – leverages partners interactions across delivery chain based on "preferred access"	Manages product life-cycle and customer relationship – co-designs, finances, installs, maintains, replenishes & supports usage - provides access to "qualified" third-parties	Acts as a problem-solving, value-creating partner who then collaborates to create new or extending values - Uses acquired info-techniques and domain expertise to move into adjacent applications	Information flows and is shared openly throughout the community of stakeholders and participants - value accrues to all participants across a much more diverse multi-party community

Fundamental changes to business models will accompany every organization's decision to utilize and act on the data flowing from its connected products.

While looking for and identifying the tools available to product-centric businesses shifting to services, it is vitally important that businesses consider whether or not the opportunity is one

that can be seized alone or in conjunction with another or even with many others.

Simply put, the overall smart systems and services opportunity is one a company can seize alone, a partner-driven opportunity, which will in one way or another be an opportunity that is shared with others, or an open collaborative opportunity.

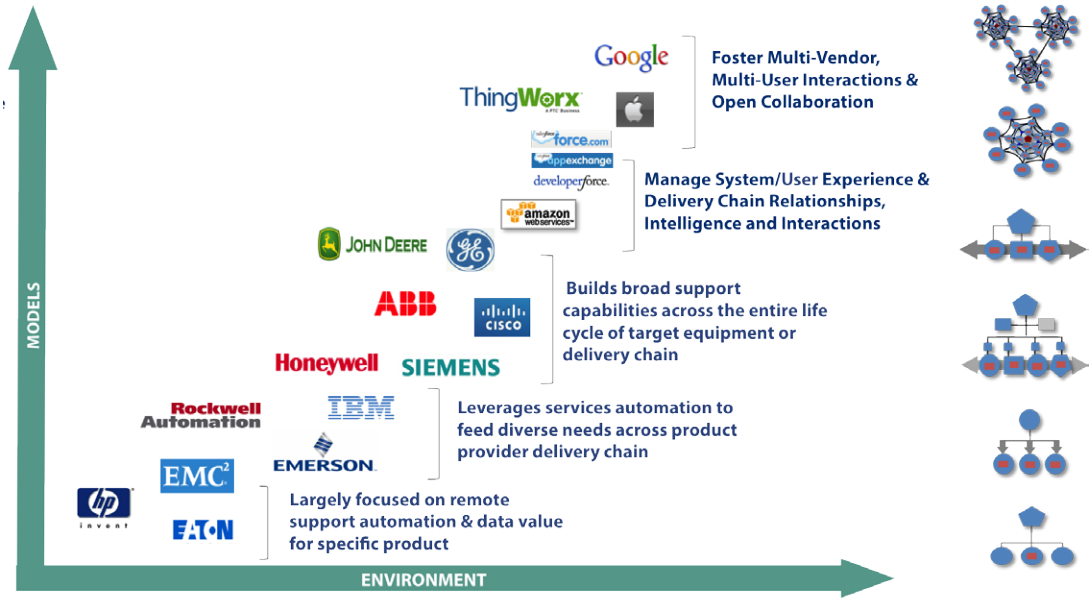
» **Solo:** Where most of the elements of the opportunity are attached directly to a product's life cycle such that they are designed to be deployed by the product player alone;

» **Partner-Driven:** Where the opportunities require multiple value adding partners working in a closely coupled fashion and are designed with partnerships in mind; and,

» **Open Collaboration:** Where the opportunity is forged around a platform model that provides for and enables extensive third party collaboration and contributions, and clearly addresses a broader scope of the customer's operations systems than any single equipment manufacturer would address alone.

The direction a company takes will help determine the kind of business model it should adopt. For players that go at it alone, it may be what we call an "embedded innovator" or "system professional." Examples of solo models include remote services for office equipment or other types of machines.

Exhibit 7: Smart System and Services Business Models Are Progressive



If you partner with others, it may be as a "solutionist" or "value chain aggregator." Examples of these models include construction and agricultural equipment from players like Deere and Caterpillar where the value chain is integrated with equipment dealers and other adjacent value added services suppliers.

But if your goal is to leverage a more open participative model, it is what we would call a "collaborator" or a "community builder."

