Hype Cycle for Emerging Technologies, 2015

Published: 27 July 2015 **ID:** G00289755

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Gartner's Emerging Technologies Hype Cycle brings together the most significant technologies from across Gartner's research areas. It provides insight into emerging technologies that have broad, cross-industry relevance and are transformational and high-impact in potential.

Table of Contents

List of Tables

List of Figures

Analysis

What You Need to Know

Gartner's Emerging Technologies Hype Cycle contains a representative set of still-maturing technologies that get a lot of interest from our clients, and technologies that Gartner feels are significant and should be monitored. This Hype Cycle targets chief digital officers, business strategists, chief innovation officers, R&D leaders, enterprise architects, entrepreneurs, global market developers and emerging technology teams by highlighting a set of technologies that will have a broad-ranging impact across the enterprise. It is the broadest aggregate Gartner Hype Cycle, selecting from the more than 2,000 technologies featured in "Gartner's Hype Cycle Special Report for 2015." For information on interpreting and using Gartner's Hype Cycles, see "Understanding Gartner's Hype Cycles."

Gartner recommends that enterprises do at least an annual scan of the technologies on this Hype Cycle to question if each technology could lead to significant value to their customers or their enterprise. As always, the scanning exercise should be extended to understand how others in your industry may leverage these technologies. This year, we encourage CIOs and other IT leaders to focus on innovation, rather than just incremental business advancement, while also gaining inspiration by scanning beyond the bounds of their industry. One of the more prominent parts of a digital business strategy is the competitive opportunity/threat section that identifies how industry dynamics and competition may change because of digital technologies.

Use this Hype Cycle to identify which technologies are emerging, and use the concept of digital business transformation to identify which business trends may result.

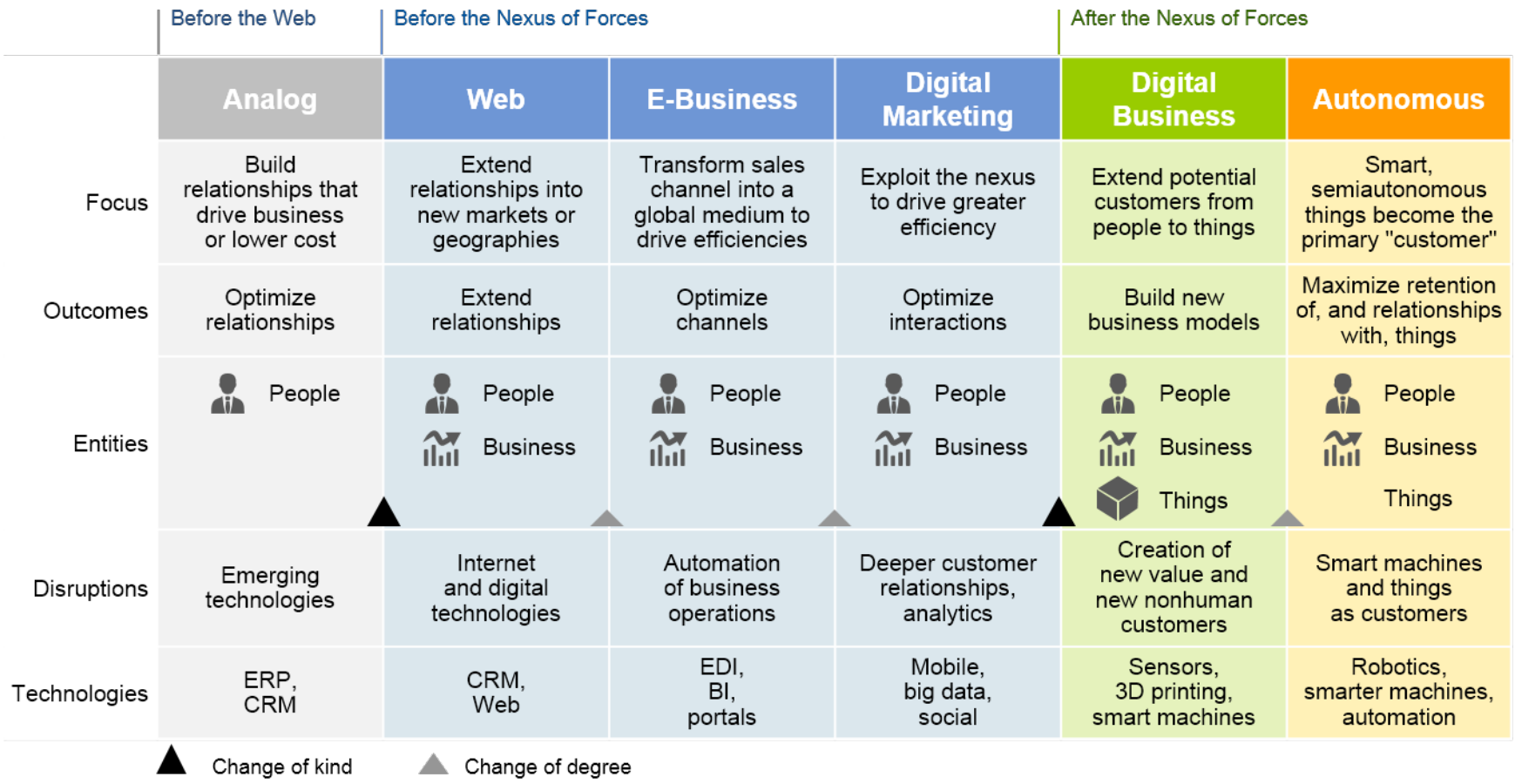
The Hype Cycle

We are continuing with the digital business theme for 2015. As enterprises embark on the journey to become digital businesses, they will leverage technologies that today are considered to be "emerging." Understanding where your enterprise is on this journey and where you need to go will not only determine the amount of change expected for your enterprise, but also map out which combination of technologies supports your progression.

As set out on the Gartner roadmap to digital business (see Figure 1 and "Get Ready for Digital Business With the Digital Business Development Path"), there are six progressive business era models that your enterprise can identify with today and aspire to tomorrow:

- Stage 1: Analog
- Stage 2: Web
- Stage 3: E-Business
- Stage 4: Digital Marketing
- Stage 5: Digital Business
- Stage 6: Autonomous

Figure 1. The Journey to Digital Business



Source: Gartner (July 2015)

Since the Hype Cycle for Emerging Technologies is purposely focused on the more-emerging technologies, it mostly supports the last three of these stages: digital marketing, digital business and autonomous. In several cases, emerging technologies will support more than one stage, such as IoT. However, the way in which IoT is integrated with business and people as an equal peer dramatically changes the way IoT systems are technically supported, as well as the business models.

Let's take a look at each of three stages in detail, and the corresponding technologies:

- **Digital Marketing (Stage 4):** The digital marketing stage sees the emergence of the Nexus of Forces (mobile, social, cloud and information). Enterprises in this stage focus on new and more sophisticated ways to reach consumers who are more willing to participate in marketing efforts to gain greater social connection, or product and service value. Buyers of products and services have more brand influence than previously. They see their mobile devices and social networks as preferred gateways and enterprises at this stage and grapple with tapping into buyer influence to grow their business. Enterprises that are seeking to reach this stage should consider the following technologies on the Hype Cycle: Gesture Control, Hybrid Cloud Computing, Internet of Things (IoT), Machine Learning, Hybrid Cloud Computing, People-Literate Technology and Speech-to-Speech Translation.
- **Digital Business (Stage 5):** Digital business is the first post-nexus stage on the roadmap and focuses on the convergence of people, business and things. The Internet of Things (IoT) and the concept of blurring the physical and virtual worlds are strong concepts in this stage. Physical assets become digitalized and become equal actors in the business value chain, alongside already-digital entities such as systems and apps. 3D printing takes the digitalization of physical items further and provides opportunities for disruptive change in the supply chain and manufacturing. The ability to digitalize attributes of people (for example, the health vital signs) is also part of this stage. Even currency (which is often thought of as digital already) can be transformed (for example, cryptocurrencies). Enterprises seeking to go past the Nexus of Forces technologies to become a digital business should look to these additional technologies: 3D Bioprinting Systems for Organ Transplant, Human Augmentation, Affective Computing, Augmented Reality, Bioacoustic Sensing, Biochips, Brain-Computer Interface, Citizen Data Science, Connected Home, Cryptocurrencies, Cryptocurrency Exchange, Digital Dexterity, Digital Security, Enterprise 3D Printing, Smart Robots, Smart Advisors, Gesture Control, Internet of Things (IoT), IoT Platform, Machine Learning, Micro Data Centers, Natural-Language Question Answering, Neurobusiness, People-Literate Technology, Quantum Computing, Software-Defined Security, Speech-to-Speech Translation, Virtual Reality, Volumetric Displays and Wearables.
- **Autonomous (Stage 6):** Autonomous represents the final postnexus stage. This stage is defined by an enterprise's ability to leverage technologies that provide humanlike or human-replacing capabilities. Using autonomous vehicles to move people or products and using cognitive systems to recommend a potential structure for an answer to an email, write texts or answer customer questions are all examples that mark the autonomous stage. Enterprises seeking to reach this stage to gain competitiveness should consider these technologies on the Hype Cycle: Autonomous Vehicles, Bioacoustic Sensing, Biochips, Brain-Computer Interface, Digital Dexterity, Human Augmentation, Machine Learning, Neurobusiness, People-Literate

Technology, Quantum Computing, Smart Advisors, Smart Dust, Smart Robots, Virtual Personal Assistants, Virtual Reality, and Volumetric Displays.

Although we have categorized each of the technologies on the Hype Cycle into one of the digital business stages, enterprises should not limit themselves to these technology groupings. Many early adopters have embraced quite advanced technologies (for example, autonomous vehicles or smart advisors) while they continue to improve nexus-related areas (for example, mobile apps).

New on the 2015 Hype Cycle for Emerging Technologies

This Hype Cycle features new entrants that enable a more fine-grained analysis of major trends. Unique to the Hype Cycle this year is the emergence of technologies that support what Gartner defines as digital humanism. The following technologies, services and trends are brand-new profiles for 2015, including:

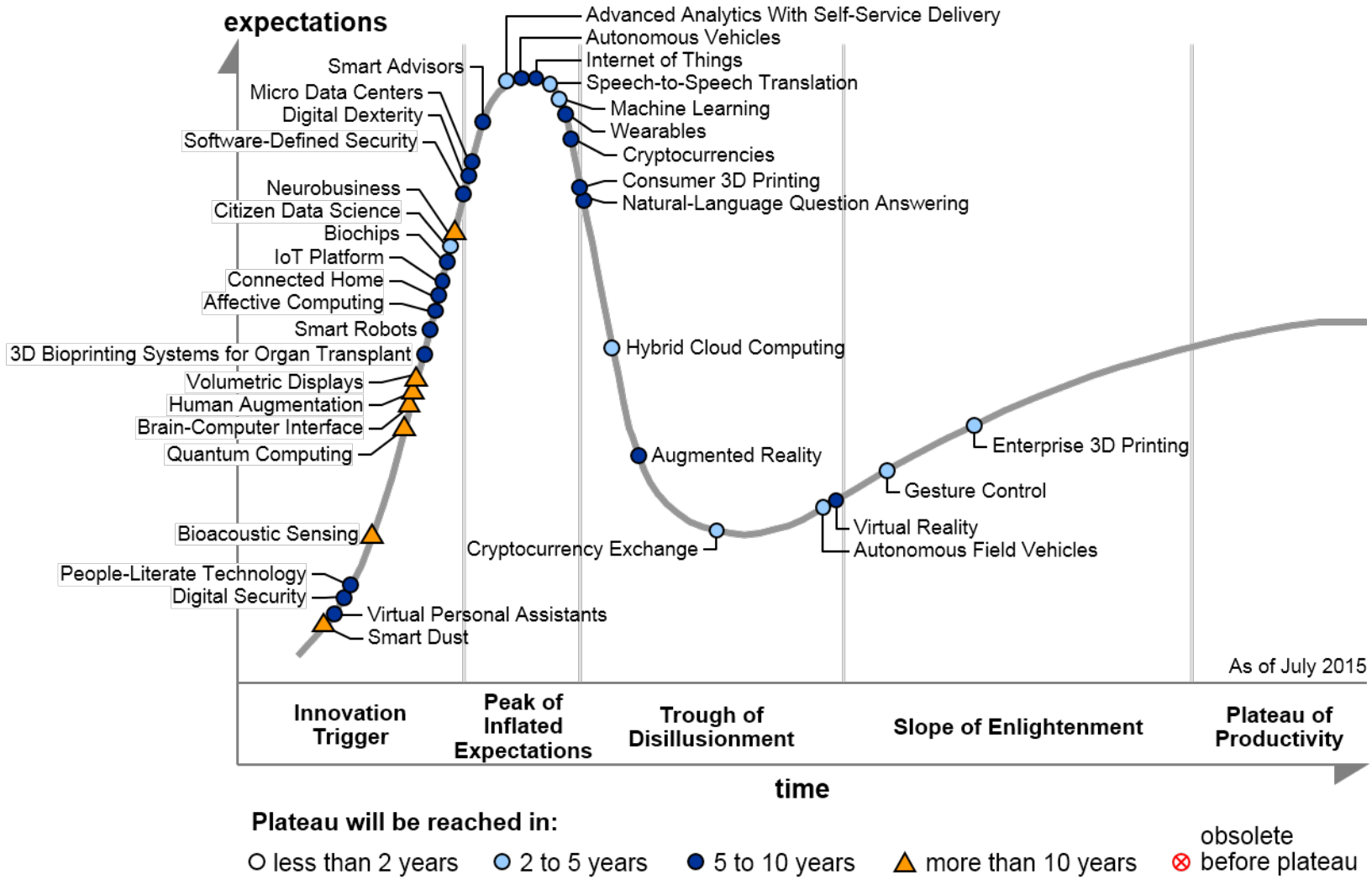
- **Advanced Analytics With Self-Service Delivery —** Added to reflect the use of advanced analytics with self-service delivery tools. These tools put information in the hands of business analysts and users to take advantage of significant potential for creating business value and competitive advantage.
- **Citizen Data Science —** Added based on the continuing trend of organizations transforming select business users into "self-service citizen data scientists," enabled with modern analytic tools to perform manual data preparation, data exploration and pattern detection.
- **Cryptocurrency Exchange —** Added to reflect a significant way in which traditional distributed transaction banking services are transforming into new platforms and services, and are changing what currency means with cryptocurrency initiatives such as bitcoin.
- **Digital Dexterity —** Added to reflect the cognitive ability and social practice needed to leverage and employ various types of media, information and technology for advantage in unique and highly innovative ways that optimize personal and business value.
- **Micro Data Centers —** Added to reflect how business leaders are requiring more business agility, performance, and service continuity that can be achieved from technology by centrally controlled autonomous micro data centers.
- **People-Literate Technology —** Added to reflect the positive change in how people emotionally connect with their technology, enabled by technical innovations such as smart advisors and virtual personal assistants that are conversational, pervasive and proactive in nature.
- **Software-Defined Security —** Added due to the pervasive impacts that digital business has on current rigid and static security infrastructure that is shifting into software-based management for flexibility and agility.

We have also added several existing profiles that existed in other Gartner Hype Cycles to specifically highlight the evolution of digital business and autonomous, including, 3D Bioprinting Systems for Organ Transplant, Autonomous Field Vehicles, IoT Platform, Machine Learning, Smart Dust, Speech-to-Speech Translation, Wearables

Major Changes

- **Autonomous Vehicles —** Shifting from pre-peak 10% to peak on the Hype Cycle, autonomous vehicles are still embryonic but represent a significant movement in advancement, with all major automotive companies putting autonomous vehicles on their near-term roadmap.
- **Bioacoustic Sensing —** Bioacoustic sensing technologies are used to capture natural acoustic conduction properties in the human body in order to use the body as input to computing devices. Moving from embryonic to emerging in maturity, this highly transformational wearable technology continues to move up the Hype Cycle as scientific advancements continue to show promising results.
- **Connected Home —** The growing momentum (from post-trigger 25% to pre-peak 35%) in connected-home solutions have introduced entirely new solutions and platforms enabled by new technology providers and existing manufacturers reinventing in what was once considered niche (entertainment electronics, home automation, security and health products).
- **Natural-Language Question Answering —** Shifting from the peak to post-peak 25%, these technologies are slowly becoming more intuitive and proactive and are engaging with mainstream consumers.

