

# MIT Technology Review

INSIGHTS | Research

## Cloud Development: The Key to Rapid Innovation



A briefing paper in association with

ORACLE®

Beyond helping businesses expedite processes, reduce risk, and increase efficiency, dynamic software development in the cloud will boost developers' productivity and increase the ability to spot promising business models, new revenue streams, and untapped potential.

In industries ranging from finance to pharmaceuticals, companies must continually replenish apps and features to keep up with competitors, both old and new. Developers play a critical role in accelerating the rate at which companies can unveil innovations and improvements – driving new advantages and foreseeing swerves in the marketplace as accurately as possible.

Now, it is the developers themselves who are due for an upgrade – in terms of their own development skills.

As companies strive to meet the ever-changing demands of their customers, they are pressuring software developers to create or add features to applications as swiftly as they can. In a fiercely competitive environment, anticipating customer needs and fulfilling them faster than rivals can is the surest path to achieving and maintaining a dominant market position.

“We’re in a fast-moving environment,” says Mike Lehmann, vice president for product management at Oracle. “The goal is to innovate quickly and efficiently to pursue new market opportunities, as well as achieving other objectives.”

Cloud technology is helping software developers pursue innovation in a feature-rich environment. Using a platform approach, they can access the infrastructure and tools they need to swiftly and efficiently build, deploy, and integrate cutting-edge applications, as well as modify existing ones.

“Software development has always been moving from an artisanal model to an industrialized one,” says Mark Rakhmievich, senior director, blockchain product management at Oracle. “We’re now able to provide better tools, frameworks, and models that help developers get things done faster and more consistently, continuously raising the level of re-use. By leveraging the readily available infrastructure and



“ APIs allow developers to concentrate on the core of what they are working on: making better experiences for users. ”

**Emmanuel Paraskakis, senior director, product management, API Management + Apiary, Oracle.**

common frameworks, developers can build value into the application much more rapidly.”

Having access to a cutting-edge application development platform promotes agility and is the fuel that accelerates app innovation. Developers seek out the best user experiences and build on the state of the art to continuously leapfrog – or disrupt – the competition. This is how developers can make a dramatic difference in customer engagement.

Application development in the cloud has been designed for efficient continuous integration/continuous development environments. Developers can simply provision workspaces with software and hardware and get to work. Workspaces include collaboration tools, coding libraries, source control, testing tools – everything required to speed the time

to value. Direct access to an abundance of useful cloud services also simplifies both front-end and back-end development.

Moving application development to the cloud eliminates the burden of assembly, integration, maintenance, and patching of all the necessary components. The cloud's now-familiar flexible, on-demand model is also cost-effective, sparing companies the need to invest in their own infrastructure. IT savings can then be redirected into experimentation and innovation.

To help the business continuously innovate, developers need the tools and capabilities to quickly design, build, and maintain high-value enterprise software. By relying on fully developed services available in the cloud, developers can bypass their learning curve and accelerate projects. They can also tap into the power of development building blocks like advanced application programming interfaces and containers to develop for emerging platforms like chatbots, blockchain, and the Internet of Things (IoT).



## APIs: No Longer an Afterthought

Application programming interfaces (APIs) help developers build apps as collections of building blocks. They are critical to quickly delivering higher-quality apps. APIs let apps share data with each other, and are a key mechanism for creating appealing digital experiences. “They are the reason we have beautiful and very rich applications on our phones today,” says Emmanuel Paraskakis, senior director, product management, API Management + Apiary at Oracle. “APIs allow developers to concentrate on the core of what they are working on: making better experiences for users.”

By documenting and designing the API first – before writing the code – developers create a strategy for a more componentized approach for adding new functionality and releasing higher-quality code. “Fixing a mistake at design is cheap, but once it is more integrated, it becomes more expensive,” says Paraskakis. “Rapid, agile development and designing in that very early stage

of the life cycle is preferable, before you spend a lot of time and energy on writing source code or implementing those APIs.”

The API-first method also boosts efficiency, as front-end development can begin even before an API is delivered, on the basis of an agreed-upon contract. And the resulting code will likely be more robust than it would have been otherwise. A developer who starts with the API is thinking about design from a user's point of view from the beginning – making developers more inclined to build APIs that are easy to understand and to access.

With a cloud-based data platform, developers can access an API blueprint of sorts, from which they can choose and subsequently iterate as the app takes shape. They can also use automated testing tools that run in the background, ensuring any changes they make in the build process follow the rules (“assertions”) embedded in the existing documentation.

With a cloud-based data platform, developers can access an API blueprint and iterate as the app takes shape.

The shift of APIs from an arcane, behind-the-scenes technology to a key component in shaping the customer experience has made them pivotal to a business's digital strategy. “Taking a customer-focused, API-first development approach is vital for both technology and business leaders,” says Paraskakis. “It helps them engage with commercial partners, suppliers and – of course – consumers.”



