

# FUTURE OF CONNECTED LIVING

AUGMENTED HUMANS IN A NETWORKED WORLD

## ABOUT INSTITUTE FOR THE FUTURE

Institute for the Future (IFF) is the world's leading futures thinking organization. For over 50 years, businesses, governments, and social impact organizations have depended upon IFTF global forecasts, custom research, and foresight training to navigate complex change and develop world-ready strategies. IFTF methodologies and toolsets yield coherent views of transformative possibilities across all sectors that together support a more sustainable future. Institute for the Future is a registered 501(c)(3) nonprofit organization based in Palo Alto, California. For more, visit [www.iftf.org](http://www.iftf.org).

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## DELL TECHNOLOGIES

Dell Technologies is a unique family of businesses that provides the essential infrastructure for organizations to build their digital future, transform IT and protect their most important asset, information. The company services customers of all sizes across 180 countries – ranging from 99 percent of Fortune 500 to individual consumers – with the industry's most comprehensive and innovative portfolio from the edge to the core to the cloud.

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## ABOUT THIS RESEARCH

Dell Technologies has partnered with the independent futures research group, Institute for the Future (IFF), to explore how emerging technologies will reshape our lives over the next decade. The research builds on the organizations' collaboration in 2017, when IFTF distilled informed opinions from 20 experts from around the world and forecast the 'next era of human-machine partnerships.' A year later IFTF is forecasting how a new dynamic between human and machine will transform our lives in 2030.

To execute this, IFTF relied on its decades-long study on the future of technology and its impact on humanity, alongside in-depth interviews with relevant stakeholders from across the globe.

Experts informing the report include:

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# INTRODUCTION

The gap between human and machine is shrinking. The difference between bits and atoms is blurring. A new era of human-machine alliances is on the horizon. Over the next decade, everything around us will become more intelligent, communicative, and connected. New kinds of networks, devices, interfaces, and artificial intelligences will help us augment, enhance, and optimize our lives. From autonomous vehicles to smart homes to digital cities we won't just live with our machines, but rather become more immersed and work in partnership with these machines and devices. We will evolve our abilities to program our lives for stability and resilience, to surpass our own limitations, to become augmented individuals. Over the next decade, the most powerful and successful relationships between people and computers will be those that are symbiotic and make use of their respective complementary strengths. Along the way, we will also undoubtedly grapple with negative unintended consequences, from possible threats to privacy and security to environmental degradation to new kinds of digital addiction. However, the only way to ensure that tomorrow's technology enables a smarter, better life for everyone, and reaches its true potential to drive human progress is to think systematically about what the future may hold and then make better decisions in the present. The goal of the foresight contained in this report is to provoke insights that lead to action. The emerging technologies, shifts, and key dilemmas presented in these pages build upon a 2017 Institute for the Future (IFTF) research initiative titled *The Next Era of Human-Machine Partnerships*. Since then, IFTF and a consortium of global experts have been examining how these human-machine partnerships will transform the economy, the way we work, and our daily lives by 2030. In tandem, Dell Technologies and Vanson Bourne surveyed 4,600 Director to C-Suite business leaders across 40+ countries to uncover their views on the impact of emerging technologies. This report is the third in the series informed by this series of research efforts.

# EMERGING TECHNOLOGIES SHAPING OUR LIVES IN 2030



In the next decade, an array of core technologies will drive major transformations in our daily lives. While each technology on its own is a force for change, it is at the intersection of multiple innovations across technology domains where new affordances are discovered, developed, and deployed. The following are a selection of core emerging technologies that, in combination with each other and advancements in software, connectivity, processing power, and multi-cloud, data-driven systems will drive or enable the shifts outlined in this report:

**Pervasive Sensors and Internet of Things (IoT):** As advances in computation and new energy sources enable the distribution of smaller devices, sensors—from ubiquitous cameras to wearable computers to environmental sensors—will reveal much about our homes, cities, bodies, and the way we live.

**Mobile Edge Computing:** Low-latency, high-bandwidth wireless networks will make it possible to move data storage and processing from your mobile device to the nearby edges of the wireless network, essentially providing any connected device the power of a supercomputer. This will allow us to push computing power ever closer to the edge, improving processing times and bringing artificial intelligence to myriad connected devices.

**5G and Beyond:** By 2030, 5G will move into maturity and 6G standards will continue the evolution of mobility networking. 5G will bring forth a new wave of significantly faster wireless connectivity, significantly reducing mobile network latency. Cities and towns will become more connected than ever, paving the way for smart cities and digital infrastructure, along with a more intelligent industrial infrastructure that thrives on automation.

**Artificial Intelligence:** After decades of slow progress, artificial intelligence is now rapidly expanding in capabilities and application areas. For example, machine learning, a branch of artificial intelligence commonly used to construct mathematical models of the world to make predictions, is employed in everything from chatbots to self-driving cars. Machine learning algorithms recognize patterns in large data sets and leverage those insights to determine what to do next while improving with each repetition of a task.

**Extended Reality (XR) and Immersive Media:** New display technologies like flexible screens, wearable VR devices, or even holograms in combination with gestural and haptic interfaces will enable fantastically compelling media experiences that stimulate all our senses. The virtual and real will blend in deeply immersive experiences that bring us closer together, no matter where we may be. The world will explain itself through augmented reality that transforms abstract or hidden information into rich, interactive moments and compelling layers of content.

# FIVE SHIFTS TRANSFORMING THE FUTURE OF CONNECTED LIVING BY 2030

As we become more connected to our machines, and one another, there will be profound changes to our daily lives.

Already, our bodies, homes, and cities are becoming laden with sensors, interconnected by invisible networks, and imbued with artificial intelligence that lives on the edges of the networks. Soon, every moment, interaction, and real-time choice will be a data point. High-resolution data about all aspects of our lives will feed a vast amount of machine learning algorithms that conduct an orchestra of AI agents to act on our behalf and execute our own individual algorithms for living. Reality will be indexable, storable, searchable, and, to some degree, programmable.

The following section describes five shifts that will shape how we live in the coming decade. Of course, these shifts do not build momentum in a bubble. They are all part of a complete system. Each shift affects the other and the whole of their impact is greater than the sum. With that in mind, consider how the following stories may play out across all aspects of your daily life as you move through the networked world:

1. **Networked Reality**
2. **Connected Mobility and Networked Matter**
3. **From Digital Cities to Sentient Cities**
4. **Agents and Algorithms**
5. **Robots with Social Lives**





# SHIFT 1: NETWORKED REALITY

Over the next decade, the line between the virtual and the real will vanish. Cyberspace will no longer be a place accessed through your computer screen, but rather an overlay on top of our existing reality. This transformation will be driven by the deployment of 5G networks that enable high bandwidth, low-latency connections for streaming, interactive, and multi-user media content. Indeed, everything will be media.

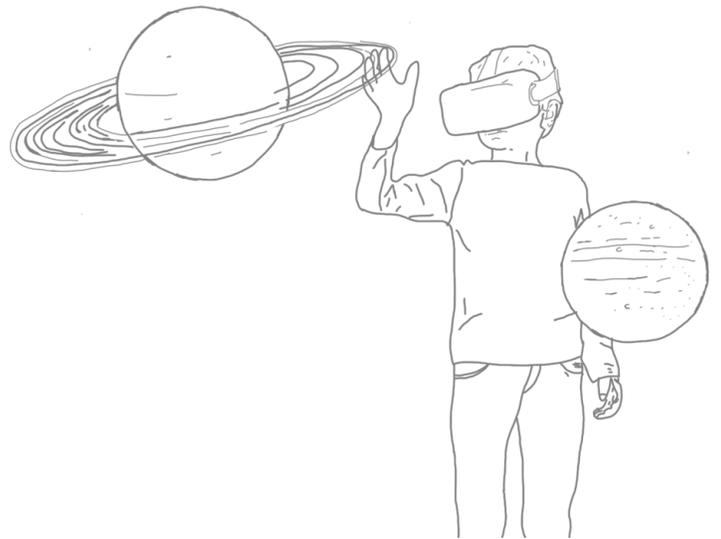
# SHIFT 1: NETWORKED REALITY

Our digital environment will extend beyond televisions, smartphones, and computer displays to include our homes, vehicles, offices, and even our own bodies. Entertainment and information experiences will no longer be episodic, but always available and contextually relevant. Our personal media spaces will flow through our daily lives awaiting our engagement through intuitive interactions and interfaces.

