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The Internet of Things

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THE INTERNET OF THINGS

Programming Business Models Through Digital Density

By JAVIER ZAMORA

The world's first car was invented in 1886 with one main purpose: moving people from point A to point B faster than a horse-drawn carriage. Fast-forward to 2017 and today's cars are more akin to roving computers with mechanical peripherals. Unlike the drivers of yesteryear, modern motorists get behind the wheel, buckle up – and then link their smartphones to a diagnostic interface and access real-time data such as their gas consumption and driving habits. In the course of a century, the concept of a car as a means of transport has been transformed.

This is just one example of the Internet of Things (IoT). When a thing – in this case, a car – is embedded with an internet connection and paired with a smartphone, it is instantly capable of communicating a plethora of rich, useful data. Increasingly, these digital connections are redefining the boundaries of competition and reshaping the sources of customer value.

In this article, I will present a framework that can help senior executives create and capture value by tapping this pool of connected data and pinpointing the programmable elements of their value proposition.

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Understanding the Power of Digital Density

IoT is not a passing fad. It represents something big: the power of being able to remotely access data generated not only by organizations and people but also *things*, regardless of their physical location, and make meaningful interactions between them. In this sense, connected data become an abstraction of the physical entity itself, which can be remotely observed, monitored and/or controlled.

Over the past 25 years, wave after wave of digital technologies have driven a steady growth of internet connections and afforded new opportunities for value creation. In the 1990s, all eyes were on the World Wide Web, which allowed consumers to purchase goods and services that used to only be accessible in-store. Since then, the tech industry has advanced at breakneck speed, introducing a raft of new concepts – from social media, Web 2.0, mobility and big data to cloud computing, virtual reality, robots and artificial intelligence.

The tendency to consider each technological innovation as an isolated phenomenon makes it difficult for senior executives to grasp their business potential. Yet all these technologies are manifestations of an overarching concept known as digital density.

Digital density occurs as a function of the number of organizations, people and things that are connected. A mere decade since the first smartphone, these connections now number in the billions.

To better understand the power of digital density, let's start by examining its two basic components – connections and data – both of which have exploded, thanks to the falling costs and expanding power of IT, and which have now reached a tipping point.

CONNECTIONS. Connections refer to the ability to link any element of the physical world – organizations, people and things – to the internet. Over the past three decades, the number of persistent connections has grown exponentially, with "persistent" defined as 24/7, always-on access, to enable unconstrained interactions and information transfers.

In the 1980s, only medium- to large-sized organizations with healthy IT budgets were connected to the internet. Outside these confines, the rest of the world remained in the unconnected dark, hindered by the high cost and complexity of technology. As Moore's law of exponentially faster, cheaper computing was realized, costs went down and technology was able to penetrate consumer markets.

During the 1990s, internet access spread to households, first with dial-up modems, then with ADSL and cable, and now with fiber optics.

The introduction of smartphones in the mid-2000s broke yet another barrier of physical space, as cell phones turned into portable computers that connected people on the go, regardless of their location. According to the business intelligence portal Statista, the installed base of IoT devices is forecast to reach 31 billion worldwide by 2020. And every time a new entity is connected, another order of magnitude is added.

DATA. The sheer volume of connected data has shaped and transformed the digital universe over the past two decades as well. In the 1990s, most of the world's data were analog, meaning that data were rendered in physical form, as printed material, for example. By 2007, the global volume of digitally connected data had reached critical mass.

The capacity to combine connections and data, and cross them with other connected data, generates myriad interactions that grow exponentially and combinatorially. However, not all of these interactions are meaningful, so the role of the executive is to select or code the ones of interest to reap the most benefits of digital density. Doing so can result in greater levels of efficiency, coordination and

EXECUTIVE SUMMARY

The exponential growth of digital connections and data generates myriad interactions between organizations, people and things that executives can leverage to enhance their current business models or create entirely new ones. But how best to harness the power of this digital density? This article presents a framework to help senior executives tap connected data and pinpoint the programmable elements of their value proposition. The author also highlights the pros and cons, so businesses can maximize the value drivers while simultaneously monitoring the privacy, reliability, security and integration issues associated with a high-digital-density environment.

