

O'REILLY®

Evolving Architectures of FinTech

Structuring a New Generation of Financial Services with
Modular Software and Agile Development Strategies



Mike Barlow

Open source software, architecture, frameworks, and tools for today's engineers.

If software is what you do, OSCON is where you want to be.
Get better at what you do and rekindle your love of all things digital.



“This is my opportunity once a year
to be completely immersed in
All Things Open Source!”

—Mike Wright, Independent



O'REILLY®

OSCON

LONDON

oscon.com/uk | [#oscon](https://twitter.com/oscon) | [@oscon](https://twitter.com/oscon)

©2016 O'Reilly Media, Inc. O'Reilly is a registered trademark of O'Reilly Media, Inc. D2365

Evolving Architectures of FinTech

*Structuring a New Generation
of Financial Services with
Modular Software and Agile
Development Strategies*

Mike Barlow

Evolving Architectures of FinTech

by Mike Barlow

Copyright © 2016 O'Reilly Media Inc. All rights reserved.

Printed in the United States of America.

Published by O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472.

O'Reilly books may be purchased for educational, business, or sales promotional use. Online editions are also available for most titles (<http://safaribooksonline.com>). For more information, contact our corporate/institutional sales department: 800-998-9938 or corporate@oreilly.com.

Editor: Susan Conant

Production Editor: Colleen Lobner

Copyeditor: Rachel Monaghan

Interior Designer: David Futato

Cover Designer: Randy Comer

Illustrator: Rebecca Demarest

September 2016: First Edition

Revision History for the First Edition

2016-09-06: First Release

The O'Reilly logo is a registered trademark of O'Reilly Media, Inc. *Evolving Architectures of FinTech*, the cover image, and related trade dress are trademarks of O'Reilly Media, Inc.

While the publisher and the author have used good faith efforts to ensure that the information and instructions contained in this work are accurate, the publisher and the author disclaim all responsibility for errors or omissions, including without limitation responsibility for damages resulting from the use of or reliance on this work. Use of the information and instructions contained in this work is at your own risk. If any code samples or other technology this work contains or describes is subject to open source licenses or the intellectual property rights of others, it is your responsibility to ensure that your use thereof complies with such licenses and/or rights.

978-1-491-96776-8

[LSI]

Table of Contents

Evolving Architectures of FinTech.....	1
Rapid Evolution and Broad Commercial Impact	2
Building Better Platforms	3
Enabling Consumers Across Networks	4
Byzantine Complexities and Myriad Possibilities	5
Banks Won't Disappear; They'll Evolve	5
What SOA and Microservices Bring to the Party	6
Developer-Friendly APIs	7
Agility and Integration Through Modularity	8
Nibbling Around the Edges of Legacy Architectures	9
Going Where Banks Fear to Tread	11
Will Blockchain Change Everything?	12
Governance Matters	13
Mutual Understanding and Better Communication	14

Evolving Architectures of FinTech

Fintech, or financial technology, is often reduced to breathless sound bites, such as “It’s like having a bank in your smartphone!” or “By this time next year, no one will be carrying cash or writing checks!”

But the fintech phenomenon is broadly misunderstood, mainly because *disruption* is a sexier headline word than *integration*. In the vast majority of cases, fintech solutions will be integrated with existing systems of hardware and software. From the perspective of fintech developers, the challenge is integrating new software with old systems. From the perspective of financial services institutions, the challenge is providing operating platforms that are friendly to developers.

Although fintech is only one piece of the global financial services ecosystem, it is rapidly evolving into something on the scope and scale of social media and online search. In the same way that email “killed” snail mail, fintech will render some forms of banking either less important or completely irrelevant. At minimum, it will fundamentally alter the way we relate to the numerous financial systems that support and surround our daily lives.

Here are some of the ways fintech will transform the landscape of financial services:

- Highly personalized digital banking and financial services will become the norm.
- For most consumers, borrowing and lending processes will become easier, safer, and more transparent.

- A small but significant minority of consumers will become “credit pariahs,” unable to obtain credit at reasonable terms.
- Speed to market will replace efficiency as the main driver in software development decision-making processes.
- Modular software architectures will be used to gain competitive advantages, not just to save costs and increase efficiency.
- The financial services industry (including banking, lending, trading, and insurance) will endure a long period of restructuring and significant job loss.

Within the financial services sector, fintech can reduce complexity and minimize friction in data-intensive areas such as personal finance, loan origination, cash transfer, consumer banking, capital markets, and equities trading.