Figure 2. Hype Cycle for Emerging Technologies, 2015



Source: Gartner (July 2015)

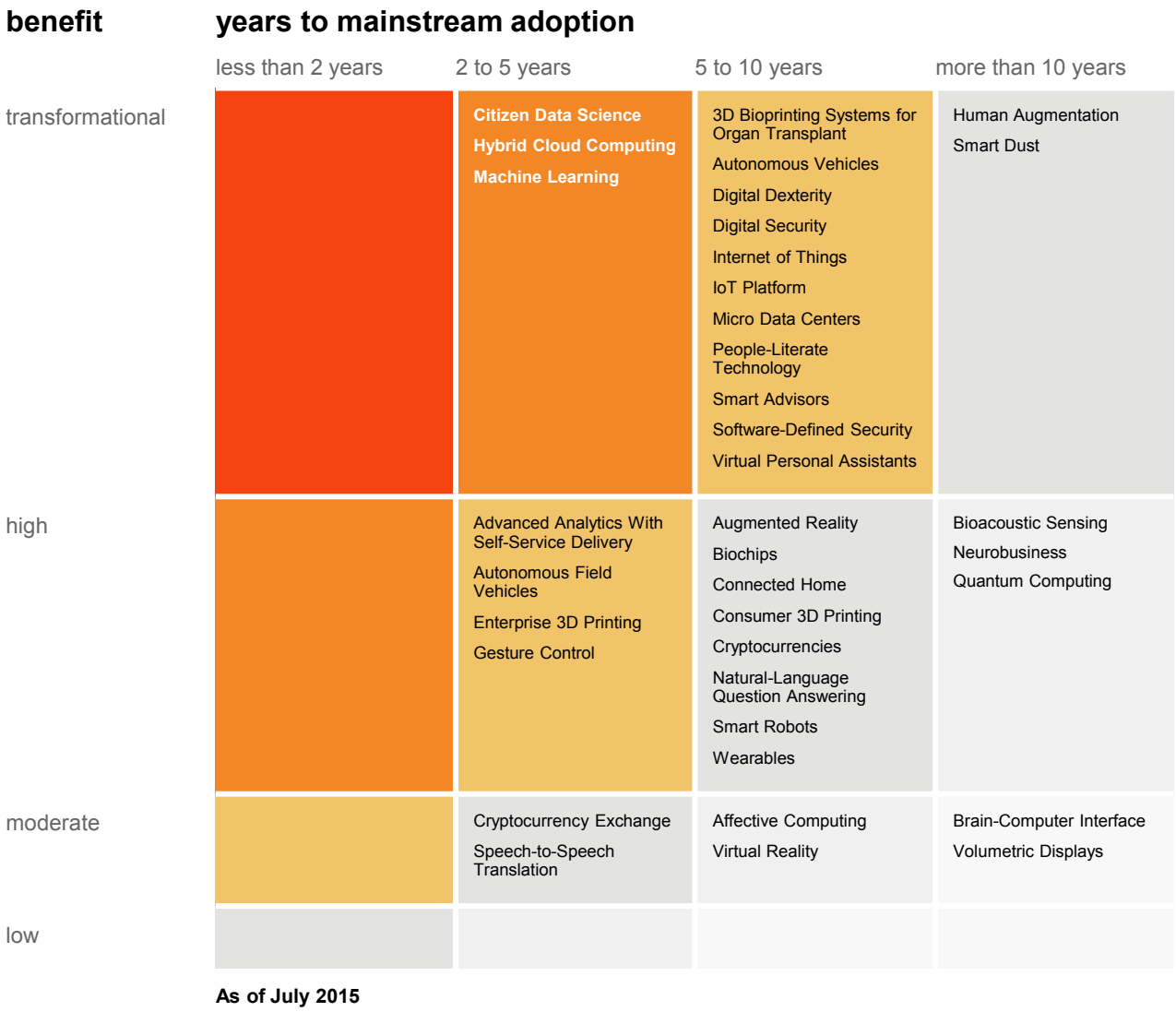
The Priority Matrix

Since this is the Hype Cycle for Emerging Technologies, it naturally has an above-average number of technologies with a benefit rating of transformational or high. It is also natural that we would find a number of technologies in the categories on two to 10 years till mainstream adoption. This is a deliberate goal of the selection process. This Hype Cycle is also specifically focused on emerging technologies, as opposed to services or disciplines.

The goal of this Hype Cycle is to highlight technologies that are emerging on the horizon and are worth considering adopting early because of their potentially high impact. However, the actual benefit often varies significantly across industries. Therefore, planners should ascertain which opportunity relates closely to their organizational requirements:

- **Two to five years to mainstream adoption:** These technologies are focused on the digital marketing stage areas such as cloud (hybrid cloud computing) and information/analytics-related areas (Citizen Data Science, Advanced Analytics With Self-Service Delivery). Also included is early digital business stage technology (Machine Learning, Autonomous Field Vehicles, Enterprise 3D Printing, Gesture Control)
- **Five to 10 years to mainstream adoption:** Here, we find a mix of technologies that span all three stages on the journey to become a digital business. However, the majority of the technologies are centered in the digital business and autonomous stages (3D Bioprinting Systems for Organ Transplant, Autonomous Vehicles, Digital Dexterity, Digital Security, IoT Platform, People-Literate Technology, Smart Advisors, Software-Defined Security, Virtual Personal Assistants).
- **More than 10 years to mainstream adoption:** These technologies are largely centered on the autonomous stage, and reflect some very interesting emerging technologies focused on human-to-machine interaction/integration (Human Augmentation, Smart Dust, Bioacoustic Sensing, Neurobusiness).

Figure 3. Priority Matrix for Emerging Technologies, 2015



Source: Gartner (July 2015)

Off the Hype Cycle

Because this Hype Cycle pulls from such a broad spectrum of topics, many technologies are featured in a specific year because of their relative visibility, but are not tracked over a longer period of time. This is not intended to imply that they are unimportant — quite the opposite. In many cases, these technologies are no longer "emerging" and are becoming more integral to business and IT (such as Big Data and Cloud Computing). In other cases, technologies were removed from the Hype Cycle in order to highlight other new emerging technologies.

Technology planners can refer to Gartner's broader collection of Hype Cycles for items of ongoing interest. Some of the technologies that appeared in the "Hype Cycle for Emerging Technologies, 2014" and do not appear in this year's report are:

- 3D Bioprinting Systems
- 3D Scanners
- Activity Streams
- Big Data
- Cloud Computing
- Complex-Event Processing
- Consumer Telematics
- Content Analytics
- Data Science
- Gamification
- In-Memory Analytics
- In-Memory Database Management Systems
- Machine-to-Machine Communication Services
- Mobile Health Monitoring
- NFC
- Prescriptive Analytics
- Quantified Self
- Smart Workspace
- Software-Defined Anything
- Speech Recognition
- Speech-to-Speech Translation
- Wearable User Interfaces

On the Rise

Smart Dust

Analysis By: Ganesh Ramamoorthy

Definition: Smart dust motes are tiny wireless micro-electromechanical systems (MEMS), robots or other devices that can detect everything from light, temperature and pressure to vibration, magnetism and chemical composition. They run on a wireless computer network and are distributed over an area to perform tasks, usually sensing through RFID. As they do not use large antennas, these systems have ranges measured in just a few millimeters.

Position and Adoption Speed Justification: At present, much of the activity surrounding smart dust is concentrated in research laboratories, such as the U.S. Defense Advanced Research Projects Agency (DARPA)-funded project at the Robotics Research Laboratory at the University of Southern California and JLH Labs. The main purpose of this research is to make motes as small as possible, which involves both evolutionary and revolutionary advances in miniaturization, integration and energy management. They also aim to make motes available at as low a price as possible. As a complete sensor/communication system integrated into a cubic-millimeter package is still a long way off, we have yet to see major commercial applications for smart dust. However, some reasonably small motes are commercially available for building controls, industrial monitoring and security applications.

Given its wide range of potential applications and benefits, this technology will, we believe, have a transformative effect on all areas of business and on people's lives in general. However, due to the lack of any major activity in terms of commercial implementations, smart dust remains in the same position on the Hype Cycle this year as it was last year.

User Advice: Smart dust motes that are available "off the shelf" can be configured with sensors that detect and measure a variety of properties, such as temperature, barometric pressure, humidity, light intensity, acceleration, vibration, magnetism, acoustic level and location (using GPS). The combination of these capabilities in a well-designed sensor network could create opportunities to deliver numerous services.

Business Impact: The potential benefits of smart dust are compelling and transformational. Given the embryonic stage of this technology's development, vendors should stake their claims via patent development for commercial applications, direct funding for research projects or equity funding for companies engaged in research and development. Smart dust will transform the way humans interact with their surroundings and create new ways for businesses to deliver services, while reducing costs in the process. This will have wide-ranging implications for businesses' technological, social, economic and legal practices across the globe.

Benefit Rating: Transformational

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Sample Vendors: Crossbow Technology; Linear Technology; MEMSIC; Millennial Net; Silicon Labs; SkyeTek

Virtual Personal Assistants

Analysis By: Tom Austin

Definition: A virtual personal assistant (VPA) performs some of the functions of a human personal assistant. With the user's permission, it:

- Observes user content and behavior.
- Builds and maintains data models (from which it draws inferences about people, content and contexts).
- Predicts users' needs.
- Builds trust.
- Acts autonomously on the user's behalf.

VPAs make everyday tasks easier (by prioritizing emails, for example), and its users generally more effective (by highlighting the most important content and interactions).

Position and Adoption Speed Justification: The VPA "perfect storm" combines:

- Compelling visions foretold by Apple, Microsoft and others.
- A technology "big bang," the intersection of improved hardware (GPUs), algorithms (deep learning and natural-language processing), and big data with which to train systems underlying VPAs.
- Products such as VPA precursors and early, narrow-purpose VPAs.

Conversational agents, such as Siri, Google Now and Cortana, and today's proactive search and advice services (such as Google Now) are precursors, not VPAs.

Early, narrow-purpose VPAs include virtual scheduling assistants, such as x.ai's Amy and inbox organizers (Google's Priority Inbox, Microsoft's Clutter and IBM's Verse, which organize emails based on content analysis and observations of prior user behavior).

Virtual customer assistants are an important VPA subclass. Providers include Creative Virtual, IPsoft and Xiaoi.

More fully featured VPAs from Google, Microsoft, IBM and others will appear between now and 2017. Office Delve is an early-stage example already available. It features APIs for third-party access.

User Advice: IT leaders should:

- Anticipate that many different types of VPAs will be available and a single "winner take all" success is unlikely to happen. Individuals may use several VPAs with different specializations, such as health-related VPAs to help with diet, exercise, the quantified self, relationships and psychological well-being; VPAs to serve as personal shoppers; personal-career development

and financial-management VPAs; and others for office-specific tasks like calendar management, email handling and external information monitoring.

- Encourage experimentation while creating opportunities for employees to share experiences and recommendations. Lead by doing.
- Prepare for mail-centered VPAs first, followed by blossoming of the full range of capabilities envisioned in Apple's 1987 movie — and more.
- Recognize that privacy, security and innovation are at odds. Watch cautiously while encouraging experimentation. Imposing too many controls too soon due to a lack of trust in your employees could eliminate the opportunity to outflank competitors. However, granting your employees too much trust could be self-defeating, unless you keep careful watch.

Carefully measure the impact of VPAs on people's behavior and performance. Use an ever-evolving set of metrics, identified by observation and crowdsourcing.

Business Impact: VPAs have the potential to transform the nature of work and structure of the workplace. They could upset career structures and enhance workers' performance, but they have challenges to overcome beyond simply moving from research labs to product portfolios. It is far too early to determine whether or how they will overcome privacy concerns (although opt-in requirements make sense). Individuals will think long and hard about what they want each VPA to see and who else might view that information. Similarly, enterprises will be concerned about employees exposing confidential information via VPAs.

Benefit Rating: Transformational

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Sample Vendors: Apple; Cognitive Scale; Creative Virtual; Google; IBM; Microsoft; Nuance; x.ai

Recommended Reading:

"Smart Agents Will Drive the Switch From Technology-Literate People, to People-Literate Technology"

"Cool Vendors in Smart Machines, 2015"

"The IT Role in Helping High Impact Performers Thrive"

Digital Security

Analysis By: Earl Perkins

Definition: Digital security combines current cybersecurity and risk practice with digital business practice to protect all digitalized assets of an organization, whether at the core of the enterprise or at its edge.

Position and Adoption Speed Justification: Gartner defines "digital" as all electronically tractable forms and uses of information and technology, including such forms as social media, cloud-based services, embedded software and systems, operational technologies, and the Internet of Things (IoT). Digital security is the alignment of information security, IT security, operational technology (OT) security, IoT security and physical security to form cybersecurity solutions. Cybersecurity must align with digital business needs to manage risk for traditional information assets at the same time as complexity grows due to the digitization of an organization's assets at the physical edges of the business. This early evolution of cybersecurity and digital business places digital security at the post-Technology Trigger phase of the Hype Cycle. Digital security is the business view of cybersecurity, where cybersecurity is governed and managed directly by the business as an asset and an enabler, not an overhead commodity as most organizations treat it today.

User Advice: Business executives, chief digital officers, chief risk officers and CIOs should reposition the role of IT as a digital business enabling service to address business issues that involve cybersecurity concerns by direct participation in the early period of digital business evolution. They should align resources and processes to develop a new governance and strategic planning model that incorporates the "race to the edge" brought on by significant technological changes that include direct business unit participation in major cybersecurity decisions. Organizational skill sets must be modified and enhanced to include new technologies and approaches that reflect scale, diversity and rapid change in the technology markets. Product managers should pursue new partners in cybersecurity technologies and services to ensure that business efforts to embrace OT, IoT and physical assets will be accommodated. Information security managers should choose to stay focused on information or embrace a wider perspective of cybersecurity brought on by these changes. Those managers must reshape enterprise security practices to be more inclusive and collaborative across business disciplines that include industrial, commercial and consumer enterprises. Information security managers can ultimately transform themselves into digital security managers as their responsibilities expand into the digital business.

Business Impact: Digital security will reshape cybersecurity process, organization and business relationships occurring in areas such as business scenario planning, supply chain management, portfolio management and risk management. Digital security will first achieve relevance with clients that achieve a more open business model where business changes are volatile and require adaptive support systems, where data is more readily available and assets are more accessible by more customers or citizens, and where information, assets and services are more distributed to the physical and digital edges of the business. This will occur initially in financial services and retail sectors, followed quickly by some forms of industrial environments where edge systems are already prevalent, such as automotive and healthcare. Over time, organizations that need to ensure the safety, confidentiality, integrity and availability of assets, no matter what form they take, will view digital business as inseparable with digital security practices.

Benefit Rating: Transformational

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Sample Vendors: Amazon; Apple; Audi; BMW; Bosch Security Systems; GE; Google; IBM; Intel; Microsoft; Samsung

Recommended Reading:

"What Securing the Internet of Things Means for CISOs"

"Top Consumer Trends That Will Impact the Digital Workplace in 2025"

"Predicts 2015: The Internet of Things"

People-Literate Technology

Analysis By: Tom Austin

Definition: People-literate technologies (PLTs) exploit natural-language processing to reduce the cognitive burden on people, letting them concentrate on their objectives instead of technical details. PLTs engage in natural-language conversations with people using touch, speech, keyboards and other means. They learn how to interact with us and master natural dialogue to improve precision and quality of experience.

Position and Adoption Speed Justification: We're just entering a natural, conversational age. Companies such as Next IT are building verbal front ends to hide the complexity of hundreds of legacy transactional systems for brokers. Microsoft has already created a keyboard-based, natural-language front end to Excel, with its PowerBI interface. Microsoft Skype/Translator is in beta and Cortana (as showcased in Windows Phone) is in the preview version of Windows 10. Google and others have similar speech recognition and translation capabilities.

Speech recognition and translation are brilliant, but imperfect. To deliver natural-language dialogue services, more work is needed on understanding and reasoning. Think back to the last time Apple's Siri or Amazon's Alexa (or any other conversational aid) actually asked you a qualifying question. They don't.

IBM Watson's natural dialogue services are one step in the right direction; x.ai's natural-language calendar negotiation agent (Amy) and IPsoft's Amelia provide more evidence of progress.

User Advice: Imagine the ultimate "clean screen" approach — workable on a desktop, a large screen, a phablet, tablet, phone or watch — a blank screen with only one blank dialogue box to which the user can type or talk and which responds intelligently, retaining and reusing previous information from earlier dialogs with this user and often asking qualifying questions before responding substantively to the user's wants or needs.

Do not fixate on computer literacy for people. The need for literacy-related training and tools will significantly diminish during the next decade.

Plan on PLTs becoming the dominant model: by 2020, at least 40% of people will primarily interact with PLTs, removing much of the perceived need to invest further in improving "computer literacy."

Examine existing natural-language dialogue examples, which include:

- Lower-level tools for adding natural-language interfaces and some semantic analysis to existing systems (see Speaktoit in "Cool Vendors in Smart Machines, 2015" and the "Natural Language Toolkit").
- Expert systems such as SGT Star, a chatbot developed for the U.S. Army with more than 800 rules to determine what to say to the person seeking information.
- Microsoft's Cortana and PowerBI.
- Yseop's cloud service and platform for building expert systems with natural-language generation capabilities.
- IPsoft's Amelia, which provides virtual customer assistants that learn from observing person-to-person interactions.
- IBM Watson, which contains an extremely broad suite of integrated natural-language processing, understanding and generation capabilities (along with a broad range of other services).

Business Impact: This approach will appear primarily in new applications. Enterprise IT leaders should be on the lookout for (and biased toward) PLTs, to improve employee (and customer) effectiveness as well as reduce operating expenses.

There will also be some retrofitting (as in the Next IT example of building a natural-language front end to hundreds of transactional systems, cited above). Over the next five years, we do not expect large enterprises to invest heavily in retrofitting existing systems of record where the employee base is experienced and stable and the feature set well known to the user base. However, where there is employee turnover, significant rapid changes in feature sets, or where enterprises face a continuing burden of providing computer literacy training, enterprise IT leaders need to consider creating people-literate front ends to make it easier for employees to adapt and excel.

Benefit Rating: Transformational

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Sample Vendors: Amazon; Google; IBM; IPsoft; Microsoft; Next IT; Speaktoit; x.ai; Yseop

Recommended Reading:

"Smart Agents Will Drive the Switch From Technology-Literate People, to People-Literate Technology"

"Cool Vendors in Smart Machines, 2015"

"Predicts 2015: Smart Machines to Complicate Labor Markets and Ethics"

"Digital Business Innovation With Smart Machines"

Bioacoustic Sensing

Analysis By: Roberta Cozza

Definition: Bioacoustic sensing captures natural acoustic conduction properties in the human body using different sensing technologies. An example of this technology is Skinput, which allows the skin to be used as an input surface. When a finger taps on the skin, the impact creates acoustic signals that are captured by a bioacoustic sensing device. Variations in bone density, size and the different filtering effects created by soft tissues and joints create distinct acoustic locations of signals, which are sensed, processed and classified by software.