> As digital density intensifies, the once sharply defined lines between the digital and physical worlds begin to fade, forging a new, blended environment, in a process known as digital transformation.

personalization, as well as an enhanced ability to anticipate change.

Digital Transformation and Disruption

The percentage of connected data per unit of activity – aka digital density – is often used to gauge a sector's potential to generate new business models. A unit of activity can be anything from a business unit, organization or sector, to a city, region or country. As digital density intensifies, the once sharply defined lines between the digital and physical worlds begin to fade, forging a new, blended environment, in a process known as digital transformation.

According to my IESE colleague Joan E. Ricart, a business model entails identifying "a new approach" for creating and capturing value to exploit business opportunities. This new approach relates to the set of interactions, both front- and back-end, involved in creating a value proposition. With this definition in mind, the rise of digital density can exert various effects, but for the purposes of this article, I will highlight two key ones.

First, it can trigger disintermediation, undermining a company's ability to monetize its value creation: think of the effect of Amazon on brick-and-mortar bookstores, or LinkedIn on conventional headhunting.

Second, digital density can spark the creation of entirely new business models that were inconceivable before. Uber's business model – connecting passengers and available drivers in real time – is only made possible through the mass adoption of smartphones. Until recently, there simply weren't enough people with mobile internet access to sustain such a business model.

Car dealerships are another case in point. Traditionally, dealerships provided the setting for both the discovery and buying phases of the customer journey, with would-be buyers visiting the showroom an average of five times before making the purchase. Today's car buyers, however, do much of the legwork online to decide which model best suits their needs and, more often than not, make a lone visit to the dealership to fill out the paperwork and drive their new car off the lot. This paradigm shift has forced dealerships to redesign their business model. Tesla, for example, uses its showrooms to display models for potential buyers but sells its cars through its website.

In any given sector, the magnitude of digital transformation is directly related to its level of digital density. As such, its impact on the business model can run the gamut – from rattling the front-end structure, as in the case of car dealers, to upending every dimension of the industry, as in the case of Uber and the taxi business model.

While these examples are specific to the automotive and transportation sectors, other industries can harness digital density to exploit untapped opportunities. How? An analysis of the digital transformation architecture may provide some insights.

New Business Model Possibilities

Powered by digital density, digital transformation has altered how global industries perform their core activities, serve customer needs, generate fresh value propositions and capture new opportunities. Let's break this phenomenon down by turning to **Exhibit 1**, which illustrates the main components of the digital transformation architecture and its two main domains: digital density and the business model.

As we can see, the digital density domain comprises three tiers. The *physical layer* refers to the organizations, people or things that are being connected. The *connection layer* is the digital interface that links the physical and digital worlds, including digitized processes like customer relationship management (CRM) and enterprise resource planning (ERP) that organizations implement; human-interface devices (web, apps, voice and motion) that people use;

and sensors or actuators embedded in things. Finally, the *data layer* includes structured (transactional) data; unstructured data (social media, videos, texts and the like); and/or data streams or flows (IoT).

Collectively, these data provide all the potential raw material that may lead to meaningful interactions. By separating the wheat from the chaff, executives can leverage these interactions to devise a value proposition and develop a revenue model.

IT enthusiasts may appreciate the parallelism between the digital density domain and a general purpose computer (GPC), in which the computer's hardware would represent the physical layer, the device drivers would denote the connection layer, and the operating system would symbolize the data layer. Just as an operating system is an abstraction of the computer's hardware, the data layer becomes an abstraction of the physical layer.

Moreover, a GPC is a fitting example of generative technology, which allows third parties to innovate and develop software or hardware to enhance the original device, with no gatekeeping. The monumental shift that separated the development of software from the wiring and rewiring of the underlying hardware led to an explosion of new developments and applications.

Similarly, the digital density domain may also be considered a form of generative technology. The data layer enables the generation of a multitude of interactions, some of which may serve as the building blocks of meaningful business models.

Programming Business Models

Designed to create and capture value, business models are traditionally grounded on defined strategies that require ongoing investments to acquire and build the needed assets. Like fixed overhead, many of these resources lack the flexibility to adapt swiftly to economic shifts and sectorial innovations. However, if businesses replace the physical resources with abstract layers of connected data, these become programmable elements of the business model. In this way, data can potentially drive corporate value propositions implemented through front- and back-office activities. And herein lie optimized processes and untapped value creation.