These are the basic business models available to product makers that decide to embrace smart systems and services. We have summarized the attributes and defining characteristics for each of the models in the tables on the previous page and below.

Moving beyond simple applications for connected products requires broader collaboration across multi-party ecosystems that drive numerous interactions between and among people, systems and devices.

These models are progressive where the value increases with the integration of each additional player's equipment and systems and the increased resulting interactions. These "complex" applications and the significant increase in interaction value they inform, inevitably require open information flows and shared data across the ecosystem and participants. Creating an unbroken circle of data and information value based on the integration of people, processes, and relationships across the complex ecosystem partners is the "holy grail" of smart systems.

04: FRAMEWORK FOR IDENTIFYING OPPORTUNITIES

Thinking about the business opportunity associated with a connected product is a highly creative process. Often there are no cut-and-dried markets to identify and size. Rather, there are whole new markets that might develop as networked products and systems are brought to market.

We believe business model design needs to transcend discrete product or service innovation. Assuming that the role of business design is only about making existing products or services more attractive no longer works. Business developers need to creatively imagine fully developed systems and whole marketplaces. Companies need to envision the design role as one that can address product, service, user experience and cumulative system value.

Today, with the emergence of connected products and information-based services, even more complexity has arisen in the design of the systems and the services as well as in the core of the products and elements within the core system. Additionally, from our viewpoint, because networks add yet more complexity to the process and because just about everything will get connected, we strongly believe business developers need to address multiple interrelated dimensions in order to fully address the nature and scope of the resulting business opportunities.

To move from thinking to research to real-world solutions, you will go through a process of synthesis and interpretation that needs to begin with a discovery phase that can help organizations connect better with the customers they serve. Done properly, discovery sets the stage to drive new concepts and innovation potential and help organizations to see tangible new opportunities. The elements that need to be addressed in the discovery phase follow here:

» **Experience:** Developing solutions based on user-centered experience for users, customers and partners;

» **Behaviors:** Understanding the many and diverse buying and usage behaviors and modes of collaboration across ecosystems and markets;

» **Relationships:** Potential to engage and leverage extended communities of users, companies, OEMs and suppliers with real-time interactions and information value;

» **Technology:** Emerging technologies, if properly nurtured and applied, can foster many opportunities to disrupt current competitive structures;

» **Skills:** Leveraging human capital and skills in this connected world to re-design and automate business processes will create entirely new solution values; and,

» **Data and Content:** Organizing the rapidly growing amounts of data from open systems for wider use, awareness, collaboration and collective intelligence.

The intersection of the six dimensions above is where discovery of business models begins. This discovery phase is where organizations can identify a "business model design challenge." The foundation of smart systems business model development is identifying a concise design challenge. This challenge will guide the queries and questions you will ask customers during field research and the opportunities and solutions you will develop later in the process.

But the whole process begins by discovering and identifying challenges customers are facing or leveraging opportunities your organization has identified and is interested in exploring. The goal is to narrow feedback and inputs from the discovery process down to one specific business system and model design challenge.

creating an unbroken circle of data and information based on the integration of people, processes, and relationships across the complex ecosystem

Once addressed, the diverse perspectives developed during discovery can help feed a more structured process that addresses the tasks that need to be undertaken to define and develop new smart systems businesses.

Inevitably, companies will fail to understand the disruptive threat inherent in the Internet of Things and connected products, and a merely defensive justification to network a product or machine may not succeed in creating sustained competitive differentiation.