Position and Adoption Speed Justification: Skinput was developed by researchers from Microsoft and the Human-Computer Interaction Institute of Carnegie Mellon University in Pittsburgh. In a prototype system, researchers focused on touch inputs on the arm and hand, and created an armband device for sensing. They evaluated different input locations, such as the fingertips and along the forearm.

The technology can also be integrated to augment the experience with a pico projector that projects dynamic graphical interfaces onto skin. For example, a telephone keypad can be projected onto the palm of the hand, allowing real-time dialing without the use of a mobile phone. Researchers have also developed a scrolling interface for projection onto the forearm. Accuracy of 95.5% for five input locations on the whole arm has been demonstrated. This project has remained under development, with no commercial product becoming available or expected in at least the next five years.

Future efforts will need to improve on the noninvasiveness of wearable bioacoustic sensor devices. Additionally, the disturbance from acoustic signals coming from other motions of the body will need to be reduced. The input method is limited to quick skin taps, which in its current form does not permit more elaborate common gestures like sliding or dragging. Additionally, body mass index fluctuations can decrease sensing accuracy, and there is a high learning curve in setting up the solution.

Other examples are the bioacoustic system from AT&T Labs that has developed a prototype bioacoustic data transfer system that can send digital keys living as vibrations through the body (bones), enabling a door to open only to the unique acoustic "signature" of the homeowner. This works in conjunction with piezo sensors and a device such as smartphone — if the bioacoustic signature matches on both the device and the door knob, the door unlocks. Another application that AT&T is looking into is the exchange of data between people, where contact information is transferred via a handshake.

Use of bioacoustic for gesture controls and interface is being commercialized with products like the Myo armband from Thalmic Labs. The Myo works by sensing the electrical signals coming from the muscles in the forearms and translated as input that a software reads to let users control different computing devices. The Myo for now works with a limited number of simple gestures to perform simple commands on devices.

User Advice: Advances in this technology should be monitored and considered in scenarios where users can benefit from always-available and easily accessible input without direct access to the keypad of a device, such as a mobile phone.

Business Impact: Using the human body as an input surface is an interesting concept for UIs. It could enable consumers to use larger and easily accessible additional input surface areas for interaction, compared with the small surface areas offered by the touchscreens on handsets. Users could benefit by having large surfaces for input without needing to carry extra items. In addition, this type of input would allow accurate "eyes-free" touch interactions, because of our natural sense of body configuration (proprioception).

Unlike other external input devices, most interactions could be performed without looking at the surface of a device. Experiments have also demonstrated a good level of accuracy in the input. Other external input approaches, such as smart fabrics or wearable computing, typically require an input device to be built into a piece of clothing, which is more complex.

Bioacoustic sensing technology enabling gesture recognition and control can have an impact in a number of applications like gaming, new ways of iteration with media and computing devices.

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Sample Vendors: AT&T; Microsoft; Thalmic Labs

Quantum Computing

Analysis By: Jim Tully

Definition: In quantum computers data is held in qubits, which have the ability to hold all possible states simultaneously. Known as "superposition," this gives quantum computers the ability to operate exponentially faster than conventional computers as word length is increased. Data held in qubits is influenced by data held in other qubits, even when physically separated. This effect is known as "entanglement." Achieving both states simultaneously is extremely challenging.

Position and Adoption Speed Justification: No particular quantum computing technology has found favor among a majority of researchers, supporting Gartner's position that the topic remains in the relatively early research stage.

Hardware based on these technologies is unconventional, complex and leading edge, yet most researchers agree that hardware is not the core problem. Effective quantum computing will require the development of algorithms (quantum algorithms) that will solve real-world problems while operating in the quantum state. The lack of these algorithms is a significant problem, although a few have been developed.

The technology continues to attract significant funding, and a great deal of research is being carried out. Although we have not seen any significant progress on the topic over the past year, publicity and hype have increased a little.

User Advice: Given the focus and achievements of research in quantum computing, our view is that general-purpose quantum computers will never be realized; they will instead be dedicated to a narrow class of use. This suggests architectures where traditional computers offload specific calculations to dedicated quantum acceleration engines. A lack of programing tools, such as compilers, is another factor restricting the broader potential of the technology. Specific applications include optimization, code breaking, image analysis and encryption.

If a quantum computer offering appears, check its usefulness across the range of applications that you require. It will probably be dedicated to a specific application and this may be too narrow to justify a purchase. Check if access is offered as a service. D-Wave Systems has now moved in this direction, and it may be sufficient at least for occasional computing requirements. Some user organizations may require internal computing resources, for security or other reasons. In these cases, use of the computer on a service basis — at least initially — would offer a good foundation on which to evaluate its capabilities.

Business Impact: Quantum computing could have a huge effect, especially in areas such as optimization, code breaking, DNA and other forms of molecular modeling, large database access, encryption, stress analysis for mechanical systems, pattern matching, image analysis and (possibly) weather forecasting. Analytics is likely to be a primary driver over the next several years.

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Sample Vendors: D-Wave Systems; Delft University of Technology; IBM; Stanford University; University of Bristol; University of Michigan; University of Southern California; Yale University

Brain-Computer Interface

Analysis By: Jackie Fenn

Definition: A brain-computer interface is a type of user interface, whereby the user voluntarily generates distinct brain patterns that are interpreted by the computer as commands to control an application or device. The best results are achieved by implanting electrodes into the brain to pick up signals. Noninvasive techniques are available commercially that use a cap or headband to detect the signals through external electrodes.

Position and Adoption Speed Justification: Brain-computer interfaces remain at an embryonic level of maturity, although we have positioned them toward the trigger-peak midpoint of the Hype Cycle to acknowledge the growing visibility of several commercial products (such as those from InteraXon, Emotiv and NeuroSky) in the emerging fields of "brain fitness" and neurogaming (that is,

brain-controlled games). The major challenge for this technology is obtaining a sufficient number of distinctly different brain patterns to perform a range of commands — typically, fewer than five patterns can be distinguished. However, this proves sufficient to play interactive games and to control equipment or even some vehicles. One approach that operates well within these constraints is to watch for the distinctive brain pattern associated with recognizing a desired goal — for example, brain-driven typing flashes letters on the screen until the desired letter is recognized by the user's brain. Many of the advances are arising from research on activating prosthetic limbs by using people's natural brain patterns, and researchers at Brown University have succeeded in reading neural signals from a low-power wireless system implanted inside the brain. The Obama administration's decade-long Brain Activity Map project will also drive improved interpretation of brain signals.

User Advice: Treat brain-computer interfaces as a research activity. Some niche gaming and disability-assistance use cases might become commercially viable for simple controls; however, these will not have capabilities that will generate significant uses in the mainstream of business IT.

Outside of medical uses for people with no other means of communication or control, other hands-free approaches to user interaction, such as speech recognition, gaze tracking or muscle-computer interfaces, offer faster and more-flexible interaction than brain-computer interfaces. The need to wear a headband to recognize the signals is also a serious limitation in most consumer or business contexts.

Business Impact: Most research is focused on providing severely disabled individuals with the ability to control their surroundings. Commercialization is centered on novelty game interfaces and applications that help users become more aware of their own brain state to improve relaxation or focus — for example, as part of quantified self-activities. As wearable technology becomes more commonplace, applications will benefit from hybrid techniques that combine brain, gaze and muscle tracking to offer hands-free interaction.

Benefit Rating: Moderate

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Sample Vendors: Emotiv; InteraXon; neurowear; NeuroSky; Personal Neuro Devices

Recommended Reading:

"Maverick* Research: Read My Mind — Will Eavesdropping on the Human Brain Lead Marketers to the Holy Grail?"

"Cool Vendors in Human-Machine Interface, 2013"

"Market Trends: New Technologies Benefit Employees and People With Disabilities"

"Maverick* Research: The Future of Humans: Get Ready for Your Digitally, Chemically and Mechanically Enhanced Workforce"

"A Brain-Computer Interface That Works Wirelessly," MIT Technology Review"

"Paraplegic in Robotic Suit Kicks Off World Cup," BBC News

Human Augmentation

Analysis By: Jackie Fenn

Definition: Human augmentation creates cognitive and physical improvements as an integral part of the human body to deliver performance that exceeds normal human limits. Augmentation examples include increased physical strength through exoskeletons, improved perception through sensory transference or adjustable aids (for example, a hearing aid with a phone app to optimize directionality), and enhanced concentration and learning through electrical brain stimulation.

Position and Adoption Speed Justification: As technology to augment human capabilities makes the transition from mobile and wearable to implantable or even genetic, organizations and society must confront a growing range of opportunities and issues relating to employees who choose — or in some cases are required or financially motivated — to enhance their bodies and minds though technology.

Increasing specialization and job competition are demanding levels of performance that will drive more people to experiment with enhancing themselves, triggering a multibillion-dollar human augmentation market during the next quarter century. However, the radical nature of the trend will initially limit it to a small segment of the population.

Based on elective augmentation trends and the growing range of augmentation opportunities available, we are positioning human augmentation midway between the trigger and the peak, even though it will be well over a decade before a significant number of organizations and individuals are affected. In the meantime, some organizations will contemplate offering their staff augmentation opportunities to increase performance, or creating policies to govern augmentation trends.

User Advice: Organizations aiming to be very early adopters of technology, particularly those whose employees are engaged in physically or mentally demanding work, should track lab advances in areas such as strength, endurance or sensory enhancement. Cognitive enhancement through technology is already represented by the growing use of — and dependence on — instant mobile access to information and community, and organizations must also continue to be ready for consumer- and employee-led adoption of the latest wearable or even implantable technologies.

Ethical controversies regarding human augmentation are emerging even before the technology becomes commonplace. Several states have already passed bills banning employers from requiring chip implants as a condition of employment. Future legislation will need to tackle topics such as whether an employer is allowed to prefer a candidate with augmented capabilities over a "natural" one. Employers will need to weigh the value of human augmentation against the growing capabilities of robot workers, particularly as robots may involve fewer ethical and legal minefields than augmentation.

Organizations can gain an early understanding of some of the opportunities and issues by tracking the Quantified Self movement, which promotes self-monitoring through sensors and devices to improve physical and mental well-being.

Business Impact: The impact of human augmentation — and the ethical and legal controversies surrounding it — will first be felt in industries and endeavors demanding extreme physical performance, such as the military, emergency services and sports, followed rapidly by those requiring intense mental focus and stamina, such as financial trading and high-stakes sales.

Technology and talent management leaders will find themselves at the intersection of technology, biology and ethics as they support and manage people who are prepared or required to augment themselves. Highly competitive work environments and performance-based incentives may require new risk measurement and monitoring techniques to detect instances of covert augmentation — for example, by monitoring for anomalies in performance and achievements.

Benefit Rating: Transformational

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Sample Vendors: Cyberdyne; Raytheon

Recommended Reading:

"Maverick* Research: The Future of Humans: Get Ready for Your Digitally, Chemically and Mechanically Enhanced Workforce"

"Technology Overview: Quantified Self"

Volumetric Displays

Analysis By: Brian Blau

Definition: Volumetric displays create visual representations of objects in three dimensions, with a 360-degree spherical viewing angle in which the image changes as the viewer moves. Unlike most 3D planar displays, which create the illusion of depth through stereoscopic or autostereoscopic technique, volumetric displays create lifelike images in 3D space.

Position and Adoption Speed Justification: Volumetric displays have barely emerged from the laboratory, but are often thought of as the iconic volumetric image of Princess Leia created by R2-D2 in the first Star Wars movie. Volumetric displays remain an elusive yet aspirational goal.

Volumetric displays fall into two categories: swept volume and static volume displays. *Swept volume* uses the persistence of human vision to recreate volumetric images from rapidly projected 2D "slices." *Static volume* displays rely on a 3D volume of active elements. Swept and static volumetric displays suffer from the significant dangers of rapidly moving parts or ionized particles in the vicinity of people, especially because the volumetric nature of the generated image convinces

the brain that it is solid and "real" and, therefore, can be touched. In all cases, the volume of data required to generate a volumetric image is considerable.

User Advice: Outside of specialized areas where budgets are not significant constraints, this technology remains firmly in the lab rather than in commercial applications. Current technologies limit the size of volumetric space that can be displayed, and the mechanical solutions create potentially dangerous, rapidly moving parts. Until alternative approaches can be delivered (which seems unlikely in the near future), volumetric displays will remain an extremely niche product. Concurrently, the rapid growth and continuing development of head-mounted displays (HMDs) threaten to overwhelm the continuing development of volumetric displays outside of specialized markets.

Business Impact: General applications are not well-developed for business use for volumetric displays. To date, simple applications in marketing have been deployed — usually targeted at high-end retail environments, and there are some specialized applications for geospatial imaging to enhance 2D maps, and for use in architectural rendering. However, most of these can be achieved at much lower costs using other more-commercialized technologies, such as 3D displays. Potential application areas include medical imaging, consumer entertainment and gaming, and design, but costs will need to fall dramatically for these to be viable for using true volumetric displays.

Benefit Rating: Moderate

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Sample Vendors: HP; Musion; Realfiction

Recommended Reading:

"Market Trends: Head-Mounted Displays for Virtual Reality and Augmented Reality"

3D Bioprinting Systems for Organ Transplant

Analysis By: Vi Shaffer

Definition: 3D bioprinting systems produce living tissue "products" functioning like human organs. Components include imaging data, design software and 3D printing devices. The two main opportunities for these systems are clinical research/testing for life sciences and fully functioning kidneys, livers or other organs for transplant. The Adoption position is based on the latter; progress on the life science front is a contributing factor. This definition or profile does not include 3D bioprinting knee/hip implants, prosthetics or similar devices.

Position and Adoption Speed Justification: 3D bioprinting for personalized human organ transplants is one of those ultimate transformative visions for healthcare's digital business era, one with very complex scientific, technical, regulatory and adoption challenges to overcome — and very profound potential business and personal health impacts when all these are conquered. We track

this category based on progress toward production of transplantable kidneys, which account for about 80% of transplant needs, with high fatality rates for waiting patients.

Following a 2014 breakthrough in blood vessel printing at Harvard, recent progress has been smaller — liver and kidney mimicking tissues for life science use. This provides the still small revenue for startups like Organovo, which also announced an intriguing skin tissue partnership with beauty industry giant L'Oreal USA. Harvard's Lewis Lab has reported progress in microscale 3D printing of rudimentary blood vessels and envisions a similar approach to produce the blood-filtering tubes inside kidneys. Therefore, we don't move this one ahead and keep it at the very far end of five to 10 years. However, Russian scientists announced a thyroid gland for a mouse in March 2015, and they project a kidney in 2018 (see the Recommended Reading section).

The viability, availability and adoption rates of actual organ products are still highly speculative.

User Advice: CIOs supporting life science companies and academic medical centers that lead in these investigations will be participating in, or closely following, approaches to tissue engineering. Although this area falls more into the realm of major emerging life science technologies than "classic" healthcare IT, as both testing R&D uses and ultimately organ manufacturing businesses emerge, CIOs should be on the lookout for new data exchanges, applications, and storage and device support requirements.

Healthcare provider CIOs, CMIOs, and other IT and medical personnel should use 3D bioprinting and other technologies for precision medicine and "rebuilding the body" to model a new construct for the scope of IT services. As IT gets ever closer, not only to supporting medical tasks, workflows and clinical decision making, but also to the delivery of medical procedures, CIOs must have clinical engineering/biomedical device management department leaders. While early instantiations of 3D bioprinting organ transplants are likely to be delivered by remote "manufacturing" services, even this scenario involves exchanges of design parameters (patient and imaging data transmitted in a different context), unique tracking in the supply chain and transplanted custom organ data of a different nature stored in the EHR.

Business Impact: 3D bioprinting is one approach to realizing a difficult dream for tissue engineers — to fulfill engineering designs and market demand for tissues, functioning human organs arteries and the like. This is one of the most dramatic examples of the potential breakthroughs that the future fusion of medicine, engineering and IT may hold. The impact of successful commercialization on the business of healthcare — and on its definition of services offered — will be profound, creating an unprecedented demand for new, custom production services of replacement organs. It would create a new "organ manufacturing" industry, change the business fundamentals of currently lucrative transplant centers, and offer an intriguing service line for medical tourism centers. Moreover, it would create new dilemmas with regard to cost-benefit analysis and medically necessary approvals for public and private payers and policymakers.

Benefit Rating: Transformational

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Sample Vendors: 3D Bioprinting Solutions; Cornell Creative Machines Lab; EOS; Organovo; Regenovo; TeVido BioDevices; The University of Iowa; Wake Forest Institute for Regenerative Medicine

Recommended Reading:

"Cool Vendors in 3D Printing, 2015"

"New Industries 2030: FabMat in Developing Countries"

"Predicts 2014: 3D Printing at the Inflection Point"

"Technology Overview for Material Extrusion 3D Printing"

D. Kolesky, R. Truby, A. S. Gladman, T. Busbee, K. Homan and J. Lewis, "3D Bioprinting of Vascularized, Heterogeneous Cell-Laden Tissue Constructs," Advanced Materials, 2013.

