The Internet of Things is changing the world, with people and machines connecting at dizzying levels and creating a labyrinth of game-changing, fast-moving Big Data. Unlocking the data mysteries can infuse your business with new superpowers to seize opportunities and zap threats. Illustrated by real-life case studies, Thingalytics shows how the alchemy of real-time analytics and smart algorithms turns fast Big Data into actionable gold nuggets.

thingalyticsbook.com
In the last century, we saw clear distinctions between the physical and the digital world. We have chipped away at these barriers with technologies in networking, unified communications, cloud, Big Data and analytics, social, mobile and of course the Internet of Things. The result—a confluence of traditionally inanimate objects tied to sensors and analytical ecosystems. In fact, every device enabled by a sensor and tied to a network takes us closer to the convergence of atoms and bits.

This transformation is analogous to the early days of social networking through peer-to-peer networks. As more people entered the networks, each individual gained from the collective insights from all the clicks, likes, transactions and interactions. The network effects create a massive treasure trove of data that ties back to information. The information piped into business processes and customer journeys provides insights that can be surfaced. Each of these patterns surfaced and questions answered creates additional intelligence to ultimately drive decisions. We can now take data and democratize decisions through these networks of people.

In parallel, the Internet of Things has occurred at geometrical scale. Constellation Research, a Silicon Valley-based analyst firm, predicts over 80 billion sensors powering Things by 2020. Consequently, objects will
talk to each other and gain network effects. The intersection of where objects engage with humans drives an unlimited set of possibilities for customer experience, smarter machines, healthcare, trading networks, fraud detection, transportation and other use cases to be discovered.

Thingalytics is happening now. Market leaders and fast followers are in the midst of this digital transformation. As organizations transform and create new business models and cultures with digital technologies a distinct set of winners and losers will emerge. Success will require organizations to invest in new technologies that not only complement, but also abstract older technologies. These technologies must deliver on mass personalization at scale and deliver in the right time context and real-time speed. Context- and intention-driven design are expected and not a luxury.

Digital Darwinism is unkind to those who wait. This brave new world of smarter machines, and the humans who engage them, will change every industry and every market segment. Today’s digital divide serves as a precursor to the impact of Thingalytics. The top three competitors in every mature market segment control 43 to 71 percent of the market share and 53 to 77 percent of the profits. Thingalytics represents this next evolution of digital disruption. Savvy leaders should take note on how to disrupt first or face disruption.

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Wang has held executive roles in product, marketing, strategy, and consulting at companies such as Forrester Research, Oracle, PeopleSoft, Deloitte, Ernst & Young, and Johns Hopkins Hospital.

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Thingalytics

Introduction
Q. What is Thingalytics?

A. Thingalytics is the use of real-time analytics and algorithms to make sense of the fast Big Data arising from the Internet of Things.

People often ask me: “John, what really is this Internet of Things? It sounds like a lot of hype about smart fridges that tell you when to buy milk.”

Actually, the Internet of Things (IoT) is much more important and transformative than that. In fact, it is going to change everything—just as the original Internet did.

We’ve all heard about innovations like self-driving cars, which are now a reality (although not yet approved for mass use). Consider the next step: In the future all cars will communicate with one another, as well as with smart roads and smart cities, to coordinate and optimize journey times—and avoid collisions.

Likewise, we are all familiar with the mobile smart phone, and we are starting to see more wearable devices like smart watches. We are now on the verge of experiencing the next generation of wearables, such as heads-up-display glasses that communicate with a location-aware “smart cloud” that can tell you if you have friends nearby or send you special shopping offers and interesting restaurant ideas—perfectly tuning this “augmented reality” to your behavior patterns and preferences.

Until recently these thrilling innovations were widely dismissed as science fiction. Today, however, they are becoming—or are close to becoming—reality. At the grassroots level, smart Things come to life by using sensors and actuators, which are then attached to networks, thereby enabling us to monitor and control them remotely. This new universe, made up of these networked smart objects—or “Things”—is called the “Internet of Things.”
The Internet of Things is about digitizing everything in the real world and integrating it into the Internet. In some cases this technology is new; for example, washing machines that we can control remotely and that can message us when a wash cycle is complete and alert us when they are about to break down. In other cases it has been around for a while; for example, digital data from the stock market that we can stream, enabling us to place our trades electronically. The Internet of Things brings together this existing digital streaming data (stock market, news, weather) with social media (Twitter, Facebook), along with new sources of data from real-world objects.

Real-world objects are “digitized” by capturing their status using sensors. Different types of sensors can track myriad factors such as temperature, location, pressure and speed. Upload those sensor readings onto the Internet, and any appropriately authorized app can consume, analyze and respond to them. Put an application programming interface (API) on the object, connected to onboard actuators, and suddenly the app can control the object remotely.

People also ask me: “Is absolutely everything connected, and if so, then how can we possibly keep an eye on it all?” They may even suggest: “I’m not sure I want to be monitored or probed, so back off.” And so I do. Promptly.

The idea of the Internet of Things has come to the fore as technology has become more capable. As the costs of sensors and connectivity drop, viable use-cases are increasingly realized. Put simply, the Internet of Things represents an emerging reality where everyday objects and devices are connected to the Internet, most likely wirelessly, and can communicate
Where this gets really interesting is when we think about a multitude of Things working together, like a swarm of ants somehow collaborating on a common goal.

As for the scale and growth of connected Things, there are many predictions. The analysis from Cisco, the company that wants to be the connector of the Internet of Things, is shown in Figure 1. Cisco estimates that by 2008, the number of Things connected to the Internet was close to 7 billion. To put that number into perspective, it exceeded the total number of people on earth.

Cisco further estimated that in 2015 the number of devices hit 25 billion and by 2020 this number will double to 50 billion. In 2015, the ratio of devices to people is 3.5:1 and will rise to 6.6:1 by 2020. In addition, the market research firm International Data Corporation (IDC) predicts that by 2020 the Internet of Things market will grow by more than $5 trillion, exceeding $7 trillion. The number of Things and the data volumes they generate are mind-boggling. As we’ll explore in this book, a whole new type of software architecture is needed to support Thingalytics.