The real world will become “clickable” so that every real object is linked to digital information about that object. We’ll interact with content and our communities through immersive interfaces that provide visceral sensations, putting us at the center of the action. Importantly, virtual reality will become social. We’ll build our digital worlds in collaboration with others, creating shared “dreamspaces” for creative expression and human connection.

But even as we create our own digital reality, we’ll also expand our instantaneous access to everything the physical world has to offer. Immersive, haptic interfaces will connect us to ubiquitous cameras, advanced telerobots, and tiny autonomous drones inhabiting physical spaces. You’ll be able to steer the remote eyes and ears so that you can choose your own unique angle. For example, an entire classroom could learn about geology by standing at the edge of an erupting volcano. A music fan could enjoy an arena concert while looking over the lead guitarist’s shoulder. A medical specialist could visit a refugee camp and guide treatment for those who are injured or ill. These telepresence systems will deliver the multisensory experiences of other places and allow us to interact with each other in natural ways as we move through remote locations. We’ll all be gifted with the science fiction superpower of (virtual) teleportation.

“ Society will be an environment of hyper-connectivity in the seams between the home, work, and car,” says Liam Quinn, Senior Vice President and Senior Fellow at Dell Technologies. “People will be more integrated into their digital environments, which will enhance and continue to drive workforce and IT transformation, and human potential and creativity.”



## A DAY IN THE LIFE—2030



LONDON,  
ENGLAND

Lauren, 38, is expecting her first child and needs help preparing the nursery in her home in suburban United Kingdom. Through her invisible smart speaker system, she calls up her friend, an interior designer based in Stockholm, for advice. Lauren “beams” her up on her bare nursery walls through an AR interface so that they can see each other face-to-face and Pia can assess the room. With a couple of clicks, she pulls up pictures of furniture to share with Lauren on a holographic display. Together, they browse the furniture in three dimensions, moving it with waves of their hands. Even though she is thousands of miles away, Pia floats each piece of virtual furniture at full scale into the empty room and together they get a feel for the space. Then, Lauren calls for her husband, away on a business trip, to see their design and get his buy-in. He’s actually still on a plane and sees the scene in augmented reality on his seatback tray table. With a few more clicks, Lauren and Pia place the furniture orders. Two hours later, an autonomous delivery truck pulls into the driveway and workhorse robots cart the new furniture inside.

# SHIFT 1: NETWORKED REALITY



## SIGNAL OF CHANGE

Bravemind is a virtual reality tool for assessing and treating post-traumatic stress disorder (PTSD). Developed at the USC Institute for Creative Technologies, the system enables clinicians to gradually expose patients to the traumatic event in a safe, controlled setting so that they can process the emotions and experiences associated with the trauma.<sup>ii</sup>