M. Moody, "3D Bioprinted Thyroid Gland by 2015, Kidney by 2018, Say Russian Scientists," 3DPrint.com, 9 November 2014.

Smart Robots

Analysis By: Kenneth F. Brant

Definition: Smart robots are smart machines with an electromechanical form factor that can work autonomously in the physical world while learning from their experiences. Smart robots sense conditions in their local environments, recognize and solve basic problems, and learn how to improve. Some have a specialized functional form, such as warehouse robots, while others have more general functional forms and/or humanoid appearances. Because of their sensory capabilities, smart robots may work alongside humans.

Position and Adoption Speed Justification: Industrial robots are certainly more advanced than smart robots in their life cycles. Smart robots have had significantly less adoption to date, which is why smart robots are positioned climbing the Peak of Inflated Expectations. Hype and expectations will continue to build around smart robots over the next few years as providers execute on their plans to expand their offerings and deliver solutions across the wider spectrum of industry-specific use cases and enterprise sizes. Hype is quickly building for smart robots as a result of several key vendors' actions:

- Amazon's acquisition of Kiva Systems and subsequent plans to deploy 10,000 Kiva robots to fill customer orders
- Google's acquisition of Boston Dynamics and seven other robotics technology companies
- Rethink Robotics' launch of Baxter and Sawyer, which can work alongside human employees
- The transfer of military and industrial technology to companies like iRobot for development of smart robots

User Advice: Users in light manufacturing, distribution, retail and healthcare facilities should consider smart robots as both substitutes and complements to their human workforce. Begin pilots designed to assess product capability and quantify benefits. Examine current business and material-handling processes into which smart robots can be deployed; also, consider redesigning business and material handling to take advantage of the benefits of smart robots with a three- to five-year roadmaps for large-scale deployment.

Business Impact: Smart robots will make their initial business impact across a wide spectrum of product- and service-centric industries. Their ability to do physical work, with greater reliability, lower costs, increased safety and higher productivity, is common across these industries. The ability for organizations to assist, replace or redeploy their human workers in more value-adding activities creates potentially high — and occasionally transformational — business benefits. Typical and potential use cases include medical materials handling, hazardous waste materials disposal, prescription filling and delivery, patient care, direct materials handling, stock replenishment, product assembly, finished goods movements, product pick and pack, e-commerce order fulfillment, package delivery, shopping assistance and customer care, and disposal of hazardous materials.

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Aethon; Amazon (Kiva); Google; Honda; iRobot; Intelligent Hospital Systems; InTouch Health; Panasonic; Rethink Robotics; Swisslog; Symbotic; VGo Communications

Affective Computing

Analysis By: Jan-Martin Lowendahl

Definition: Affective computing technologies sense the emotional state of a user (via sensors, microphone, cameras and/or software logic) and respond by performing specific, predefined product/service features, such as changing a quiz or recommending a set of videos to fit the mood of the learner.

Position and Adoption Speed Justification: True affective computing technology, with multiple sensor input, is still mainly at the proof-of-concept stage in education, but it is gaining more interest as online learning expands and seeks means to scale with retained or increased quality. A major hindrance in its uptake is the lack of consumerization of the needed hardware and software involved. It has to be inexpensively available for students because they use their personal devices before education institutions can deploy affective computing software. Products such as Affectiva's Affdex or ThirdSight's EmoVision are promising because they enable relatively low-cost, packaged access to affective computing functionality. These are mostly aimed at testing media/advertising impact on consumers, but experiments are underway to guide, for example, real-time film plot adaption, something very close to adaptive learning.

The leading research lab in this field, MIT's Affective Computing Group, has many projects and is working on sensors, such as wristband electrodermal activity sensors connected by Bluetooth to a

smartphone, and software, such as the MIT Mood Meter, which assess the mood on campus based on frequency of smiles as captured by ordinary webcams. A breakthrough in a more consumer-oriented area such as gaming will allow affective computing to be applied at a larger scale. If facial recognition services for identification and proctoring in online learning, from companies such as Smowl and KeyLemon, sold affective computing as an add-on, it would make the capability more accessible. Another interesting and more specialized branch of affective computing involves robots such as the Emote project.

Successful affective computing will most likely involve a complex architecture in order to combine sensor input and provide an accurate response in real time. Mobile learning via cloud services and smartphones/tablets will play a key role in the first few generations, (due to high-capacity computing combined with a discrete device with many sensors). As content (for example, textbooks) becomes more digitized and is consumed on devices that have several additional sensors (for example, tablets with cameras and accelerometers), interesting opportunities will arise to mash up the capabilities of, for example, an open adaptive learning platform such as Cerego or CogBooks and ThirdSight's EmoVision, making affective computing for untutored learning more accessible. This will increase the number of data points available for statistically based adaptive learning.

Altogether, the complexity of affective computing merits a position that is still in the trigger phase, with at least 10 years until it reaches the Plateau of Productivity.

User Advice: Most institutions should only continue to follow the research and development of affective computing in education and other industries. However, in order to be prepared for the strategic tipping point of implementation, institutions should start estimating the potential impact in terms of possible pedagogical gains and financial impact, such as increased retention for online learning. Institutions with a large online presence, or that want to exploit the hype for brand recognition, should get involved now. Partner with automotive suppliers, consumer electronics companies and universities (particularly online) to further explore this field.

Affective computing can involve collecting sensitive data about students, which makes it important to make sure that any privacy laws and concerns of the users are met (such as policy about if, when and how data is stored). Preferably, any use of affective computing should involve an "opt-in" process.

Business Impact: One important advantage of this technology is that, even if it is inferior to a face-to-face student-teacher interaction, it scales well beyond the 100-plus-student lectures that today offer limited individual pedagogical adaptivity. A potential complement or competition to remedy the scalability problem is the social-media-based peer-mentoring approach, as exemplified by Livemocha and, more lately, by massive open online courses (MOOCs).

In general, affective computing is part of a larger set of approaches to further personalize the educational experience online. Another example is adaptive learning that depends on the statistical data of learners in the same pedagogical situation. It is also related to context-aware computing in general.

The ultimate aim of affective computing in education is to personalize and enhance the learning experience of the student, which should result in tangible results like higher grades, faster throughput and higher retention. These results will benefit students, institutions and society.

Benefit Rating: Moderate

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Sample Vendors: Affectiva; Affective Media; IBM; Pearson Education; ThirdSight

Recommended Reading:

"Business Model Innovation Examples in Education"

Connected Home

Analysis By: Fernando Elizalde

Definition: A connected home is networked to enable the interconnection and interoperability of multiple devices, services and apps, ranging from communications and entertainment to healthcare, security and home automation. These services and apps are delivered over multiple interlinked and integrated devices, sensors, tools and platforms. Connected, real-time, smart and contextual experiences are provided for the household inhabitants, and individuals are enabled to control and monitor the home remotely as well as within it.

Position and Adoption Speed Justification: The connected home is a concept that overarches several technologies, devices, applications, services and industries. As such, it is defined in this technology profile to provide a framework for the Hype Cycle of the same name.

The concept has evolved from home automation and energy management solutions to a much more complex concept that incorporates the idea of the "smart home" expanding, without being exhaustive, to:

- Media entertainment
- Home security
- Monitoring and automation
- Health and fitness
- Education
- Energy management products and services

The connected home exists today mostly as silos of services and products and underlying enabling technologies that sometimes compete with each other. Yet the interconnection of home electronics and devices has been simplified enormously in the past few years, with content and information

being distributed throughout the home via a variety of devices. Solutions have also become less expensive largely because of:

- The maturity of access technologies (such as broadband, Wi-Fi and 4G)
- The development and standardization of radio technologies, including low-energy networking standards (such as Bluetooth LE, ZigBee and Z-Wave), allowing for low-cost wireless connectivity in any device in the home
- The simplification of user interfaces

The connected home will evolve into the rendering of increasingly intelligent systems which, by using smart learning algorithms and predictive analytics, will develop into smart home experiences. This is resulting in a rapid progress in the Hype Cycle toward the Peak of Inflated Expectations.

User Advice: The last 12 months have seen fast development in the connected-home space, with Google's Nest, Samsung and ARM, among others, forming the Thread Group with the task of building a mesh networking protocol. The AllSeen Alliance, based on Qualcomm's open-source AllJoyn protocol, and the Open Interconnect Consortium, behind which are Intel and Broadcom, were also launched during the past 12 months. Also, Apple announced its connected-home software framework, HomeKit, which has not been released for consumers yet. In view of these developments:

- Develop partnership strategies to build your existing expertise in devices, services and customer relationships. Provide a unified user experience and compelling integrated connected-home solutions.
- Partner with software providers for a unified platform. Base your solutions on standardized protocols and home gateways to speed up market adoption.
- Offer ease of use and reasonable hardware costs, differentiating the quality of experience on the services you have on offer by providing efficient support.
- Provide real value and disruptive solutions to the consumer, rather than a novelty or just aesthetics.

Business Impact: Connected-home solutions affect a wide spectrum of manufacturers (white goods, entertainment electronics, home automation, security, and fitness and health products), as well as network infrastructure and service providers, ranging from energy utilities and surveillance to healthcare providers, communications and digital entertainment services.

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Adolescent

Sample Vendors: ADT; Apple; Arris; AT&T; Deutsche Telekom; Google; Icontrol Networks; Inc.; Insteon; Samsung Electronics; Technicolor

Recommended Reading:

"Market Trends: An Integrated Approach Will Pay Dividends in the Connected Home"

"Market Trends: New Money-Making Apps and Services for the Connected Home"

"Market Trends: CSPs Invite Themselves Into the Connected Home"

IoT Platform

Analysis By: Alfonso Velosa; Yefim V. Natis

Definition: An Internet of Things (IoT) platform is a software suite or cloud service (IoT PaaS) that facilitates operations involving IoT endpoints (sensors, devices, multidevice systems and fleets), cloud and enterprise resources. The platform monitors IoT event streams, enables specialized analysis and application development, engages back-end IT systems, and may help control the endpoints to support IoT solutions. The IoT platform responsibilities may be distributed and fulfilled in part near the devices or in a public or private cloud.

Position and Adoption Speed Justification: Enterprises continue to engage with the increasing variety of IoT endpoints, seeking traditional benefits like asset optimization, while discovering new business opportunities and revenue models. The sophistication, scale and business value of these interactions call for increasingly advanced technology resources. The Web-scale IoT platform capabilities can enable basic and advanced IoT solutions and digital business operations. The IoT platform may manifest as a single cloud service or be distributed between the endpoints, public cloud and enterprise private IT.

An increasing imperative of excellence in digital business scenarios amplifies the hype around the future of IoT and propels vendor and user investments in IoT platforms and services. The continued rapid increase of popularity of these technologies will push IoT platforms up to the Peak of Inflated Expectations, before the buildup of practical experience brings them to mainstream productivity and maturity.

User Advice: **CIOs, IT planners and architects:**

- Establish a task force or center of excellence (COE) composed of IT and business unit personnel to manage the objectives, planning, design, deployment and monitoring of IoT initiatives that IoT platforms enable. This COE can coordinate strategic planning, tactical vendor negotiations, resource sharing and impact assessment across your organization.
- To measure the success of IoT initiatives, work with business units to establish measurable objectives: cost reductions, process improvements, new revenue opportunities or improved customer satisfaction.
- IoT projects are likely new to your organization, and substantial training may be required. Start with smaller initiatives to allow for the learning period.
- Look for IoT platform offerings (software and/or services) that incorporate some support of:

  - Device and its application software management
  - Data aggregation, integration, transformation, storage and management
  - Event processing: rule engines/orchestration/BPM
  - Programmability
  - Analysis and visualization
  - Security
  - Multiprotocol communications
  - Endpoint and IT application adapters
  - Self-service user interface
- Understand that an IoT platform is a starting point. Few IoT platforms will match your project requirements. Customize the platform to target the unique circumstances of your project. Dedicate resources or budget for a service partner to audit your environment, design your architecture and implement your system to produce an IoT business solution.
- Evaluate candidate IoT platforms on power, productivity and fit to your design, skills and objectives based on the available capabilities before considering future vendor plans (in the fast-changing IoT market, roadmaps change). Plan to minimize vendor lock-in.

Business Impact: There is a significant business opportunity to achieve greater value and make better decisions from the insights, information and data that are generated by instrumented devices and to provide better control of things distributed across the enterprise, its external business partners and customers. Unfortunately, this data has been largely locked into the devices — due mostly to lack of connectivity, but also lack of standards, systems and processes to obtain this data systematically; in some cases, it has even been due to ignorance.

IoT platforms act as the intermediary between the "thing" and the IT world and therefore facilitate the introduction of a new, potentially transformative wave of innovation to enterprises and consumer businesses in the pursuit of digital business, smart business decisions and intelligent business operations. Most enterprises will need to experiment to determine their optimal IoT architectures, cultural fit and business models.

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: ARM; Bosch Software Innovations; Eurotech; GE; ioBridge; IBM; Microsoft; PTC; Solair

Recommended Reading:

"Build Your Blueprint for the Internet of Things, Based on Five Architecture Styles"

"Best Practices in Exploring and Understanding the Full Scope of IoT Solutions"

Biochips

Analysis By: Jim Tully

Definition: Biochips relate to a number of technologies that combine semiconductor and biological sciences. The most common form is based on an array of molecular sensors on the chip surface — typically referred to as "lab-on-chip." The underlying mechanism utilizes microfluidic micro-electromechanical systems (MEMS) technology. Biochips are used to analyze biological elements such as DNA, ribonucleic acid and proteins, in addition to certain chemicals.

Position and Adoption Speed Justification: In biological applications, the biochip technology has not been taken to a level where biochips can be administered by nonspecialists. For significant market growth to occur, the use of biochip technology will need to move from specialist laboratories into doctors' surgeries and, later, into the consumer market. It will take at least five years for biochips to enter doctors' surgeries, while consumer biochips for self-diagnosis are probably five to 10 years away. The potential demand could be huge — provided the costs are sufficiently low. The need to demonstrate consistent accuracy outside of R&D laboratories is a challenge for biochip vendors. In some markets, U.S. Food and Drug Administration approval is needed, and it delays the time to market considerably for this use of the technology.

Interest in the use of biochips for chemical compound detection is growing because of the need for explosive sensing in relation to terrorism.

User Advice: Clients should observe the various uses of lab-on-chip devices as they emerge. These will give ideas for possible additional use cases:

- **Medical applications for clinical purposes.** An area of focus for specific devices is a biochip to detect flu viruses. H5N1 (bird flu) and H1N1 (swine flu) versions have been produced. Urinalysis is another application for detection of urinary tract infection and kidney function. One of the benefits of this technology is faster analysis than traditional techniques, because multiple tests can be carried out in parallel. Insulin and glucose detection has also been demonstrated in laboratory conditions.
- **Detection of food pathogens.** This involves the analysis of bacterial contaminants in food and water. STMicroelectronics and Veredus Laboratories have developed a device that can detect E. coli, salmonella, listeria and other pathogens. The device can detect more than 10 such pathogens simultaneously.
- **Chemical and biohazard analysis.** Further extensions of the technology are aimed at chemical analysis, particularly for detecting explosives and biohazards.

Mobile device manufacturers have experimented with the addition of biochips onto cases of mobile phones. This could facilitate health screening services offered by mobile operators or their partners.

Biometric sensing, including DNA fingerprinting development, also represent significant opportunities.

Business Impact:

- CIOs in health provider organizations should recognize that the amount of data produced from large-scale use of biochips would be very considerable. The devices are likely to become connected and, therefore, be part of the Internet of Things. Secure transmission and storage of data will be essential.
- Biochips are likely to be viable sooner than you realize, and specific areas of relevance include medical diagnosis, pollution monitoring, biological research, food safety, airport security and military uses (biological warfare).
- Biochips represent an emerging market for vendors that have MEMS/microfluidic capabilities. Packaging vendors in particular should take a note of this technology.
- Other businesses will also be affected — most notably mobile device manufacturers and mobile operators, physical security screening organizations, and semiconductor vendors.

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Sample Vendors: Affymetrix; Agilent Technologies; Imec; Owlstone; STMicroelectronics

Recommended Reading:

"Silicon Technology and Biotechnology Paths Converge"

Citizen Data Science

Analysis By: Rita L. Sallam; W. Roy Schulte; Alexander Linden

Definition: Citizen data science is a branch of data science that allows users to extract advanced insights from data while not requiring the users to be highly skilled. Central to citizen data science are rapidly progressing tools that streamline data preparation, provide strong user guidance around the different data science operations (correlations, clustering, predictions) and often automate various modeling and pattern-detection steps on the user's behalf.

Position and Adoption Speed Justification: Current data discovery approaches enable business users to do manual data preparation, data exploration and some pattern detection, but building advanced analytics models has required data scientists who are expensive and in short supply. For every new data scientist hired, companies can enable five knowledge workers to implement their own self-service citizen data science by using modern analytic tools. This also reduces the exploratory phase for highly skilled data scientists, making them more productive and impactful on the organization, even as their numbers grow through new university data science programs and

on-the-job training. Gartner predicts that, through 2017, the number of citizen data scientists will grow five times faster than the number of data scientists.

User Advice: For analytics leaders:

- Implement a program (technology, process and skills) for developing citizen data scientists, if there is a need to deliver more advanced insights to a broader range of users without expanding the use of highly skilled data scientists.
- Monitor the capabilities (technology) and roadmaps of your business intelligence, data discovery and data science platforms, as well as the emerging startups as they mature in terms of the data preparation required, types of data that can be analyzed, and the types of predictive analytics algorithms supported.
- Look for opportunities for citizen data science to complement existing user-oriented data discovery and professional data science initiatives.
- Assess your organization's readiness (process and skills) for business-user-accessible advanced analytics in terms of alignment with business outcomes and skills.
- Educate business leaders and decision makers about the potential impact of a broader range of users leveraging advanced analytics, but stress the need for responsible use and governance to avoid negative consequences.
- Identify automating algorithms to detect patterns in data can be used to reduce the exploration phase of analysis.
- Improve highly skilled data science productivity, but recognize that you still need to validate the model, findings and application.

