Cognitive Computing In Technology, Media and Telecom
Seeing Through the Hype To Find the Right Path, Right Now
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Introduction

Technology breakthroughs, remarkable as they are, unfortunately have an all-too-frequent handmaiden: Hype. “Cognitive Computing,” (a term we use here interchangeably with “Artificial Intelligence”) is without any doubt a prime example. For every story about a truly astonishing AI triumph—such as Google’s “DeepMind” beating the world’s champion Go player¹—there are a bushel of press releases describing how the Artificial Intelligence that’s built into product X will straightaway transform your company into an industry leader.

This is an obvious dilemma for business leaders anxious to take advantage of a new generation of Cognitive Computing tools, and who are therefore eager to separate AI’s wheat from its chaff. And so any number of white papers have been written to help executives with this task. Most, though, concentrate on the AI tools themselves—discussions which, as we will soon see, are often of little value—rather than explain what a C-suite executive can expect those tools to accomplish.
Which is why this paper takes a different approach. From working with hundreds of clients, vendors and front-line AI researchers, Deloitte has developed a sophisticated understanding of AI, one that allows us to weed out the hype and identify the business cases where Cognitive Computing will deliver the most value. While many of the newest AI tools are new and rapidly-evolving, these are use cases for which even the most cautious companies can take advantage of AI today without fear of finding themselves stuck on the bleeding edge with unproven or even flawed technologies.

Specifically, we believe AI can today...

... help automate back-end business processes, reducing costs and freeing up staff for the sort of value-added analytical work they typically are now too swamped to undertake. We call this “Robotic and Cognitive Automation.”

... allow businesses to mine the mountains of data they are now collecting, from the Web and elsewhere, to make sharper, faster decisions - “Cognitive Insights.”

... help companies better connect with customers, anticipating their needs and spotting potential problems - “Cognitive Engagement.”

We are avoiding a lengthy discussion of specific Cognitive Computing tools and techniques because, for good or bad, most of the terminology associated with AI—including the very phrase “AI”—have been co-opted by marketing departments. A term like “machine learning” may mean entirely different things depending on the company invoking it. Potential AI customers are advised to take this into account as they evaluate competing “Cognitive Computing” products, as what might seem like identical offerings from their brochures might be dramatically different under the hood. (Indeed, some of them might seem suspiciously like the same product previously sold without any mention of “AI” at all.)

Perhaps the only useful definition of Cognitive Computing is the most general one: It’s a set of technologies that allows for greater flexibility with bigger and less-rigidly structured data sets, and which allows computers to work with text and images in a manner previously associated only with humans. That said, there is usually no clear demarcation between a computer that is and is not “artificially intelligent.” Digital technology has been growing more robust and capable from its very earliest days; the current blossoming of AI should best be thought of as a growth spurt, rather than some entirely new species.

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Thinking about Cognitive Computing as just the latest phase in the ongoing evolution of technology has an additional benefit, in that it helps bring clarity to decisions about AI implementations. No clear-thinking executives OK a big technology acquisition simply because they are enamored of the technology itself; instead, they need to be convinced it will make some significant contribution to the enterprise. The same is true for AI. There is nothing to gain from “doing AI” simply because everyone else seems to be.

None of this is to suggest that there aren’t extremely compelling reasons to being including AI into your operations on a timely basis. For example, a recent Deloitte survey of early Cognitive Computing adopters found that three-quarters of them expected it to be making significant contributions to their business within three years.

At this point, we need to call attention to something that is too often overlooked in discussions of artificial intelligence. Despite the common description of AI as “thinking machines,” there is no current AI technology that comes even close to replicating the entirety of human intelligence. (Whether one is even on the horizon is the topic of a lively debate.) AI products perform specific, well-defined tasks, and often it takes considerable patience and prodding to get them to do even those. Human common sense and judgment have not been automated.

A corollary of the preceding is that while AI technology can perform a specific operation with greater efficiency and sophistication, it will be of little use if that task isn’t part of a system that is efficiently-designed in the first place. With AI, like with any other technology, automating an inefficient process simply speeds up the inefficiency. Executives who expect AI to be some sort of salve over a dysfunctional operation will not simply be disappointed; they will find themselves further behind their competition. AI can be part of a general housecleaning, but it certainly can’t be a substitute for an edifice about to crumble for want of a proper foundation.
Cognitive Computing: A set of technologies that allows for greater flexibility with bigger and less-rigidly structured data sets, and which allows computers to work with things like text and images in a manner previously associated only with humans.
AI and Cognitive technologies are expected to have widespread use at nearly all companies in all sectors of the economy. But they have an especially compelling rationale at Technology, Media and Telecom firms, on account of some of the unique data analysis needs and business model challenges that TMT companies face.