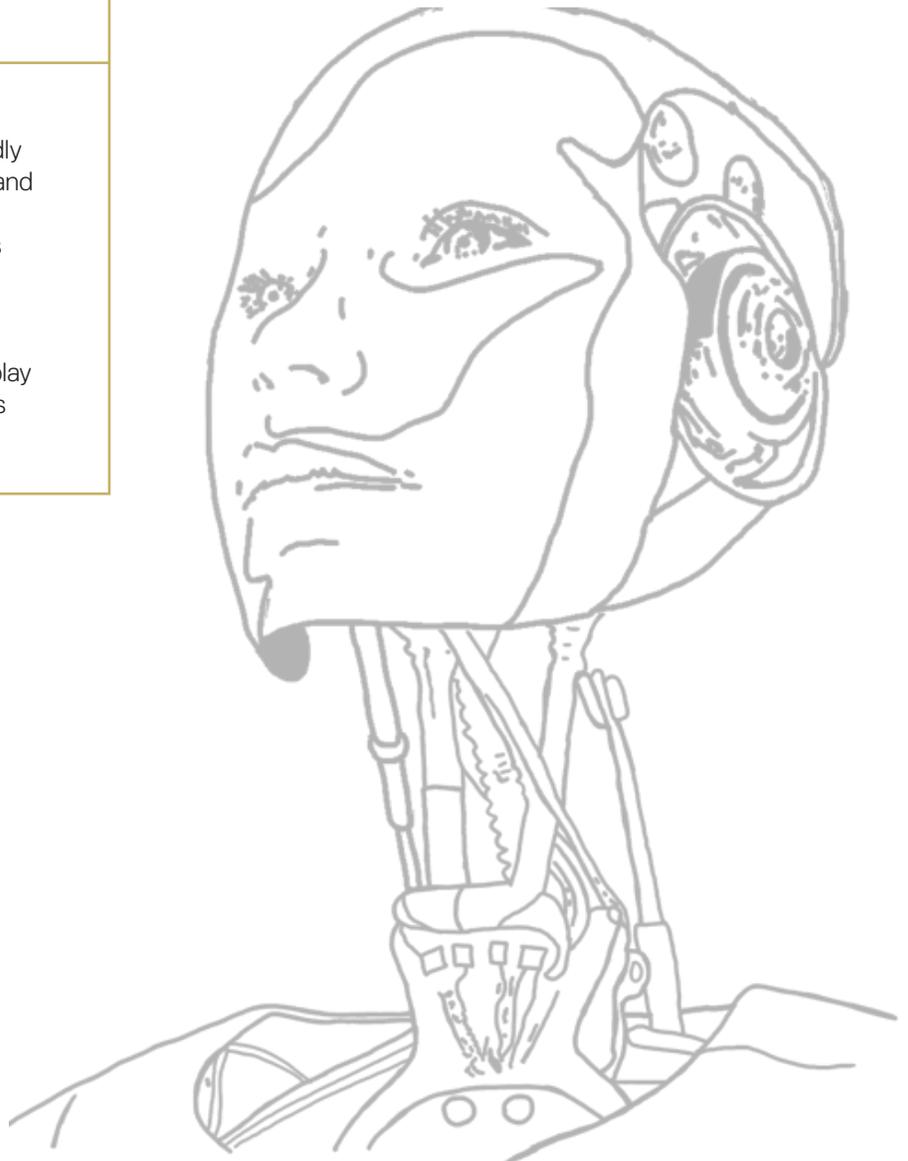
## SIGNAL OF CHANGE

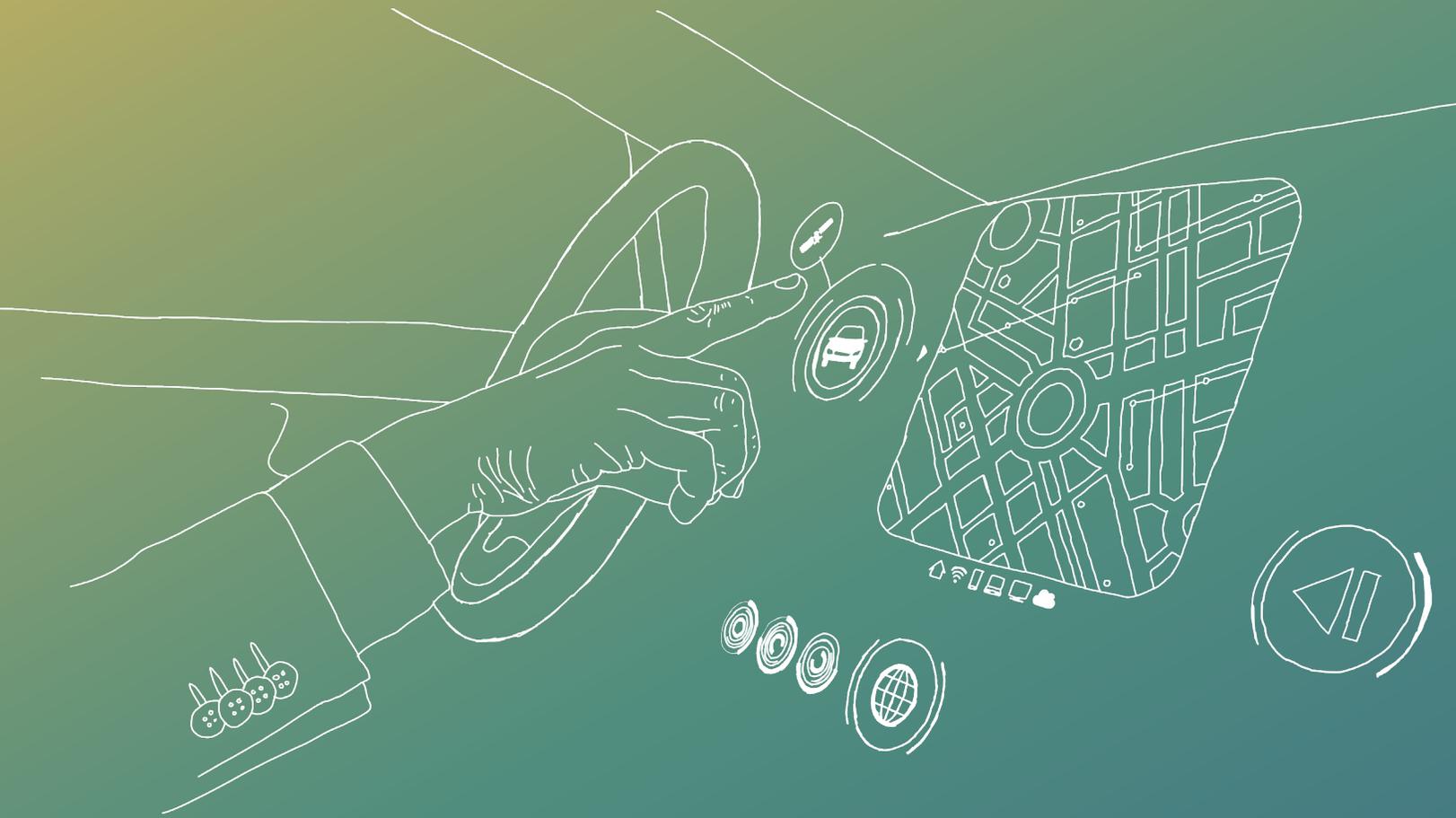
Toyota's T-HR3 is a 1.5-meter tall humanoid robot to demonstrate the possibility of "friendly and helpful robots that coexist with humans and assist them in their daily lives," according to Akifumi Tamaaki, general manager of Toyota's Partner Robot Division. When the operator, wearing a variety of motion sensors, walks or reaches out to pick up an object, the robot follows suit. Meanwhile, a head-mounted display enables the person to see through the robot's "eyes."<sup>iii</sup>



## DATA POINT

In the Dell Technologies and Vanson Bourne survey, 56% of 4,600 global business leaders said they would welcome day-to-day immersion in virtual and augmented realities.<sup>iv</sup>





# SHIFT 2: CONNECTED MOBILITY AND NETWORKED MATTER

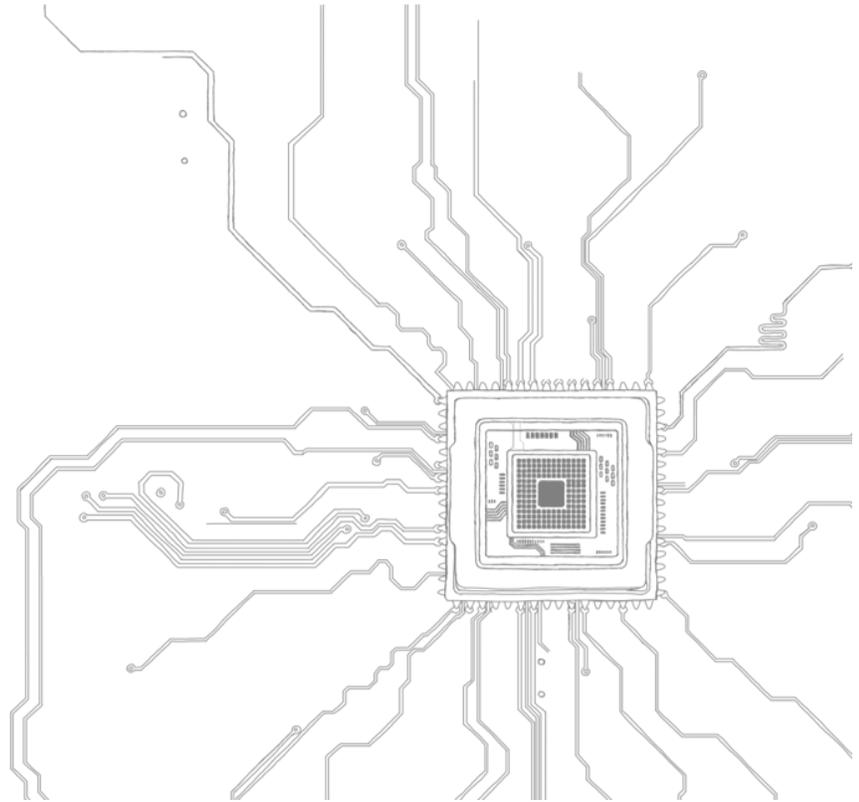
Tomorrow's transportation systems will resemble the packet-switched networks underlying the Internet. Mobile computers will take the form of autonomous vehicles traversing the arteries of our smart, digital cities.

## SHIFT 2: CONNECTED MOBILITY AND NETWORKED MATTER

Sometimes, we will ride inside the mobile computers, trusting them to take us where we need to go in the physical world as we interact in the virtual spaces available to us wherever we are. As we ride, no longer distracted by the requirements of driving, the vehicle becomes our mobile living room. Screens in the passenger compartment deliver immersive entertainment experiences that integrate with what's happening outside the vehicle. For example, in a space-themed video game, the bumps and turns of the real road could be mirrored in the computer graphics as a visceral ride in a lunar buggy.

Other form factors of these mobile computers will be more like hyperconnected trucks with drivers that never sleep, traversing networks of roads, highways, and even rivers to pick up and deliver cargo of all kinds. Objects with embedded sensing, computation, and communication will be tracked through a smart supply chain of autonomous trucks. After you place an order for a product, intelligent algorithms at the company identify a robot-powered warehouse with your item and will summon an autonomous delivery vehicle to bring it to you.

Autonomous vehicles of the future will also do double-duty as nomadic sensors on the Internet of Things. Not only will they identify road maintenance needs, measure pollution and other ambient environmental conditions, they will also be outfitted with depth cameras that image the roads for safe travel. Ultimately, those same kinds of cameras will scan and map the city at unprecedented resolution to feed photorealistic virtual reality simulations that mirror the real world.



### A DAY IN THE LIFE—2030



Seeking a break from the hectic city life, Julianne and Clark decide to bring their two children, ages 4 and 12, north to Port Macquarie for an impromptu beach getaway. Clark logs into weCaravan, an autonomous taxi app that specializes in family-friendly vehicles. Clark hails one of their self-driving mobile living rooms. When the boxy vehicle arrives, the parents are greeted with ice cold drinks and an immersive nature documentary on the VR system. Their four-year-old continues to watch the movie she started in the house, while their 12-year-old connects to a telerobot in Cairo so she can remotely explore the Great Pyramids for a school assignment. Upon arrival in Port Macquarie, the mobile living room docks at a “hotel hub” for autonomous transports right on the beach. The hub provides all the amenities of a hotel—beach activities, restaurant, fitness center—while the mobile living room converts into a suite for sleeping.

# SHIFT 2: CONNECTED MOBILITY AND NETWORKED MATTER



## SIGNAL OF CHANGE

In cities adjacent to rivers, the waterways offer another route for matter to move on board autonomous vehicles. Dell EMC and Nokia are leading an effort in the historic Dutch city of Delft to reduce truck traffic in the congested city center through semi-autonomous, hydrogen-powered barges moving through under-utilized canals. The trial includes development of a Common Information Space for Smart City Logistics: “a scalable digital platform connecting the entire logistics chain in and around the city as well as a backbone for the navigation guidance system.”