To bridge theory and practice, let's consider Progressive Corporation, a U.S. insurance provider that has taken personalization to a new level through its Snapshot program. Through this opt-in initiative, customers plug a small device (the connection layer) into the onboard diagnostic (OBD) of their car, which tracks their driving behavior (the physical layer) and sends the data (the data layer) back to Progressive. The company compiles a 30-day "snapshot" and offers discounted rates to customers deemed to be good drivers. The program is voluntary, so drivers can also opt to pay a premium based on the standard car insurance criteria such as age, area of residence and car model.

Another example of the possibilities of digital density is Waze. Founded in 2008 – a year after the launch of the iPhone – and acquired by Google in 2013, Waze is a GPS-based navigation app for smartphones and tablets that provides real-time traffic information so users can pick the fastest route. By all accounts, Waze is a win-win: drivers with the app get up-to-the-minute traffic information, while simultaneously serving as "road sensors" for other Waze users. As a result, the more drivers who use the app (connections), the higher the accuracy (connected data) and the better the service.

Ecosystems: Beyond Value Chains

According to the strategy expert Michael Porter, the massive deployment of smart, connected products has unleashed a third wave of IT-driven competition. Today, IT is no longer relegated to simply automating or coordinating certain elements of the value chain; rather, it has become a core driver of the value proposition.

Connected data in the digital domain come

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The author of numerous publications and two international patents, Zamora focuses on the digital transformation of organizations through the application of new digital technologies, with an emphasis on redesigning processes and the challenges of developing a digital mindset. Outside the academic arena, he is the cofounder of Inqbarna, a company that specializes in the development of apps for smartphones and tablets.

EXHIBIT 1

Digital Transformation Architecture

BY ANALYZING EACH LAYER, WE MAY FIND NEW, UNTAPPED VALUE POTENTIAL.

Business Model Domain			
VALUE CAPTURE LAYER >>>	Revenue Model		
VALUE CREATION LAYER>>>	Interactions		
	Back-end	Front-end	
Digital Density Domain			
DATA LAYER >	Data: source / type / frequency		
	Structured	Unstructured	Streams
CONNECTION LAYER>	Digitized processes	Human-interface devices	Sensors/ actuators
PHYSICAL LAYER >>>	Organizations	People	Things (hardware/ devices)

to represent an abstraction of the diverse components of the business model's physical domain. As Ramon Casadesus-Masanell and Joan E. Ricart note in their article, "How to Design a Winning Business Model," it is precisely this separation between physical assets and digital interaction that lends malleability to business models, since assets can be reconfigured or programmed as needed.

This programmability of business models offers infinite possibilities to identify potential value propositions and build relevant business cases. In a first derivative, firms can leverage connectivity to enhance their current business model by:

- maximizing efficiency, through remote management and control;
- optimizing existing assets, through predictive maintenance;
- extending the value proposition, with digital extensions and upgrades;
- shifting from a product to service, such as pay-as-you-go.

The evolution of the car, as described at the beginning of this article, illustrates these possibilities. Until recently, the value of the car resided in the car itself as a means of transportation. As technology evolves, however, its value proposition is shifting to one of a mobility service, as evidenced by the surge of car-sharing platforms.

In a second derivative, the programmability of the business model offers even greater promise, since it enables firms to create value propositions outside their traditional value chains. By recombining and connecting disparate assets and actors, companies can leverage new types of interactions that were unfathomable in an unconnected world owing to their high transaction costs. This phenomenon redefines industry boundaries and prompts a shift from linear value chains to new, richer ecosystems or "value nets."

PROS & CONS OF DIGITAL DENSITY

As with any disruptive force, digital density triggers both pros and cons. Let's consider these each in turn. See **Exhibit 2**.

Value Drivers of Digital Density

On the plus side, executives can create and capture value when they code the meaningful interactions generated in the data layer and harness them to optimize efficiency, anticipate changes, improve coordination and personalize their offering.

HIGHER EFFICIENCY. Companies have traditionally used digital technologies to boost operational efficiency, automating or redesigning processes to optimize production times, cut associated costs and reduce manufacturing errors. Perhaps no sector illustrates this better than the automotive industry, which has introduced robots and computer-integrated manufacturing (CIM) to streamline its entire supply chain.