- While all firms are being forced to deal with an explosion of data, the problem is especially pronounced in the Technology sector. Consider the semiconductor industry, which every few years brings out new chips with double the parts count of the model they’re replacing. (Intel chips are closing in on 10 billion transistors each.) This places unprecedented demands throughout the design and manufacturing process. While semiconductor fabrication has historically been a driver of cutting-edge computer aided design methodologies, the industry is now turning to machine learning to bring a new level of efficiency to these processes.

- Media companies are uniquely challenged by the deterioration of traditional business models, by the proliferation of new distribution channels and by the need to decide what sorts of new content they should expend resources producing and how they should best match that content with an increasingly fragmented customer base.

- Telecom companies finds themselves dealing with users who are increasingly willing to shift suppliers, bringing a new intensity to familiar problems such as engaging customers and managing churn. They also face vexing infrastructure management problems as new networks, both wired and wireless, increase in complexity.

Throughout this paper, we’ll use Case Studies to demonstrate how TMT companies are turning to Cognitive Technologies to help them tackle the new Automation, Insight and Engagement challenges being posed by today’s fast-changing and totally-unforgiving business environment.
Robotic and Cognitive Automation

Transforming How Work Gets Done

Robotic and Cognitive Automation shares a lot with its blue-collar cousin in the factory. But instead of using computer-controlled devices to assemble disparate parts into, say, an automobile, it works with information, gathering bits of data from multiple sources and assembling them into, say, an invoice. Both forms of automation have the same rationale: Relieving humans of tedious and repetitive work while guaranteeing uniformly high-quality end products. But while factory automation can be dated to the 19th Century, modern R&CA is relatively new. And thanks to developments in Artificial Intelligence, it is undergoing extremely rapid technological development, evolving beyond its roots in the simplest of clerical applications and beginning to encroach on the terrain of some of the white-collar world’s most highly-trained professionals.

First-generation automations are already widely-used in business, largely because of their relative simplicity. When you call your bank to activate a new credit card or cancel a stolen one, an R&CA system is working in the background on the relatively straightforward task of updating all of the relevant customer records. Another common use case involves processing invoices, which invariably require accounting departments to gather information from a number of documents: The date from one,
the address of the payee from another; the amount due from a third. An R&CA system can be easily trained to fetch these for itself. If the data is already in some digital form, and if the format and location of the data is always the same, the task is trivial. In fact, it’s not much more complicated than an Excel macro, though one that works across many different applications.

Difficulties arise when the documents exist in paper form, in which case an Optical Character Recognition system must convert them to text, a step that usually requires a modicum of human oversight to make sure errors weren’t made in the transcription process. Even more complexities are encountered when the data isn’t presented consistently; a simple matter of differently-formatted dates can throw off a rudimentary automated process.

This is where Cognitive Computing enters the picture. One of the hallmarks of AI is allowing computers to deal with unstructured data as easily as they do with information neatly arranged in rows and columns. The Receivables operation of a large business may receive invoices in a host of different formats. R&CA vendors have learned to build enough intelligence into their systems to operate smoothly despite these disparities.

The complexity of automations, and the associated built-in AI functionality, grows from there. For example, end-of-quarter financial reporting involves gathering information from a shelf full of different documents, a “swivel chair” task that can often require a team of accountants. Doing so requires a fairly sophisticated ability to find, say, quarterly sales figures, even though it may be listed in different currencies and different languages. Newer R&CA systems have the smarts to be able to clear such hurdles. As a result, they are moving beyond accounting into adjacent back office functions, including tax preparation and human resources. They have become especially popular in offshore operations centers, which house a multitude of different staff function from an entire region in a single office.

While they have their origins in bookkeeping, the sky is the limit in what R&CA platforms are capable of. Many cutting-edge systems resemble nothing so much as full-blown AI systems. In fact, an industry debate is underway as to whether the somewhat prosaic term “R&CA” still even applies to them. Some of the best examples are from the field of law. Machine learning-based platforms now have the ability to search through libraries of case studies to find one where the issues are similar to those they are currently litigating. Patent attorneys find the software especially useful, on account of the sheer number of virtually identical filings that must be searched through in connection with a dispute.