“This collaboration is a perfect example of how Industrial IoT networks can be used to connect sensors, vehicles and machines to take advantage of the power of automation to address a daunting societal challenge—keeping goods moving while reducing the carbon footprint of that activity,” says Laurent Le Gourrierec, head of Strategic Partnerships at Nokia.v



## SIGNAL OF CHANGE

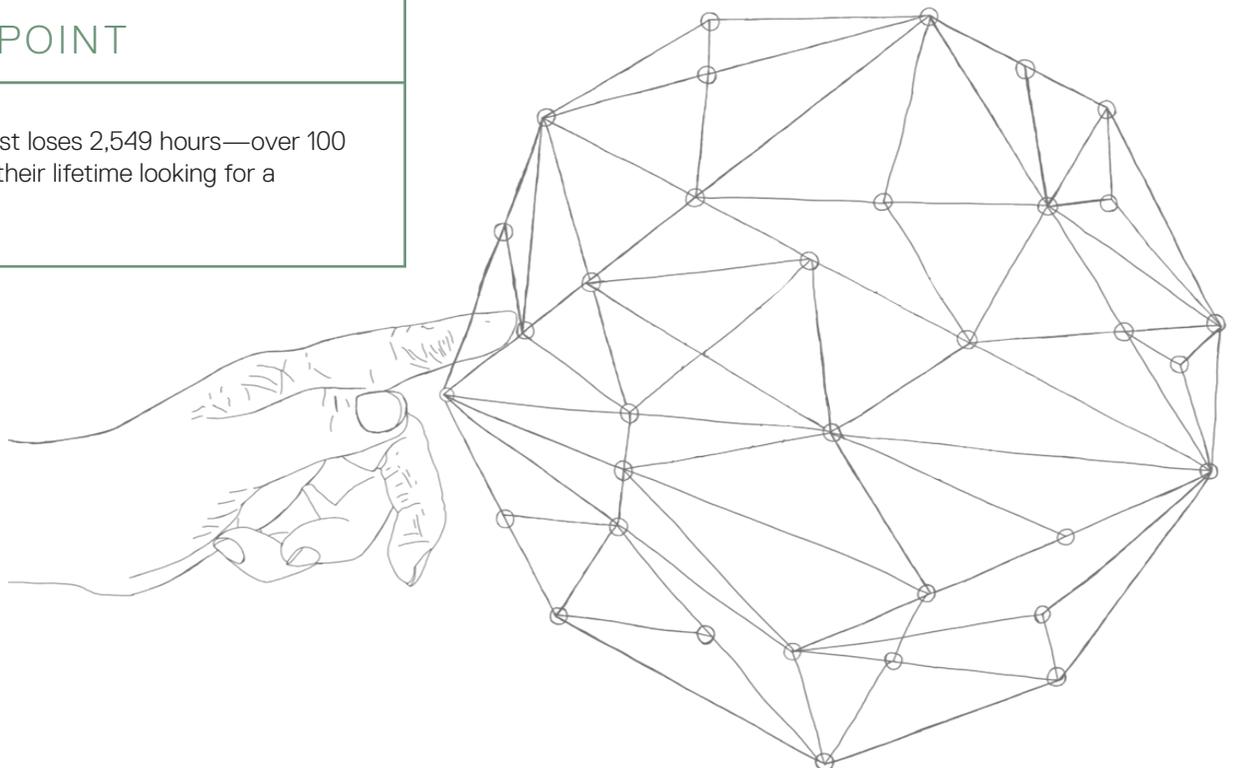
*“Where would you live if you could commute each workday in an autonomous-driving, fully-functional, connected, comfortable, mobile office space? What if the service was provided via an on-demand subscription basis? Or what if it was provided by one employer yet not another – which company would you work for?”*

These are the questions that Volvo hopes its 360c autonomous concept car provokes. The vehicle’s interior converts between a sleeping pod, workspace, living room, and entertainment space. The exterior of the car is laden with a 360-degree band of light and speakers that signal intention like acceleration or imminent lane changes. The aim is to create a universal standard for fully autonomous vehicles to visually and aurally communicate on the road.v



## DATA POINT

The average motorist loses 2,549 hours—over 100 days—throughout their lifetime looking for a parking space.vii





## SHIFT 3: FROM DIGITAL CITIES TO SENTIENT CITIES

Today, more than half of the people on Earth live in a urban areas. According to the United Nations, that proportion will increase to 68% over the next three decades.<sup>viii</sup> This level of growth will present huge challenges and opportunities for businesses, governments, and citizens across many domains including health, transportation, security, energy, the environment. Whether these urban crucibles succeed will depend on how smart and digitally enabled they become.

## SHIFT 3: FROM DIGITAL CITIES TO SENTIENT CITIES

“

A digital city should be intelligent, entrepreneurial, and sustainable,” says Amit Midha, President, Asia Pacific & Japan and Global Digital Cities, Dell Technologies.<sup>ix</sup>

”

Midha’s vision will be realized through the confluence of 5G, wireless networks, the Internet of Things, and machine learning. At the intersection of those technologies, an expansive “connectome” of links between humans, machines, and everyday objects will emerge. Sensors will make transportation safer, while new data about how we engage with our infrastructure will inform resource allocation and increase sustainability. The city will quite literally come to life through its own networked infrastructure of smart objects, self-reporting systems, and AI-powered analytics.

Imagine: Intelligent roads will gossip with autonomous vehicles about traffic and safety. Smart power grids will keep a constant vigil on their overall complete health, and specifics all the way down to the stability of a single utility pole. Meanwhile, the opening of government data will foster urban innovation at all levels, from the municipal to the grassroots. For example, high-resolution data, pervasive municipal wireless networks, and mobile sensors will enable citizen activities such as to participate directly in mapping local pollution with mobile devices or tracking the availability of fresh food in poor areas. Traditional city services and utilities will increasingly be informed by real-time data to maximize resources, increase efficiency, and build resilience.

As information technology is integrated into every building, sidewalk, car, home, lamppost, and garbage can, we have an opportunity to reengineer our relationships with our governments, the built environment, and each other. If we succeed, smart, digital cities will become a vibrant platform for innovation, inclusion, and community.

### A DAY IN THE LIFE—2030



Danny, 42, an account executive at a large advertising agency, receives an alert from his bot that a potential client he has been courting for over a year happens to have a cancellation. The client’s bot has asked if Danny can meet in 20 minutes to discuss a new product release. Danny immediately agrees and jumps on the OnTime app, a city government app platform that translates real-time data of the city streets to user-friendly applications. For example, through this app, he can see that foot traffic on Happi Street is quite congested, but that there are six municipal scooters available down the block from his office. A local environmental group feeds crowdsourced, hyperlocal pollution data into the OnTime app so Danny can identify the route with the cleanest air. Most recently, a start-up has built a paid, premium app that shares live wait-times at nearby restaurants and cafes. It’s also connected to local fish and produce market sales data so customers can be alerted where to find the freshest restaurant fare at any hour. While riding to meet the potential client, he asks his AI to reserve a table for two at a sushi restaurant that not only has no wait, but also just received an order of sustainable tuna caught only an hour ago.