The numbers involved aren't trivial. By some **estimates**, the financial services industry generates roughly \$13 trillion annually—about 17 percent of the world's economy. Revenues from global payments, an area in which fintech is rapidly expanding, are expected to exceed \$2 trillion by 2020, according to a recent McKinsey **report**.

Rapid Evolution and Broad Commercial Impact

“Fintech isn't just for bankers, brokers, and hedge fund managers. It's also for merchants and shopkeepers. And increasingly, fintech is for consumers,” says Michael Minelli, vice president of commercialization at Mastercard Labs, the global research and development division of **Mastercard**. “Essentially, fintech is for anyone who handles money, which means it's a truly global transformation.”

For example, Mastercard recently unveiled **MasterPass**, a digital payment solution enabling omni-channel shopping experiences. MasterPass works in-store, in-aisle, in-app, and online. It also uses advanced security methods, such as tokenization with bank identification and verification of cardholders to protect consumers from fraud. Merchants can use MasterPass APIs (application programming interfaces) and SDKs (software development kits) to enable checkout within mobile apps or online.

Mastercard Labs has also built **Qkr! with MasterPass**, a mobile order-ahead platform used in a variety of consumer scenarios, such as paying and splitting bills at restaurants; paying for gas and park-

ing; in-seat ordering at stadiums, movie theaters, and lounges; and paying for school and club fees, lunches, and supplies.

“The digital shift represents a major change in financial services, and we see this as the biggest opportunity for Mastercard since the introduction of plastic,” says Minelli. “We have to think differently, design products differently, and innovate faster than ever before to keep pace with customer expectations.”

Building Better Platforms

Studies of big data generated by ecommerce sites have shown that fewer clicks will result in higher sales volumes and increased customer loyalty. In other words, consumers are more likely to complete purchases when they are required to perform only a minimum of tasks. Nowadays, it’s a given that removing friction from payment processes generates higher sales.

In 2014, **Braintree** launched One Touch mobile payments for **PayPal**. The following year, it rolled out a web-based version of the platform. Both versions basically enable consumers to pay for goods and services across multiple applications with one click, eliminating the need to re-enter usernames and passwords.

In brief, here’s how One Touch works:

- When a PayPal user opts in to One Touch on a specific device (for example, a smartphone or laptop), PayPal first validates the user using its proprietary risk systems. If the validation is successful, a token is placed on the user’s device, indicating that the user wants to use One Touch for future purchases with participating merchants on that device and browser combination.
- When that user wants to pay with PayPal at checkout on the same device and browser, PayPal will validate the token that is stored in the browser against its backend risk systems. If validation is successful, PayPal will securely authenticate the user for that checkout transaction without requiring the user to type in a password.

It’s a lot of work on PayPal’s end, but the company figures it’s worth the extra effort. One Touch is also another step in the direction of creating coherent fintech platforms, rather than one-off apps, for enabling “anywhere, everywhere” ecommerce. It also foreshadows

the critical role of software architecture in emerging fintech ecosystems.

Arnold Goldberg, PayPal's head of global merchant products, foresees the day when PayPal will serve as a secure and highly trusted operating system providing a diverse range of inherent capabilities.

Both consumers and merchants want the ability to use a wide variety of payment systems. "Merchants are already realizing that their websites aren't the only destinations for consumers," says Goldberg.

Enabling Consumers Across Networks

Nowadays, a consumer's decision to purchase an item often begins on a social network such as Facebook, YouTube, Twitter, or Pinterest. But most sites don't make it easy for consumers to transition seamlessly from an initial impulse to a completed purchase.

For example, let's say you see something on Instagram that you want to buy. But the seller is only selling through eBay or Etsy. In a perfect world, says Goldberg, you would be able to purchase the item without leaving your news feed. "We're trying to demystify the process and remove the unnecessary friction and complexity, while maintaining the security and trust needed by all parties to complete the transaction," he says.

Goldberg predicts that "over the next two or three years," the ability to deliver seamless and secure experiences to buyers and sellers across multiple platforms and applications will prove "disruptive" to traditional models of commerce and older software architectures. "The cost of developing new software continues to come down," he says. But fear of the unknown prevents many financial service companies from exploring or adopting new technology solutions. "As an industry, we need to become more aggressive about adopting Agile, DevOps, and open source," he says. "At the end of the day, proprietary software hasn't shown that it's more secure or more effective than open source software."