To be sure, all of this work was previously done by entry-level legal workers; no computer can yet plan a legal strategy or write a compelling brief, much less make a court appearance. But the technology is beginning to nibble away at the edges of legal employment. Estimates of the decline in billable hours lawyers can expect from this automation over the next five years range from 2.5 percent to 13 percent. Which raises the inevitable question: What is a company to do with the labor that R&CA saves? While companies will obviously want to look carefully at whatever staff reductions these technologies might make possible, the better long-term option is likely to be for them to consider redeploying freed-up resources to make their overall operations smarter and more pro-active.
Real World Case Studies

Robotic and Cognitive Automation in TMT

• **Technology:** A Fortune 50 global technology company faced a formidable set of regular accounting and reporting challenges. To help improve these finance functions, Deloitte worked with the company on an R&CA system that would increase its control over the reporting function as well as allow it to close its books in a shorter time period and at lower cost. The system was created using “Agile” software techniques, which minimize development risks by providing constant feedback from stakeholders about the state of the project. In just eight weeks, the team was able to develop a set of automated processes that had a combined value opportunity of three FTEs and which established a pathway for extending the automated processes into other reporting functions.

• **Media:** While welcoming reader comments on news stories, newspapers like the New York Times first screen them to make sure they don’t violate any of the paper’s guidelines. Until recently, the company had 14 human moderators, who could process only 12,000 comments a day, a time-consuming process that limited comments to only 10 percent of Times’ articles. But Jigsaw, a machine learning tool from Google, was able to speed the process, flagging potentially troublesome comments. As a result, fully a quarter of Times’ piece are now accompanied by comments.8

• **Telecommunications:** ComRes Telecom is a South Florida-based telecommunications providers whose customer footprint spans the globe. Its customers are effectively out of business if ComRes’ systems go down, and so configuring its IT systems, backing up accounts and the like are a matter of highest importance. Those tasks were once done manually, requiring more than half of the IT staff’s workday. An AI-based automated solution reduced the operation to a fraction of the time, and with much greater reliability.9
It's widely appreciated that quantities of business data are currently growing at astronomical rates, to the point where many companies often find themselves unable to efficiently store it all, much less put it to productive use. Cognitive Insights provides a suite of tools that allows companies to not only manage the torrent of information they collect every day—from their business reporting tools, from the field, from their supply chains, from social media, from sensors that are part of the “Internet of Things,” among many other sources—and then use that information to generate real-time insights that create value for their business.

Imagine a situation like the following. A telecom customer walks into a store with questions about her account. The sales person can immediately access the customer’s complete history with the company, including recent queries into its call center. The sales person can quickly ascertain from the customer if her issues had been satisfactorily resolved, and then take care of any that weren’t.

If the customer’s experience had been an unpleasant one, machine learning software trained on the company’s customer base can recommend actions—perhaps a waiver of a portion of a monthly bill—that have been shown, via tracking Net Promoter Scores, to improve customers’ feelings about the company. With that bit of lingering unfinished business taken care of, the sales person can then move to assisting the customer with the reason for her store visit, confident that she will be in a better state of mind than when she first walked in the door.

This example is typical of the robust, real-time inquiries that companies implementing Cognitive Insights will be able to make in all aspects of their operations. Is a vendor on track for its next shipment? Are there indications from a CRM system that a crucial customer may be reconsidering an important order? Are there signs that sales of a particular product are slowing with a key demographic, requiring, if not a re-design, than at least a special promotion?
To be effective, a world-class Cognitive Insights program must be able to draw on multiple data sets to give answers in real time. Just as important, though, is that the queries must be able to originate with the line managers most in need of the information. The days when routine data requests needed to be routed through the IT department, usually hopelessly backlogged with its own priorities, are long gone. To be of optimum value, Cognitive Insights need to not only be performed rapidly; the ability to access them must also be distributed democratically throughout the parts of the organization where they are most useful.

Consider the remarkable results that a humble email marketing department was able to accomplish with this new tool set. Caesars Entertainment used a Cognitive Insights system that combines machine learning and natural language processing to improve its campaigns. The system knew enough about each customer’s personality to ascertain which words or phrases would trigger the emotions that would make the customer more willing to open the email and click on the ad. Caesars increased the rate of opened emails by as much as 24 percent, and improved click-through rates by as much as 46 percent.\(^\text{10}\)

For companies that generate revenue from digital ads, even incremental improvements in click-throughs can deliver stunning returns. A recent report from a major technology firm showed that it could generate hundreds of millions of dollars in additional earnings by improving the accuracy of click-through predictions by a mere 0.1 percent. As it happened, the company’s AI system was so advanced that it was able to improve click-throughs by nine times that amount.\(^\text{11}\)

Being this agile with Cognitive Insights requires rethinking a company’s strategies in both hardware and software. Traditional siloed data—sales in one location, billing in another, social media activity elsewhere still—needs to be integrated, preferably into a single “data lake.” Analytical software needs to be upgraded from the relatively static tools of an earlier generation—the sort responsible for the infrequently-updated “executive dashboards” that were once considered state-of-the-art—to new machine learning-influenced tools that, for the uninitiated, have curious-sounding names like “boosting,” “bagging,” and “random forests.”