# SHIFT 3: FROM DIGITAL CITIES TO SENTIENT CITIES



## SIGNAL OF CHANGE

In 2011, the Tōhoku earthquake in Japan led to a major nuclear disaster at the Fukushima Daiichi Nuclear Power Plant. Shortly after, volunteers at hacker spaces in Los Angeles and Tokyo launched a citizen science effort, called Safecast, to use DIY sensor systems to monitor environmental radiation information for public safety and study. Since then Safecast, now a non-profit organization, has developed several open-source devices that citizens can place in their yards, mount to vehicles, or even attach to drones to record radiation readings and contribute to the dataset that Safecast says is the largest of its kind ever. They've recently integrated air quality readings into the map as well.\*



## SIGNAL OF CHANGE

Singapore Power Ltd. piloted a new mobile app that provided more than 300,000 citizens with data about their own energy and water consumption in an effort to conserve resources and lower utility bills. The app offered a home utilities audit to identify the appliances using the most energy and water, established savings targets, and outlined data-driven steps to conserve. The system also enabled users to compare their usage with their peers.\*ii



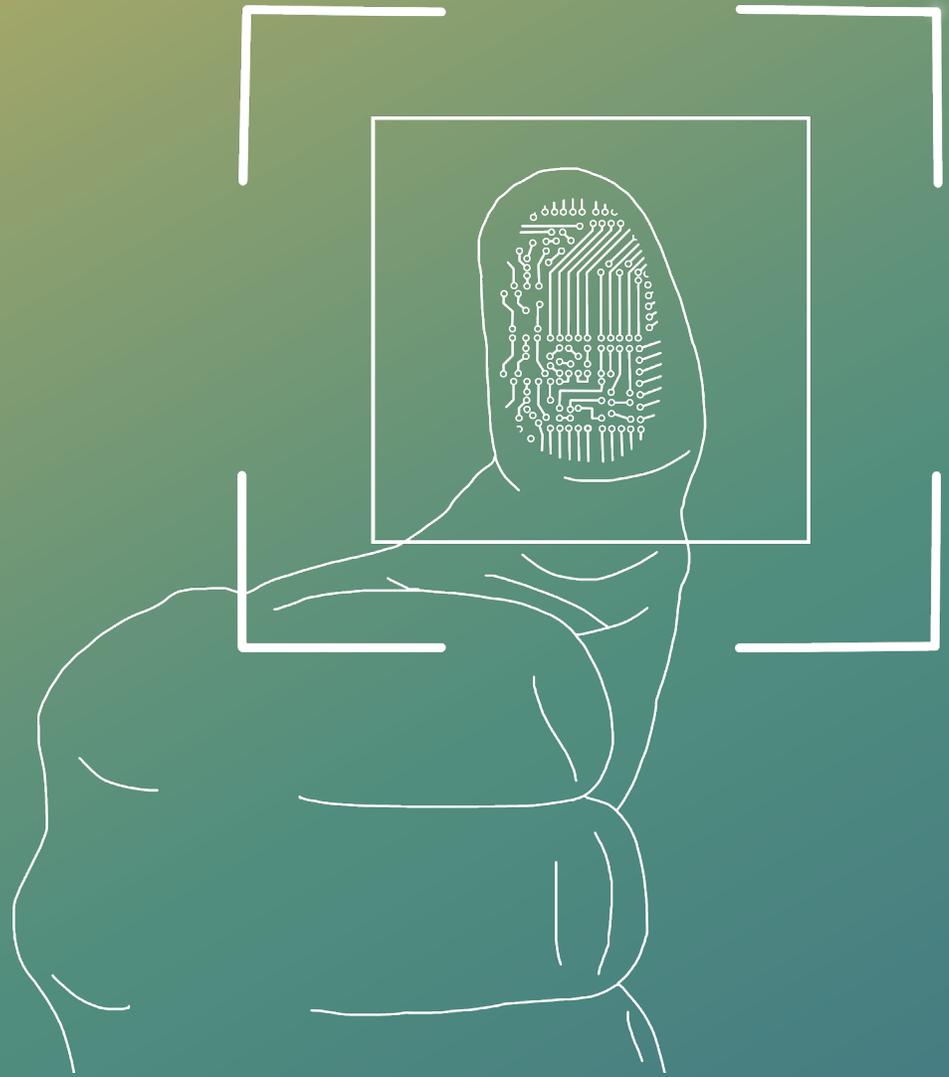
## SIGNAL OF CHANGE

In a proof-of-concept trial, the City of Las Vegas, Nevada partnered with NTT DATA Services, Dell, and others to build and deploy a network of digital eyes and ears that gathers real world data on everything from traffic flows to crowd dynamics. For example, cameras on traffic signals look out for cars driving in the wrong direction, a common occurrence in a particular part of downtown. Data about precisely where and when dangerous driving occurs along with other traffic characteristics will inform roadway improvements. In another application, microphones can listen for unusual or concerning sounds, a gunshot for instance, and triangulate the source for further investigation.\*iii



## DATA POINT

By 2020, a city of 1 million people will generate 200 million gigabytes of data per day.\*iiii



## SHIFT 4: AGENTS AND ALGORITHMS

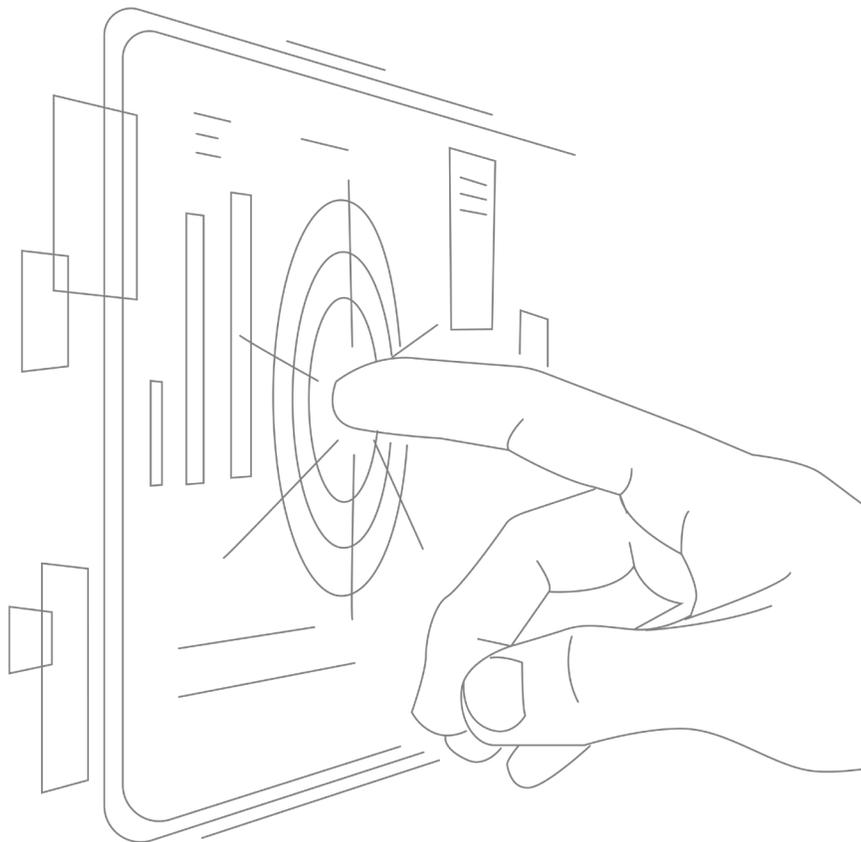
By 2030, we will each be supported by a highly personalized “operating system for living.” The system will be context aware, anticipate our needs, and behave proactively. Rather than you having to interact with multiple single purpose apps, tomorrow’s intelligent agents will understand what you need—from a night out on the town to a new deck on your house—and liaise with various web services, other bots, and networked objects to get the job done.

## SHIFT 4: AGENTS AND ALGORITHMS

The Life Operating System (Life OS) will analyze our actions to deliver new insights and experiences and support us with “nudges” and interventions to meet our desired goals around health, lifestyle, and work. It will look out for us, keeping tabs on our mental and physical health and raising flags when necessary. We’ll ask for its advice on everything from shopping to job tasks to dating. The big data generated merely by day-to-day living will inform simulations and predictive analysis that help us make better choices while revealing “knobs” we can tweak in our daily routines to improve our lives.

As the Internet of Things comes to life, the Life OS will generate and manage a “physical graph” of autonomous physical objects and systems, from washing machines to self-driving vehicles to entire smart homes. Importantly, the Life OS will become a media concierge in our networked reality. It will serve as a content filter, enabling us to manage the massive rivers of digital information coursing through our blended worlds of virtual and real environments. The Life OS will allow us to sip from the information firehose of our future.