Goldberg also advocates for updating financial services platforms to make them more "developer friendly," a sentiment shared by software architects and developers interested in creating fintech solutions. From his perspective, there's a "huge mismatch" between most legacy platforms and "anyone trying to actually build something new." Navigating those "murky waters" can be difficult for develop-

ers and startups. “We need to make it easier for people who are building new things and creating new solutions,” says Goldberg. “It’s not rocket science; it’s more an issue of cleaning up existing platforms and decreasing friction for developers.”

Security is also a major concern, he says. “Improving the customer experience is important, but we also spend lots of time and energy securing the interactions between consumers and merchants. Security is an area in which mobile devices are actually superior... because there’s an amazing amount of telemetry from your phone we can use to verify that you really are who you say you are.”

Byzantine Complexities and Myriad Possibilities

Credit and lending are two of the most powerful and lucrative profit centers of the global financial services industry. But each is incredibly complex and bound by centuries of tradition.

In the credit card business, for example, there are acquirers, issuers, payment facilitators, and processors. There are also card associations, such as Mastercard, Visa, American Express, and Discover. It’s easy to swipe your credit card, but the process behind the curtain is complicated. There are authorizations, address verifications, batch submittals, captures, chargebacks, clearings, currency conversions, holdbacks, interchange fees, and settlements. “Most people have no idea of the complexities involved,” says Minelli. “It’s a complicated dance, with many participants and players.”

Those complexities, of course, provide opportunities for developers and entrepreneurs. “If you’ve discovered how to make the system more effective and more convenient, people will definitely listen to your pitch,” he says.

Banks Won’t Disappear; They’ll Evolve

Jason Gardner, founder and CEO of [Marqeta](#), does not expect fintech to put banks out of business. Marqeta develops and provides payment processing technologies for physical card, virtual card, and tokenized card solutions, for credit, debit, and prepaid—all key elements of the existing financial services ecosystem.

“I’m a bit of a contrarian,” says Gardner, explaining that fintech isn’t about disrupting banks. “Our customers in alternative lending, on-demand services, expense management, and ecommerce all need the banks. People forget that companies like Mastercard and Visa are networks of 19,000 banks. None of us could operate within the payment services industry without banks...anything involved with moving money also involves the banking system.”

From Gardner’s perspective, the banks need to decide if their brands should be “front and center, or behind the scenes.” Either way, banks are critical to the larger ecosystem and will remain important players. “I’m a strong believer in creating a robust ecosystem,” he says. “What excites me most about fintech is the ability to innovate quickly. You didn’t have that opportunity before. Today, we have publicly available APIs and open source technology. We have modern hardware and open source databases. Small merchants can use mobile phones as POS [point-of-sale] terminals, enabling them to accept credit cards instead of just cash or checks.”

But the daunting regulatory environment of the financial services industry scares away many developers and entrepreneurs. “The industry is heavily regulated, with all sorts of bureaucracies at the state and federal levels of government,” says Gardner. “The degree of complexity frightens many developers and startups.”

Marqeta is among a handful of newer fintech companies that combine technical expertise with market knowledge to overcome regulatory hurdles and provide practical technology solutions. “Marqeta’s issuing and processing payment platform is built for developers and innovators who are quickly reinventing commerce. We have just the right mix of DNA,” says Gardner.

Looking forward, a significant portion of “fintech DNA” will be composed of flexible software architectures such as SOA (service-oriented architecture) and microservices.

What SOA and Microservices Bring to the Party

Although SOA and microservices are different in many ways, they are both examples of service-based distributed architectures, which means their application components are accessed remotely over a network and connected through a layer of APIs.

Imagine that you're managing a fantasy baseball team and you can select a different lineup of players not only for each game, but also for each inning and each at-bat. Service-based architectures like SOA and microservices offer similar flexibility and opportunities for creativity.

But flexibility and creativity come with risks. There's no single rack-mounted box you can point to and say, "There's the problem." For the most part, the applications and the data are somewhere in the cloud. Getting them together at the precise moment you need them is the tricky part.

The financial services sector is a heavily regulated industry, and regulators like to know where data is stored. Telling regulators that your data is "somewhere in the cloud" will not make them happy.

Ideally, of course, the rules and regulations governing finance would evolve to keep pace with advances in financial technology. But the realities of modern politics make smooth progress unlikely, so be prepared for bumps in the road.

Developer-Friendly APIs

As suggested earlier in this report, the evolution of healthy fintech ecosystems will require financial services companies to create platforms with APIs that developers can access and use easily, since APIs are basically the glue holding everything together.