This new breed of software is far more data-intensive than its predecessors; it also has the ability to “learn on the job,” continuing to improve its performance with time. Its only downside, a relatively minor one, is that it requires a certain amount of “training” before it can be unleashed on a particular problem.

Many of the examples given here have involved a single discrete item, such as predicting the likely behavior of a particular customer with a given set of experiences. But this is not to suggest that Cognitive Insights can’t shed light on the sorts of “big questions” that executives must deal with in the course of their responsibilities. No current system can advise a management team on, say, whether a given merger is worth pursuing. But to the extent that management has collected data associated with the decision, Cognitive Insights can be used to mine that data, looking for trends and patterns. While some of the trends it spots may well have been noticed by human managers, it’s likely that others will have been forever buried beneath many layers of seemingly random data, their excavation only possible due to the a generation of hardware and algorithms that are changing the face of business wherever they are deployed.
Real World Case Studies

Cognitive Insights in TMT

• **Technology**: Amazon’s Web Services has become a core part of the Seattle tech company’s suite of offerings. And so Amazon has recently turned to machine learning techniques to track the order pipeline more accurately, sparing it the expense of adding computers when they are not needed or being caught short-handed when demand suddenly spikes. The system catches the sorts of signals that even the most alert human might miss, such as an enterprise sale being dragged out longer than usual.\(^\text{12}\)

• **Media**: Few decisions are more important for a film studio than deciding which films to “green light.” Even the most advanced AI can’t predict the next blockbuster, but Disney is doing its best to bring as much technology as it can to help guide these decisions. A Disney-developed system known as “factorized variational auto-encoders measures” uses deep learning and facial scanning software to track the emotions of audience members as they watch a movie. The system is “Big Data” in action; using it in a few thousand test subjects generated more than 16 million data points for later analysis.\(^\text{13}\)

• **Telecom**: One of the keys to resolving a customer issue on the first call is for the service representatives to have the relevant information at the tips of their fingers. Verizon developed a cognitive platform that monitors data continuously from a plethora of unstructured sources, using high performance analytical and decision engines. The system is able to hone in on correlations that helped tease out a consumer’s intent when they called in. The result: Improve customer service and a sharp boost in first-call resolution rates.\(^\text{14}\)
Spend any time as an anthropologist watching 18- to 34-year olds, the cohort commonly referred to as “Millennials,” and there are two bits of their behavior you will notice right away. First, they seldom allow even a few minutes to pass without consulting their mobile phone (which is commonly the latest, most expensive model.) And second, they rarely use the device for anything as mundane as an actual “phone call.” Instead, their preferred method of communication is texting, whether it is with a roommate on the other side of the living room or a favorite brand located on the other side of the country.

Millennials prefer texting to talking. More than any other factor, it is this essentially sociological shift that is responsible for the massive disruption in customer engagement that is beginning to be felt across all industries. With Cognitive Engagement, the traditional “customer support” functions typically routed to a call center are instead handled via computer, often but not always in text-based interactions. This allows companies to deliver uniform, high-quality customer support at scale.

To be sure, AI-style technological advances, especially in fields like Natural Language Processing, play a crucial enabling role in making Cognitive Engagement possible. But absent the behavioral change of a significant
part of the population, it’s doubtful that customers would be as receptive to Cognitive Engagement as they appear to be.

The umbrella technology associated with Cognitive Engagement has the unfortunate name of “chatbot.” Unfortunate because for many non-Millennials, especially those who spend more time on computers than on mobile phones, the term “chatbot” conjures up a window that pops up at the bottom of an e-commerce Web page with a usually-unwelcome offer of assistance.