In some instances, the Life OS will evolve into a kind of outboard brain, demonstrating the power of human-machine collaboration where the combinatorial power is more than the sum of the parts. Competitive chess players refer to this kind of human-computer team as a “centaur,” referring to the mythological creature that has the torso, head, and arms of a human but the body of a horse. Humans have broad knowledge, flexibility, instincts, and ethics while computers are millions of times faster than our brains. For many tasks, the combination of a human and an external Life OS will be unbeatable.



### A DAY IN THE LIFE—2030



NEW YORK CITY,  
NEW YORK

Sasha’s digital home assistant, Ty, sends her a quick reminder that she is hosting old college roommates for drinks later tonight in her tiny, 380-square foot apartment. Sasha replies, “Thanks, Ty! I completely forgot about it. Can you please make it happen?” Even with vague instructions, Ty knows what needs to be done to orchestrate the evening: trigger the smart home to fold up her Murphy-style bed to the wall, start the dishwasher for clean glassware, and robotically roll out the wheeled bar cart in the kitchen cabinet. Next, Ty scans through Sasha’s friends’ social media profiles and text messages, collecting enough information on their dietary and cocktail preferences to place an order for light appetizers and beverages to be delivered 15 minutes before the guests arrive. A custom playlist generated by a superstar AI DJ fills the room with music just as the doorbell rings.

# SHIFT 4: AGENTS AND ALGORITHMS



## SIGNAL OF CHANGE

Stanford researchers demonstrated a machine learning system that successfully identified signs of depression in subjects based entirely on recordings of their facial expressions, voice tone, and spoken words. The system was correct 80% of the time. According to lead researcher Fei-Fei Li and her colleagues, the study suggests how speech recognition, computer vision, and natural language processing can be combined to help patients and mental health caregivers, facilitating access to low-cost universal mental health care.<sup>xiv</sup>



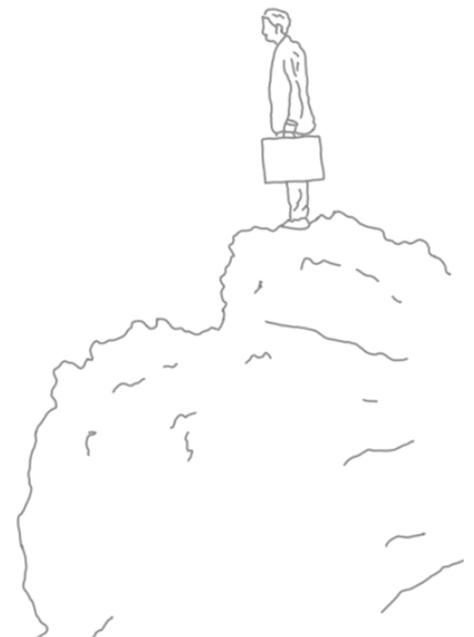
## SIGNAL OF CHANGE

As a college student, Joshua Browder racked up far too many parking tickets. So, he developed an AI lawyer to appeal the tickets by writing personalized letters and navigating the bureaucracy on his behalf. It worked perfectly. Now, his free app, DoNotPay, also negotiates bank fees, fixes credit report errors, files lawsuits over data breaches, and helps homeless people access services they qualify to receive.<sup>xv</sup>



## DATA POINT

In the Dell Technologies and Vanson Bourne survey of 4,600 global business leaders, 76% of respondents expect they will restructure the way they spend their time by automating more tasks.<sup>xvi</sup>





## SHIFT 5: ROBOTS WITH SOCIAL LIVES

Within ten years, personal robots will finally be ready for prime time. Yes, in some cases, robots will replace humans, freeing us up to do the things we are good at and enjoy. In many situations though, they'll become our collaborators: augmenting our skills, extending our abilities, and giving us a helping hand or three.

## SHIFT 5: ROBOTS WITH SOCIAL LIVES

Today, the term “social robot” usually refers to autonomous robots that interact with humans under rules defined by society. For robots to emerge from factories and laboratories though, they’ll need to know how to navigate unstructured environments that were primarily built for human inhabitants. Tomorrow’s social robots will be socially engaged with us, but also with each other. When one robot learns, or is taught, a task like how to fold a fitted sheet, it will upload that newfound knowledge to its social (robot) network.

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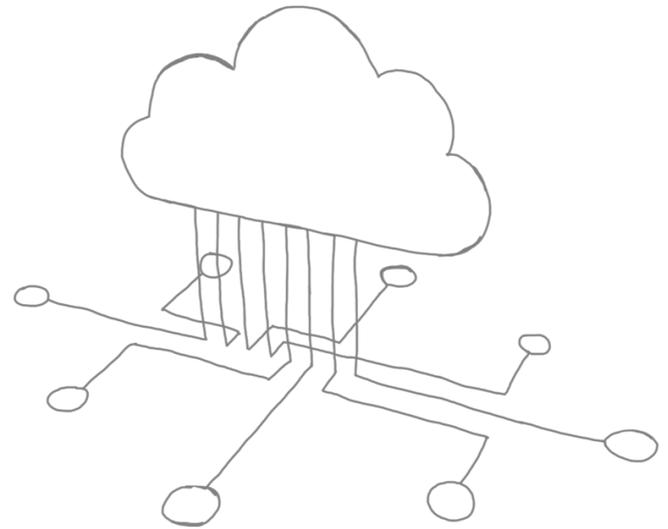
As UC Berkeley robotics professor Ken Goldberg said in a recent IFTF interview, “Once a robot has learned something, there should be a way for it share that information easily with other robots.”

That’s the idea behind Goldberg’s laboratory’s Dex-Net as a Service (DNaaS) system that enables robots to lean on computers in the cloud to calculate the best grasp, and even gripper, for uploaded shapes. Eventually, your home robot could ask for guidance from the network before it treats your best crystal like a paper cup.<sup>xvii</sup>

”

While a social network for robots to connect with other likeminded bots and talk shop seems like a natural step, huge challenges remain. For example, there must be a way for a robot to generalize the information it gleans from a compatriot in its network. Not every dinner table is the same shape. And not every robot has the same gripper. The social network itself must have some smarts too, so that it can abstract out common rules from various experiences: how to grasp a wine glass, the most efficient way to vacuum the floor, or whether to avoid toddlers when chopping firewood.

And as each robot fine-tunes a shared program for its own specific needs, it could then upload that to the robot “commons” as well. This is much like how open-source software repositories work today, leveraging the social power of the network to crowdsource innovations that accelerate progress.



### A DAY IN THE LIFE—2030



Nadia, 82, lives alone in the outskirts of Bangalore. After becoming a widow 20 years ago, Nadia moved into a communal senior living center, where her fellow residents became her main social network. However, over the past decade, they’ve slowly started to disappear, whether moving into their children’s homes, nursing homes, or passing away. To combat social isolation, Nadia’s two children gifted her with the latest robot companion, Kiki, who has been programmed to befriend, converse, and socialize with humans, especially with older people. Kiki is part of a larger robot community that silently exchanges new behavioral and social learnings, such as what to say when someone feels sad, how to laugh at a joke, or how to remind their human companions to take medicine, eat dinner, or get exercise in a way that doesn’t seem condescending.

# SHIFT 5: ROBOTS WITH SOCIAL LIVES



## SIGNAL OF CHANGE

Developed by researchers at the University of Technology, Sydney, Numbots is a proof-of-concept online platform that, “enables robots to learn new skills autonomously from their social circles.” The system addressed three challenges that robots (and humans) face in the automatic sharing of skills: how to represent a skill to other robots, how a robot can recognize that they have something useful to offer other robots, and finally how a robot can determine that a generic skill is useful to tackle its own unique problem. The researchers first use case demonstration was, naturally, for the robots to learn to serve a drink.<sup>xviii</sup>



## DATA POINT

In the Dell Technologies and Vanson Bourne study, 70% of respondents would welcome people partnering with machines/robots to surpass our human limitations.<sup>xix</sup>



# NAVIGATING DILEMMAS: PREPARING FOR 2030

The shifts described above point toward a future where humans are the most important node in the network and the machines (and their creators) have our best interests at heart. The reality though, is that almost every technology described in this report can also be a Pandora's box of unintended consequences or a platform for malicious behavior. Even as we push for progress, we must manage dilemmas like those below that could cast a shadow on a bright future.