"The API has emerged as the easiest way to integrate new service offerings with existing infrastructure," says [Sam Newman](#), a senior consultant developer at [Thoughtworks](#) and the author of *Building Microservices: Developing Fine-Grained Systems* (O'Reilly). "Finer-grained APIs make it easier to access and integrate newer and older types of services in a more controlled and safe way than traditional integration technologies of the past," says Newman. "An organization that has effectively exposed finer-grained APIs will be able to integrate more easily with new services developed by third parties and other organizations. It will also be able to expose its own offerings in ways that generate new opportunities and potential value."

Agility and Integration Through Modularity

Fintech innovation will also require agility and integration, says **Mark Richards**, a software architect with over 30 years' experience and the author of *Microservices vs. Service-Oriented Architecture* (O'Reilly). "I like to define agility as the ability to respond quickly to change," he says. "That means you need modular software. When you have modular software, you can compartmentalize functionality and isolate changes so they don't impact other applications."

The problem is that most of the existing legacy architectures are **monolithic** rather than modular, which makes it difficult to integrate new services. "When I think about the challenges preventing wider adoption of fintech, the two words that spring to mind are *agility* and *integration*," says Richards. "Those challenges can be overcome by migrating to more agile and modular architectures."

That's where SOA and microservices, which are both highly flexible and modular, come into play. "I see SOA solving the integration problem," says Richards. "Integrating with heterogeneous platforms is one of SOA's sweet spots."

But relying exclusively on SOA to solve integration issues would be a mistake, he says. "Then you're going back to square one, where you have immovable architectures throughout the enterprise that are difficult to change quickly."

He foresees the emergence of hybrid architectures incorporating the best qualities of SOA and microservices. "I see hybrid solutions as a balancing point. You sacrifice some scalability and some agility, but you have less risk and more security," says Richards.

Ignoring or downplaying risk and security issues would be fatal to banks and other financial services companies. With memories of the global recession still relatively fresh, it's understandable that bankers and regulators are leery of complicated technology solutions. At the same time, SOA and microservices enable developers to create new financial products more quickly than ever before. It's interesting to note that when SOA was introduced, it was touted primarily for its ability to save costs by reusing code. Now, it's touted for its ability to help developers complete projects faster.

But is faster always better? It used to be that we went from "too small to care" to "too big to ignore" to "too big to fail" in a series of more

or less orderly steps. Today, says Richards, many companies leap directly from “too small to care” to “too big to fail” overnight.

Alipay, a payment platform operated by Ant Finance, an affiliate of Alibaba, has 450 million users. Within the span of a few years, Alipay has become one of China’s leading payment services. Most of us can remember when Alibaba’s claim to fame was printing t-shirts on demand.

The rise of Alipay demonstrates the power of combining scalable fintech solutions with highly disciplined business strategies. It also hints at the dangers of scaling quickly. In complex systems, there are always hidden variables and unexpected outcomes. In a laboratory setting, those kinds of risks might be acceptable. But in the real world, with trillions of dollars in play, a modicum of caution isn’t necessarily a bad thing.

Nibbling Around the Edges of Legacy Architectures

If you find it ironic that in Europe and America, the financial services industry trails other industries in adopting the newest forms of information technology, you are not alone. Most IT experts agree with you. “Banks adopted IT before most other industries, which means they have more legacy infrastructure than any other sector of the economy. That makes it more difficult for them to integrate newer technologies,” says Newman.

It also explains why the fintech phenomenon looks as though it is evolving more rapidly in regions of the world where there is less existing infrastructure. In Africa and parts of Asia, for example, there are far fewer traditional banks than in Europe and America. The absence of incumbent infrastructure makes it easier for newcomers to gain footholds and create novel types of business models.

M-Pesa is the best-known example of an innovative fintech service that capitalized on a region’s lack of banking infrastructure. M-Pesa provides essential money transfer, financing, and microlending services through a mobile platform developed by **Vodafone**. The service was launched in 2007 in Kenya, and has expanded to Afghanistan, South Africa, India, Romania, and Albania. In addition to creating new economic opportunities, it also brought social change to millions of people who previously had no access to safe or legal

forms of banking. “It’s interesting to note that M-Pesa probably would not have been allowed to exist in the West, largely because of regulatory hurdles,” says Newman.