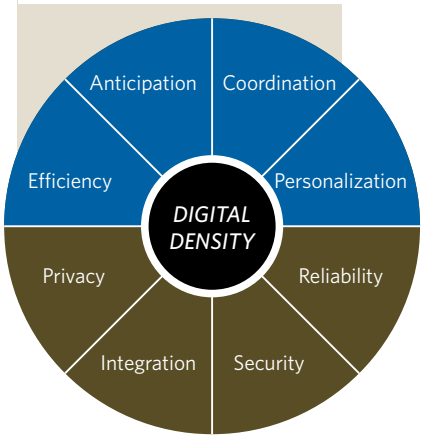
As digital density approaches 100 percent, the manufacturing process is undergoing a paradigm shift. Stefan Ferber, vice president for engineering at Bosch Software Innovations, has described it this way: "The Internet of Things allows for a new way of organizing industry production: by connecting machines, warehousing systems and goods, we can create smart production systems that basically control each other without requiring any manual intervention."

> The true benefit of big data depends not on the volume generated, but on the insights it provides to help organizations enhance their decision-making and apply it to their strategic frameworks.

EXHIBIT 2

Value Drivers & Challenges

DIGITAL DENSITY TRIGGERS BOTH PROS AND CONS. EACH OPPOSING WEDGE REPRESENTS ITS TRADE-OFF.



ANTICIPATING CHANGES. The increase of digital density allows executives to access and analyze a vast amount of data, and hone their competitive strategies by anticipating patterns and trends that this big data reveals.

The true benefit of big data depends not on the volume generated, but on the insights it provides to help organizations enhance their decision-making. In this regard, big data is only helpful insofar as executives are able to use it to describe a process, to predict future patterns based on current conditions, and/or to prescribe or recommend a course of action. Thus, the three main value drivers of big data – description, prediction and prescription – depend on the degree to which organizations apply them to their strategic frameworks. In this way, firms can trace what is going on throughout the entire life cycle of their products in great depth and detail, and even in real time.

Rolls-Royce, one of the world's leading manufacturers of aero engines, offers an interesting application. Anticipating the rise of big data, the British multinational decided to equip its engines with multiple sensors to record real-time operating data and use those data to predict technical issues before they arose. In this way, Rolls-Royce expanded its value proposition to offer both physical engines to aircraft manufacturers, as well as predictive maintenance services to airlines. This shift revolutionized the sector and transformed the company from an industry incumbent to a trailblazing innovator.

GREATER COORDINATION. The physical-location constraints of organizations, people and things are diluted when companies can gain remote access to the data they generate. This breakthrough permits the coordination of resources that were previously isolated due to high transaction costs. And the offering can be extended via third-party value propositions as part of new ecosystems or platforms.

One example is Under Armour, which embeds sensors in its sportswear. This takes the company beyond the sportswear business and into the realm of personal health, lifestyle and fitness, where the rich behavioral data of millions of users become assets for a broader ecosystem of associated products, licenses and experiences.

ENHANCED PERSONALIZATION. The surge in digital density solves the age-old paradox of the analog world, in which companies were forced to choose between economies of scale or economies of scope by offering either a standard product for a mass market or a more specialized product for a niche market. Thanks to newfound efficiency and traceability, companies can create fully customized products that adapt to the habits and preferences of individual consumers, while targeting the mass market at the same time. Progressive's Snapshot option would exemplify the power of personalization to benefit both provider and client.

The lack of regulation surrounding data ownership, privacy and cybersecurity is aggravated by the speed of change. As IoT continues to blur the boundaries, the fallout of security breaches can be catastrophic.

Challenges of Digital Density

A high-digital-density environment is not without its drawbacks. Although digital density can transform industries and allow businesses to reach new levels of competitiveness, it also creates new challenges that global organizations need to recognize and address, related to privacy, reliability, security and integration.

PRIVACY. People and organizations generate most of the connected data gathered in high-digital-density domains. A debate is currently under way over who owns these data: the internet platforms that collect the data or the individuals and organizations that submit the data. Personal data are a new asset class, which prompts the need for data banks that have clear governance regarding their use and protection. The issue of privacy also underscores the trade-off between the degree of personalization and the amount of stored data required.