Every mobile phone call, smart watch reading, Facebook update, connected home heating adjustment, and smart car trip generates a new piece of data. The result is massive clouds of data, all of which are interconnected. As both the volumes and the velocities of data continue to increase exponentially, many firms are struggling to scale their existing infrastructures. Going further, firms have to re-imagine how they do business—leveraging the Internet of Things to become more competitive.

Modern businesses require new, agile systems to handle the computational explosion of sensory inputs and reference data generated
by the Internet of Things. Thingalytics is all about collecting the right information, analyzing it in the right way and driving the right decisions to make systems smarter and even self-learning.

The IoT becomes very exciting when we see how lives can be saved, fraud avoided, customers delighted and carbon emissions reduced. It gets scary, however, when we realize that a single mistake can mean millions of dollars lost in seconds, company reputations ruined in moments and lives put at risk. In this book we explore how to enable the opportunities of IoT while avoiding the threats, by presenting pertinent use-cases such as the following.
Predicting the Future

On the coast of Algeria a factory chugs away making plastics for its customers, secure in the knowledge that its electricity won’t conk out. It was not always so. Algeria’s domestic energy demands often outstrip supply, making it difficult for factories and other businesses to rely on their power sources. Today, however, Algeria and other African countries are supplementing their growing infrastructures with natural gas-fueled, on-site power technologies, such as the General Electric Jenbacher1 power generator used by the plastics factory.

Roughly 11,000 Jenbacher generators are currently operating worldwide. These massive engines—8.4 meters (27.6 feet) long by 4.7 meters (15.4 feet) wide (about as big as a good-sized travel trailer)—can be used to power everything from large factories to small cities. Reliability is key: Factories must produce; cities must be livable.

To achieve this end, GE has made aggressive service-level agreements (SLAs) for these engines. In the event of a failure, engineers have to get the machine serviced and back in action within a specified timeframe. And—even more of a challenge—these engines should experience only a very limited number of breakdowns. In fact, the objective is a 99.999 percent uptime from each engine. This is tough to achieve!

The trick to ensuring that a machine is always up and running is not to wait for it to break down, but, rather, to fix it before it breaks down. This is a difficult task, however, because Jenbacher engines are used in a variety of ways; for example, some run at a constant rate, whereas others experience peaks and troughs of heavy and light usage. If you could constantly monitor the usage, then you would know exactly what could go wrong and when. And that’s exactly what GE does.

Bill Ruh runs a lesser-known division of GE—GE Software. His mission is to make GE’s customers’ systems 1 percent more efficient. One percent doesn’t sound like much, does it?

In fact, a 1 percent fuel reduction in power generation equates to a savings of $66 billion over 15 years for GE’s customers. This is not a trivial sum. Significantly, GE’s equipment is already highly efficient. So, how do they improve it?

The answer is that Bill’s department monitors the behavior of the Jenbacher machines by using smart systems software that includes 300 sensors that are reviewed continuously. The department analyzes and visualizes the data and compares it to predictive maintenance rules over time. They use smart analytics to determine when a generator bearing will wear out or malfunction, or how much life is left in a sparkplug—at any point in time. It is this increase in efficiency and uptime that will generate the 1 percent improvement.

**When Algorithms Go Wrong...**

Early on the morning of August 1, 2012, a tiny piece of code nudged an automated trading system into action on the U.S. stock market. As trading began, the rogue command triggered a buy order for 140 different stocks on the New York Stock Exchange (NYSE). In a frenzied buying spree, Knight Capital Group’s trading platform scooped up shares in companies ranging from General Electric to the semiconductor company Spansion. Spansion’s stocks changed hands at least 4 million times—all in the space of 45 minutes!

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What happened? Subsequent investigations revealed that Knight Capital had installed new software\(^4\) that conflicted with old code, which was supposed to have been deleted. The clash caused a flood of orders to surge onto the NYSE, without the benefit of volume caps.

By the time the trading firm realized that its system was wreaking havoc on the marketplace, the rogue trades had dramatically pushed up the value of many stocks. Because Knight’s capital base had been sucked dry by the buying spree, it had to sell the overvalued shares back into the market—often at a loss. This single piece of errant code had cost the company around $440 million, or roughly $10 million per minute! The losses sent customers fleeing to other trading companies and tripped a torrent of selling in Knight Capital shares, wiping out 20 percent of the company’s value in a matter of hours and leaving the firm’s market capitalization below the amount of losses it had sustained.

Knight Capital teetered on the edge of insolvency as its executives desperately sought funding from “white knights” from other business sectors\(^5\). Four days after the debacle, the company was saved by a consortium consisting of Getco LLC, Blackstone Group LP, Stephens, Inc. and Jefferies Group, Inc., as well as Stifel and TD Ameritrade, which put together a $400-million rescue package.

How could a trading company fall from the lofty peaks of success and respectability into the chasm of imminent bankruptcy in the space of less than an hour? Today’s super-fast algorithms and high-speed electronic trading systems rule global markets, and errors such as Knight Capital’s coding mistake can move markets—or even take down a firm—in a matter of minutes.

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So what did we learn from Knight? The Internet of Things will feature super-fast algorithms that make real-time decisions. Capital markets is just one example; everyone makes mistakes, and algorithms that make decisions cannot run unsupervised. Super-fast algorithms require super-fast safety systems that can keep up with the algorithms and detect when they are going off course, in which case they can either shut them down or make them safe. That is the painful lesson not just from Knight Capital but from the many other market crises we have witnessed. And, it is a lesson we must apply to the entire Internet of Things, as our lives become increasingly dependent on it.

A Personal Shopping Assistant that Knows You Better than You Do

Who wouldn’t like to have a personal shopping assistant? Imagine an assistant that knows your tastes intimately, understanding that you will not consider any labels that are not from one of your favored designers. This dream shopping assistant is also aware of your spending habits and knows that you rarely pay full price for your designer gear, preferring special offers.

Your dream shopper also knows that you don’t have the patience for Internet orders; instead, you like to seize an in-store bargain from one of your favorite boutiques, and you are a workaholic, so you shop only during your lunch break or on your way home. Who can afford such an assistant? Now, suppose that your assistant is not a human but, rather, a smart algorithm. The algorithm knows your spending habits, your current location and which products are available in stores—including price comparisons and special offers. Further, it can push relevant offers to you through your smart phone.