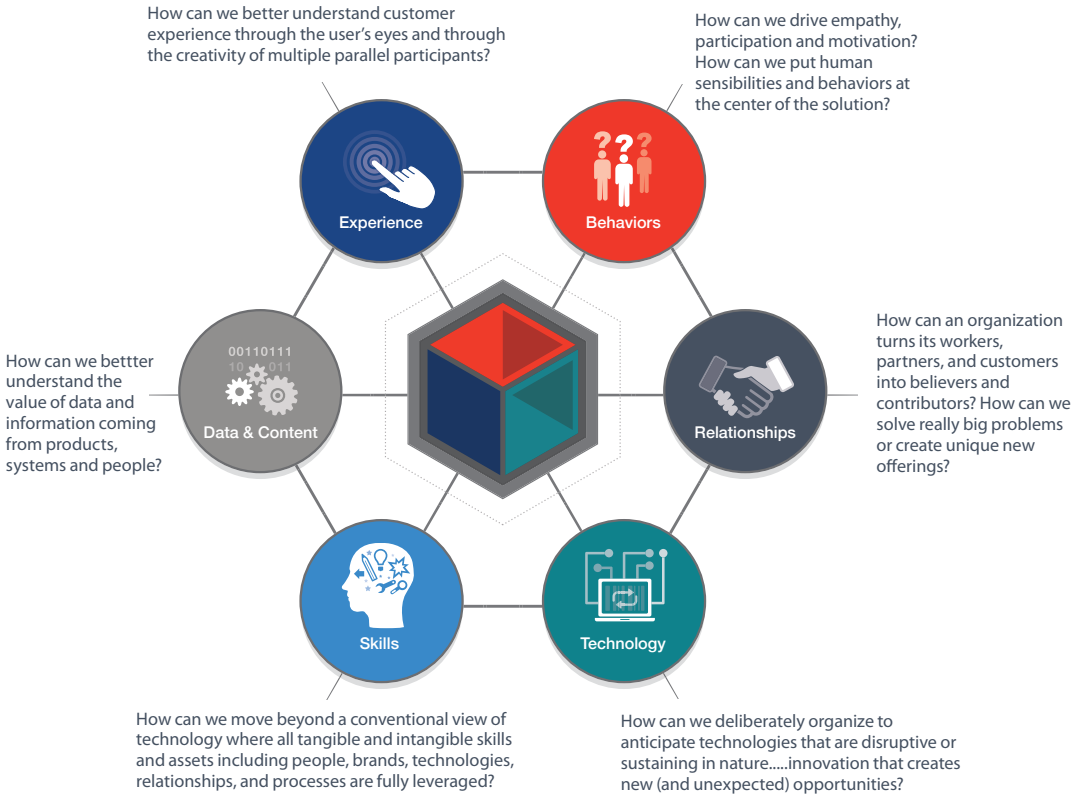
Fortunately, a simple process and methodology, which we present at the end of this document, will allow most companies to think through the advantages of pushing towards new models and allow many to find the required motivation.

Still, many companies will be hampered in their thinking by a tendency to assume that the company after networking and smart systems will be the same company and in the same business as before networking. This is a safe assumption in almost no case.

The first fact about a networked product, which is so obvious that no one needs to be told, is that it will capture and convey valuable data. The second fact, not quite so obvious, is that these new data become a core asset. The third fact, an obscure leap for many managers, is that information as an asset makes for fundamental changes in a company's business. The fourth fact, which makes things simple but by no means easy, is that most changes brought about when information becomes central have the effect of moving a company toward an entirely new service business model.

We say this is simple but not easy, because while the fact that service moves to the fore is not hard to grasp, in practice service is a paradigm so foreign to manufacturers that they cannot understand, let alone implement, the changes necessary to make the shift successfully.

Exhibit 8: Smart System Design Framework



Many companies have already seen some of the challenges inherent in shifting to a services-driven business. In fact, the phrase "shift to services-driven business," though accurate, can be dangerously misleading as it can make the required corporate culture and business model changes sound almost tame. They aren't. The era of near perfect, real-time information about physical assets and customer behaviors is looming like a tanker coming out of the fog. Any degree of complacency – even from those who consider themselves "advanced" – will be deadly.

The next great step in IT and OT development—completely fluid information and fully interoperating devices, people and systems—requires a new generation of data and application integration platform technology that will make information itself truly portable in both the physical and information spaces, and among any conceivable smart information devices and machines.

Technology advancements need to engender new system elements and new services. Correctly balanced, technology and new service delivery modes can help customers reach their goals of increased operating efficiency, reduced costs, automated system upgrades, and more efficient operations. Achieving this critical balance is the challenge that most OEM's smart services developments must focus on solving.