## Chatbots: Much More than Talk

With the demands for communication to be instant, expressive, and available across multiple channels, there has been a tremendous rise in the popularity of instant messaging apps like Facebook Messenger, WhatsApp, Instagram, WeChat, and voice-driven virtual assistants such as Amazon Alexa, Google Assistant, Apple Siri, and Microsoft Cortana.

Conversational AI – or chatbot technology – represents the next generation of customers and employee engagement. Besides delivering an immersive experience, chatbots can automate customer interactions (answering queries about a retailer’s return policies, for example, or describing a bank’s various loan offerings). This frees up customer service reps to focus on higher-value tasks and deliver personalized engagements. They can then pivot to engaging more with customers, raising the return for investing in this technology.

But this can be easier said than done. Delivering a natural conversational experience requires a solution tightly integrated with the right channels, including dialogue flow with a full state engine, conversational AI platform, and syncing up with enterprise data. In the past, only businesses with deep domain knowledge of machine learning algorithms, data, and models to train the algorithms could deliver this functionality.

“What we have created is a complete chatbot solution that packages all of this in a very easy and consumable way where non-technical domain experts can use the AI models without knowing anything about AI and design,” says Suhas Uliyar, vice president of bots AI and mobile product management at Oracle. “We have also simplified channel integration to just a few clicks, leveraging the power of the Oracle PaaS platform to integrate with a variety of data sources.”

Conversational AI platforms are at the heart of a chatbot that provides a natural conversational experience. It’s only logical that these platforms will evolve to support natural ambient human experiences across multiple channels such as mobile apps, and immersive experiences like augmented and virtual reality. The complexity comes in maintaining the context and conversation within the same conversational channel. Multiple bots and applications must have a seamless paradigm in order to work together.

“Developers need to rely on the expertise of others to assemble the entire platform, because there are just too many unique disciplines involved across multiple channels,” says Uliyar. This is why a cloud-based, visual development environment and framework that simplifies the deployment of fully functional multi-channel experiences is so key in the chatbot environment.



## Conversational AI platforms are at the heart of a chatbot that provides a natural conversational experience.

This type of platform can more easily connect to mobile-optimized and mashup APIs, available in a readily accessible API catalogue for data from enterprise and non-enterprise backend systems of record. Uliyar points out that these APIs can include channel context-specific services such as natural language processing (NLP) chatbots, AI-based object recognition for augmented reality (AR), and mobile-first services such as push notifications, offline sync, and location services.



## Blockchain: Unlimited Potential to Reinvent B2B Collaboration

While blockchain started as the foundation for exchanging assets ranging from cryptocurrencies and utility tokens to securities, new applications are emerging that bring information transparency and trust into government, finance, health care, commerce, education, and media. Every industry will be affected – from their marketplaces, supply chain processes, information sharing requiring trusted provenance, and many track-and-trace applications, ranging from food to pharmaceuticals to physical parts for cars, planes, and more.

Providing access to the cloud-based blockchain network opens the door to game-changing business capabilities

As organizations explore the potential of blockchain, they need their developers to be able to quickly prototype blockchain-based applications. They'll need three things to do this: a quick-to-provision blockchain foundation, rich distributed ledger APIs and tooling to develop and test smart contracts, and simple-to-integrate APIs for applications to drive smart contract transactions and query the ledger.

The blockchain foundation is a distributed system that maintains a tamper-proof ledger, processes transactions, and ensures consensus among the participants. The promise of blockchain is due to its elegant architecture, open source-based components, and simple deployment requirement – from a laptop to a cloud provider. However, for most developers in these early days, the key is to look to the dominant cloud providers and standards bodies to innovate quickly and to shape the delivery platform.

“Business-critical applications require production-ready blockchain infrastructure with enterprise-grade attributes, such as performance, scalability, and resilience, plug-n-play application integration capabilities, API-driven development approach, and operational characteristics,” says Rakhmievich.

At the heart of the blockchain are smart contracts – business logic created by developers to maintain the ledger data and run application-triggered transactions that update and query the electronic ledger. The APIs that manage access to the ledger insulate this business logic from the underlying issues of consensus, validation, confidentiality, and replication, so developers can focus on evaluating data in the business objects maintained by the ledger (assets, documents, and the like). The smart contract controls transaction routing, exception handling, approvals, and visibility.

Once the smart contracts are in place, application developers need simple ways of driving transactions and query data, without worrying

about the asynchronous complexity of blockchain interactions. Wrapping and exposing smart contract methods through REST (Representational State Transfer) APIs provides this capability, enabling blockchain apps to be easily accessible from cloud-based and on-premises systems of record, or newly built front-end applications that handle stakeholder interactions in a particular blockchain application.