That is exactly the approach that forward-looking firms like DBS Bank in Singapore are pioneering. DBS calls this personal assistant a “Digital Concierge.” DBS collaborates with retail partners to make
highly personalized location-aware offers that enrich the lives of their customers, generate greater revenues for the retailers and enhance customer loyalty for the bank.

The Digital Concierge is an example of what is to come. We are at the cusp of a smart algorithm revolution that is fed by data coming from the Internet of Things and offers the potential to enrich your life wherever you go.

What if your favorite pizzeria could determine that you were driving by on your way home? It could pop your usual pizza into the oven and text you that it will be ready in 10 minutes. All you have to do is stop and pick it up. And, if you don’t want it, the pizzeria can offer it in slices to other passersby—a win-win situation.

Or, perhaps you are in the market for a new laptop, and you go to a shopping mall to buy one using your bank credit card. You decide to shop later for a new laptop case. Meanwhile, your credit card has communicated your purchase and your possible need for a case to local retailers, one of which offers you a 30 percent discount. You duck in to take advantage of the discount and then receive a text message with another offer—this time for a 10 percent discount at a restaurant if you arrive within 30 minutes.

The idea of on-time offers is capturing the imagination of retailers large and small. With good reason: Turkcell, the leading Turkish mobile phone operator, has determined that customers are 10 times more likely to respond to on-time offers than to more generalized offers.

As more and more devices interact, individuals develop a richer digital identity. The more information that becomes accessible to service providers, the better they can understand their customers’ needs and wants. Going further, this enhanced understanding gives them an even greater opportunity—to anticipate customers’ every desire. Online retailer Amazon, an early adopter and innovative user of Big Data, went so far as to speculate that it might start delivering products before its customers order them.
**Thingalytics**

You may wonder what GE’s power-generation engines, Knight Capital’s “Knightmare on Wall Street” and DBS Bank’s Digital Concierge have in common. On the surface, a smart power-generation engine looks nothing like a trading system run amok, which looks nothing like a smart marketing system. The truth is that all of these cases are all about Things.

Things are digitized objects, each with its own digital ID. They can be anything from a person, to a heart rate monitor, to a power-generation engine, to a vehicle, to a stock. All of these Things create data, and that data is often fast and big: “fast data,” because it is often changing rapidly and streaming at us; “Big Data,” because volumes quickly add up and because incoming data may also need to be cross-referenced and enriched by searching massive Big Data repositories.

Nearly everyone and everything can have a digital ID. In addition, a Thing communicates other data parameters in update “events” over the Internet as Things change. The GPS locator on your mobile device creates a data set that informs other people where you are. It also can remember where you have been and anticipate where you are going.

Thingalytics is about apps that drive smarter behavior and ultimately turn the Internet of Things into an intelligent, self-learning environment. To accomplish these goals, Thingalytics apps have to piece together the story of the Things, analyze the situation and make smart decisions. This situation is complicated by fast Big Data. Apps frequently face the challenge of searching for a needle in a haystack when the haystacks are moving past on a conveyer belt!

My term “Thingalytics” is a composite of “Things” and “Analytics.” Analytics is the brains of an app; it
performs the smart analysis to determine whether we should take an action. Analytics for Things has to be able cope with the scale, speed and complexity of the Internet of Things!

The Benefits of Thingalytics
Lessons learned from GE, Knight Capital and DBS allow us to immediately identify four benefits that we can gain by employing Thingalytics correctly:

> **Thingalytics Benefit #1: Optimizing operations to increase efficiency**

As in GE’s case, monitoring how a machine, a system or a business is running—plus monitoring the surrounding environmental conditions and making smart adjustments—can save us money, resources and time.

For example, we can:

- Match the nearest, most relevant doctor to a health crisis in a hospital
- Modify the course and speed of container ships, trucks or trains to reduce fuel usage
- Adjust the temperature in an office in response to the presence of people

In these and countless other ways a business can become smarter and more efficient by continuously optimizing Things.

To increase efficiency, one connected machine can help other machines by sensing and communicating information about its environment. As an example, an 18-wheel truck with sensors in its engine can send signals to other trucks in its convoy—informing the other
engines about the gradients it encounters or inclement weather conditions, thereby helping the other trucks maximize fuel and brake performance.

One very hopeful side-effect of increased efficiency is the potential to improve health throughout the world; for example, medical professionals can treat more cases or prioritize the urgent cases. Further, we could reduce carbon emissions with fewer vehicles traveling along more efficient routes, combined with more efficient energy production.

> **Thingalytics Benefit #2: Avoiding threats**

Knight Capital is an example of how modern-day crises can come upon us faster than ever. Across all businesses, identifying and preventing impending risks, fraud and other threats before they become critical is vital to minimizing fines, losses and reputational damage. How firms detect, preempt and deal with these continuous disruptions, and whether they can transform them into opportunities, helps to define their competitive advantage. If, for example, monitors could have detected the early signs that Knight’s algorithm was malfunctioning, such as too many orders and order pricing errors, they could have shut off its access to the market.

> **Thingalytics Benefit #3: Seizing opportunities to increase revenue**

Identifying “in-the-moment” opportunities to place an algorithmic trade, up-sell to a customer or push a smart offer (as per DBS Bank) all constitute new opportunities to increase revenue. Battles for business supremacy are already being fought based on first-mover advantage, where the Thingalytics algorithm that spots the opportunity first and moves on it is the winner.
**Thingalytics Benefit # 4: Supercharging customer experience**

Radically improved predictive models of what individual customers do and do not want, driven by Big Data analytics, are revolutionizing consumer marketing. Combined with the opportunity for real-time location and context-aware applications, we can now push the right content in the right place at the right time. The result: happier customers.

Equally important is the capability to spot and deal with unhappy customers as early as possible. For example, if a hotel can identify a Diamond-tier guest who has been waiting to check in for 10 minutes, then the manager can head off his or her unhappiness by offering a “fast track” check in. This type of special treatment will not just solve the problem—it will also make the guest feel welcome. Or, consider a customer using an ATM machine that has run out of cash. A bank can proactively text a message of apology to the customer, along with a map to the nearest functioning ATM. Any organization that identifies issues proactively and responds sensitively engenders a warm response from its customers.