Although the hurdles are high, they haven’t stopped a new generation of entrepreneurs from using fintech solutions to launch startups. When Matt Oppenheimer was working in Nairobi, he noticed that people often sent money to relatives via informal networks of minibus taxi drivers. “You handed your money to the driver of a *matatu* (minibus) and you prayed that he actually brought it to your mother in another village,” recalls Oppenheimer. His experiences in Kenya eventually led him to start **Remitly**, a mobile payments service that enables consumers to make person-to-person international money transfers from the United States and Canada to the Philippines, India, and Mexico.

“The cool thing about our business is that we answer the needs of a population that’s been really underserved,” says Oppenheimer. “Until recently, the whole process of transferring cash was fraught with risk, delays, and costs. Now people can send money to relatives from their mobile phones. It’s much safer and much less costly.”

In addition to potentially improving the lives of billions of people, entrepreneurs like Oppenheimer see opportunities for leveraging fintech innovation to create new markets. The global remittance industry handles \$500 billion annually. Of that total, 8 percent “disappears” in the form of fees. “That’s \$40 billion being taken away from families who need the money their relatives send them,” says Oppenheimer. “Not only is that money taken, it’s taken in a way that’s not transparent.”

Replacing informal or illegal money transfer systems with digital systems that are legal, transparent, safe, and convenient seems like a win-win for everyone but the loan sharks and *matutus*.

Innovative services like M-Pesa and Remitly demonstrate the viability of business models based on fintech software architectures. Investors are keeping close watch on the fintech space, and carefully funding new ventures that seem promising. Those investments will also spur banks and other traditional players to develop or invest more heavily in fintech. “The banks are starting to get scared, which is good,” says Newman. “The big players really haven’t been challenged, but they’re starting to see innovators nibbling around the edges.”

That “nibbling around the edges” is actually making the big banks a little braver about investing in fintech solutions, especially for their retail divisions, which tend to serve younger consumers.

Going Where Banks Fear to Tread

Banks generally avoid lending to small businesses. From the typical banker’s point of view, small business loans simply aren’t profitable enough to justify the bank’s investment of time and resources.

The reluctance of banks to engage with small businesses has left the field open to startups like **OnDeck**, **Fundbox**, and **Kabbage**. “If you’re a small business owner and you need a loan of less than \$250,000, the banks are hard to deal with,” says Rob Frohwein, an intellectual property lawyer who cofounded Kabbage in 2008. “But data technology is the great equalizer in many ways.”

Because Kabbage connects electronically with a borrower’s data, “we can create a living, breathing product,” says Frohwein. Unlike traditional banks, which still rely almost entirely on paper records to loan applicants, “we understand how your business looks today, tomorrow, the day after tomorrow, and all the days after that.”

In addition to leveraging real-time data to monitor creditworthiness, companies like Kabbage can potentially customize products based on a customer’s cash flow. “This is when it gets interesting, when data moves from the back office to informing the products themselves,” says Frohwein. “With access to your data, I should be able to deliver customized suggestions for products.”

Here’s how that might play out in the real world. Let’s say the data collected by Kabbage indicates that your small business typically has great cash flow in September and October, but lackluster cash flow in January and February. Theoretically, Kabbage could alter your loan payments so they align more closely with your actual cash flow. For most small business owners, that would be like manna from heaven.

“Having access to data over time allows you to modify your products over time,” says Frohwein. In other words, when you have more cash, you would make bigger payments, and when you have less cash, you would make smaller payments. “If we notice that your cash flow is spread out more evenly, we would spread out the pay-

ments more evenly. That adds a lot of value to our relationship,” he says.

Will Blockchain Change Everything?

Any conversation about fintech has to touch on blockchain, the sequential distributed database that is foundational to cryptocurrencies like Bitcoin. But enabling Bitcoin transactions represents only a fraction of blockchain’s potential impact across the fintech universe.

“Blockchain has the potential to change financial processing radically by speeding up asset processing time and reducing operational costs,” says Blythe Masters, a former JP Morgan Chase executive credited with inventing the modern credit default swap and the CEO of [Digital Asset Holdings](#), a startup providing settlement and ledger services to the financial services community. “Faster settlement means less risk in the financial system and lower capital requirements.”

While the Bitcoin blockchain “has some features that are problematic in the context of regulated financial institutions,” Masters says, “alternatives known as private or permissioned distributed ledgers, which limit participation to known and approved parties and improve upon privacy, transparency, and throughput capacity” are gaining trust across the banking community.