New businesss model innovation needs to reduce a significant percentage of the complexities that customers and users face with connected platform development, systems management and application delivery. The challenges of networking smart devices, developing connected product applications, integrating complex IT systems and unifying services delivery in a coherent and cost-effective manner have been big hurdles to adoption that OEM's businesses need to address.

Radical new thinking about connected product technology must begin at the most basic levels. OEM business development teams need to future proof their innovations by making the fewest possible assumptions about the nature of networked objects and the data they produce, carry or process - the company needs to take a much broader, all-encompassing view of device data and information. Ultimately, these types of solutions will radically alter how new applications are realized and customers supported.

CAPTURING THE VALUE OF SMART CONNECTED SYSTEMS

To achieve real compound value in smart systems applications, equipment players and value adders will need to think and act differently. A renewed focus on developing ecosystems and the critical relationships that will drive value are key to success.

Integrating physical and virtual systems will require expert application knowledge as well as a deep understanding of how these systems will work. Choosing the right partners, players that fully understand the different elements involved, and are financially stable, and correctly aligned with delivery requirements will be critical to successful deployments.

Smart services applications are highly specialized. Embedding connectivity into the next generation of devices, ensuring they are deployed profitably and that new cloud and services delivery capabilities can scale across multiple industries and countries, are challenging tasks.

Automated information gathering from even the simplest of devices can easily generate millions of data points every day. Each of these data points may contain a very tiny snippet of information, like an event time-stamp or the physical state of a specific product. They must be subjected to sophisticated integration and analytics that turn them into actionable intelligence.

Companies pursuing Smart Systems initiatives will need to define organization-wide IT, network and data architecture standards. They will also need to effectively employ a platform to integrate and synchronize applications and data from disparate sources into compatible formats. Finally, they will need to take advantage of proven data science solutions that can leverage diverse new information sources.

Investment in new tools and a "future proof" platform and architecture will help manage the rapidly rising complexity of these systems and be a minimum requirement for success. Equally important will be selecting the right partners to help integrate and deploy these solutions.

Working with emergent technology innovators, but also with established players, where there is a deeply rooted understanding of the complexities of large global customers needs, will help ensure successfully deployed solutions.

Any successful OEM's core skills in product development and realization will play a key role; a company's solutions can be re-designed to create digital value at every level for users and customers, creating an unbroken chain of innovation and solution value.

OEM's have the chance to create a new chapter in the story of smart systems that will inform new value in the converged Internet of Things and People arena.

Since all that we are describing is a radical departure from current offerings and business practices, and is driven by a very unique set of needs, it stands to reason that this type of solution does not fall within the narrow specialties of most existing players. In fact, the innovation being described is probably best viewed as an entirely new chapter in the marketplace. This is particularly true given the disjointed patchwork of solutions presently in place and the apparent lack of vision from existing players of what's required in the future. The opportunity to lead in developing and shaping this market looks wide open for creative players.

05: SMART SYSTEMS DESIGN

Today, with the emergence of connected products and information-based services, even more complexity has arisen in the design of systems and services as well as in the core of the product. Because networks add yet more complexity to the process and because just about everything will get connected, we strongly believe this environment requires combinations of several disciplines and methods in order to fully address the nature of smart connected business opportunities.

To discover, design and develop innovative Smart Systems, organizations must consider all the elements involved and the context they fit into. The benefits that will flow from the recognition that traditional strategy and product development protocols will not meet the needs of a connected business are significant.

Smart Systems Design integrates multidisciplinary processes and methods in new ways. It is a new field that connects organizations and customers in novel ways:

- Smart Systems are informed and supported by complex network and information interactions that are are truly about "real-time" user experience;
- Smart Systems are based on business models that are wholly new and different;
- Smart systems are driven by integration of the physical and virtual worlds;
- Smart Systems drives new levels of personalization as well as participatory design and interactions; and,
- Smart Systems directly informs services with new information value.

creating smart systems is about abandoning traditional planning and development protocols

Design, as well as strategy, is concerned with creating values and making them visible, not to mention profitable. Business strategy and design today need to extend to the experience that customers will have with connected products, services, spaces or a mix of these and, therefore must integrate the processes and systems that are behind these experiences with decisions related to both design and strategy.