We’ll see many examples of these four benefits as we explore real-world scenarios throughout this book.

**Listening to Your Things**

There is a certain Seussian ring to Thingalytics. It brings to mind Dr. Seuss’s children’s book *The Cat in the Hat*, where Thing 1 and Thing 2 were both troublemakers and problem solvers. Thing 1 and Thing 2 were known for their ability to find anything—“anything, anything under the sun!”

Thingalytics is the opposite: Keeping track of Things is difficult, and extracting insights from the constantly streaming updates is even more difficult. At the same time, Thingalytics becomes immensely valuable.

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6 [http://en.wikipedia.org/wiki/The_Cat_in_the_Hat](http://en.wikipedia.org/wiki/The_Cat_in_the_Hat)
after you have devised the killer apps. A key lesson we shall see throughout this book is that discovering those apps involves a process of experimentation. It all starts with tapping into the fast Big Data flowing from the Things. Collecting Big Data and not analyzing it is like collecting stamps and not showing them to anyone. Innovative firms don’t know for certain if their theories are right; they start experimenting, measure the results and adapt quickly.

If patterns in the data about Things that tell a story can be identified and utilized properly, then they can provide companies with exciting and profitable opportunities. If not, they can sit unnoticed and unloved at the bottom of dark, dank databases. You have to put the Big Data about Things to work; otherwise, it is useless. You need to find insights and act upon them quickly, because you frequently have only a short time window to respond.

Big Data and the Things of the Internet are the fuel with which a new generation of companies will power their profits. McKinsey\textsuperscript{7} Global Institute identifies Big Data the next frontier for innovation, competition

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and productivity. The amounts of data being created are so voluminous that they are measured in quintillions ($10^{18}$) of bytes: 2.5 quintillion bytes of new data are created every day. Every byte created adds to the innumerable bytes that already exist—and they can tell us a story. The story might be about the personal spending habits of an iPhone user, or it could be about the engine capabilities of an 18-wheel truck, or an overspending trading platform. The trick is to winkle out the story, thus identifying a trend, a pattern or an anomaly that you can use.

**Enterprise Empowerment**

The Internet of Things is causing a great deal of excitement among many corporations, which believe that Big Data will drive future profits. McKinsey claims, for example, that a retailer using Big Data to its full capacity “could increase its operating margin by more than 60 percent.”

Similarly, Gartner describes Big Data and the Internet of Things as the beginning of a new era, the “Digital Industrial Economy.” Peter Sondergaard, Senior Vice President at Gartner and global head of research, offered the following perspective on the new digital world: “Every budget is an IT budget, every company is a technology company, every business is becoming a digital leader and every person is becoming a technology company.”

Gartner Fellow Dave Aron explains: “The digital winners are ruthlessly and fearlessly creating the digital industrial economy. Roles are changing. Business models are changing. Timeframes are changing. Industry and company boundaries are blurring. We can’t rely on old practices, safe relationships, legacy

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8 Marketwatch, October 7, 2013: “Gartner Says It’s the Beginning of a New Era: The Digital Industrial Economy.”
technologies and known vendors. We have to explore, adapt and adopt new digital realities. We have to be fearless digital leaders.”

Thingalytics is the future for fearless digital leaders who don’t want to fly blind. The digital world is there for the taking; the sky is the limit. If we do not use it, however, we risk being left behind and called digitally myopic.

**Exploring Thingalytics the Book**

In this book we will explore many real-world examples of Thingalytics in action, and we will meet several visionaries who are involved in pioneering these new apps. We will analyze the lessons learned by these innovators, and we will explore what the future can bring. We will also consider what the technology implications are and how we can cope with them.

In Chapter 1, “It’s All About Me,” we explore how Thingalytics is empowering a new generation of personalized marketing and customer experience applications.

In Chapter 2, “Machines with Feelings,” we look into industrial and retail processes and consider how smarter machines are enhancing efficiency, reducing costs and improving customer experience.

In Chapter 3, “Home Is Where the Smart Is,” we investigate how new intelligent Thingalytics apps are revolutionizing cooking, cleaning, washing and TV watching.

In Chapter 4, “Take Two Smart Pills and Call Me in the Morning,” we examine the hospital of the future and how it is already manifesting itself today.

In Chapter 5, “I’m the Chairman of the Board,” we explore smart self-learning algorithms that function as the “brains” of Thingalytics, focusing particularly on automated trading.

In Chapter 6, “RoboCops: Smarter than the Average Criminal,” we delve into how we can spot and ideally navigate around threats and
problems, including some thoughts as to how Knight Capital and similar crises could have been avoided.

In Chapter 7, “Planes, Trains and Automobiles,” we discuss Thingalytics apps for smart logistics and autonomous transport systems.

In Chapter 8, “The Technology Behind Thingalytics,” we explore some of the technology issues involved in supporting massive-scale Thingalytics apps, and we consider how new Big Data streaming analytics architectures in the cloud could be the key to successfully meeting this challenge.

Finally, Chapter 9, “Go Forth and Use Thingalytics!” concludes our discussion by summarizing the lessons learned and explaining how you can move forward and use Thingalytics to improve your business.

Happy reading!
It’s All About Me
Ozlem’s Shoes

Ozlem Demirboga has barely enough time to grab a sandwich at lunch-time, never mind shopping for the designer shoes that she loves. Today, however, as she leaves her office in Istanbul, Turkey, to pick up some lunch, she receives a text message on her mobile phone that is too good to pass up.

What is this special message? It is an announcement from a boutique on the next street for a promotion for 20 percent off top designer shoes if she comes in within the next hour. Ozlem⁹ has time to take a quick detour, and she picks up a great pair of discounted shoes.

It is no coincidence that Ozlem loves designer shoes and that she received a promotion for them. Ozlem is not just an ordinary mobile user. She happens to be in charge of customer experience management at Turkish mobile carrier Turkcell. In fact, she was responsible for the mobile location-aware promotion application that just sent her the message. The message came from a new breed of real-time marketing systems that can make informed and relevant offers in exactly the right place and at exactly the right time to exactly the right customer.