Business Impact: Citizen data science forms the foundation of the next-generation data discovery user experience. It will make insights from advanced analytics more accessible and pervasive in the enterprise, creating new business value and improving competitiveness. It will be a key driver of analytics adoption during this decade and will relieve some pressure on the demand for data scientists. Citizen data science will be to data science and data discovery what an automatic transmission is to a car, or what a GPS device is to celestial navigation in a ship or airplane.

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: BeyondCore; ColdLight; DataRPM; IBM Watson Analytics; SAP; SAS

Recommended Reading:

"Predicts 2015: A Step Change in the Industrialization of Advanced Analytics"

Neurobusiness

Analysis By: Jackie Fenn

Definition: Neurobusiness is the capability of applying insights from neuroscience, behavioral science and psychology to improve business outcomes.

Position and Adoption Speed Justification: "Neurobusiness" is a relatively new term referring to the use of psychology and other social sciences to deliver actionable business insight. Popularized over the past few years by a flood of behavioral science books (see Recommended Reading section for this technology profile), the sometimes counterintuitive findings from decades of psychological research are being applied to a range of business challenges and opportunities. Neuroscience, in particular, offers a growing ability to monitor, understand and affect the physical mechanisms of the brain, which in turn promises precision in influencing attitudes, actions and behavior. Further insights will be gained from advances in emotion detection technologies (e.g., recognition of facial microexpressions and brain-scanning techniques, such as functional magnetic resonance imaging [fMRI], which detects patterns of neural activity based on blood flow in various regions of the brain).

Interest in neurobusiness is growing and we have moved the adoption rate from less than 1% of target audience to 1% to 5% of target audience. However, the technological advances are likely to come before a clear understanding of how to apply the findings in effective and ethical ways. We expect at least a decade's worth of active experimentation before neurobusiness achieves its full potential, providing an opportunity for organizations that embrace the approaches aggressively, yet thoughtfully.

User Advice: Consumer-facing organizations should examine the potential for applying neurobusiness insights in their marketing organizations (i.e., neuromarketing) by developing in-house expertise or hiring one of the growing number of boutique companies that conducts custom studies using targeted equipment such as fMRI machines. Evaluation should include an assessment of potential privacy and legal issues.

Organizations with high-demand, high-stress or high-achievement workforces should hire experts in behavioral science or anthropology to apply insights from human cognitive processing in designing improved processes, collaboration or work environments.

Leaders, managers and HR professionals should study and incorporate "brain-aware" principles from neurobusiness into meetings, management training and leadership communications to improve employee engagement, innovation and behavior change.

Business Impact: Neurobusiness has the potential to deliver a broad impact across industries and across many areas of organizational activity. Specific areas of focus will be:

- **Marketing.** Because marketing is all about engagement and influence, marketing professionals have long been early adopters of psychology and behavioral science. They have also been the first to adopt neuroscience lessons in a formal way in neurometric research, which aims to understand customers' brain responses to marketing stimuli.

- **Customer Experience.** Organizations with customer-facing opportunities are continually trying to increase the number of "moments of delight " and the psychological addiction to a product or service. Engagement techniques such as gamification and emotional design are increasingly being applied to the customer experience, and the next frontier will be more direct and precise application of the neuroscience of engagement.
- **Employee Performance and Decision Support.** A productive area for neurobusiness is enhancing employee creativity, productivity and decision making — for example, by addressing challenges such as unconscious decision biases or adopting practices such as mindfulness training. The insights can be effectively delivered as training and coaching, or embedded into software and website design. This will drive top executive and top professional personal and team performance improvement.
- **Human Capital Management.** Many human resources professionals in large organizations are already deeply involved in tracking and applying social, behavioral and organizational psychology and change management, and they are adding neuroscience to the list of relevant research disciplines that inform their programs. Targets for behavioral change might include innovation, creativity, ethical awareness and productivity.

In the long term, neurobusiness will emerge as a high-impact business discipline across industries (thus the Benefit Rating of High), although the benefits will be focused on significantly improving the effectiveness of current activities, rather than creating whole new approaches.

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Recommended Reading:

"Innovation Insight: Neurobusiness Validates Behavioral Sciences as a Transformational Business Discipline"

"Maverick* Research: Living and Leading in the Brain-Aware Enterprise"

"Maverick* Research: Myths and Realities in the Brain-Aware Enterprise"

"Maverick* Research: Socially Centered Leadership"

D. Rock, "Your Brain at Work: Strategies for Overcoming Distraction, Regaining Focus, and Working Smarter All Day Long," HarperCollins, 2009.

D. Kahneman, "Thinking, Fast and Slow," Farrar, Straus and Giroux, 2012.

D. Ariely, "Predictably Irrational: The Hidden Forces That Shape Our Decisions," HarperCollins, 2010.

Software-Defined Security

Analysis By: Neil MacDonald

Definition: Software-defined security (SDSec) is an umbrella term covering a number of security technologies that benefit when the security policy management is abstracted from the underlying security policy enforcement points.

Position and Adoption Speed Justification: Information security infrastructure is too rigid and static to support the rapidly changing needs of digital business and to provide effective protection in a rapidly changing threat environment. Increasingly, security vendors are shifting more of the policy management out of individual hardware elements and into a software-based management plane for flexibility in specifying security policy, regardless of location. There are several areas within SDSec that are emerging — software-defined perimeters, software-defined segmentation, and software-defined data protection.

User Advice:

- Look beyond the hype. There are several areas where organizations are finding value in SDSec use cases today.
- Don't make the mistake of assuming "software defined" means software only. Security hardware will still be needed for deep inspection at demarcation points.
- Require all security platform vendors to open up via APIs for full programmability of their infrastructure
- Pressure security platform vendors for their roadmaps to support OpenStack and other cloud management platforms.

Business Impact: Information security cannot be an inhibitor to the needs of digital business. SDSec will bring speed and agility to the enforcement of security policy, regardless of the location of the user, the information or the workload.

Benefit Rating: Transformational

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Sample Vendors: CloudPassage; Illumio; Trend Micro; vArmour; Vidder

Recommended Reading:

"What Is the Value of a Software-Defined Data Center?"

At the Peak

Digital Dexterity

Analysis By: Nick Ingelbrecht; Don Scheibenreif; Mike Gotta

Definition: Digital dexterity is the cognitive ability and social practice needed to leverage and employ various types of media, information and technology for advantage, in unique and highly innovative ways that optimizes personal and business value.

Position and Adoption Speed Justification: Digital dexterity is climbing the peak of the Hype Cycle in recognition of the fact that digital business strategies demand a critical "people" component, but in many cases, organizations have yet to work out exactly what is needed and how to permeate it across the organization.

Digital dexterity is the blending of media, information and technology literacies into an applied expertise and social practice.

Most employers have recognized the requirement for technology literacy, but rarely mandate competency beyond the IT organization. Digital dexterity involves agility and ease, curiosity, critical thinking and interest in accommodating new and intersecting flows of information, media and technology to solve problems and uncover opportunities. Digital dexterity will move rapidly through the hype when a critical mass of organizations implements digital business strategies that recognize people — as well as technology — are equal partners in the digital workplace. Digital dexterity is an ability that needs to be nurtured throughout the entire organization. Building digital dexterity across large organizations will take years in many cases; whereas smaller, more agile organizations will be able to hire, fire, nurture and incentivize the digital dexterity talent they need to compete.

User Advice:

- Digital workplace leaders should work with human resources and line-of-business leaders to project digital dexterity workforce requirements and implement a strategy for attracting, developing and retaining the optimum mix of staff with such talent.
- Backfill gaps in digital dexterity via a talent search across the organization, through worker realignment, through purposeful recruitment processes as well as exploiting outsourced talent.
- Provide assessment, training and outplacement to build digital dexterity and an "outside-in" mindset.
- Understand and evangelize digital dexterity across the organization as a critical enabler for the digital workplace and the digital business.

Use a maturity model approach to map out the level of digital dexterity that exists in the organization today, what the future requirements are in relation to the digital business strategy. Map out how to meet the required levels of digital dexterity and the likely recruitment/sourcing approaches.

Digital dexterity is one of a set of core competencies required to sustain the digital workplace. Today, the digital workplace is characterized by a shift away from repetitive process jobs to nonroutine work, requiring agility, problem-solving skills that can cope with high levels of ambiguity and constant change as well as creative thinking. In many organizations, digital dexterity is an under-recognized capability, yet it is one of the most critical components of digital business success. Digital workplace leaders should place special emphasis on talent in the areas of social, mobile and analytics, supported by HR policies that encourage skills acquisition through individual plans, performance reviews, job descriptions and recruiting practices.

Digital dexterity can be a learned ability that improves with training, mentoring, application and practice and will become an essential cross-organizational skill.

Business Impact: Digital dexterity is a transformational capability that is applicable across the entire organization and across different industries. It defines the critical "people" component that enables digital businesses to thrive. Organizations need to develop a business and cultural environment that enables them to operationalize employees' digital dexterity and apply it in novel and intelligent ways.

By 2020, 75% of businesses will become — or prepare to become — digital businesses. To achieve this, they will need to build digital dexterity into the workplace and make full and effective use of media and information to mobilize and deliver results in both the physical and virtual environment. As such, digital dexterity is a superset of other literacies — the core are media, information, technology — but other literacies inform it (critical thinking, reading, writing, among others). Digital dexterity enables people to forge effective personal and working relationships with others across physical and virtual environments — enabling digital workers to leverage media, information and technology to effectively make decisions, build community, solve problems and so forth.

Digital dexterity will revolutionize the way work is done by virtue of the shift to agile working practices, the offloading of processes and repetitive tasks to smart machines, flatter management hierarchies and highly collaborative work styles.

Most organizations have historically managed with a highly static view of their staff capabilities. While most enterprises spend funds to train employees on improving their capabilities within the context of their assigned tasks, few prepare employees to navigate the technology, business and media landscape and examine these in light of their impact on change within the organization. Furthermore, employees must not only be trained to take advantage of technologies, but must also learn how to implement process changes using such technologies within the workplace. Fewer than 10% of organizations have an adequate level of digital dexterity to run their operations competitively today. The imperative for organizations to embrace digital dexterity does not entail the end of the professions, but rather seeks to leverage and nurture the technical skills of successful professionals to take them and their organization to the next level of performance.

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Recommended Reading:

"Using a Competency-Based Assessment and Interview Approach to Ensure Talent Fit for Bimodal IT"

"Creating Your Digital Edge Through a Competency-Based Talent System"

"Maverick* Research: Profit From Society's Digital Evolution or Be Dominated by It"

"Top 10 Strategic Predictions for 2015 and Beyond: Digital Business Is Driving 'Big Change'"

H. Jenkins, "Confronting the Challenges of Participatory Culture: Media Education for the 21st Century," The MIT Press, 2009

Micro Data Centers

Analysis By: Jay E. Pultz; David J. Cappuccio

Definition: A micro data center is modular or containerized and is smaller than a computer room — usually no more than a rack of equipment or two — and typically one rack or less. All required IT functionality (such as uninterruptible power supply systems for servers and facilities) is contained in the micro data center, designed to handle specific needs (accumulating sensor data or small remote office support, for example) at distributed locations and typically managed from a large data center.

Position and Adoption Speed Justification: For more than 20 years, small computer rooms (as small as a closet) have been subsumed into larger, consolidated data centers — a trend we see continuing unabated. Yet not all IT capabilities need to be (or should be) local to business or for factors such as latency or site-specific operations. Additionally, with the distributed nature of the Internet of Things (IoT), there will be a need to accumulate and process data locally before it is sent to a larger data center for additional analysis.

Micro data centers are typically based on more mature IT and facilities technology — although new features, including integration, packaging, containerization and remote management have been added. Trends such as the distributed nature of the IoT means that micro data centers will be much more widely deployed than they are now. They can be located virtually anywhere, including as stand-alone centers in appropriate containers (for environmental protection), typically found in branch offices. Micro data centers use any available means for communication, but are typically connected into an office LAN/WAN.

User Advice:

- Design micro data centers to run autonomously, but controlled centrally.
- Create a standard, self-contained solution designed for easy deployment, simple replacement and remote monitoring and management.
- Focus on maximizing operational independence, while minimizing IT skills and risks at remote sites.

Business Impact: This functional capability widely exists (such as retail sites and bank branches), but micro data centers differ through their standardization, integration, remote management and enhanced security. These solutions promise significantly lower costs and enhanced manageability. We view micro data centers as transformative to supporting digital business development, with a particular focus on the IoT and expect them to be deployed in their thousands (and possibly tens of thousands) across most enterprise verticals.

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: AST Modular; Elliptical Mobile Solutions; Huawei Technologies; Panduit; Rittal; Schneider Electric; Zellabox

Recommended Reading:

"Apply a Self-Contained Solution to Micro Data Centers"

Smart Advisors

Analysis By: Kenneth F. Brant

Definition: Smart advisors are a class of smart machines that advise users about the state of operations, make recommendations on best decisions to take, or give the best answers to their questions. Natural-language processing is typically necessary for advisors' to interact with humans. Highly specialized, deep content curation and ingestion (including real-time accessions), along with rigorous training, are necessary for smart advisors to excel at their jobs. Smart advisors also improve with experience by employing machine learning.

Position and Adoption Speed Justification: Hype is high — above what we would normally expect on the basis of user adoption of smart advisors to date — mainly due to IBM's highly publicized success with Watson in popular culture. IBM has since made clear its aggressive commercial intentions for smart advisors with its landmark investment in IBM Watson Business Solutions, including licensing and investment ventures designed to rapidly accelerate and widen smart advisor development. Its acquisition of AlchemyAPI in 2015 also gives IBM greater access to developers to execute on this strategy. Focused providers, like IPsoft and Saffron, and IT services leaders, such as Accenture, Deloitte and Wipro, that can rapidly expand the channel to enterprise users were all active on the supply side of the market in the past 12 months, contributing to the hype of smart advisors. IPsoft's launch of Amelia in September 2014 and Saffron's launch of SaffronStreamline in March 2015 are positive signs that the supply-side market for smart advisors is developing alternative approaches and wider customer choices across industry segments. The speed to maturity, however, reflects how difficult we believe it will be — overcoming technological, commercial and cultural challenges — to make smart advisors robust to a broad segment of users.

User Advice: Enterprises in healthcare, life sciences, financial services, retail, and manufacturing and natural resources — where relatively high labor costs intersect with needs for big data exploration and highly individualized user advice — should develop a multiyear strategic plan (with proposed business cases, feasibility studies and vendor evaluations) for smart advisors by the end of 2015.

Strategic business unit and/or line-of-business leaders need to champion these early programs and incubate an exploratory and learning mentality.

Recognize this is a major shift in the way you will do business, and commit adequate time and resources to the long-term development of smart advisors — do not expect quick success and returns. Invest in developing informatics talent for these pilots.

Pilot several smart advisors and assess the best fit against your use cases, including ease and cost to maintain over the long term. Consider both operational improvement and big data exploration benefits; pilots should assess smart advisors' ability to reduce costs and improve service levels and also determine their ability to discover new commercial avenues in big data. Make sure to assess employee and customer acceptance and use findings to justify and prepare for the change management programs that will be necessary in deploying smart machines at scale.

Business Impact: The potential business impact of smart advisors is great. They offer the biggest business impacts in industries where the presence of big, dynamic and largely unstructured data is compounded by the need for highly individualized business decisions and customer recommendations.

Smart advisors promise:

- Faster R&D breakthroughs and time to market.
- Greater returns on promotional spending decisions.
- Lower costs of complex customer service.
- Greater availability and reliability of complex customer service.
- Differentiation of complex customer service and brand enhancement.

The cost and complexity of developing smart advisors put them out of the direct reach of the large majority of consumers for the near future. We expect consumer usage will be accessed via enterprises that have deployed smart advisors and made them available to their customers as a premium service through at least 2017.

Benefit Rating: Transformational

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Sample Vendors: Digital Reasoning; IBM Watson Group; IPsoft; Saffron

Advanced Analytics With Self-Service Delivery

Analysis By: Robert Hetu

Definition: Advanced analytics, including techniques such as predictive analytics, interactive data visualization, pattern matching, machine learning and optimization, and automated decision support, is provided to business users through self-service interfaces.

Position and Adoption Speed Justification: Advanced analytics capabilities will drive human and machine decision making, helping the retailer compete in the digitalized marketplace. Incorporation of self-service and big data discovery capabilities will improve the real-time business decision-making process. Retailers that don't have advanced analytics capabilities in their technology toolkit could be toppled by an inability to capitalize on revenue opportunities presented by the Internet of Things. Acknowledging the broader impact of advanced analytics, we have enveloped data visualization in merchandizing into this technology profile. This action combined with the fact that many technology providers have approached this subject with a specific focus on retail drove this technology profile to appear at the peak. The speed of development for advanced analytics combined with the implications of digital business will cause this technology profile to progress relatively quickly.

User Advice: Acquire new tools that are much easier for business users than traditional business intelligence applications. Deliver advanced analytics in-process via inclusion in applications or through self-service. View this as a required preparation for the explosion of data from digitalization and the Internet of Things, where technology will be required to support human decision making.