The convergence of design with strategy and related innovation processes will inevitably lead to a new integrated set of processes, methods and disciplines -- the advent of what we are calling Smart Systems Design.

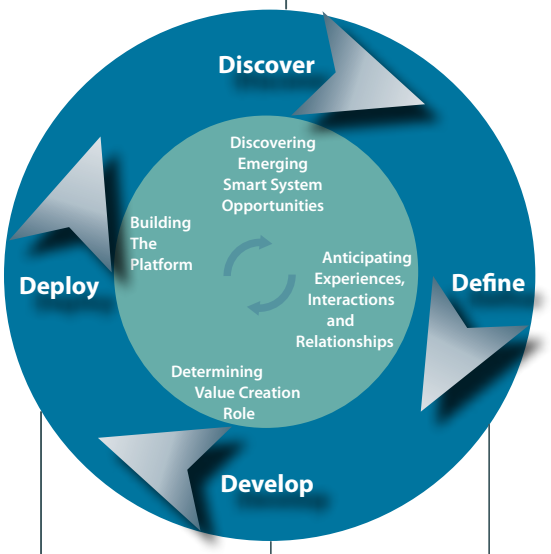
SMART SYSTEMS DESIGN PROCESS

Harbor's business model design process consists of four phases. In creating your initial discovery and plans, you'll be thinking about the activities a customer performs with, around, and related to networked products. You'll need to untether your imagination from your current product and think about the new, connected smart systems application opportunity. The first two phases of work — the discovery process as well as defining who can potentially partner and collaborate with you — set the stage to drive new concepts and innovation potential and help organizations to see tangible new opportunities.

The capabilities of your organization and partners will help inform the feasibility of target solutions. In thinking about the experience of the end customer—where and how the community members or the end-users experience this solution — you must identify the range of capabilities required for making this real.

Once a solution has been conceived, designed and modeled, you will need to turn your attention to the long-term success of the solution which depends upon the intentional design of revenue streams that can sustain the offering over time. Let the value provided to the end customer be your starting point as you design the revenue models and business case.

Smart Systems Design is a new discipline.....



Discovering Emerging Smart Systems Opportunities

Explore

Who are our customers? What are their experiences?

What personas, applications, devices & systems does our product or service touch? What is the nature of the interactions?

How can we best use technological and market uncertainty to our advantage?

Experience

What primary customer activities can we observe; be involved with?

Which activities represent opportunities for us? Do these activities benefit from smart devices and/or services?

What adjacent activities can we observe; be involved with? Will these activities benefit from smart devices and/or services?

Map

What elements will combine to create value for the customer? What benefits can be added over time & what advantages will they bring?

Are there special challenges in making the value salient to the customer?

Do these elements extend existing product or service offerings or are they completely new?

Based on desired peer interaction & technology maturity, is the timing right?

Defining Interactions, Collaboration & System Values

Developing Value Creation Model & Role

Deploying the Smart System

driven by a core set of critical questions.....

Conceive

Who will be the users and customers potentially participating in our solution?

What needs, concepts and solutions will serve our users, customers and partners?

Who are our natural allies (players; devices; peers); what companies will play or contribute to the new system; who is best poised to help develop our opportunity?

What formal and informal relationships might exist in the future?

Participate

Is there an explicit (or implicit) community of participants? If so, which participants interact with which value elements?

What manner of interactions can we use to drive empathy? involvement? innovation?

Who can we invite to collaborate? Which potential participants can help us best understand the user/ system experience?

How can we best present, iterate and test our system concepts; hypothesis?

Prototype

How should we prototype the customer and partner experiences?

What are the critical information interfaces? Interactions? How will information flow between and among constituents?

What are the key system elements & design factors?

How can we quickly iterate our assumptions to learn more?

Model

What characteristics should we use to segment our users, custoemrs, markets and articulate the benefits of our proposed offering?

Which actual or anticipated segments are most attractive?

What role/s can we/they play in the proposed system?

What ecosystem configuration best supports our strategy; open; closed; hierarchical; select members?

Which value elements should we own; which should we obtain by partnering?

What are the business model alternatives; which is best aligned with the offering?