Turkcell has a huge customer base with more than 34 million mobile subscribers. It also has an incredible opportunity to innovate with cutting-edge services that can increase revenues. To achieve these goals, however, Ozlem must make these services attractive and “sticky”—a positive experience that discourages subscribers from going over to other carriers.

Ozlem and her team have launched a series of smart applications designed around the mobile user, which are winning Turkcell new customers and increasing the average revenue per user (ARPU). These smart applications are location- and context-aware. In other words, they track the locations and behaviors of customers who have “opted in,” meaning

⁹ Ozlem has since left Turkcell in order to pursue a graduate degree.
they have shared their preferences, likes and dislikes. By enabling marketers to carefully target appropriate customers, these applications can dynamically improve the experiences of those customers.

The criteria of right place, right time and relevance are all important to a successful mobile promotion. Getting even one of these criteria wrong can seriously annoy a customer.

**I Want It All; I Want It Now**

About 25 years ago, the Internet was extremely disruptive to traditional “bricks-and-mortar” retail businesses. New online retailers such as Amazon took market share away from “Main Street” by offering a greater choice of merchandise, immediate availability and speedy delivery. This was shopping in a new, virtual world.

The Internet of Things is poised to completely disrupt that model. In today’s mobile era consumers are increasingly using smart phones equipped with location-tracking sensors. The unfolding wearable computing era is adding smart watches and, soon, smart “heads-up-display” glasses—integrating information on-the-go into our interactions in the real world. This means that, using Thingalytics, we can start to overlay information about the real world around us in a real-time, location- and context-aware manner.

All of this mobile technology, from cell phones to tablets and wearable devices, affords us instant gratification. Because we have this technology at our fingertips, we are becoming increasingly demanding. Today waiting even 24 hours to order an item online is too long! We want it all, we want it now and we don’t want to spend a lot of time searching for it. Thus, location-awareness, combined with a hunger for real-time,
is creating something new! We want the digital world to read our mind and plot a course to our heart’s desire. This doesn’t mean, however, that we’re prepared to receive irrelevant solicitations. Just the opposite: We are growing ever more impatient in our expectations that our online experience be completely personalized.

As a result, mobile technology, combined with Thingalytics, has fueled a new wave of applications that embrace this impatience. These apps are designed to enhance the next generation of customer experience to make customers feel special by seeking out their interests and enriching their experiences in the “real world.” And yes, Main Street can use Thingalytics to fight back!

Mobile devices and applications create a wellspring of fast Big Data that in turn helps firms to refine and enhance their offerings for mobile users—if they use this data properly! This new generation of applications empowers retailers, telecommunications providers, banks, hotels and other companies to tailor a user’s every experience. By explicitly embracing the opportunities created by mobility—including tracking/location—and by personalizing the customers’ experience, a business can make customers feel that they are receiving special treatment.

Main Street can use Thingalytics to tap into the mobile, location-aware world, which offers tremendous opportunities to reduce costs and increase revenues. Thanks to GPS and other location tracking, your mobile device knows where you are at any given time. Today’s technology enables service providers to filter the world for you—and only you. Personalization is the future of mobility: In the end, it is all about me. And I want it now!
Right Place, Right Time, Not Spam

Receiving a promotion for something that is too far away to be convenient, or receiving it too late—after you’ve left the area or after the offer has expired—is very frustrating. Most importantly, however, receiving a promotion for something that is not relevant to you is just like being subjected to spam email. You might overlook this type of message once or twice, but receiving spam frequently is extremely annoying. Further, receiving it on your mobile phone feels like a breach of privacy: It is following you on your personal device! You could rapidly become fed up with your mobile carrier and perhaps even change networks.

Customers changing networks is a mobile carrier’s worst nightmare. The technical term used by mobile carriers for subscribers who leave is “churn.” Customer churn and retention levels have long plagued providers. Many studies have estimated that churn rates range between 20 percent and 30 percent in most regions.

Mobile carriers focus on three primary objectives:

1. **Increasing market share**
   - Carriers can attract new customers by launching new, innovative services before their competitors do, or by simply offering a better quality of service than the competition.

2. **Maximizing the average revenue per user (ARPU)**
   - Making as much money as possible from customers by maximizing the purchasing potential of each and every subscriber.
3. Minimizing churn

- Making services “sticky” so customers don’t change networks. This is a key goal, because winning new customers is many times more expensive than retaining existing ones.

A mobile promotions application addresses all three concerns:

1. It attracts new customers by offering an innovative service that personalizes their experiences and makes compelling offers that are directly targeted to them.

2. It has the potential to attract new subscribers and increase ARPU, provided it doesn’t spam them.

3. It minimizes churn, if it is implemented properly. If not, then it can be perceived as spam and consequently can increase churn.

As Ozlem walks down the streets of Istanbul, thousands of other workers and shoppers are also going about their business. Significantly, almost all of them are carrying cell phones. The majority of them subscribe to the same mobile carrier as Ozlem—Turkcell. However, only Ozlem and a few other subscribers will receive the promotion about the designer shoes. Specifically, only those customers whom the retailer has identified as nearby, interested and highly relevant will receive the promotion. Thousands of other subscribers who are nearby will not receive this offer. Several of them, however, will receive different offers that are more relevant to their interests as well as their spending and shopping habits.

It is not just complex applications like location-aware promotions that can yield results. Ozlem cites the example of an enhancement to an existing simple application that proved highly successful. The application
was designed to “up-sell,” or to convince prepaid Turkcell subscribers to purchase additional minutes. Many subscribers prepay, buying minutes on a pay-as-you-go basis. Turkcell developed an application that monitors subscribers’ remaining minutes. If they are likely to run out of minutes during a call, then the application sends them an offer to purchase additional time there and then.

Ozlem contends that sending the message to customers before they run out of minutes has made the application many times more profitable than the previous version, which delivered a message only after the minutes had run out. The previous version relied on offline, batch-based analysis of remaining minutes. The new version utilizes a real-time event-driven approach to proactively send out an offer before the prepaid minutes expire.