In fact, chatbots represent a suite of increasingly-sophisticated AI tools that, as far as users are concerned, can have all manner of different appearances. A chatbot might look like the familiar e-commerce text box, perhaps with an animated “avatar” to increase the sense of the encounter being personalized. Or, it might be implemented as a mobile phone chat experience, albeit one with a computer rather than a person responding on the other end. A particular form of chatbots are embedded in the home automation products like Google Home and Amazon Echo that have become enormous marketplace successes. Chatbots might even take the form of a telephone voice response system, though one vastly more robust that the primitive “Press 1 for Account Information” solutions that gave the first iterations of these products such a bad reputation.

One of the core enabling technologies for a cutting edge Cognitive Engagement solution is Natural Language Processing (NLP). This involves the extraordinarily complex task of getting a computer to do what human beings accomplish without effort—figuring out what someone “means” when they say something. Fortunately, the field has seen remarkable progress during the last decade. It is now possible for a chatbot to understand that “There is a charge I don’t understand,” “Why is this month’s bill so high?” and “How come I owe you $20 more than I did in April?” are different forms of the same customer issue.

When dealing with voice inputs, there is an additional challenge of speech-to-text conversion; i.e., making sure the user’s words are accurately transcribed into text. That, too, is a vexing AI problem that has seen astounding progress in recent years, but it’s separate from the issues associated with the semantic problem of extracting the essential “meaning” of the transcribed sentences.

Of course, understanding a question only has value if you can provide the answer. Doing so with chatbots involves having some sort of data base—very broadly defined—of the relevant company policies and procedures. There are many different approaches that companies can take to developing these data sets. In simple cases, with few variations and permutations, the process might be done manually, with staffers creating a simple matrix of possible answers.

But as the processes involved grow more complicated, so too do the technologies that can be employed to deal with them. For example, sophisticated machine learning techniques can be tapped to process and organize vast quantities of both text and data. That was how one insurance company was able to create a chatbot that was so proficient in answering customer queries about term life policies that its bot allowed customers sign up for a product without ever leaving the chatbot app.

At Deloitte, we believe that Cognitive Engagement represents the future of customer service. But the technology is still in the early days of its roll-out. Many companies are implementing the systems internally at first, to handle routine HR or computer help desk queries. In certain well-defined use cases, where company policies are straightforward, issues can be handled by the chatbot alone, without the need for human intervention on most cases.

For business leaders contemplating Cognitive Engagement solutions, the first question usually involves identifying the situations in which chatbot technology would be effective. The appropriate use cases tend to have several common characteristics. They typically generate a large number of queries, with the same issues tending to come up over and over. The relevant corporate policies and procedures are relatively straightforward, and don’t overly rely on human judgment. And chatbots are especially useful when multiple data bases need to be consulted in developing a response. Computers, of course, can run these sorts of cross-platform queries with great efficiency.

As to why adopt Cognitive Automation in the first place, there is the obvious headcount savings that chatbot adoption might make possible. However, we at Deloitte strongly advise clients that there are far more useful ways to think about Cognitive Engagement. Chief among them is gaining the ability to deliver a uniform, high-quality customer experience in a cost-effective manner. And whatever use the technology may have in taking costs out of an operation, its real value involves freeing up staffers for the sorts of higher-end, more analytical services that can increase customer satisfaction and thus the value of your brand.
Real World Case Studies

Cognitive Engagement in TMT

• Technology: Ticketbis is an eBay-owned Web service that creates a secondary market where ticket-holders for sporting and cultural events can re-sell their tickets. Growing use of the site created customer support challenges, which lead to Ticketbis teaming up with a vendor, Inbenta, for a chatbot self-service feature that assisted customers with requests and queries. Customers are welcomed by an interactive and animated ‘Help’ window that uses Natural Language Processing technology, among other techniques, to field questions and develop automated responses. The system is “smart” enough to be known when to hand off an interaction to a human customer service agent. The technology is sufficiently robust that Ticketbis can use it to handle 85 percent of all of its customer services requests.16

• Media: Modern streaming content providers like Netflix are constantly releasing new material, much more than any customer can keep up with. As a result, one of their biggest challenges is making sure users know about the new programs that might interest them. Netflix has been a pioneer in using technology for developing these “recommendation engines.” In 2009, for example, it famously conducted the “Netflix Prize” crowd-sourcing competition, which invited outside programmers to develop algorithms more efficient than the ones created in-house. More recently, Netflix has taken advantage of the new breed of machine learning technologies to further improve its recommendation process. The company also is an active participant in Silicon Valley’s AI ecosystem, hosting sessions at which experts from companies such as Google and Facebook exchange ideas. The business value of a finely-tuned recommendation engine is readily apparent to Netflix, which says that the technology add roughly $1 billion a year to revenues by way of reduced churn.17