To ensure success, enlist help from business unit heads to build a strong business case for investment, by looking for opportunities across multiple disciplines to drive true customer centricity. Invest in advanced analytics providers that specialize in retail, with awareness that some of the most innovative solutions may come from small vendors. Select a set of tools capable of delivering a diverse set of self-service and big data discovery capabilities and integrate them with the existing BI and analytics platform. Use Gartner's business moments to educate the business community about digital business and the Internet of Things and its anticipated dramatic impact on the retail marketplace.

Business Impact: Retailers use advanced analytics with self-service delivery tools to put information in the hands of business analysts and users to take advantage of significant potential to create business value and competitive advantage. Advanced analytics with self-service delivery will transform the retail organization by providing the ability to analyze big data and take appropriate actions to expand business opportunities. The complexity of the retail organization structure and widely dispersed decision-making responsibility makes retail a prime opportunity to expand the use of advanced analytics in daily decision making. Impacts will include improvement of execution of the retail basics, thereby retaining and growing customer base, revenue and profitability.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Applied Predictive Technologies; Epicor Retail; IBM; Manthan; Oracle; OrderDynamics; Profitect; Retail Insight; SAP; SAS

Recommended Reading:

"Retailers Find Success Using Self-Service and Advanced Analytics"

"Critical Capabilities for Advanced Analytics Platforms"

"Business Moment: Reconstructing the Retail Consumer Experience"

"Digital Businesses Will Compete and Seek Opportunity in the Span of a Moment"

"Seize the Moment: Driving Digital Business Into 2015"

Autonomous Vehicles

Analysis By: Thilo Koslowski

Definition: An autonomous vehicle is one that can drive itself from a starting point to a predetermined destination in "autopilot" mode using various in-vehicle technologies and sensors, such as lasers, radars and cameras, as well as advanced driver assistance systems, software, map data, GPS and wireless data communication.

Position and Adoption Speed Justification: Continued advancements in sensor, positioning, imaging, guidance, artificial intelligence (AI), mapping and communications technologies, combined with advanced software and cloud computing, are gaining in precision to bring the autonomous vehicle closer to reality. However, complexity and cost challenges remain high in 2015, which is impacting reliability and affordability requirements.

During 2014, autonomous vehicles efforts have been prominently featured by mainstream media, which is leading to unrealistic and inflated expectations. Key challenges for the realization of autonomous vehicles continue to be centered on cost reductions for the technology, but they increasingly include legal and ethical considerations, such as liability and driver-related aspects.

The pace of technology innovations and individual country, state and global legislation will likely initially result in specific, limited-use cases for self-driving vehicles in the short term (for example, low-speed city driving/highway driving).

User Advice: The introduction of self-driving vehicles will occur in three major phases: from automated, to autonomous, to driverless vehicles. Each phase will require more-sophisticated and reliable capabilities that rely less on human driving intervention.

Automotive companies, service providers, governments and technology vendors (for example, software, hardware, sensor, map data and network providers): Collaborate on joint research and investments to advance the required technologies and work on legislative frameworks for self-

driving cars. Realize that the main implications of self-driving vehicles will be on economic, business and societal dimensions.

Educate all constituencies of the benefits of self-driving vehicles: Consumer education is critical to ensure that demand meets expectations once autonomous vehicle technology is ready for broad deployment. For example, drivers will need to be educated on how to take over manually in case an autonomous vehicle disengages due to technical error or to changing environmental conditions. Specific focus needs to be applied to the transitional phase of implementing autonomous or partial-autonomous vehicles with an existing older fleet of nonenabled vehicles. This will have implications for driver training, licensing and liability (as in insurance).

Business Impact: Automotive and technology companies will be able to market autonomous vehicles as having innovative driver assistance, safety and convenience features, as well as an option to reduce vehicle fuel consumption and to improve traffic management. The interest of nonautomotive companies highlights the opportunity to turn self-driving cars into mobile-computing platforms that offer an ideal platform for the consumption and creation of digital content, including location-based services and vehicle-centric information and communication technologies.

Autonomous vehicles are also a part of mobility innovations and new transportation services that have the potential to disrupt established business models. For example, autonomous vehicles will eventually lead to new offerings that highlight mobility-on-demand access over vehicle ownership, by having driverless vehicles pick up occupants when needed. Societal benefits from reduced accidents, injuries and fatalities and improved traffic management can be significant, and could even slow down or potentially reverse other macroeconomic trends. For example, if people can be productive while being driven in an autonomous vehicle, living near a city center to be close to work won't be as critical, which could slow down the process of urbanization.

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Embryonic

Sample Vendors: Anki; Bosch; Continental Automotive Systems; Google; Intel; Knightscope; Mobileye; Nokia; Nvidia; Ottomatika; Quanergy Systems; Valeo; ZMP

Recommended Reading:

"Cool Vendors in Automotive and Smart Mobility, 2015"

"Uber Shifts Lanes, Aims to Pass Automakers Through Technology"

"Survey Analysis: Automotive Ethernet's Impact on the Automotive Industry"

"Predicts 2015: Connected-Vehicle and Mobility Innovations Inspire New Digital Business Opportunities"

"Maverick* Research: Crashing Industries and Our Societal Beliefs — The Real Implications of the Autonomous Vehicle"

"Google Moves Autonomous Cars Closer to Reality"

Internet of Things

Analysis By: Jim Tully; Alfonso Velosa

Definition: The Internet of Things (IoT) is the network of dedicated physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment. The IoT comprises an ecosystem that includes things, communication, applications and data analysis.

Position and Adoption Speed Justification: Enterprises vary widely in their IoT technology adoption. At a simple level, adoption can be classified into the following categories:

1. No familiarity or experience of IoT. These are the majority of enterprises.
2. Unfamiliar with the IoT, but exploring and piloting use cases. Focused on finding the best business and technology models.
3. Already have connected things in a basic capacity but want to explore moving to greater levels of value.
4. Leaders and drivers of IoT technologies and solutions. These enterprises are utilizing IoT to generate new revenue streams (mostly services) and achieve efficiency benefits.

The adoption of IoT and the types of architectures used vary in each of these enterprise categories and by industry. The dropping costs of technology, large number of vendors and ease of experimentation push implementation forward. Yet, security concerns and the lack of standards and business models still limit IoT adoption. Regardless, few companies have achieved the fourth or even the third level. We see no sign of a slowdown in hype and have left the position unchanged at the peak.

User Advice: **CIOs:**

- Continue to identify ways in which you can gain value from IoT. Communicate the business value of IoT such as new revenue or cost reductions to the CEO and the board. Influence your CEO and CFO to work with external consultants if necessary. Work on aligning IT with OT resources, processes and people.
- Ensure the architecture teams are ready to incorporate IoT entities at all levels.
- Look for standards in areas such as wireless protocols and data integration to make better IoT technology investments. Take part in relevant standards initiatives where possible.

Product managers:

- Experiment and work out the benefits to you and customers in having your products Internet-enabled. Carefully analyze the possibilities of creating service revenue in product-centric businesses.
- Start talking with your partners, and seek out new partners to help your enterprise pursue IoT opportunities.

Strategic planners and innovation program leaders:

- Experiment and look to other industries as sources for innovative uses of the IoT. Work with others in the organization to prototype concepts for discussion and exploration purposes.

Information management:

- Increase your knowledge and capabilities with big data. The IoT will produce two challenges with information: volume and velocity. Knowing how to handle large volumes and/or real-time data cost-effectively is a requirement for the IoT.

Information security managers:

- Assign one or more individuals on your security team to fully understand the magnitude of how the IoT will need to be managed and controlled. Have them work with their OT counterparts on security.

Directors of integration:

- Plan to invest in requisite skills and technology to support tight integration between IoT platforms and various back-end systems — over the life of your IoT projects, you will spend more on the cost of doing back-end system integration than on the IoT platform itself.

Business Impact: The IoT has broad applications for enterprises and consumers. Connected things will help drive revenue, lower costs, and improve enterprise processes and asset utilization in one of, or a mix of, these usage scenarios:

- **Manage —** Monitor and optimize. For example, sensors on an asset can help to maximize the utilization and increase uptime.
- **Charge —** Monetization on a pay-per-use basis. For example, car insurance business models based on mileage and improved risk profile assessment based on sensor measurements.
- **Operate —** Remotely operate things to avoid the need to go on-site. For example, field assets such as valves can be controlled remotely.
- **Extend —** Extend with digital services such as content, upgrades and new functionality. For example, connected healthcare equipment can receive software upgrades that improve functionality.

- **Experience —** Customer experience and service can be enhanced. For example, sensing the status of a customer's product, or detecting customer proximity, creates the ability to provide services such as promotions, advertising, authentication and payment.

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Atos; Bosch; Cisco; GE; IBM; Infosys; Microsoft; PTC; Tech Mahindra

Recommended Reading:

"Best Practices in Exploring and Understanding the Full Scope of IoT Solutions"

"The Internet of Things and Related Definitions"

Speech-to-Speech Translation

Analysis By: Magnus Revang

Definition: Speech-to-speech translation involves translating one spoken language into another. It combines speech recognition, machine translation and text-to-speech technology.

Position and Adoption Speed Justification: Speech-to-speech translation entails three steps: converting speech into text, translating text, and converting text to speech. In effect, anything that may be converted to text may be translated. Microsoft Skype is beta testing speech-to-speech translation of dialogue between a selection of languages.

While there has been little adoption of the technology by enterprises to date, due to accuracy limitations and response times, the availability of low-cost consumer products may drive interest and progress for higher-end applications. We continue to anticipate rising hype and capabilities during the next two years, and a growing breadth of applicability during the next five years.

Vendors can build on their investments in speech recognition to create a translation system that can be used to support dialogue.

User Advice: Do not view automated translation as a replacement for human translation but, rather, see it as a way to deliver approximate translations for limited dialogues in which no human translation capability is available. Evaluate whether low-cost consumer products can help during business travel or first-responder situations. Leading-edge organizations can work with vendors and labs to develop custom systems for constrained tasks.

Business Impact: Consumer mobile applications are the first to attract significant interest. Potential enterprise applications include on-site interactions for fieldworkers, as well as government security and emergency and social service interactions with the public. In the U.N. General Assembly, more than 20 languages are spoken, and the yearly meeting transcription fees are significant — finding ways to automate that would provide welcomed cost relief.

Speech-to-speech translators can help improve the social interaction between foreign soldiers and local inhabitants in the urban settings of modern-day theaters of war. In the longer term, multinational call centers and internal communications in multinational corporations will benefit, particularly for routine interactions. However, internal collaborative applications may be limited because strong team relationships will unlikely be forged, if the only way to communicate is through automated translation.

Benefit Rating: Moderate

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Cellictica; Facebook; Google; IBM; Microsoft; Philips; Science Applications International Corp.; SpeechTrans

Machine Learning

Analysis By: Alexander Linden; Lisa Kart

Definition: Machine learning is a discipline that provides computers with the ability to learn from data without being explicitly programmed. Supervised learning aims at learning classifications or estimations, whereas unsupervised learning aims to extract anomalies, patterns and relationships from data via methods such as clustering, dimensionality reduction and density estimation.

Position and Adoption Speed Justification: As a three-to-four-decade-old discipline, machine learning (ML) is at the forefront of technology priorities, given its amazing range of business impact. Predictive analytics, ensemble techniques and deep learning — all either part of or strongly driven by ML — are also experiencing hype. The drivers for continued growth and adoption are the upcoming surges in data volume and complexities that conventional engineering approaches are increasingly unable to handle.

User Advice: As the number of sensors, devices and customer interaction points increase and result in surging datasets, machine learning must be considered not only as an alternative approach to traditional engineering, but also as an integral future component in modern engineering disciplines. Most data-intensive industries would be well advised to develop deeper in-house skills and, in certain cases, even start building networks to local and international experts.

Business Impact: Machine learning drives improvements and new solutions to business problems across a vast array of business and social scenarios:

- Automation
- Drug research
- Customer relationship management
- Supply chain optimization

- Predictive maintenance
- Operational effectiveness
- Workforce effectiveness
- Fraud detection
- Automated vehicles
- Resource optimization

The more complex the problem, the more likely that monitoring and control of it cannot be effectively mastered by even the smartest engineers. In the future, necessary advances in transportation, energy, medicine and manufacturing will not be possible without machine learning.

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Alpine Data Labs; Angoss; BigML; FICO; GE Intelligent Platforms; H2O; IBM; KNIME; Microsoft; SAP; SAS

Recommended Reading:

"Magic Quadrant for Advanced Analytics Platforms"

"Machine Learning Drives Digital Business"

"Cool Vendors in Data Science, 2015"

Wearables

Analysis By: Angela McIntyre

Definition: Wearables are electronics designed to be worn on the body and are the interface between humans and computing. They may sense the human body or the environment around the wearer and transmit the information to a smartphone, a connected home gateway or the cloud. Examples of wearable electronics are smartwatches, smart garments, wristbands, sensors on the skin and headsets.

Position and Adoption Speed Justification: This past year saw the hype on wearables reach the Peak of Inflated Expectations and become tempered with realism about the value consumers and businesses perceive in new wearable devices. Today, data collected from wearable sensors yields insights that are marginally useful to wearers and businesses. Apps and algorithms that can interpret data from wearable sensors are needed to increase the usefulness of recommendations. Apps on smartphones are enabling new capabilities and insights from wearables.

Yet interest in wearables remains high, and Apple, Google and others are fostering ecosystems expected to gain traction. Apple Watch may spur interest in smartwatches among mainstream consumers. Android Wear will enable a consistent user interface across different brands and types of wearables and increase the use of voice user input.

Wearables will enable services to become more personalized to the preferences and needs of the user through contextual information and bio-data gathered through wearable electronics. Similarly, wearable devices will serve as controllers for other devices in the Internet of Things. For example, consumers with Nest thermostats can control them remotely through Google Glass. Similarly, the Pebble smartwatch can take a photo with the GoPro camera and start a car engine remotely. Workers can update the information management systems in factories with voice commands or video through smartglasses.

User Advice: Explore longer-range opportunities for always-on information access through smartglasses or smartwatches through voice input and video, but evaluate risks before heavily investing. Create policies around personal privacy, especially for collecting personal data and taking pictures of others without permission.

Enable people to be healthier through participation in employer wellness programs, healthcare providers and insurance companies that include incentives for sharing data through wearable fitness trackers. The general health of the consumer or employee can be measured with wearables, including body temperature, exercise, heart rate and heart rate variability (stress).

Invest now in deployments or pilots for wearable user interfaces in the enterprise. Start with wearables for mobile workers who cannot conveniently put aside what they have in their hands to use a phone or tablet or who need to keep their heads up or to hold on for safety. Provide remote expert help through wearable cameras to employees repairing industrial equipment to reduce downtime.

Where time-motion efficiency is essential to productivity, such as in call centers and logistics organizations, employers are investigating wearables, such as gaze tracking through audio headsets and showing tasks on head-mounted displays (HMDs). Conduct a cost-benefit analysis, especially before developing custom solutions for lower-paid workers in cost-sensitive roles.

Business Impact: Early industries to adopt wearable electronics are aerospace and police, followed by sports, manufacturing, logistics, transportation, field service, oil and gas, retail and healthcare. The healthcare market stands to benefit from wearable user interfaces that enable mobile health monitoring, especially for heart conditions. Wearable cameras are ready for deployment now for use cases such as police/security and inspections. Field service and manufacturing are using streaming video to an expert who sees what the wearer sees, which is useful for training or expert assistance. Sports is using wearables on players for an "in-the-game" perspective in tracking the performance of athletes. Augmented reality solutions on HMDs have the promise to increase productivity by providing part labels, checklists, maps and instructions superimposed on real-world views.

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Aliph; Apple; Eleksen; Epson; Eurotech; Fitbit; FitLinxx; General Dynamics Itronix; Google; Kopin; LXE; Microsoft; Motorola; Oculus VR; Pebble; Plantronics; Recon Instruments; Samsung; Sony; Vuzix

Recommended Reading:

"Cool Vendors in Wearable Electronics, 2015"

"Forecast: Internet of Things, Endpoints and Associated Services, Worldwide, 2014"

"Innovation Insight: Smartglasses Bring Innovation to Workplace Efficiency"

"Market Trends: Enter the Wearable Electronics Market With Products for the Quantified Self"

"Forecast: Wearable Electronic Devices for Fitness, Worldwide, 2014"

Cryptocurrencies

Analysis By: David Furlonger; Ray Valdes

Definition: Cryptocurrencies are a subset of the larger category of digital currency — virtual money — that is created by private entities without the backing of governments, transacted using digital mediums (usually relying on a peer-to-peer network of nodes, rather than centralized server). bitcoin was the first to appear in the cohort of cryptocurrencies, and remains the most prominent example. Some cryptocurrencies leverage the bitcoin technology stack, while others implement their own due to perceived limitations of the core bitcoin stack.

Position and Adoption Speed Justification: Despite the launch of bitcoin in January 2009, cryptocurrencies are still in relatively early stages of adoption, representing a minuscule fraction of a percentage of global economic transactions. bitcoin has known limitations (primarily around scalability, but also scope). These limitations are being addressed by extensions to bitcoin protocols (such as the "sidechain" mechanism, profiled elsewhere in this Hype Cycle), and by competing cryptocurrencies (altcoins) that layer on top of bitcoin or seek to replace it with an entirely new technology stack. It is not yet clear which of the more than 400 alternatives will prevail over the long term, despite the early (and ongoing) dominance of bitcoin.

The characteristics that most cryptocurrencies share are decentralized, peer-to-peer, and a reliance on cryptographic mechanisms for transaction identity, generation of new value and exchange of value. There is potential for a disruptive effect on established financial systems, but significant challenges remain.