Whether it is a simple application or a highly complex one, the winning characteristics are the same: right place, right time, not spam. Achieving these characteristics requires continuous and proactive monitoring, analysis and response to huge amounts of ever-changing events.

Location, Location, Location

Mobile applications that respond to the changing locations of people or things are becoming more commonplace. Location tracking can be applied to animals on a farm, vehicles in a supply chain, cars on highways, packages in a distribution network and pallets in a warehouse. Tracking these people, animals and things can feed data into bespoke applications that deliver the customer experience. And, this is just the beginning. Location-aware applications are going to feature prominently in responsive 21st century businesses, for two primary reasons:
1. The applications are increasingly easy to build and deploy.

2. The location-tracking hardware and mobile devices that control the applications are widely available.

The tracking technology in Turkcell’s location-aware promotions application triangulates the location of the cell phone ID that is built into the wireless handset. Unlike some GPS-based applications, this approach can work inside office buildings and shopping malls—a real benefit for Turkcell’s promotions.

Using Thingalytics, Turkcell can process and make smart decisions on the huge data flows coming in from their 35 million mobile subscribers. The data includes location changes, user preference and/or behavior updates, information about new location-aware campaigns being launched, and changes to existing campaigns. Thingalytics helps to make Turkcell all about the customer.

**Disruptive Disintermediation, Dynamic Offers**

Disintermediation—the practice of removing the middleman—has haunted banks for many years. It began with customers investing their money in the stock market, rather than with their local bank, supplanting agents, brokers and resellers in the process. Today, thanks to the Internet, applications such as PayPal and Google Wallet are all contributing to bank disintermediation. The creation of the “mobile wallet”—with the ability to organize, store and access everything in your wallet from your mobile phone—has opened up the world of mobile payments and is giving traditional banks a scare.

Thanks to the Internet, applications such as PayPal and Google Wallet are all contributing to bank disintermediation.
Banks surveyed in a 2013 study\textsuperscript{10}, when mobile wallets had yet to take off, identified companies such as Google as the biggest threat to their business due to these companies’ mobile wallet offerings. Today, businesses from PayPal to Google to Starbucks are offering customized versions of their mobile wallets, along with discounts, promotions and loyalty schemes that make their products stickier. They are also creating a sticky situation for traditional banks that are mired in the old-fashioned checking account and credit card business model.

Not surprisingly, many banks have developed creative new strategies to counteract this threat. For example, DBS, Singapore’s largest bank and one of the leading regional banks in Asia, came up with an idea to beat the disintermediating mobile wallet disruptors at their own game. The bank launched some revolutionary mobile services for its customers that have increased both customer loyalty and the utilization of DBS’s financial products.

David Backley, the Managing Director for Consumer Bank Technology at DBS, concedes that one of the basic drivers for developing these new services was the threat of the mobile wallet. David and DBS implemented a strategy to take the bank’s game to the next level by adopting a leadership position in “mobile, intelligent banking.”

The first step was to get closer to customers and provide them with a better credit card experience, to encourage them to pay using their cards rather than a mobile wallet application. As David explained: “Ideally we’d like to have a personal relationship manager for every customer; someone who knows each customer and personalizes his or her banking experience. But it’s impossible to have human relationship managers for 4 million people. So, we decided to use technology as the relationship manager.”

\textsuperscript{10} Elliott Holley, Banking Technology, October 21, 2013: “Google is banks’ biggest fear finds innovation survey.” http://www.bankingtech.com/177022/google-is-banks-biggest-fear-finds-innovation-survey/
In Singapore people frequently shop and eat out. They usually take their credit cards and mobile phones with them. They also like to receive special offers. David wanted to make these offers in real-time, based on customer location, interests and characteristics, rather than after-the-fact.

To create real-time, mobile phone-delivered services, DBS needed the capability to analyze and respond intelligently to events as they unfolded. In other words, the special offers had to reach the customers while they were close to their shopping and dining facilities.

“We’re in a unique position—where all of our interactions with customers happen in real-time,” David explains. “You need event-driven analytics to decide what you do with such interactions or events.”

DBS customers can (of course) access their accounts on mobile devices. They can also opt in to receive carefully targeted and relevant cross-sell and up-sell offers both while they are shopping and after they have purchased items with their credit cards.

Consider this scenario: You go into a computer store to buy a new laptop. You select the laptop, but you don’t buy a laptop bag because you want to shop around first. Your propensity to shop around for the bag is not as unique as you might think. In fact, a computer model predicted that you were going to do just that.

How could a computer “know” this? The answer is that it found that nearly 75 percent of people of your gender, age range, socioeconomic class and spending habits are likely to do the same thing. Of course, the store where you purchased your laptop wants to sell you the laptop bag. So, it sends you a text message offer for 25 percent off any laptop bag if you complete the purchase within the next 15 minutes. The store, in
partnership with the bank, has made this promotion. They really want your business.

This kind of responsive cross-sell and up-sell application opens up a whole new world of possibilities. Although targeting you through your mobile device is the ultimate goal, the bank can still offer you deals without one. For example, when you swipe your credit card, DBS knows where you are, and it can make an offer to you via the store. However, the really compelling opportunity is to provide services in the same style as Turkcell. For customers who opt in, the bank can push opportunities based on right place, right time and relevant offers to customers’ smart phones.

Because a bank collects a great deal of financial information about its customers, it is in a powerful position to categorize customers and statistically predict the behavior of people in certain categories. The bank can analyze your likelihood to purchase a particular product based on your previous buying habits and which “buckets” the statistical computer models put you in. For example, it can determine whether you are more likely to buy a product in a store or over the web. You would then receive the promotional offers wherever you shop. The bank’s partners want to target the most relevant customers—and the bank has a good shot at it by using Thingalytics.

**Time to Eat**

Dynamic offers are not limited to stores; they can also be used for many other retail offerings including travel, hotels and even food. Consider a customer in the young executive salary bracket who is looking to purchase an expensive camera or DVD player at a shopping mall with her DBS credit card. Within minutes she will get a discount offer for a popular nearby restaurant. The restaurant is making an offer—through the bank—of a certain discount for a small window of time. When the
customer pays the restaurant bill, again with her bank’s card, she may receive an SMS offer for a prize draw that encourages her to continue shopping at the mall.