• Telecom: All mobile carriers are faced with the problem of massive customer bases that regularly have service and engagement issues. Large call center staffs are required to meet this demand, but companies are finding that chatbots allow them to get more work done with fewer resources. Vodafone has embarked on a program to give its chatbot, TOBi, increased functionality, for example by offering customers a voice activation option that makes it easier for Vodafone to authenticate their identity the next time they call in. A customer records a word or phrase, and on subsequent calls, voice recognition technology is used to ensure that it is the same speaker. (The alternative is the usual gauntlet of security questions, such as date of birth and mother’s maiden name.) The company is also expanding the bot’s “knowledge base.” Now it can drill down into highly technical areas, such as the ins and outs of roaming plans.18
To better understand how front line managers see AI unfolding, Deloitte recently conducted a survey that included responses from AI “early adopters” at various technology, media and telecommunications companies. The biggest takeaway, by far, is that business leaders who have already begun using AI are highly enthusiastic about the transformative role it will play in their companies. They foresee sweeping, across-the-board changes touching all facets of their operations, from developing basic business models to interacting with long-term customers.19

In fact, 49 percent of TMT companies say the main benefit of AI is to create more value for their customers, whether it’s
bring about. Tech giants such as Amazon, Facebook, and Google are incorporating advanced AI not only into their products, but also into their customer-facing operations; they are also investing billions acquiring AI companies. Against such an elite group of cutting-edge competitors, even early adopters in TMT may feel they are at a disadvantage and must sprint to catch up.

This leads to a question we at Deloitte are asked by our clients whenever the topic of AI comes up … which these days is essentially in every conversation. “We understand why Google is going big into AI,” we hear. “But that’s because it’s their product. What about us? We’re nowhere close to selling AI. Are you saying we have to become an AI company too?”

The honest answer, from the survey and from our thousands of client interactions, is, “Yes … in a manner of speaking.”

That doesn’t mean you need to go on a hiring binge and bring on board a team of Deep Learning experts, and then look around for something for them to do. What it does mean is that every company needs to have some form of in-house AI expertise, enough for them to keep up with developments in the field and to understand how cognitive solutions can help in the transformation of even those companies not yet moving to productize it. This paper has laid out three areas where Cognitive Computing can deliver significant business advantages; more are surely in their way. Companies need to have the in-house experience to be able to assess which of these incoming technologies will be useful, and to then be able to successfully implement those that make the cut. Since this will usually occur with the assistance of outside vendors, companies need to be confident that they, and not their vendors, are the ones calling the shots.

The relationship between in-house AI expertise and effective use of the technology was clearly evident in our survey. Consistently reported having a much easier time also putting AI to good use improving their operations. As we have seen earlier, successful use of cognitive technologies involves much more than bolting on some vendor product with little regard for the organization’s underlying structure and processes. Cognitive competence developed in product development usually spreads, as if by osmosis, to other parts of the company. A company that has experience incorporating “Big Data”-style Cognitive Insights technology into its products will have a head start on understanding how to best structure its own internal data, to be able to mine it for the sorts of game-changing insights that can bring significant competitive advantage. The same is true for Automation and Engagement; helping customers tackle these use cases inevitably allows a company to do better at them itself.
Endnotes


3. Intel's Broadwell-based Xeon v4 chip, especially the one with 22 cores (released in 2016) already housed 7.2 billion transistors. With transistor count doubling every two years (Moore's Law), the next generation platform will likely push the transistor count past 10 billion transistors per chip. Source: Chris Williams, Intel's Broadwell Xeon E5-2600 v4 chips: So what's in it for you, smartie-pants coders, The Register, March 31, 2016, https://www.theregister.co.uk/2016/03/31/intel_broadwell_epi_xeon_e5_2600_v4/


5. The Deloitte Digital Democracy Survey, 11th edition (2017) finds that streaming has gone mainstream, with nearly half of US households purchasing subscriptions to a streaming service as of 2016. Millennials are driving this trend in the US, as they now value their streaming video subscriptions more than pay TV. And complementing the findings from this survey, Deloitte’s Global Mobile Consumer Survey (US edition), 2017 finds there was a notable shift in smartphone usage to consume long-form video. Thirty-one percent of consumers streamed films on mobile phones in 2017, compared to 22 percent in 2016. See 2017 global mobile consumer survey: US edition, Deloitte.


20. Ibid.

21. Ibid.

22. Ibid.
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