Innovate

What technology innovation is available to enhance or extend our system's value?

What is the architectural "blueprint" behind the customer experience?

What technology alllies will be required for system/service realization?

Validate

How can we best test our business design? What is the best means to prove our system's value in the field?

How attractive are the economics of the business case; what will it cost to bring the system to market? Will it result in cost savings; new values; new experience?

Architect

What are the key systems and ecosystem design factors? How will our role or the role of others evolve?

What is the business system that will best enable the customer experience

How should the new system be positioned in the marketplace?

Invest

How can we align investments and resources with our chosen strategy?

How should we approach critical make, buy, partner decisions?

Build

What is our system development and launch plan?

What technology allies will be required for product / service / system realization?

What organization levers will best drive this business? What leadership priorities will drive the most effective market role?

What are the critical path elements that need to addressed: activities; timing; responsibilities; costs; uncertainties?

What key on-going support elements need to be in place to continue to enhance our objectives?

What will be the mode of iteration for improving and expanding the business?

Custom and Configured Research Interactions Help Support Strategy

Player Profiles, Ecosystem Maps, Analysis and Database

Harbor Research has completed 500 player profiles on top companies in the IoT market including mapping their customer, competitor, investor and partner ecosystems.

Smart Systems Market Model and Forecast

Harbor's proprietary smart systems device demographics database and model helps strategic business developers evaluate opportunities, make decisions around pricing models and craft marketing and sales strategies.

Research Briefs, Data Books and Playbooks

Harbor's research on markets and technologies within the overall Smart Systems and the Internet of Things arena that provide a forward-looking, distinct perspective on new market and technology growth opportunities. Explore our editorial calendar for our latest research

Market, Technology and Event Briefings

Briefings provide your team a download on current market dynamics and trends, emergent technologies, or a company's movements.

Focused Market Intelligence Tracking

We employ proprietary algorithms to scour news sites, blogs, trade publications and social media feeds for curate information about markets, technologies players and events all organized against our Smart Systems and IoT taxonomy.

On-Going Queries and Analyst Support

Acting "on-call", our analysts will pull and aggregate specific data, profiles or explanations in configured responses to answer your specific questions and meet your unique needs.

Configured Research and Analysis

Recognizing that many clients have needs that reach beyond published reports, Harbor conducts "configured" research and analysis on topics that are emerging across the landscape providing updates based on specific areas clients are focused on.

Custom Market Modeling and Forecasting

We have designed our market map and forecast model for configured and custom modeling. Leveraging our extensive device segment coverage, clients can create custom forecasts to look at quantifiable elements beyond shipments and associated revenues.

Strategic Business Reviews

Clients will have the opportunity to attend a collaborative session with analysts from Harbor Research on a bi-annual basis. These discussions address strategic questions about market, technology and player opportunities your team is focused on.

ABOUT HARBOR RESEARCH

An internationally recognized research, technology, and business development consulting firm, Harbor Research has predicted, tracked, and driven the development of the Internet of Things since our inception in 1984. While our history is long, our strategy is simple: capture and create value by combining accurate data discovery and analysis with creative systems-thinking. It is this mindset that has given us the privilege of working with some of the greatest companies in the world. Today, we continue to work with C-level executives and top management of some of the world's most consistently successful companies and innovative startups. In the same way that the market has flexed and grown over the years, our services and experience have grown to make us the premier service organization you see today. We work with clients in a variety of ways including consulting, advisory, research and content development, thought leadership and workshop facilitation.

Thought Leadership

As much as we would like to say there is a simple linear process and recipe to drive new smart systems innovation, the nature and complexity of the Internet of Things makes that impossible. Harbor brings order to that complexity, by framing opportunities with a holistic view of the market.

Unique Process

We provide our clients with rigorous analysis and insight to support critical new business design and development decisions. Our research, content and modeling provides an ideal context for discovery, ideation and planning.

Vibrant Community

Building new ventures for the internet of Things requires new and very different modes of design and development – In working with a vast set of market leaders and disruptive players we push the boundaries of collaboration to include many new and unfamiliar participants.

If you or your colleagues would like to learn more:

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