Of course the bank knows your credit worthiness as well, so it can up-sell to you in another way. When a customer makes a large purchase such as a flat-screen TV using a DBS credit card, the bank can analyze the customer’s credit score and, if appropriate, initiate a call from customer care to offer an installment plan. Paying off the purchase in, say, 12 monthly installments benefits both the consumer and the bank—which makes a profit and ensures that the customer still has available credit on his or her card for future purchases. Similarly, if a customer uses a DBS credit card to pay for travel services such as a flight, the bank or a partner can try to up-sell a relevant travel insurance policy just as the customer is booking the trip.

David of DBS maintains that as the bank learns more about the science behind real-time campaigns, it can fine-tune these efforts. For example, it could tweak offers throughout the day to enhance their effectiveness, based on continuous analysis of the campaign’s performance. The ongoing visibility of campaign efficacy is enabled by real-time dashboards, which provide the credit card team with continuous insight. It is possible to monitor the parameters of a campaign based on key performance indicators (KPIs) to ascertain whether the campaign has achieved the predicted number of responses within a time window. Firms can also determine whether a limited availability offer is in danger of being oversubscribed. If it is, then they could remove the offer and replace it with a similar one to avoid disappointing customers.
Of course, services that have so much visibility into customers’ information raise many privacy concerns. To address these concerns, David emphasizes that it is critical that such services are opt in and that customers have tight control over the contact policy. For example, a customer may indicate that he or she wants no more than one marketing message per day. The system must honor this request or risk damaging the bank’s relationship with the customer.

**Intelligent Pricing**

Building on the thinking behind DBS’s dynamic offering services, one compelling scenario I see in the future is intelligent pricing. Imagine if there were no fixed prices for products. Instead, a smart pricing system could adjust the price up or down depending on demand and/or other parameters.

This scenario is similar to the advanced pricing models used at banks’ dealing desks for over-the-counter bond and currency markets. The banks respond to electronic requests for quotes (RFQs) by categorizing customers into bands and then adjusting the spread; that is, the amount of profit the banks receive from each transaction. The spread depends on how attractive the bank finds the customer’s business and how likely the customer is to accept the bank’s quote.

It is interesting to think about such advanced real-time pricing models finding their way into the consumer realm. Banks such as DBS and credit card companies, in conjunction with retail partners, are well placed to offer such services.
Smart Theme Parks

A great example of Thingalytics being used in a smart environment is a visionary project being developed at Disney Parks called “Next Generation Experience” (NGE). In a February 2011 article in the Orlando Sentinel, Disney’s Parks and Resorts Chairman Tom Staggs revealed some of the park’s $1 billion project. Spurred by guests’ complaints about long wait times for rides and other popular attractions, Disney Parks developed NGE as “a version of Fast Pass for an entire Disney vacation.” Future guests will be able to provide their preferences and even pre-book rides, attractions and seats at shows and restaurants before leaving home.

The more compelling opportunity, however, is the real-time, dynamic personalization of the Disney experience. Once guests arrive, the park will be able to determine who they are and where they are—and then personalize their experience. The tracking technology is likely to consist of radio frequency identification, or RFID, tags embedded in wristbands. Another option involves smart apps downloaded to location-enabled smart phones. A smart app would provide navigation assistance around the park and would also be able to make recommendations based on individual customer preferences. For example, if your ride of choice has very long lines, then the NGE app could recommend an alternative ride and even book you a slot. Anyone who has had to wait for an hour or more with small children to get into “It’s a Small World” in 95-degree heat can appreciate the value of this technology.

Going further, if the park knows your location, then it can also optimize the movements of the “cast,” the Disney characters such as Snow White and Goofy that wander around the park. Cast members can seek out particular guests because they

Being able to track the locations of guests and even re-route them dynamically enables the parks to make optimal use of their resources.
know where they are. Another bonus when small children are becoming fractious in the heat!

From Disney’s point of view, the NGE project offers outstanding business benefits. Being able to track the locations of guests and even re-route them dynamically enables the parks to make optimal use of their resources.

Pursuing this line of thought, Disney can take the same approach as Turkcell by offering mobile, targeted, location-aware promotions. For example, it can highlight special offers on photos taken on rides or on merchandise that fits the guests’ interests and spending habits as the guests move around the park. By applying these principles Disney can radically increase the average value per guest. Guests will have much more time to spend money if they are not spending the bulk of their day waiting in line—plus they will be in a much better mood!

**Gambling on Technology**

I witnessed another effective strategy to improve the customer experience while also minimizing fraud when I was working with a large casino chain in the Asia-Pacific region. The chain operates a loyalty card system in which patrons earn points for playing different games in a casino. To earn these points patrons need to swipe their loyalty card at each gaming table. When patrons earn enough points they receive some type of reward; for example, a free dinner. Because customers have to swipe in at each game, the casino knows who is playing at each table. Further, because dealers have to enter wins and losses on a mini keyboard at the gaming tables, the casino also knows, both in real-time and over time, each player’s win-loss profile.

And, the benefits to the casino can go even further. The technology tracks the movements of gaming chips through the casino by embedding them with RFID tags. This technology enables management to track the chips throughout the casino. This system helps to ensure there is no foul play—which benefits the majority of gamblers as well as the casino.
Utilizing all of this technology alongside Thingalytics has enabled the casino to implement an extremely advanced fraud surveillance system. For example, the casino can detect potential collusion among players or between players and dealers. Even though the casino employs only a handful of surveillance experts who know what to look for, it has thousands of surveillance cameras. When the casino detects potential fraud, it can automatically feed the output of the nearest camera to a surveillance expert who can make a judgment as to what is going on. There is an upside to this arrangement—the casino can respond intelligently when high rollers are in town and shower them with love and attention, thereby encouraging customer loyalty.