## Privacy paradox

People will increasingly value privacy even as they give more of it away

Sixty-eight percent of respondents to the Dell and Vanson Bourne survey expect that in 2030 they will be more concerned about their privacy than they are today. And almost 74% of respondents consider data privacy to be a top societal-scale challenge that must be solved.<sup>xx</sup> Even with those rising concerns, the shifts described in the report will most certainly lead to a massive increase in the amount of personal data that companies and governments can access and will need to manage. As users become more informed about how they are being surveilled, they will demand tools that enable them to identify, verify, and control the data they are sharing. In turn, individuals will create opportunities to monetize and benefit from revealing their digital footprints.

## Cognitive overload

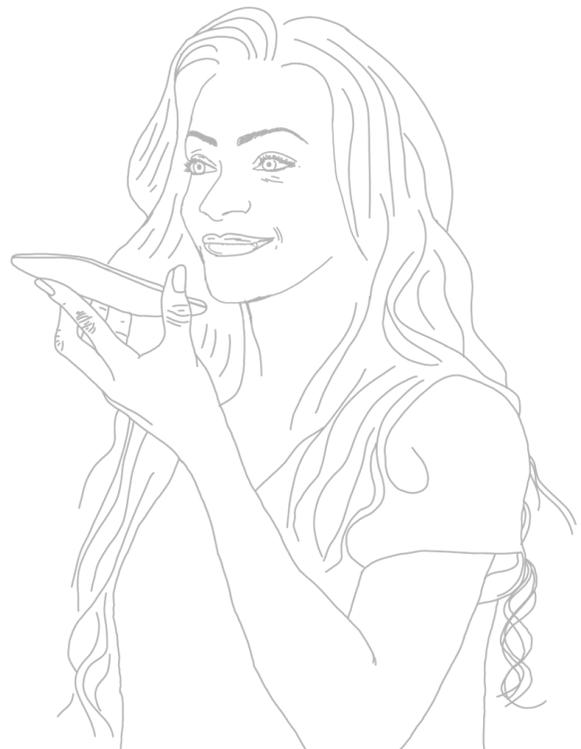
Cognitive overload will increase exponentially

“Information overload” has become a cliché, yet the stress associated with the onslaught of digital media surrounding us is very real. We wring our hands about our children’s “screen time” while science debates the impact of too much digital technology on developing brains. The truth is that not all usage of digital technology is equal. Meanwhile, nobody is certain yet of the psychological or neurological impact of increasingly immersive and potentially even addictive media. By the time we have the benefit of hindsight, today’s tablets and smartphones will be replaced by different interfaces and experiences. Over the next decade, we’ll see the rise of new technologies and solutions to help alleviate the symptoms of cognitive overload, protect our brains, and manage information overload.



### SIGNAL OF CHANGE

Project Alias is open-source “parasite” hardware that fits over a smart speaker and generates white noise to prevent the speaker from perpetually eavesdropping and enable the owner to control what information is shared. When the user says a certain phrase, the white noise stops and Alias passes on your verbal commands to the speaker.<sup>xxi</sup>



# NAVIGATING DILEMMAS: PREPARING FOR 2030

## Municipal data silos

In digital cities, data silos will be a drag on innovation

While there is great potential for digital cities to use big data to increase efficiency and empower citizens, the real value will come when applications and algorithms can communicate with one another across departments, agencies, utilities, and other organizations. At the very least, “siloed” approaches will only lead to costly and unnecessary redundancies. At worst, a lack of interoperability and openness will result in an infrastructure Tower of Babel that makes it impossible to derive real efficiencies, scale solutions, or spark civic innovation.

## Algorithmic inequality

Algorithmic bias can reinforce racial and gender stereotypes

Already, algorithms help humans decide who to hire, whom to loan money, and what appears in your news feed. However, AIs aren’t developed in a vacuum devoid of human values, opinions, and belief systems. Sometimes, a creator may purposely or unconsciously add their own prejudices to the code; other bias may be the result of technical limitations, skewed data, or just bad design. While algorithmic fairness, and transparency has become a research rallying cry, the challenge is that many algorithms we live by are “trade secrets” that companies count on for their competitive advantage.

## Deepfakes and distrust

Deepfakes will make it impossible to believe what we see on video

Immersive interfaces can deliver compelling, sensory-complete experiences generated by synthetic storytellers. Meanwhile, the ability to fake reality is becoming democratized. Already, free software is available allowing people to impersonate others in video chat, put words into politicians’ mouths on newscasts, and even generate fake humans that are nearly indistinguishable from the real thing. By 2030, new forms of identity manipulation and impersonation will undermine trust in individuals and institutions. How can we know what’s true and who do we trust to tell us?

## Black box systems

Black box algorithms will raise questions of trust and transparency

As artificial intelligence systems deepen in complexity they increasingly become “black boxes:” systems where the inputs and outputs are understood, but the internal workings are a mystery to the users and, frequently, the creators. On the one hand, that lack of transparency into how the algorithms work will dramatically increase the risk of failure. On the other hand, black boxes will make it easier to hide deceptive, coercive, and malicious practices behind inscrutable code.



### SIGNAL OF CHANGE

Research from MIT computer scientist Joy Buolmami, founder of the Algorithmic Justice League, and her colleagues revealed gender and skin-type bias in three commercial face recognition systems. According to their analysis, “the three programs’ error rates in determining the gender of light-skinned men was never worse than 0.8 percent. For darker-skinned women, however, the error rates ballooned — to more than 20 percent in one case and more than 34 percent in the other two.”<sup>xxiii</sup>



### SIGNAL OF CHANGE

Researchers from Stanford and Adobe and their collaborators demonstrated a system that automatically edits “talking head” video so that the speaker appears to say whatever the user types. While there are numerous entertainment applications like movies and videogames, the same technique could be used to falsify what a public figure appears to be saying.<sup>xxiii</sup>

# NAVIGATING DILEMMAS: PREPARING FOR 2030

## Urban planning orthodoxy

### Smart cities require smarter urban planning

While there is great potential for technology like sensors, smart grids, and the Internet of Things to push cities toward increased sustainability, implementing those solutions in an efficient and practical way requires a new approach to urban planning. This isn't about top-down technological investment by municipalities but rather cultivating a system-level view that recognizes all stakeholders—government, technology companies, and citizens. From the beginning, there must be clarity about the desired outcome and flexibility about the technology used to get there. The city becomes a platform for innovation: the government partners with the private sector to provide for the needs of its citizens, from energy to transportation to waste management.