Providing access to the cloud-based blockchain network opens the door to game-changing business capabilities, such as real-time inter-company systems reconciliations and the establishment of a single source of truth for siloed business functions and software systems. The pre-assembled, hardened blockchain platform, delivered as a public and private managed cloud service, allows rapid experimentation to determine business potential and easy transition to production-ready deployment – two factors critical to the success of a blockchain in an enterprise.



## Internet of Things: Sensing Where It's Useful

With the availability of sensors connected to ubiquitous networks, and advances in real-time data processing coupled with big-data architectures, the Internet of Things is poised to significantly transform businesses. While IoT has interesting use-cases in the consumer space, according to Atul Mahamuni, vice president of IoT applications at Oracle, the industrial IoT segment is seeing quicker adoption of solutions that deliver clearer operational visibility, predictive insights, and increased automation for manufacturing, transportation and logistics verticals.

To build IoT solutions, developers need the expertise to collect and ingest data from sensors, process those data streams with stream processing, and detect anomalous patterns in the data. Deeper analysis of this data can help predict equipment failure, calculate and forecast complex business key performance indicators, and create insightful visualizations on dashboards and mobile user-experiences.

The technology stack supporting this includes components from different disciplines. Starting with networking, you need to manage various protocols to collect data from sensors. Once you collect the data, you need to find events using complex event processing (CEP) or stream processing engines. A sophisticated rules engine detects incidents and triggers automated responses into business workflows. Using a lambda architecture (a data-processing architecture designed to handle massive quantities of data, such as Apache Spark) for speed, predictive models will quickly combine streaming, business, and historical data. Underlying event processing is data management. Data persistence design requires careful cost and performance choices due to extreme data volumes and data variety (structured and unstructured). Lastly, for user interactions, you need to build web and mobile front-ends with visualizations.

Two newer interaction technologies showcase the value transformation that IoT enables – digital twins and chatbots. Digital twins let users create a virtual representation of a physical asset, complete with sensors and able to simulate operations. Modeling usage prior to deployment will predict equipment behavior, saving time and money and mitigating industrial risk. Digital twins are the natural extension of fully deployed industrial sensors



Two newer interaction technologies showcase the value transformation that IoT enables — digital twins and chatbots.

on people, machines, and equipment. Chatbots offer a natural language or human conversational experience to query and control IOT equipment in real time. Integrating mobile chatbots with IOT data will also revolutionize human and machine interaction for productivity and safety.

Developers need the expertise to collect and ingest data from sensors, process those data streams and detect anomalous patterns.

Due to this complexity, many IoT projects either stall in their initial phases or fail to achieve their potential. “The key to a successful IoT project is to start with the business outcome, figure out what analytical/predictive insights you need to achieve that outcome, and let that drive what data you need to collect from the sensors,” says Mahamuni, whose involvement with the technology reaches back almost a decade. “We like to think about IoT as a way to extend the operations workflows to the physical world. We call this process ‘IoTification’ of a business process.” For example, employees feed data manually in many transportation management systems today. A business process, such as deploying maintenance trucks, can be extended using data collected and analyzed from an IoT-enabled fleet by “IoTifying” the transportation/logistics application.

This outcome-focused approach to IoT deployment ensures that the return on investment (ROI) is quantified early on, the right predictive algorithms are developed, and only the appropriate set of data is collected from the sensors. “We recognized this need in the market a few years ago, and have created a set of purpose-built solutions for common IoT use cases such as asset monitoring for asset-intensive companies, and several others,” says Mahamuni. “By leveraging pre-packaged apps and extensible platforms for monitoring assets, equipment, fleet vehicles, and industrial workers, it becomes extremely easy to drive adoption of IoT solutions that ‘IoTify’ the business applications by extending business workflows to the physical world of industrial assets.”



“The key to a successful IoT project is to start with the business outcome, figure out what analytical/predictive insights you need to achieve that outcome, and let that drive what data you need to collect from the sensors.”

Atul Mahamuni, VP for IoT/Analytics, Oracle.



## Containerization: In Isolation, an Improved Developer Experience

The pace at which developers can work is not merely a product of their experience, of course. They need technological support that will help them move code as fluidly as possible to and from different environments: development, testing, staging, and production. With DevOps, a sophisticated toolchain automates the build, deploy, and operate cycles, keeping a check on operational concerns. The end goal: improved developer velocity to release early, often, and with fewer errors.

Containers, microservices, and server-less architectures are an essential part of the DevOps toolchain. By wrapping applications in containers – which run on top of an operating system, making them much lighter than virtual machines (VMs) – developers can ensure their software will always operate in an identical and much faster way.