Although cryptocurrencies are potentially very secure (transactions can be readily verified, but impossible to defraud), they also carry significant issues that undermine the principles of money as a store of value, unit of account and medium of exchange:

- Questionable governance and transparency

- Lack of regulation and the threat of misdirected regulation
- Complicated generation/issuance
- Limited ubiquity
- Limited usability
- Limited exchangeability
- Mixed speed of exchange acceptability and authorization
- Concerns about their use in potentially illegal activities
- Data storage requirements
- Computer network stability and topology of peer-to-peer network
- Market stability

Despite these issues, there are, on the other hand, driving factors behind the adoption of cryptocurrencies. These include the cost, complexity and inflexibility of established payment mechanisms and financial systems, and (in some geographic regions) the lack of trust in centralized financial institutions. During the next five to 10 years, currencies will increasingly be used for specific customer use cases. Not one currency will dominate the market.

User Advice:

- Monitor the development of cryptocurrencies to assess the likelihood of customer adoption and usage.
- Discuss with customers the perceived value proposition for their use of these currencies to better inform the development of products, loyalty schemes and partnerships.
- Discuss with regulators their supervision and monitoring of cryptocurrencies as part of the global financial marketplace, and their impact on regulation and compliance.
- Assess employee use of these currencies to protect against operational risk in the event of unintended compliance problems.
- Plan (technology and business roadmaps) for the potential integration of cryptocurrencies with mainstream mediums of exchange — for example, review changes to execution and risk systems.

Business Impact: The impact for the financial services industry is gathering momentum as senior executives recognize the threats (e.g., to their payment franchises as well as the potential for new revenue capture via the creation of new value streams). The niche use of cryptocurrencies creates customer use cases that identify different customer behaviors offering insight into future mainstream B2C interactions. CIOs must conduct proofs of concepts to better understand the nature of these use cases, as well as uncovering the potential for different offerings in the form of information and security brokerage, trusted advisory services, payment gateways, etc.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Recommended Reading:

"The Future of Money Is the Programmable Economy, Not Just Bitcoin"

"Maverick* Research: In a Post-Bitcoin World, Metacoin Platforms Enable the Programmable Economy"

"Future of Money: Using Cloud Capacity as a Currency"

"The Nexus of Forces Is Reshaping the Future of Money"

Sliding Into the Trough

Consumer 3D Printing

Analysis By: Pete Basiliere; Nick Jones

Definition: Consumer 3D printing is the market for devices that are typically used in the home by family members, as well as prosumers. The 3D printers are generally based on low-cost material extrusion technology that are in the $500-to-$1,000 price band but can range up to $2,500.

Position and Adoption Speed Justification: 3D printing by consumers is an emerging market. A sign of the market's growth is the large number of startups and large manufacturers around the world that are bringing sub-$1,000 printers to market. Interestingly, the major 2D printer manufacturers continue on the sidelines, mainly conducting research or providing OEM capabilities to third parties.

For many consumers, however, do-it-yourself kits to build a 3D printer costing a few hundred dollars are too much trouble, while assembled 3D printers costing up to $2,500 are too expensive. However, for general consumers, who inevitably compare the cost of a 3D printer with the $100 to $250 they may spend on a 2D printer, the price is too rich. While a wide range of rudimentary 3D printers that extrude plastic material is on the market, some with price points in the $500 range, even these are too expensive for general consumer use, especially when the cost to license or purchase 3D creation software tools is factored into the purchase. As a result, the dominant near-term consumer use of 3D printing will be the purchase of items whether made by an artist, sold by a consumer goods company or available through an online service bureau.

User Advice: Retailers must test selling 3D printers in their physical and online stores. Successful consumer use of 3D printers requires an ecosystem — software, materials and printer — that is more complex than that associated with 2D printing on paper. Retailers need to think carefully about how they will support this technology with the customer service basics — essential things that a

customer expects when shopping with the retailer, such as stock availability, warranties and postsale service and support.

Physical and online retailers must also explore the use of 3D printing by experimenting with low-volume manufacturing of high-margin, custom-designed pieces — for example, fashion jewelry and eyeglass frames — sold through in-store kiosks and hassle-free Web-based service bureaus. In both cases, market studies must determine the materials that consumers prefer and the price points they are willing to meet.

Business Impact: The hype in the general press has heightened consumer awareness of the technology and curiosity about printing custom-designed items, ranging from jewelry to prostheses to weaponry, at home. Retailers selling 3D printers or items produced with 3D printers must investigate the legal implications of customers using devices sold by them to manufacture potentially lethal weapons, and they must take steps to ensure that 3D-printed items made per their customers' orders comply with local copyright and related laws.

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Sample Vendors: 3D Systems; Afinia; Beijing Tiertime Technology; Flux; Magicfirm; Stratasys; Ultimaker; XYZprinting

Recommended Reading:

"Cool Vendors in 3D Printing, 2015"

"3D Printer Market Survey Reveals Enterprise Demand Drivers for Technology, Printer and Vendor Decision Making"

"Forecast: 3D Printers, Worldwide, 2014"

Natural-Language Question Answering

Analysis By: Tuong Huy Nguyen; Whit Andrews

Definition: Natural-language question answering (NLQA) technology is composed of applications that provide users with a means of asking a question in plain language. A computer or service can answer it meaningfully, while maintaining the flow of interaction.

Position and Adoption Speed Justification: Nonconversational, information-centered answers are already possible (for example, through Cortana, Google Now and Siri). However, the ability to conduct even a brief conversation — with context, antecedent development and retention, and relevancy to individual users — is in its infancy. The challenges in effective interpretation of idiomatic interrogative speech, matching it to knowledge bases of potentially infinite scope, and the

selection of a limited number of answers (even just one) remain profoundly difficult. More than five years will pass before such capabilities are commonplace.

Adjacent technologies are providing NLQA with strong momentum. Cortana is expected to be integrated in Windows 10 for desktops, is currently integrated in more than 500 apps and can also integrate with universal Windows apps. Google Now has enabled custom voice actions for third-party apps (currently limited to partners). Siri is now using its own Web crawler (Applebot) and is rumored to get an aesthetic redesign in iOS 9. Baidu has hired noted artificial intelligence pioneer Andrew Ng. He is charged with overseeing the new R&D facility in Silicon Valley, aimed at expanding the company's capabilities around natural-language processing and human-machine interfaces, including voice recognition, semantic intelligence and machine translations. As such, we've moved the profile significantly past the peak.

User Advice: NLQA is a distinct component among a broader set of technologies that enable smart advisors and virtual personal assistants. As such, it's positioned to be a strong enabler of these and other technologies, such as cognitive computing and speech recognition. Furthermore, it can serve as a two-way steppingstone toward building an effective NLQA system.

The computing power required to accomplish a genuinely effective "trivia competitor" is expensive but will become less so with time. Any projects founded on such facility must be experimental but in the foreseeable future will include diagnostic applications of many kinds, as well as commercial advice and merchandising and strategic or tactical decision support. "Augmentation" of human activity and decision making is the key thought. No decision support application comes, fully formed, from nothing — it will be expert humans who build it, design the parameters and develop the interface. Humans will, similarly, evaluate its advice and decide how to proceed. A good idea is to begin with experimental technologies, such as chatbots, and to work toward more sophisticated technologies as they become commercially accessible.

Business Impact: Ultimately, the ability for line workers or unschooled consumers to achieve effective responses from machines without using expertise in framing queries will generate new kinds of information exploitation by diminishing information friction yet more. Given a limited set of answers and an effective means of capturing plain language requests, it is easy to see computers more effectively providing guidance in various environments. Business use cases include diagnostic support in healthcare (whether for expert or nonexpert users), customer care and call center, and consumer services (such as those that Siri provides).

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Sample Vendors: Apple; Cognitive Code; EasyAsk; Expect Labs; HP; IBM Watson; Microsoft; Nuance; Sherpa Software; Vlingo; Wolfram Research; [24]7

Recommended Reading:

"Emerging Technology Analysis: Natural-Language Question Answering"

"Siri and Watson Will Drive Desire for Deeper and Smarter Search"

Hybrid Cloud Computing

Analysis By: Donna Scott; David W. Cearley

Definition: Hybrid cloud computing is the coordinated use of cloud services across provider boundaries among public, private and community cloud service providers. Like a cloud computing service, a hybrid cloud computing service is scalable, elastic, has self-service interfaces and is delivered as a shared service using Internet technologies. Hybrid cloud computing implies significant integration between the internal and external (or two or more external) environments at the data, process, management or security layers.

Position and Adoption Speed Justification: Hybrid cloud offers enterprises the best of both worlds — the cost optimization, agility, flexibility, scalability and elasticity benefits of public cloud in conjunction with the control, compliance, security and reliability of private cloud. As a result, virtually all enterprises have a desire to augment internal IT systems with external cloud services. Hybrid cloud takes a number of forms including service integration, availability/disaster recovery, cross-service security, policy-based workload placement and runtime optimization, and cloud service composition and dynamic execution (for example, cloudbursting).

While most organizations are integrating applications and services across service boundaries, we estimate approximately 10% to 15% of large enterprises have implemented hybrid cloud computing beyond this basic approach — and or relatively few services. This declines to less than 10% for midsize enterprises, which mostly are implementing the availability/disaster recovery use case. While most companies will use some form of hybrid cloud computing during the next three years, more advanced approaches lack maturity and suffer from significant setup and operational complexity. Positioning on the Hype Cycle advances toward the Trough of Disillusionment as organizations continue to gain experience in designing cloud-native and optimized services, and seek to optimize their spending across on-premises and off-premises cloud services.

User Advice: When using multiple external cloud computing services, establish security, management and governance guidelines and standards to coordinate the use of these services with internal applications and services to form a hybrid environment. Approach sophisticated cloudbursting and dynamic execution cautiously, because these are the least mature and most problematic hybrid approaches. To encourage experimentation and cost savings, and to prevent inappropriately risky implementations, create guidelines/policies on the appropriate use of the different hybrid cloud models. Coordinate hybrid cloud services with noncloud applications and infrastructure to support a hybrid IT model. Consider cloud management platforms, which implement and enforce policies related to cloud services.

Business Impact: Hybrid cloud services enable an enterprise to scale beyond its data centers to take advantage of the elasticity of the public cloud — and, therefore, it is transformational when implemented because changing business requirements drive the optimum use of private and public cloud resources. This ideal approach offers the best-possible economic model and maximum agility. It also sets the stage for new ways for enterprises to work with suppliers and partners (B2B), and

customers (business-to-consumer), as these constituencies also move toward a hybrid cloud computing model.

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: BMC Software; HP; IBM; Microsoft; OpenStack; RightScale; VMware

Recommended Reading:

"How to Prepare Your Network for Private and Hybrid Cloud Computing"

"Exploring Cloud Management Trends and Actions to Take"

"Solution Path: Implementing a Hybrid Strategy for Cloud Integration"

"Is Your Colocation Provider Cloud-Enabling or a Cloud Impediment?"

Augmented Reality

Analysis By: Tuong Huy Nguyen; CK Lu

Definition: Augmented reality (AR) is the real-time use of information in the form of text, graphics, audio and other virtual enhancements integrated with real-world objects and presented using a head-mounted-type display or projected graphics overlays. It is this "real world" element that differentiates AR from virtual reality. AR aims to enhance users' interaction with the environment, rather than separating them from it.

Position and Adoption Speed Justification: Interest and adoption continues to move this technology steadily forward. Therefore, we have moved it three positions ahead on the hype curve. Current technology is best-suited for purpose-built, specialized solutions. As such, position and adoption speed will vary by vertical and industry. This profile represents a homogenized view of AR implementations across market segments.

Market interest and innovation are moving in a positive direction. For example, at South by Southwest (SXSW) 2015, Blippar announced plans to extend its visual identification capabilities into a visual search tool that will eventually identify *all* real-world objects (regardless of a pre-existing partnership with the product/brand). The app will initially focus on entertainment (movies, DVDs), key top brands, fruits and dogs.

Furthermore, developments and announcements from leading IT vendors (such as Intel, Google, Facebook and Amazon) serve as a two-way steppingstone for AR development. Advancements in head-up display hardware will provide more compelling hands-free use cases for AR, as well.

User Advice: Decide on the audience for your AR solution. Internal- and external-facing solutions are not transposable. Restrict initial trials to a specific task or goal. Set benchmarks against

unaugmented solutions to understand risks and benefits. Set the business goal for your AR implementation before choosing a provider. Rich and robust offerings can bring value only if you have a clear intention for the deployment. For external-facing implementations, use AR as an extension of your brand and experience. For internal-facing implementations, use AR as a tool that will enhance employee job function (for example, delivering context-specific information at the point of need for mobile workers, or enhancing business processes via AR-based training and instruction).

Business Impact: By leveraging device sensors, AR acts as a digital extension of the users' senses, and it serves as an interface for humans to the physical world. It provides a digital filter to enhance the user's surroundings with relevant, interesting and/or actionable information.

AR bridges the digital and physical world. This has an impact on both internal- and external-facing solutions. For example, internally, AR can provide value by enhancing training, maintenance and collaboration efforts. Externally, it offers brands, retailers and marketers the ability to seamlessly combine physical campaigns with their digital assets.

As such, AR is broadly applicable across many markets, including, but not limited to: retail, marketing, mining, engineering, construction, energy and utility, automotive, logistics, manufacturing, healthcare, education, customer support, and field service.

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Adolescent

Sample Vendors: Blippar; Catchoom; Daqri; Google; Metaio; Nokia; Qualcomm; Total Immersion; Wikitude; Zugara

Recommended Reading:

"What Product Developers Need to Know About New Sensing and Recognition Capabilities in Augmented Reality"

"Market Guide for Augmented Reality"

Cryptocurrency Exchange

Analysis By: Ray Valdes; David Furlonger

Definition: A cryptocurrency exchange is an online service that provides for the exchange of currencies, usually from cryptocurrency such as bitcoin to national currencies or to other cryptocurrencies. Users maintain accounts in an exchange, and the funds can be submitted and withdrawn through bitcoin transfers, bank wires or possibly credit card payments.

Position and Adoption Speed Justification: Cryptocurrency exchanges comprise the means by which the average person can participate in the digital currency economy. They are still in the early stages of adoption.

Each exchange establishes a market in a cryptocurrency, with prices for buy and sell orders that depend on the demand and activity in that market. These prices roughly correspond, but not exactly, to prices in other exchanges, similar to other exchanges, leading to opportunities for arbitrage across exchanges. Because volumes are small, there is the possibility of market manipulation within an exchange and across exchanges, especially when there is a spike in speculative activity.

Exchanges play an important role in facilitating the cryptocurrency user experience, especially when combined with an online digital wallet. The process of using bitcoin is cumbersome enough, even with these mechanisms. But without them, the adoption rate of bitcoin and other cryptocurrencies would be much lower.

User Advice: Use cryptocurrency exchanges as a means for facilitating transactions with bitcoin and other cryptocurrencies, and for converting to and from national fiat currencies. However, do not keep your entire cryptocurrency asset base in any one exchange. Consider exchange-based assets to be at risk, and manage the risk by using multiple exchanges and keeping the majority of your assets offline.

Business Impact: Cryptocurrency exchanges form an essential part of the ecosystem for bitcoin and other cryptocurrencies. They are mostly decoupled from the global financial system at present. Going forward, we can expect greater integration of cryptocurrency markets and exchanges with traditional exchanges. In May 2015, the NYSE announced a bitcoin price index (NYXBT) that reflects data from the bitcoin Coinbase Exchange (an exchange in which NYSE is minority investor).

Benefit Rating: Moderate

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Recommended Reading:

"Hype Cycle for the Future of Money, 2014"

"Maverick* Research: In a Post-Bitcoin World, Metacoin Platforms Enable the Programmable Economy"

"The Future of Money Is the Programmable Economy, Not Just Bitcoin"

Autonomous Field Vehicles

Analysis By: Rich McAvey

Definition: Autonomous field vehicles (AFVs) are unmanned marine, air or ground platforms that can be configured to bring a wide variety of sensor payloads to remote locations. Depending on their mission, they can be deployed to hold a stationary position, follow a predefined route or patrol freely within geographic boundaries.

Position and Adoption Speed Justification: Oil and gas companies continued to undertake operations in extreme environments, such as the sea floor, the Arctic and jungles. As they do, de-manning operations continues to rise as a top business priority to improve safety and reduce costs. Accordingly, oil and gas companies are turning to remote operations and AFVs to perform certain operational functions in areas that were previously off limits.

Unmanned marine vehicles are the most common AFV. They are very versatile and can conduct many missions, such as patrolling routes around rigs, holding a fixed position to create a communications link between subsea acoustic modems and satellite digital communications, or freely traversing within geographic boundaries to search for natural hydrocarbon seeps. Unmanned aerial vehicles are rising in popularity and are conducting an expanding range of missions, such as inspecting dangerous sites or monitoring site conditions. Unmanned trucks and transporters, which are extensively used in other industries such as mining, are, so far, not widely used in upstream oil and gas.

The market for AFV for oil and gas use consists mostly of specialized vendors, each providing vehicles, support infrastructure and services. AFV adoption typically takes the form of an isolated, bundled service from a specialized vendor such as an oil field service (OFS) vendor. These vendors provide a bundled service that includes the AFV lease, field-to-corporate network connections, data management and analytic capabilities. Accordingly, most early adoption decisions are being made by business/engineering managers, often outside the purview of IT.

User Advice: AFVs are an important form of smart machines for the industry, and their use will grow substantially very quickly. The combination of a long mission duration and a flexible configuration of sensor payloads marks a significant step beyond alternative sensor deployment options, like fixed stations, manned vessels or satellite imagery. Business pressure to increase operations in extreme environments means that IT departments will be pressed to move quickly to integrate AFV systems and data where and when business managers adopt them.