**Smart Hotels**

I have been involved in a very exciting Thingalytics project that is being run by a major global hotel chain. The chain wants to provide a better customer experience by being able to identify people who stay frequently, determine where they are in their hotels and evaluate the kind of experience they are having. To achieve this, they are using “inside” location-tracking technologies. Members of the loyalty scheme can download a smart app that can then track their experience in the hotel, giving them the ability to receive offers and giving the hotel the ability to continuously learn about customer behavior and respond when opportunities present themselves to enhance a customer’s experience.

The hotel employs two main location-tracking technologies:

- iBeacon technology, which uses low-power Bluetooth to detect when a patron’s cell phone is nearby.

- Technology from Aruba Networks, which uses Wi-Fi signal strength to determine in which zone a patron is located.
With these technologies, combined with Thingalytics, some compelling applications are being developed. One application is used by front desk staff. As patrons line up to check in, the staff can tell who is in the line, how long they have waited and their tier in the loyalty program. A Gold member waiting a long time might trigger extra staff being diverted to the check-in area or a visit from the manager.

Another application can track which zones of the hotel its patrons visit both on their first trip and on subsequent trips. They might notice, for example, that patrons tend not to visit a particular restaurant on their first trip. After they have eaten there, however, most patrons go back. This pattern suggests that the restaurant is not easy to find but it is popular once patrons discover it. So, perhaps the hotel should improve the signage! Building on this data, the hotel can track the sentiments conveyed by social media postings in particular areas. For example, a Tweet claiming “terrible meal” posted from within the restaurant probably means the hotel needs to look into quality control—and fast!

“Super” Markets

Another exciting project I have experienced introduces another sensory technology: video analytics. A major supermarket chain, which would prefer to remain incognito for now, is experimenting with a system that incorporates cameras and digital signage in multiple stores. Combined with Thingalytics, these technologies can track customers and personalize a shop—even without knowing who the customers are. In other words, customers do not even need to carry a smart phone! Cameras
and digital signs located throughout the stores enable the supermarket to track everyone’s shopping experience and to tempt shoppers to look for and take up offers they might otherwise have missed.

One particularly interesting video analytics algorithm can conduct facial analysis on every customer who walks past. It can determine whether customers are male or female, their approximate age and even how happy they are—by tracking their facial expressions!

Firms can use this technology to explore real-time demographic-driven marketing. For example, they can establish a metric such as: “If more than two men over 30 are standing in area X and at least one of them looks sad, then play this offer on the nearest screen.” The offer might say “Cheer up—special offer on beer—two for the price of one. Come to Aisle Y and print a coupon.” By tracking coupon use at checkout, the supermarket can calculate the take-up rate. They can then use this data to assess the effectiveness of the offer.

Ideally, specific offers are targeted at particular demographics, and they can be adjusted depending on the desired target audience. Stores can employ this visual analysis approach to Thingalytics to vary offers based on how people are feeling. It used to be that only people could judge you by your facial expressions. Now algorithms are doing it too!!

**Conclusions**

The next decade will be absolutely fascinating. Wearable computing is going to go mainstream. Google Glass is one device that particularly interests me. This is a wearable glass that can project information on a tiny screen. Actually, it isn’t very good—but as this book goes to print Google is removing it from the market to focus on improvements\(^\text{11}\). In the next decade we are going to see more nonintrusive wearable glasses that can project information directly into your line of sight.

\(^{11}\) [http://techcrunch.com/2015/01/19/today-is-the-last-day-to-buy-google-glass/]
So, as you walk down the street and look into a store window, items that interest you will be highlighted. As you approach the store, items will be priced personally for you—based on your propensity to buy and your membership in loyalty schemes. Comparison prices with other nearby stores might also be listed. When you gaze at a coffee shop sign, your display will identify all of your social media friends who are in there—so you can meet them for coffee (or avoid them)! When you look at a bus, your glasses indicate the route; that way you know it is the right bus. You can also see how close the nearest taxi cab is—because your Uber or Lyft app is integrated into your glasses.

This kind of augmented reality view will essentially mash up the entire cloud and personalize and localize it for you. These technologies will need to analyze billions of updates per second to determine whom a company’s products or offers are relevant to, to provide this personalized view. The software architectures behind this kind of app require a new science of smart Big Data analytics, which we explore in Chapter 7.

The mobile, wearable revolution is simultaneously an opportunity for and a threat to businesses. For the banks, shops, telecommunications companies, casinos, hotels and supermarkets that seize the opportunity, Main Street is becoming Mobility Street, with a chance to assume a leadership position as their industry transforms.

As we walk around with our smart phones and sophisticated tablets, we create clouds of real-time, fast Big Data that Thingalytics-savvy users can “translate” into information to provide us with an enhanced customer experience. The banking, shopping, casino or hotel customer who is offered a personalized location-aware experience might spend more money, feel better and become more loyal. Right place, right time and relevant is the key. It has to be all about me!
For the retailer, hotelier, bank or telecommunications company the benefits of Thingalytics are also enormous. These entities can learn what their customers want and how they behave, to help improve their business. They can also spot immediately when their customers are most receptive to an offer. Equally as important, they can spot when something is going wrong; for example, an ATM machine runs out of cash or a customer is waiting in line for too long. Finally, they might be able to spot fraud more easily because algorithms can track errant behaviors faster than humans can.

We are fast approaching an augmented reality world, where wearable computing, combined with Thingalytics, beams the personal experience straight into our line of site. I am genuinely concerned about what some compulsive shopaholics might achieve with this personal shopping radar!
John Bates

Dr. John Bates is a pioneer in the fields of the Internet of Things and Big Data Streaming Analytics. Wall Street and Technology named him one of the "Innovators of the Decade" and Institutional Investor lists him as one of the "Tech 50" most influential technologists. John holds a Ph.D. in Computer Science from Cambridge University UK and was a tenured academic until he left to found Apama, the revolutionary real-time analytics company. He has served as CTO at Progress Software and is currently CMO and Head of Industry Solutions at Software AG.

The Internet of Things is changing the world, with people and machines connecting at dizzying levels and creating a labyrinth of game-changing, fast-moving Big Data. Unlocking the data mysteries can infuse your business with new superpowers to seize opportunities and zap threats. Illustrated by real-life case studies, Thingalytics shows how the alchemy of real-time analytics and smart algorithms turns fast Big Data into actionable gold nuggets.

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