According to cloud application monitoring service Datadog<sup>1</sup>, containers churn nine times faster than VMs. And, with certain cloud infrastructure offerings today, it's possible to host containers directly on “bare metal,” meaning installed directly on hardware, absent an operating system, for additional performance and security.

By standardizing the different environments and eliminating the need for manual intervention, containers reduce costs, boost production, and improve agility in the cloud, resulting in reduced cycles to market. While most solutions are proprietary and closed, new offerings take an open-source, open standards-based approach to container offerings. Open source is being rapidly adopted in this space, accelerating developer innovation. With tools like Docker and Kubernetes in the mix, enterprises can customize a container and orchestration solution that enables them to build and scale economically and efficiently.

“Oracle has been actively building out cloud products around Docker and Kubernetes and advancing that work in open source and within the larger container community. For example, last year Oracle joined the Cloud Native Computing Foundation (CNCF),” says Mike Lehmann, vice president for product management, Oracle.

“There is a lot of exciting work to be done with our partners here to keep up with the rapidly maturing developer demands.” The CNCF is a vendor-neutral group with the mission of making cloud-native computing more broadly integrated and universal. Containers are the new model for app development, with reusable resources across cloud providers. And the collective impact of all cloud-based software development is the speeding up of processes, reducing risk, and increasing efficiency.

Containers, microservices, and server-less architectures are an essential part of the DevOps toolchain.



## Cloud is Built for Speed

---

Businesses are under pressure to continuously evolve their offerings and customer experiences. To do that, they need a responsive IT function, which the cloud can help them deliver. But the cloud can also undermine IT productivity if what it offers amounts to a collection of components that must be organized, managed, certified, and maintained. Developers don't just need tools; they also need increasingly intelligent components that are well-integrated and ready to run.

Adding a fully developed blockchain protocol around existing multi-party transactions, for example, is certainly easier than piecing it together manually. Similarly, ready-to-use components make it possible for any company to take chatbots beyond a simplistic form and extend them with enterprise APIs, NLP, and mobile support. Finding the ROI of IoT can be achieved with applications pulled from the cloud. And utilizing APIs and containers is fully possible when the infrastructure is ready to go.



In today's competitive business world, combining innovation and agility is key—and this is what application development in the cloud provides.

---

Being able to build applications while rapidly adopting emerging technologies is what developers do. In today's competitive business world, combining innovation and agility is key – and this is what application development in the cloud provides. With ready-to-go infrastructure and easy-to-use tools, via the cloud, developers are poised to help businesses compete at the speed they need.

---

<sup>1</sup>Please see <https://www.datadoghq.com/docker-adoption/>

*Cloud Development: The Key to Rapid Innovation* is a briefing paper by MIT Technology Review Insights. It is based on research and interviews conducted between October 2017 and November 2017. We would like to thank all participants in this project as well as the sponsor, Oracle. MIT Technology Review Insights has collected and reported on all findings contained in this paper independently, regardless of participation or sponsorship.

April 2018

## From the sponsor

The Oracle logo, consisting of the word "ORACLE" in white, uppercase letters on a red rectangular background.

The Oracle Cloud offers complete SaaS application suites for ERP, HCM and CX, plus best-in-class database Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) from data centers throughout the Americas, Europe and Asia. For more information about Oracle (NYSE:ORCL), please visit us at [oracle.com](http://oracle.com).

### Trademarks

Oracle and Java are registered trademarks of Oracle and/or its affiliates. Other names may be trademarks of their respective owners.

To learn more about app dev trends, visit [oracle.com/dev-test-deploy](http://oracle.com/dev-test-deploy)

## About MIT Technology Review Insights

For more than 100 years MIT Technology Review has served as the world's longest-running technology magazine, the standard bearer of news and insights on how the latest technologies affect the world around us. Read by a global community of innovators, entrepreneurs, investors and executives at the highest level, it offers an unrivaled authority that is backed by the world's foremost technology institution, and features editors with a deep technical knowledge and understanding of technological advances.

MIT Technology Review Insights is the content solutions division of MIT Technology Review. It includes two main divisions: Research and Live Events. Aligned with the same stellar editorial heritage and standards as the magazine itself, we leverage our access to a wide network of subject matter experts and leading content contributors to create custom content for clients who want to reach new audiences with relevant, cogent and high-quality stories and experiences to users wherever they want it – in digital, print, online, and via unique in-person experiences.

*While every effort has been taken to verify the accuracy of this information, MIT Technology Review Insights cannot accept any responsibility or liability for reliance by any person on this report or any of the information, opinions or conclusions set out in this report.*



## MIT Technology Review Insights

 [insights.techreview.com](https://insights.techreview.com)

 @techreview @mittr\_insights

 [insights@technologyreview.com](mailto:insights@technologyreview.com)