Accordingly, forward-thinking CIOs should begin preparations early in order to move at the pace required by business asset teams. Early steps should include assessments of technical architecture, security strategies and data management policies, as well as the design of analysis platforms and cross-company collaboration solutions. In addition, governance policies, processes and standards will likely require significant revision to orchestrate the manifold aspects of managing AFVs without generating excessive operational, legal or regulatory risk. As AFVs become integral components of the field operating landscape, upstream companies need to integrate them with other business, IT and OT systems.

Business Impact: Monitoring extreme operating environments and efficiently conducting high-risk equipment inspections are becoming increasingly important for oil and gas companies. AFVs are smart machines that provide operational transparency in extreme environments.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Early mainstream

Sample Vendors: AeroVironment; Liquid Robotics; Monterey Bay Aquarium Research Institute; Scripps Institution of Oceanography; Sky-Futures

Virtual Reality

Analysis By: Brian Blau

Definition: Virtual reality (VR) provides a computer-generated 3D environment that surrounds a user and responds to an individual's actions in a natural way, usually through immersive head-mounted displays (HMDs). Gesture recognition provides hand and body tracking, and haptic (or touch-sensitive) feedback may be incorporated. Room-based systems provide a 3D experience for multiple participants; however, they are more limited in interaction capabilities.

Position and Adoption Speed Justification: Virtual reality is used in high-end simulation and training applications, including military simulation and training like flight simulators, truck operator training in specialized environments (such as mines), and accident investigation in several industries. It is also used in scientific visualization and modeling, including geomodeling in the oil industry and genome mapping, as well as for product design, where VR systems are used to experience automobile or equipment design.

Entertainment-based VR that uses immersive and interactive storytelling techniques could disrupt major markets by creating new types of entertainment experiences and user interfaces versus the traditional movie theater and television flat screen approach that has been the norm since movies were invented more than 100 years ago. Medical professionals will use VR for telepresence doctoring or even remote surgery. Immersive military applications are more advanced than other types of VR, and the time to plateau of five to 10 years is consistent with adoption in the consumer and more traditional consumer-like usage for businesses.

VR experiences are typically used with HMDs. The most well-known is the Oculus Rift, but others such as Sony's Project Morpheus or even Microsoft's HoloLens will be the display devices for virtual worlds. These HMD devices will be available starting in late 2015 and into 2016.

User Advice: While VR can be amazingly sophisticated, the level of customization can come at a high cost. Recent advances in HMD technologies may help ease these obstacles, so developers should focus on building effective and quality experiences. Standards for artificial intelligence scripting, object metadata and social identity data are becoming more popular due to the increased use of personal and social networking technologies, which will help developers make VR more personalized and intelligent. Technologies like cloud graphics processing and mobile video games, as well as the proliferation of broadband access, will allow application developers to integrate VR more easily into their products.

VR developers should consider targeting immersive video game development, interactive movies, live immersive experiences, or mission-critical training and simulation activities because it can offer higher degrees of fidelity than simple screen-based systems. Businesses should consider VR for exploring design issues in the early stages of decision making for high-cost products or architectural designs.

Business Impact: Virtual reality can support a wide variety of simulation and training applications, including rehearsals and response to events. VR can also shorten design cycles through immersive collaboration, and enhance the user interface experience for scientific visualization, education and entertainment.

Benefit Rating: Moderate

Market Penetration: 1% to 5% of target audience

Maturity: Adolescent

Sample Vendors: Barco; Digital ArtForms; Mechdyne; NextVR; Oculus VR; Presagis; Sony; Valve; Virtual Heroes; WorldViz

Recommended Reading:

"Market Trend: Head-Mounted Displays for Virtual Reality and Augmented Reality"

"Innovation Insight: Augmented Reality Will Become an Important Workplace Tool"

"Cool Vendors in Human-Machine Interface, 2015"

Climbing the Slope

Gesture Control

Analysis By: Fernando Elizalde

Definition: Gesture control is the ability to recognize and interpret movements of the human body to interact with and control a computer system without direct physical contact.

Position and Adoption Speed Justification: The broad proliferation of forward-facing video cameras on devices has accelerated gesture recognition adoption in a broad range of business and personal applications. In multiuser environments or where more accuracy is required, assisted gesture control — which makes use of additional physical objects (such as gloves and wands with inertial sensors) — can enhance the interpretation or resolution of detectable movements.

Simultaneously, alternative sensing technologies are being commercialized (such as the Leap Motion Controller) offering submillimeter discrimination within a limited, or desktop-size, zone. The limitation in screen size of tablets and large-screen smartphones, as well as the emergence of "hover and swipe" rather than the existing "touch and swipe," may enable a richer set of commands

and applications for these devices. The most recent development is the explosion of wearable devices, where gestural movements recognized by video or by inertial sensors play a key role in the user interface. Still to come is the likelihood of gesture control playing a key role in controlling autonomous devices (such as robots) in a mixed human/robot workplace environment.

A market-defined "language" of universally recognized gestures (similar to what has happened in the multitouch area) will emerge to form the base from which more specialized control can be developed.

User Advice: Composite interfaces (combining gesture, movement, facial and voice recognition) can create a rich, immersive and intuitive interface to deliver new capabilities in very competitive environments. Emerging specific business applications include in-store virtual mirrors, which use gesture control to enable users to select garments and see them superimposed on their bodies, and remote physiotherapy, fitness and well-being applications. The ability to interact from a distance or behind a window opens up applications in digital signage, banking and other areas.

In the near-term and midterm future, we anticipate an acceleration in the pace of adoption. The growing availability of gesture-controlled devices, the rapidly increasing accuracy of these devices and the growing number of devices requiring control are rendering the traditional control paradigms inappropriate. Gesture control, which allows control from the distant "lean-back zone" to the immediate "lean-in zone" and even the "wearable zone," is looking increasingly likely as the new interaction paradigm.

Gesture control is just one element in a collection of technologies (including voice recognition, facial recognition, location awareness, 3D displays and augmented reality) that combine well to reinvent human-computer interaction, especially around wearable devices. Enterprises should:

- Evaluate handheld and camera-based gesture recognition for potential business applications involving controlling screen displays from a distance
- Evaluate wearable devices to see where they may be employed to enable new modes of interaction
- Evaluate the emerging generation of desktop-oriented devices, and consider what role they may play in the "lean-in" operating zone
- Consider how these may be combined with location-based information and augmented-reality displays

Business Impact: The ability to interact and control without physical contact frees the user and opens up a range of intuitive interaction opportunities, including the ability to control devices and large screens from a distance. For smaller desktop, handheld and wearable devices, the ability to control the device without physical contact opens up valuable possibilities in a variety of markets, but especially in healthcare applications (where physical contact may result in the transfer of infectious material). Gesture control also benefits the design aesthetics of touch-based devices, allowing users to avoid unsightly fingerprints on their devices.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Early mainstream

Sample Vendors: Apple; Atheer Labs; eyeSight; Elliptic Labs; GestureTek; Google; Gyration; iNUI Studio; Leap Motion; Microsoft; Nintendo; Oblong; SoftKinetic; Sony

Enterprise 3D Printing

Analysis By: Pete Basiliere

Definition: Enterprise 3D printing refers to the application of 3D printers for product design, development and prototyping, as well as their use in manufacturing processes to produce finished goods.

Position and Adoption Speed Justification: 3D printing technologies have been available for product prototyping and short-run parts manufacturing for almost 30 years. Yet enterprise 3D printing is still an adolescent market, at the low end of the 5%-to-20% market penetration range, and is characterized by evolving technology capabilities, methodologies and associated infrastructure workflows. More and more manufacturers are seriously considering, and in some cases are already using, 3D printing of new and replacement parts. If printing parts is not possible, then the use of 3D printing to produce factory tools, jigs and fixtures can still make an enterprise's manufacturing operations more cost-effective and responsive.

While the range of materials that can be 3D printed is narrow and slowly expanding, enterprises are evaluating the "cross-over point" when the total cost of long-run, traditionally manufactured parts is less than the total cost of short-run 3D printing of the same items. The available material range, finished-part quality and total cost including postprocessing all factor into an enterprise's decision whether to use 3D printing. So, too, does the fact that innovative new designs with unusual or complex geometry that can only be produced with 3D printing are now possible.

Applications of 3D printing abound across many industries, whether the parts are produced with an in-house printer or through a 3D print service bureau. The aerospace and automobile industries were early adopters of 3D printing. Dental appliance and hearing aid manufacturers, which came later to the market, are now aggressively using 3D printing to mass-customize their products. Footwear and toy makers have employed 3D printing for prototyping for years but are now also using the technology for short-run, personalized products. Use cases abound, but enterprise user adoption globally remains low.

User Advice: Marketing, engineering and operations management must weigh the trade-offs between 3D-printing new and replacement parts and employing traditional manufacturing approaches. While finished-goods printing may have limited uses in a given enterprise, all organizations must consider the use of 3D printing to create the jigs, fixtures and cutting tools used as part of their traditional manufacturing processes. Similarly, managers who are responsible for service and repairs should consider use of 3D printing to produce replacement parts.

3D printing also opens the market for "repairing" rather than "replacing" items. Not only can vendors create replacement parts for relatively current products, but they can also create parts to replace out-of-stock parts for very old products that otherwise would be discarded and replaced by a new product purchased by the consumer. The lives of older appliances and other household items will be extended, whether used by the original purchaser or by someone who buys the item secondhand and then repairs it.

COOs and staff who are responsible for manufacturing operations must develop a 3D printing strategy that will ensure that the adoption of 3D printing occurs at the point where the quality and cost are better than in traditional manufacturing technologies and practices. More importantly, they must be open to the innovative designs that can be produced only with 3D printing and which may revolutionize their markets.

Business Impact: 3D printing enables innovative designs and new material compounds that offer game-changing products, ones that will not only improve the current product offering but may also dramatically alter it. 3D printing tools, jigs and fixtures can reduce the manufacturing costs for items that are not themselves 3D-printed, improving productivity and quality while making manufacturers more agile.

3D printing of replacement and spare parts can significantly reduce the amount of inventory and warehouse space by enabling long-tail manufacturing of low-volume items. It would also extend the lifetime of products as repairs and upgrades are 3D-printed. 3D printing also makes creation of unique customer products more scalable across many manufacturing industries and facilitates co-creation of products with customers.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: 3D Systems; Concept Laser; EnvisionTEC; EOS; ExOne; Formlabs; Mcor Technologies; Stratasys

Recommended Reading:

"Cool Vendors in 3D Printing, 2015"

"Market Guide for 3D Print Service Bureaus, 2015"

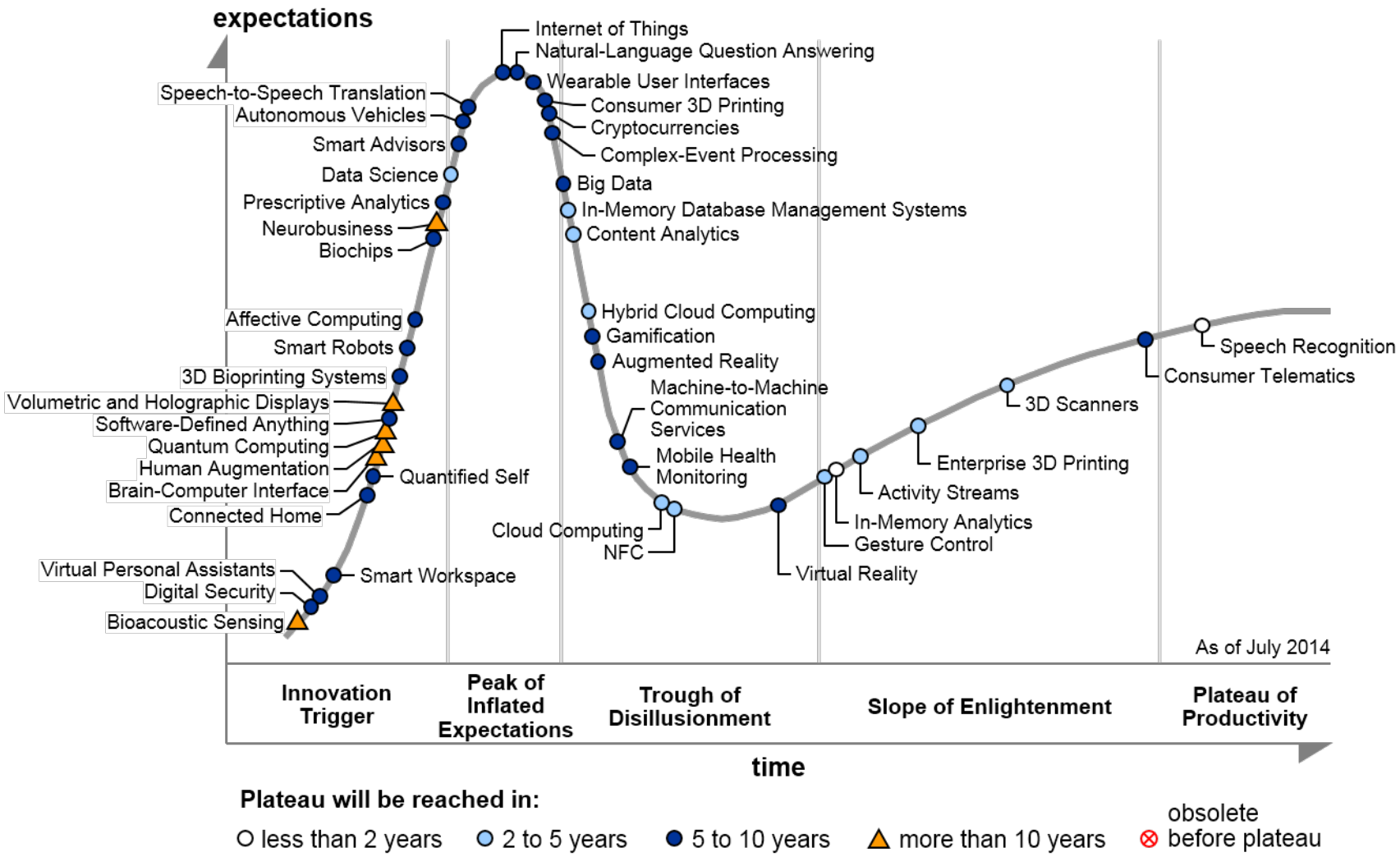
"3D Printer Market Survey Reveals Enterprise Demand Drivers for Technology, Printer and Vendor Decision Making"

"Forecast: 3D Printers, Worldwide, 2014"

"Market Guide for 3D Printing"

Appendixes

Figure 4. Hype Cycle for Emerging Technologies, 2014



Source: Gartner (July 2014)

Hype Cycle Phases, Benefit Ratings and Maturity Levels

Table 1. Hype Cycle Phases

Phase	Definition
Innovation Trigger	A breakthrough, public demonstration, product launch or other event generates significant press and industry interest.
Peak of Inflated Expectations	During this phase of overenthusiasm and unrealistic projections, a flurry of well-publicized activity by technology leaders results in some successes, but more failures, as the technology is pushed to its limits. The only enterprises making money are conference organizers and magazine publishers.
Trough of Disillusionment	Because the technology does not live up to its overinflated expectations, it rapidly becomes unfashionable. Media interest wanes, except for a few cautionary tales.
Slope of Enlightenment	Focused experimentation and solid hard work by an increasingly diverse range of organizations lead to a true understanding of the technology's applicability, risks and benefits. Commercial off-the-shelf methodologies and tools ease the development process.
Plateau of Productivity	The real-world benefits of the technology are demonstrated and accepted. Tools and methodologies are increasingly stable as they enter their second and third generations. Growing numbers of organizations feel comfortable with the reduced level of risk; the rapid growth phase of adoption begins. Approximately 20% of the technology's target audience has adopted or is adopting the technology as it enters this phase.
Years to Mainstream Adoption	The time required for the technology to reach the Plateau of Productivity.

Source: Gartner (July 2015)

Table 2. Benefit Ratings

Benefit Rating	Definition
Transformational	Enables new ways of doing business across industries that will result in major shifts in industry dynamics
High	Enables new ways of performing horizontal or vertical processes that will result in significantly increased revenue or cost savings for an enterprise
Moderate	Provides incremental improvements to established processes that will result in increased revenue or cost savings for an enterprise
Low	Slightly improves processes (for example, improved user experience) that will be difficult to translate into increased revenue or cost savings

Source: Gartner (July 2015)

Table 3. Maturity Levels

Maturity Level	Status	Products/Vendors
Embryonic	■ In labs	■ None
Emerging	■ Commercialization by vendors ■ Pilots and deployments by industry leaders	■ First generation ■ High priceMuch customization
Adolescent	■ Maturing technology capabilities and process understanding ■ Uptake beyond early adopters	■ Second generation ■ Less customization
Early mainstream	■ Proven technology ■ Vendors, technology and adoption rapidly evolving	■ Third generation ■ More out of box ■ Methodologies
Mature mainstream	■ Robust technology ■ Not much evolution in vendors or technology	■ Several dominant vendors
Legacy	■ Not appropriate for new developments ■ Cost of migration constrains replacement	■ Maintenance revenue focus
Obsolete	■ Rarely used	■ Used/resale market only

Source: Gartner (July 2015)

Gartner Recommended Reading

Some documents may not be available as part of your current Gartner subscription.

"Understanding Gartner's Hype Cycles"

More on This Topic

This is part of an in-depth collection of research. See the collection:

- Gartner's Hype Cycles for 2015: Five Megatrends Shift the Computing Landscape

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