## Economic insecurity

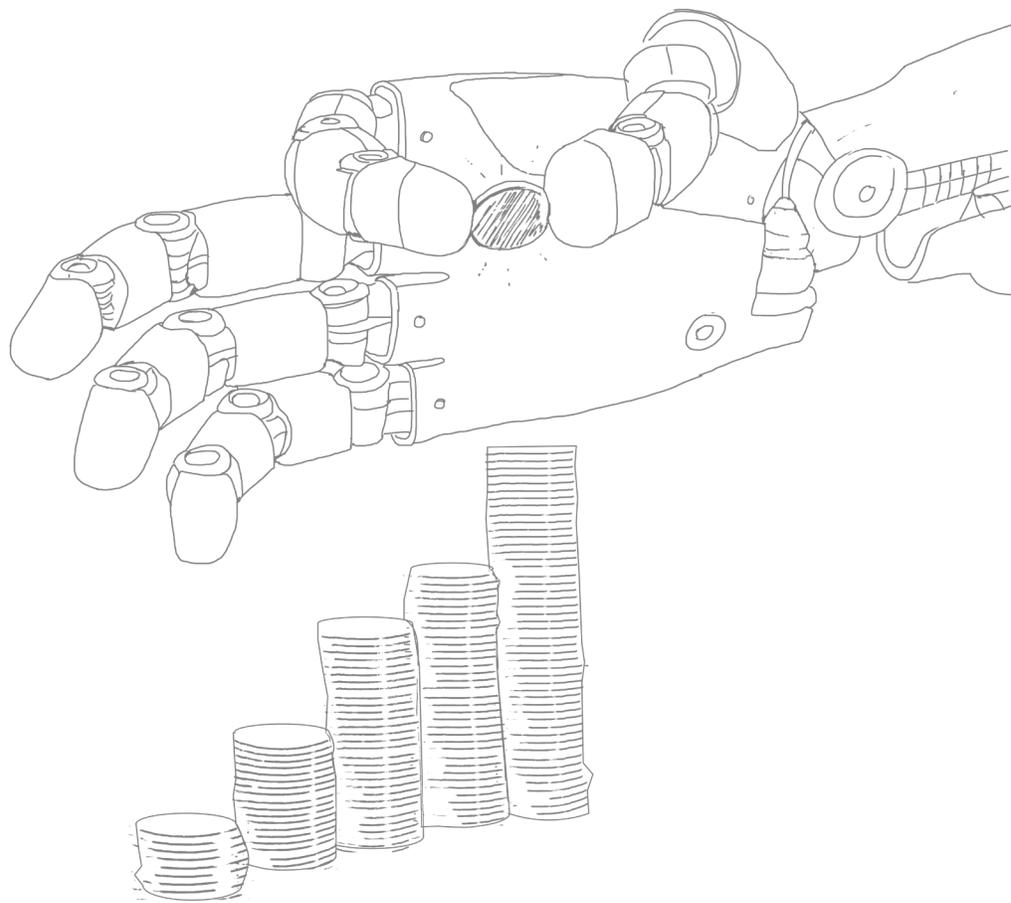
### Emerging technologies can support equity or inequality

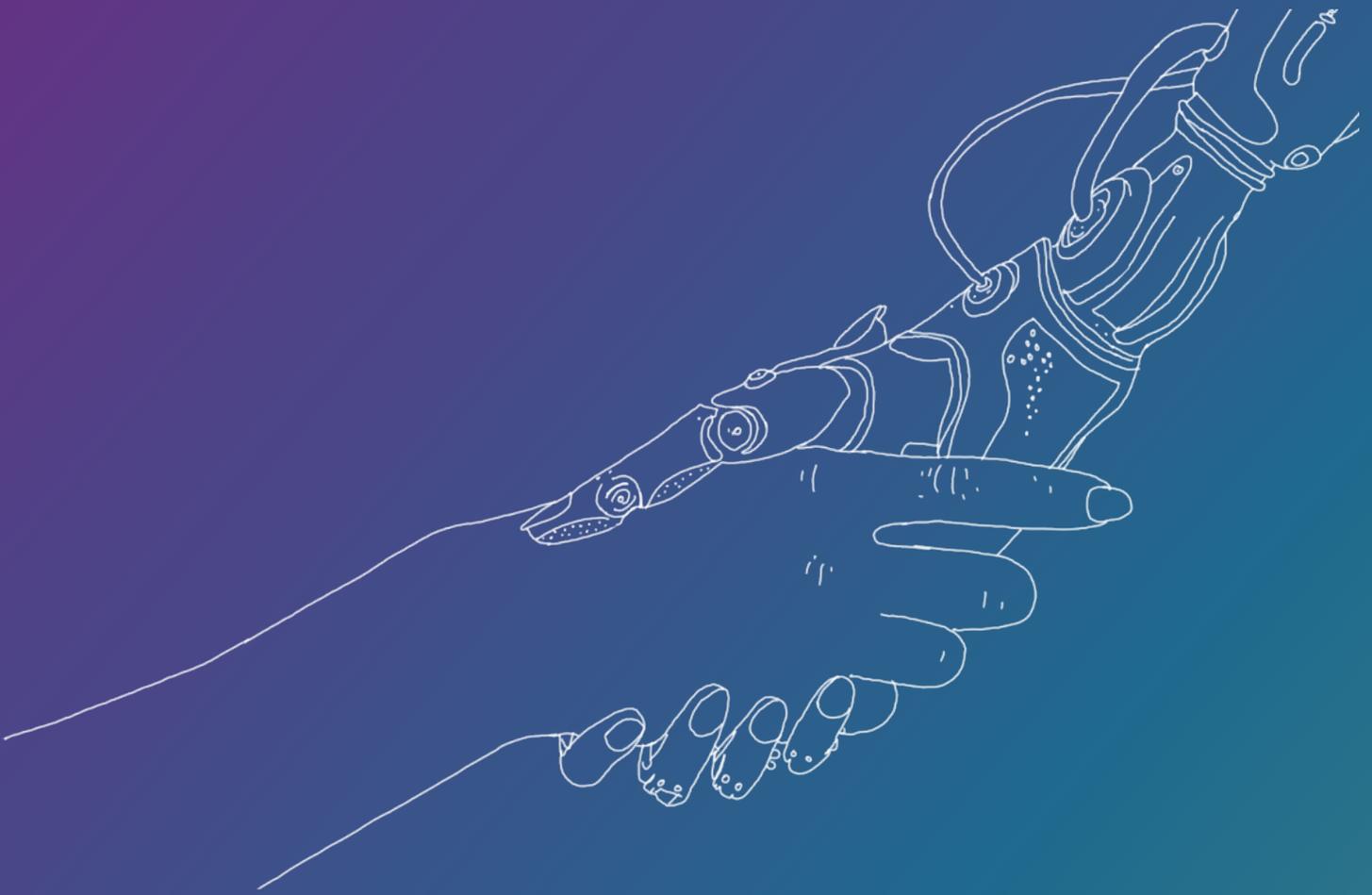
According to Oxfam International, 82% of all wealth created in 2017 went to the top 1%, while the bottom 50% saw no increase at all.<sup>xxv</sup> Against this massive wealth inequality, we face the development of new technologies that have the potential to help deliver economic equity or produce catastrophic social, and ecological, damage. Hopefully, the emerging technologies described in this report will help support the design of new online platforms, systems of universal basic assets, and policy and regulatory solutions that could form the foundation of an economically secure future that works for everyone. This shift and the resulting opportunity are discussed in detail in the prior IFTF report for Dell, titled *Future of Work: Forecasting emerging tech's impact on work in the next era of human-machine partnerships*.

## DRM dangers

### Digital Rights Management (DRM) increases IoT insecurities

ARM, the semiconductor and software design company, forecasts that by 2035, there will be nearly one trillion devices online.<sup>xxiv</sup> But even if you personally own one hundred (or one thousand) of those devices—from smart doorbells to a self-driving car—what you do with the device may not be under your control. Digital rights management (DRM) technologies give the companies that made the product a way to control the device (and its software) long after you bought it. Worse, the DRM and its processes are hidden, making it much easier for malicious parties to hijack devices without being detected. Even if you do find a security flaw or dangerous bug, disclosing it may be illegal. The grassroots right to repair movement is advocating for regulation that gives owners control over the devices they purchase.





# CONCLUSION

As our world becomes alive with intelligent devices and new immersive media enable us to share our dreamspaces with others, we have the opportunity to create more balanced, enjoyable, and equitable lives for ourselves. We could become augmented individuals, empowered with new technologies that enhance our cognitive abilities, increase our productivity, and potentially help balance work and life for everyone. Our cities could become more connected, efficient, sustainable, and more liveable.

Moving the shifts described in this report to move from the realm of what is possible to what is probable will require a new level of partnership between people and machines. It will also demand new relationships, systems, and alliances among individuals, organizations, and governments. After all, it is people, not machines, who are ultimately responsible for building and nurturing a new infrastructure that serves the cause of universal human progress.

Technological advancement will help it possible to improve our lives in myriad ways but technology is not the only force shaping the future. Social and economic forces also create new opportunities and challenges. Navigating these complex systems for the benefit of all will require foresight, imagination, and fortitude. So while this report presents a vision for the future of technology, it also highlights what separates us from our machines and calls for us to celebrate what it really means to be human.

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