The current lack of regulation surrounding data ownership, privacy and cybersecurity is aggravated by the rapid speed of technological change. As a result, companies will only be able to exploit the intrinsic benefits of high-digital-density spaces if they are able to establish a relationship of trust with their customers and are transparent in their use of personal data.

RELIABILITY. Another new development inspired by IoT is that companies have been able to take the data generated by the components of their business model (organizations, people and things) and convert their once standalone products into as-a-service value propositions, whose functionality is extended throughout the product life cycle via regular software updates. But this, too, has a downside: the more that businesses integrate technology as a core component of their value proposition, the more their success depends on the reliability of its associated software.

On top of this, the veracity of information generated in highly complex environments becomes less reliable, making it harder to classify and manage. High-end cars – which can contain 100 million lines of code – exemplify this enormous complexity. As IT migrates from a siloed business function to capture center stage as a core driver of value creation, businesses should reconsider their corporate structure to ensure it has adequate in-house IT expertise. As a recent Capgemini study has warned, less than 10 percent of the engineers in the automotive industry are software engineers. Given that industry's technological transformation, this may be less than ideal.

SECURITY. Back when only organizations had internet connections, the issue of data security entailed protecting the perimeters. In today's altered playing field, numerous dimensions of the business plan have become hyperconnected end to end, exponentially increasing the potential points of attack.

Lloyd's of London CEO Inga Beale captured this shift when she said, "In 1975, the split of assets of the S&P 500 market value was 83 percent tangible and 17 percent intangible. Today this has completely reversed to 16 percent tangible and 84 percent intangible. This transition is driving changes to the risk landscape because intangible, digital assets are becoming increasingly vulnerable to new threats like cyberattacks."

As IoT continues to blur the boundaries between the physical and digital realms, the fallout of security breaches can lead to catastrophic outcomes. Imagine the fallout if health devices, energy infrastructures or government databases are compromised. This heightened level of risk calls for a meticulous design of new services to prevent, detect and respond to cyberattacks.

INTEGRATION. In a high-digital-density environment, no single company can provide the complete value proposition to their clients.

Amid the explosion of computers, smartphones, tablets and sensors, business leaders are asking: how do we tap the power of this paradigm shift? A new digital mindset is required to deal with the challenges.

This calls for partnerships able to exchange connected data in real time. And those connections need to be seamless.

For this reason, standards must be ratified to enable horizontal platforms to communicate, operate and program the myriad devices that constitute IoT, regardless of the type of device, manufacturer or industry. At present, some standards have been established to regulate the connection of organizations and people to the internet, but this is not the case for connecting things. This sphere presents an extremely fragmented landscape laden with big players who, more often than not, reproduce their own IoT "walled garden" or "intranet of things." Time will tell which among the hundreds of IoT platforms will reach mass adoption to become the de facto standard.

Apart from agreeing some shared standards, ecosystem participants will need to agree how to share the value derived from their connected data. The use of application program interfaces (APIs) becomes important for participating companies to be able to integrate their systems in this richer, high-digital-density environment.

Going to the Next Level

Amid the explosion of computers, smartphones, tablets and sensors, business leaders are increasingly asking: how do we tap the power of this paradigm shift?

As we have seen in this article, the first step entails identifying the programmable elements of your value proposition, and then pinpointing the meaningful interactions in the data layer that might maximize efficiency, anticipation, coordination and personalization. This programmability component offers greater levels of flexibility to reconfigure your current business model or create an entirely new one – one that surpasses the traditional value chain of your sector.

But, in the domain of digital density, all that glitters isn't gold: despite clear benefits, digital density presents distinct challenges related to privacy, reliability, security and integration that executives must continuously monitor and control.

Above all, a new digital mindset is required to deal with the managerial challenges this presents at the strategic as well as operational level. My *IESE Insight* article co-written with my Information Systems Department colleagues Evgeny Káganer and Sandra Sieber details the "Five Skills Every Leader Needs to Succeed in the Digital World."

In the end, long-term success in a digitally dense world depends on your organization's ability to maximize the value drivers while minimizing the potential challenges, and learning to navigate an ecosystem in which the rules, rights and regulations are being written as we go along. ☐

TO KNOW MORE

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