Improved standardization will also be critical to wider adoption. “The Hyperledger Project being run under the auspices of the Linux Foundation is one important open source initiative that has been formed with the goal of creating a common standardized infrastructure, which in turn will drive adoption of blockchain,” says Masters.

Major market infrastructure providers like [ASX](#) (Australian Security Exchange) and [DTCC](#) (Depository Trust & Clearing Corporation), which already count the world’s major banks as their customers, are actively exploring blockchain technology, she says.

“We don’t see blockchain as a disruptive technology but rather a constructive technology that will disrupt inefficient business processes within and between institutions,” says Masters.

Governance Matters

It's difficult to estimate where the market for fintech will level off, but it's clearly growing. Inevitably, the spread of fintech raises questions about IT governance in financial services companies.

“I think you will see a resurgence of interest in IT governance, because in the absence of governance, you have chaos—which would be unacceptable in the financial services industry,” says Chris Moschovitis, an IT governance expert and chief executive officer at [tmg-edia](#), an independent technology consulting company. “For fintech, governance will be absolutely critical. Here's why: IT exists to *generate* value. Cybersecurity exists to *protect* value. They are parallel tracks and ideally, they shouldn't touch,” he says.

Governance, for example, would prevent a financial services enterprise from creating an organizational structure in which the chief information security officer (CISO) reports to the chief information officer (CIO). That reporting structure might make sense from a technology perspective, but it might be catastrophic from a risk perspective. “It would lead to very bad outcomes, since cybersecurity and value generation are in direct conflict,” says Moschovitis. “That's a good reason for having fintech governance, because the various relationships involved in the process aren't always completely clear and unambiguous. If I'm the CIO of a fintech company, my goal is creating powerful software applications to crush the competition. Without governance, I will face no constraints and I will try to move as fast as I can without delays.”

Governance, which flows from the board to the executives to the IT department, is “the commonsense bible that sets forth the rules of the road,” he says, preventing technology from running amok.

With fintech, a large part of the risk stems from the unintended consequences of moving too quickly. Service-based software architectures like SOA and microservices enable developers to perform leaps that would have seemed almost magical five or six years ago. But those leaps aren't free—the price is unforeseen risk, which can prove very expensive.

Mutual Understanding and Better Communication

There is a chasm between software developers and financial services companies, but the chasm is not unbridgeable. Building the bridge, however, will take some effort from both sides. As mentioned at the beginning of this report, software architects and developers have different perspectives than bankers and brokers. Both sides are driving toward similar goals, but each faces a different set of challenges. Developers need accessible platforms with APIs; financial services companies need software that delivers real value and profitability.

If you're a startup, Minelli advises you to do your homework and figure out how to make your applications work within existing financial services ecosystems. "Yes, the banks have to do a better job of creating developer-friendly platforms," he says. "But the developers have to do a better job of creating products that banks can use. For developers, that means understanding how banks assess risk, calculate profitability, and integrate new services with their existing systems."

For the moment, it seems, both sides are expecting too much from the other. The developers want platforms they can plug into easily; the banks want applications that will generate profits quickly for their lines of business. What's needed is greater mutual understanding and more communication.

"You don't always have to throw knock-out punches. Not everything you create has to be disruptive or earth shattering," says Minelli. "Chances are, if you're working in the US, Canada, or Europe, you won't have to invent something like M-Pesa that works *despite* the lack of banking infrastructure," he says. "In fact, you'll be more successful if you understand existing infrastructure and make sure your software is a good fit."

About the Author

Mike Barlow is an award-winning journalist, author, and communications strategy consultant. Since launching his own firm, Cumulus Partners, he has worked with various organizations in numerous industries.

Barlow is the author of *Learning to Love Data Science* (O'Reilly, 2015). He is the coauthor of *The Executive's Guide to Enterprise Social Media Strategy* (Wiley, 2011) and *Partnering with the CIO* (Wiley, 2007). He is also the writer of many articles, reports, and white papers on numerous topics, including smart cities, ambient computing, predictive maintenance, advanced data analytics, and infrastructure.

Over the course of a long career, Barlow was a reporter and editor at several respected suburban daily newspapers, including the *Journal News* and the *Stamford Advocate*. His feature stories and columns appeared regularly in the *Los Angeles Times*, *Chicago Tribune*, *Miami Herald*, *Newsday*, and other major US dailies. He has also written extensively for O'Reilly Media.

A graduate of Hamilton College, he is a licensed private pilot, avid reader, and enthusiastic ice hockey fan.